Centennial Coal

CLARENCE COLLIERY

Wollangambe River Environmental Monitoring Program Report

March to August 2017

September 2017

Centennial Coal Environment Matters

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1. INTRODUCTION

On 25 September 2015 Clarence Colliery (Clarence), in compliance with Clean Up Action 6 of Clean Up Notice No. 1532719, submitted a Draft Environmental Monitoring Program (EMP) to the NSW Environmental Protection Authority (EPA).

EPA required the EMP be developed in order to be able to obtain information about the recovery of the River after the spill of coal fines on 2 July 2015, and the intent of the EMP was to determine the state of the aquatic ecosystem of the Wollangambe River following the completion of the clean-up activities, with monitoring for a period of time not less than 18 months, concentrating on sections of the River below where coal fines entered the River and downstream for at least 12 kilometres.

Following its review of the Draft EMP, the EPA proposed changes to the program based on the following;

- The importance of sediments in the affected part of the River as the sink for coal fines remaining in the River.
- The need to assess the impact of the coal fines spill for a period of not less than 18 months.
- The confounding factors relating to the impact of the non-spill factors from Clarence, such as the ongoing impact of the mine water discharge and the past accumulation of metals in the sediments of the River.
- The advice of the Greater Blue Mountains World Heritage Area Advisory Committee to Centennial Coal dated 2 December 2015.

A copy of the Revised EMP, dated 5 April 2016) is attached as **Appendix A** to this report. Further detail regarding the implementation of the EMP is including as a Pollution Reduction Program (PRP) within the Clarence Colliery Environment Protection Licence 726 (EPL726), as outlined below:

U1 Wollangambe Environmental Monitoring Program

U1.1 The Licensee must implement the Revised Wollangambe River Environmental Monitoring Program (5 April 2016).

U1.2 The Licensee must commence implementation of the Program in August 2016.

U1.3 The Licensee must provide interim reports in accordance with the Program. The reports must be;

- provided every seven (7) months from 31 August 2016; and
- received by the EPA's Central West (Bathurst) office on the last day of the month each report is due e.g. the first report is to be received on 31 March 2017.

U1.4 The Licensee must provide to the EPA's Central West (Bathurst) office a final report in accordance with the requirements of the Program within two (2) months of the completion of the Program.

This is the second interim report as required under PRP condition U1.3 (due by 31 October 2017) on the implementation and progress of the EMP, and reports on additional monitoring undertaken and completed between March and August 2017.

2. SAMPLING PROGRAM

The revised EMP requires seven sampling locations, two sites upstream of the coal fines spill entry to the river (one upstream and one downstream of the Clarence Colliery LDP2 discharge entry to the river), and five sites downstream of the spill entry site - to include three sites within the section of river where coal fines were found, one site sufficiently further downstream assumed not to be impacted by the spill plus an intermediary site.

Additional site selection criteria included the following:

- Utilise existing river monitoring sites where possible.
- Match site locations to increasing river stream order where possible.

Figure 1 shows the adopted sampling locations along the Wollangambe River. The sites are described as follows:

- *US1 Background upper catchment site (1st order stream).* This site is located at the existing OEH W1 site. It is upstream of the LDP aquatic ecology monitoring site WGRup but it is the LDP WQ1 site and following two seasons of parallel monitoring at sites US1 and WGRup, the US1 site has now been adopted for both this EMP and the LDP aquatic ecology monitoring programs.
- *US2 Between LDP2 entry and spill entry (upper end of 3rd Order stream section).* Located at the existing LDP aquatic ecology monitoring site WGRdown.
- *DS1 One kilometre downstream of spill entry point (half way through 3rd Order stream section).* Located at the existing LDP aquatic ecology monitoring site WGRXdown.
- *DS2 About 3.5km downstream of spill entry point (at the upper end of the 4th Order stream section).*
- *DS2 About 5km downstream of spill entry point (about one quarter way into the 4th Order stream section).*
- *DS4 About 10.6km downstream of spill entry point (about three- quarter way through the 4th Order stream section above the bells Creek confluence at Mount Wilson).*
- *DS5 Around 19km downstream of spill entry point (about 5km into the 5th order stream section), and located just below the 3rd order Bell Creek confluence at Mt Wilson.*

The EMP specifies that for each of the above sites sediment and water column, macro-invertebrates and vertebrates (fish and frog) sampling are to be undertaken, and that in addition visual inspections for remaining and accumulated coal fines must be undertaken. The details for each of these monitoring elements are described further in the report sections below.

The EMP also specified a sampling schedule over a two and half year period that included monthly sampling for six months for some sites followed by bi-monthly sampling for the remainder of the EMP plus a mix of quarterly, biannual and yearly requirements for other sites and study elements. **Table 1** identifies the relevant sampling periods for all sites and study elements and the study elements that have been completed to date are shown hatched in grey.

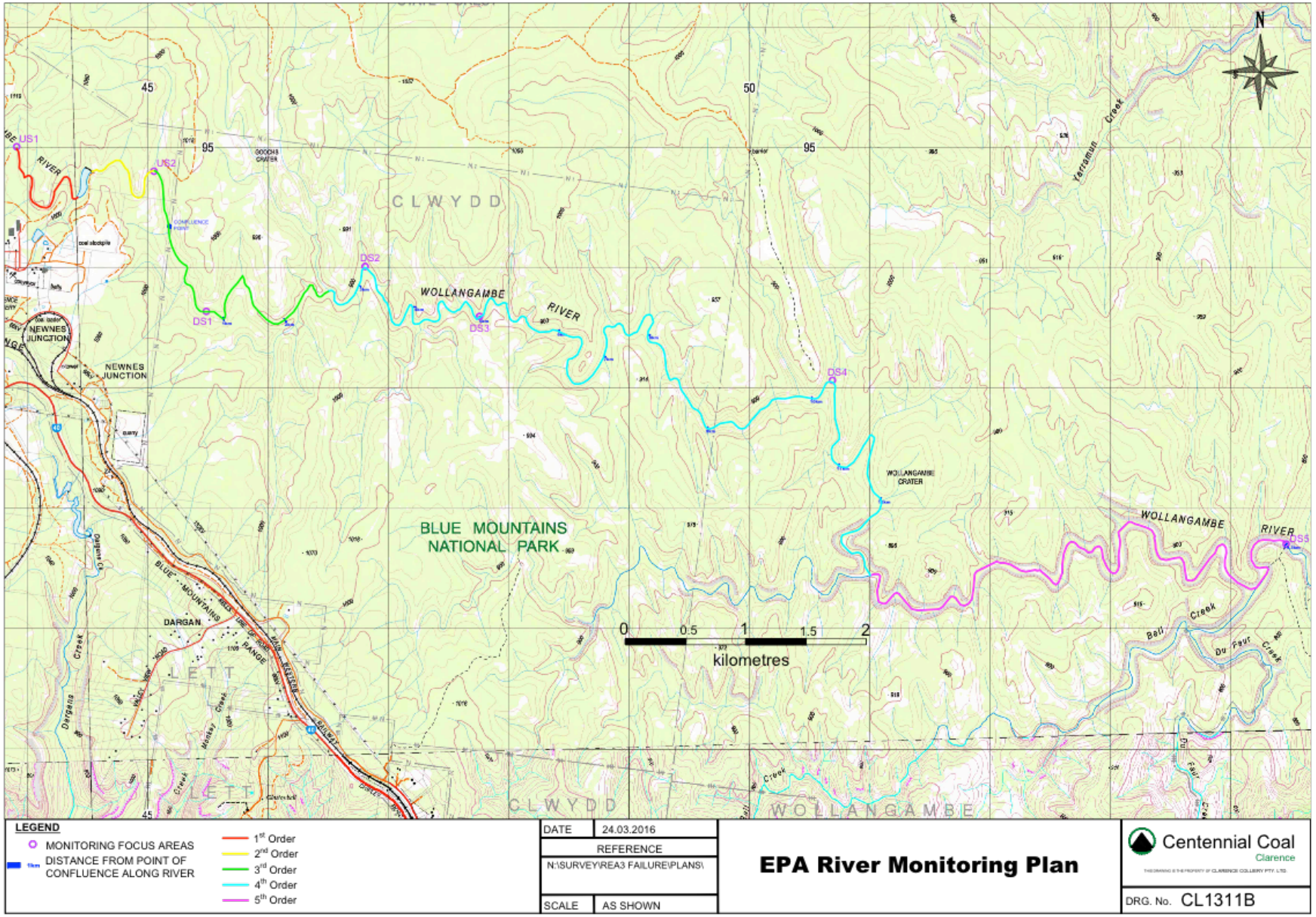


Figure 1. Wollangambe Monitoring Locations US1 through to DS5, in relation to Clarence Colliery

Table 1. Wollangambe River EMP Sampling Schedule

Calendar Year	Study Month	Calendar Month	Petrographic Analysis		Sediment Metals		Water Quality		Macro-Inverts	Fish & Frogs	Coal Fines Visual Inspections			Reports
			US1, US2, DS4	DS1, DS2, DS3	US1, US2, DS4	DS1, DS2, DS3	US1, US2, DS4	DS1, DS2, DS3	US1 to DS4	US1 to DS4	US1, US2, DS4	DS5	DS1, DS2, DS3	
2016	1	Sep							Sp 16					
2016	2	Oct												
2016	3	Nov												
2016	4	Dec												
2017	5	Jan												
2017	6	Feb												
2017	7	Mar							Au 17					No 1
2017	8	Apr												
2017	9	May												
2017	10	Jun												
2017	11	Jul												
2017	12	Aug												
2017	13	Sep							Sp 17					No 2
2017	14	Oct												
2017	15	Nov												
2017	16	Dec												
2018	17	Jan												
2018	18	Feb												
2018	19	Mar							Au 18					No 3
2018	20	Apr												
2018	21	May												
2018	22	Jun												
2018	23	Jul												
2018	24	Aug												
2018	25	Sep							Sp 18					No 4
2018	26	Oct												
2018	27	Nov												
2018	28	Dec												
2019	29	Jan												
2019	30	Feb												
2019	31	Mar												Final

2.1 Report Layout

The data for this summary report are contained in the following appendices:

- **Appendix B** provides the ALS laboratory reports for all the EMP water and sediment analysis surveys undertaken for this reporting period (March to August 2017).
- **Appendix C** provides the available ALS Microscope and Petrography data reports.
- **Appendix D** provides the MPR Autumn 2017 Aquatic Ecology report undertaken during this reporting period.

Data summary results are presented in the four following sections,

- **Section 2.2** Rainfall and Mine Discharge Data,
- **Section 3** Water Quality Monitoring Data,
- **Section 4** Sediment Metals, Petrography Analysis & Coal Fines Inspections, and
- **Section 5** Aquatic Ecology Monitoring Results.

Each Section provides a short outline of sampling methods, an explanation of how the data have been presented and a summary of analytes that are found at *below detection* concentrations.

2.2 Rainfall & Mine Discharge Data

Daily rainfall measurements are recorded at Clarence Colliery Meteorological Station located at Clarence Colliery pit top and operated on the Collier's behalf by ALS Global. Note that rainfall is recorded for the actual calendar day from midnight to midnight.

Background long-term mean monthly totals are acquired from Bureau of Meteorology Newnes Forest Centre Station (means based on data recorded from 1938 to 1999).

Clarence Colliery LDP 2 mine discharge data are collected by automatic flow monitors operated by ALS Global and both the site weather data and discharge flow are provided via a web link.

Daily rainfall and mine discharge data for the 2015 to 2016 spill plus clean phase of the program are shown graphically in **Figure 2**, and the data for the EMP monitoring program to date (2016 to 2017) are shown graphically in **Figure 3**. **Table 2** shows daily rainfall for the present reporting period.

Note that there was no rainfall data available for the Clarence Gauge from July 2017 to the end of the sampling period in August. A comparison of Springvale rainfall data to Clarence data for the 180-day period prior to the Clarence gauge failing indicated that the accumulated average difference between the two gauges for daily rainfall was 0.09mm. The overall mean for the 180 differences (± standard error of the mean) was 1.61mm ± 0.12mm. Accordingly, daily rainfall data from the Springvale Mine site from July 2017 onwards were substituted for the missing Clarence data.

Table 2 Daily Rainfall March to August 2017 (Clarence Mine data to 1st June and Springvale Data to 31st Aug 2017)						
Day	Mar	Apr	May	Jun	Jul	Aug
1	1.2	0.2	0.2	0	0	7.2
2	1.8	0	0	0	0	0
3	0.2	0	0	0.2	0	0
4	3.6	0.8	0	0	1.6	11.6
5	2.6	0.4	0	0	0.2	0.6
6	2.4	0.6	0	0.4	0.2	0.2
7	0.2	0.2	0.4	3.8	0	0
8	0	0	0	17.2	0	2.4
9	0	0	0	1.4	0	0.2
10	1	9.8	0	10.4	0.2	0
11	0	0	0	18.8	0	0
12	0	0	0	1.4	0	0
13	0	0	0	0.2	0	0
14	0	0	0	0	0.2	0
15	23.8	0.2	4.8	0.4	0.6	0
16	2.4	0	0	0.4	0	0
17	9	0	0.2	0	0	3.6
18	0.2	0	0	0	0.2	0.4
19	14.8	0	0	0.2	0	7.4
20	3	0.2	2	0.2	0.2	0
21	0	0	17.8	0.4	0	0.2
22	32	0.2	0.2	0	0	0
23	2	0	0	0.2	0	0
24	5	0	0	0.2	0	0
25	0.8	0	0	0	0	9.2
26	1.8	1	0	0	0	0
27	0.2	2.4	0	0	1	0
28	0	0	0	0	0	0.8
29	0	0	0.8	0	0.8	0
30	0	0	0	0	0.2	0
31	21.8		0		0	0
Monthly Total	129.8	16.0	26.4	55.8	5.4	43.8

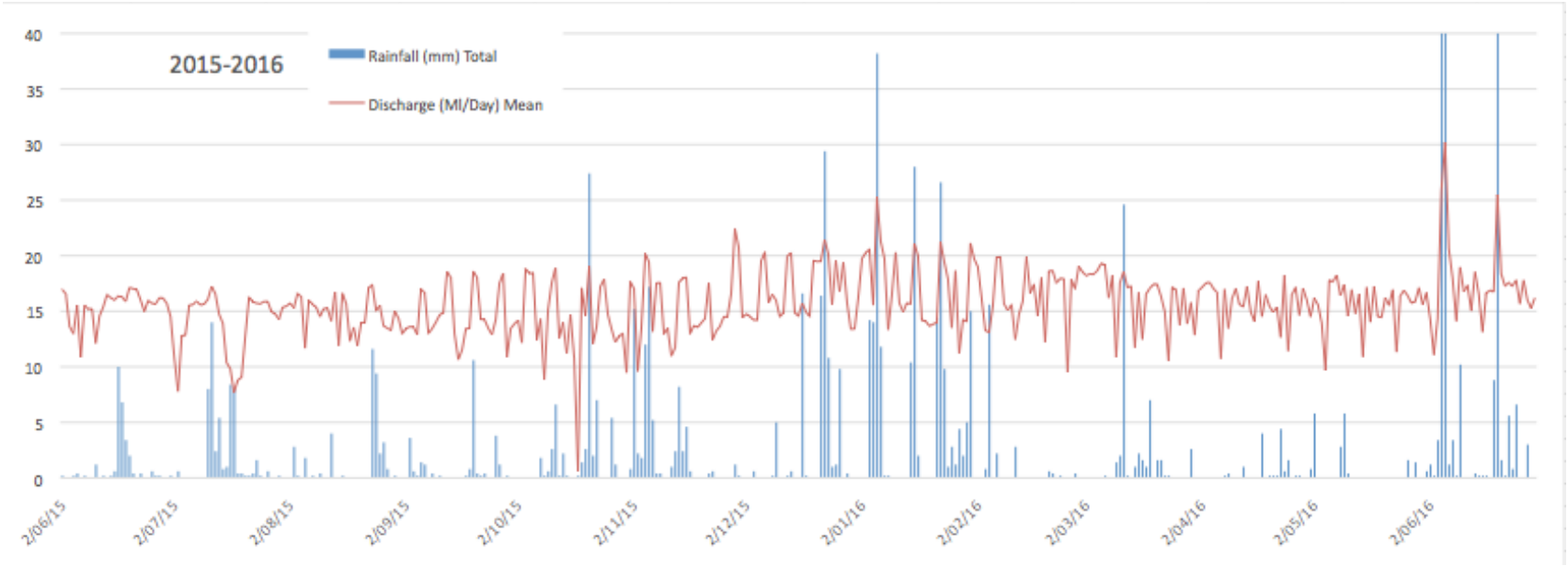


Figure 2.

Daily Rainfall & LDP Discharge

Flow 2015 to 2016

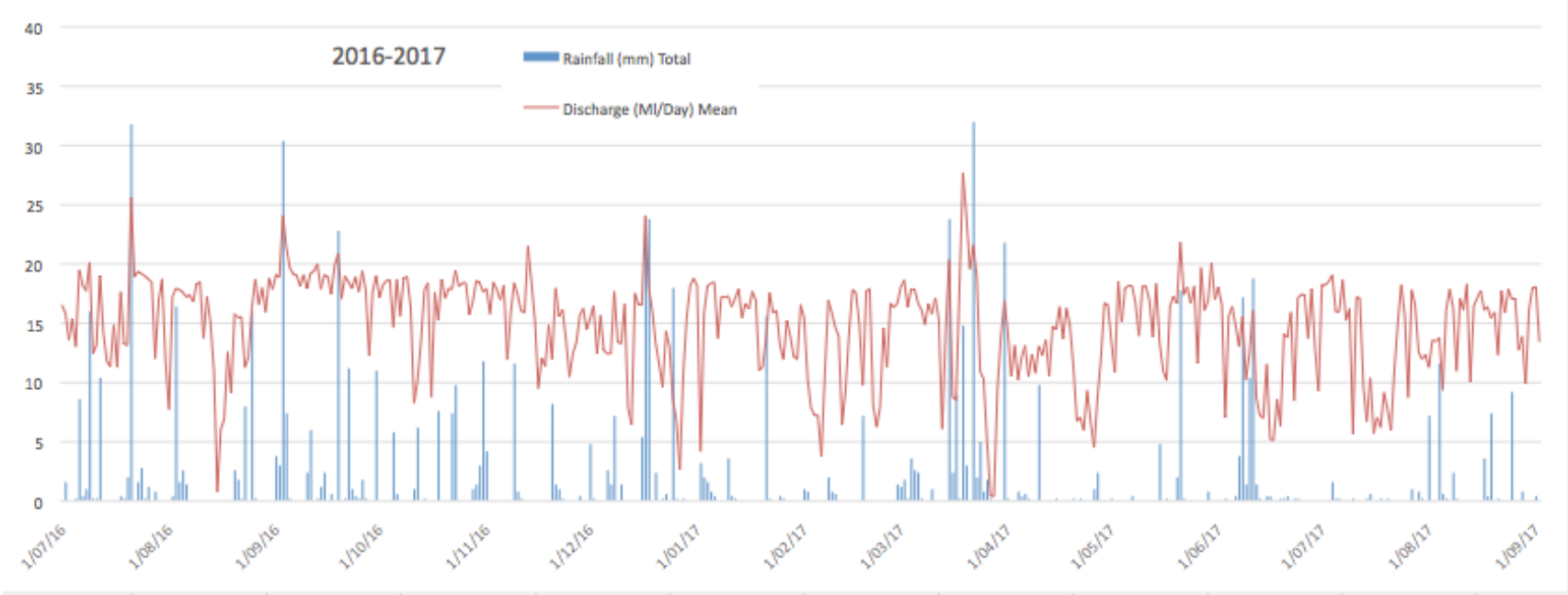


Figure 3.

Daily Rainfall & LDP Discharge

Flow 2016 to 2017

3 WATER QUALITY MONITORING RESULTS

Section 3.1 provides a summary of water quality monitoring and outlines how the data are presented. Water quality monitoring results are provided in **Sections 3.2** (Physical and Mineral), **3.3** (Nutrients and Organics) and **3.4** (Metals and Metalloids).

3.1 Methods and Data Presentation

Field Methods:

Water quality sampling is undertaken using a combination of metered water quality measurements and collection of water samples for subsequent laboratory analysis:

- For this present six-monthly period and for the remainder of the EMP sampling period a submersible Yeo-Kal 911 water quality data logger is and will be used to record water temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all sampling sites. The meter is calibrated daily before commencing field work and calibration is checked at the completion of each day's field work.
- Water samples are collected into suitable containers supplied by the NATA registered laboratory, and kept chilled in back-packs, then in a chilled esky for delivery to the laboratory on the same day.
- Due to the time taken to access Downstream sites and the requirement to deliver the samples to the laboratory on the same day where possible, water samples for dissolved metal analysis are not field-filtered.
- For some of the remote sites where samplers were unable to exit the site in time to deliver the samples on the same day, samples were kept chilled in a refrigerator overnight for delivery to the lab in the morning.

Data Presentation:

For each section the results are presented in a **Summary Table**, and are shown graphically in **Control Charts** and **Box-plots**:

- The **Summary Table** presents the analyte detection limit (DL), sample size, the number of sample values above DL, minimum, median, mean, standard deviation (SD) of the mean, 80th percentile and maximum value for each analyte over all sampling events to date. **Note that all results are expressed as mg/L.**
- Results for analytes that have all or most analytic results below detection are shaded in grey with no (or reduced) sample statistics calculated and no bar charts or box plots produced.
- Depending on sample size the following general rules apply to calculation of site statistics:
    - If no values >DL, <DL indicated in all statistical cells (the min, max, mean cells etc).
    - if one value >DL, then maximum value only shown,
    - if two values >DL, then maximum and minimum values shown only,
    - If three values >DL (for sample size of 5 through to 10), then use half DL values for calculation of statistics, and show the DL as the minimum value.
    - For analytes with 3 or more values above DL, median, mean, SD and 80th percentile statistics are calculated using halve DL values.
- The **Control Charts** provide results for the concentrations of each analyte over time for all six sites, from the first sample run in the first monitoring period (August

2016) to the most recent sample for this current monitoring period (August 2017). Most are shown in line graph mode.

- Where analyte values are similar across sites making discrimination of site differences difficult to see in line graph mode, the control graphs are shown in the form of clustered bar charts.
- Given the variation in sampling frequency between sites for the period August 2016 to February 2017 (see **Table 1**), the control graph quarterly data for sites US1, US2 and DS4 are shown as isolated data points, whereas the monthly data for sites DS1, DS2 and DS3 appear as continuous lines. Based on the inter-monthly variation observed in analyte values for DS1, DS2 and DS3, lines connecting quarterly data points for sites US1, US2 and DS4 over this period would be misleading.
- **Box Plots** compare the summary statistical results for each analyte per site over the complete sampling program to date:
    - The upper and lower sides of the main box show the quartile (75 and 25 percentile) values for the data. The range between these values is called the interquartile range (IQR).
    - The line through the box shows the median (50 percentile) for the data and the cross (X) shows the mean value for the data.
    - The box 'whiskers' generally show the maximum and minimum values provided the data are all within 1.5 IQRs either side of the IQR.
    - If there are outlier data (i.e. values outside this range), they are shown as small circles located on both sides or on one side of the whiskers (depending whether the outliers are very low or very high value) and the whiskers on the side that have outliers then shows the 1.5 IQR limits for the data. Outliers will then indicate the relevant minimum or maximum value.

3.2 Physical & Mineral Water Quality Monitoring Data

The physical and mineral water quality results for each sampling location and event are provided below in Site Summary **Tables 3 to 8**, Control Charts, and Box Plots:

- Results for water pH, Electrical Conductivity and Turbidity for the first six months of sampling were intermittent and are a mix of laboratory measurements and field measurements - where available, and field Temperature results were only available when water sampling coincided with aquatic ecology sampling. Whilst the field and laboratory results are generally compatible, the laboratory EC results are always calculated as EC at 25°C and field conductivity is measured at field ambient water temperature.
- Electrical Conductivity, water temperature, pH and turbidity results for the next six-monthly reporting period are all based on field measurements.
- Metered dissolved oxygen sampling during water sampling only commenced in May 2017.
- TSS (<5mg/L), Hydroxide and Carbonate Alkalinity (< 1mg/L) concentrations were all <DL for all sites and for all sampling times to date, and are not shown in Control Graphs or Box Plots.
- Total Hardness, Dissolved Sulphur, Calcium, Magnesium and Potassium were all <DL (of 1mg/L) for Site US1 over all sample times and are shown in Control Graphs and Box Plots as Detection Limit value.

Table 3 US1 Physical and Mineral Water Quality Summary Statistics

	Temp	Dissolved Oxygen	EC	pH	Turbidity	TSS	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Total Hardness as CaCO3	Chloride	Dissolved Sulfur as S	Total Sulfur as S	Sulfate as SO4	Calcium	Magnesium	Sodium	Potassium	Total Anions	Total Cations
	°C	% sat	µS/cm	pH Units	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L
Detection limit (DL)	NA	NA	NA	NA	NA	5	1	1	1	1	1	1	1	1	1	1	1	1	1	0.01	0.01
Sample size (n)	4	3	4	5	1	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	4	3	4	5	1	0	0	0	2	2	0	5	0	2	2	0	0	5	0	5	5
Min	6.41	79.8	25	5.14	-	<DL	<DL	<DL	1	1	<DL	5	<DL	1	1	<DL	<DL	3	<DL	0.16	0.13
Median	13.6	86.0	31.0	5.84	-	<DL	<DL	<DL	-	-	<DL	6.0	<DL	-	-	<DL	<DL	4.0	<DL	0.19	0.17
Mean	13.8	84.3	30.0	6.00	-	<DL	<DL	<DL	-	-	<DL	5.8	<DL	-	-	<DL	<DL	3.8	<DL	0.19	0.16
SD	7.0	4.0	3.6	0.77	-	<DL	<DL	<DL	-	-	<DL	0.8	<DL	-	-	<DL	<DL	0.8	<DL	0.02	0.04
80th percentile	19.3	86.7	32.4	6.42	-	<DL	<DL	<DL	-	-	<DL	6.2	<DL	-	-	<DL	<DL	4.2	<DL	0.20	0.18
Max	21.5	87.2	33	7.19	8.5	<DL	<DL	<DL	3	3	<DL	7	<DL	1	1	<DL	<DL	5	<DL	0.22	0.22

Table 4 US2 Physical and Mineral Water Quality Summary Statistics

	Temp	Dissolved Oxygen	EC	pH	Turbidity	TSS	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Total Hardness as CaCO3	Chloride	Dissolved Sulfur as S	Total Sulfur as S	Sulfate as SO4	Calcium	Magnesium	Sodium	Potassium	Total Anions	Total Cations
	°C	% sat	µS/cm	pH Units	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L
Detection limit (DL)	NA	NA	NA	NA	NA	5	1	1	1	1	1	1	1	1	1	1	1	1	1	0.01	0.01
Sample size (n)	4	3	5	5	1	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	4	3	5	5	1	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5
Min	12.3	83.8	283	5.48	-	<DL	<DL	<DL	16	16	114	3	32	27	82	29	8	2	3	2.34	2.55
Median	15.8	84.5	286.0	6.70	-	<DL	<DL	<DL	24.0	24.0	123.0	4.0	35.0	33.0	100.0	31.0	11.0	3.0	4.0	2.65	2.68
Mean	16.4	86.6	301.2	6.54	-	<DL	<DL	<DL	24.0	24.0	124.2	3.8	34.4	32.4	101.6	32.2	10.6	3.2	3.8	2.70	2.71
SD	4.3	4.2	23.6	0.65	-	<DL	<DL	<DL	7.9	7.9	7.3	0.4	2.3	3.6	14.4	2.8	1.7	0.8	0.4	0.25	0.15
80th percentile	19.4	88.6	322.6	6.93	-	<DL	<DL	<DL	28.0	28.0	128.4	4.0	36.2	35.2	109.2	34.4	12.0	4.0	4.0	2.92	2.78
Max	21.7	91.4	333	7.20	9.0	<DL	<DL	<DL	36	36	134	4	37	36	122	36	12	4	4	2.97	2.96

Table 5 DS1 Physical and Mineral Water Quality Summary Statistics

	Temp	Dissolved Oxygen	EC	pH	Turbidity	TSS	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Total Hardness as CaCO3	Chloride	Dissolved Sulfur as S	Total Sulfur as S	Sulfate as SO4	Calcium	Magnesium	Sodium	Potassium	Total Anions	Total Cations
	°C	% sat	µS/cm	pH Units	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L
Detection limit (DL)	NA	NA	NA	NA	NA	5	1	1	1	1	1	1	1	1	1	1	1	1	1	0.01	0.01
Sample size (n)	7	4	10	10	1	9	10	10	10	10	9	10	10	9	10	10	10	10	10	10	10
n > DL	7	4	10	10	1	0	0	0	10	10	9	10	10	9	10	10	10	10	10	10	10
Min	11.2	82.5	263	5.54	-	<DL	<DL	<DL	15	15	101	3	26	23	72	24	8	3	3	2.03	2.23
Median	16.8	84.9	293.5	6.74	-	<DL	<DL	<DL	23.5	23.5	120.0	4.0	33.0	32.0	98.0	30.5	10.5	3.5	4.0	2.64	2.68
Mean	16.5	86.1	297.0	6.66	-	<DL	<DL	<DL	24.0	24.0	117.8	4.1	32.4	32.1	94.5	30.0	10.7	3.5	3.6	2.56	2.62
SD	3.4	4.2	27.7	0.44	-	<DL	<DL	<DL	6.4	6.4	10.0	1.4	3.8	5.1	13.0	3.2	1.4	0.5	0.5	0.26	0.21
80th percentile	19.3	88.3	309.6	6.97	-	<DL	<DL	<DL	26.8	26.8	127.4	4.0	35.2	34.4	104.8	32.2	12.0	4.0	4.0	2.79	2.81
Max	20.9	92	358	7.13	4.8	<DL	<DL	<DL	37	37	129	8	38	42	108	35	13	4	4	2.88	2.86

Table 6 DS2 Physical and Mineral Water Quality Summary Statistics

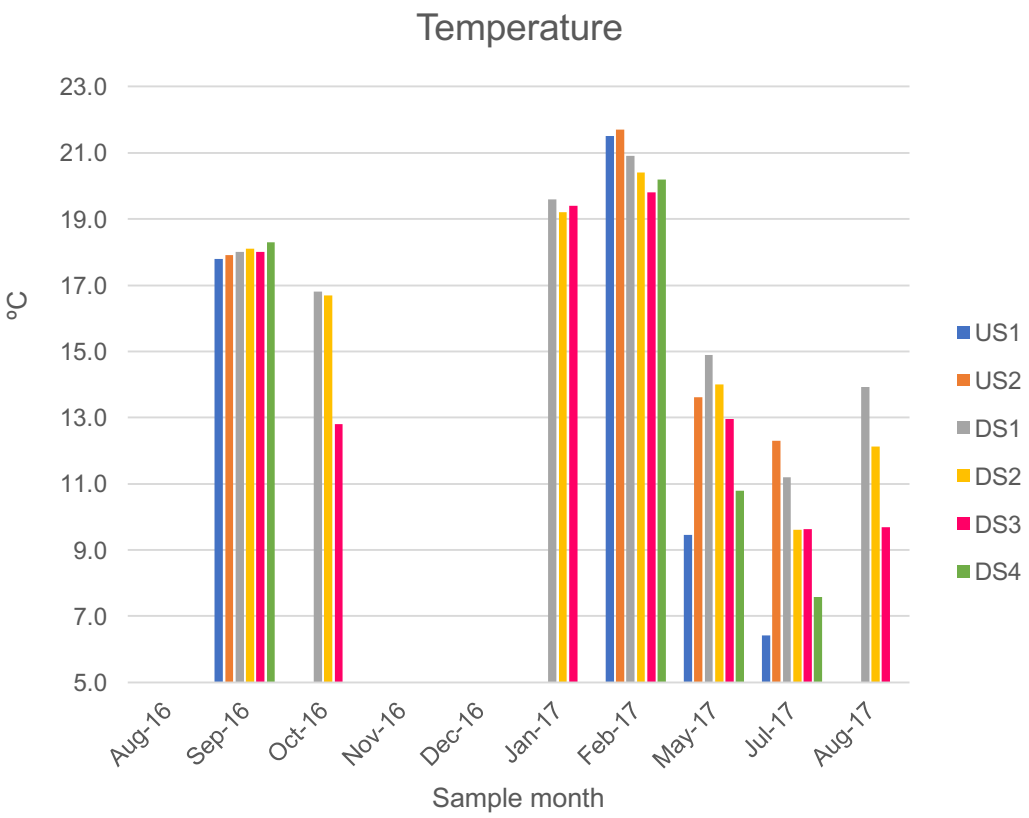
	Temp	Dissolved Oxygen	EC	pH	Turbidity	TSS	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Total Hardness as CaCO3	Chloride	Dissolved Sulfur as S	Total Sulfur as S	Sulfate as SO4	Calcium	Magnesium	Sodium	Potassium	Total Anions	Total Cations
	°C	% sat	µS/cm	pH Units	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L
Detection limit (DL)	NA	NA	NA	NA	NA	5	1	1	1	1	1	1	1	1	1	1	1	1	1	0.01	0.01
Sample size (n)	7	4	10	10	1	9	10	10	10	10	9	10	10	9	10	10	10	10	10	10	10
n > DL	7	4	10	10	1	0	0	0	10	10	9	10	10	9	10	10	10	10	10	10	10
Min	9.6	79.8	197	5.60	-	<DL	<DL	<DL	14	14	94	3	23	20	66	23	8	2	2	1.83	2.07
Median	16.7	84.8	276.0	6.84	-	<DL	<DL	<DL	21.0	21.0	114.0	4.0	30.5	31.0	91.0	28.0	10.0	3.0	3.5	2.49	2.44
Mean	15.7	85.4	268.6	6.71	-	<DL	<DL	<DL	21.4	21.4	111.4	4.1	30.2	30.1	86.9	28.0	10.1	3.2	3.4	2.35	2.46
SD	4.0	5.3	32.4	0.43	-	<DL	<DL	<DL	6.3	6.3	9.8	1.4	3.3	5.4	12.7	2.6	1.3	0.6	0.7	0.27	0.20
80th percentile	19.0	88.6	288.0	6.99	-	<DL	<DL	<DL	24.6	24.6	119.4	4.0	33.0	32.4	98.4	30.0	11.2	4.0	4.0	2.55	2.66
Max	20.4	92.3	312	7.06	3.9	<DL	<DL	<DL	35	35	124	8	34	40	101	32	12	4	4	2.66	2.69

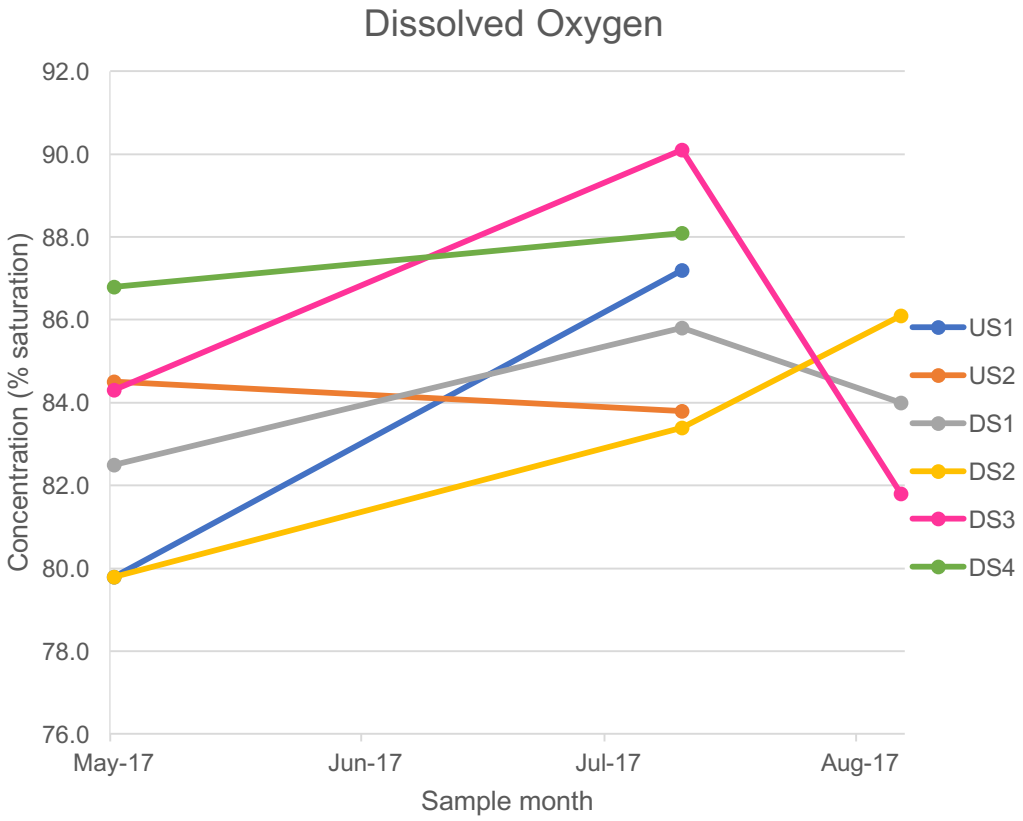
Table 7 DS3 Physical and Mineral Water Quality Summary Statistics

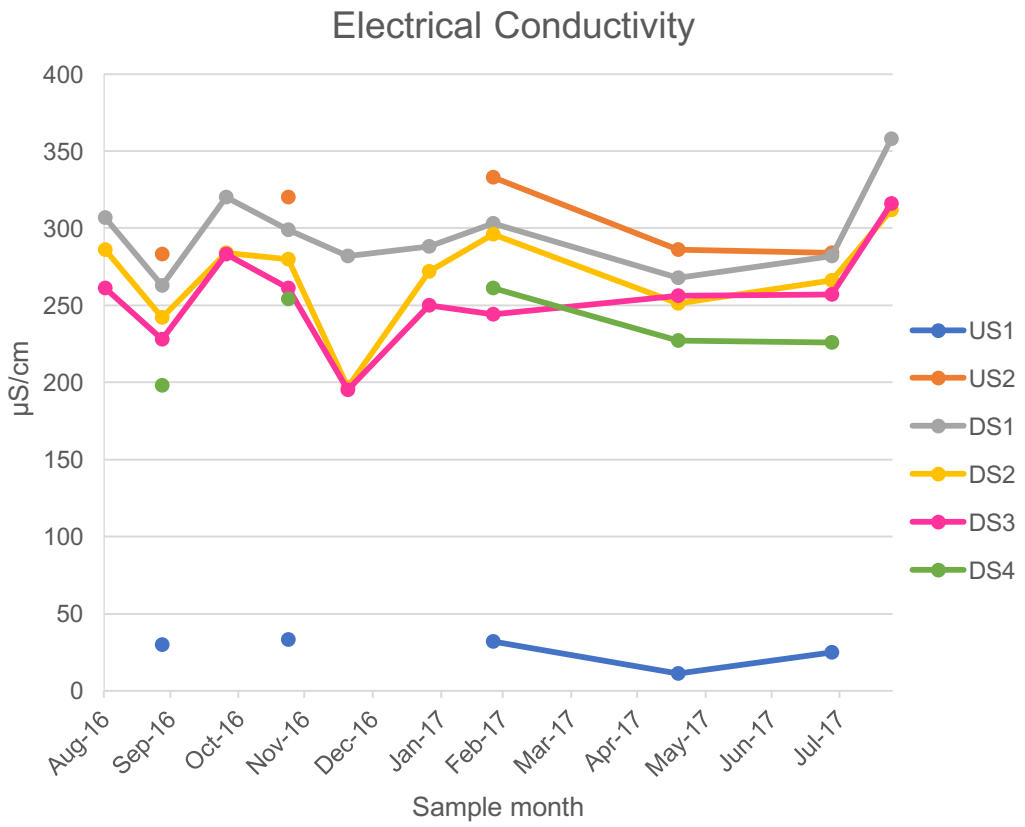
	Temp	Dissolved Oxygen	EC	pH	Turbidity	TSS	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Total Hardness as CaCO3	Chloride	Dissolved Sulfur as S	Total Sulfur as S	Sulfate as SO4	Calcium	Magnesium	Sodium	Potassium	Total Anions	Total Cations
	°C	% sat	µS/cm	pH Units	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L
Detection limit (DL)	NA	NA	NA	NA	NA	5	1	1	1	1	1	1	1	1	1	1	1	1	1	0.01	0.01
Sample size (n)	7	4	10	10	1	9	10	10	10	10	9	10	10	9	10	10	10	10	10	10	10
n > DL	7	4	10	10	1	0	0	0	10	10	9	10	10	9	10	10	10	10	10	10	10
Min	9.62	81.8	195	5.69	-	<DL	<DL	<DL	12	12	93	3	23	21	66	24	6	2	2	1.84	2.02
Median	13.0	87.2	253.5	6.82	-	<DL	<DL	<DL	21.5	21.5	101.0	4.0	28.5	28.0	82.0	26.0	9.5	3.0	3.0	2.26	2.24
Mean	14.6	87.2	230.2	6.73	-	<DL	<DL	<DL	20.6	20.6	103.4	4.1	28.3	28.3	81.0	26.1	9.3	3.2	3.0	2.21	2.28
SD	4.4	5.0	84.5	0.45	-	<DL	<DL	<DL	6.1	6.1	8.4	1.4	3.2	5.4	11.7	2.4	1.5	0.6	0.5	0.21	0.19
80th percentile	19.1	91.1	265.4	7.00	-	<DL	<DL	<DL	23.2	23.2	110.0	4.0	30.2	30.4	91.2	27.4	10.2	4.0	3.0	2.40	2.43
Max	19.8	92.7	316	7.37	2.9	<DL	<DL	<DL	33	33	118	8	34	40	98	31	11	4	4	2.45	2.62

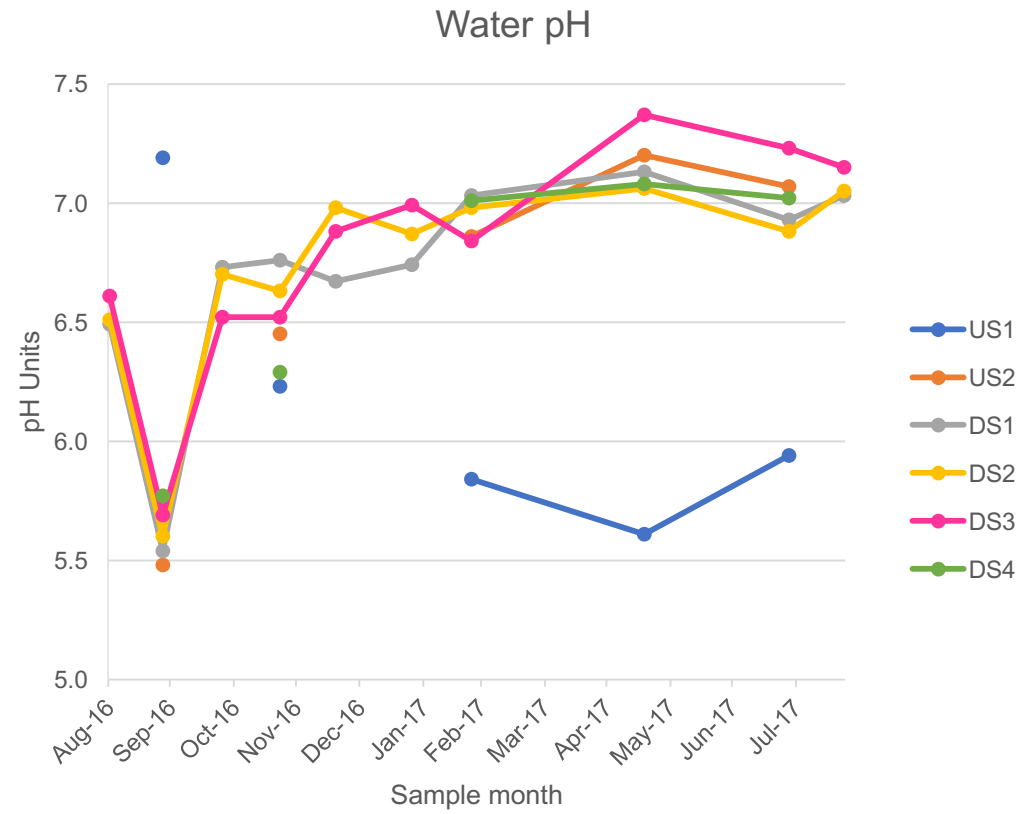
Table 8 DS4 Physical and Mineral Water Quality Summary Statistics

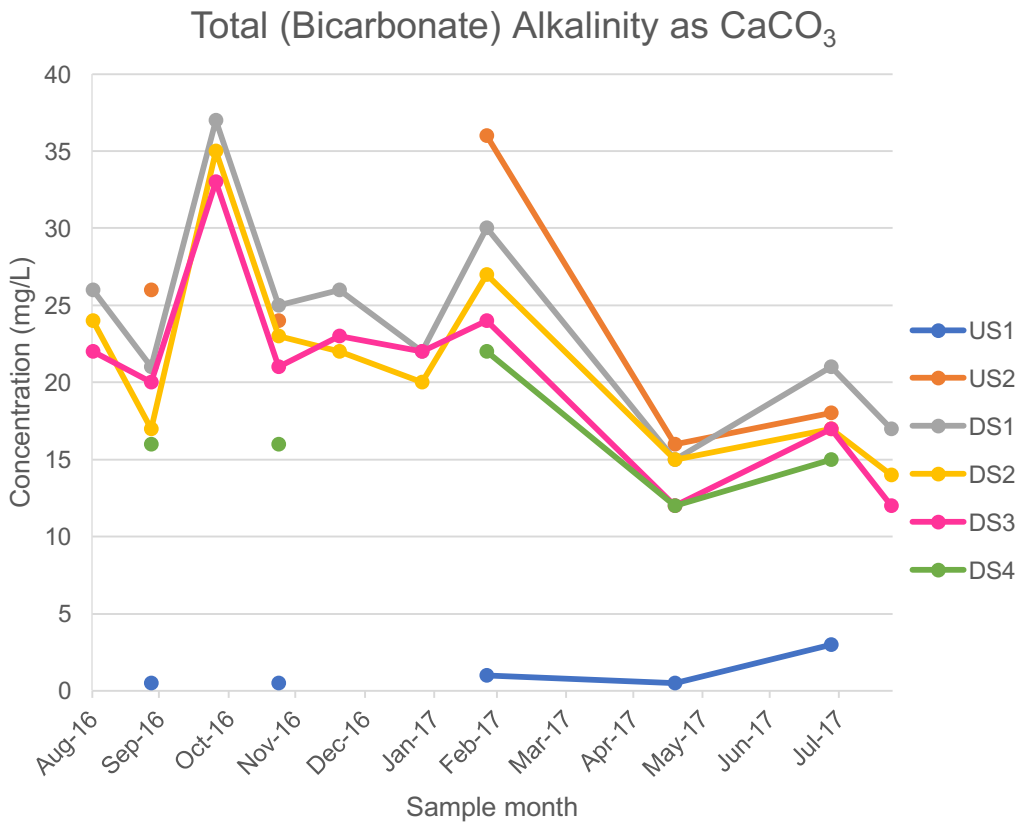
	Temp	Dissolved Oxygen	EC	pH	Turbidity	TSS	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Total Hardness as CaCO3	Chloride	Dissolved Sulfur as S	Total Sulfur as S	Sulfate as SO4	Calcium	Magnesium	Sodium	Potassium	Total Anions	Total Cations
	°C	% sat	µS/cm	pH Units	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L
Detection limit (DL)	NA	NA	NA	NA	NA	5	1	1	1	1	1	1	1	1	1	1	1	1	1	0.01	0.01
Sample size (n)	4	3	5	5	1	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	4	3	5	5	1	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5
Min	7.6	86.8	198	5.77	-	<DL	<DL	<DL	12	12	88	3	21	19	62	22	7	2	2	1.72	1.94
Median	14.5	88.1	227.0	7.01	-	<DL	<DL	<DL	16.0	16.0	91.0	4.0	27.0	26.0	79.0	24.0	8.0	3.0	3.0	2.07	1.99
Mean	14.2	91.3	233.2	6.64	-	<DL	<DL	<DL	16.2	16.2	91.8	3.8	25.4	24.8	76.6	23.6	8.0	2.8	2.8	2.03	2.03
SD	6.0	6.6	25.2	0.58	-	<DL	<DL	<DL	3.6	3.6	4.5	0.4	2.9	3.6	11.5	1.5	0.7	0.8	0.4	0.20	0.12
80th percentile	19.1	94.6	255.4	7.04	-	<DL	<DL	<DL	17.2	17.2	94.2	4.0	27.2	27.2	83.2	25.0	8.2	3.2	3.0	2.12	2.06
Max	20.2	98.9	261	7.08	2.5	<DL	<DL	<DL	22	22	99	4	28	28	92	25	9	4	3	2.27	2.24

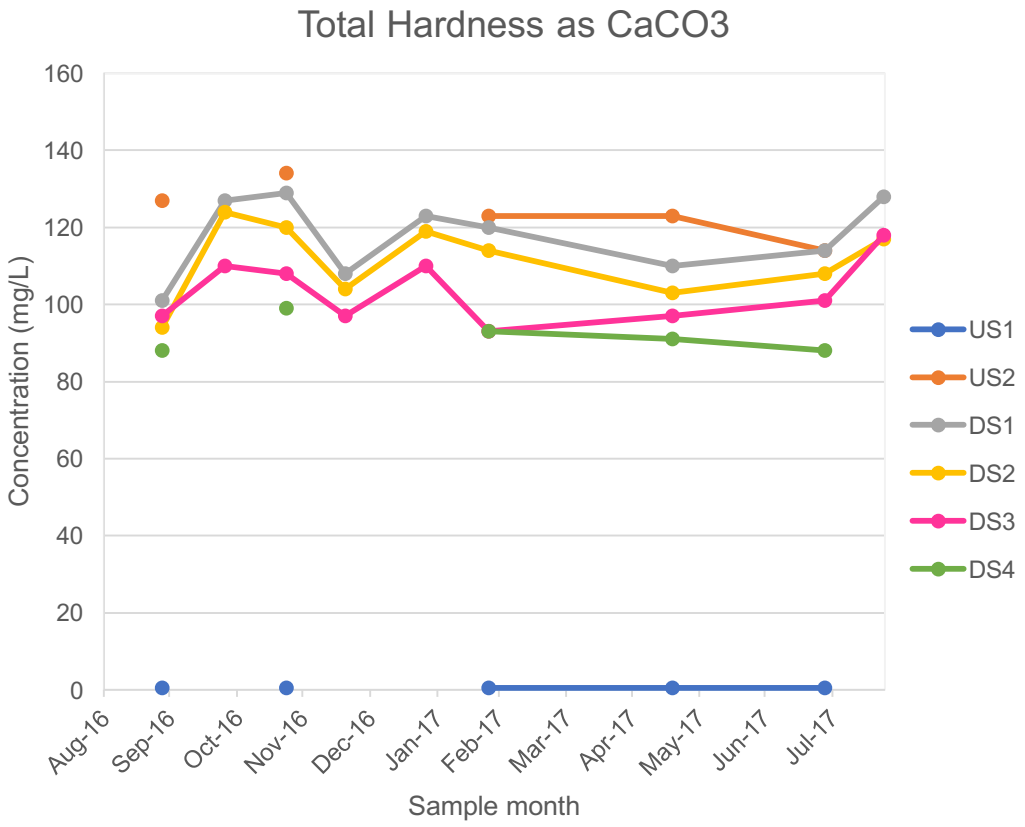

Temperature
23.0
21.0
19.0
17.0
15.0
13.0
11.0
9.0
7.0
5.0
°C
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

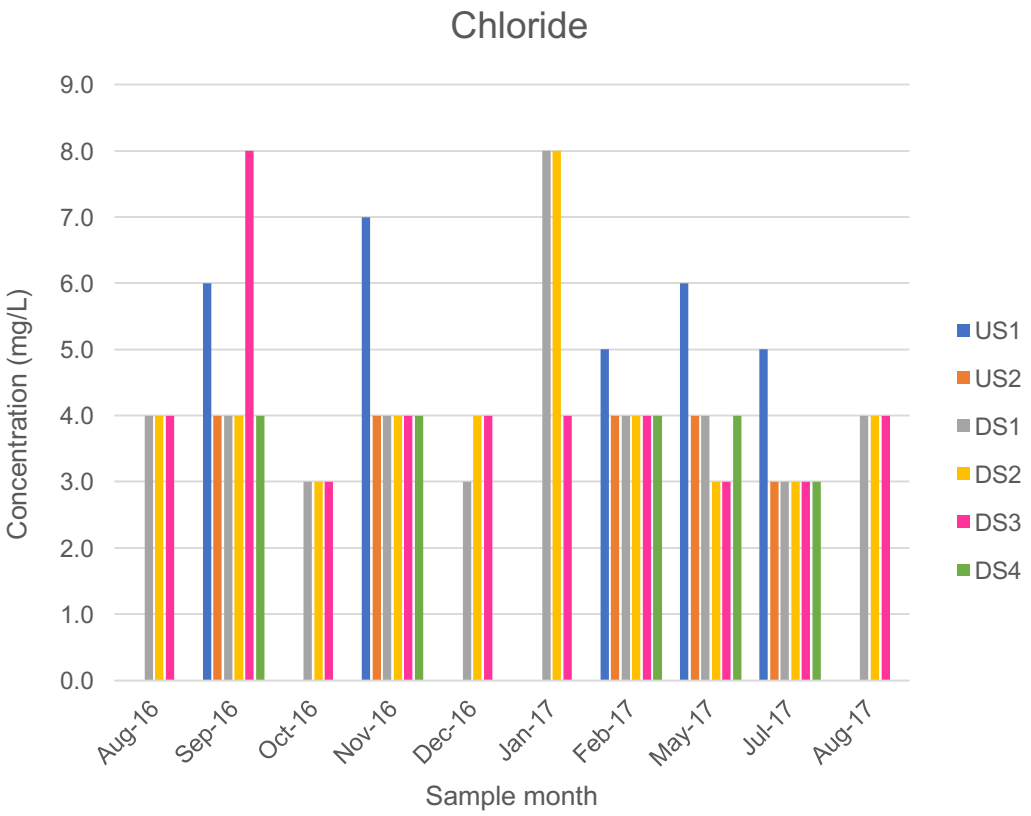

Dissolved Oxygen
92.0
90.0
88.0
86.0
84.0
82.0
80.0
78.0
76.0
Concentration (% saturation)
May-17
Jun-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

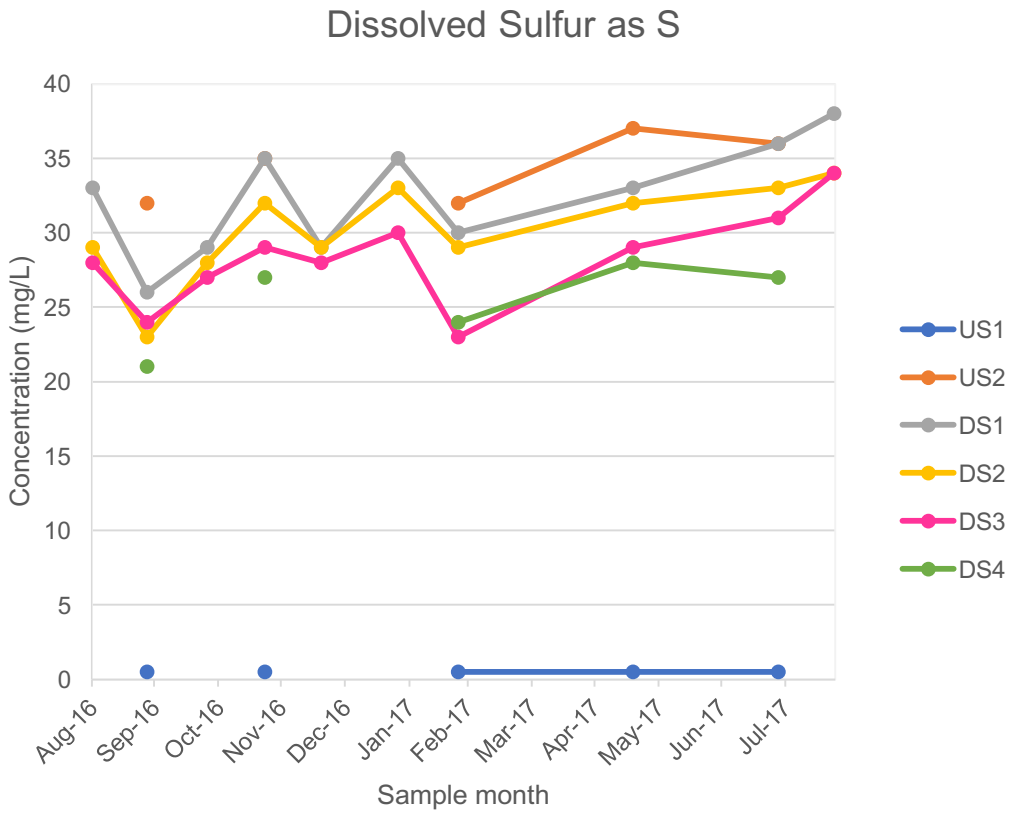

Electrical Conductivity
400
350
300
250
200
150
100
50
0
µS/cm
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

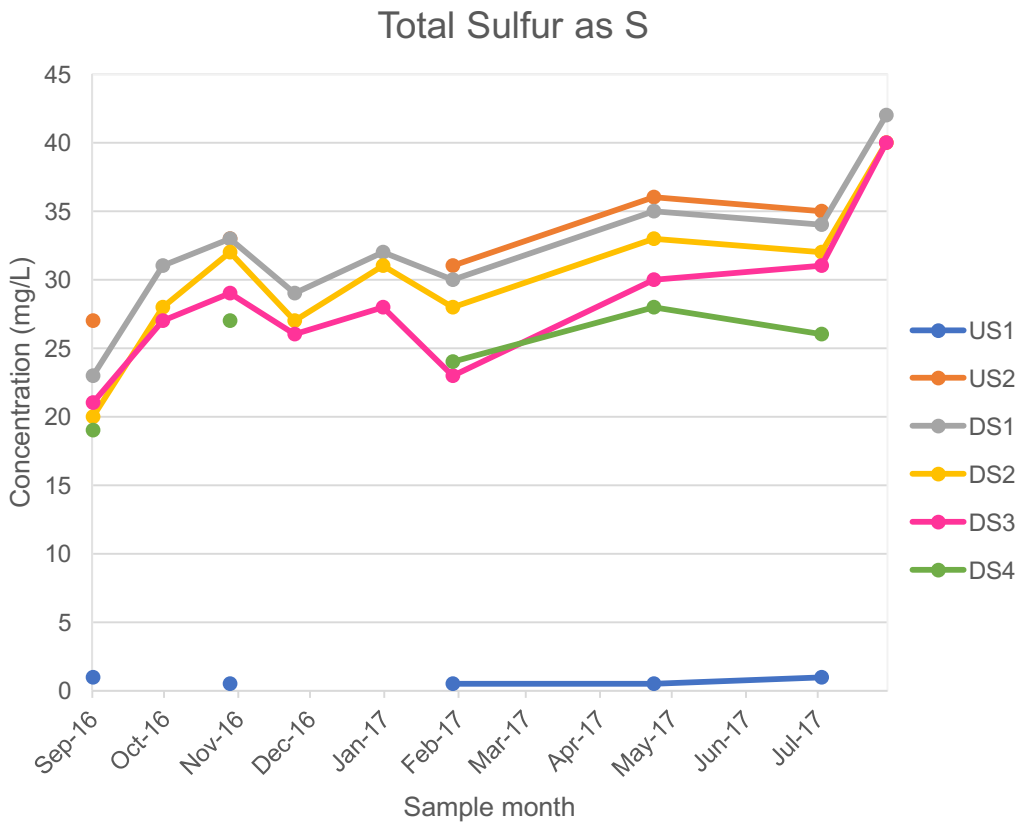

Water pH
7.5
7.0
6.5
6.0
5.5
5.0
pH Units
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

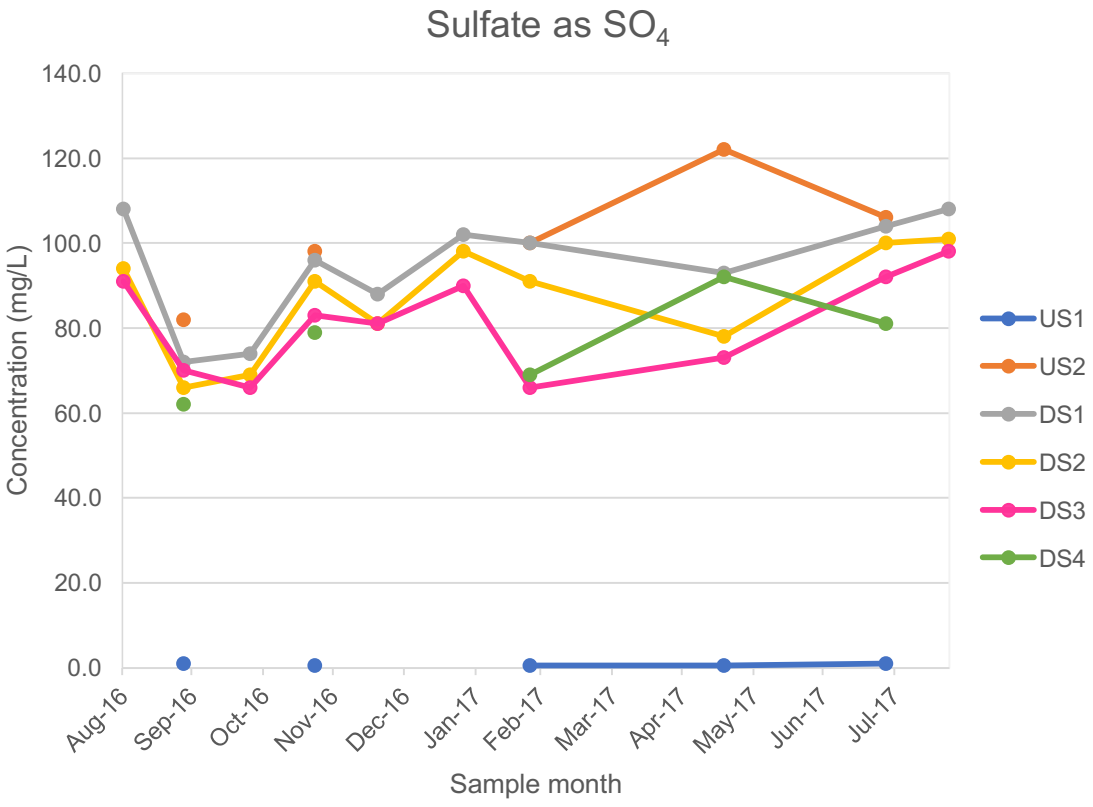

Total (Bicarbonate) Alkalinity as $CaCO_3$
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

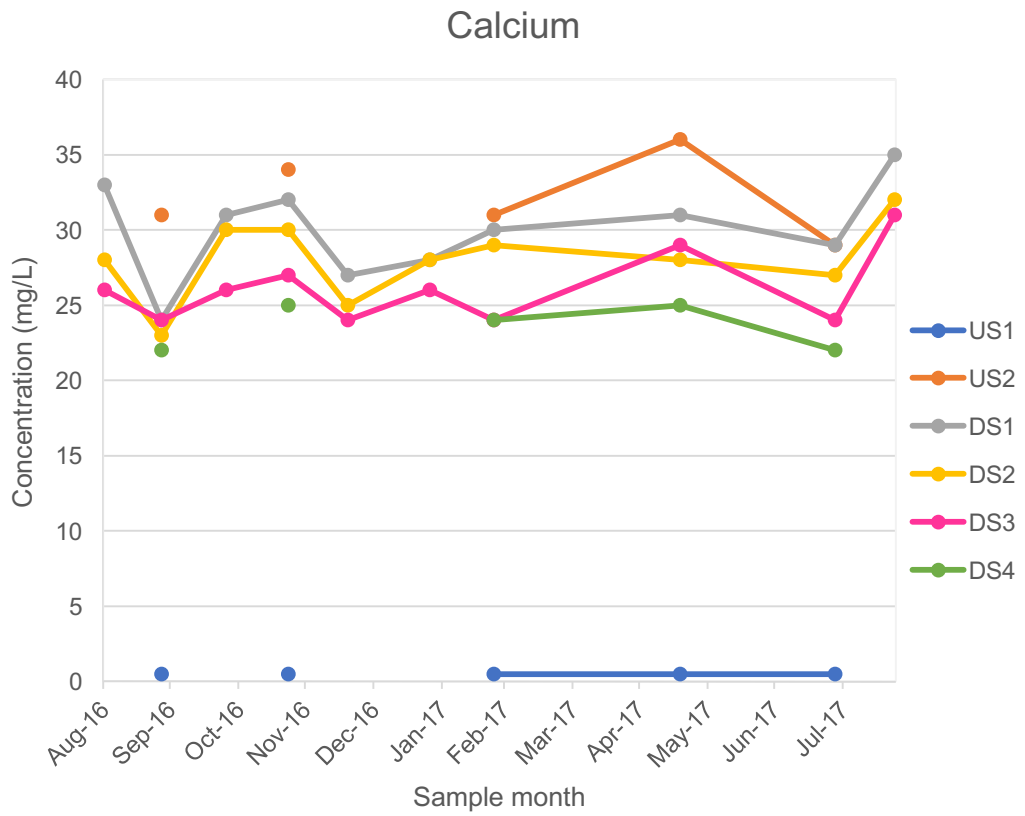

Total Hardness as CaCO3
Concentration (mg/L)
160
140
120
100
80
60
40
20
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

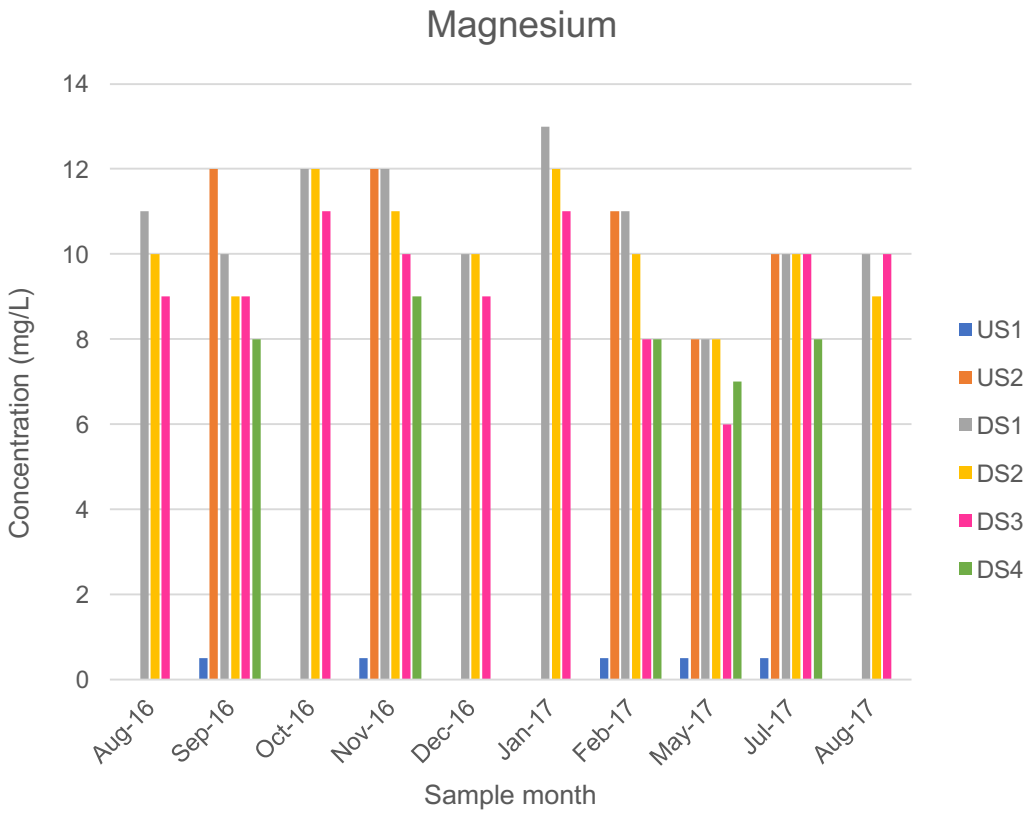

Chloride
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

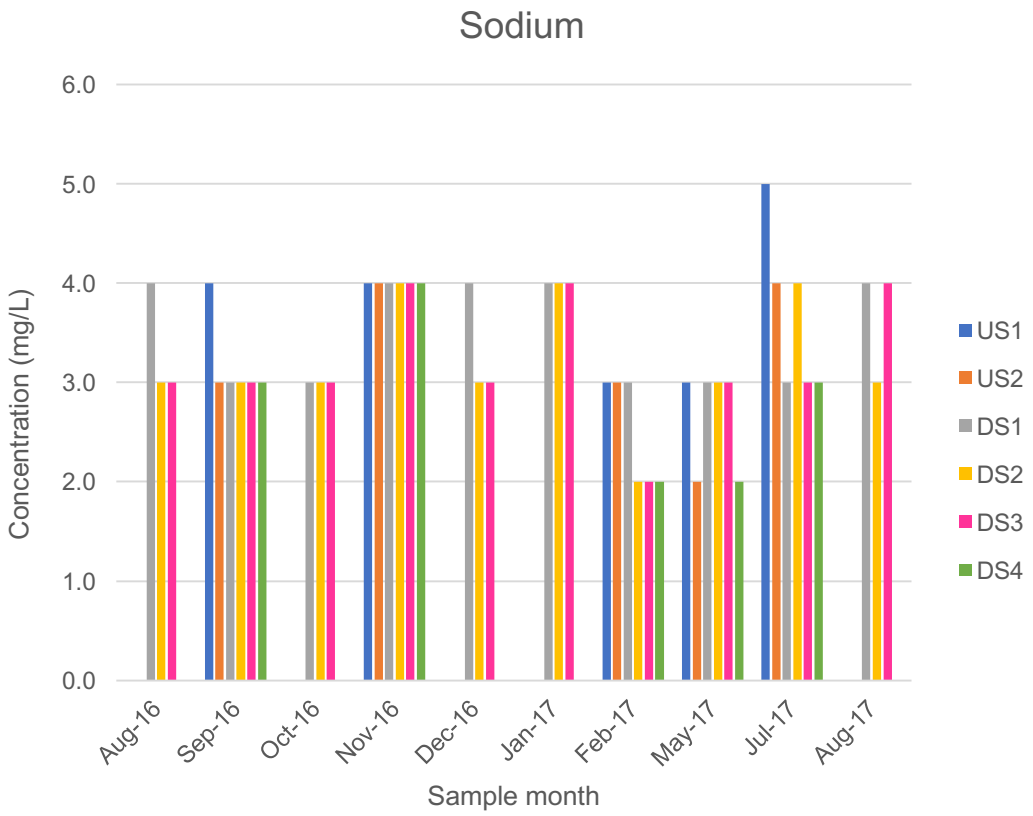

Dissolved Sulfur as S
40
35
30
25
20
15
10
5
0
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

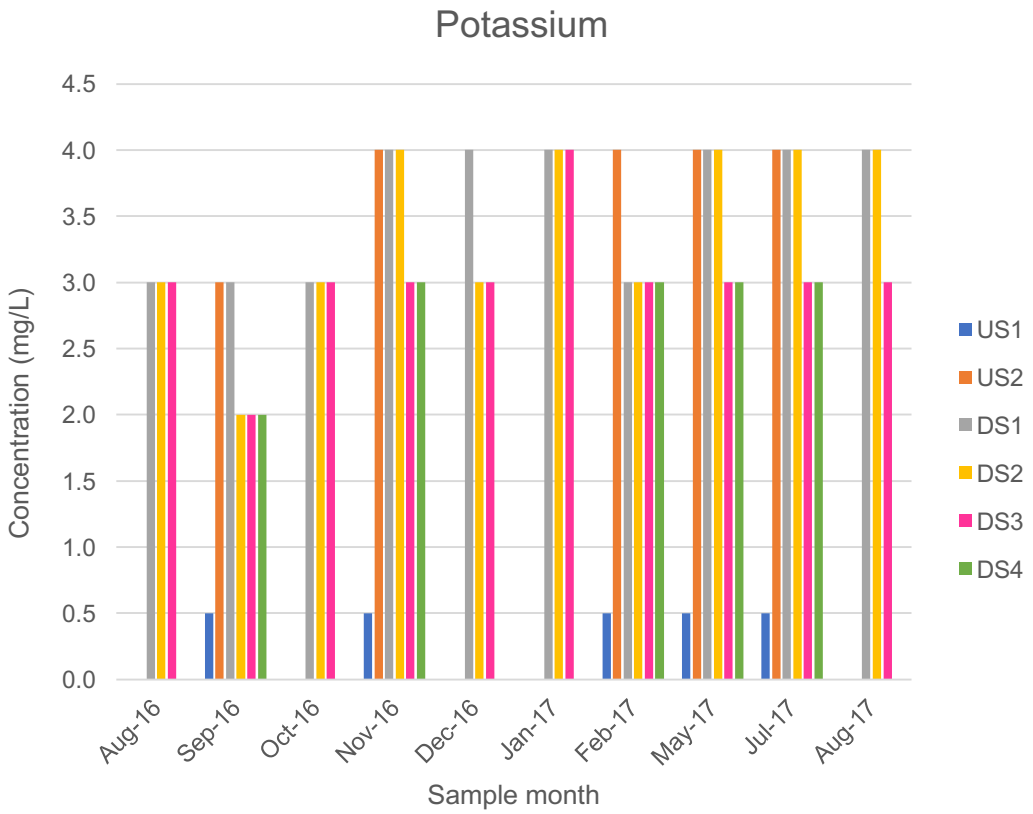

Total Sulfur as S
Concentration (mg/L)
45
40
35
30
25
20
15
10
5
0
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

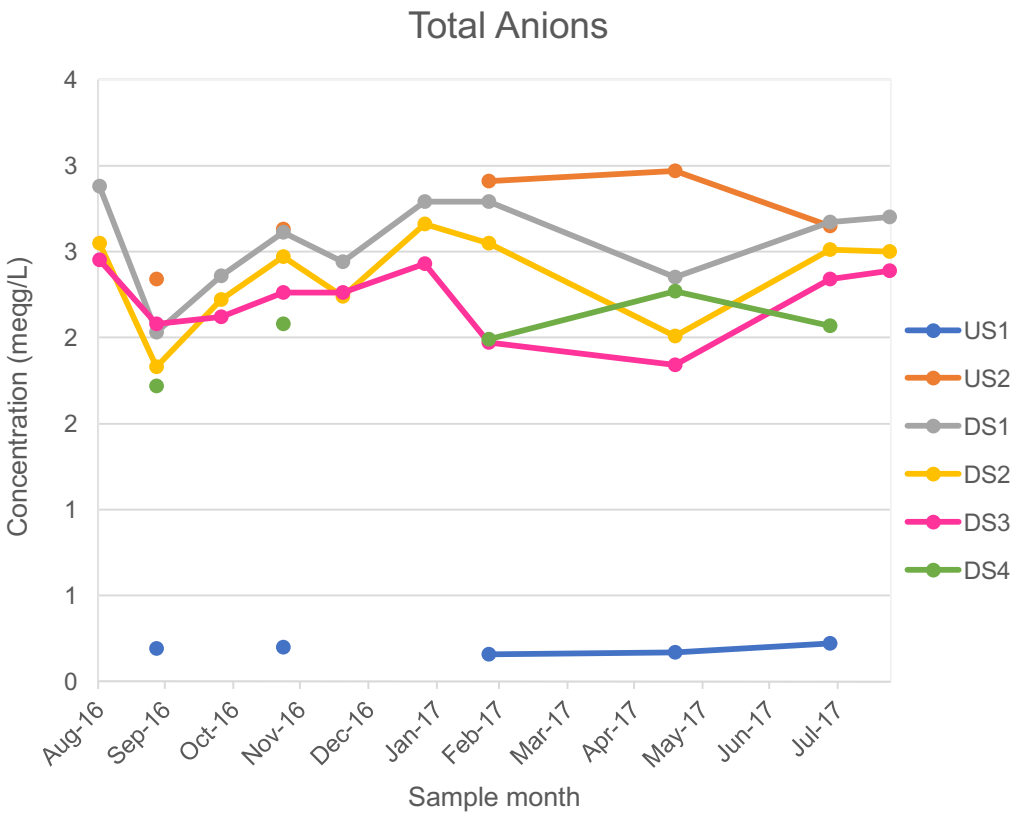

Sulfate as SO_4
Concentration (mg/L)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

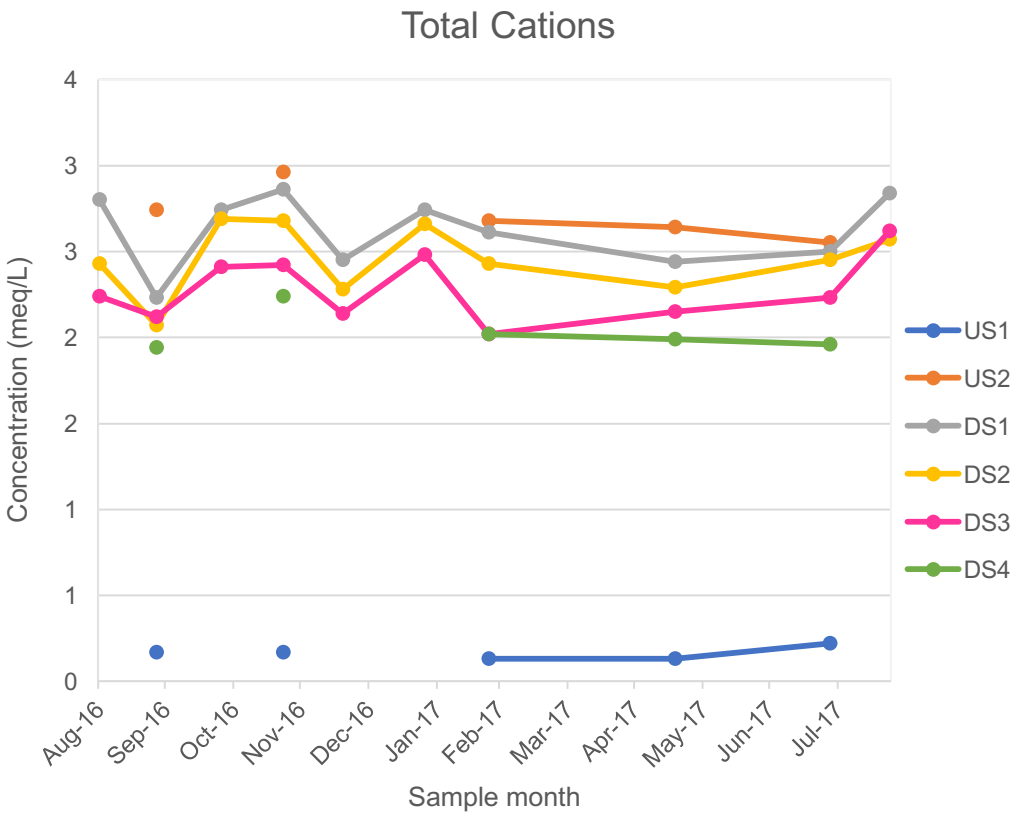

Calcium
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

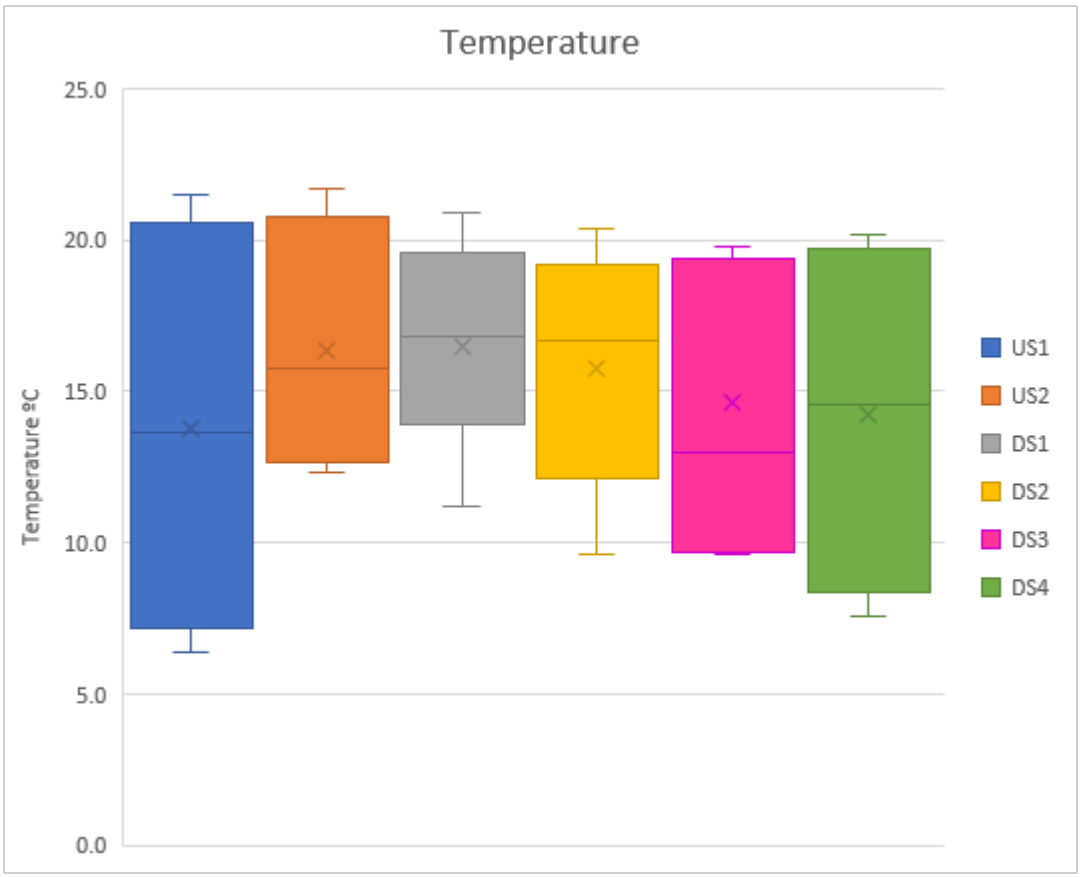

Magnesium
Concentration (mg/L)
14
12
10
8
6
4
2
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

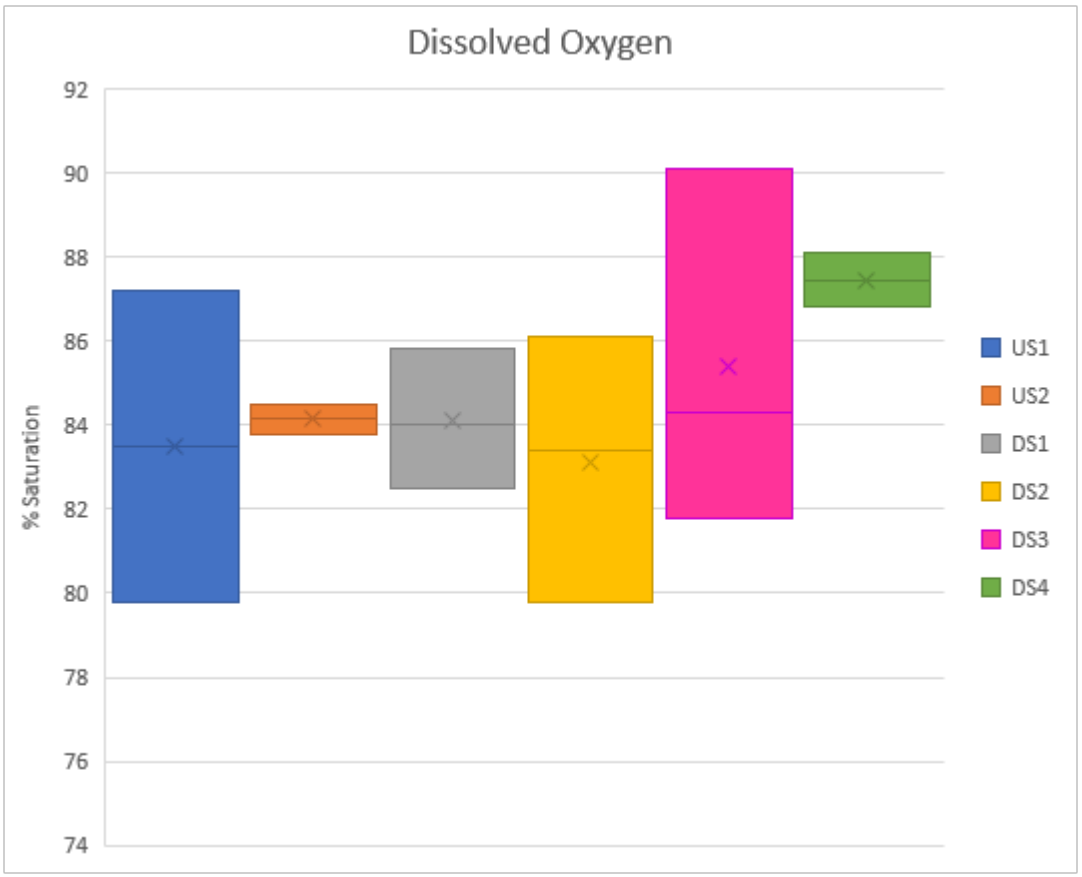

Sodium
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

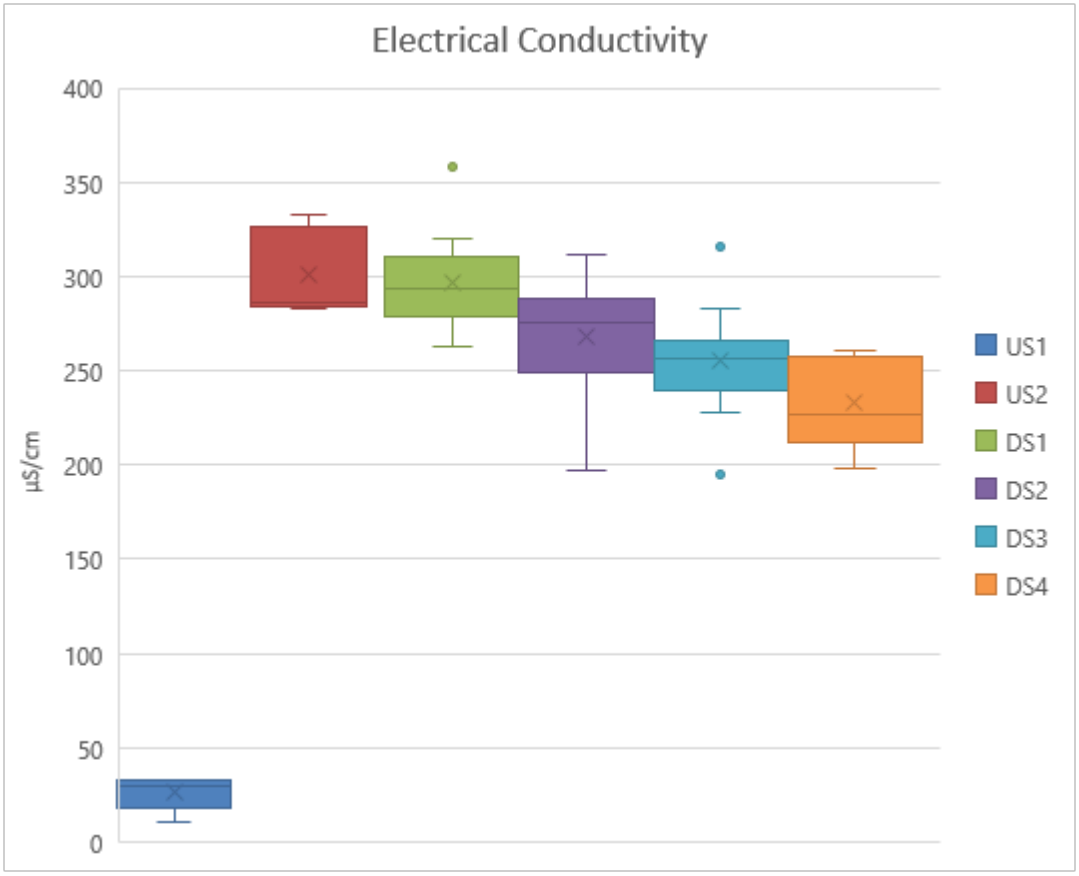

Potassium
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

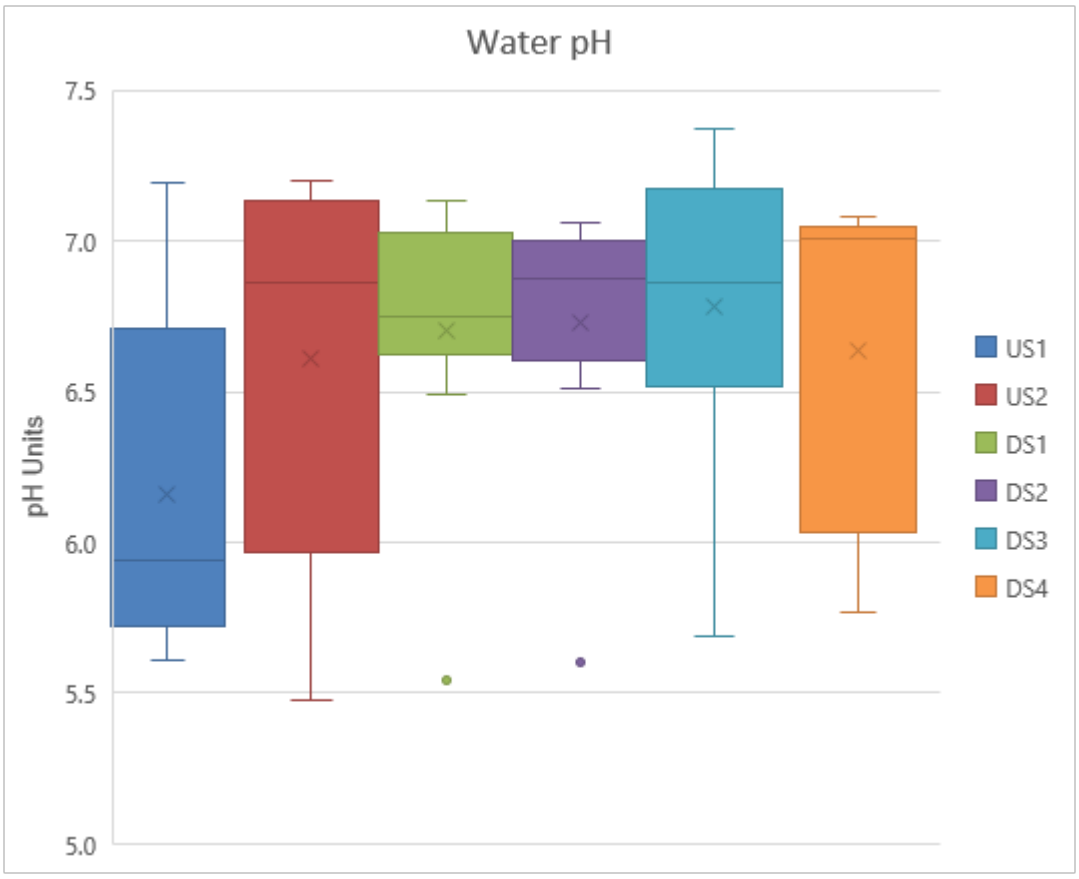

Total Anions
Concentration (meqg/L)
4
3
3
2
2
1
1
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

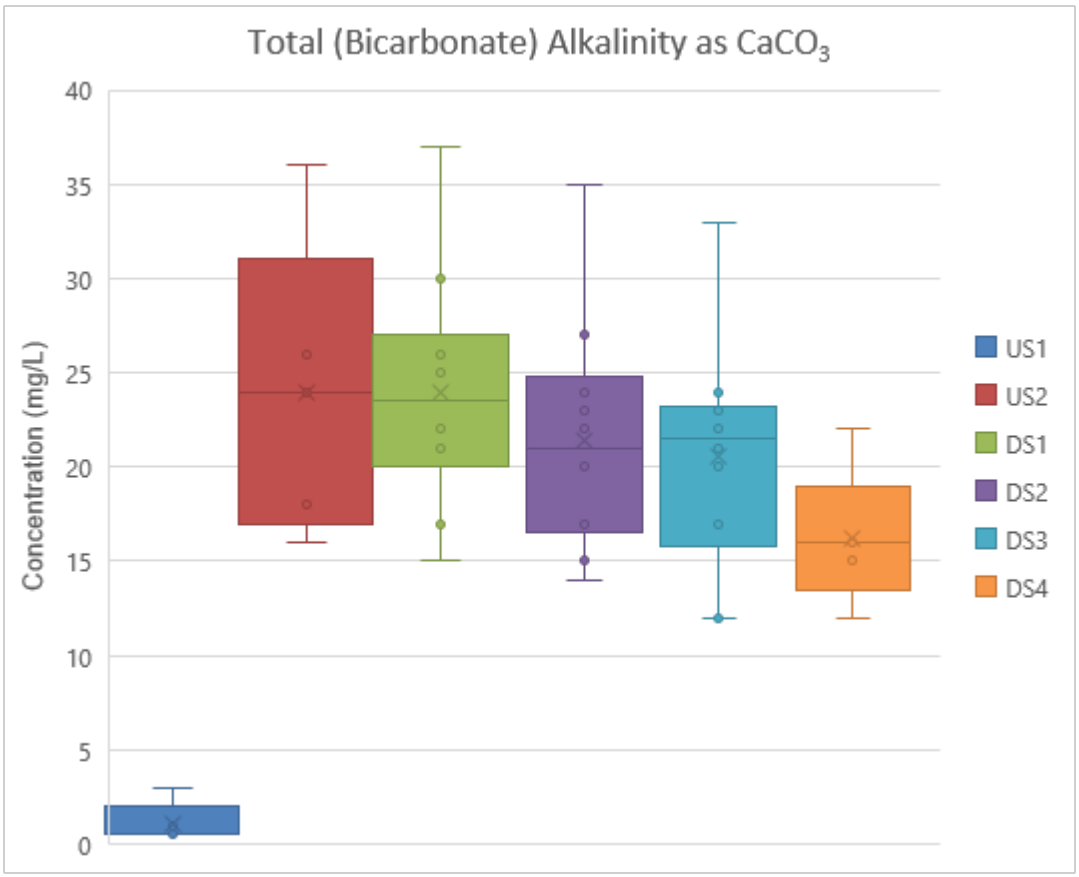

Total Cations
Concentration (meq/L)
4
3
3
2
2
1
1
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

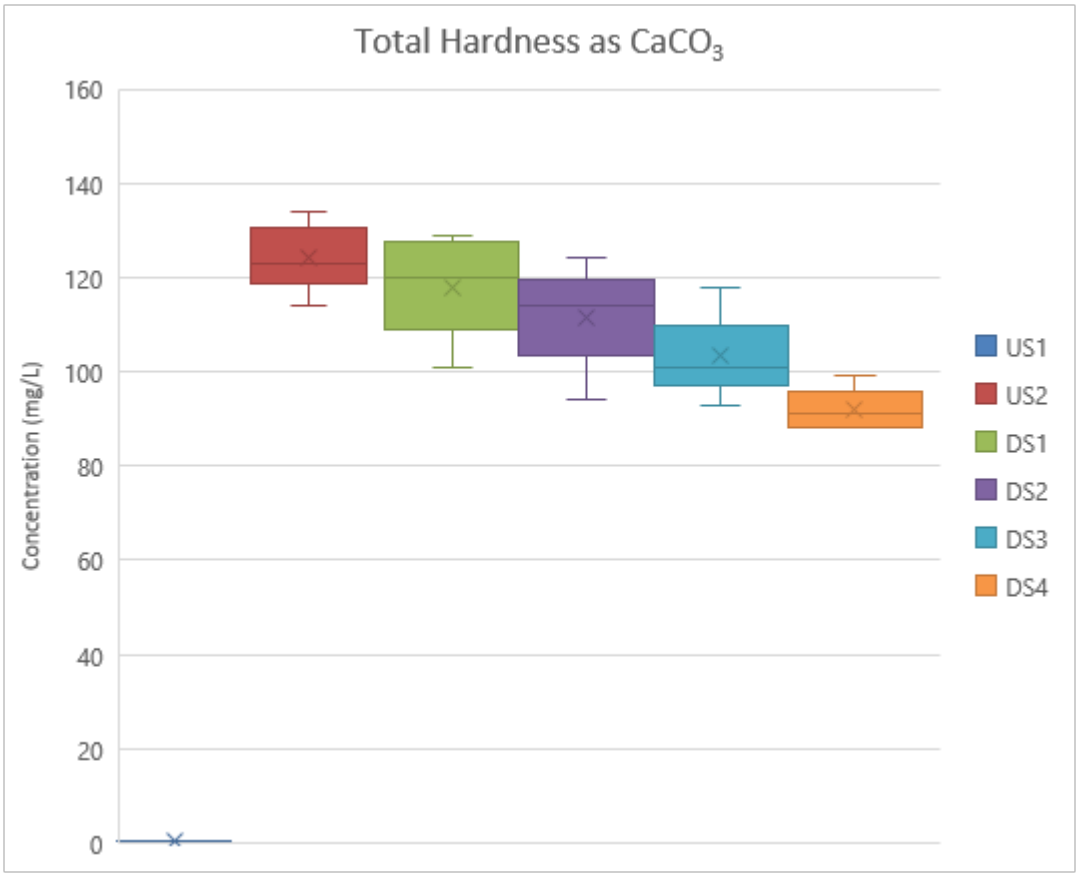

Temperature
25.0
20.0
15.0
10.0
5.0
0.0
Temperature ºC
US1
US2
DS1
DS2
DS3
DS4

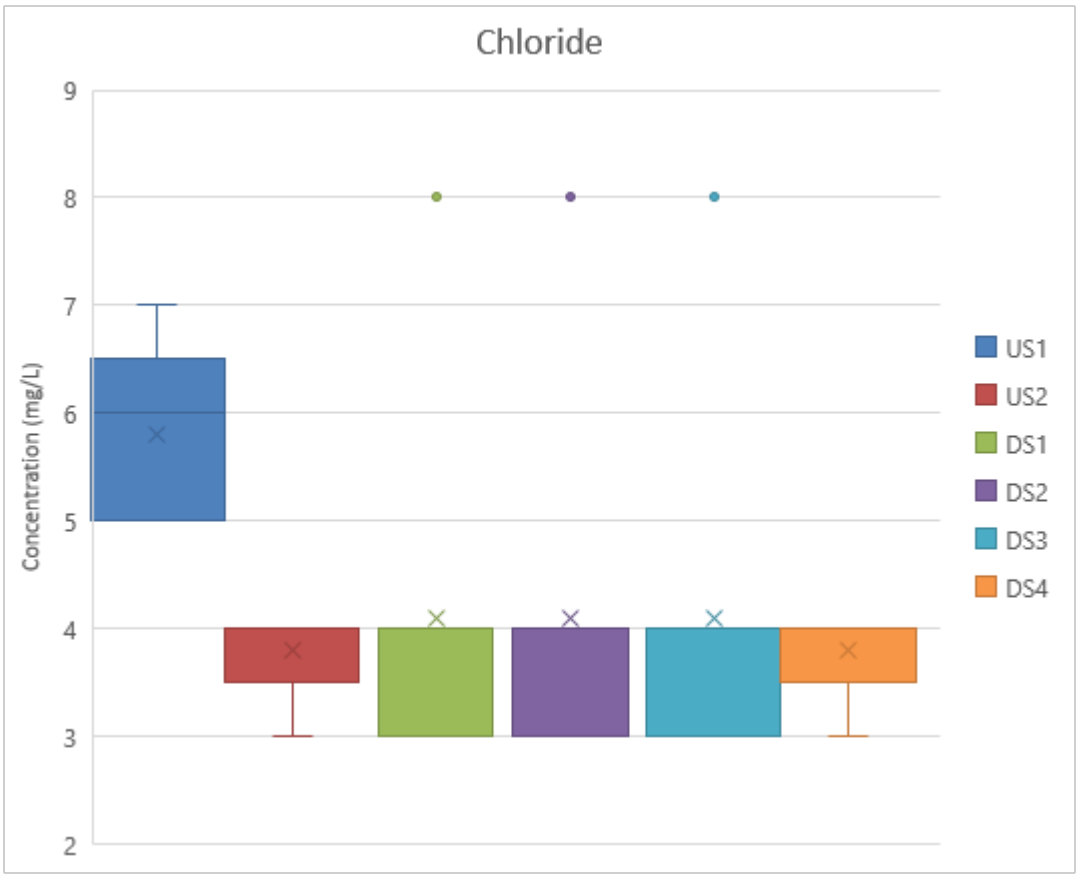

Dissolved Oxygen
92
90
88
86
84
82
80
78
76
74
% Saturation
US1
US2
DS1
DS2
DS3
DS4

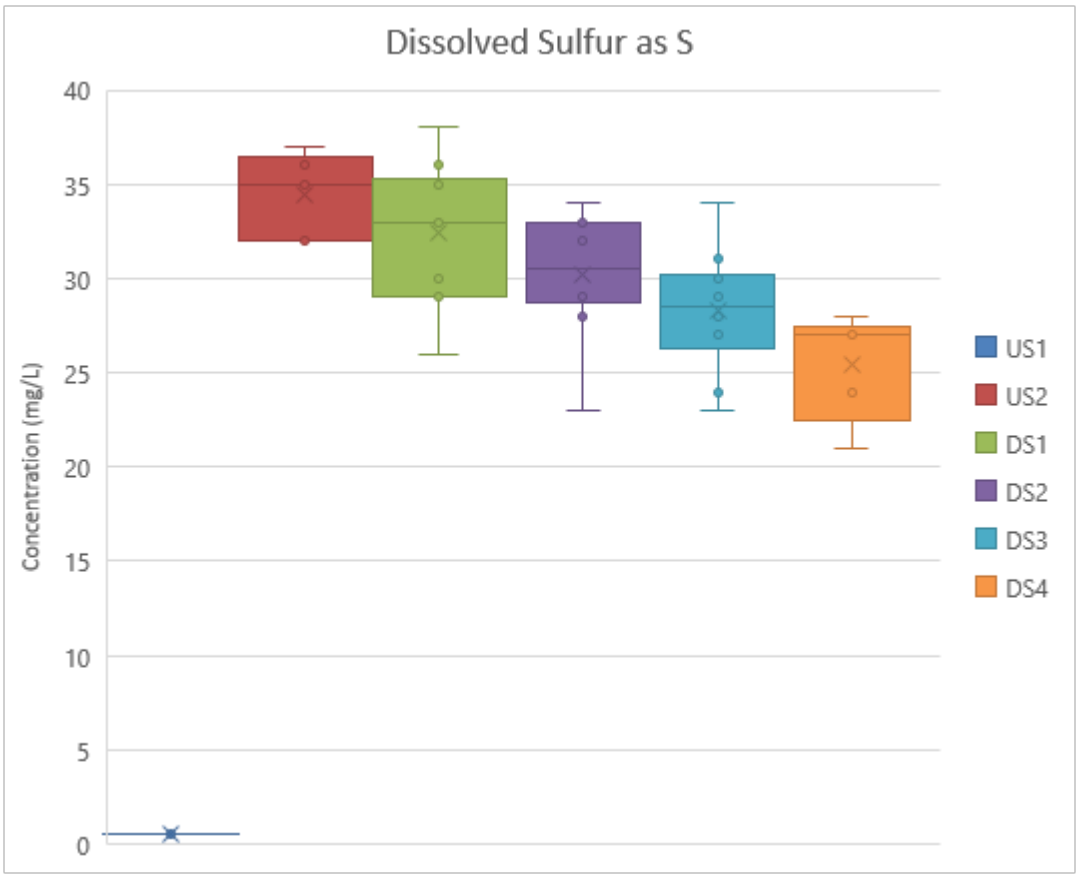

Electrical Conductivity
400
350
300
250
200
150
100
50
0
µS/cm
US1
US2
DS1
DS2
DS3
DS4

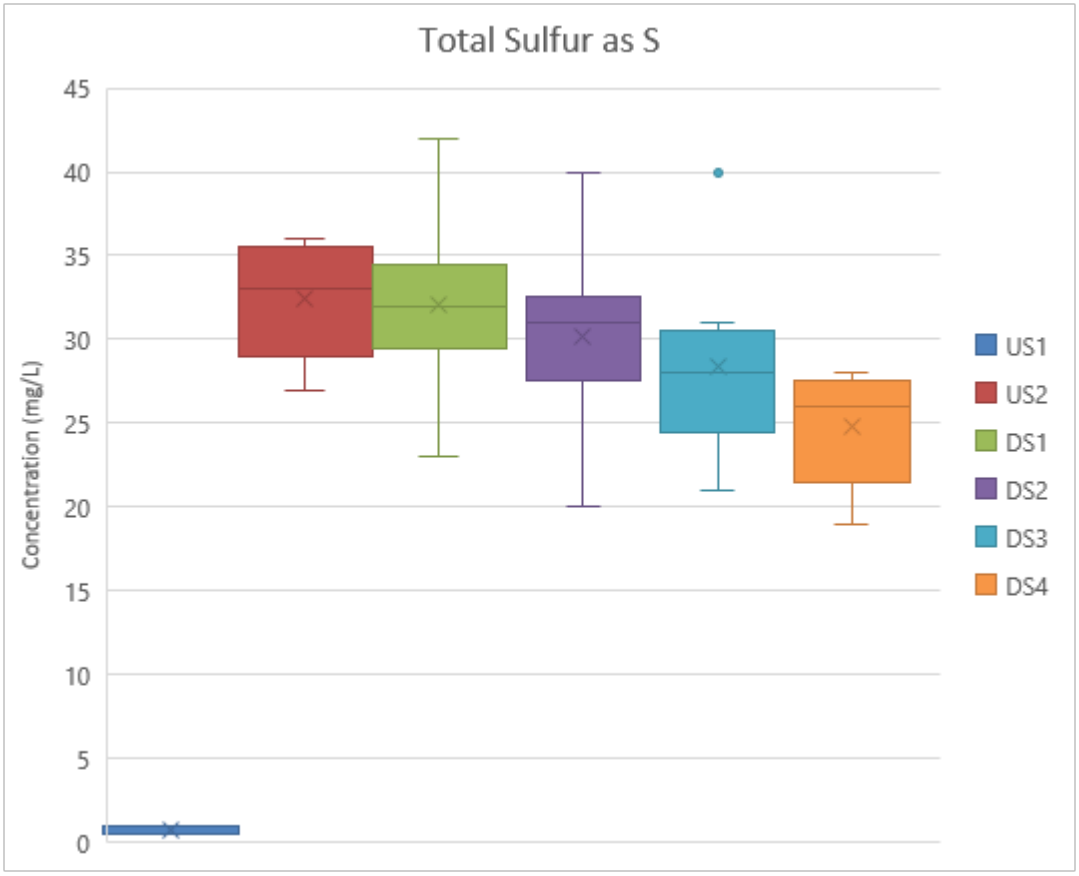

Water pH
7.5
7.0
6.5
6.0
5.5
5.0
pH Units
US1
US2
DS1
DS2
DS3
DS4

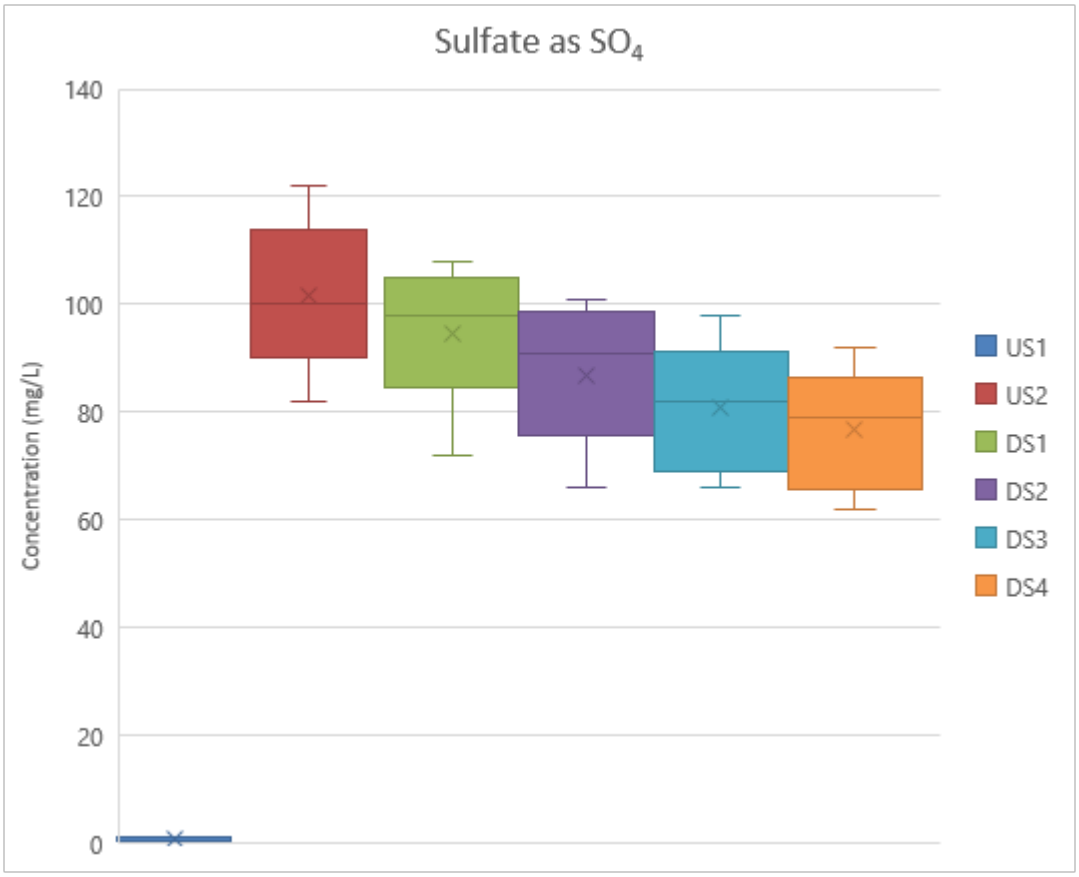

Total (Bicarbonate) Alkalinity as $CaCO_3$
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
US1
US2
DS1
DS2
DS3
DS4

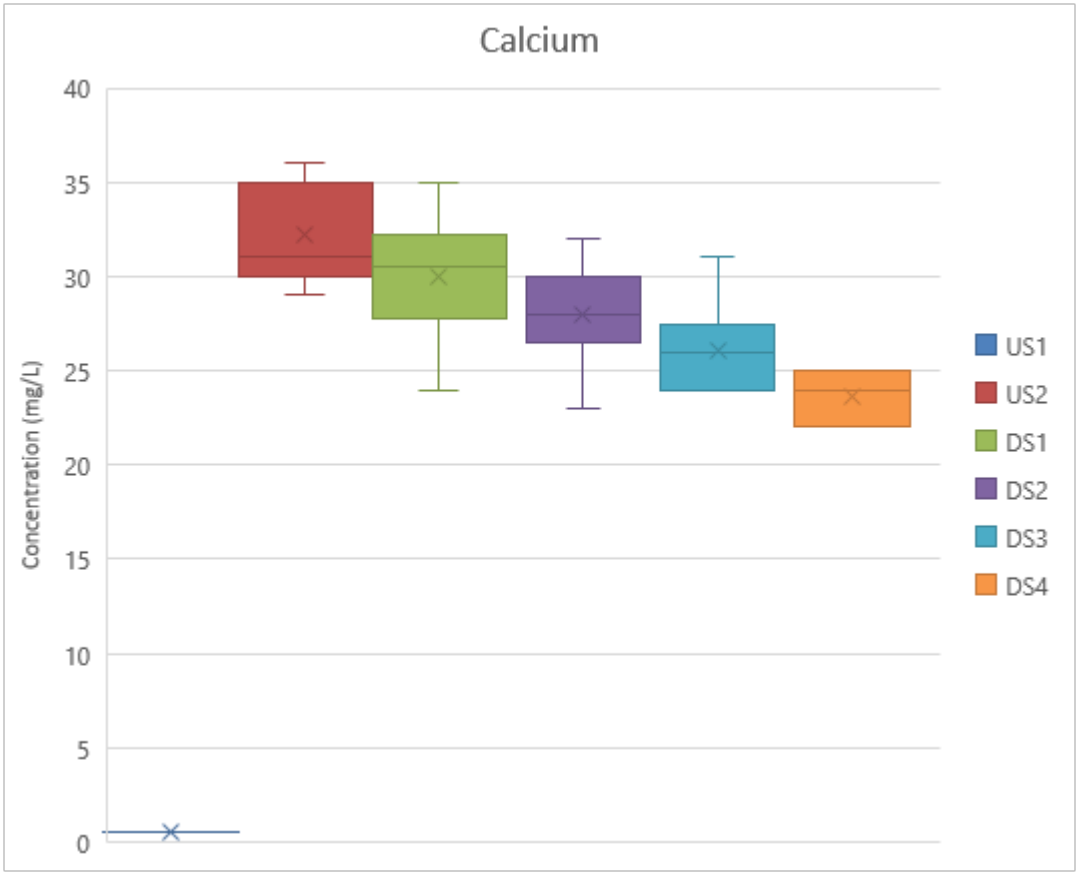

Total Hardness as $CaCO_3$
Concentration (mg/L)
160
140
120
100
80
60
40
20
0
US1
US2
DS1
DS2
DS3
DS4

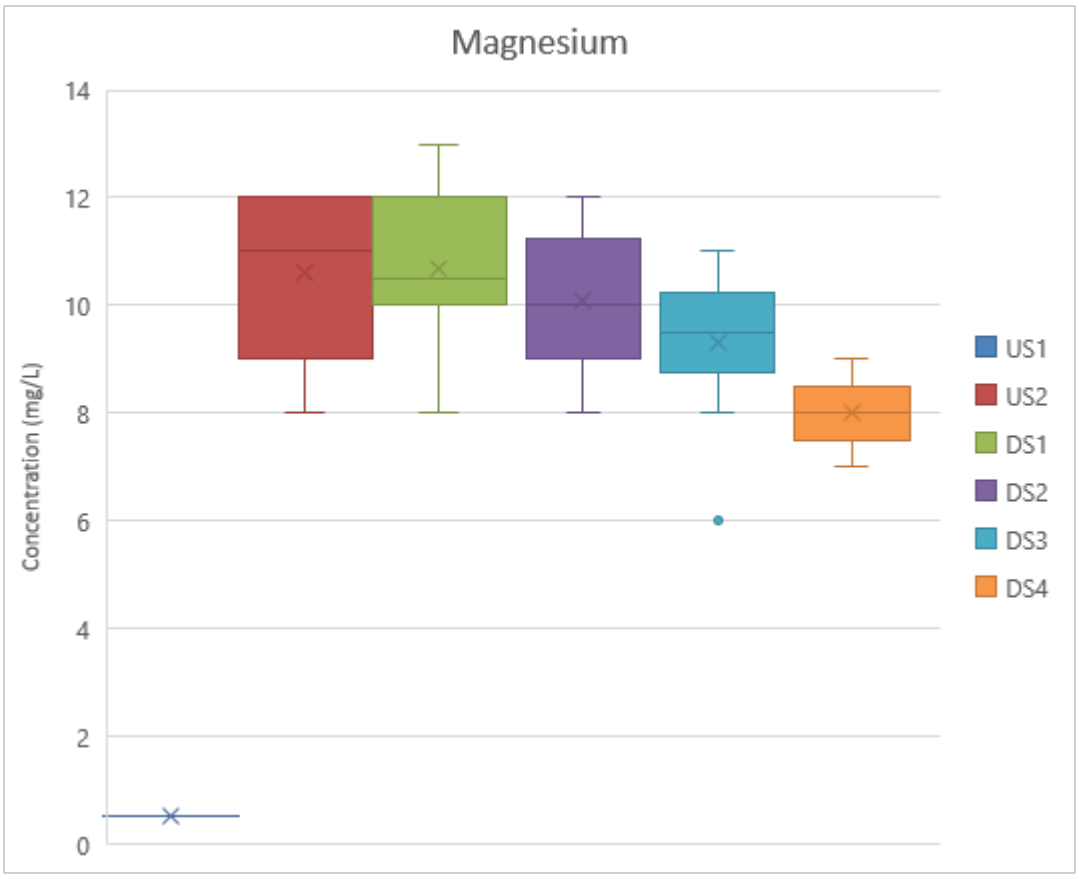

Chloride
Concentration (mg/L)
9
8
7
6
5
4
3
2
US1
US2
DS1
DS2
DS3
DS4

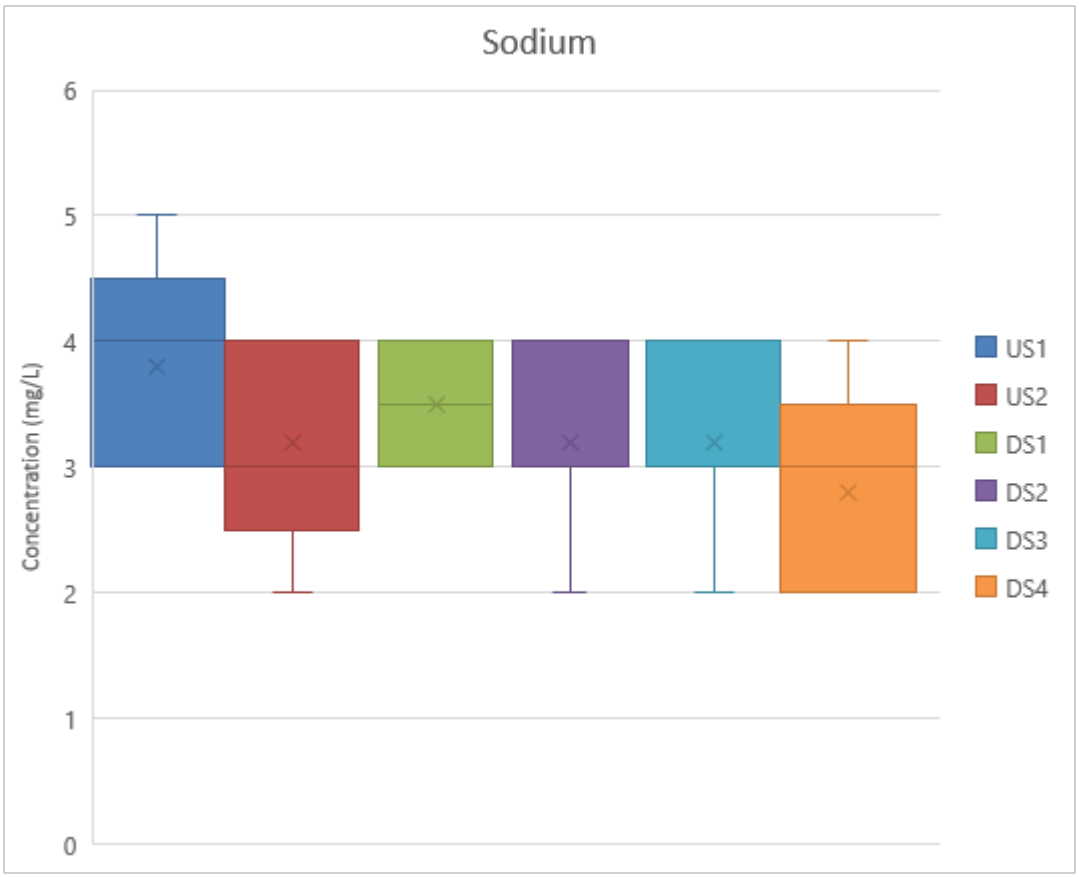

Dissolved Sulfur as S
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
US1
US2
DS1
DS2
DS3
DS4

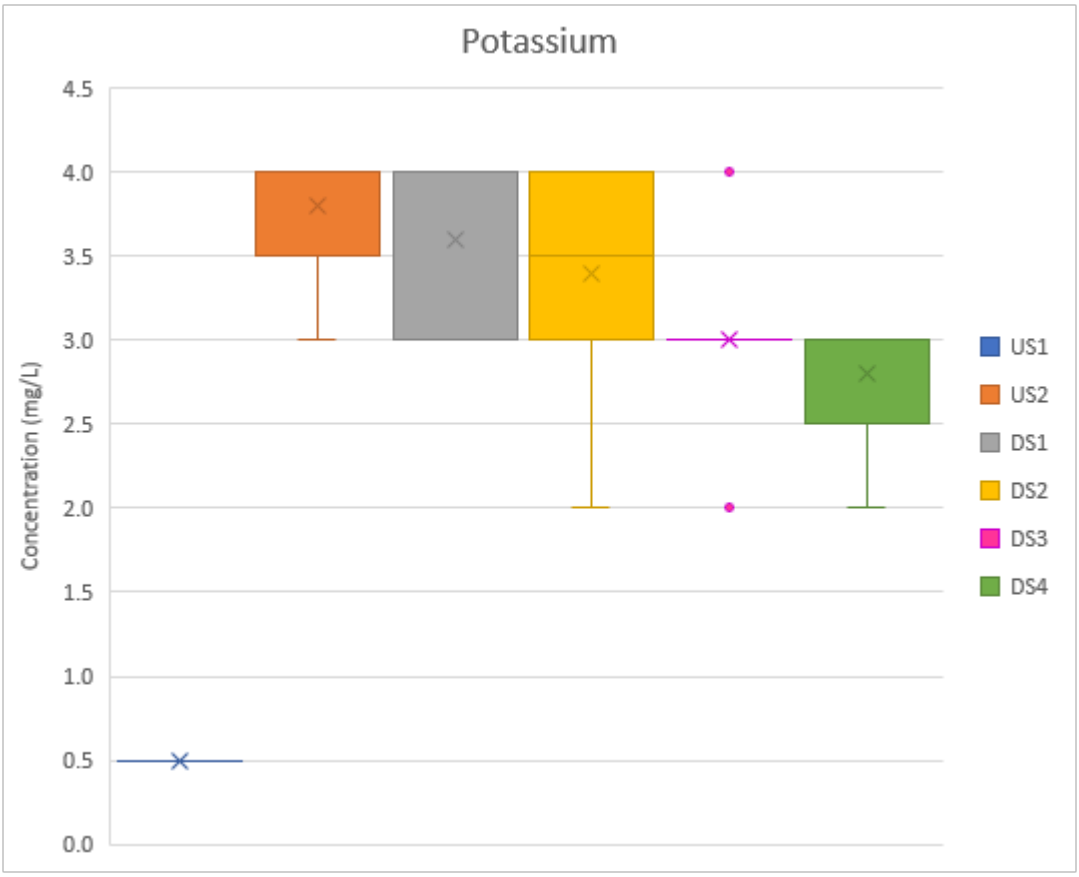

Total Sulfur as S
Concentration (mg/L)
45
40
35
30
25
20
15
10
5
0
US1
US2
DS1
DS2
DS3
DS4

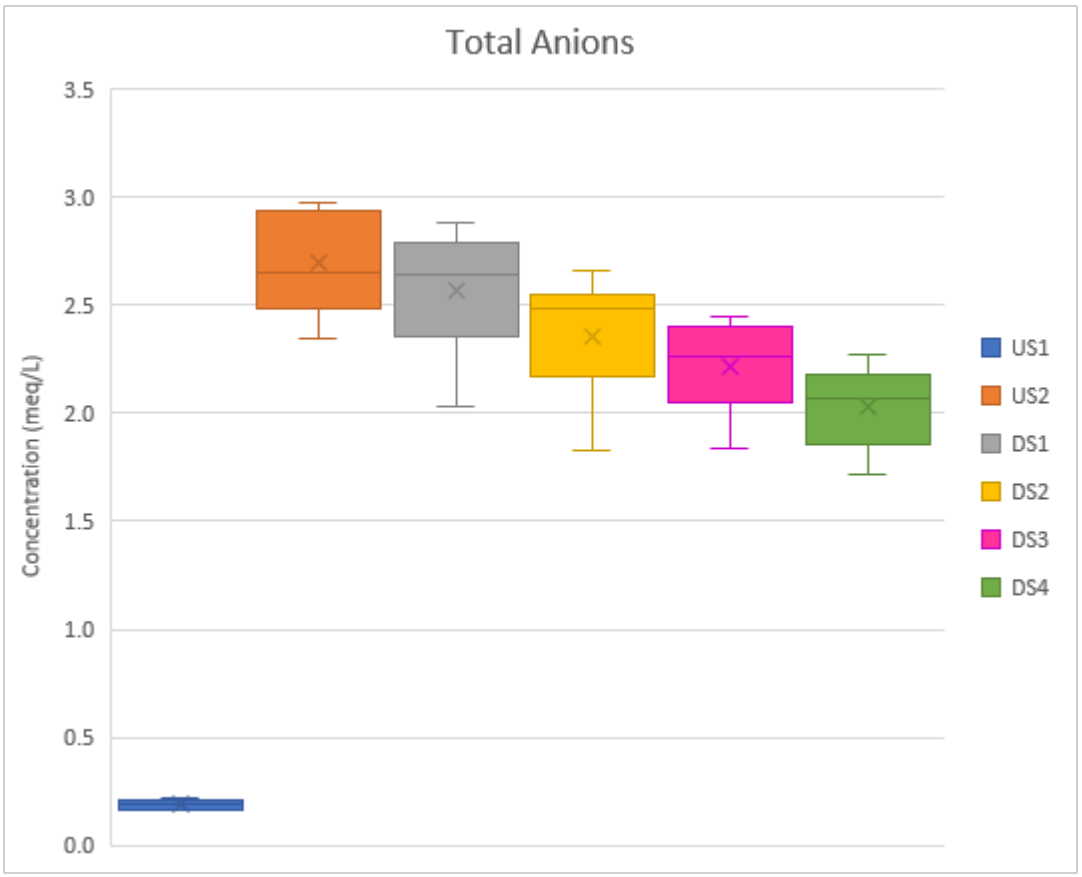

Sulfate as SO_4
Concentration (mg/L)
140
120
100
80
60
40
20
0
US1
US2
DS1
DS2
DS3
DS4

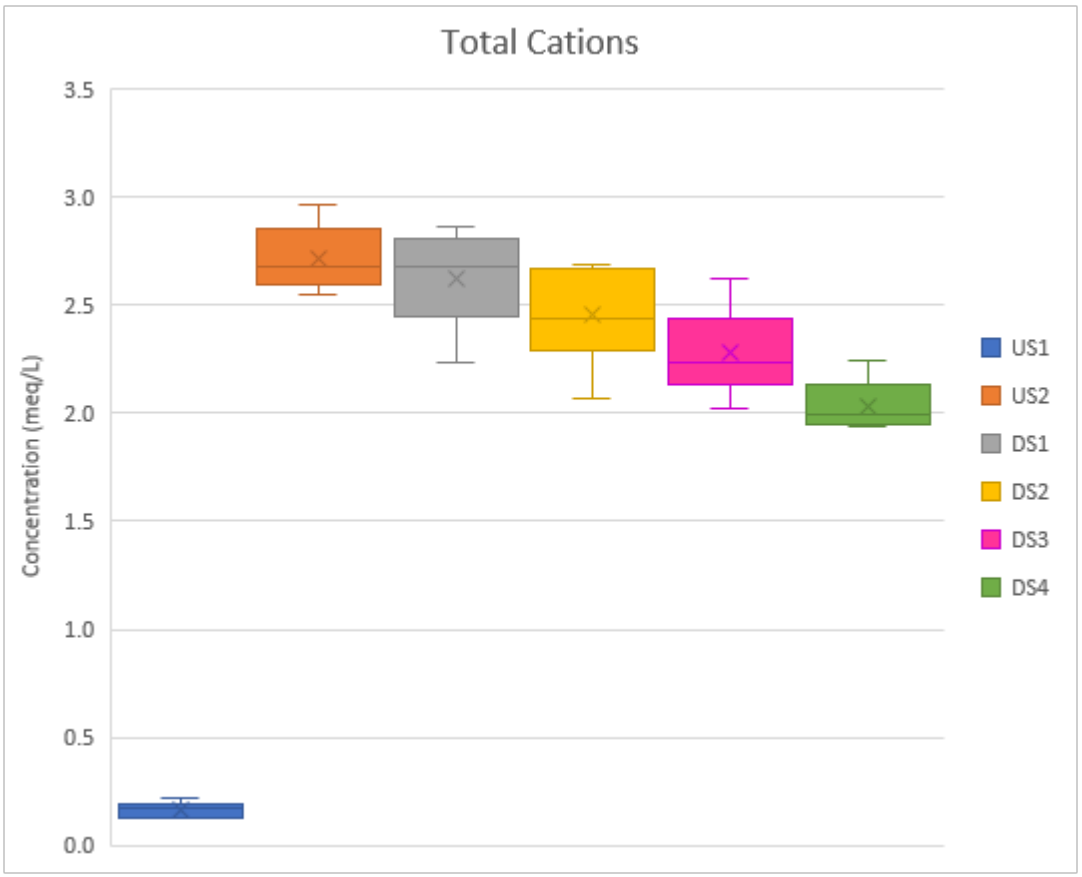

Calcium
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
US1
US2
DS1
DS2
DS3
DS4


Magnesium
Concentration (mg/L)
14
12
10
8
6
4
2
0
US1
US2
DS1
DS2
DS3
DS4


Sodium
Concentration (mg/L)
6
5
4
3
2
1
0
US1
US2
DS1
DS2
DS3
DS4


Potassium
Concentration (mg/L)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
US1
US2
DS1
DS2
DS3
DS4


Total Anions
Concentration (meq/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
US1
US2
DS1
DS2
DS3
DS4


Total Cations
Concentration (meq/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
US1
US2
DS1
DS2
DS3
DS4

3.3 Nutrients & Organics Water Quality Monitoring Data

The nutrients and organics water quality results for each sampling location and event are provided below in Site Summary **Tables 9 to 14**, Control Charts, and Box Plots:

- Nitrite Detection Limit (DL < 0.01mg/L), Oil and Grease (DL < 5 mg/L), Total Phenol (DL < 0.05mg/L), Total Cyanide (DL < 0.004mg/L) and Fluoride (DL < 0.1mg/L) concentrations were all below DL for all sites and for all sampling times to date, and are not plotted as Control Graphs or Box Plots.
- Total Phosphorus(TP) concentrations at sites US2, DS1 and DS3 where all below detection.
- TKN was below detection for all surveys at sites US2 and DS4.
- Total Nitrogen (TN) was below detection for all surveys at sites DS2 and DS4.
- TP, TKN, and TN at the sites nominated above are graphed at Detection Limit values in the Control Graphs and Box Plots.

Table 9 US1 Nutrient and Organic Water Quality Summary Statistics

	Nutrients							Dissolved		Total			Organics		Misc	
	Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Silicon as SiO2	Silicon	Silicon as SiO2	Silicon	Total Organic Carbon	Oil & Grease	Phenols	Total Cyanide	Fluoride
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.01	0.01	0.01	0.1	0.1	0.01	0.1	0.05	0.1	0.05	1	5	0.05	0.004	0.1
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	3	0	2	2	2	2	1	5	5	5	5	5	0	0	0	0
Min	0.01	<DL	0.01	0.01	0.1	0.1	-	3.9	1.82	4.2	1.98	2	<DL	<DL	<DL	<DL
Median	0.01	<DL	-	-	-	-	-	4.7	2.19	5.0	2.26	2	<DL	<DL	<DL	<DL
Mean	0.01	<DL	-	-	-	-	-	4.9	2.30	4.9	2.26	2	<DL	<DL	<DL	<DL
SD	0.01	<DL	-	-	-	-	-	0.9	0.43	0.5	0.19	0	<DL	<DL	<DL	<DL
80th percentile	0.02	<DL	-	-	-	-	-	5.3	2.47	5.1	2.37	2	<DL	<DL	<DL	<DL
Max	0.03	<DL	0.03	0.03	0.2	0.2	0.02	6.4	2.99	5.6	2.51	2	<DL	<DL	<DL	<DL

Table 10 US2 Nutrient and Organic Water Quality Summary Statistics

	Nutrients							Dissolved		Total			Organics		Misc	
	Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Silicon as SiO2	Silicon	Silicon as SiO2	Silicon	Total Organic Carbon	Oil & Grease	Phenols	Total Cyanide	Fluoride
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.01	0.01	0.01	0.1	0.1	0.01	0.1	0.05	0.1	0.05	1	5	0.05	0.004	0.1
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	3	0	1	1	2	2	0	5	5	5	5	2	0	0	0	0
Min	0.01	<DL	-	-	0.2	0.2	<DL	5.0	2.35	4.8	2.24	1	<DL	<DL	<DL	<DL
Median	0.01	<DL	-	-	-	-	<DL	5.4	2.52	5.9	2.61	-	<DL	<DL	<DL	<DL
Mean	0.03	<DL	-	-	-	-	<DL	5.7	2.68	5.7	2.61	-	<DL	<DL	<DL	<DL
SD	0.04	<DL	-	-	-	-	<DL	0.8	0.38	0.6	0.24	-	<DL	<DL	<DL	<DL
80th percentile	0.05	<DL	-	-	-	-	<DL	6.1	2.85	6.1	2.82	-	<DL	<DL	<DL	<DL
Max	0.11	<DL	0.04	0.04	0.2	0.2	<DL	7.1	3.32	6.4	2.84	2	<DL	<DL	<DL	<DL

Table 11 DS1 Nutrient and Organic Water Quality Summary Statistics

	Nutrients							Dissolved		Total			Organics		Misc	
	Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Silicon as SiO2	Silicon	Silicon as SiO2	Silicon	Total Organic Carbon	Oil & Grease	Phenols	Total Cyanide	Fluoride
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.01	0.01	0.01	0.1	0.1	0.01	0.1	0.05	0.1	0.05	1	5	0.05	0.004	0.1
Sample size (n)	10	10	10	10	10	10	10	10	10	9	9	10	10	10	10	10
n > DL	3	0	5	5	2	2	0	10	10	9	9	5	0	0	0	0
Min	0.01	<DL	0.01	0.01	0.2	0.2	<DL	5.2	2.42	5.0	2.35	1	<DL	<DL	<DL	<DL
Median	0.01	<DL	0.01	0.01	-	-	<DL	5.5	2.54	5.8	2.66	0.75	<DL	<DL	<DL	<DL
Mean	0.01	<DL	0.01	0.01	-	-	<DL	5.6	2.61	5.7	2.61	0.95	<DL	<DL	<DL	<DL
SD	0.01	<DL	0.01	0.01	-	-	<DL	0.6	0.27	0.4	0.16	0.60	<DL	<DL	<DL	<DL
80th percentile	0.01	<DL	0.02	0.02	-	-	<DL	5.6	2.64	6.0	2.74	1.20	<DL	<DL	<DL	<DL
Max	0.03	<DL	0.03	0.03	0.3	0.3	<DL	7.1	3.33	6.3	2.80	2	<DL	<DL	<DL	<DL

Table 12 DS2 Nutrient and Organic Water Quality Summary Statistics

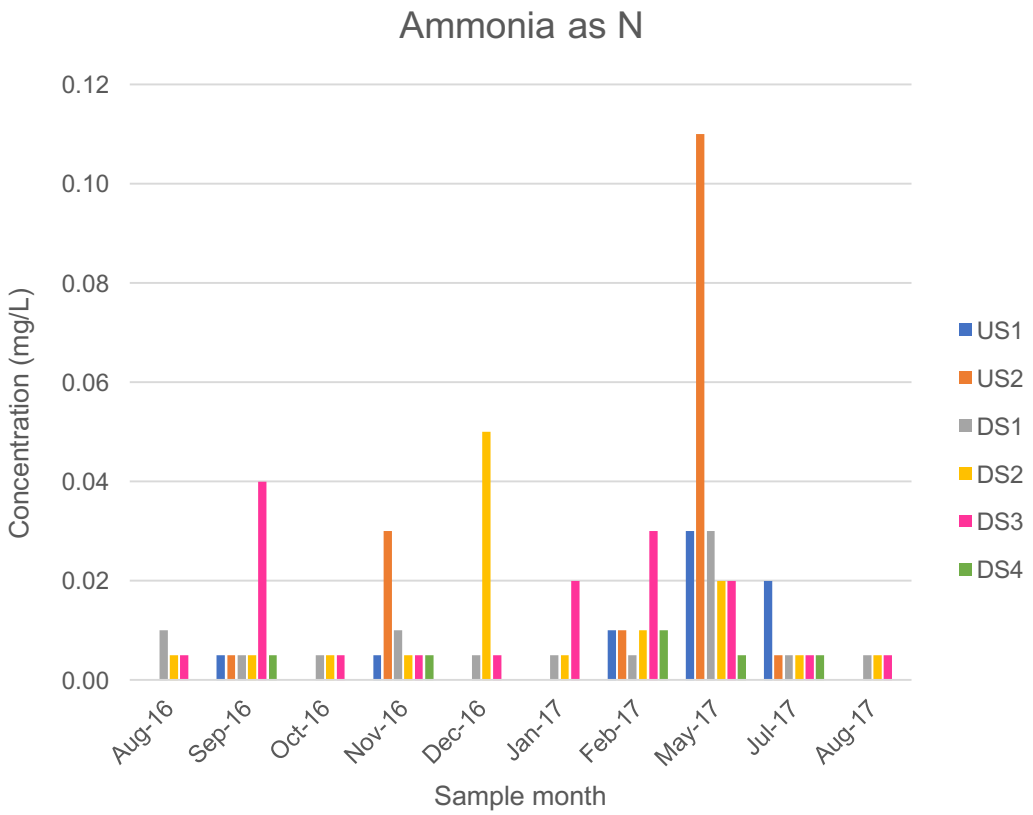
	Nutrients							Dissolved		Total			Organics		Misc	
	Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Silicon as SiO2	Silicon	Silicon as SiO2	Silicon	Total Organic Carbon	Oil & Grease	Phenols	Total Cyanide	Fluoride
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.01	0.01	0.01	0.1	0.1	0.01	0.1	0.05	0.1	0.05	1	5	0.05	0.004	0.1
Sample size (n)	10	10	10	10	10	10	10	10	10	9	9	10	10	10	10	10
n > DL	3	0	6	6	0	0	1	10	10	9	9	2	0	0	0	0
Min	0.01	<DL	0.01	0.01	<DL	<DL	-	5.0	2.36	4.7	2.20	1	<DL	<DL	<DL	<DL
Median	0.01	<DL	0.02	0.02	<DL	<DL	-	5.5	2.54	5.6	2.63	-	<DL	<DL	<DL	<DL
Mean	0.01	<DL	0.02	0.02	<DL	<DL	-	5.6	2.60	5.6	2.59	-	<DL	<DL	<DL	<DL
SD	0.01	<DL	0.01	0.01	<DL	<DL	-	0.6	0.26	0.5	0.20	-	<DL	<DL	<DL	<DL
80th percentile	0.01	<DL	0.02	0.02	<DL	<DL	-	5.6	2.63	5.9	2.75	-	<DL	<DL	<DL	<DL
Max	0.05	<DL	0.03	0.03	<DL	<DL	0.03	7.0	3.25	6.4	2.85	2	<DL	<DL	<DL	<DL

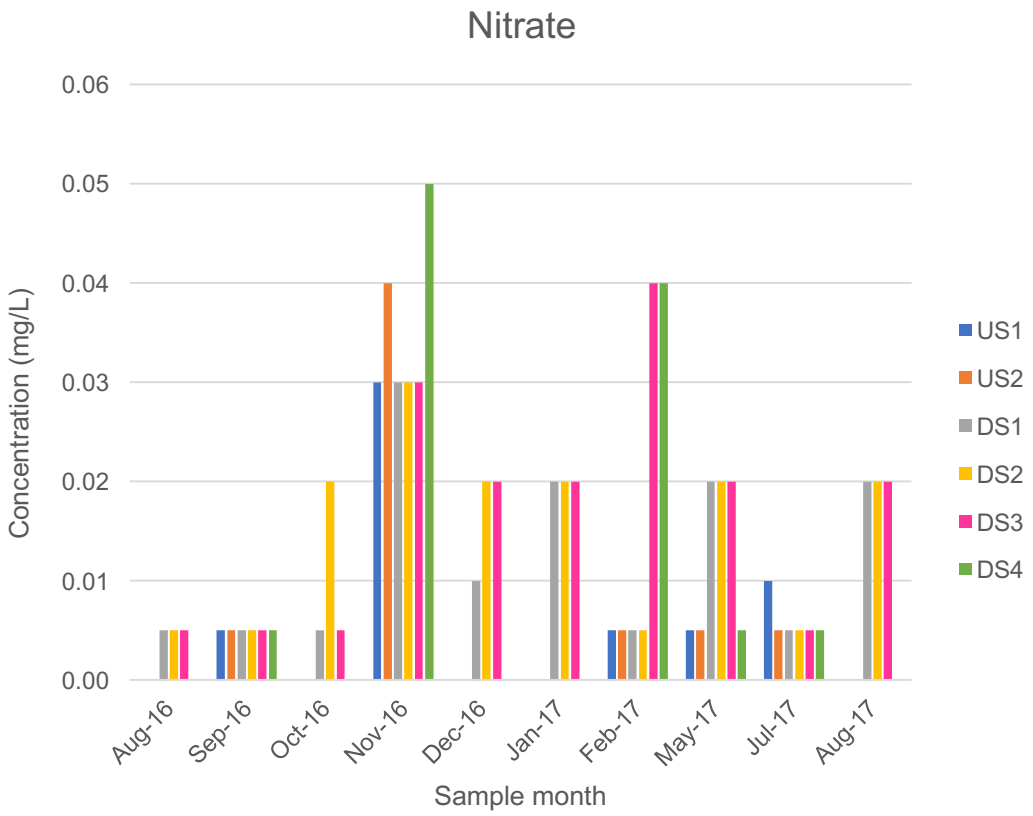
Table 13 DS3 Nutrient and Organic Water Quality Summary Statistics

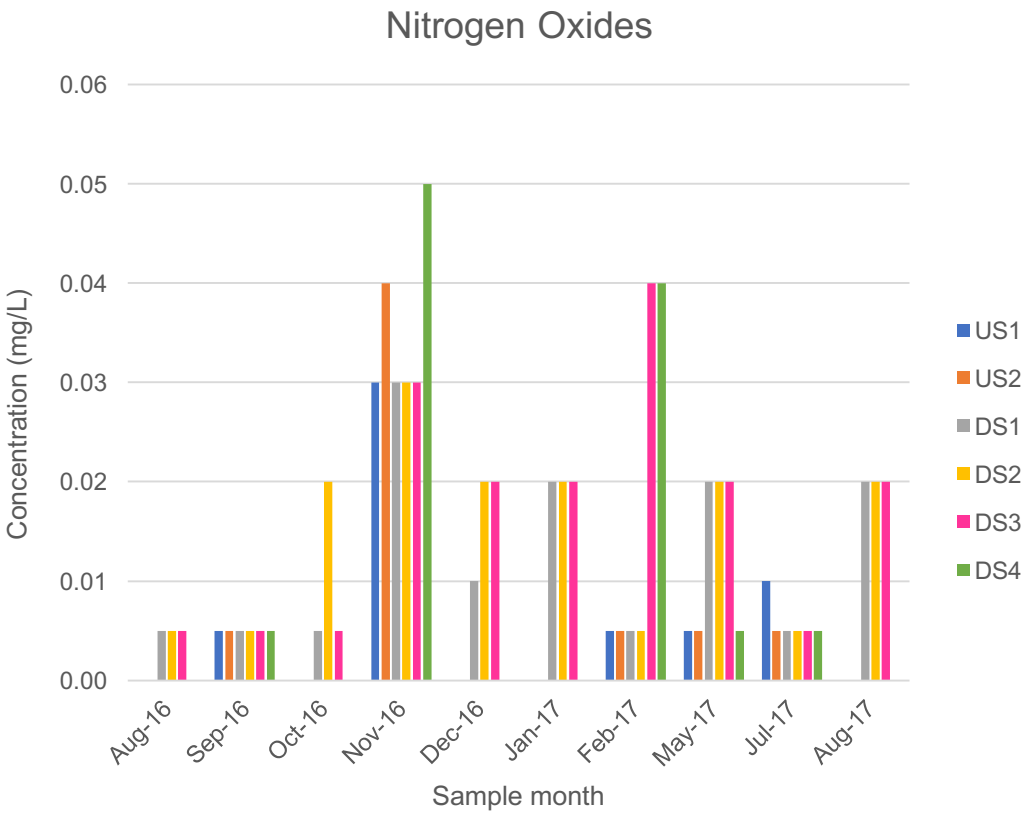
	Nutrients							Dissolved		Total			Organics		Misc	
	Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Silicon as SiO2	Silicon	Silicon as SiO2	Silicon	Total Organic Carbon	Oil & Grease	Phenols	Total Cyanide	Fluoride
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.01	0.01	0.01	0.1	0.1	0.01	0.1	0.05	0.1	0.05	1	5	0.05	0.004	0.1
Sample size (n)	10	10	10	10	10	10	10	10	10	9	9	10	10	10	10	10
n > DL	4	0	6	6	1	1	0	10	10	9	9	1	0	0	0	0
Min	0.01	<DL	0.01	0.01	-	-	<DL	5.0	2.32	4.7	2.20	-	<DL	<DL	<DL	<DL
Median	0.01	<DL	0.02	0.02	-	-	<DL	5.3	2.49	5.6	2.57	-	<DL	<DL	<DL	<DL
Mean	0.01	<DL	0.02	0.02	-	-	<DL	5.5	2.55	5.5	2.55	-	<DL	<DL	<DL	<DL
SD	0.01	<DL	0.01	0.01	-	-	<DL	0.5	0.24	0.5	0.19	-	<DL	<DL	<DL	<DL
80th percentile	0.02	<DL	0.02	0.02	-	-	<DL	5.5	2.55	5.8	2.69	-	<DL	<DL	<DL	<DL
Max	0.04	<DL	0.04	0.04	0.1	0.1	<DL	6.8	3.20	6.3	2.80	2	<DL	<DL	<DL	<DL

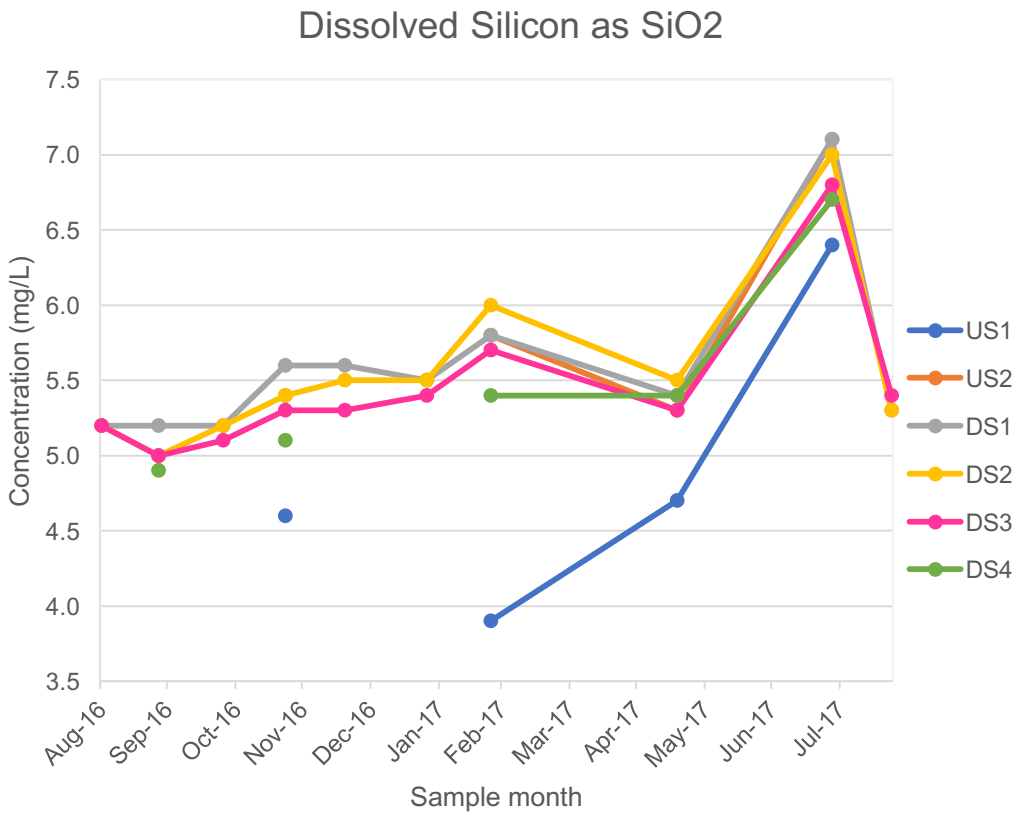
Table 14 DS4 Nutrient and Organic Water Quality Summary Statistics

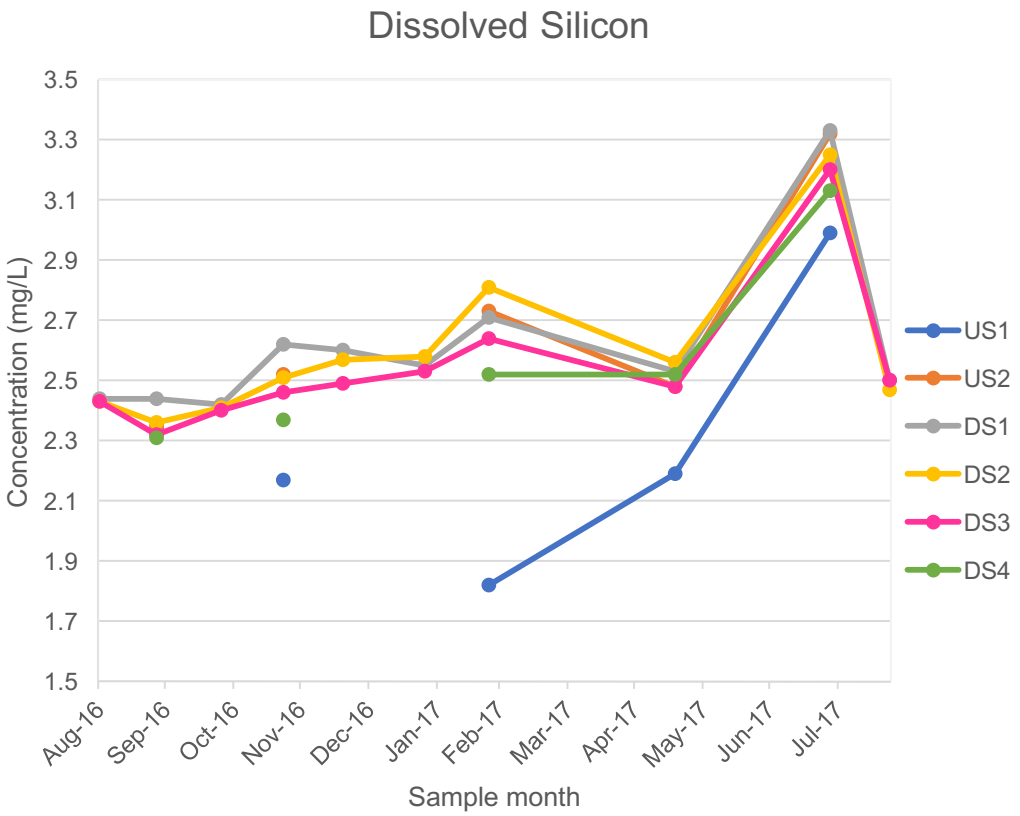
	Nutrients							Dissolved		Total			Organics		Misc	
	Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Silicon as SiO2	Silicon	Silicon as SiO2	Silicon	Total Organic Carbon	Oil & Grease	Phenols	Total Cyanide	Fluoride
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.01	0.01	0.01	0.1	0.1	0.01	0.1	0.05	0.1	0.05	1	5	0.05	0.004	0.1
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	1	0	2	2	0	0	1	5	5	5	5	1	0	0	0	0
Min	-	<DL	0.04	0.04	<DL	<DL	-	4.9	2.31	4.6	2.16	-	<DL	<DL	<DL	<DL
Median	-	<DL	-	-	<DL	<DL	-	5.4	2.52	5.5	2.55	-	<DL	<DL	<DL	<DL
Mean	-	<DL	-	-	<DL	<DL	-	5.5	2.57	5.4	2.48	-	<DL	<DL	<DL	<DL
SD	-	<DL	-	-	<DL	<DL	-	0.7	0.33	0.5	0.21	-	<DL	<DL	<DL	<DL
80th percentile	-	<DL	-	-	<DL	<DL	-	5.7	2.64	5.6	2.59	-	<DL	<DL	<DL	<DL
Max	0.01	<DL	0.05	0.05	<DL	<DL	0.02	6.7	3.13	6.1	2.71	2	<DL	<DL	<DL	<DL

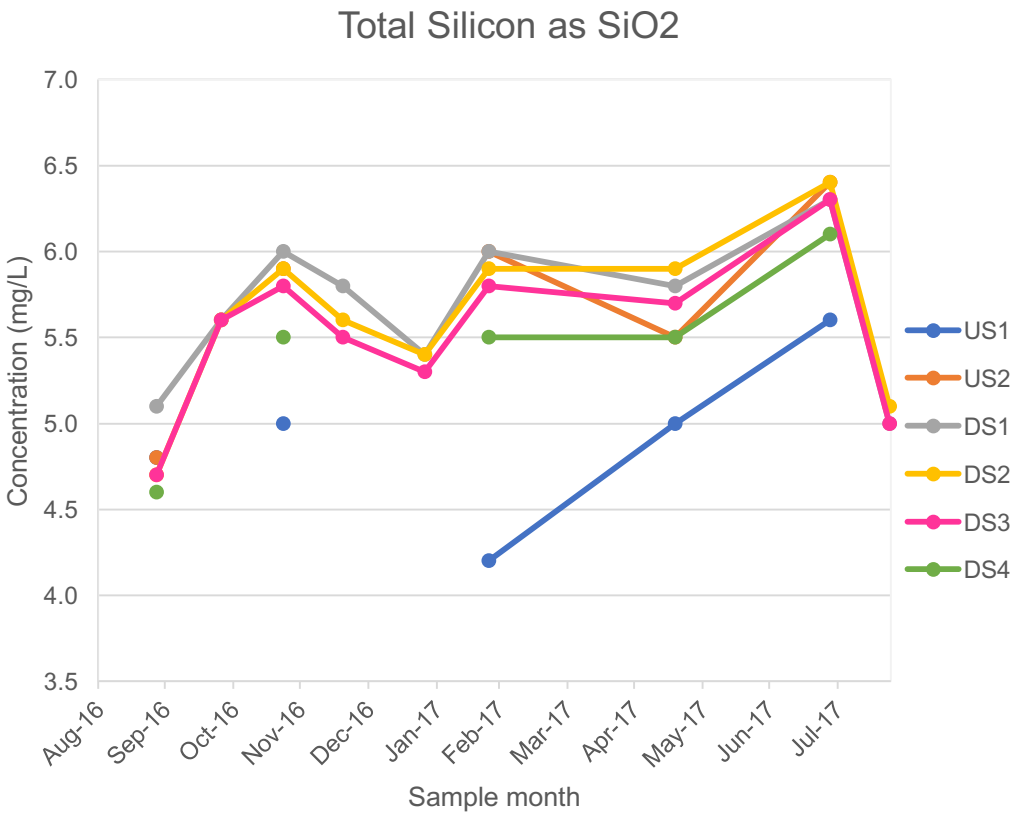

Ammonia as N
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

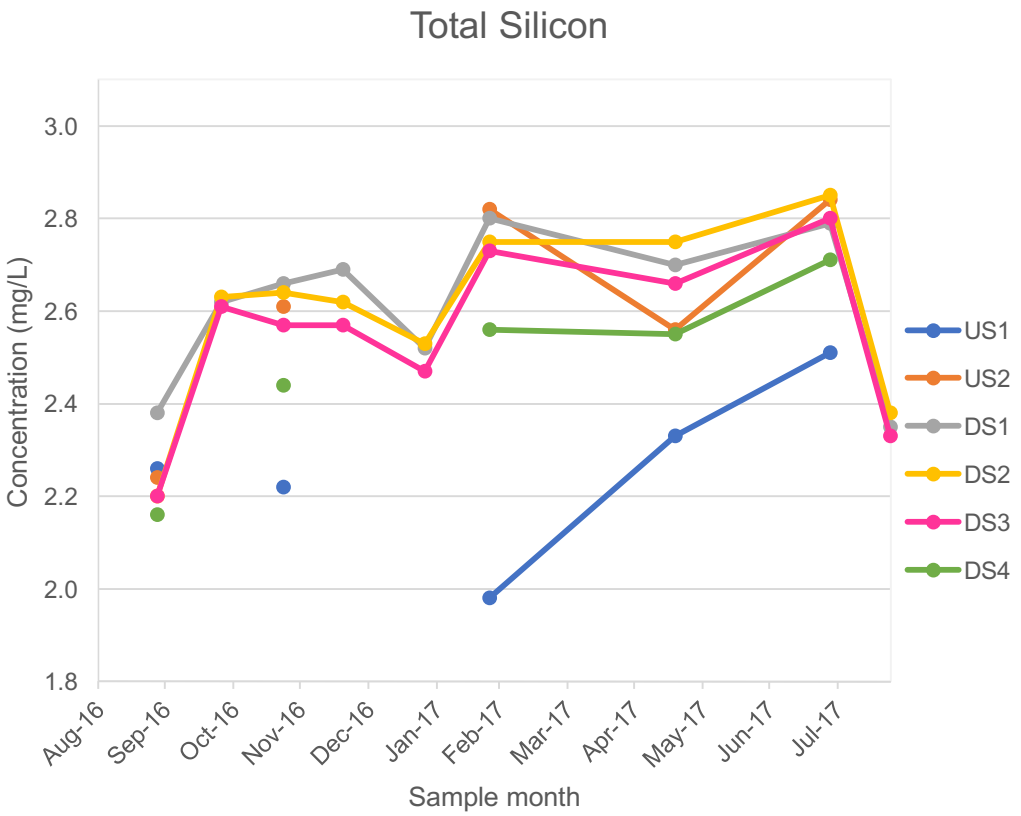

Nitrate
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Nitrogen Oxides
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Dissolved Silicon as SiO2
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Dissolved Silicon
Concentration (mg/L)
3.5
3.3
3.1
2.9
2.7
2.5
2.3
2.1
1.9
1.7
1.5
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Total Silicon as SiO2
Concentration (mg/L)
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Total Silicon
Concentration (mg/L)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
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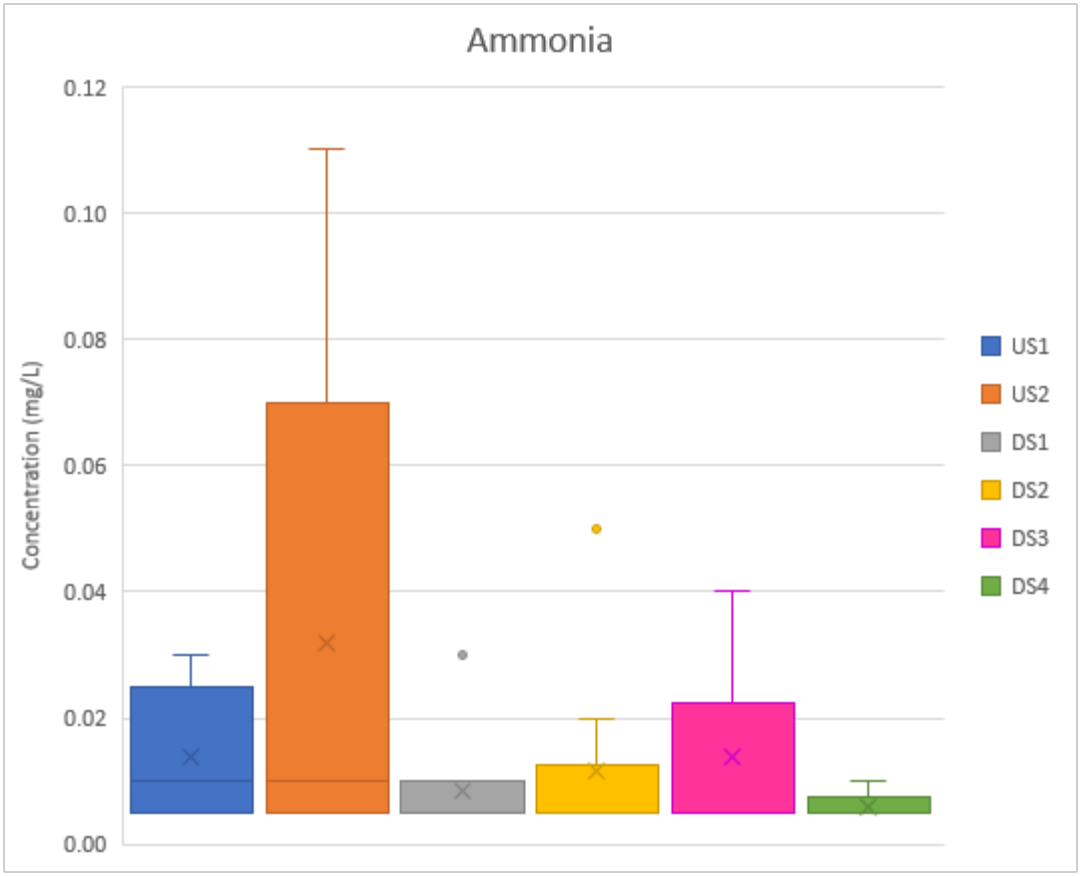
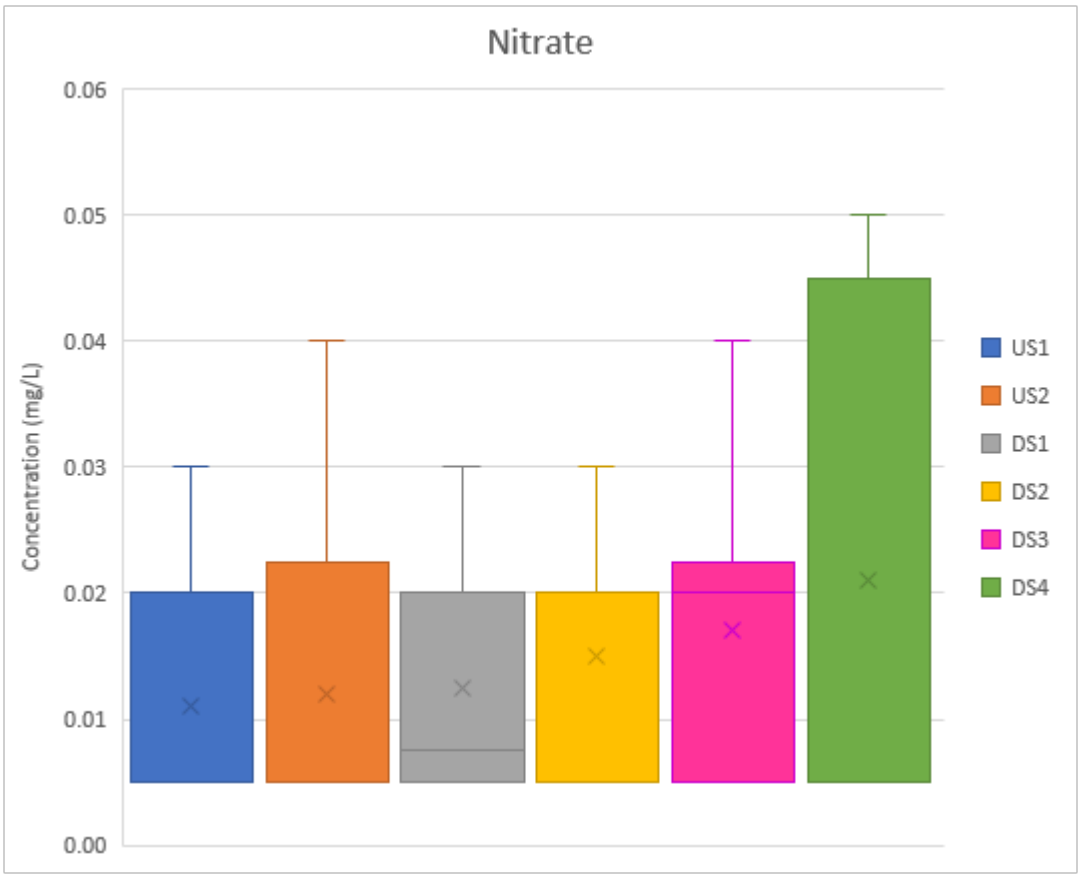
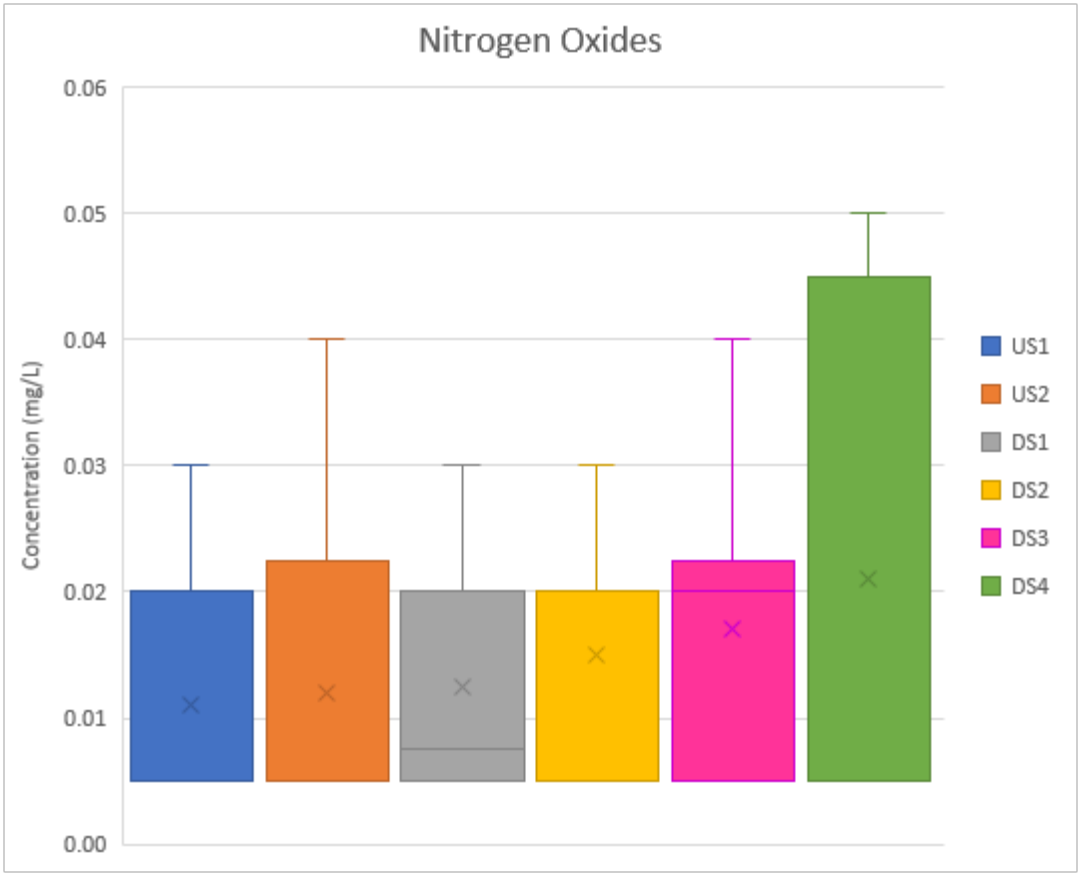
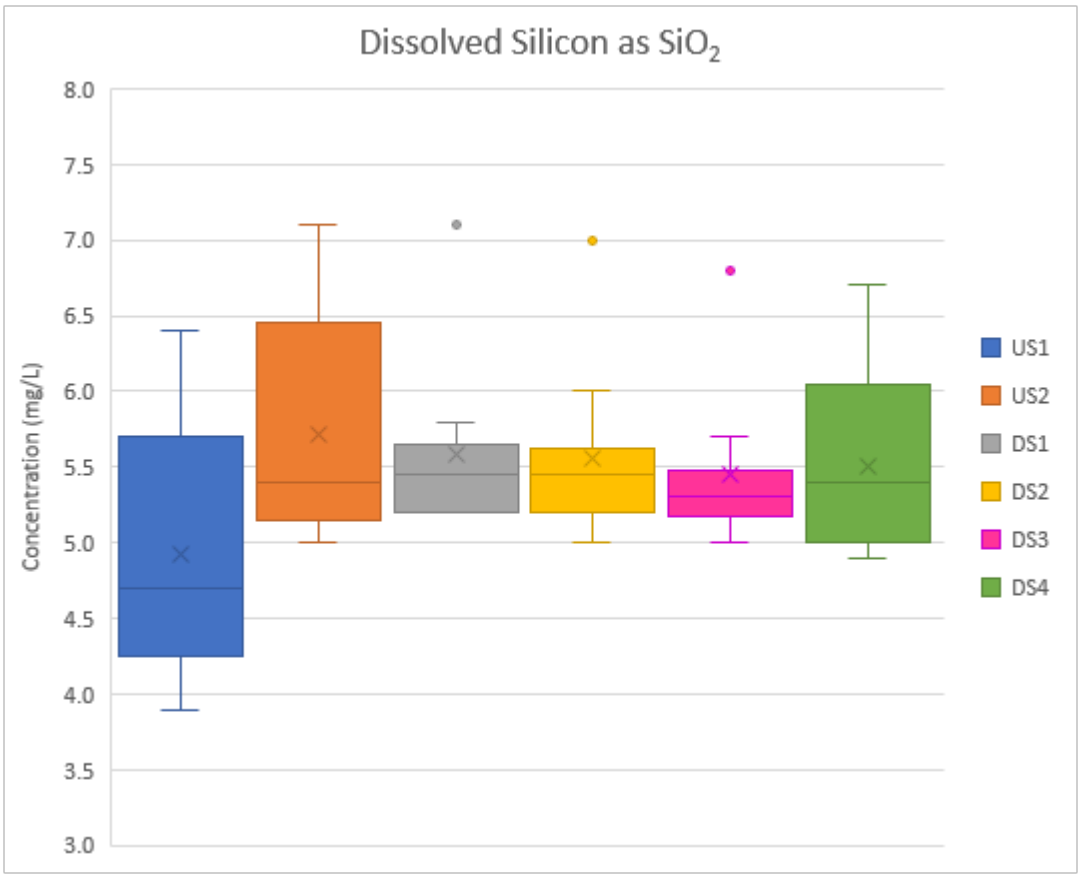
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Ammonia
Concentration (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
US1
US2
DS1
DS2
DS3
DS4


Nitrate
Concentration (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4


Nitrogen Oxides
Concentration (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4


Dissolved Silicon as SiO_2
Concentration (mg/L)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
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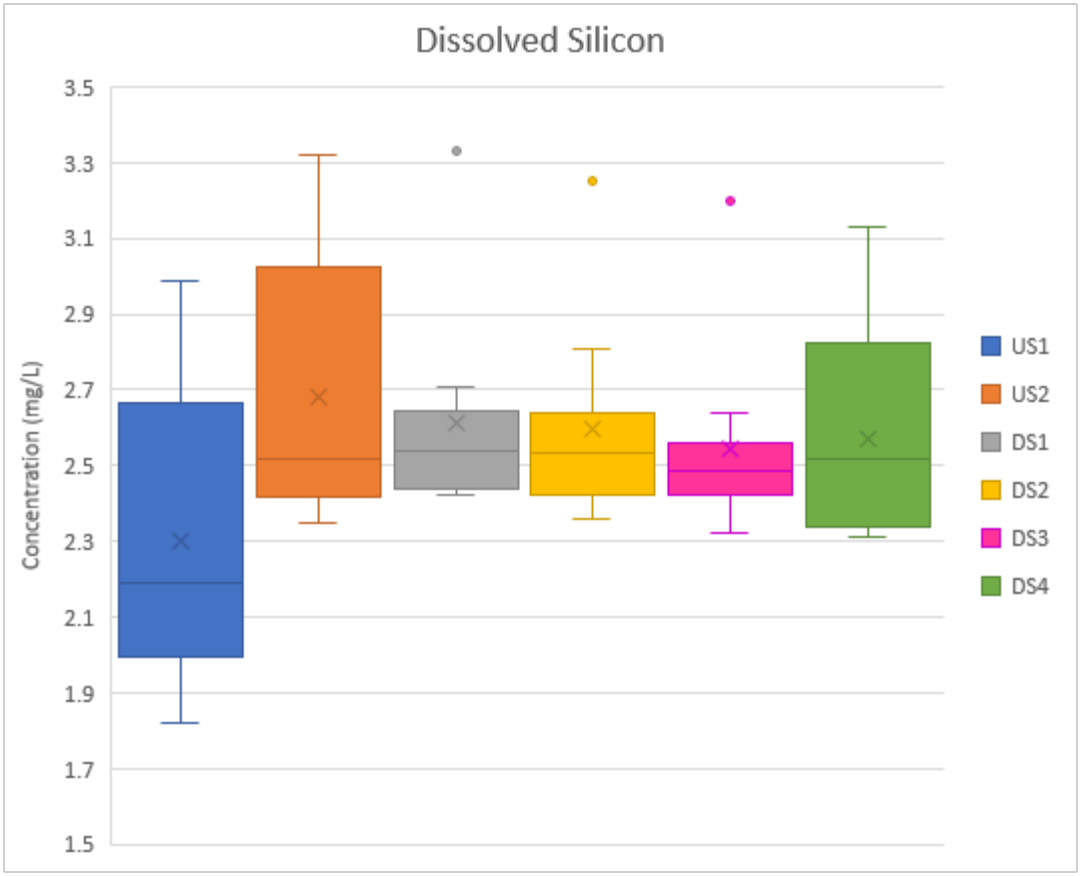
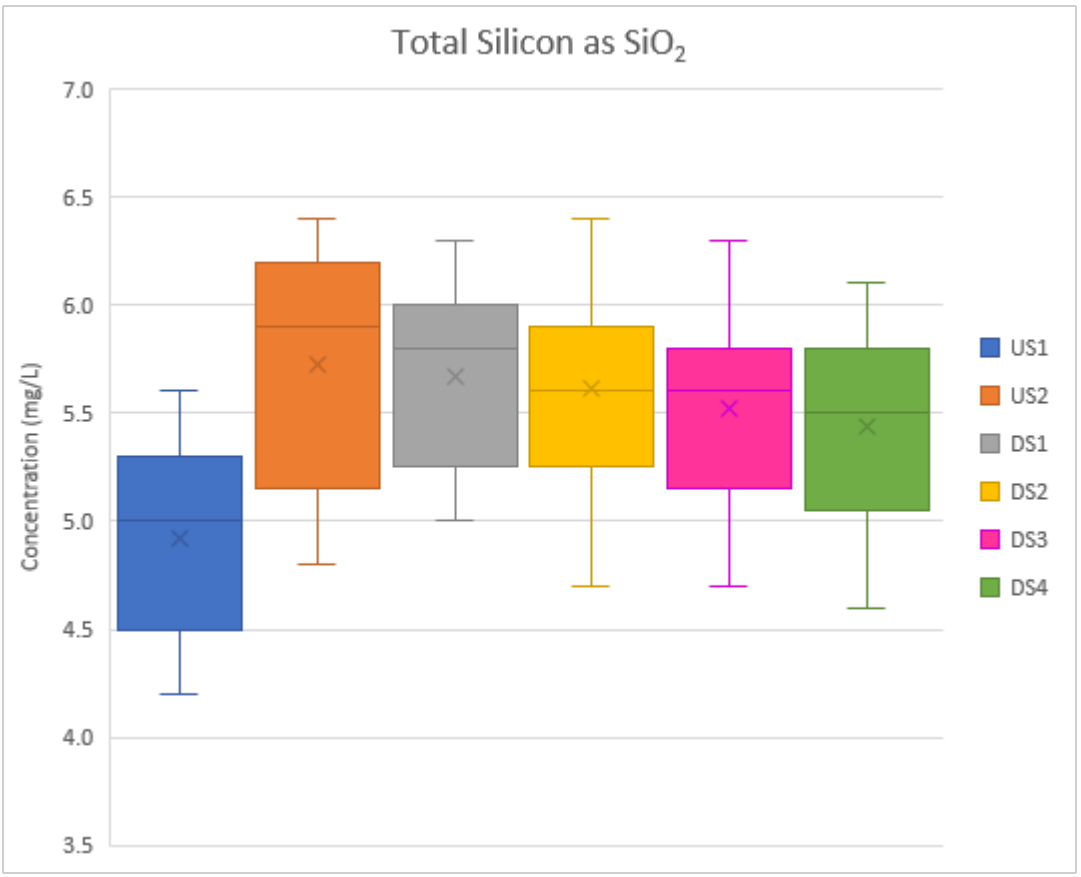
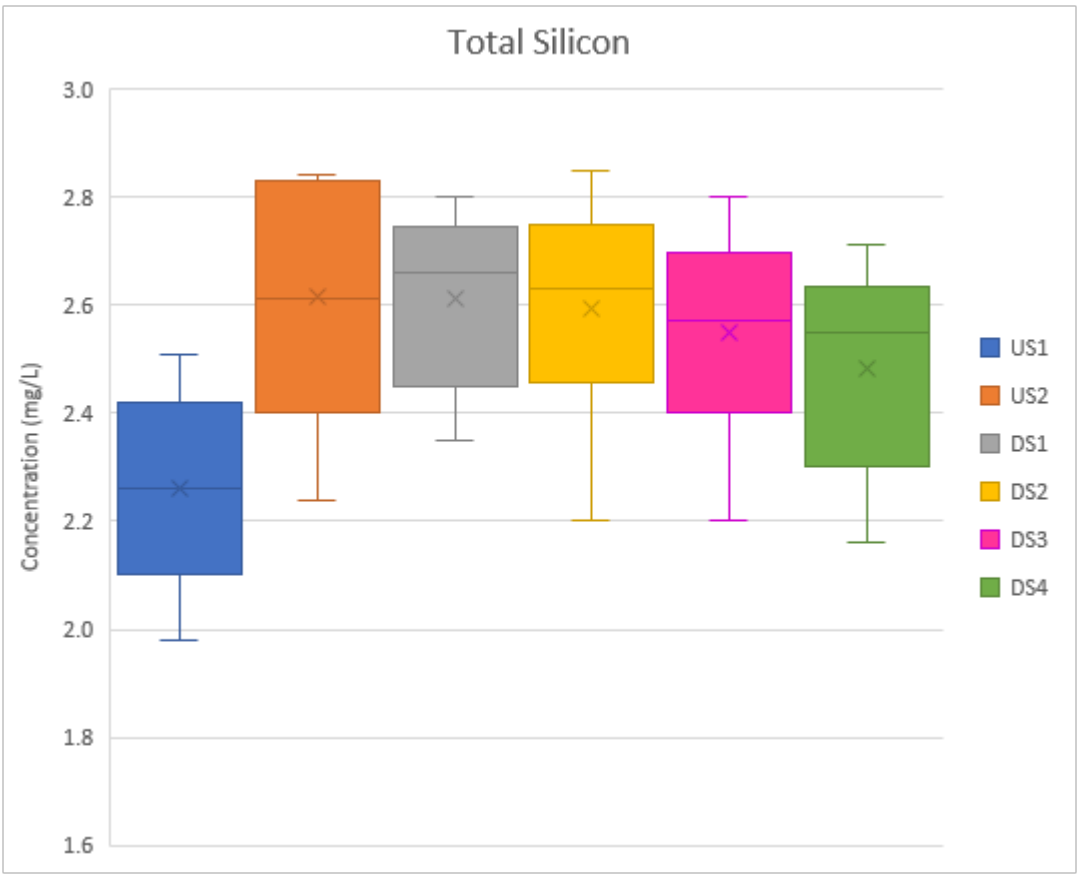
3.0
US1
US2
DS1
DS2
DS3
DS4


Dissolved Silicon
Concentration (mg/L)
3.5
3.3
3.1
2.9
2.7
2.5
2.3
2.1
1.9
1.7
1.5
US1
US2
DS1
DS2
DS3
DS4


Total Silicon as SiO_2
Concentration (mg/L)
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
US1
US2
DS1
DS2
DS3
DS4


Total Silicon
Concentration (mg/L)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
US1
US2
DS1
DS2
DS3
DS4

3.4 Metals and Metalloids Water Quality Monitoring Data

The metal and metalloid water quality results for each sampling location and event are provided below in Site Summary **Tables 9 to 14** and associated Control Charts and Box Plots:

- Of the 21 analytes only Aluminium Barium, Cobalt, Iron, Lithium, Manganese, Nickel, Rubidium, Strontium and Zinc had total and/or dissolved concentrations above detection limits for a meaningful number of samples and sites, and Molybdenum concentrations were above detection at a few replicate samples for sites US2, DS1 and DS2. The results for these sites are graphed in the Control Graphs and Box Plots below.
- Of the remaining analytes, Selenium concentrations were all below the (higher) detection limit of 0.01mg/L for all samples, whereas the ANZECC (2000) Default Trigger Level for 95% protection of biota (DTV95) is 0.005mg/L.
- The remaining analytes (Antimony, Arsenic, Beryllium, Boron, Cadmium, Chromium, Copper, Lead and Uranium) had no or a very few samples above Detection.

Table 15 US1 Metal and Metalloid Water Quality Summary Statistics

	Total Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	5	0	0	1	5	0	0	0	0	0	1	5	0	0	0	0	5	0	1	1	5
Min	0.04	<DL	<DL	-	0.004	<DL	<DL	<DL	<DL	<DL	-	0.046	<DL	<DL	<DL	<DL	0.003	<DL	-	-	0.42
Median	0.07	<DL	<DL	-	0.008	<DL	<DL	<DL	<DL	<DL	-	0.061	<DL	<DL	<DL	<DL	0.004	<DL	-	-	0.82
Mean	0.08	<DL	<DL	-	0.008	<DL	<DL	<DL	<DL	<DL	-	0.062	<DL	<DL	<DL	<DL	0.004	<DL	-	-	0.72
SD	0.05	<DL	<DL	-	0.003	<DL	<DL	<DL	<DL	<DL	-	0.014	<DL	<DL	<DL	<DL	0.001	<DL	-	-	0.19
80th percentile	0.10	<DL	<DL	-	0.010	<DL	<DL	<DL	<DL	<DL	-	0.072	<DL	<DL	<DL	<DL	0.005	<DL	-	-	0.84
Max	0.16	<DL	<DL	0.001	0.013	<DL	<DL	<DL	<DL	<DL	0.004	0.082	<DL	<DL	<DL	<DL	0.005	<DL	0.009	0.06	0.86
	Dissolved Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	5	0	0	0	5	0	0	0	0	1	2	5	0	0	0	0	5	0	0	0	5
Min	0.02	<DL	<DL	<DL	0.005	<DL	<DL	<DL	<DL	-	0.001	0.033	<DL	<DL	<DL	<DL	0.002	<DL	<DL	<DL	0.13
Median	0.04	<DL	<DL	<DL	0.007	<DL	<DL	<DL	<DL	-	-	0.051	<DL	<DL	<DL	<DL	0.004	<DL	<DL	<DL	0.42
Mean	0.04	<DL	<DL	<DL	0.007	<DL	<DL	<DL	<DL	-	-	0.052	<DL	<DL	<DL	<DL	0.004	<DL	<DL	<DL	0.41
SD	0.02	<DL	<DL	<DL	0.002	<DL	<DL	<DL	<DL	-	-	0.018	<DL	<DL	<DL	<DL	0.001	<DL	<DL	<DL	0.22
80th percentile	0.06	<DL	<DL	<DL	0.008	<DL	<DL	<DL	<DL	-	-	0.066	<DL	<DL	<DL	<DL	0.004	<DL	<DL	<DL	0.56
Max	0.07	<DL	<DL	<DL	0.009	<DL	<DL	<DL	<DL	0.010	0.010	0.076	<DL	<DL	<DL	<DL	0.004	<DL	<DL	<DL	0.68

Table 16 US2 Metal and Metalloid Water Quality Summary Statistics

	Total Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	5	1	0	0	5	0	0	5	0	0	5	5	1	5	5	0	5	0	5	0	4
Min	0.02	-	<DL	<DL	0.019	<DL	<DL	0.007	<DL	<DL	0.017	0.076	-	0.026	0.015	<DL	0.053	<DL	0.025	<DL	0.05
Median	0.02	-	<DL	<DL	0.020	<DL	<DL	0.007	<DL	<DL	0.019	0.129	-	0.037	0.015	<DL	0.058	<DL	0.039	<DL	0.08
Mean	0.03	-	<DL	<DL	0.020	<DL	<DL	0.009	<DL	<DL	0.019	0.143	-	0.038	0.015	<DL	0.056	<DL	0.036	<DL	0.07
SD	0.01	-	<DL	<DL	0.001	<DL	<DL	0.005	<DL	<DL	0.002	0.071	-	0.011	0.000	<DL	0.003	<DL	0.009	<DL	0.03
80th percentile	0.03	-	<DL	<DL	0.021	<DL	<DL	0.010	<DL	<DL	0.020	0.178	-	0.042	0.015	<DL	0.059	<DL	0.044	<DL	0.09
Max	0.05	0.001	<DL	<DL	0.022	<DL	<DL	0.018	<DL	<DL	0.021	0.257	0.002	0.056	0.016	<DL	0.059	<DL	0.046	<DL	0.10
	Dissolved Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	1	0	1	0	5	0	0	5	0	0	5	5	1	5	5	0	5	0	5	0	2
Min	-	<DL	-	<DL	0.017	<DL	<DL	0.005	<DL	<DL	0.018	0.067	-	0.025	0.013	<DL	0.052	<DL	0.022	<DL	0.05
Median	-	<DL	-	<DL	0.019	<DL	<DL	0.006	<DL	<DL	0.018	0.121	-	0.034	0.014	<DL	0.056	<DL	0.030	<DL	-
Mean	-	<DL	-	<DL	0.019	<DL	<DL	0.008	<DL	<DL	0.018	0.131	-	0.034	0.014	<DL	0.056	<DL	0.033	<DL	-
SD	-	<DL	-	<DL	0.001	<DL	<DL	0.004	<DL	<DL	0.001	0.062	-	0.008	0.001	<DL	0.003	<DL	0.009	<DL	-
80th percentile	-	<DL	-	<DL	0.019	<DL	<DL	0.009	<DL	<DL	0.018	0.169	-	0.036	0.014	<DL	0.058	<DL	0.042	<DL	-
Max	0.03	<DL	0.004	<DL	0.020	<DL	<DL	0.015	<DL	<DL	0.020	0.224	0.001	0.046	0.015	<DL	0.059	<DL	0.044	<DL	0.06

Table 17 DS1 Metal and Metalloid Water Quality Summary Statistics

	Total Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
n > DL	9	0	0	0	10	0	0	10	0	0	10	10	3	10	10	0	10	0	10	0	3
Min	0.01	<DL	<DL	<DL	0.016	<DL	<DL	0.002	<DL	<DL	0.016	0.043	0.001	0.021	0.012	<DL	0.048	<DL	0.018	<DL	0.05
Median	0.02	<DL	<DL	<DL	0.020	<DL	<DL	0.006	<DL	<DL	0.018	0.069	0.001	0.036	0.014	<DL	0.057	<DL	0.036	<DL	0.03
Mean	0.02	<DL	<DL	<DL	0.020	<DL	<DL	0.006	<DL	<DL	0.017	0.095	0.001	0.036	0.014	<DL	0.056	<DL	0.038	<DL	0.04
SD	0.01	<DL	<DL	<DL	0.002	<DL	<DL	0.004	<DL	<DL	0.001	0.076	0.000	0.014	0.001	<DL	0.004	<DL	0.015	<DL	0.03
80th percentile	0.02	<DL	<DL	<DL	0.022	<DL	<DL	0.008	<DL	<DL	0.018	0.101	0.001	0.043	0.014	<DL	0.059	<DL	0.044	<DL	0.07
Max	0.05	<DL	<DL	<DL	0.022	<DL	<DL	0.016	<DL	<DL	0.019	0.293	0.001	0.065	0.015	<DL	0.060	<DL	0.072	<DL	0.09
	Dissolved Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
n > DL	2	0	0	0	9	0	0	9	0	0	9	9	2	9	9	0	9	0	9	0	0
Min	0.01	<DL	<DL	<DL	0.016	<DL	<DL	0.002	<DL	<DL	0.014	0.039	0.001	0.017	0.011	<DL	0.048	<DL	0.013	<DL	<DL
Median	-	<DL	<DL	<DL	0.020	<DL	<DL	0.004	<DL	<DL	0.017	0.054	-	0.028	0.014	<DL	0.055	<DL	0.032	<DL	<DL
Mean	-	<DL	<DL	<DL	0.019	<DL	<DL	0.005	<DL	<DL	0.016	0.092	-	0.031	0.013	<DL	0.054	<DL	0.032	<DL	<DL
SD	-	<DL	<DL	<DL	0.002	<DL	<DL	0.004	<DL	<DL	0.001	0.085	-	0.013	0.001	<DL	0.005	<DL	0.014	<DL	<DL
80th percentile	-	<DL	<DL	<DL	0.021	<DL	<DL	0.008	<DL	<DL	0.017	0.098	-	0.041	0.014	<DL	0.057	<DL	0.041	<DL	<DL
Max	0.04	<DL	<DL	<DL	0.022	<DL	<DL	0.014	<DL	<DL	0.018	0.304	0.002	0.058	0.015	<DL	0.062	<DL	0.058	<DL	<DL

Table 18 DS2 Metal and Metalloid Water Quality Summary Statistics

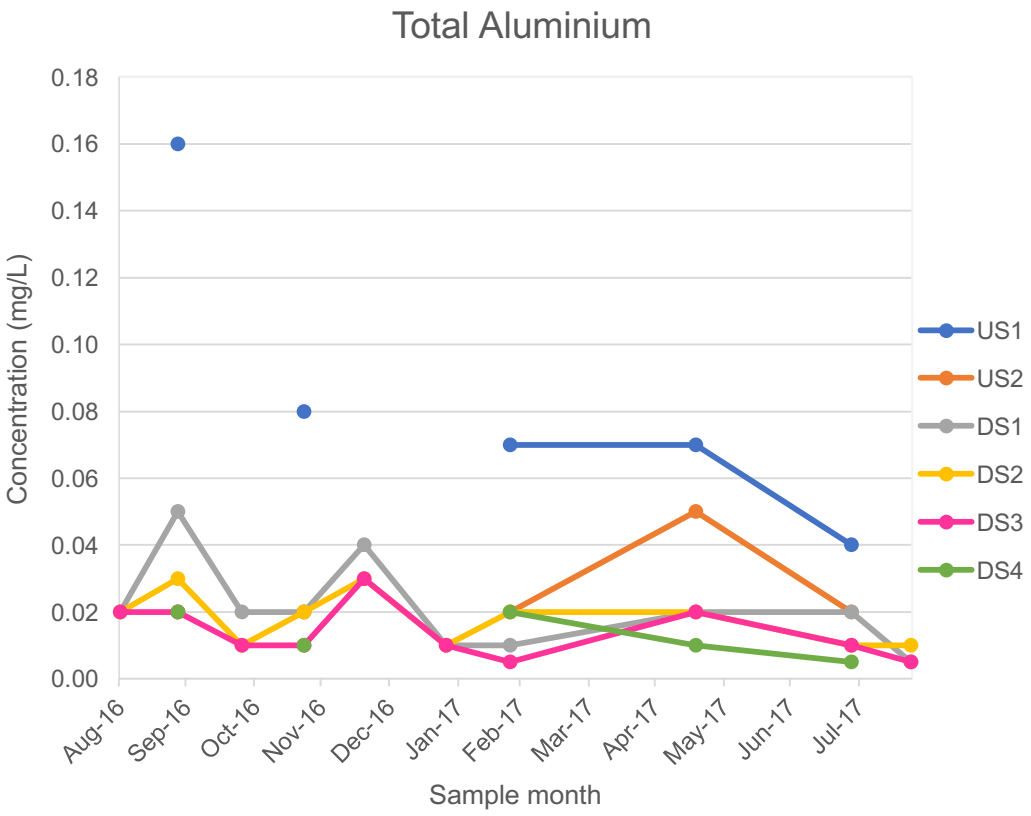
	Total Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
n > DL	10	2	0	0	10	0	1	9	0	0	10	10	1	10	10	0	10	0	10	0	5
Min	0.01	0.001	<DL	<DL	0.016	<DL	-	0.001	<DL	<DL	0.014	0.029	-	0.015	0.010	<DL	0.044	<DL	0.014	<DL	0.05
Median	0.02	-	<DL	<DL	0.018	<DL	-	0.003	<DL	<DL	0.016	0.042	-	0.028	0.013	<DL	0.053	<DL	0.032	<DL	0.04
Mean	0.02	-	<DL	<DL	0.018	<DL	-	0.004	<DL	<DL	0.016	0.066	-	0.028	0.013	<DL	0.053	<DL	0.032	<DL	0.04
SD	0.01	-	<DL	<DL	0.002	<DL	-	0.003	<DL	<DL	0.001	0.050	-	0.009	0.002	<DL	0.004	<DL	0.010	<DL	0.02
80th percentile	0.02	-	<DL	<DL	0.019	<DL	-	0.007	<DL	<DL	0.016	0.078	-	0.038	0.014	<DL	0.056	<DL	0.040	<DL	0.06
Max	0.03	0.002	<DL	<DL	0.021	<DL	0.003	0.008	<DL	<DL	0.018	0.192	0.001	0.042	0.015	<DL	0.058	<DL	0.047	<DL	0.07
	Dissolved Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
n > DL	2	0	0	0	9	0	0	9	1	0	9	9	1	9	9	0	9	0	9	0	0
Min	0.01	<DL	<DL	<DL	0.015	<DL	<DL	0.001	-	<DL	0.012	0.028	-	0.014	0.010	<DL	0.044	<DL	0.014	<DL	<DL
Median	-	<DL	<DL	<DL	0.018	<DL	<DL	0.003	-	<DL	0.015	0.045	-	0.022	0.013	<DL	0.051	<DL	0.030	<DL	<DL
Mean	-	<DL	<DL	<DL	0.018	<DL	<DL	0.003	-	<DL	0.015	0.062	-	0.025	0.013	<DL	0.051	<DL	0.027	<DL	<DL
SD	-	<DL	<DL	<DL	0.002	<DL	<DL	0.002	-	<DL	0.002	0.053	-	0.009	0.002	<DL	0.005	<DL	0.009	<DL	<DL
80th percentile	-	<DL	<DL	<DL	0.019	<DL	<DL	0.004	-	<DL	0.016	0.067	-	0.031	0.013	<DL	0.055	<DL	0.031	<DL	<DL
Max	0.01	<DL	<DL	<DL	0.020	<DL	<DL	0.008	0.001	<DL	0.017	0.192	0.004	0.041	0.015	<DL	0.059	<DL	0.040	<DL	<DL

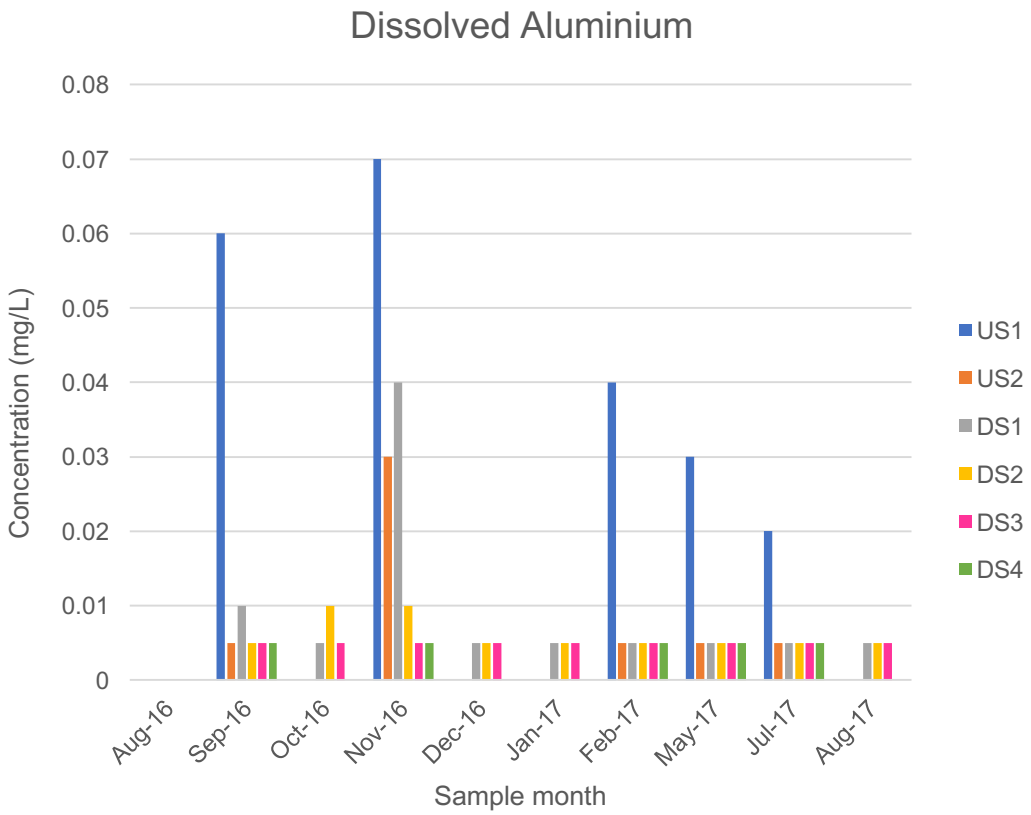
Table 19 DS3 Metal and Metalloid Water Quality Summary Statistics

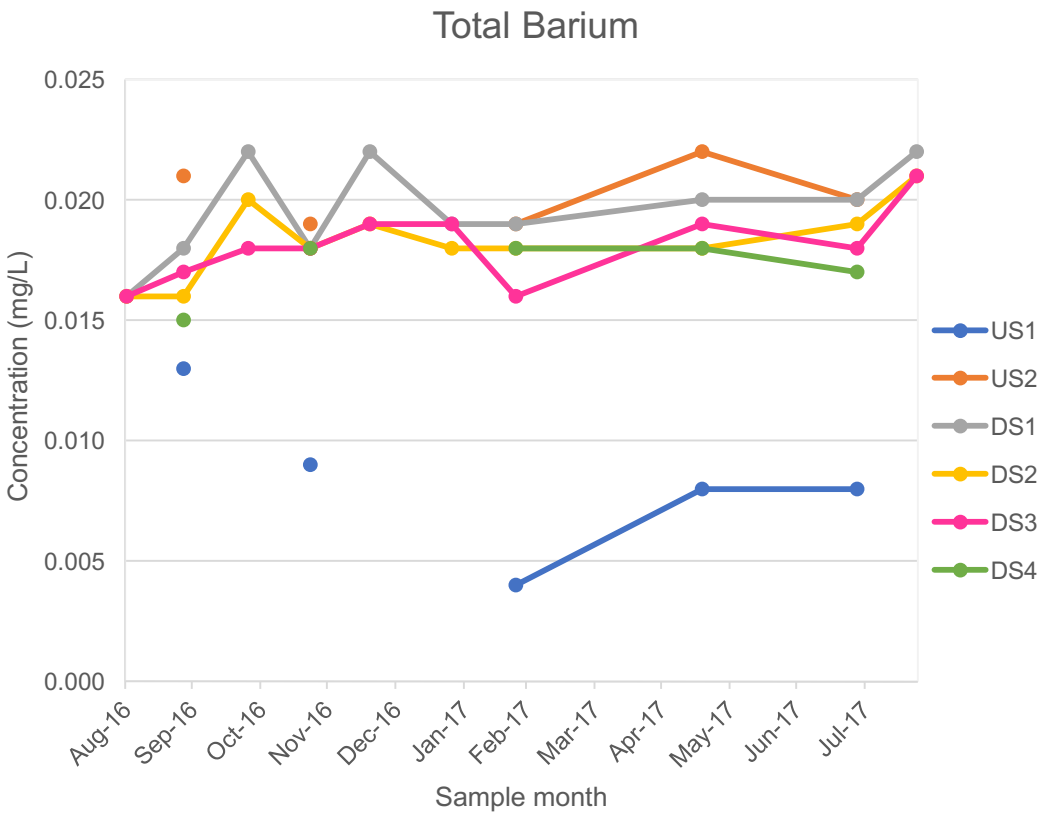
	Total Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
n > DL	8	0	0	0	10	1	1	8	0	0	10	10	0	10	10	0	10	0	10	0	0
Min	0.01	<DL	<DL	<DL	0.016	-	-	0.001	<DL	<DL	0.014	0.023	<DL	0.013	0.010	<DL	0.043	<DL	0.012	<DL	<DL
Median	0.01	<DL	<DL	<DL	0.018	-	-	0.002	<DL	<DL	0.015	0.033	<DL	0.024	0.013	<DL	0.050	<DL	0.027	<DL	<DL
Mean	0.01	<DL	<DL	<DL	0.018	-	-	0.003	<DL	<DL	0.015	0.046	<DL	0.025	0.012	<DL	0.050	<DL	0.027	<DL	<DL
SD	0.01	<DL	<DL	<DL	0.002	-	-	0.002	<DL	<DL	0.001	0.032	<DL	0.009	0.001	<DL	0.003	<DL	0.009	<DL	<DL
80th percentile	0.02	<DL	<DL	<DL	0.019	-	-	0.004	<DL	<DL	0.016	0.064	<DL	0.034	0.014	<DL	0.052	<DL	0.032	<DL	<DL
Max	0.03	<DL	<DL	<DL	0.021	0.000	0.001	0.006	<DL	<DL	0.017	0.119	<DL	0.039	0.014	<DL	0.054	<DL	0.044	<DL	<DL
	Dissolved Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
n > DL	0	0	0	0	9	0	0	7	0	0	9	9	0	9	9	0	9	0	9	0	0
Min	<DL	<DL	<DL	<DL	0.015	<DL	<DL	0.001	<DL	<DL	0.012	0.021	<DL	0.012	0.010	<DL	0.042	<DL	0.012	<DL	<DL
Median	<DL	<DL	<DL	<DL	0.017	<DL	<DL	0.002	<DL	<DL	0.014	0.028	<DL	0.023	0.012	<DL	0.047	<DL	0.025	<DL	<DL
Mean	<DL	<DL	<DL	<DL	0.017	<DL	<DL	0.002	<DL	<DL	0.014	0.043	<DL	0.023	0.012	<DL	0.048	<DL	0.023	<DL	<DL
SD	<DL	<DL	<DL	<DL	0.002	<DL	<DL	0.002	<DL	<DL	0.001	0.035	<DL	0.009	0.001	<DL	0.004	<DL	0.007	<DL	<DL
80th percentile	<DL	<DL	<DL	<DL	0.019	<DL	<DL	0.003	<DL	<DL	0.015	0.051	<DL	0.027	0.013	<DL	0.051	<DL	0.028	<DL	<DL
Max	<DL	<DL	<DL	<DL	0.020	<DL	<DL	0.005	<DL	<DL	0.015	0.126	<DL	0.039	0.013	<DL	0.054	<DL	0.030	<DL	<DL

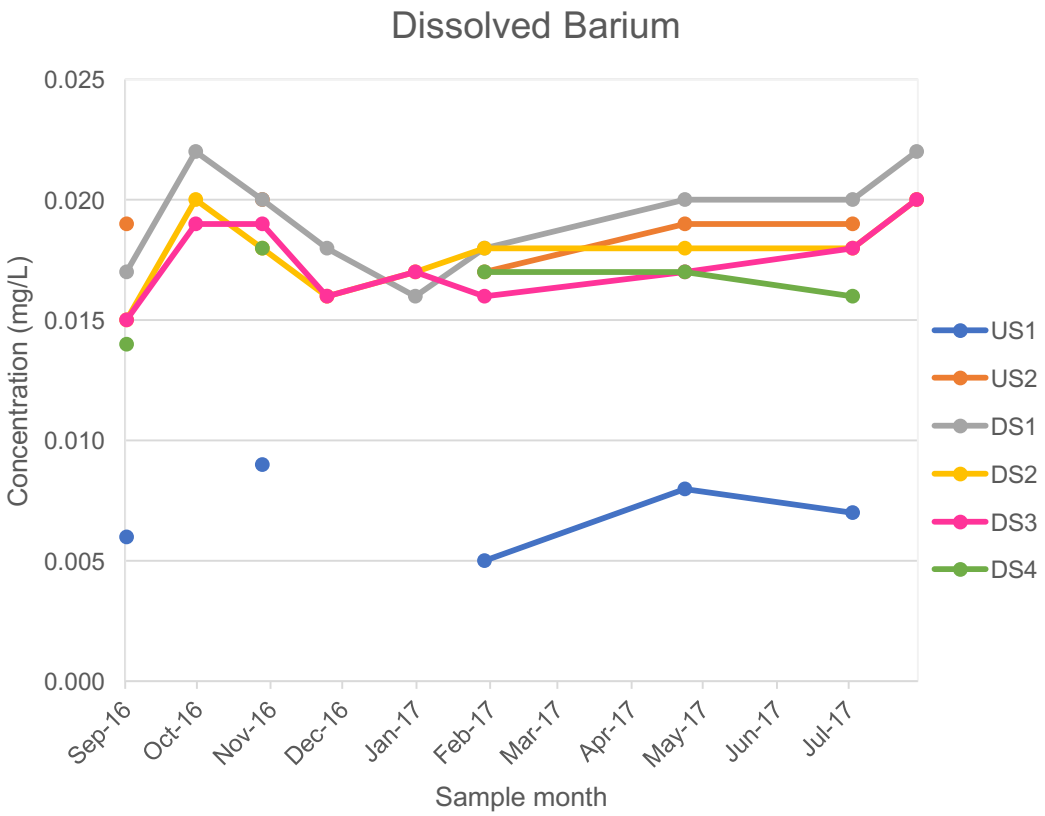
Table 20 DS4 Metal and Metalloid Water Quality Summary Statistics

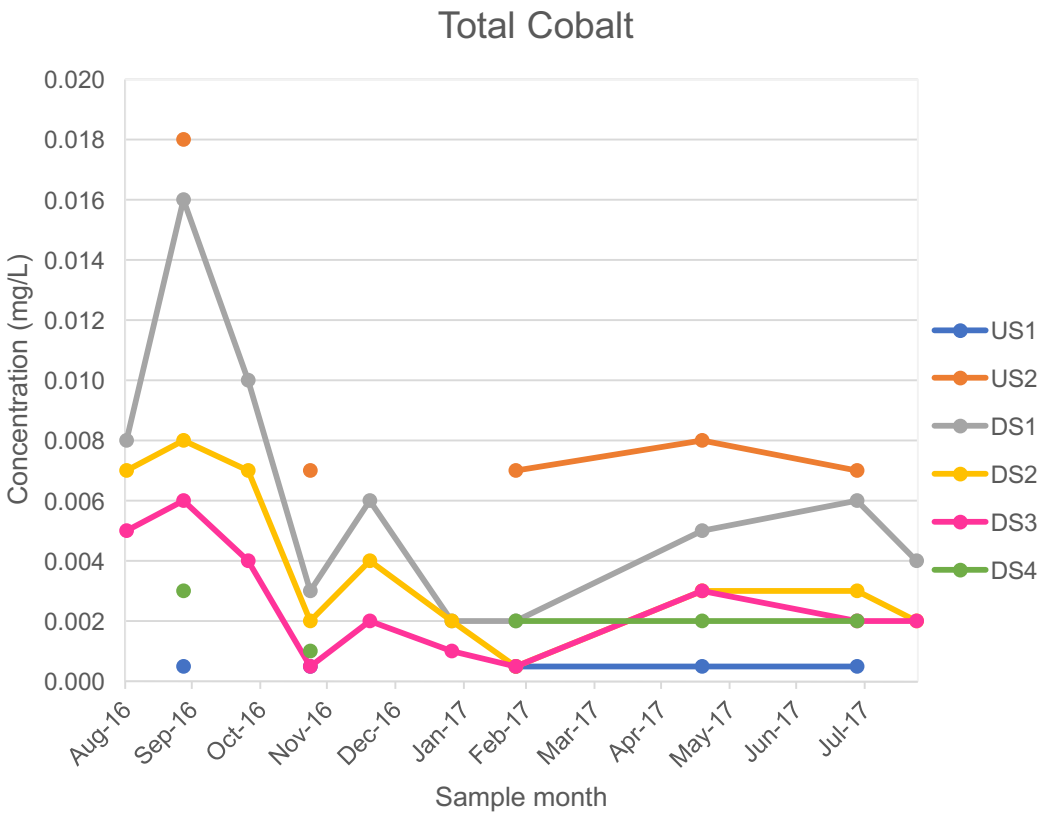
	Total Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	4	0	0	0	5	0	0	5	0	0	5	5	0	5	5	0	5	0	5	0	1
Min	0.01	<DL	<DL	<DL	0.015	<DL	<DL	0.001	<DL	<DL	0.012	0.024	<DL	0.012	0.010	<DL	0.042	<DL	0.012	<DL	-
Median	0.01	<DL	<DL	<DL	0.018	<DL	<DL	0.002	<DL	<DL	0.013	0.046	<DL	0.018	0.011	<DL	0.044	<DL	0.024	<DL	-
Mean	0.01	<DL	<DL	<DL	0.017	<DL	<DL	0.002	<DL	<DL	0.013	0.043	<DL	0.019	0.011	<DL	0.044	<DL	0.020	<DL	-
SD	0.01	<DL	<DL	<DL	0.001	<DL	<DL	0.001	<DL	<DL	0.001	0.014	<DL	0.007	0.000	<DL	0.002	<DL	0.007	<DL	-
80th percentile	0.02	<DL	<DL	<DL	0.018	<DL	<DL	0.002	<DL	<DL	0.013	0.052	<DL	0.023	0.011	<DL	0.046	<DL	0.025	<DL	-
Max	0.02	<DL	<DL	<DL	0.018	<DL	<DL	0.003	<DL	<DL	0.014	0.061	<DL	0.029	0.011	<DL	0.047	<DL	0.028	<DL	0.06
	Dissolved Metals																				
	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Uranium	Zinc	Boron	Iron
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection limit (DL)	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.05	0.05
Sample size (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n > DL	0	0	0	0	5	0	0	5	0	0	5	5	0	5	5	0	5	0	5	0	0
Min	<DL	<DL	<DL	<DL	0.014	<DL	<DL	0.001	<DL	<DL	0.011	0.025	<DL	0.011	0.010	<DL	0.040	<DL	0.011	<DL	<DL
Median	<DL	<DL	<DL	<DL	0.017	<DL	<DL	0.002	<DL	<DL	0.012	0.036	<DL	0.018	0.010	<DL	0.042	<DL	0.020	<DL	<DL
Mean	<DL	<DL	<DL	<DL	0.016	<DL	<DL	0.002	<DL	<DL	0.012	0.039	<DL	0.017	0.011	<DL	0.042	<DL	0.019	<DL	<DL
SD	<DL	<DL	<DL	<DL	0.002	<DL	<DL	0.000	<DL	<DL	0.001	0.014	<DL	0.005	0.001	<DL	0.002	<DL	0.006	<DL	<DL
80th percentile	<DL	<DL	<DL	<DL	0.017	<DL	<DL	0.002	<DL	<DL	0.012	0.044	<DL	0.019	0.011	<DL	0.044	<DL	0.023	<DL	<DL
Max	<DL	<DL	<DL	<DL	0.018	<DL	<DL	0.002	<DL	<DL	0.013	0.062	<DL	0.025	0.013	<DL	0.046	<DL	0.025	<DL	<DL

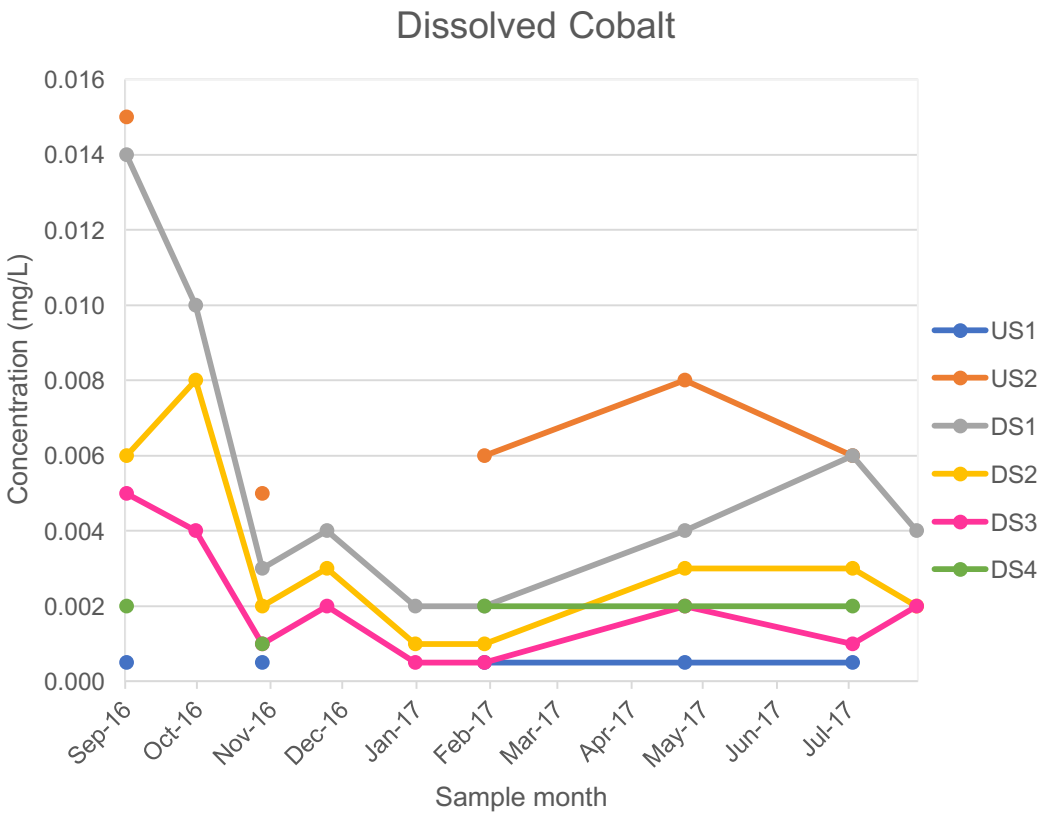

Total Aluminium
Concentration (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

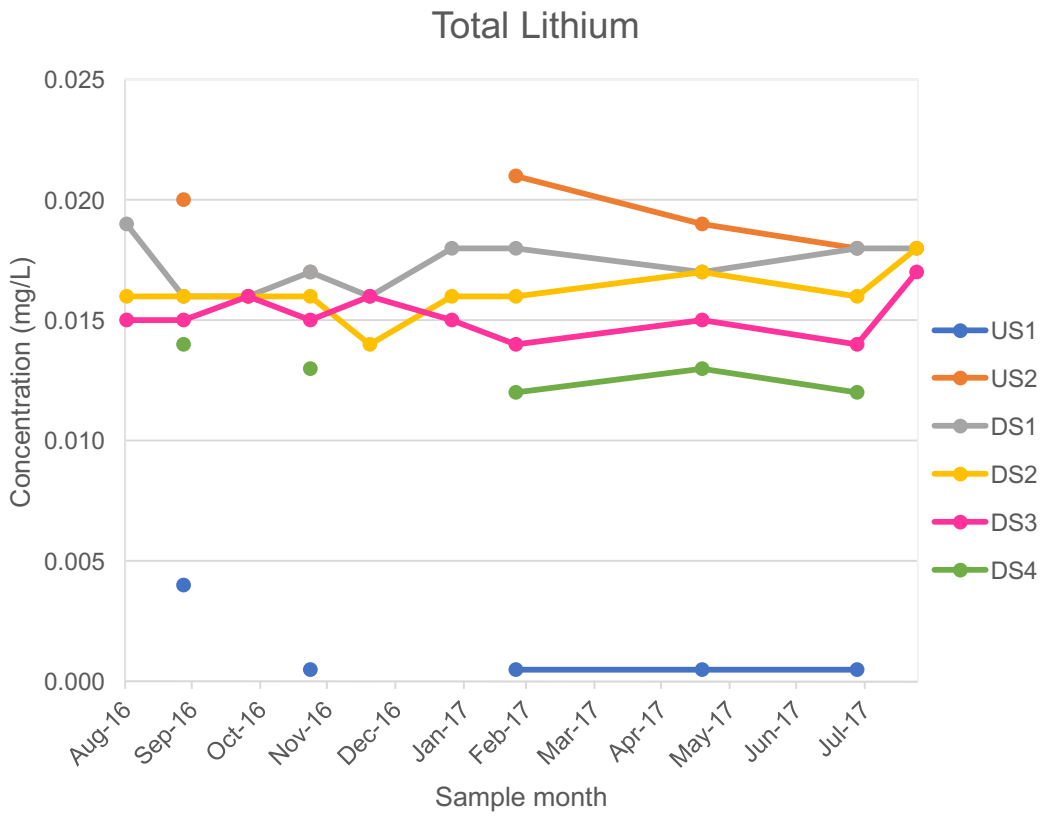

Dissolved Aluminium
Concentration (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

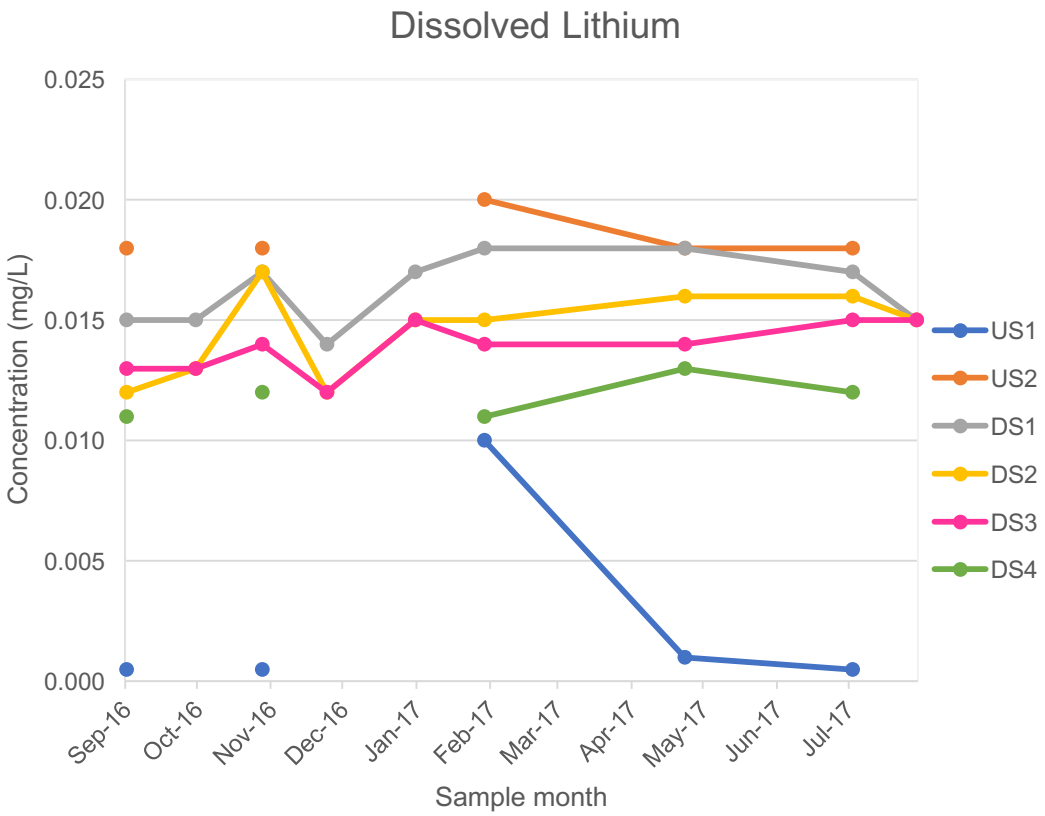

Total Barium
0.025
0.020
0.015
0.010
0.005
0.000
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

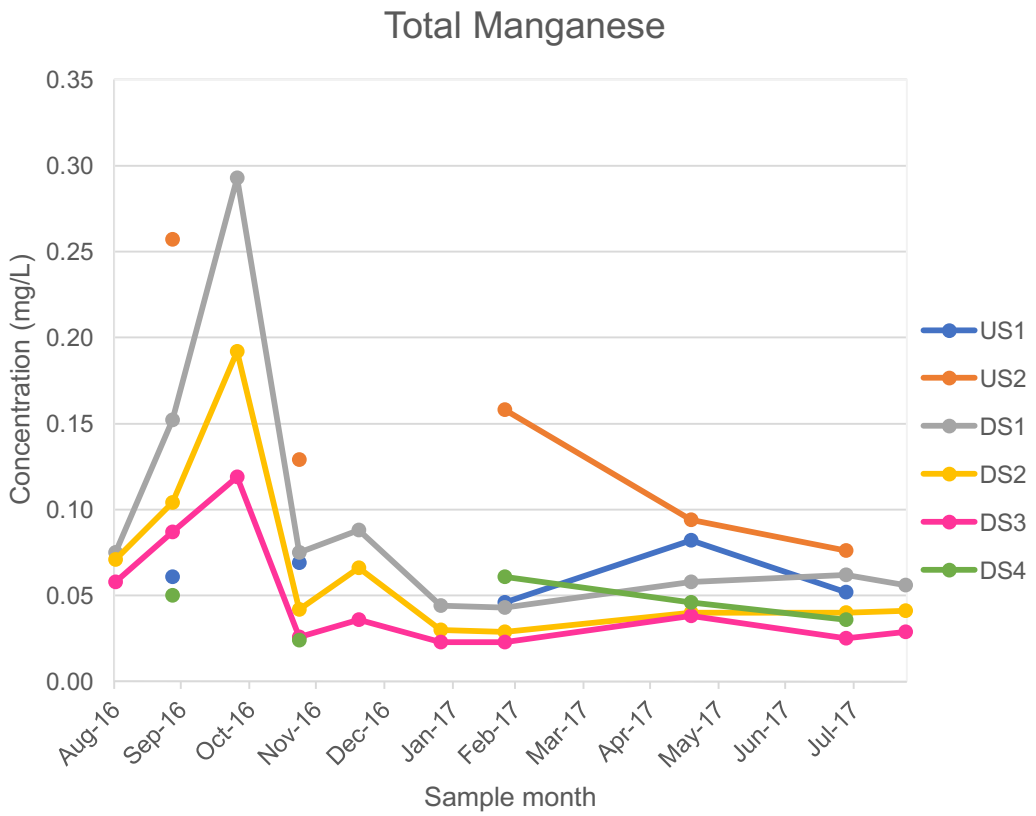

Dissolved Barium
0.025
0.020
0.015
0.010
0.005
0.000
Concentration (mg/L)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

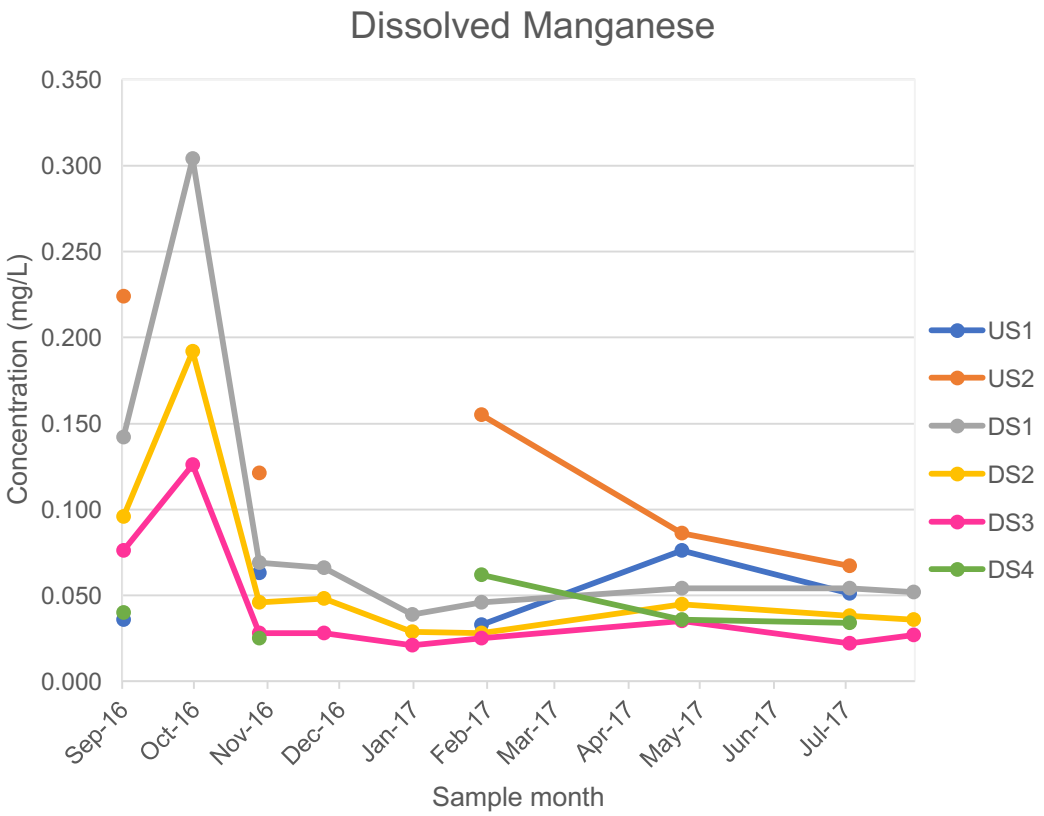

Total Cobalt
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

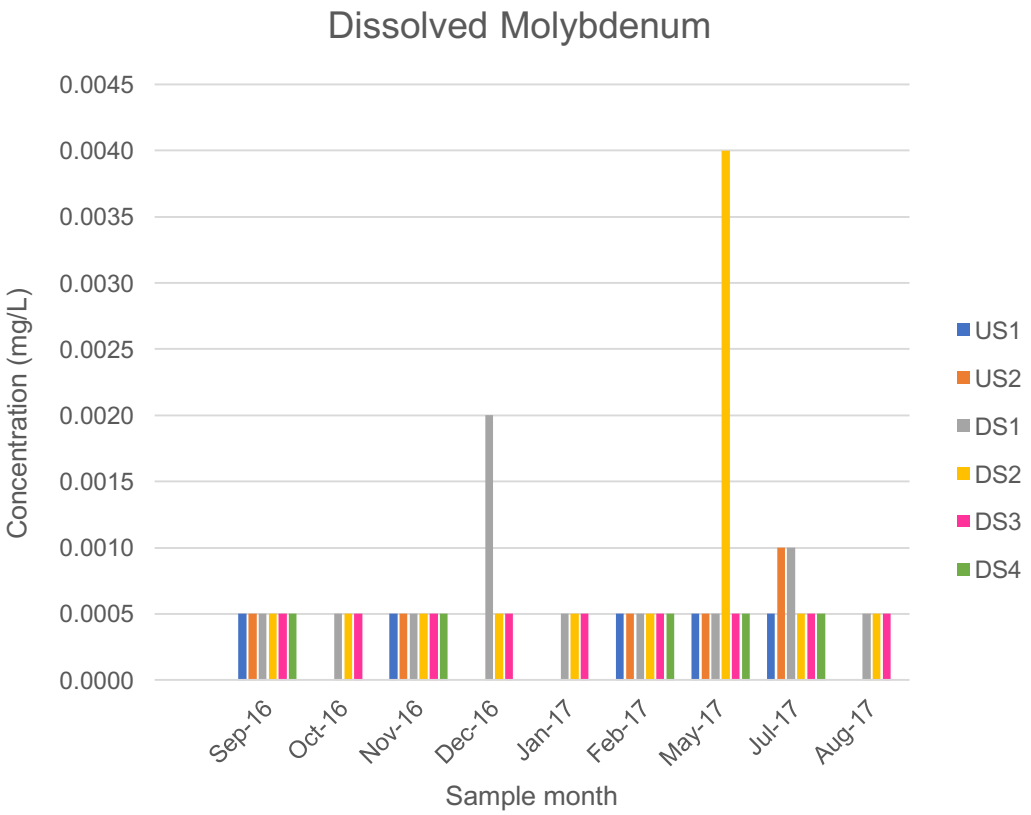

Dissolved Cobalt
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Concentration (mg/L)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

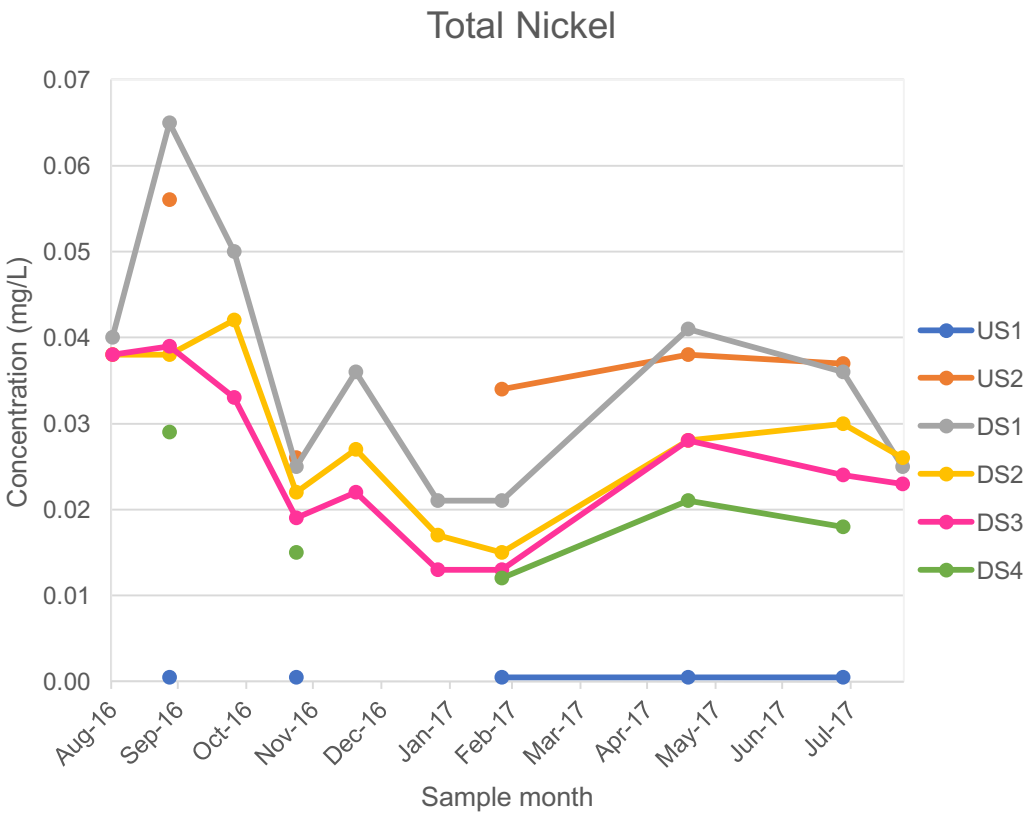

Total Lithium
0.025
0.020
0.015
0.010
0.005
0.000
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

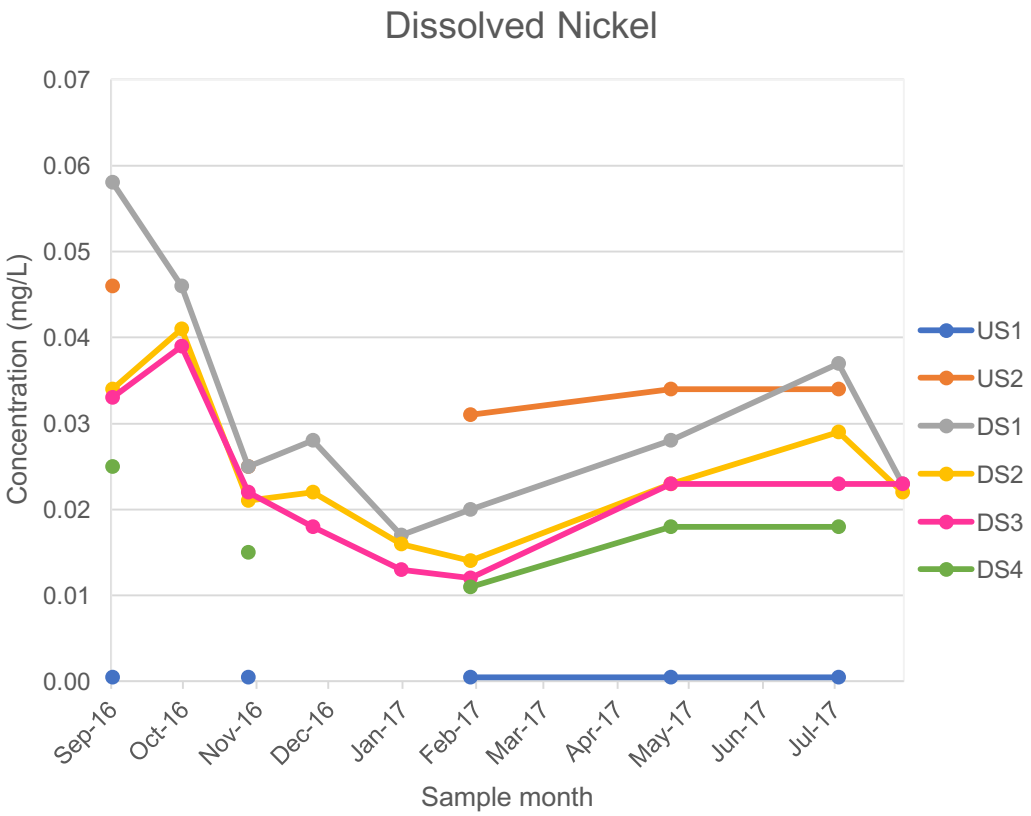

Dissolved Lithium
0.025
0.020
0.015
0.010
0.005
0.000
Concentration (mg/L)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

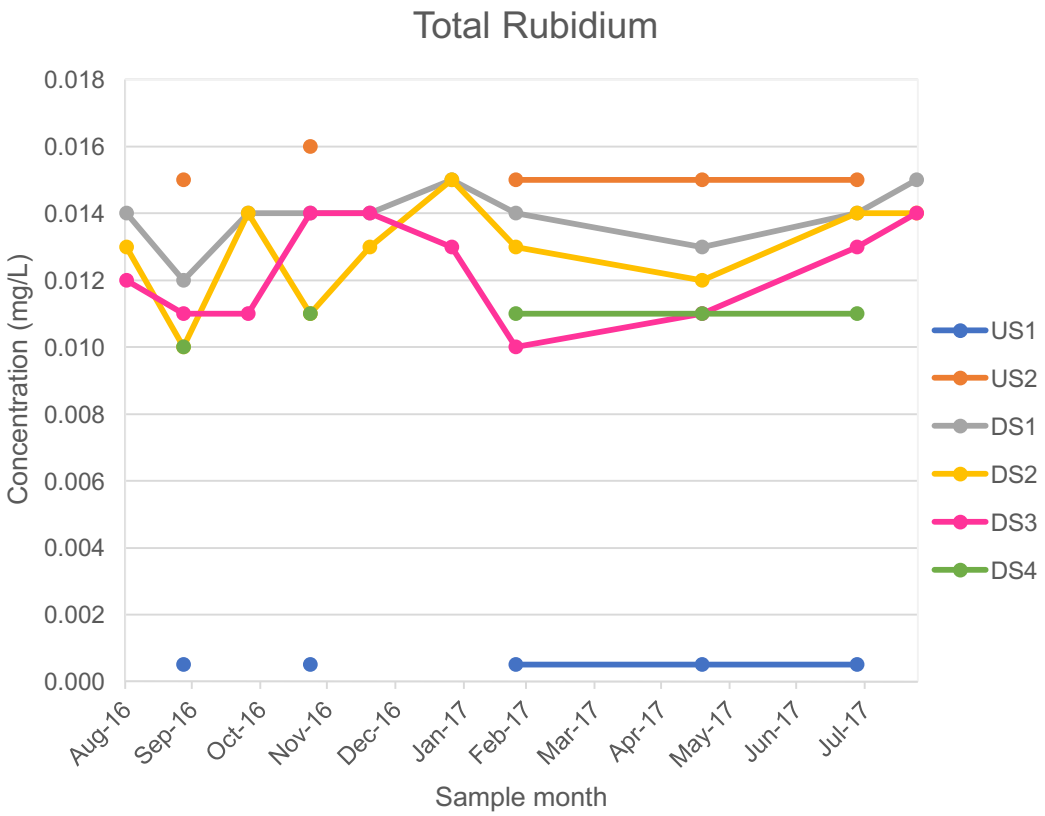

Total Manganese
Concentration (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

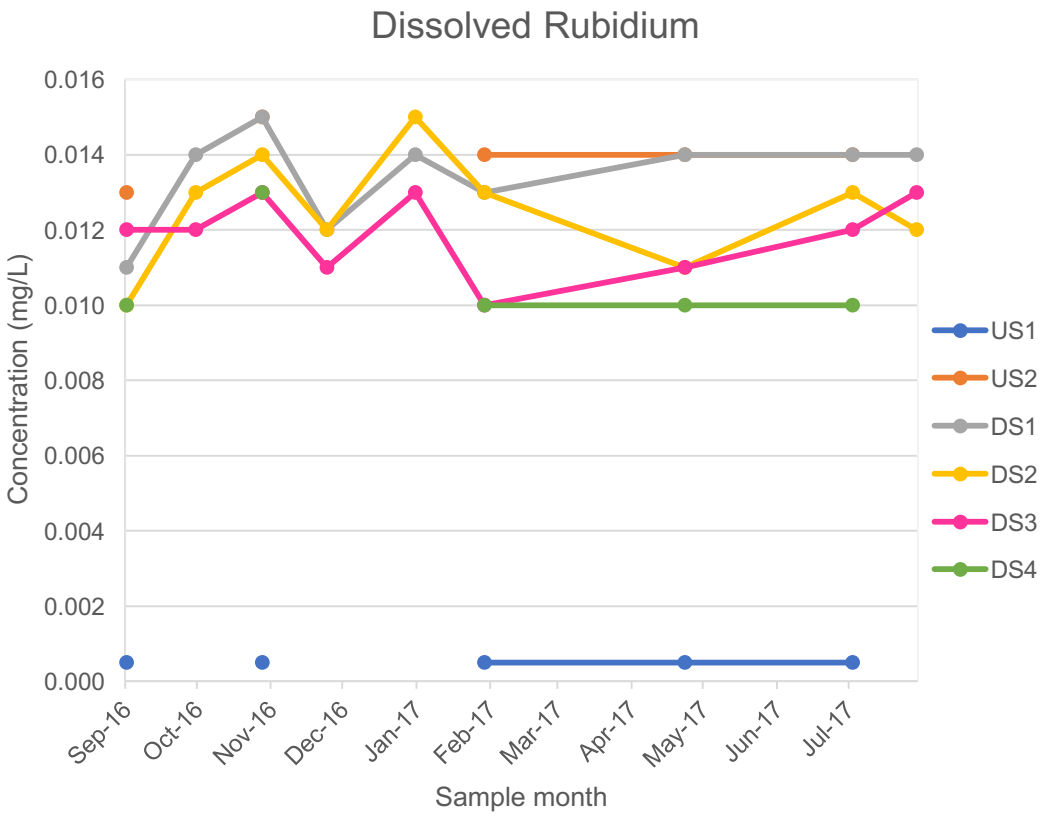

Dissolved Manganese
Concentration (mg/L)
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

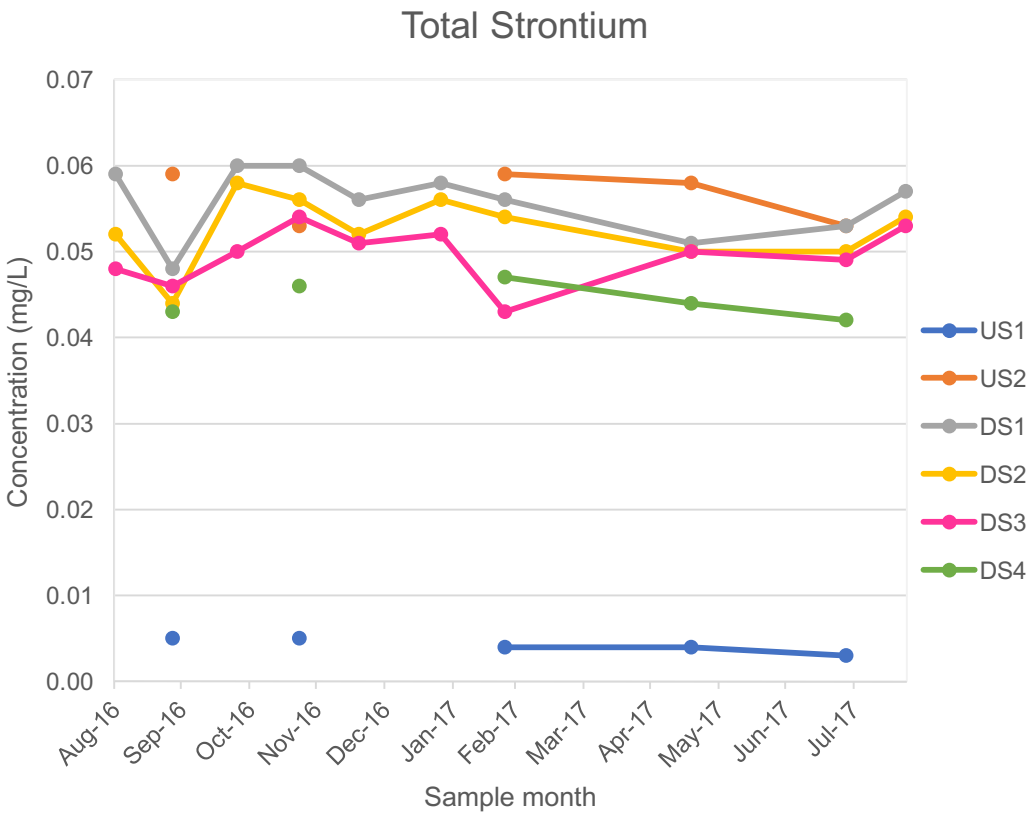

Dissolved Molybdenum
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Concentration (mg/L)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

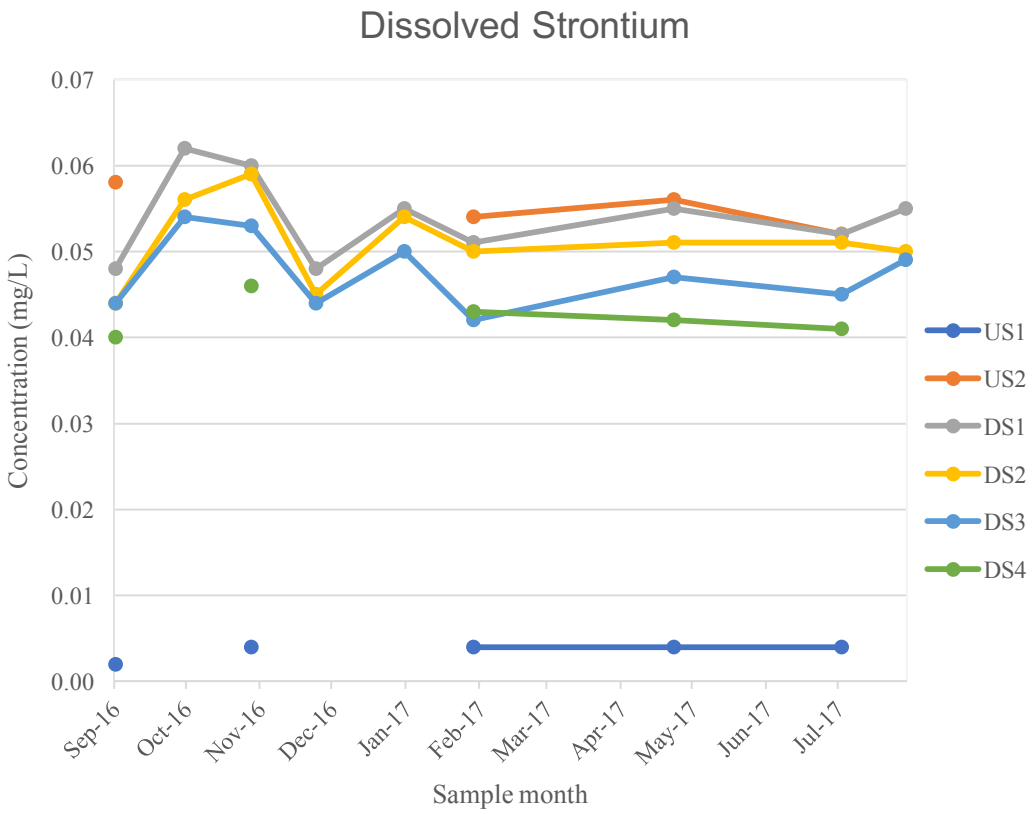

Total Nickel
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

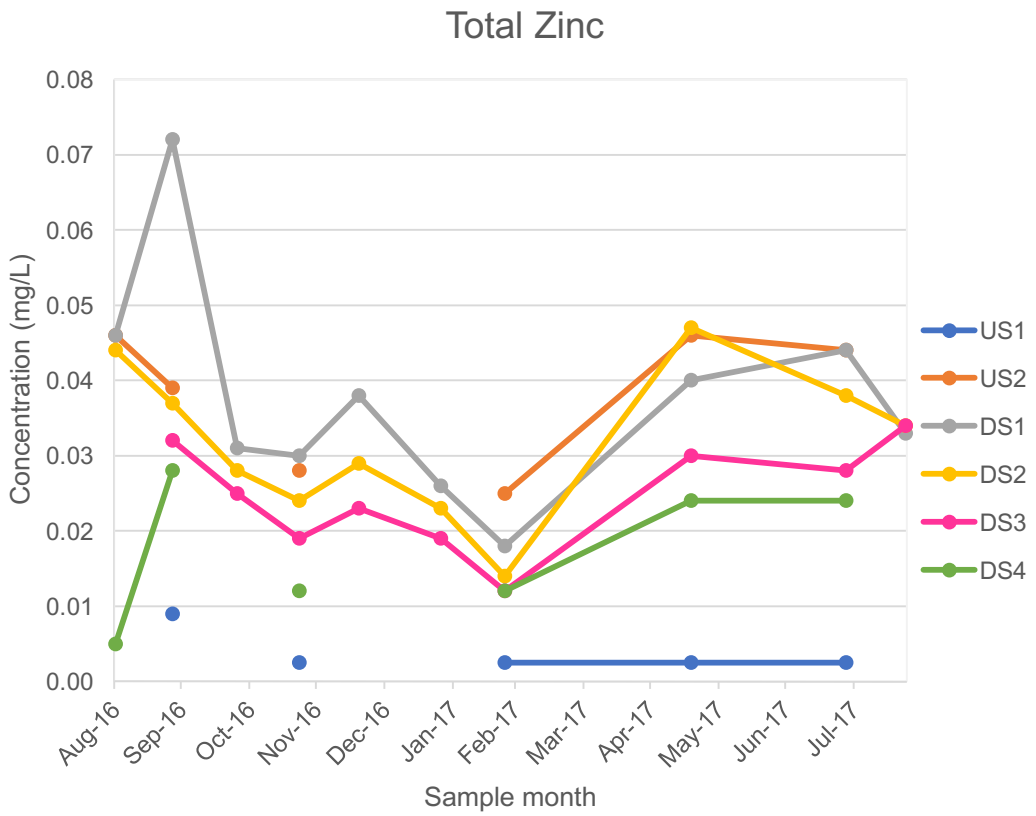

Dissolved Nickel
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

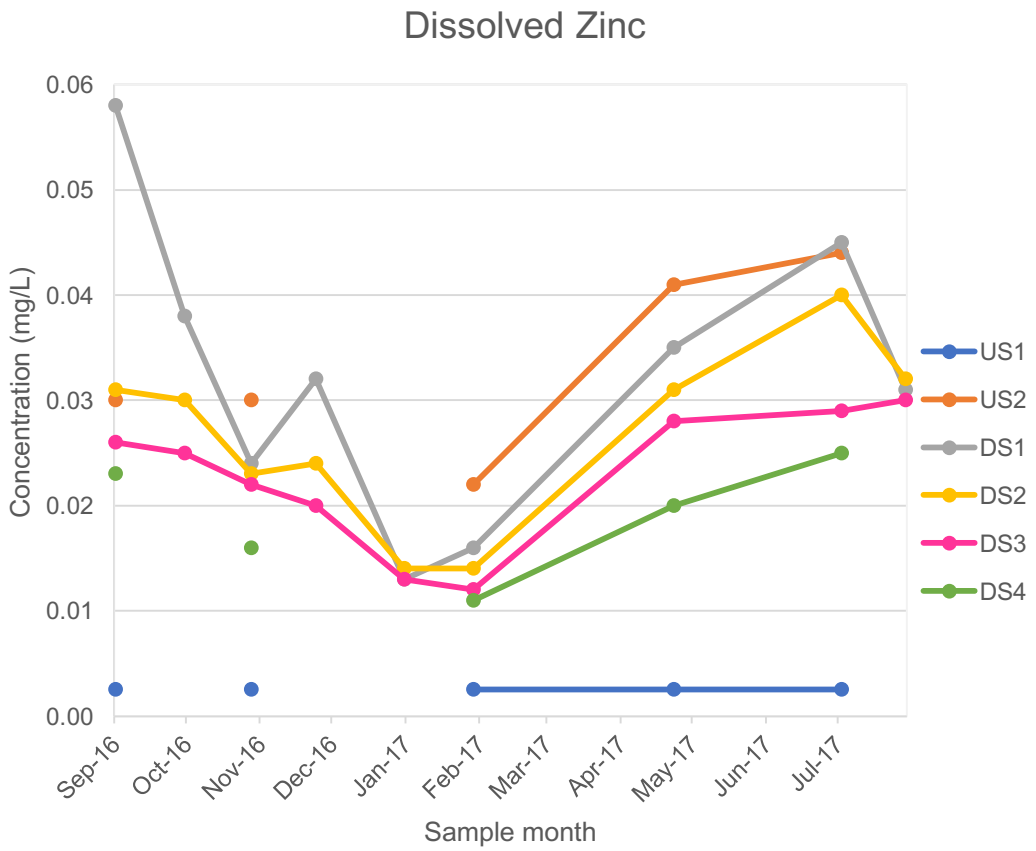

Total Rubidium
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

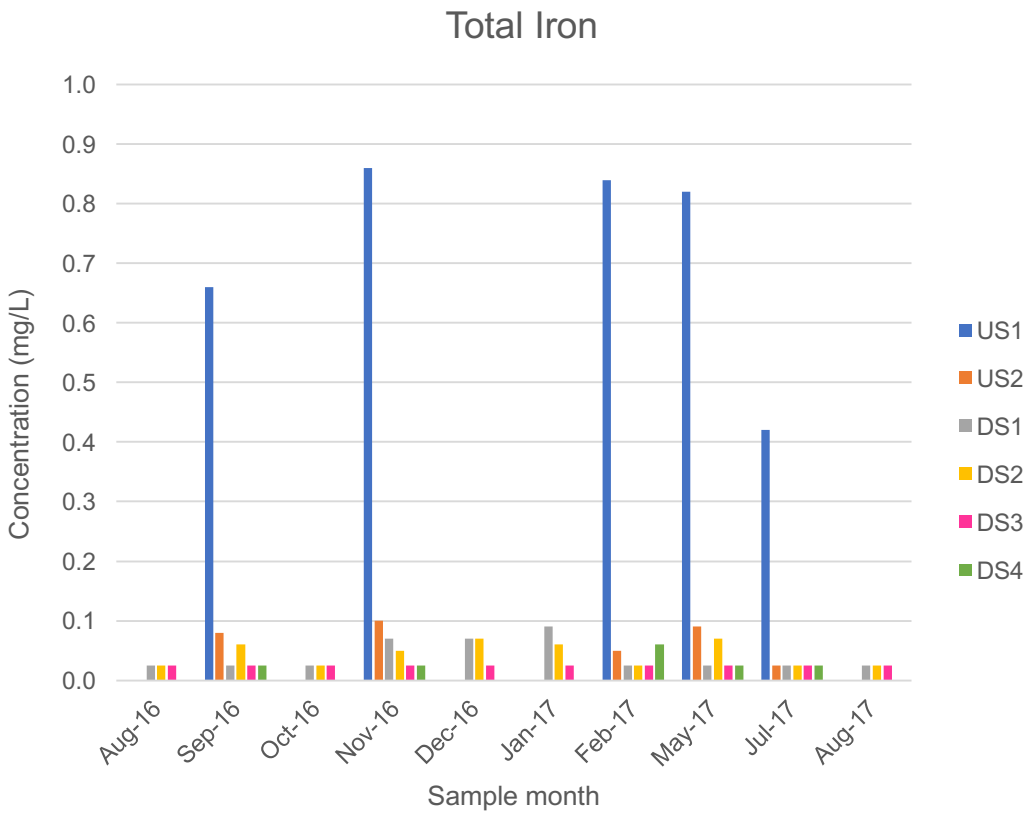

Dissolved Rubidium
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Concentration (mg/L)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

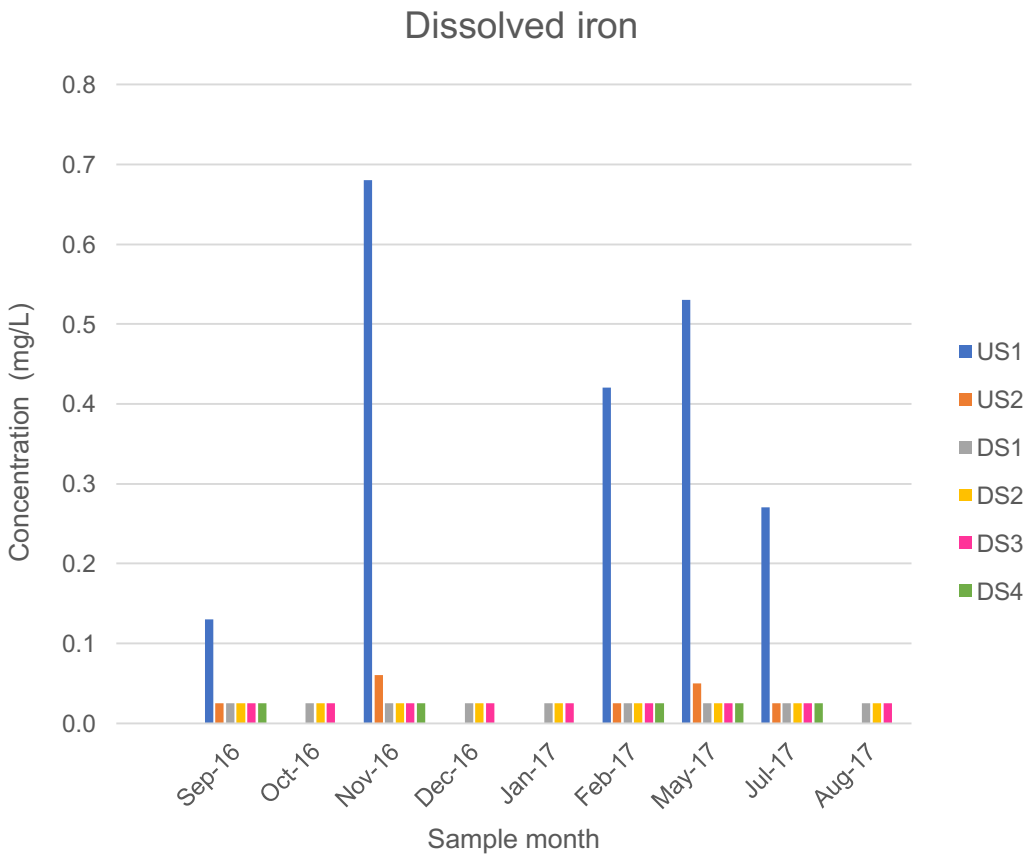

Total Strontium
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

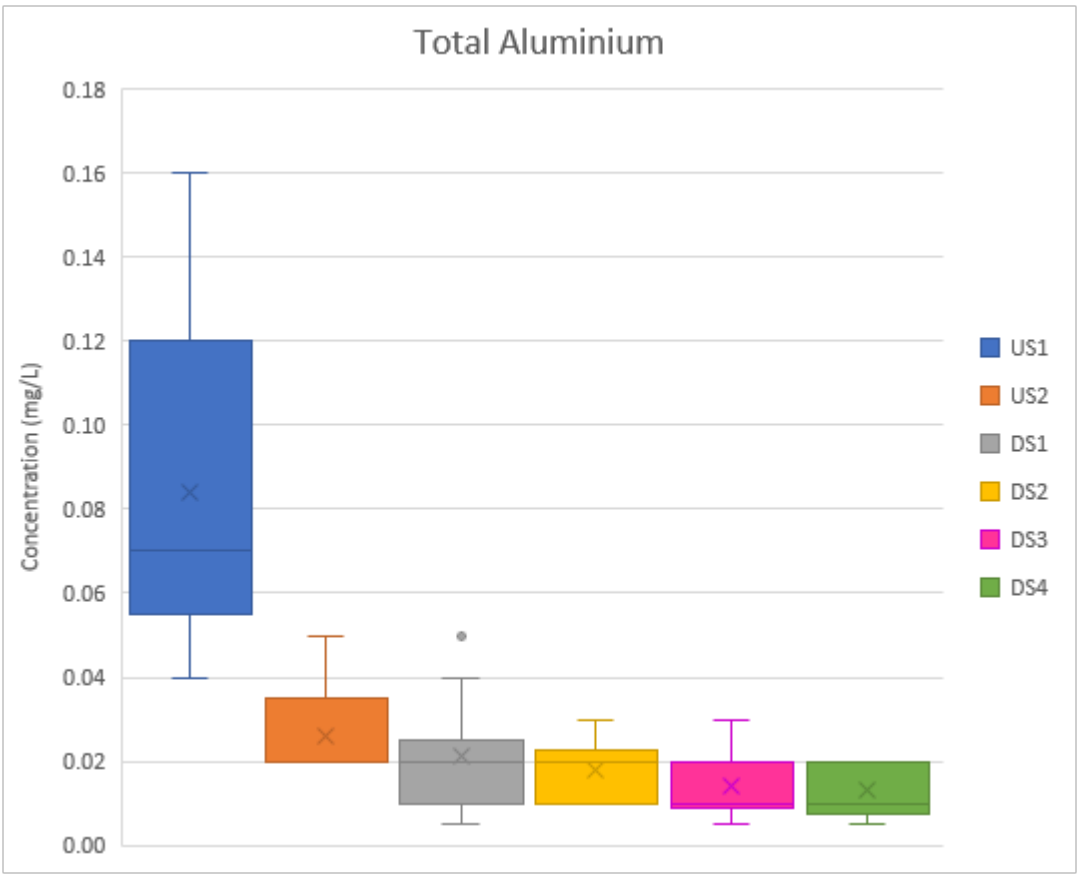

Dissolved Strontium
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

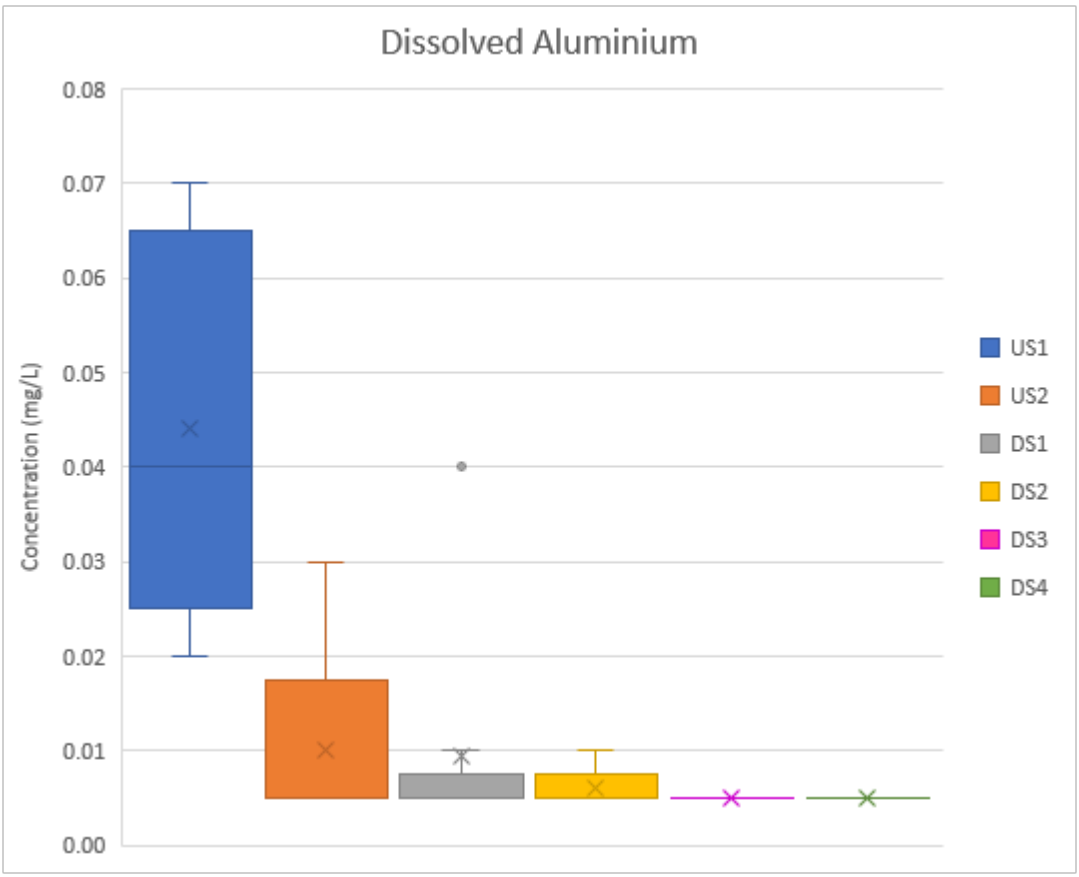

Total Zinc
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

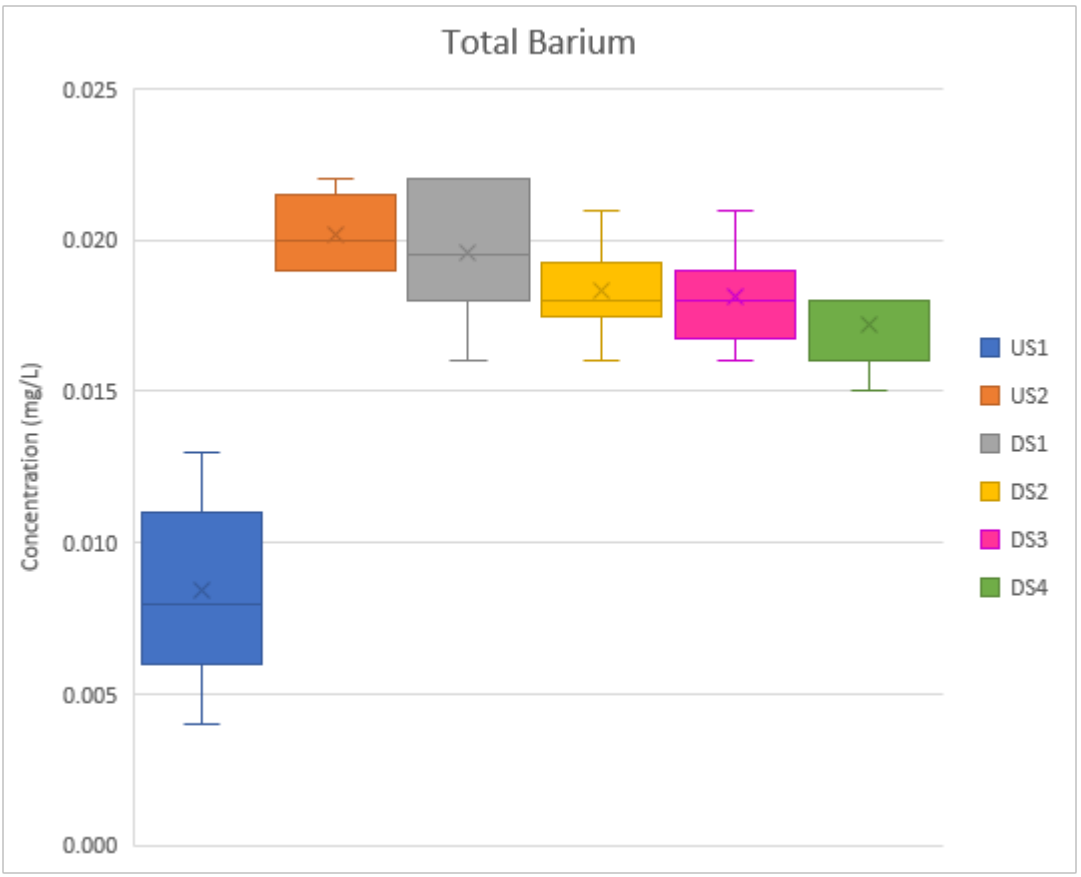

Dissolved Zinc
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Concentration (mg/L)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

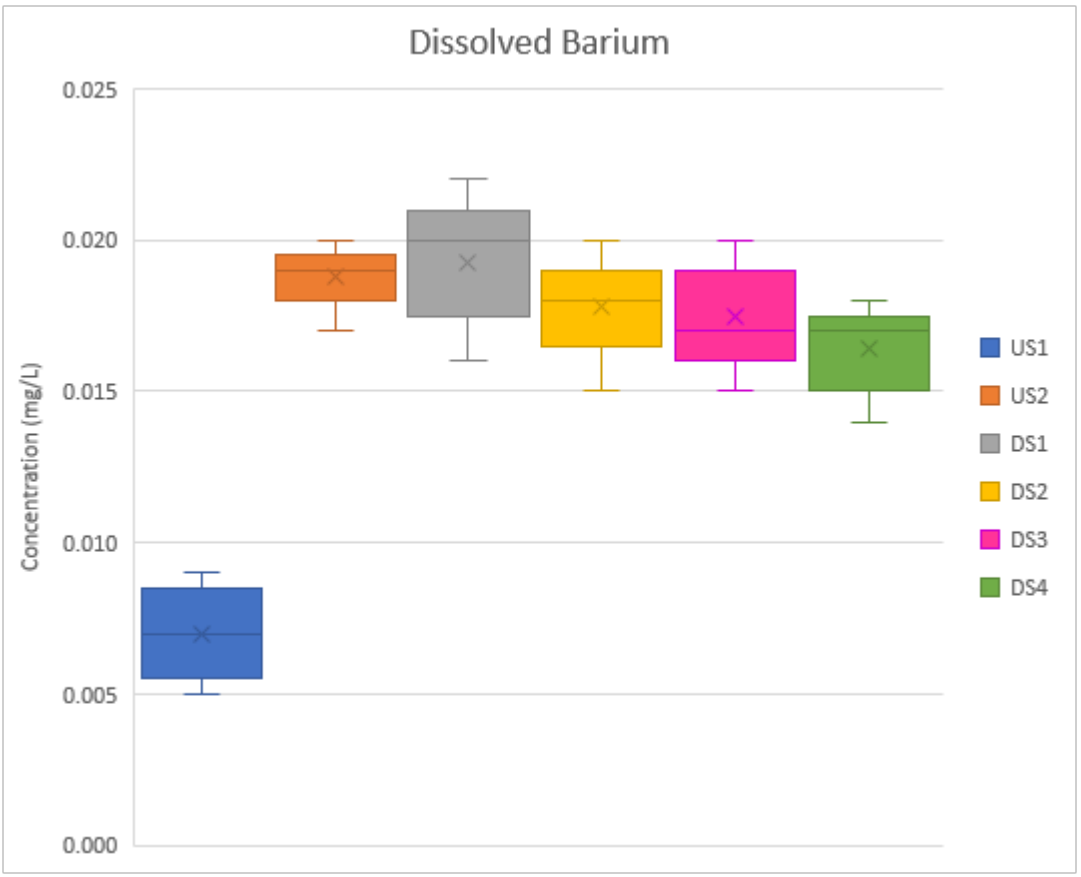

Total Iron
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Concentration (mg/L)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

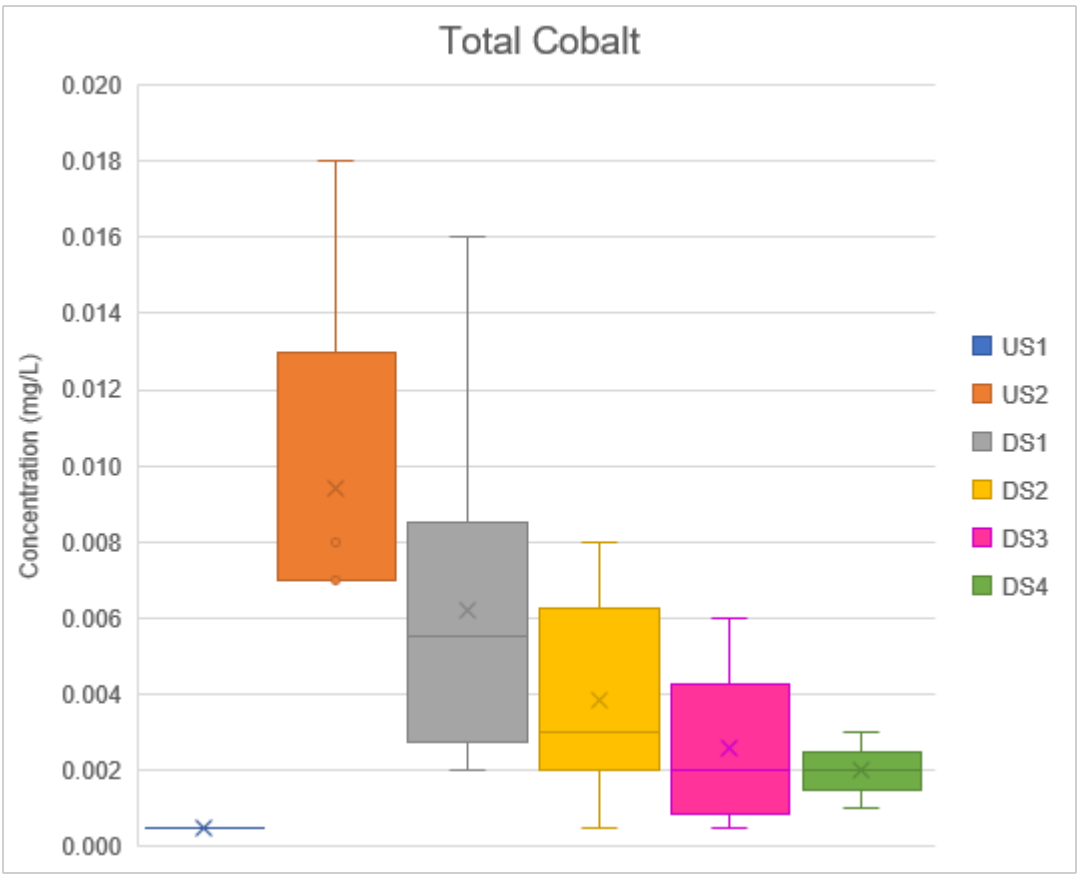

Dissolved iron
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Concentration (mg/L)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

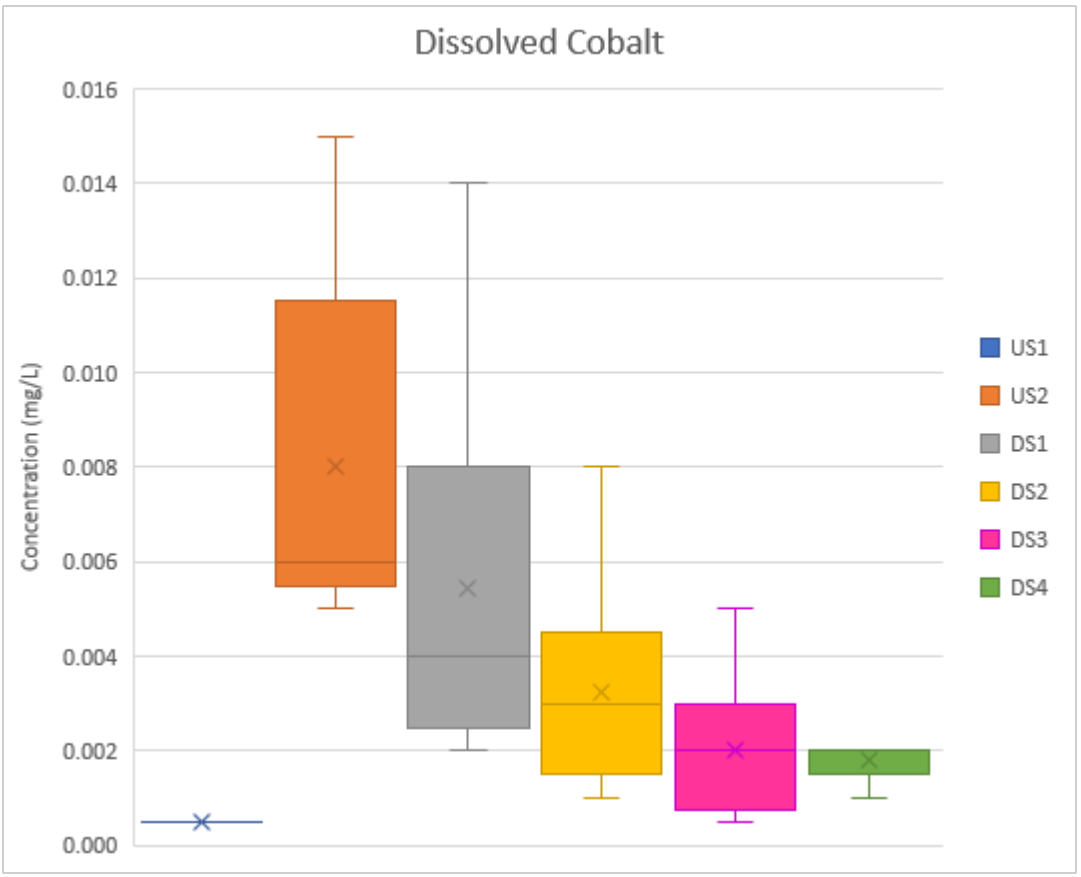

Total Aluminium
Concentration (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
US1
US2
DS1
DS2
DS3
DS4

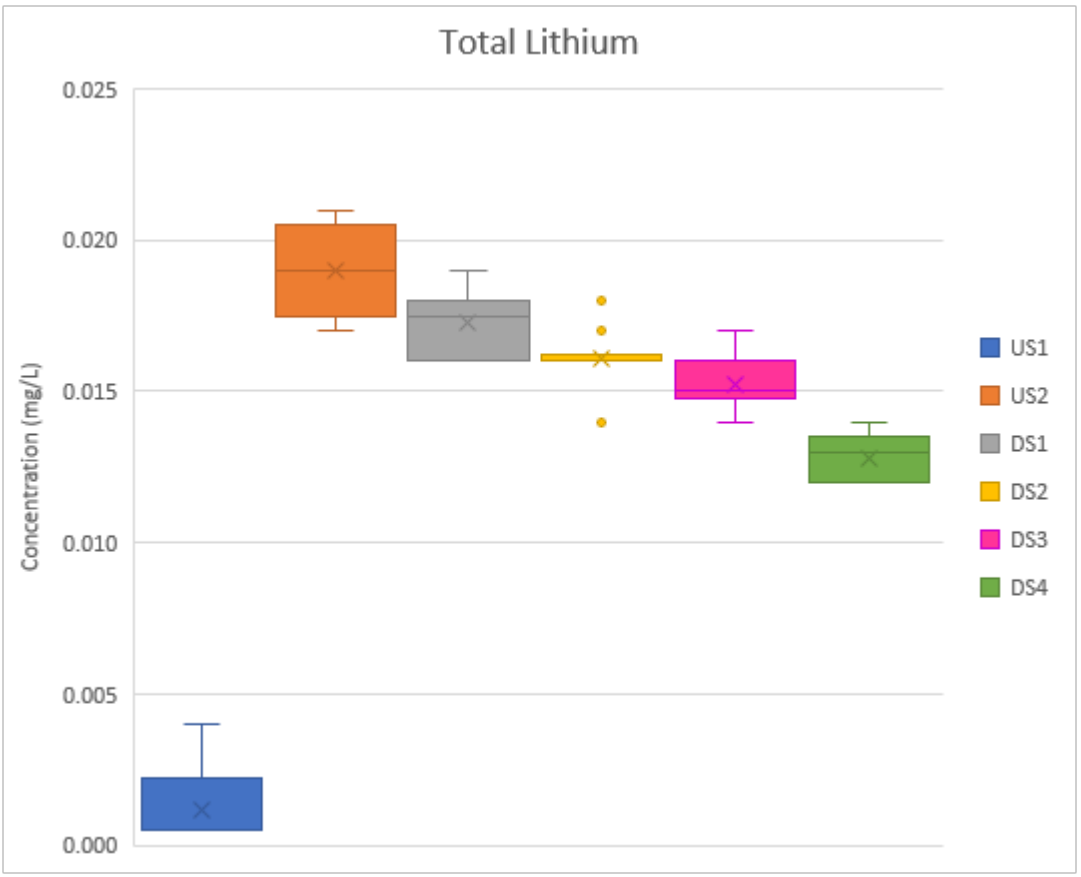

Dissolved Aluminium
Concentration (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4

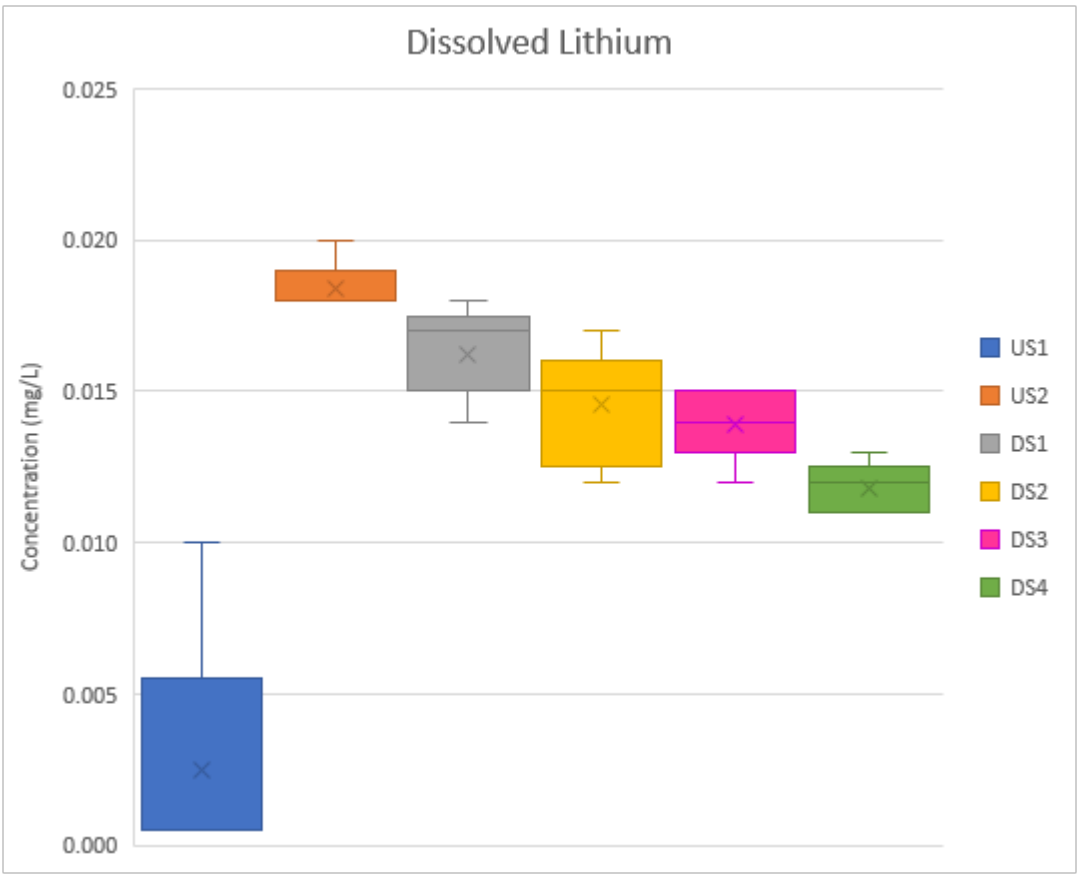

Total Barium
0.025
0.020
0.015
0.010
0.005
0.000
Concentration (mg/L)
US1
US2
DS1
DS2
DS3
DS4

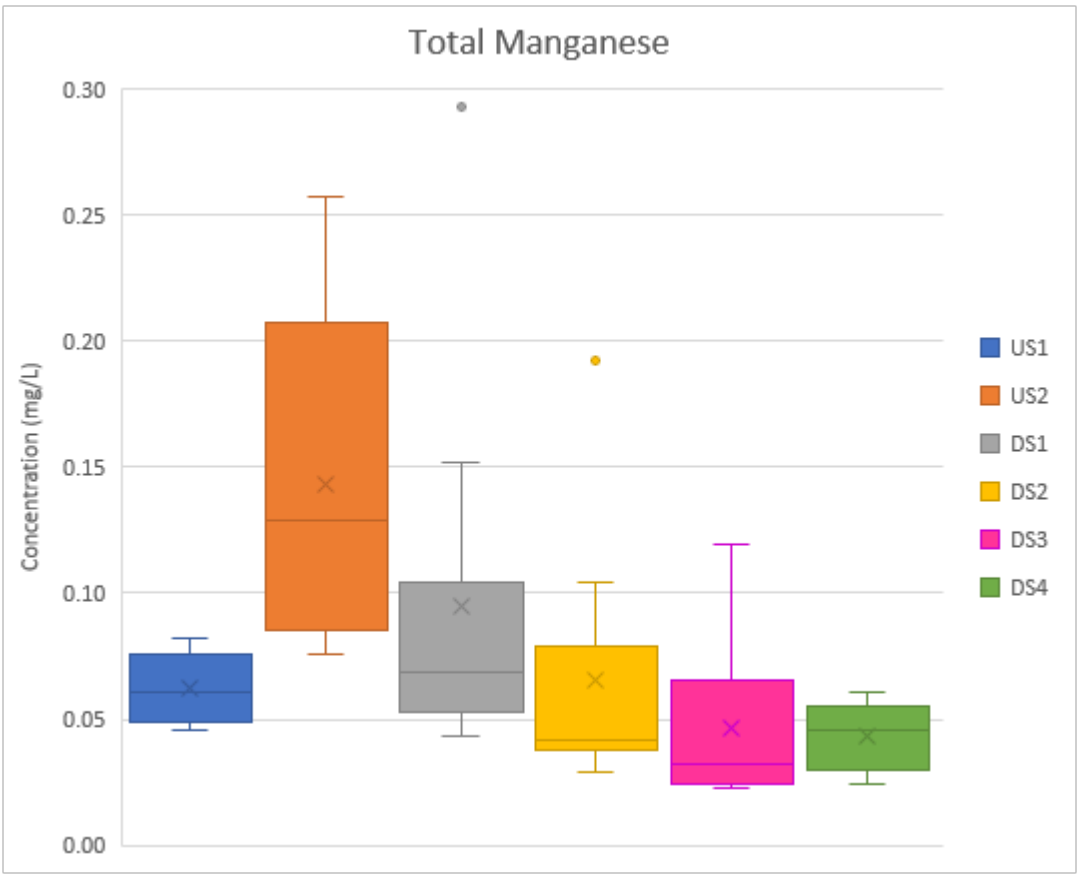

Dissolved Barium
0.025
0.020
0.015
0.010
0.005
0.000
Concentration (mg/L)
US1
US2
DS1
DS2
DS3
DS4

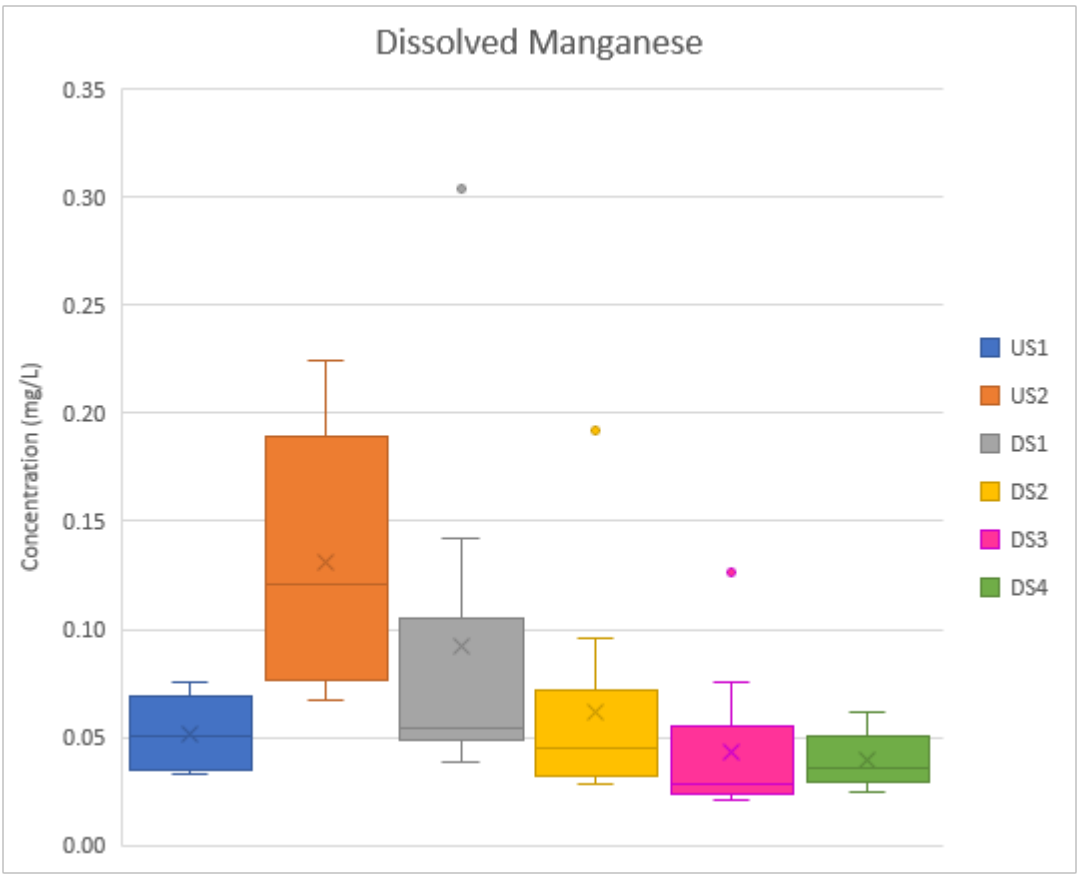

Total Cobalt
Concentration (mg/L)
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
US1
US2
DS1
DS2
DS3
DS4

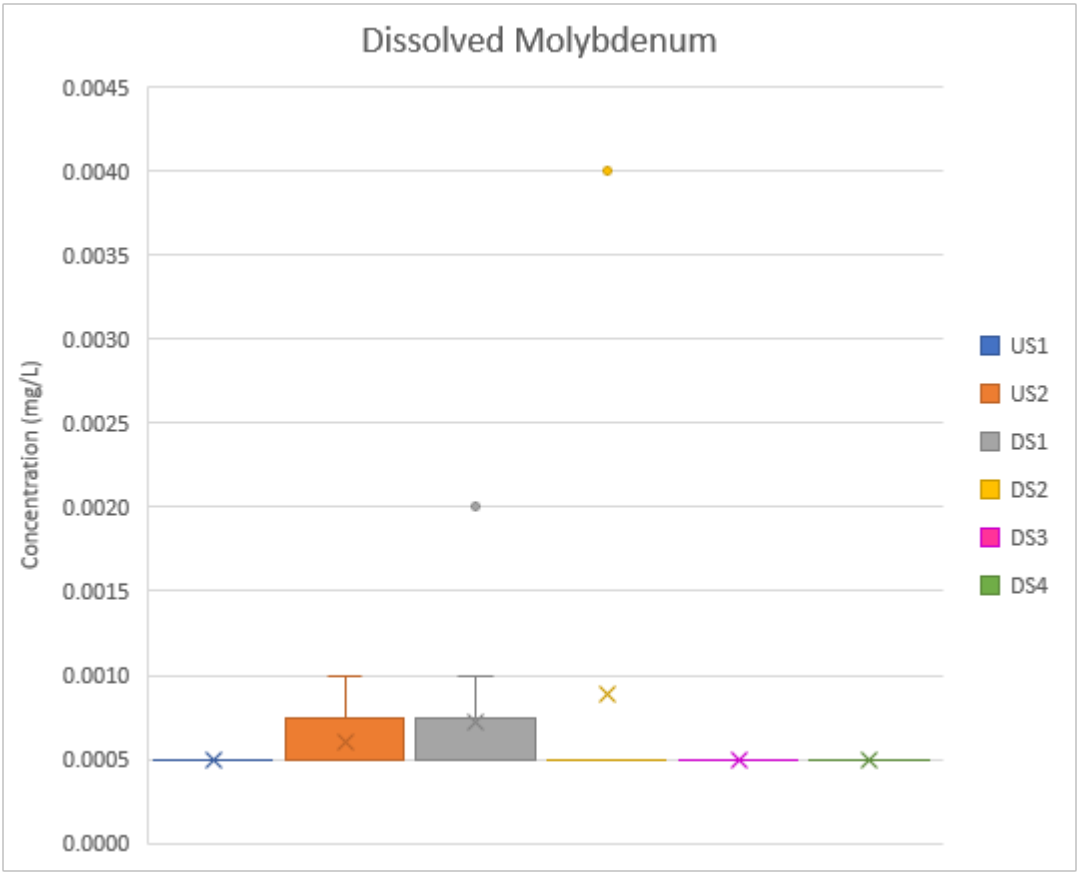

Dissolved Cobalt
Concentration (mg/L)
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
US1
US2
DS1
DS2
DS3
DS4

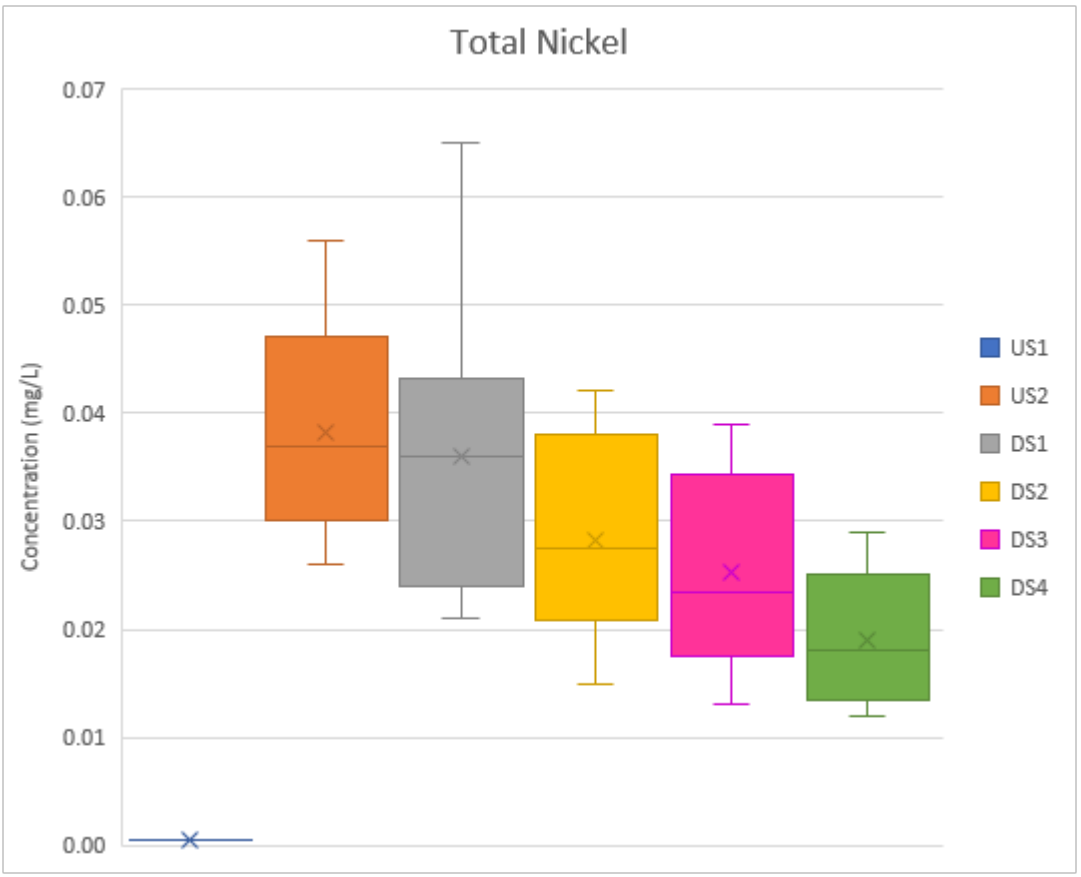

Total Lithium
Concentration (mg/L)
0.025
0.020
0.015
0.010
0.005
0.000
US1
US2
DS1
DS2
DS3
DS4

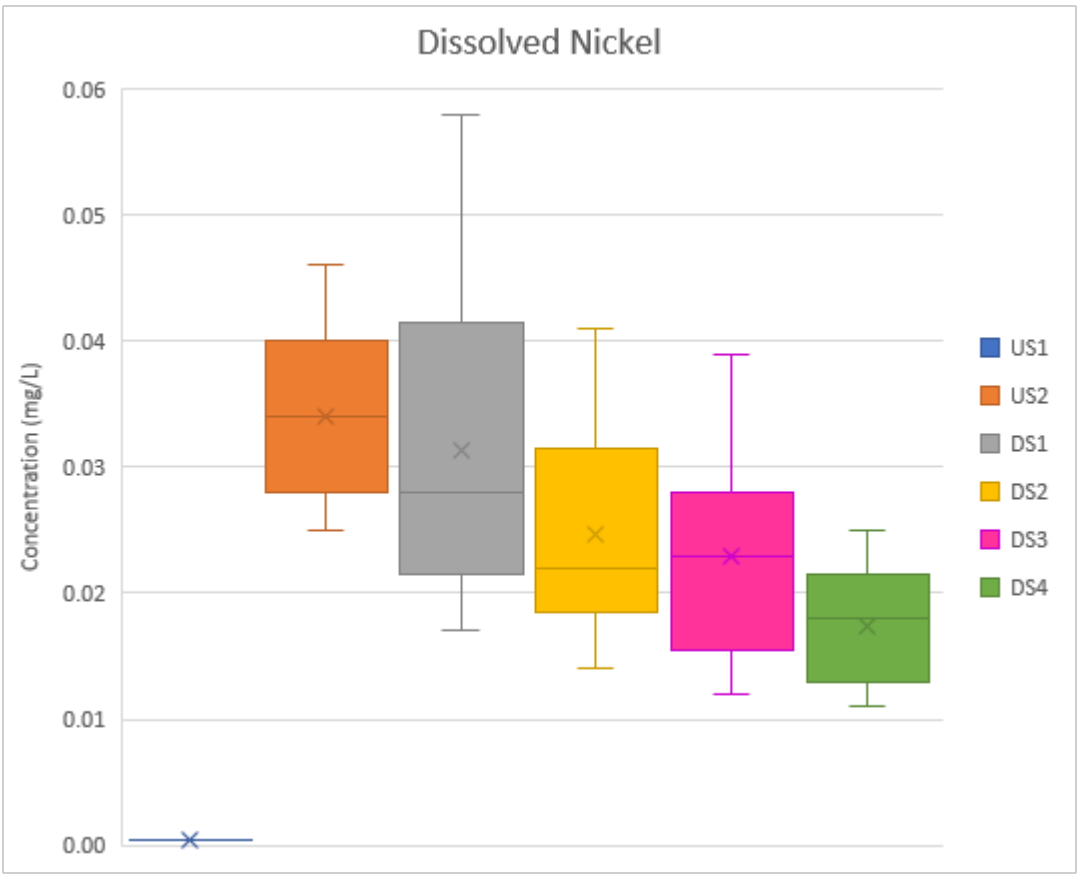

Dissolved Lithium
Concentration (mg/L)
0.025
0.020
0.015
0.010
0.005
0.000
US1
US2
DS1
DS2
DS3
DS4

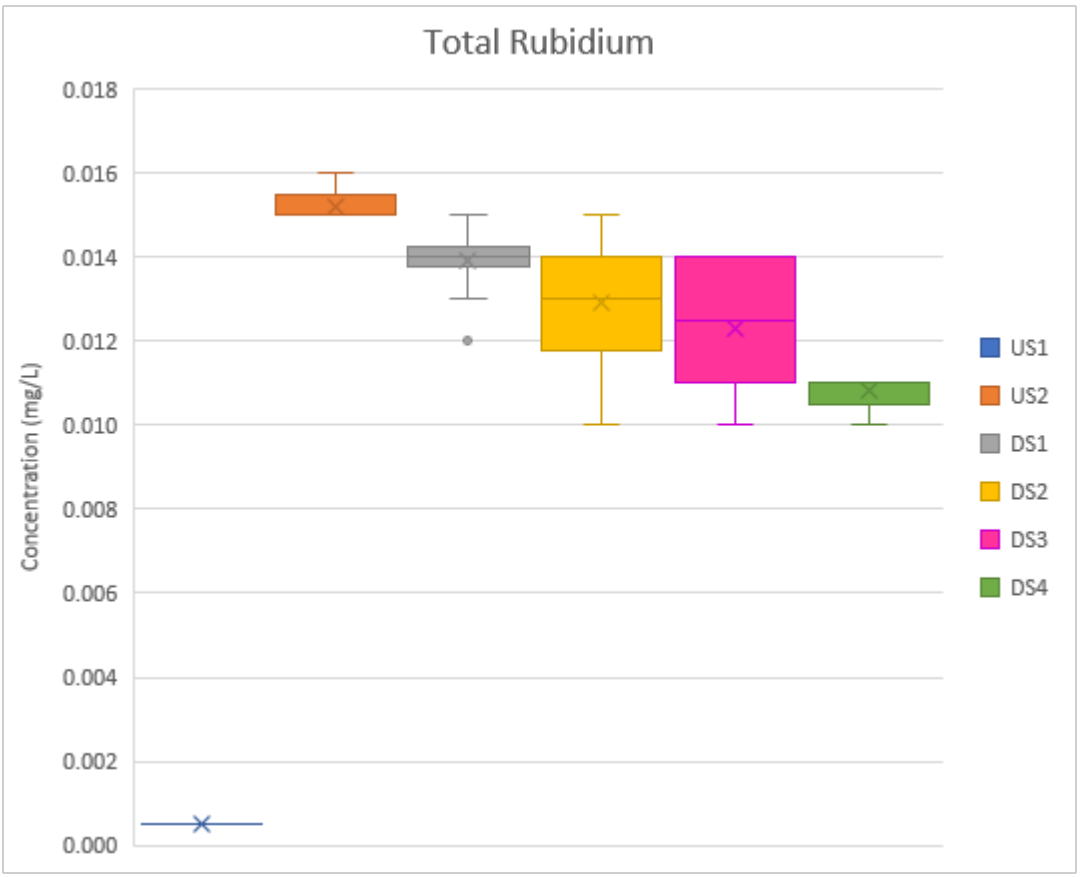

Total Manganese
Concentration (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
US1
US2
DS1
DS2
DS3
DS4

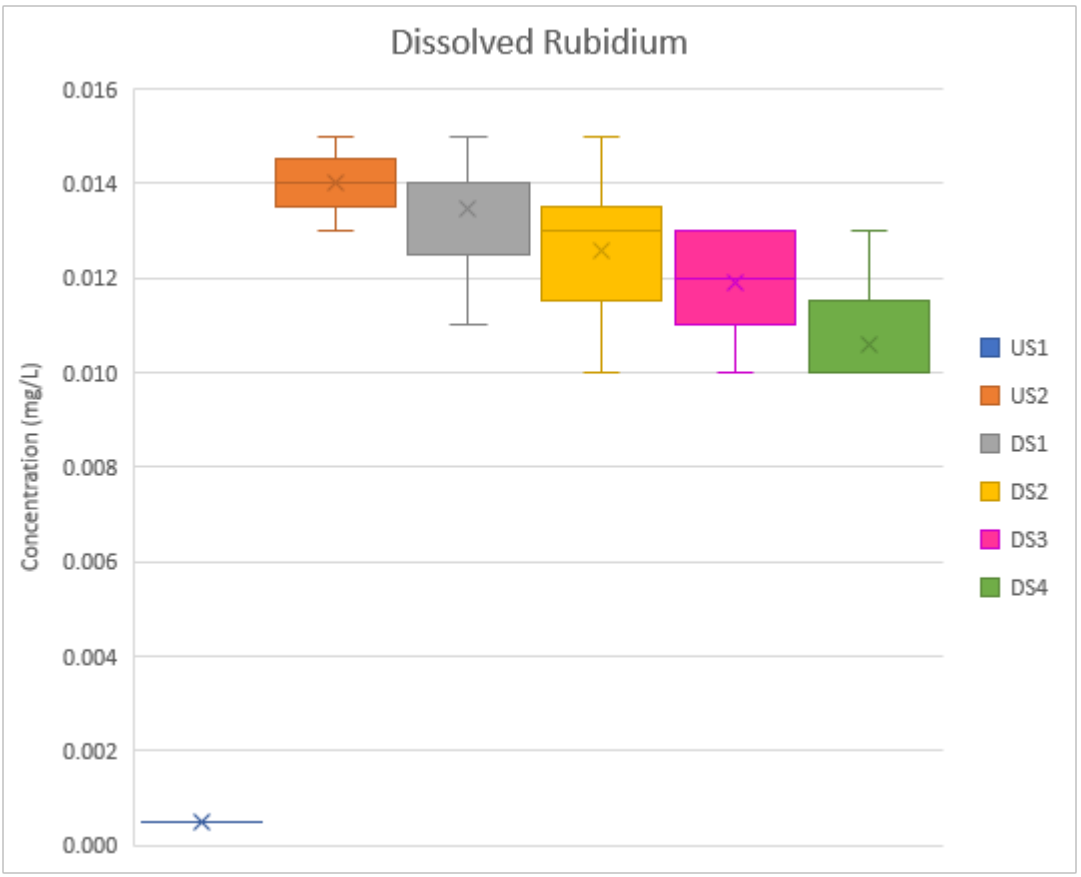

Dissolved Manganese
Concentration (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
US1
US2
DS1
DS2
DS3
DS4

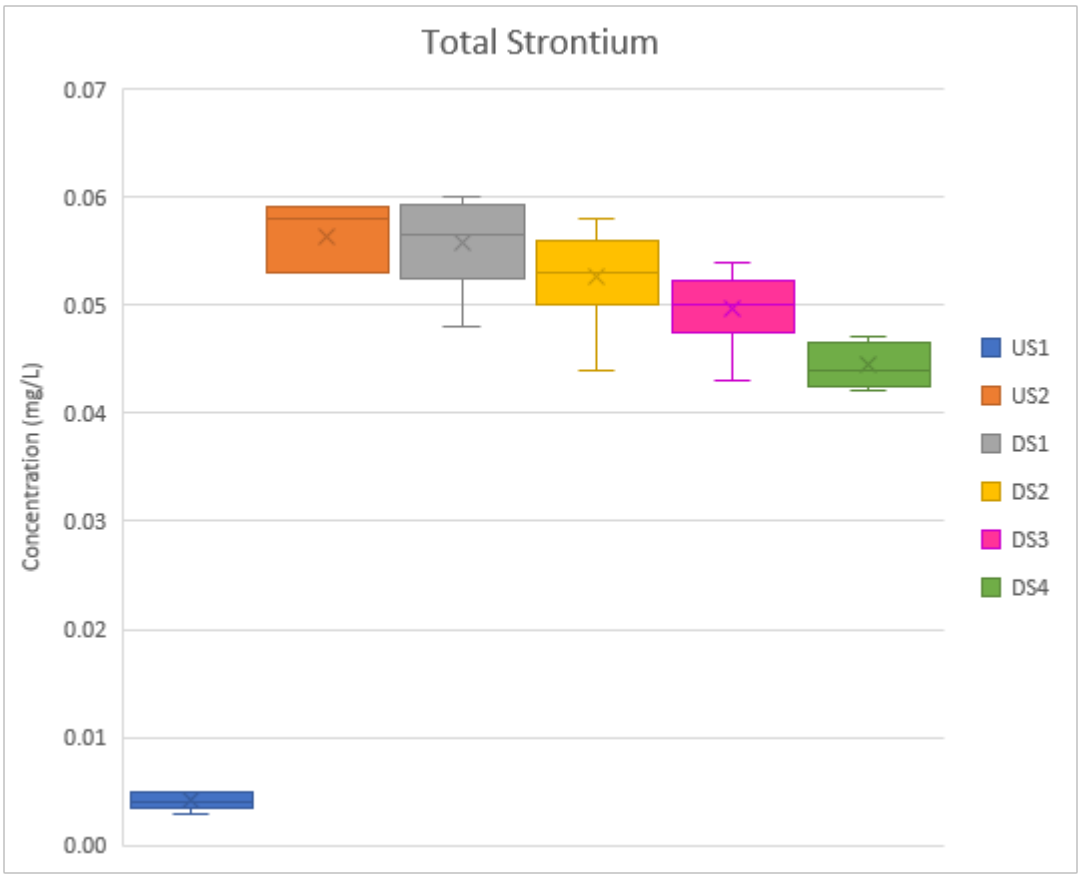

Dissolved Molybdenum
Concentration (mg/L)
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
US1
US2
DS1
DS2
DS3
DS4

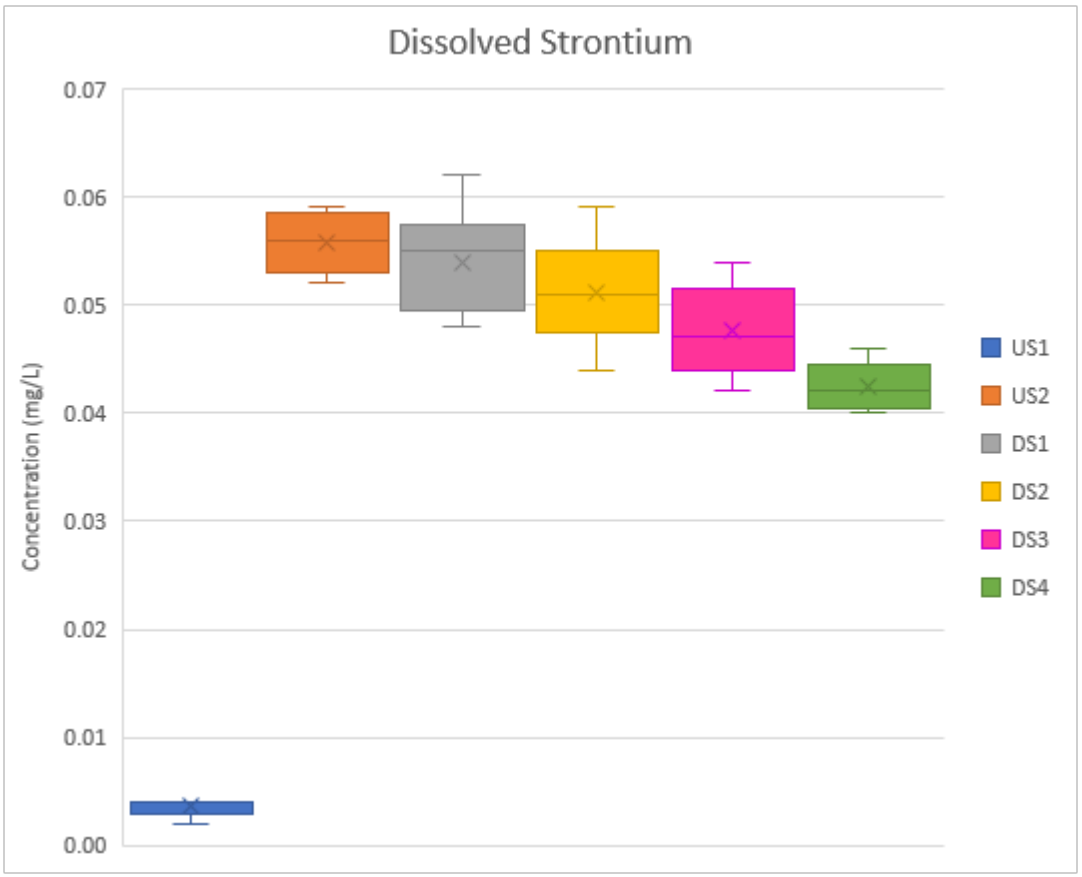

Total Nickel
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4

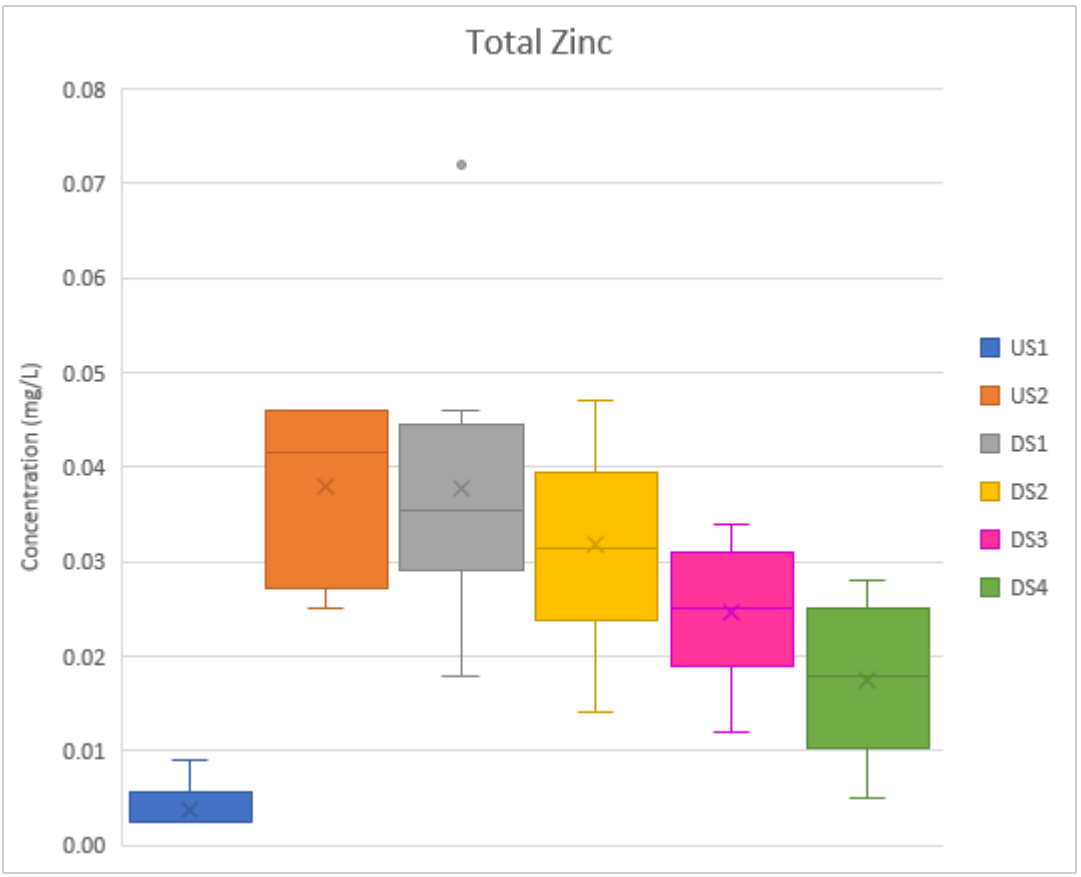

Dissolved Nickel
Concentration (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4

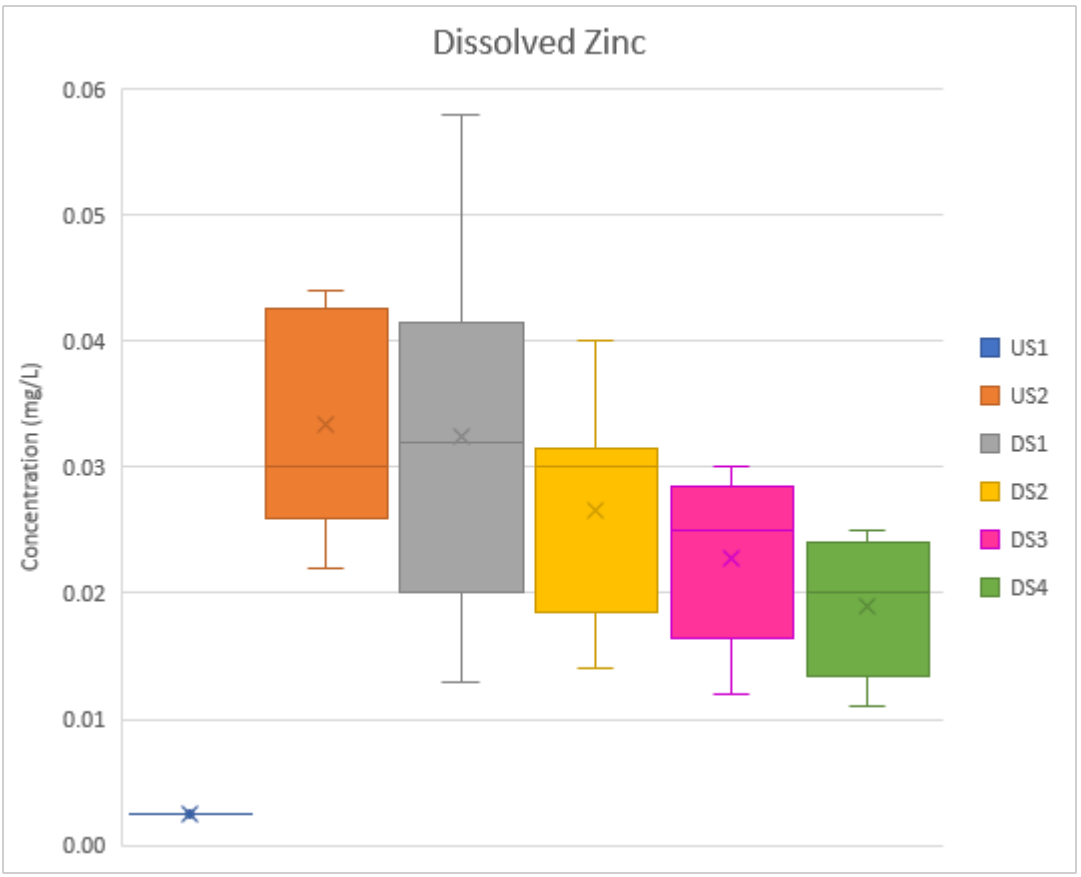

Total Rubidium
Concentration (mg/L)
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
US1
US2
DS1
DS2
DS3
DS4

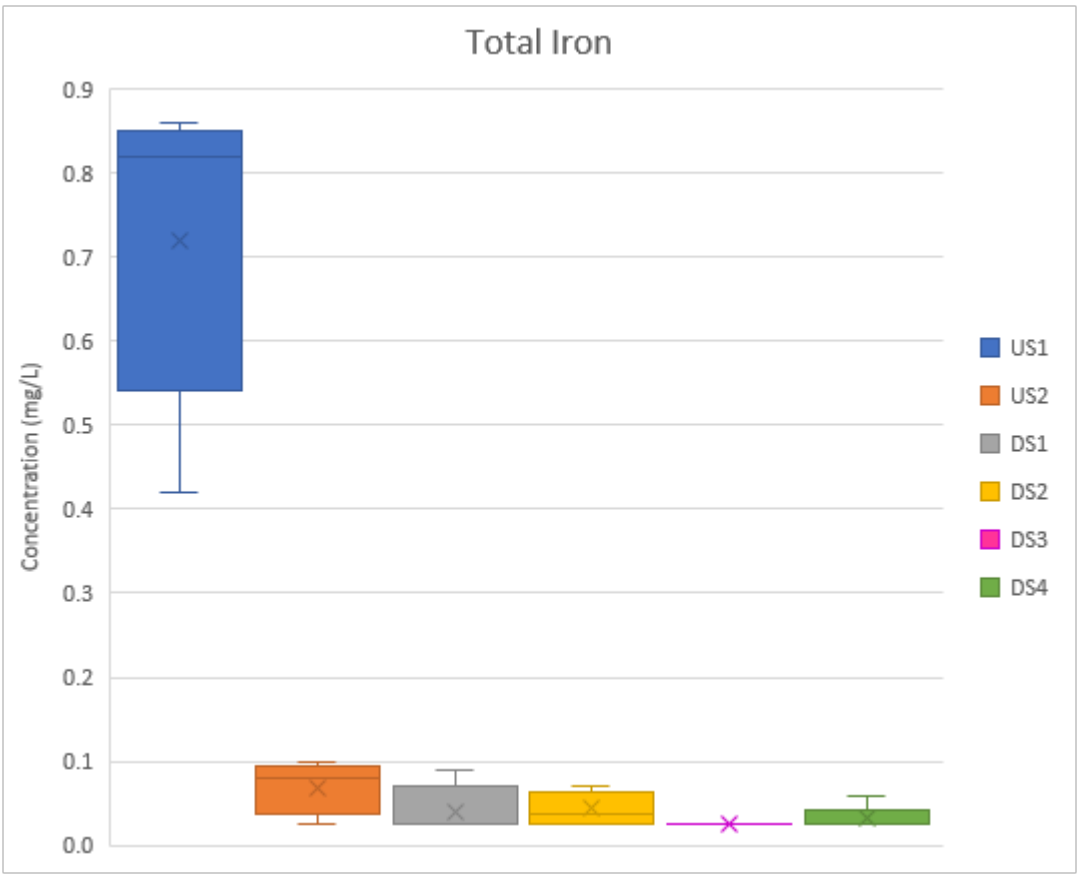

Dissolved Rubidium
Concentration (mg/L)
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
US1
US2
DS1
DS2
DS3
DS4

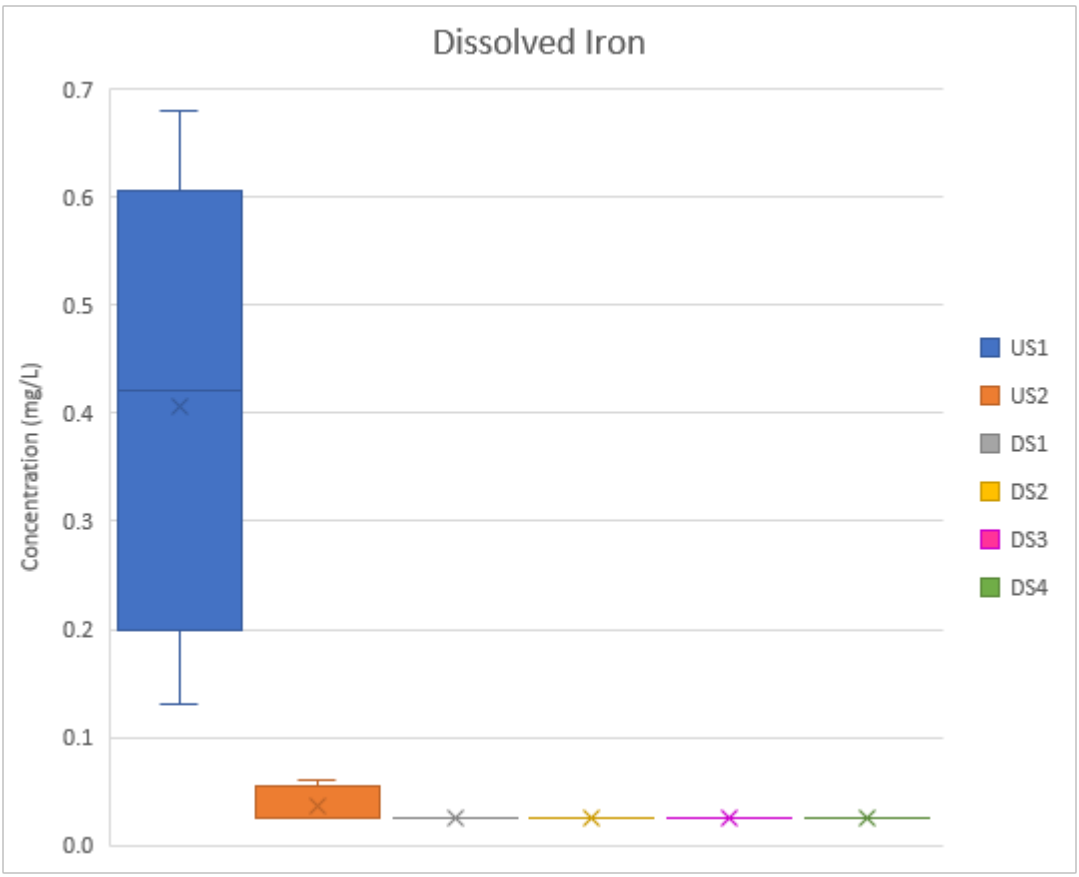

Total Strontium
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4


Dissolved Strontium
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4


Total Zinc
Concentration (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4


Dissolved Zinc
Concentration (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
US1
US2
DS1
DS2
DS3
DS4


Total Iron
Concentration (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
US1
US2
DS1
DS2
DS3
DS4


Dissolved Iron
Concentration (mg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
US1
US2
DS1
DS2
DS3
DS4

4. SEDIMENT QUALITY & COAL FINES MONITORING RESULTS

The Sediment Metals data for this reporting period are located in **Appendix B a**nd the available Microscopic Analysis Reports plus Petrography results are provided in **Appendix C.**

Section 4.1 provides a summary of sediment and fines monitoring methods and outlines how the data are presented.

Sediment total metals summary results are provided in **Section 4.2**. **Section 4.3** provides the Petrography summary results and **Section 4.4** summarises the results of the Visual inspection for coal fines.

4.1 Methods and Data Presentation

Field Methods:

Sediment sampling for the present six-monthly reporting period has been undertaken as per the EMP requirements:

- Three replicate sediment samples are collected to a depth of 10 cm at each of the nominated sites.
- The replicates are spaced 10m apart along a 20m stretch of the river.
- Samples are labelled and kept chilled for transport to the analysis laboratory.
- The laboratory then splits each replicate sample with one half submitted for total metal in sediment analysis for the same suite of analytes nominated for the water quality sampling.
- The other half of each split replicate sample is submitted for petrographic analysis.

For the coal-fine searches, visual inspections were made of the relevant sampling areas at all sampling events and at least once per quarter visual searches were completed covering a distance of approximately 500m upstream and 500m downstream of each sampling location.

Data Presentation:

For **Section**s **4.2** and **4.3**, the results are presented in **Summary Tables**, and are shown graphically in **Control Charts** and **Box-plots**:

- The **Section 4.2 Summary Tables** present the analyte detection limit (DL), sample size, the number of sample values above DL, minimum, median, mean, standard deviation (SD) of the mean, 80th percentile and maximum value for each analyte over all sampling events to date. **Note that all concentration data are presented as mg/Kg.**
- Results for analytes that have all or most analytic results below detection are shaded in grey with no (or reduced) sample statistics calculated and no bar charts or box plots produced.
- Depending on sample size the following general rules apply to calculation of site statistics:
    - If no values >DL, DL indicated in all statistical cells (the min, max, mean cells etc).
    - if one value >DL, then maximum value only shown,
    - if two values >DL, then maximum and minimum values shown only,

  - If three values >DL (for sample size of 5 through to 10), then use half DL values for calculation of statistics, and show the DL as the minimum value.
  - For analytes with 3 or more values above DL, median, mean, SD and 80th percentile statistics are calculated using halve DL values.
- The **Control Charts** provide results for the concentrations of each analyte over time for all seven sites, from the first sample run in the first monitoring period (August 2016) to the most recent sample for this current monitoring period (August 2017). Most are shown in line graph mode.
  - Where analyte values are similar across sites making discrimination of site differences difficult to see in line graph mode, the control graphs are shown in the form of clustered bar charts.
  - For the initial sediment analysis (i.e., for samples collected in August 16), the detection limits for all analytes were set high and most were adjusted down for subsequent analyses. Consequently, statistical results for the first sample run where DL values have been set at half detection, result in a higher graphed value than subsequent data utilising half the lower detection limits. The site data that are affected are DS1 to DS3 and all analytes are affected except Aluminium, Boron, Iron and Sulphur as S (where the detection limit has remained unchanged at 50mg/kg) and for Cobalt, Manganese and Zinc where there were no values lower than detection for these sites on that occasion.
- **Box Plots** compare the summary statistical results for each analyte per site over the complete sampling program to data:
  - The upper and lower sides of the main box show the quartile (75 and 25 percentile) values for the data. The range between these values is called the interquartile range (IQR).
  - The line through the box shows the median (50 percentile) for the data and the cross (X) shows the mean value for the data.
  - The box 'whiskers' generally show the maximum and minimum values provided the data are all within 1.5 IQRs either side of the IQR.
  - If there are outlier data (i.e. values outside this range), they are shown as small circles located on both sides or on one side of the whiskers (depending whether the outliers are very low or very high value) and the whiskers on the side that have outliers then shows the 1.5 IQR limits for the data. Outliers will then indicate the relevant minimum or maximum value.

4.2 Sediment Total Metal Monitoring Data

The sediment total metal summary statistics for each sampling location and event are provided below in Site Summary **Tables 9 to 14**, Control Charts, and Box Plots:

- Selenium (DL < 1 mg/kg) and Boron (DL< 50mg/kg) concentrations were all <DL for all sites and for all sampling times to date, and are not plotted as Control Graphs or Box Plots.
- Cadmium (DL < 0.1mg/kg) concentrations were all <DL for all sites and for all sampling times to date with a signal replicate sample analysis at DS3 that returned a value of 0.1mg/kg. Cadmium results are not plotted as Control Graphs or Box Plots.
- Beryllium and Molybdenum concentrations were <DL (0.1mg/kg) at site US1 for all sample occasions and for 14 of 15 replicate samples at DS4.
- Uranium concentrations were <DL (0.1mg/kg) for all samples at sites US1 and DS4.
- Sulfur as S concentrations were <DL for 14 of 15 replicate samples at US1 and 13 of 15 replicate samples at DS4.

Table 21 US1 Sediment Summary Statistics

	Total Metals																					
	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Sulfur as S	Uranium	Zinc
Detection limit (DL)	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	50	0.1	0.5
Sample size (n)	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
n > DL	15	1	12	15	0	0	0	15	15	14	15	15	11	15	0	12	15	0	15	1	0	11
Min	230	-	0.1	0.8	<DL	<DL	<DL	0.2	0.1	0.1	810	0.3	0.1	11.2	<DL	0.1	0.1	<DL	0.2	-	<DL	0.5
Median	360.0	-	0.1	1.6	<DL	<DL	<DL	0.5	0.4	0.4	1610.0	0.5	0.1	44.6	<DL	0.2	0.3	<DL	0.4	-	<DL	0.6
Mean	635.3	-	0.2	2.2	<DL	<DL	<DL	0.6	0.5	0.5	2206.0	0.6	0.1	58.1	<DL	0.2	0.3	<DL	0.5	-	<DL	0.7
SD	875.0	-	0.1	1.6	<DL	<DL	<DL	0.4	0.5	0.5	1695.4	0.4	0.1	53.0	<DL	0.1	0.1	<DL	0.3	-	<DL	0.5
80th percentile	618.0	-	0.2	3.0	<DL	<DL	<DL	0.6	0.7	0.6	3188.0	0.8	0.2	62.3	<DL	0.2	0.3	<DL	0.6	-	<DL	0.8
Max	3750	0.1	0.4	7.1	<DL	<DL	<DL	1.9	1.8	2.1	7330	1.7	0.3	210.0	<DL	0.6	0.7	<DL	1.4	90	<DL	2.4

Table 22 US2 Sediment Summary Statistics

	Total Metals																					
	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Sulfur as S	Uranium	Zinc
Detection limit (DL)	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	50	0.1	0.5
Sample size (n)	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
n > DL	15	9	15	15	14	0	0	15	15	15	15	15	15	15	14	15	15	0	15	4	5	15
Min	310	0.1	0.2	9.6	0.1	<DL	<DL	0.3	5.1	0.6	760	0.7	0.1	103	0.1	6	0.3	<DL	0.4	50	0.1	13.7
Median	520.0	0.1	0.3	21.2	0.2	<DL	<DL	0.5	197.0	1.0	1320.0	1.2	3.6	1820.0	1.0	153.0	0.5	<DL	1.1	25.0	0.1	211.0
Mean	764.7	0.1	0.3	20.6	0.2	<DL	<DL	1.1	172.2	1.6	2248.7	1.5	3.3	1620.4	0.9	134.9	0.7	<DL	1.3	33.7	0.1	190.2
SD	706.2	0.1	0.1	5.8	0.1	<DL	<DL	1.4	95.6	1.1	2575.4	0.8	1.8	792.4	0.5	70.9	0.4	<DL	0.6	15.1	0.1	95.6
80th percentile	672.0	0.2	0.3	25.3	0.3	<DL	<DL	1.1	231.4	2.1	2190.0	1.9	4.5	2236.0	1.2	189.2	1.0	<DL	1.5	52.0	0.1	261.2
Max	2920	0.2	0.6	28.9	0.5	<DL	<DL	4.9	300	4.3	10800	3.2	5.2	2530	1.6	226.0	1.6	<DL	2.7	60	0.2	313

Table 23 DS1 Sediment Summary Statistics

	Total Metals																					
	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Sulfur as S	Uranium	Zinc
Detection limit (DL)	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	50	0.1	0.5
Sample size (n)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
n > DL	30	11	26	29	25	0	0	29	30	27	30	26	29	30	26	30	29	0	29	5	9	30
Min	260	0.1	0.1	0.1	0.1	<DL	<DL	0.1	0.4	0.1	330	0.1	0.1	2.5	0.1	0.2	0.1	<DL	0.1	50	0.1	0.5
Median	645.0	0.1	0.3	16.4	0.2	<DL	<DL	0.6	164.5	1.2	1090.0	1.1	3.9	1430.0	1.0	124.5	0.9	<DL	1.3	25.0	0.1	155.5
Mean	1203.3	0.3	0.5	16.9	0.2	<DL	<DL	1.0	172.8	1.4	1490.0	1.3	3.7	1428.5	0.9	123.7	0.9	<DL	1.4	34.2	0.1	160.8
SD	865.6	0.7	0.7	5.6	0.1	<DL	<DL	1.0	65.2	0.8	995.1	0.5	1.5	463.5	0.2	41.9	0.4	<DL	0.7	28.4	0.1	58.4
80th percentile	2072.0	0.1	0.3	20.0	0.3	<DL	<DL	1.1	198.0	1.6	1624.0	1.6	4.8	1826.0	1.1	148.2	1.2	<DL	1.6	25.0	0.1	198.6
Max	3280	0.2	0.4	29	0.4	<DL	<DL	4	418	5.0	4440	2.0	6.8	2410.0	1.3	216.0	1.9	<DL	3	170	0.2	323

Table 24 DS2 Sediment Summary Statistics

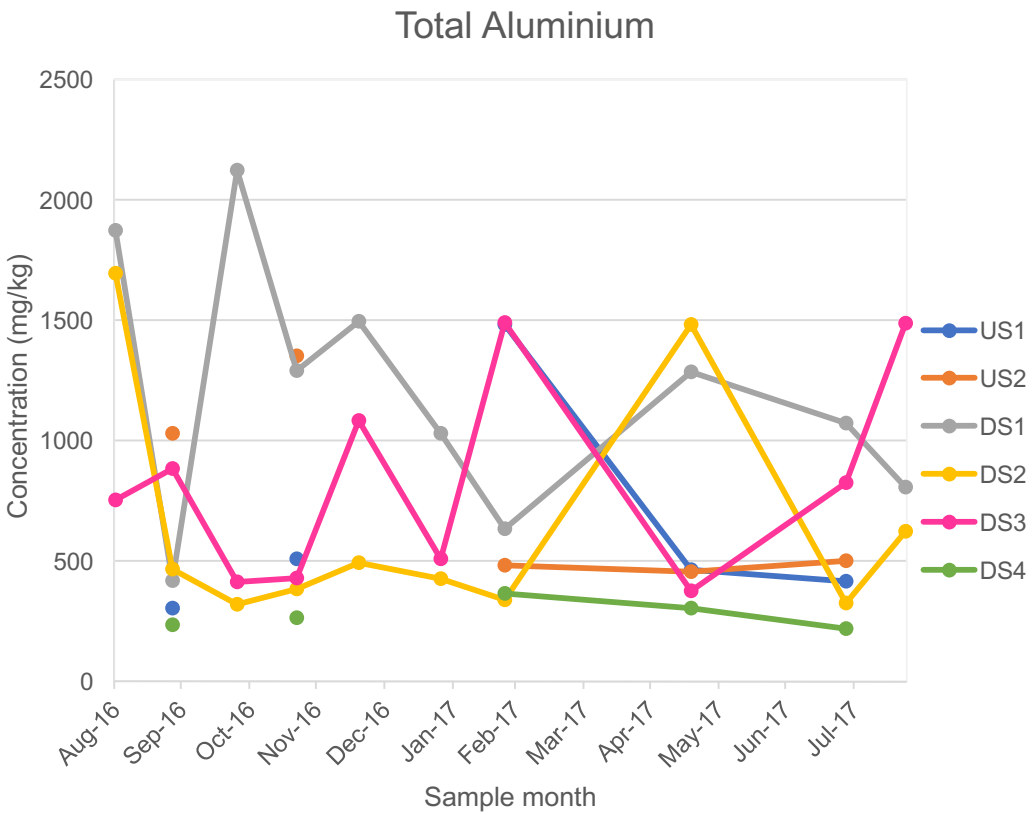
	Total Metals																					
	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Sulfur as S	Uranium	Zinc
Detection limit (DL)	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	50	0.1	0.5
Sample size (n)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
n > DL	30	2	14	28	11	0	0	30	30	27	30	27	30	30	25	30	30	0	28	3	5	30
Min	250	0.1	0.1	0.1	0.1	<DL	<DL	0.3	3.8	0.1	410	0.1	0.5	13.5	0.1	11.00	0.3	<DL	0.1	50	0.1	18.3
Median	385.0	-	0.1	4.3	0.1	<DL	<DL	0.6	22.1	0.6	825.0	0.9	1.0	169.5	0.2	19.8	0.6	<DL	0.9	25.0	0.1	25.9
Mean	656.0	-	0.3	5.1	0.1	<DL	<DL	1.0	23.8	0.8	1359.3	1.1	1.0	185.1	0.2	22.6	0.7	<DL	1.0	30.2	0.1	29.7
SD	585.3	-	0.7	3.6	0.1	<DL	<DL	1.0	10.0	0.6	1387.1	0.6	0.3	91.4	0.3	7.6	0.3	<DL	0.6	16.3	0.0	11.2
80th percentile	758.0	-	0.2	6.3	0.1	<DL	<DL	1.2	31.1	1.0	1788.0	1.5	1.2	276.2	0.2	27.4	0.9	<DL	1.1	25.0	0.1	35.5
Max	2360	0.1	0.3	20	0.2	<DL	<DL	4	44.4	1.4	6610	2.3	1.6	418.0	0.3	39.0	1.8	<DL	3	90	0.2	67

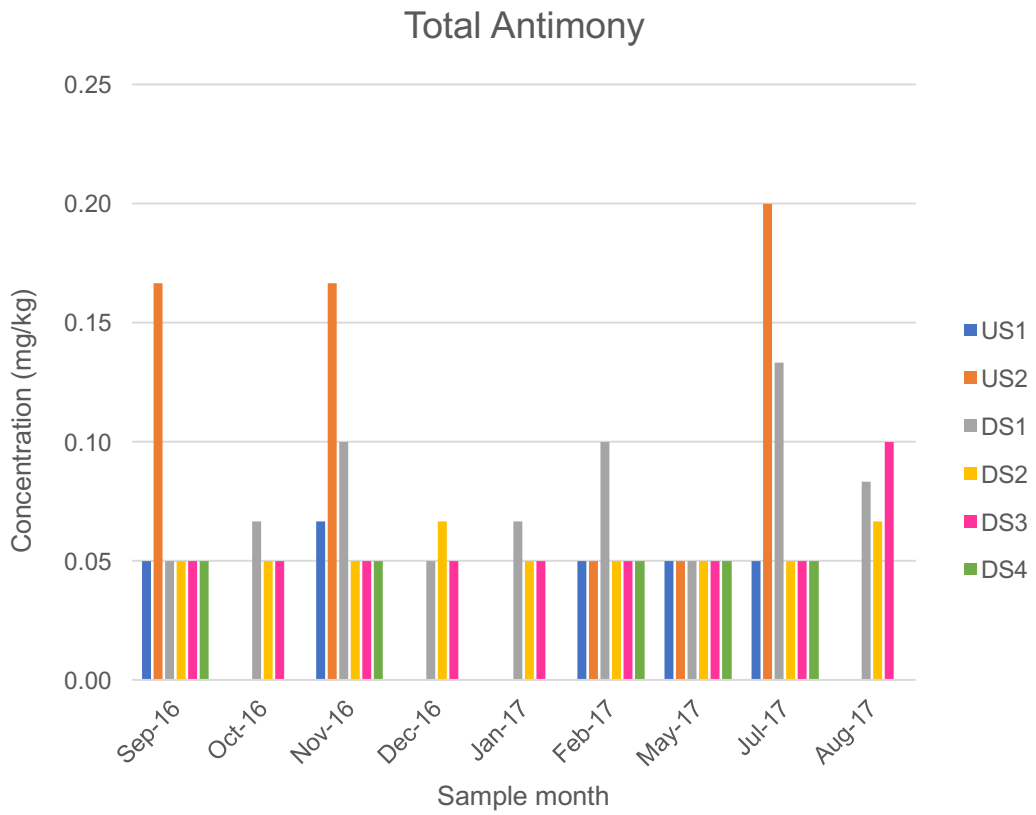
Table 25 DS3 Sediment Summary Statistics

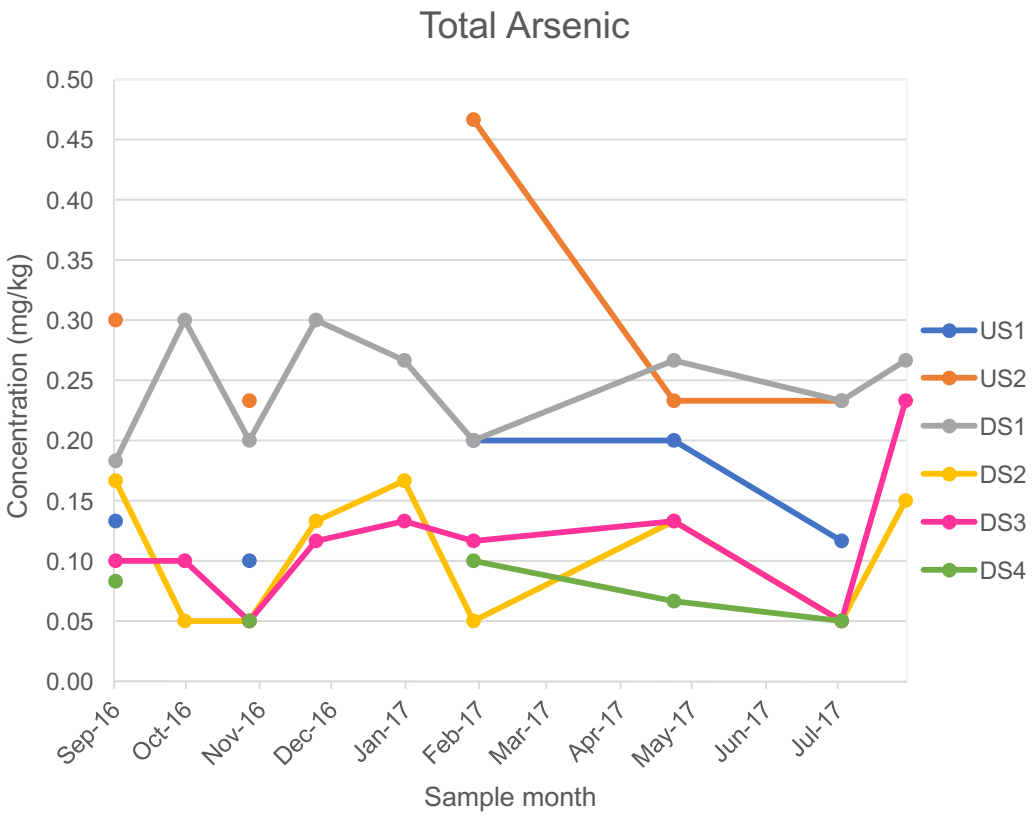
	Total Metals																					
	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Sulfur as S	Uranium	Zinc
Detection limit (DL)	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	50	0.1	0.5
Sample size (n)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
n > DL	30	1	11	27	5	0	1	29	30	27	30	27	29	30	10	30	30	0	27	6	4	30
Min	160	-	0.1	0.1	0.1	<DL	-	0.1	4	0.1	160	0.1	0.1	18.7	0.1	5.6	0.3	<DL	0.1	50	0.1	8
Median	405.0	-	0.1	3.6	0.1	<DL	-	0.8	10.2	0.6	1185.0	0.7	0.7	89.3	0.1	12.0	0.8	<DL	0.8	25.0	0.1	18.3
Mean	825.3	-	0.4	5.7	0.1	<DL	-	1.2	16.6	1.3	1458.0	1.4	0.7	128.9	0.2	16.8	0.9	<DL	1.2	67.3	0.1	24.5
SD	984.2	-	0.7	7.5	0.2	<DL	-	0.9	18.2	1.9	1271.5	1.6	0.3	135.7	0.3	15.3	0.5	<DL	1.3	164.5	0.2	23.6
80th percentile	874.0	-	0.2	5.4	0.1	<DL	-	1.9	21.5	2.3	1876.0	2.1	1.0	143.8	0.1	19.1	1.1	<DL	1.2	30.0	0.1	24.5
Max	3910	0.2	0.6	42.4	1.1	<DL	0.1	4.1	93.4	10.2	5370	8.9	1.7	753.0	0.5	75.6	2.4	<DL	7	920	0.9	125

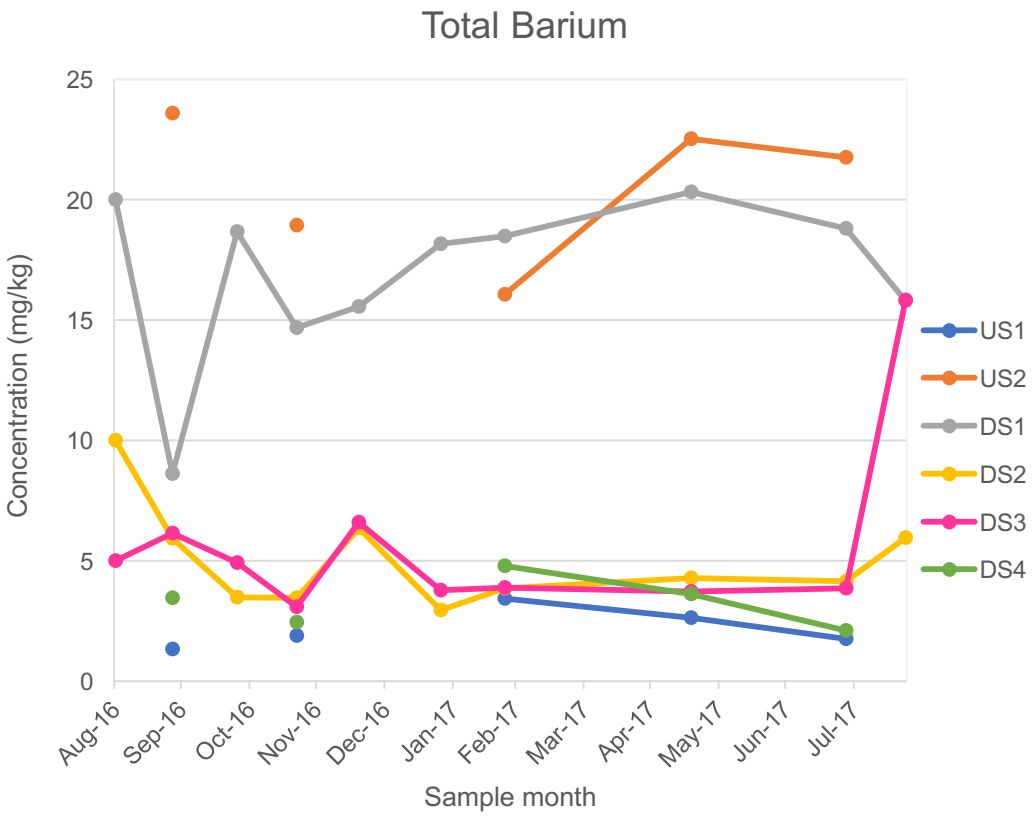
Table 26 DS4 Sediment Summary Statistics

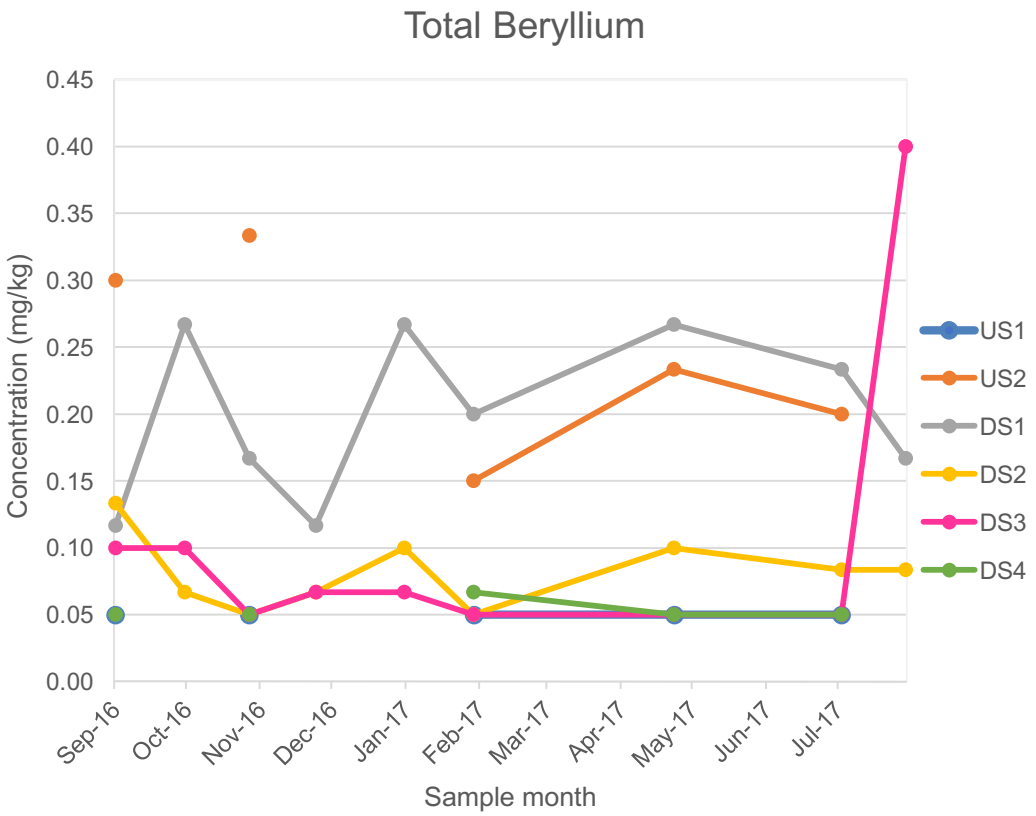
	Total Metals																					
	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Rubidium	Selenium	Strontium	Sulfur as S	Uranium	Zinc
Detection limit (DL)	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	50	0.1	0.5
Sample size (n)	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
n > DL	15	0	4	15	1	0	0	15	15	14	15	15	15	15	1	15	15	0	15	2	0	15
Min	130	<DL	0.1	1.3	-	<DL	<DL	0.2	2.2	0.1	400	0.3	0.2	14.4	-	1.7	0.2	<DL	0.2	50	<DL	2.3
Median	250.0	<DL	0.1	2.8	-	<DL	<DL	0.4	10.0	0.3	650.0	0.6	0.6	59.7	-	11.0	0.4	<DL	0.6	-	<DL	13.2
Mean	278.0	<DL	0.1	3.3	-	<DL	<DL	0.5	11.4	0.5	662.7	0.7	0.6	86.4	-	10.5	0.5	<DL	0.7	-	<DL	13.0
SD	109.7	<DL	0.0	1.8	-	<DL	<DL	0.3	7.4	0.4	187.1	0.4	0.3	67.0	-	6.9	0.3	<DL	0.5	-	<DL	8.4
80th percentile	364.0	<DL	0.1	4.3	-	<DL	<DL	0.6	18.8	0.6	844.0	0.8	0.8	153.8	-	16.0	0.6	<DL	0.8	-	<DL	22.5
Max	530	<DL	0.2	7.4	0.1	<DL	<DL	1.3	25.3	1.6	930	1.8	1.1	220	0.1	23.9	1.5	<DL	2.3	50	<DL	26.9

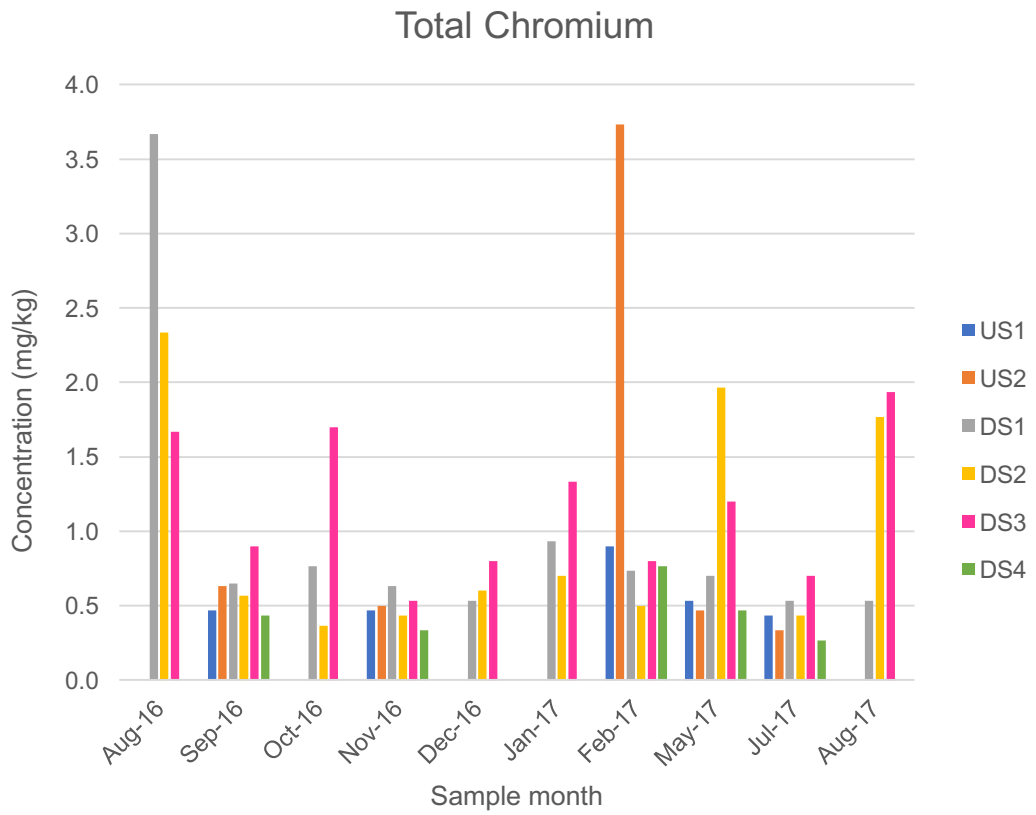

Total Aluminium
2500
2000
1500
1000
500
0
Concentration (mg/kg)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

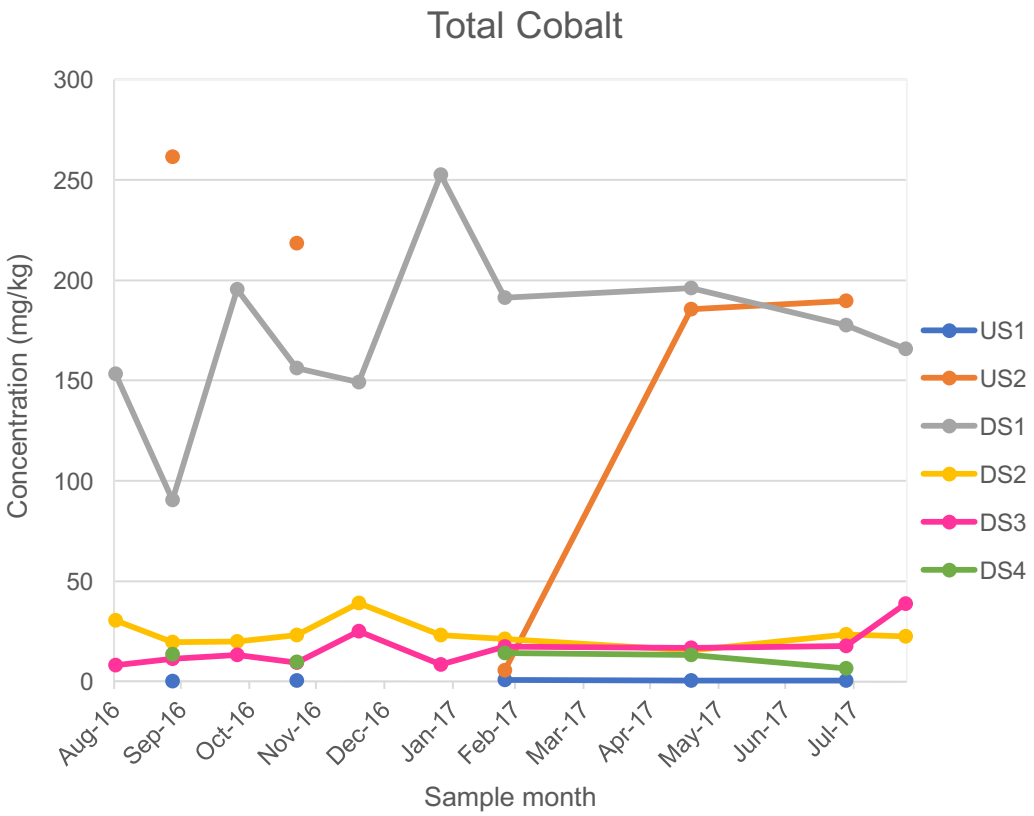

Total Antimony
0.25
0.20
0.15
0.10
0.05
0.00
Concentration (mg/kg)
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

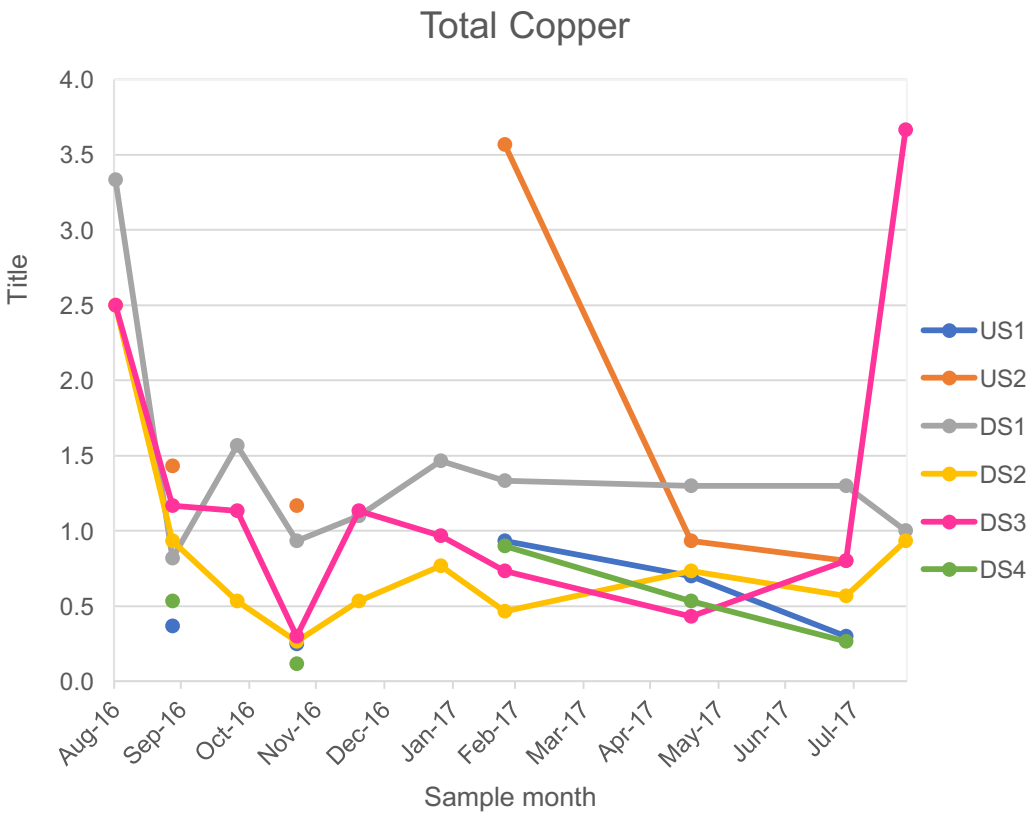

Total Arsenic
Concentration (mg/kg)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

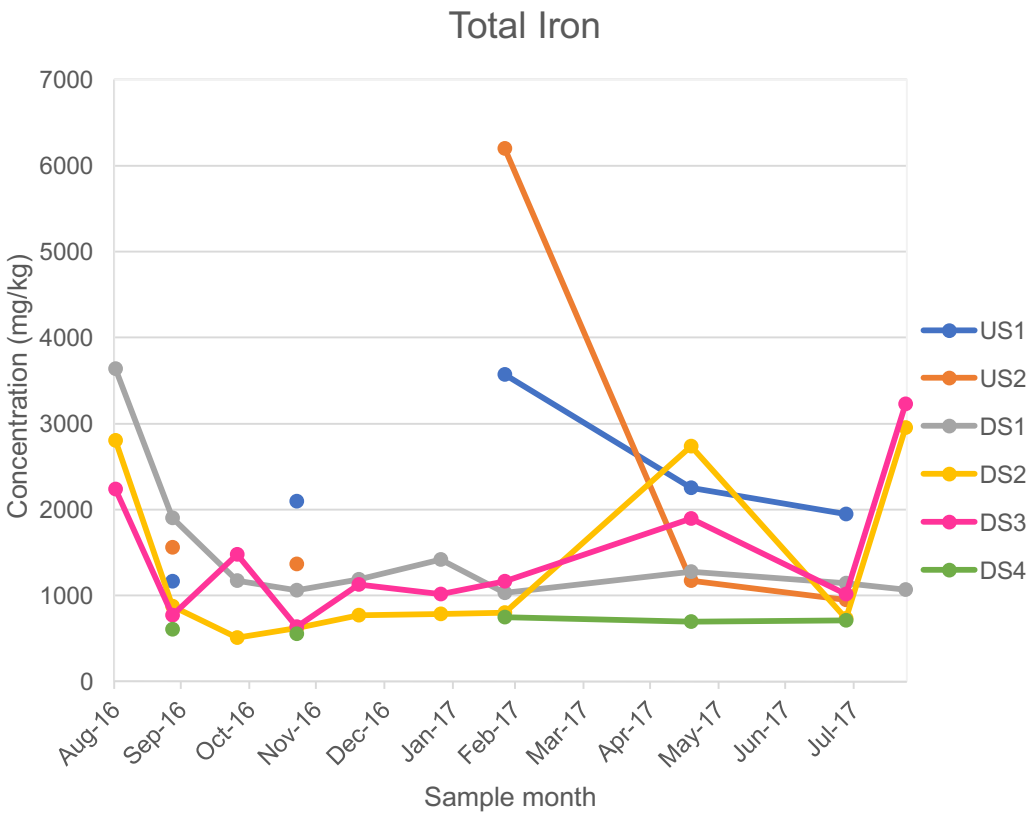

Total Barium
Concentration (mg/kg)
25
20
15
10
5
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

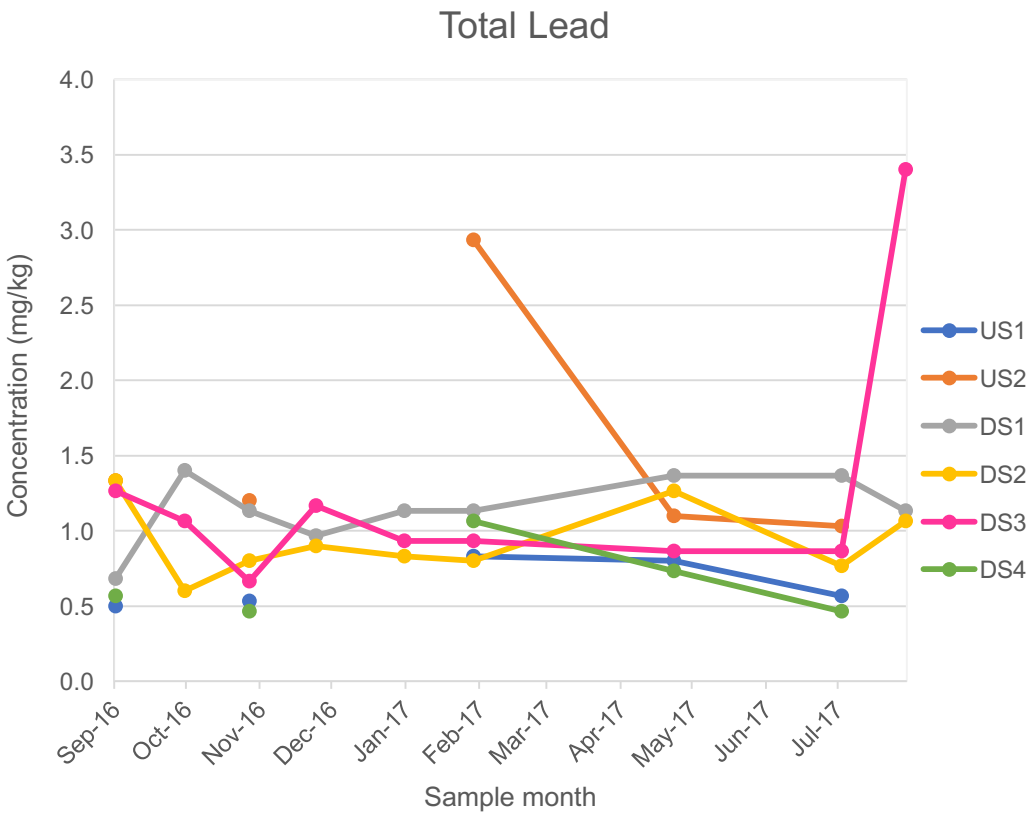

Total Beryllium
Concentration (mg/kg)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

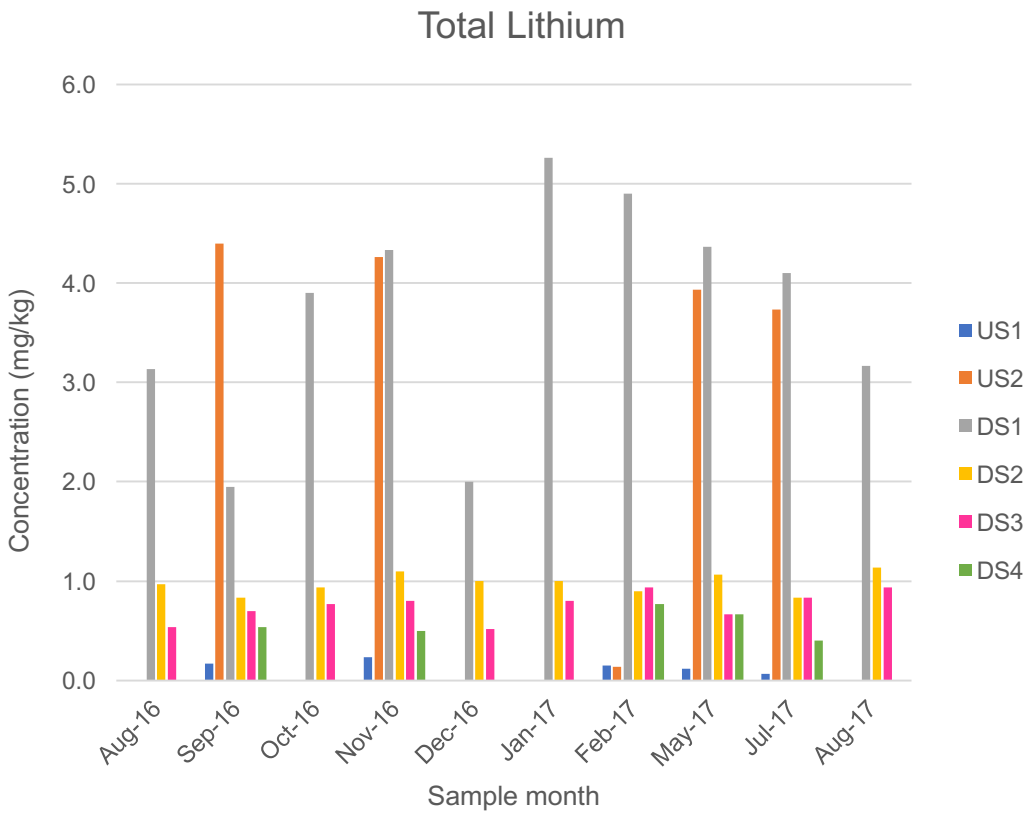

Total Chromium
Concentration (mg/kg)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

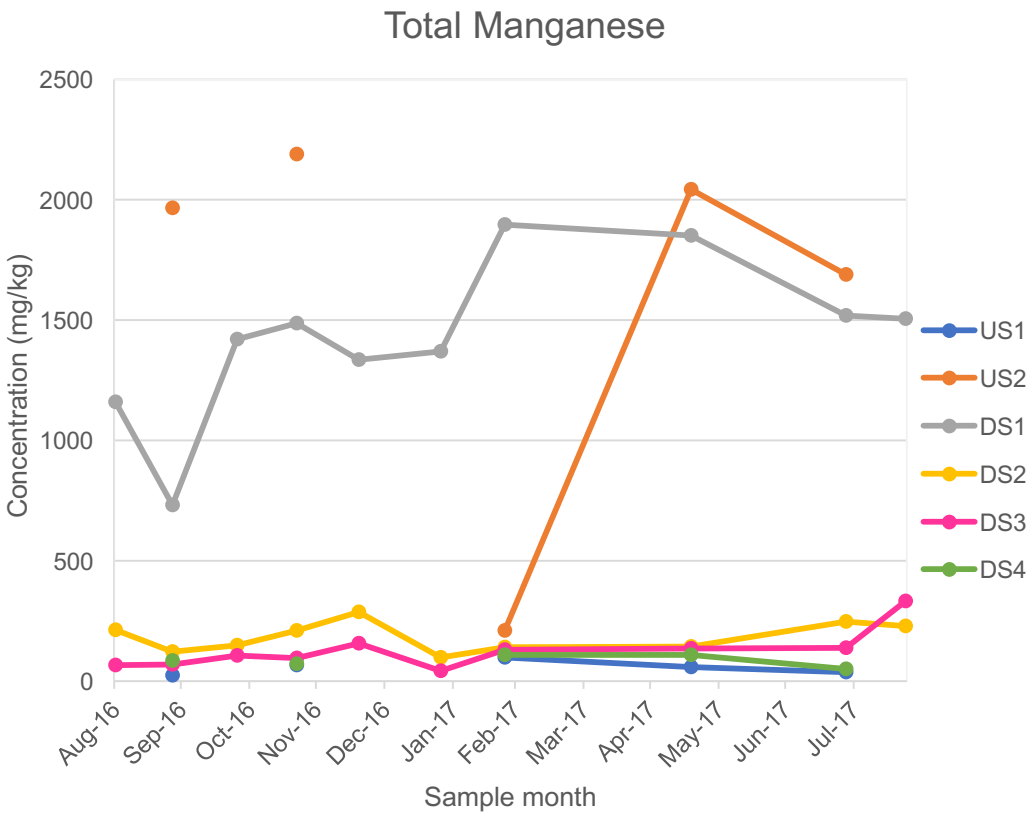

Total Cobalt
Concentration (mg/kg)
300
250
200
150
100
50
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

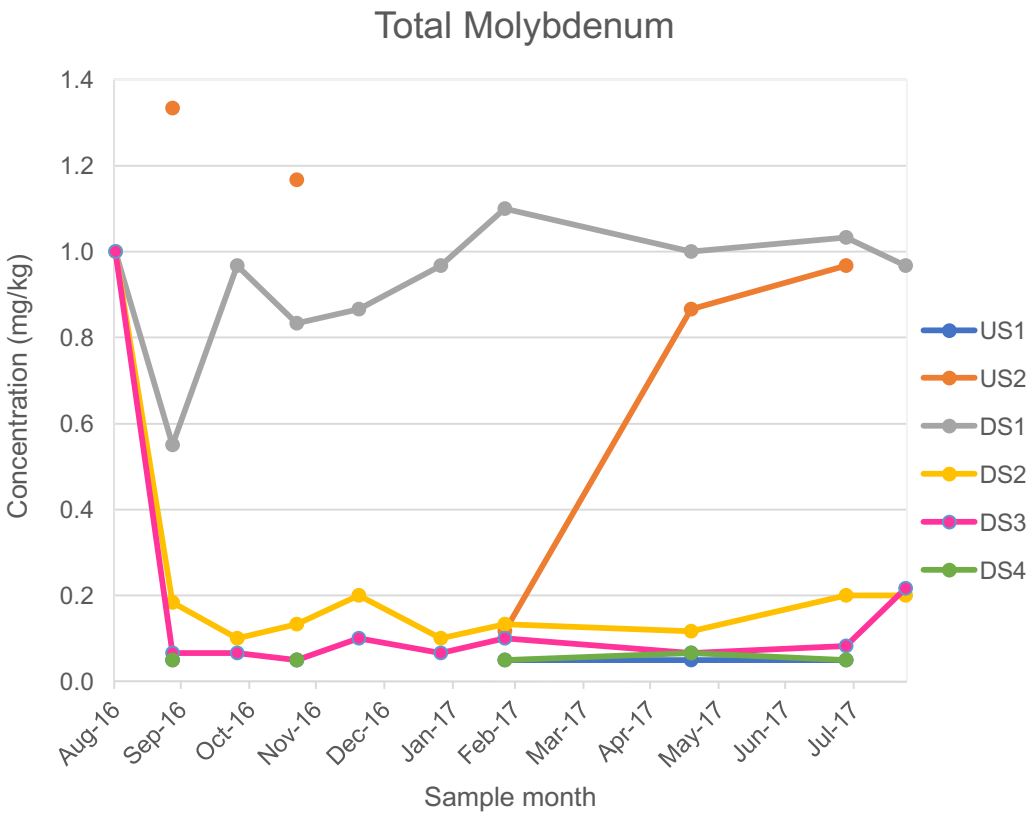

Total Copper
Title
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

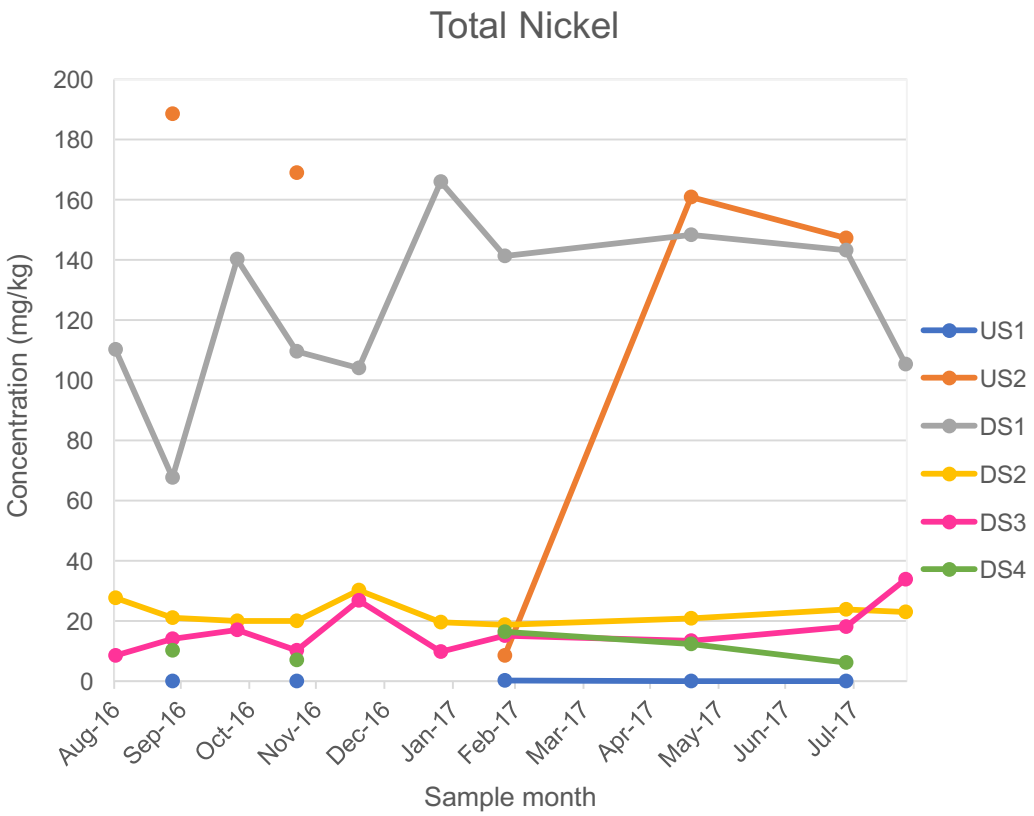

Total Iron
Concentration (mg/kg)
7000
6000
5000
4000
3000
2000
1000
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

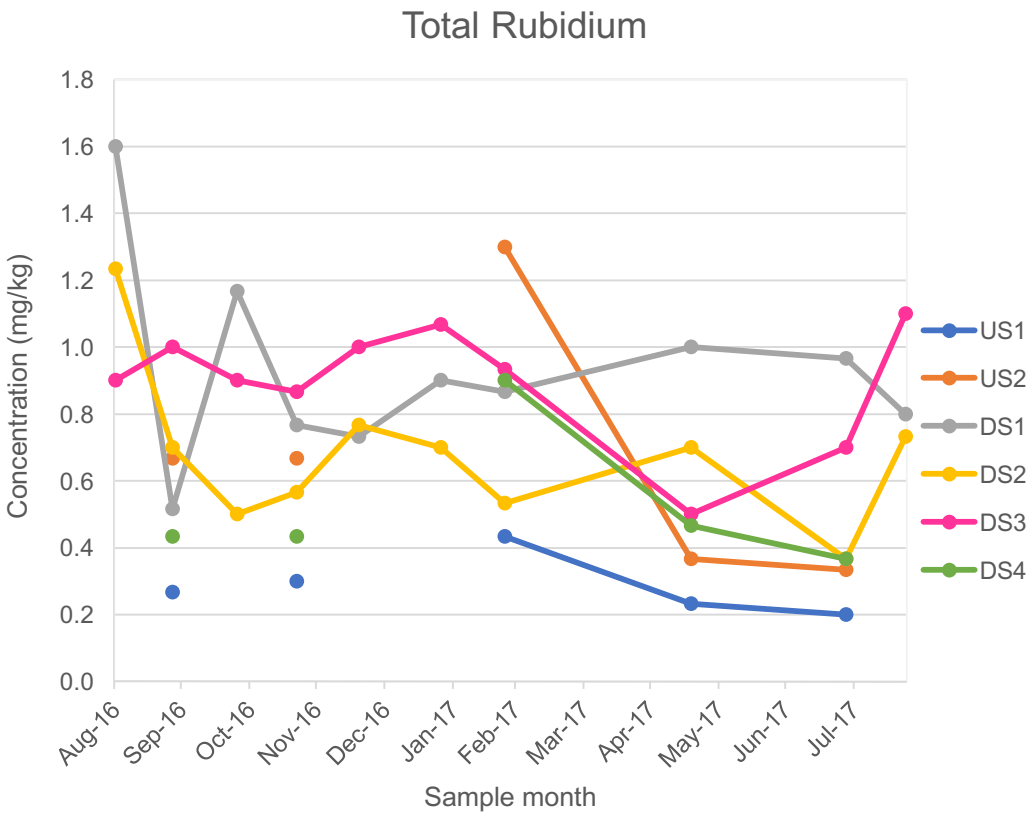

Total Lead
Concentration (mg/kg)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

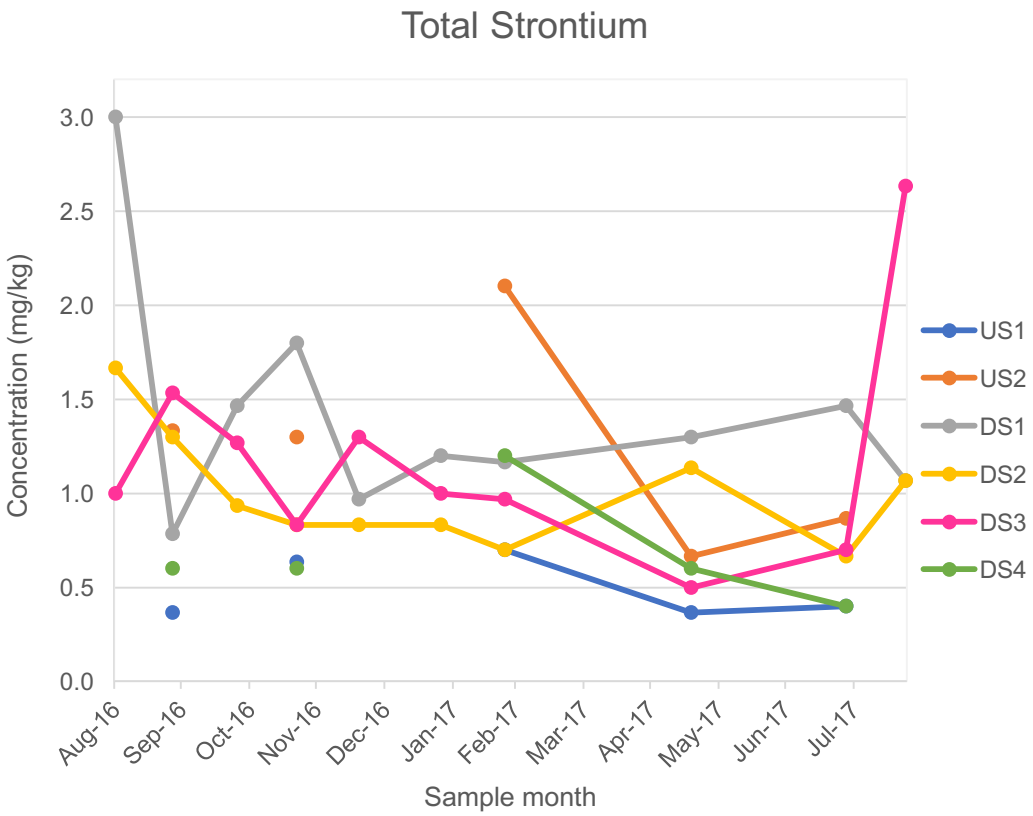

Total Lithium
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Concentration (mg/kg)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

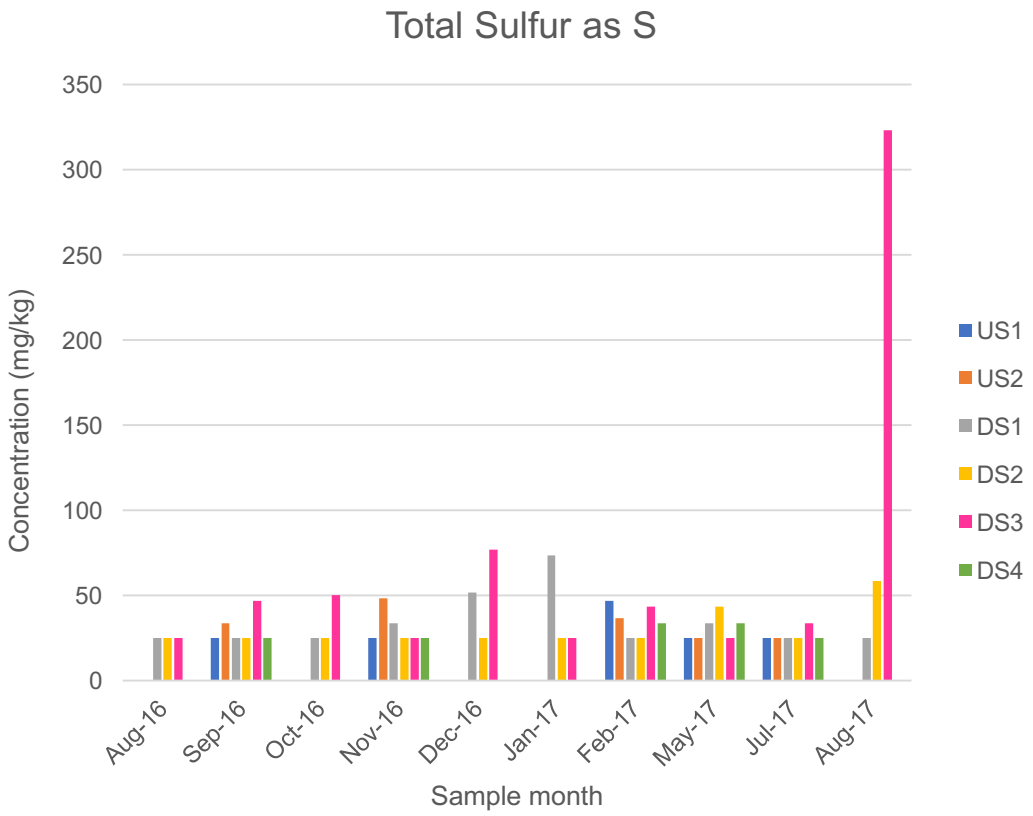

Total Manganese
2500
2000
1500
1000
500
0
Concentration (mg/kg)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

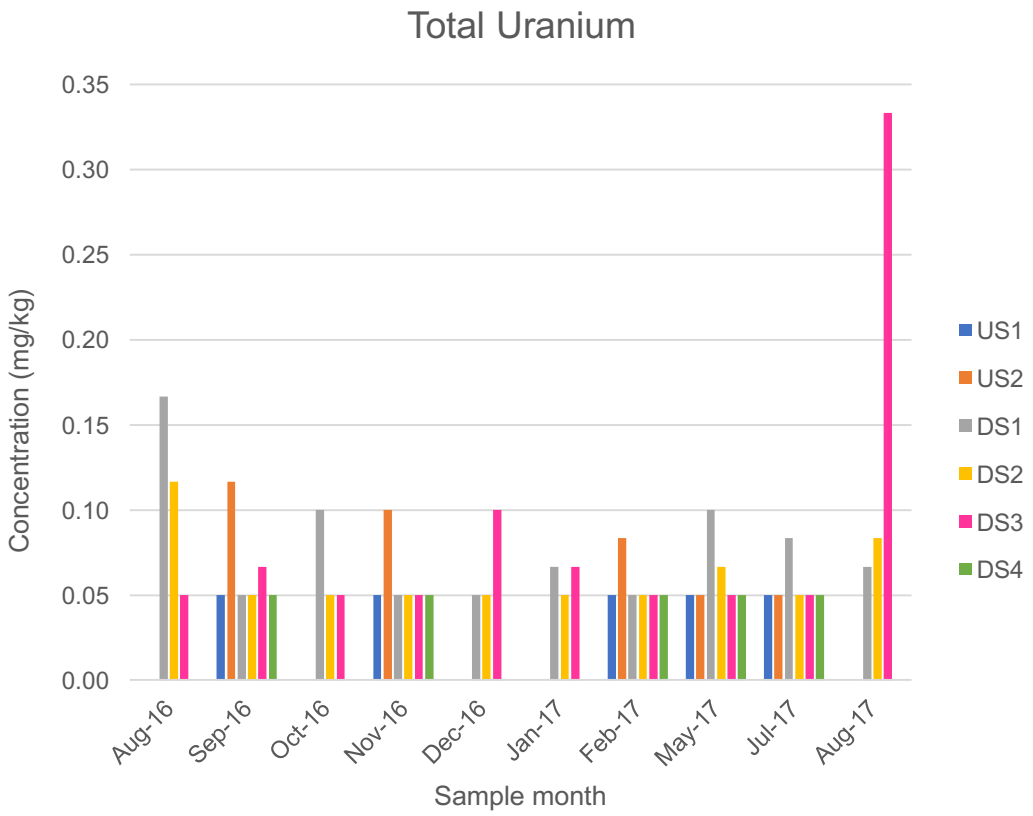

Total Molybdenum
Concentration (mg/kg)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

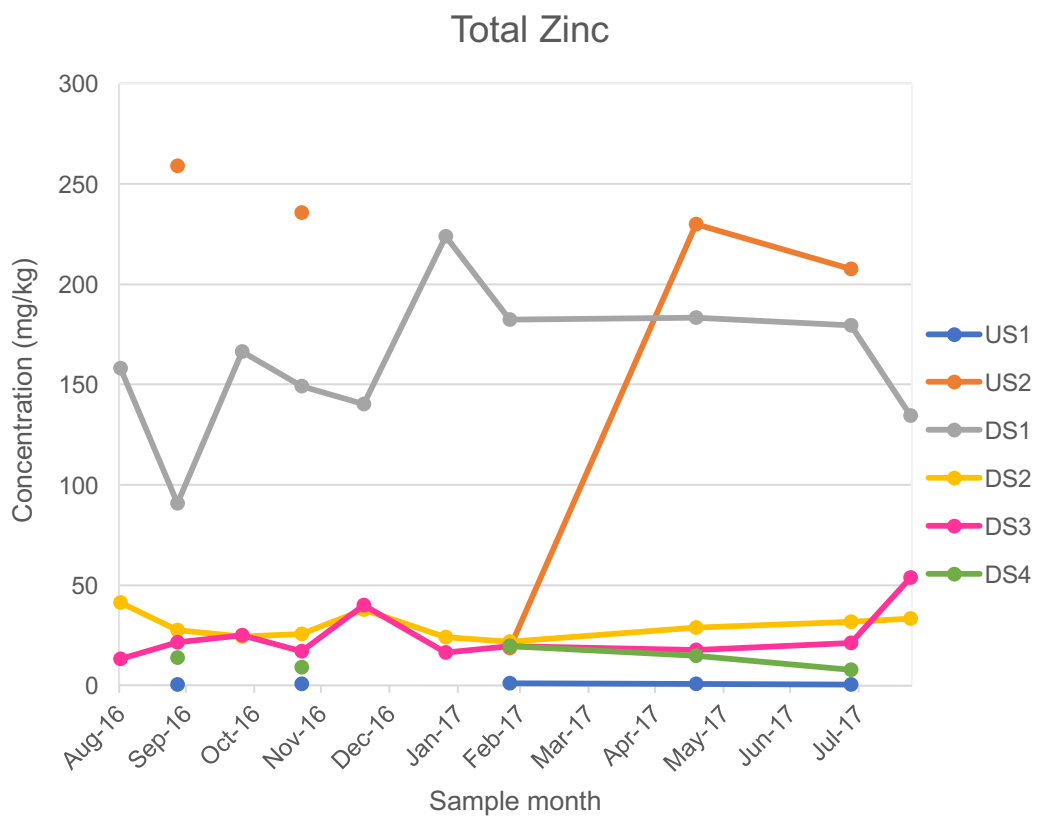

Total Nickel
Concentration (mg/kg)
200
180
160
140
120
100
80
60
40
20
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

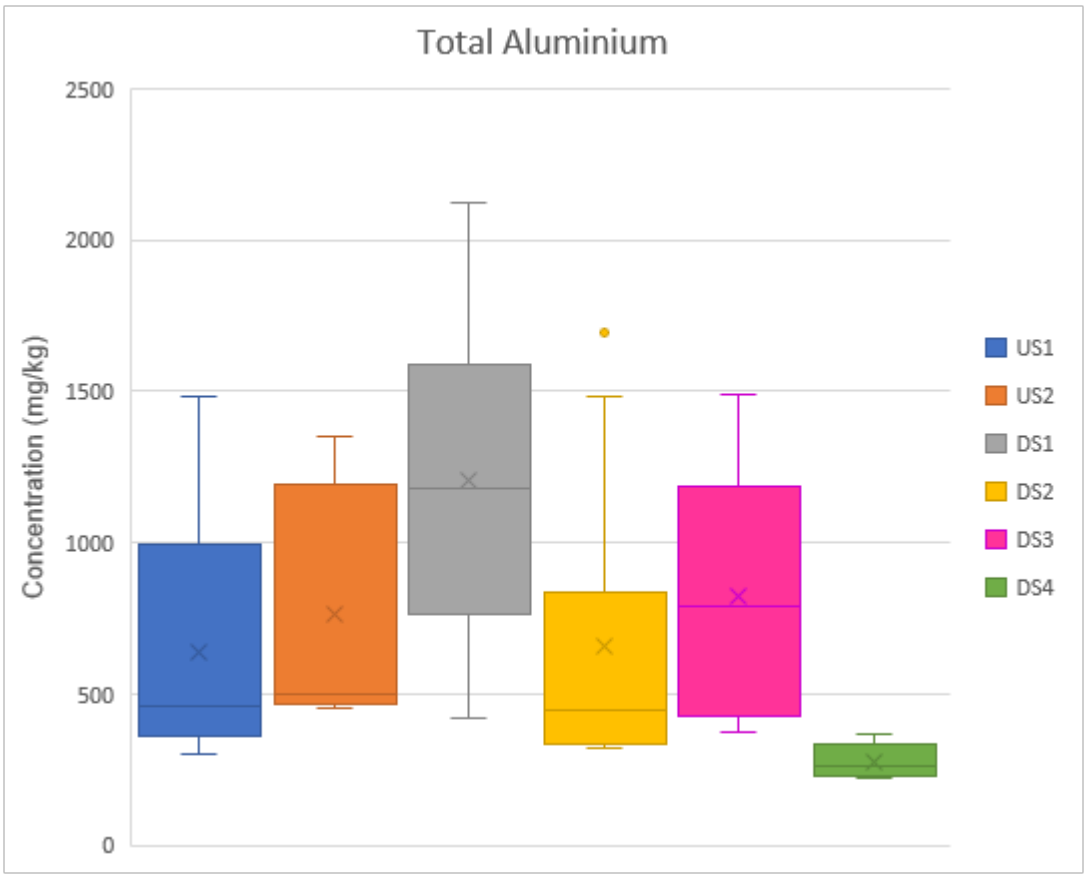

Total Rubidium
Concentration (mg/kg)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

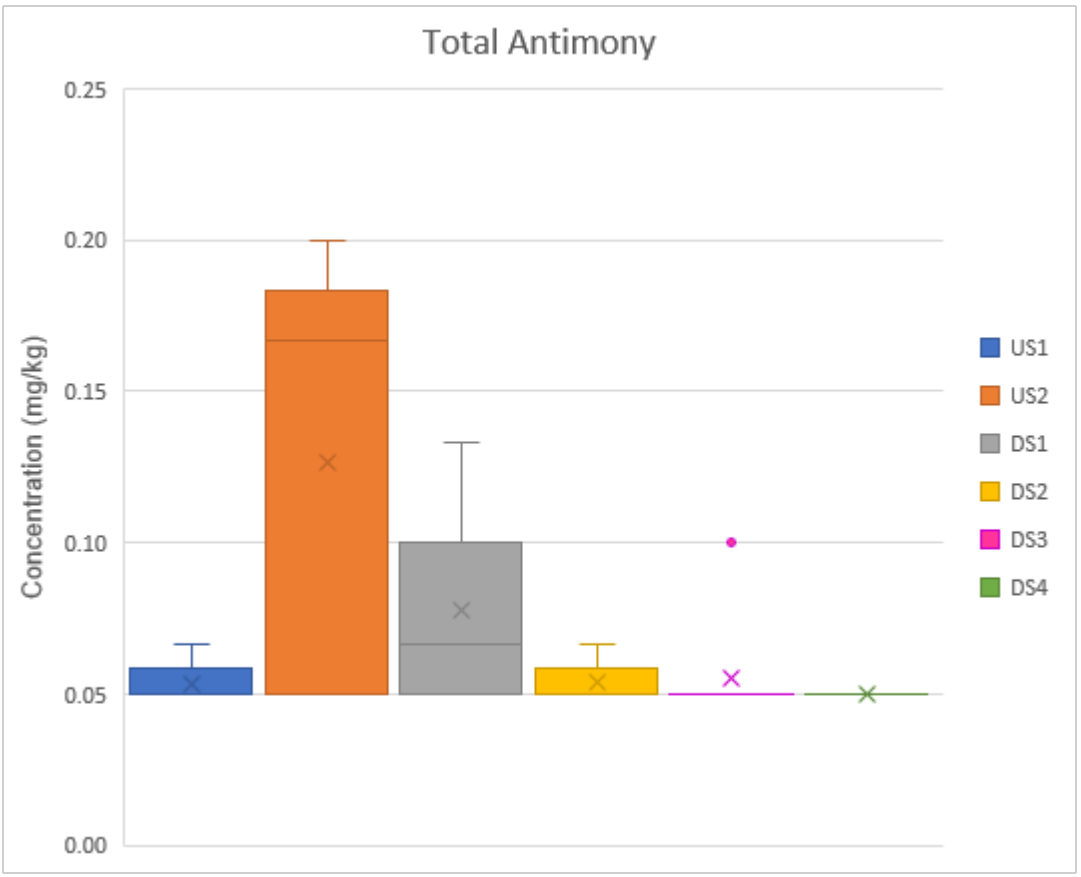

Total Strontium
Concentration (mg/kg)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

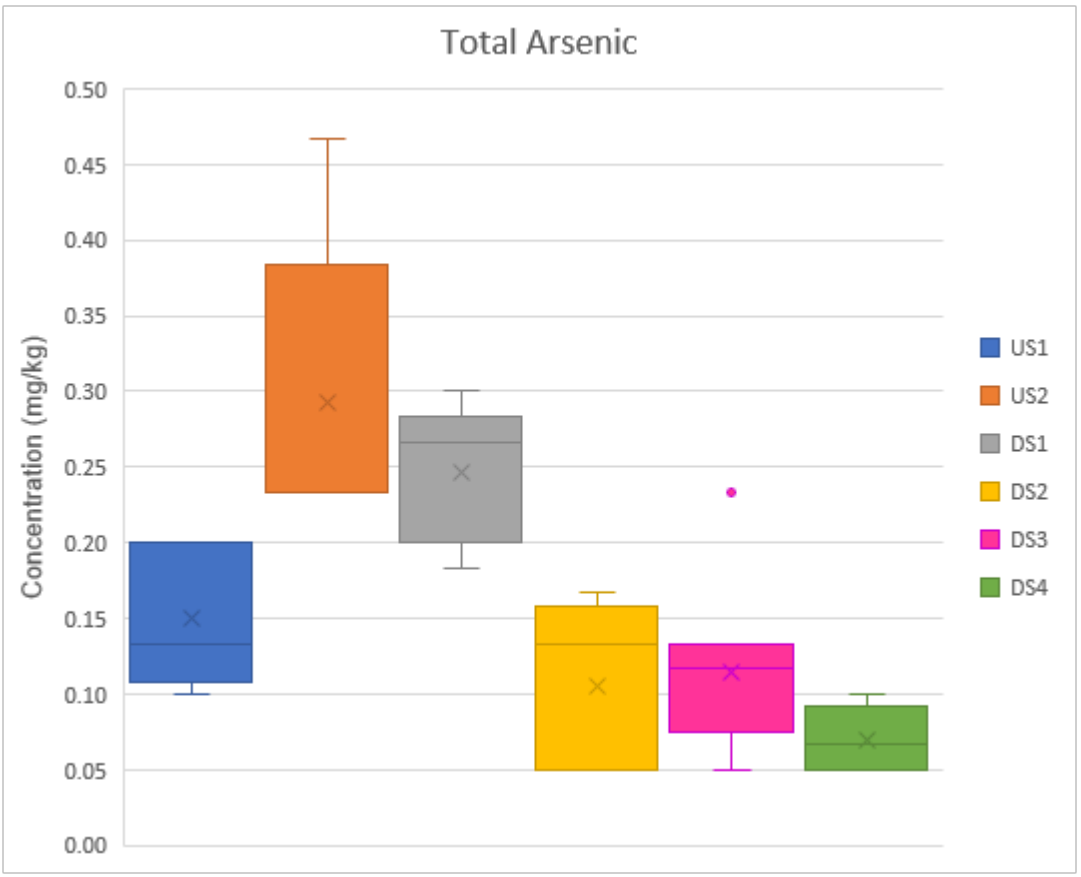

Total Sulfur as S
350
300
250
200
150
100
50
0
Concentration (mg/kg)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

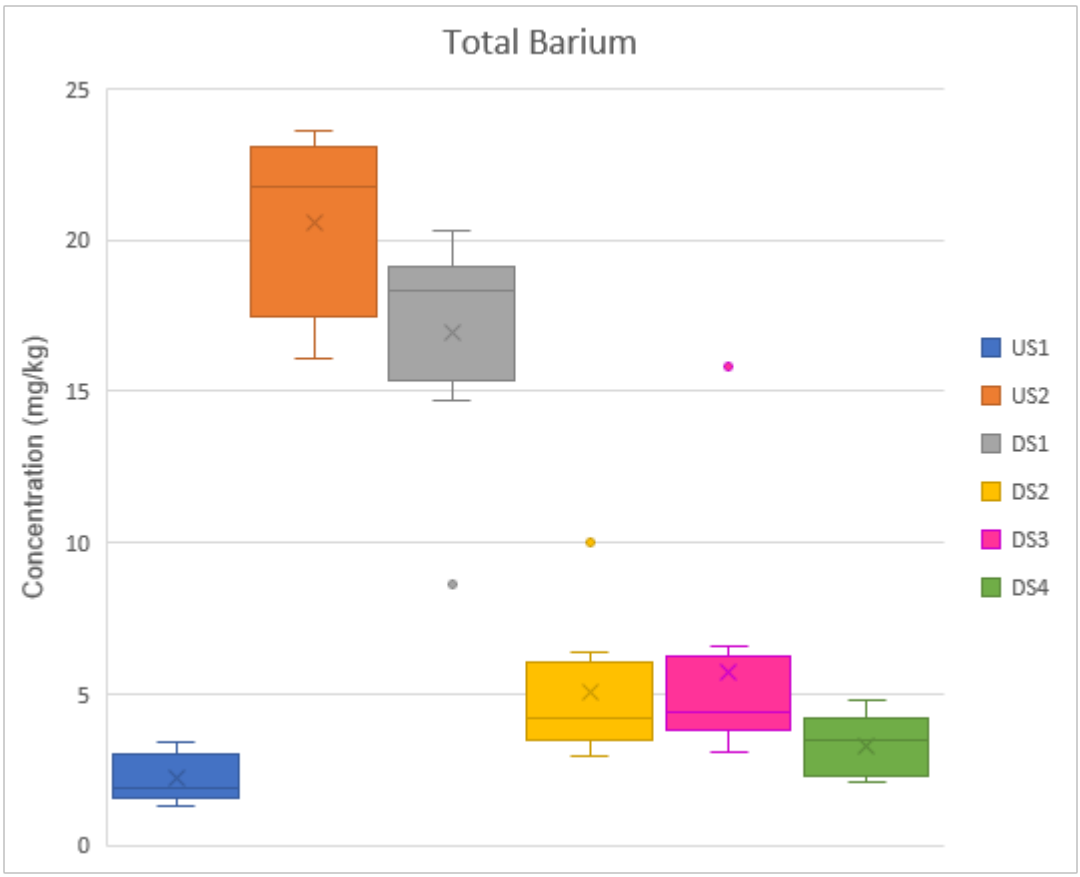

Total Uranium
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Concentration (mg/kg)
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
May-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

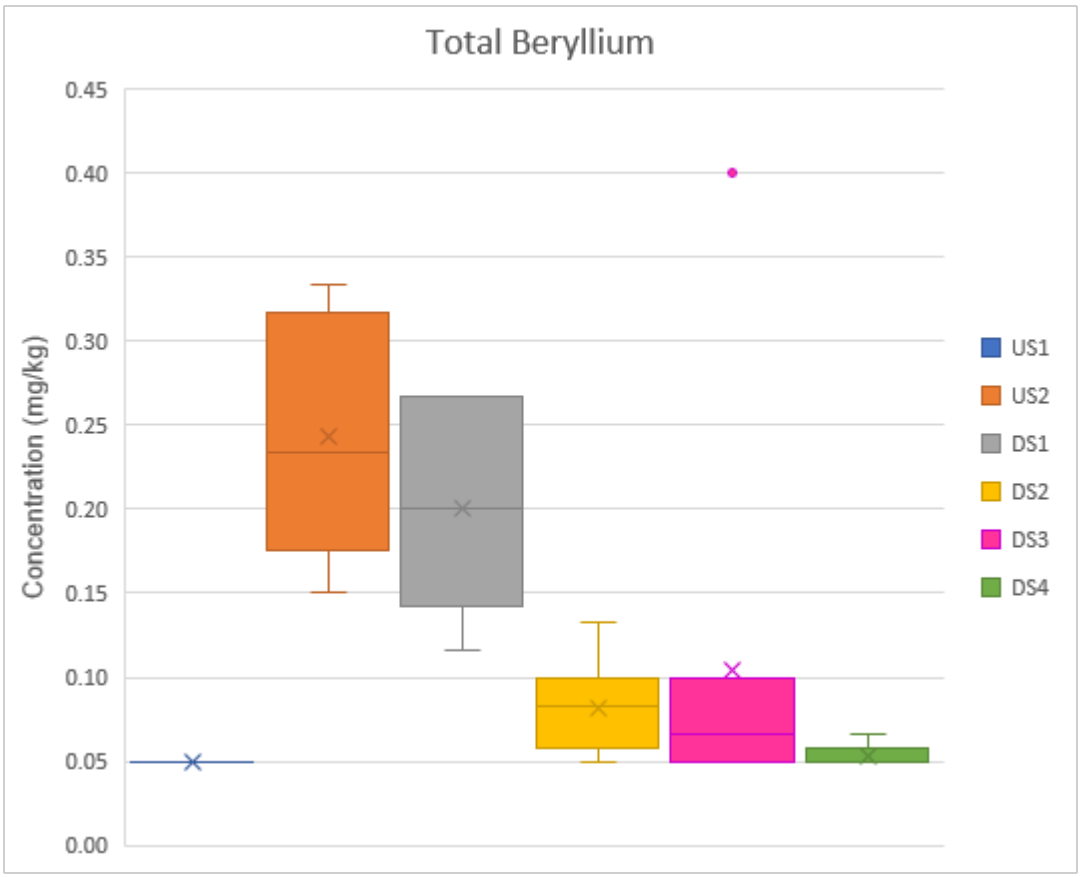

Total Zinc
Concentration (mg/kg)
300
250
200
150
100
50
0
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

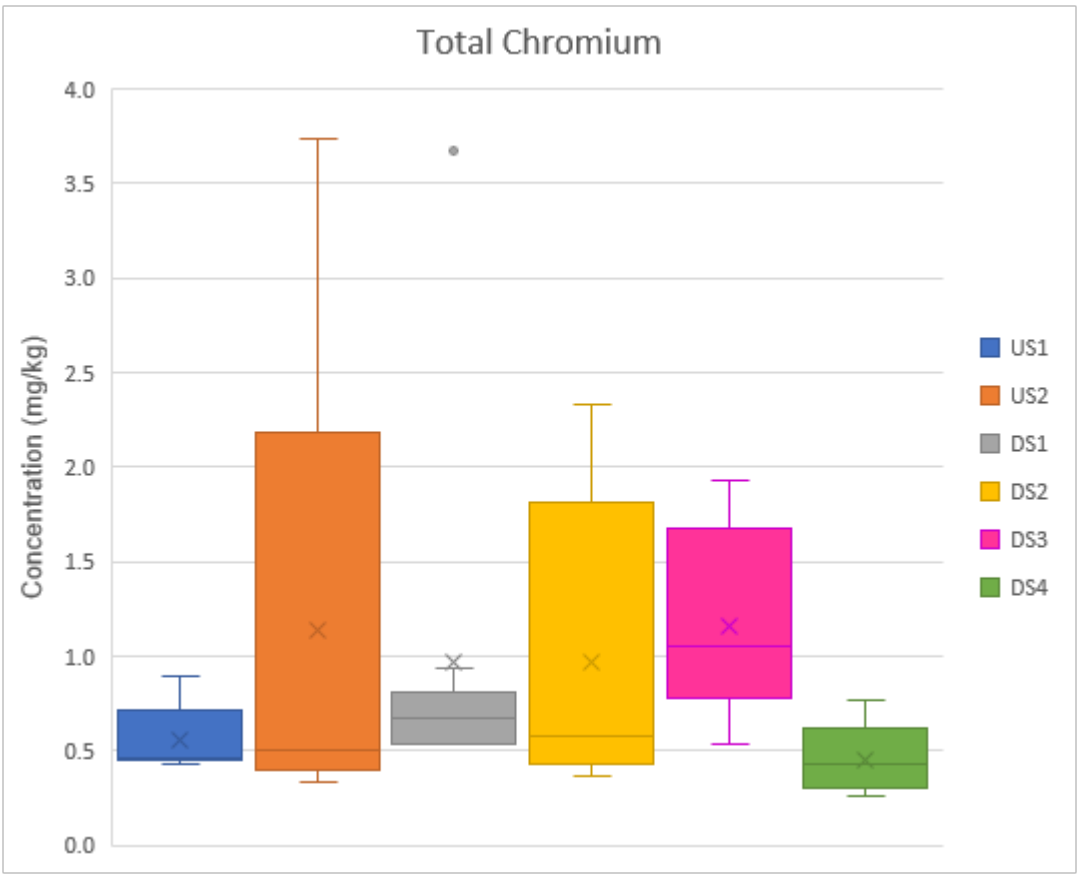

Total Aluminium
Concentration (mg/kg)
2500
2000
1500
1000
500
0
US1
US2
DS1
DS2
DS3
DS4

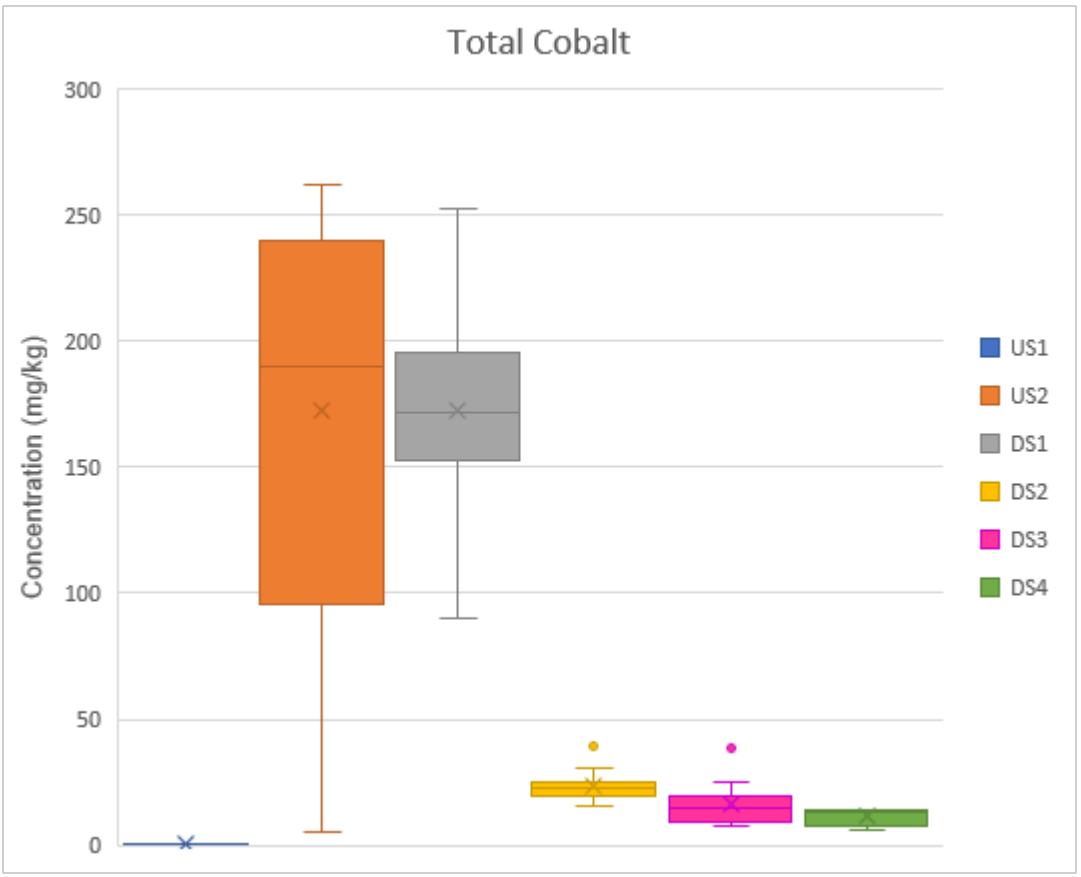

Total Antimony
Concentration (mg/kg)
0.25
0.20
0.15
0.10
0.05
0.00
US1
US2
DS1
DS2
DS3
DS4

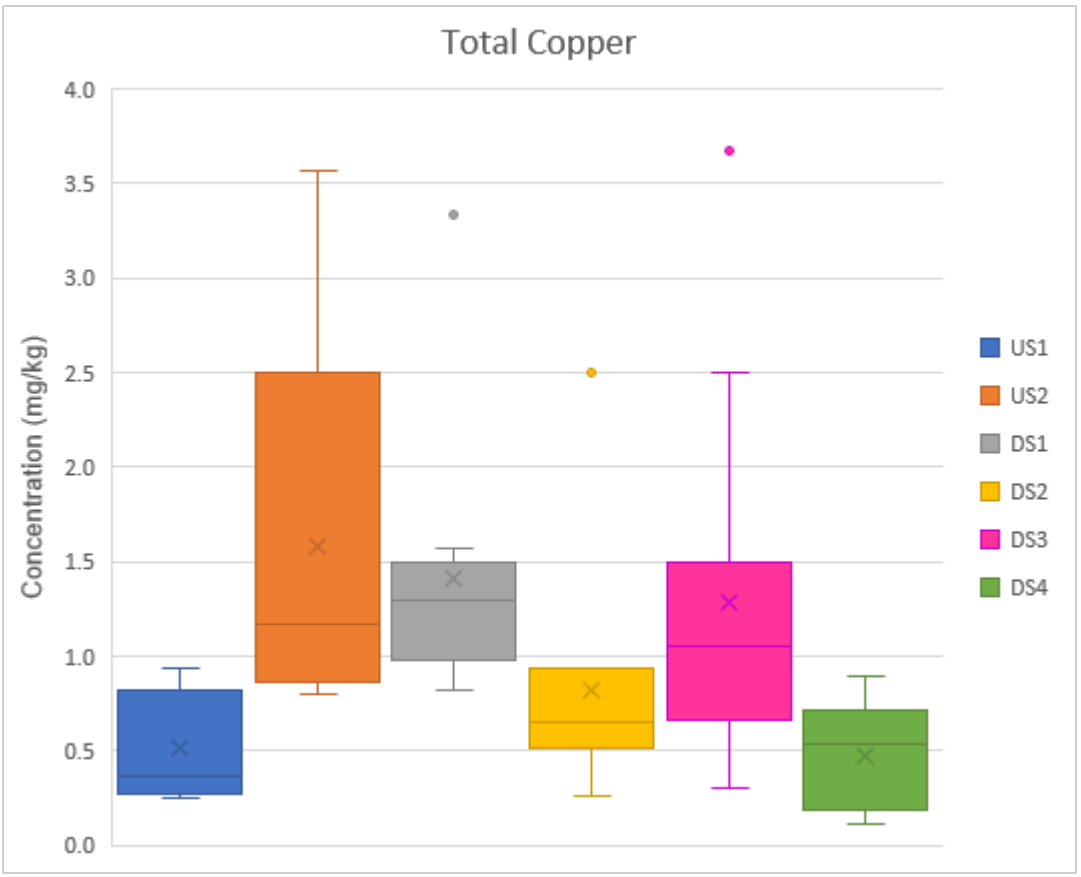

Total Arsenic
Concentration (mg/kg)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
US1
US2
DS1
DS2
DS3
DS4

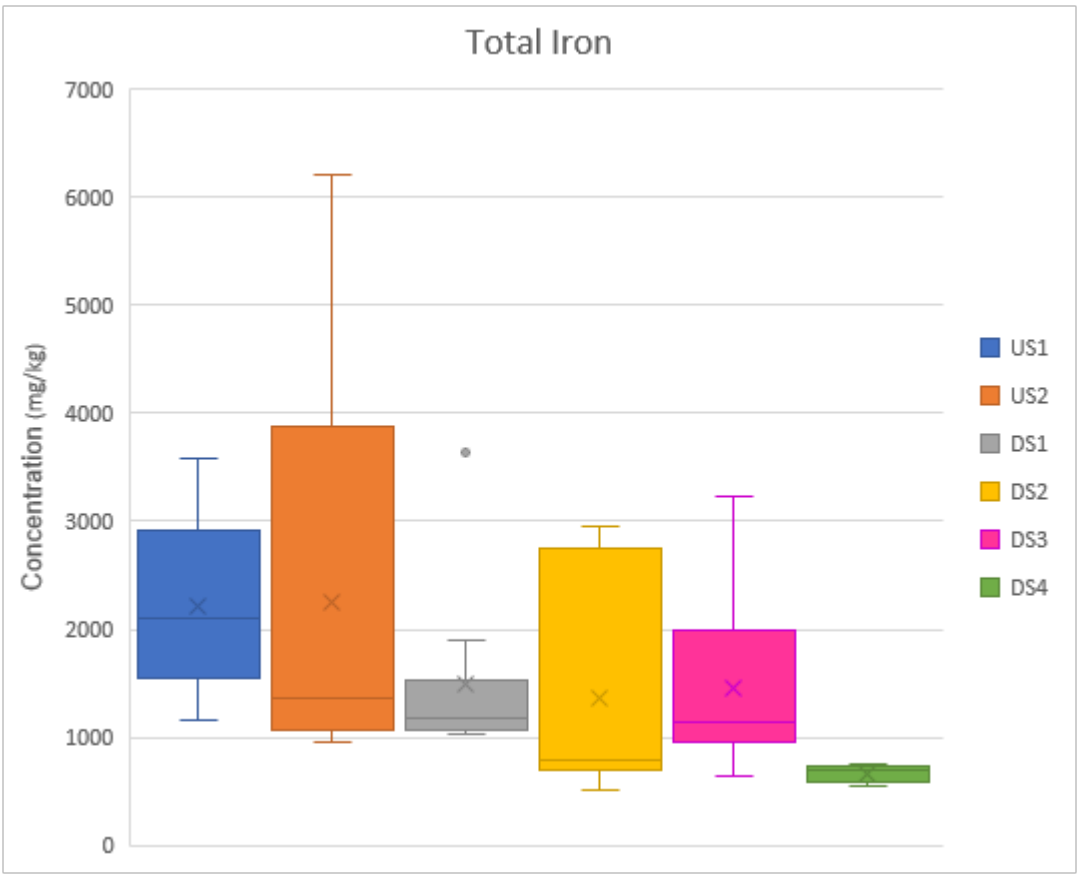

Total Barium
Concentration (mg/kg)
25
20
15
10
5
0
US1
US2
DS1
DS2
DS3
DS4

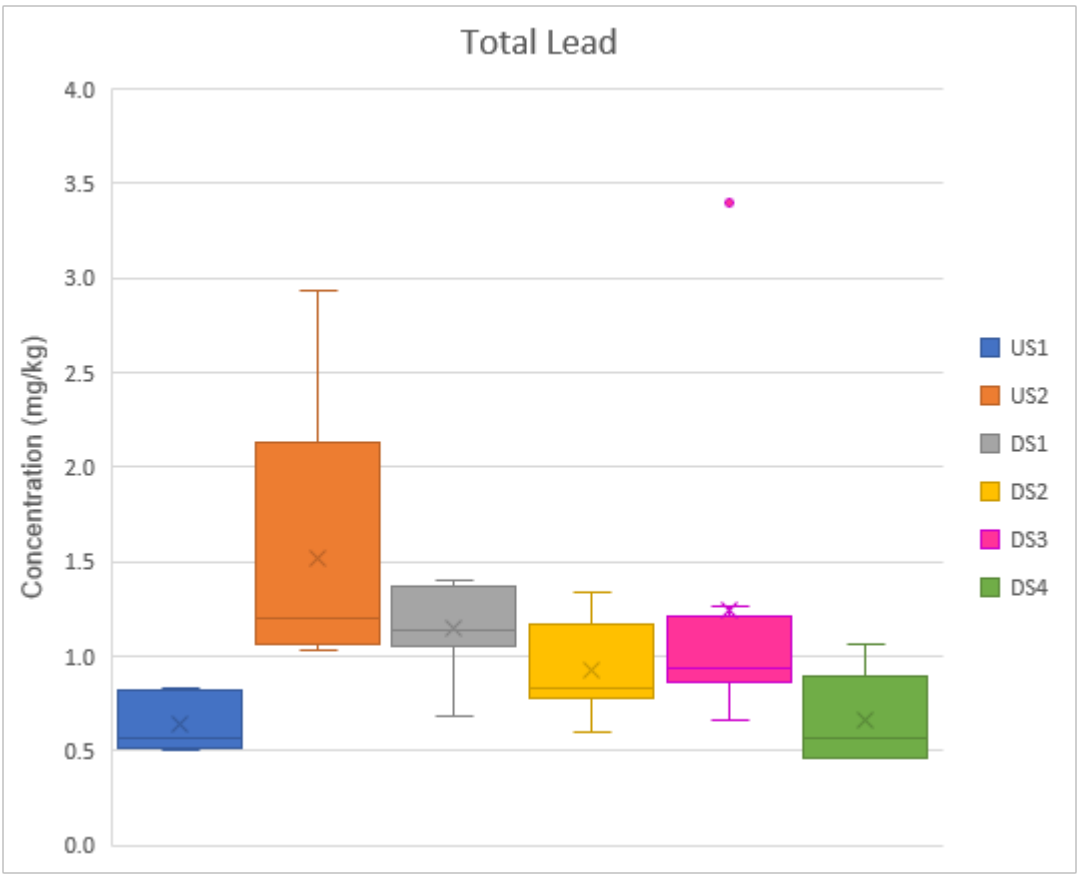

Total Beryllium
Concentration (mg/kg)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
US1
US2
DS1
DS2
DS3
DS4

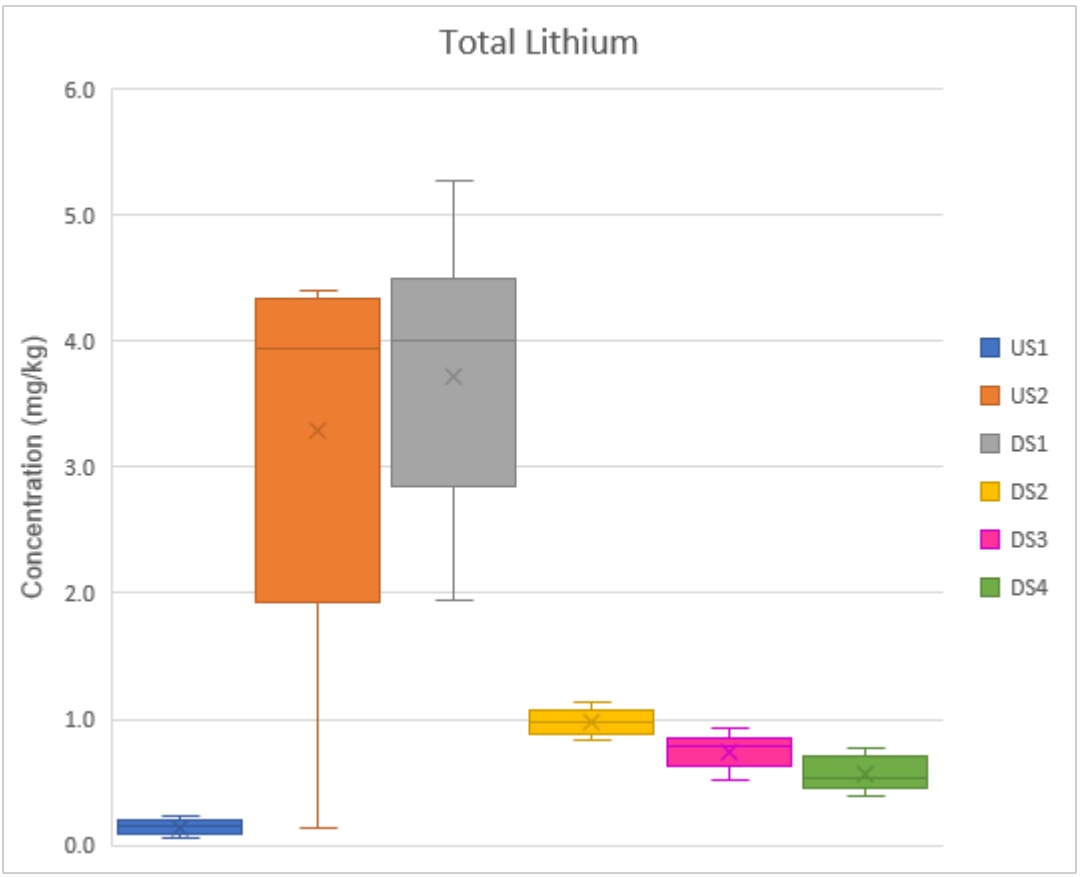

Total Chromium
Concentration (mg/kg)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
US1
US2
DS1
DS2
DS3
DS4

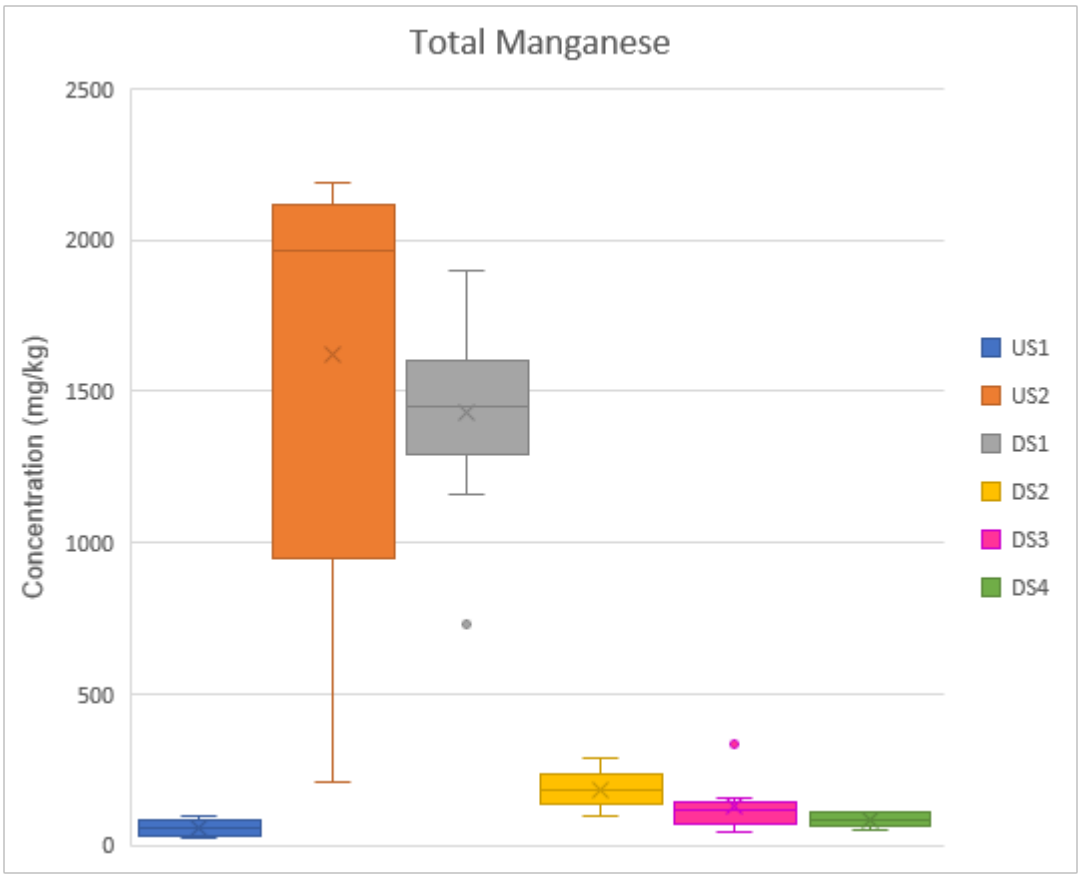

Total Cobalt
Concentration (mg/kg)
300
250
200
150
100
50
0
US1
US2
DS1
DS2
DS3
DS4

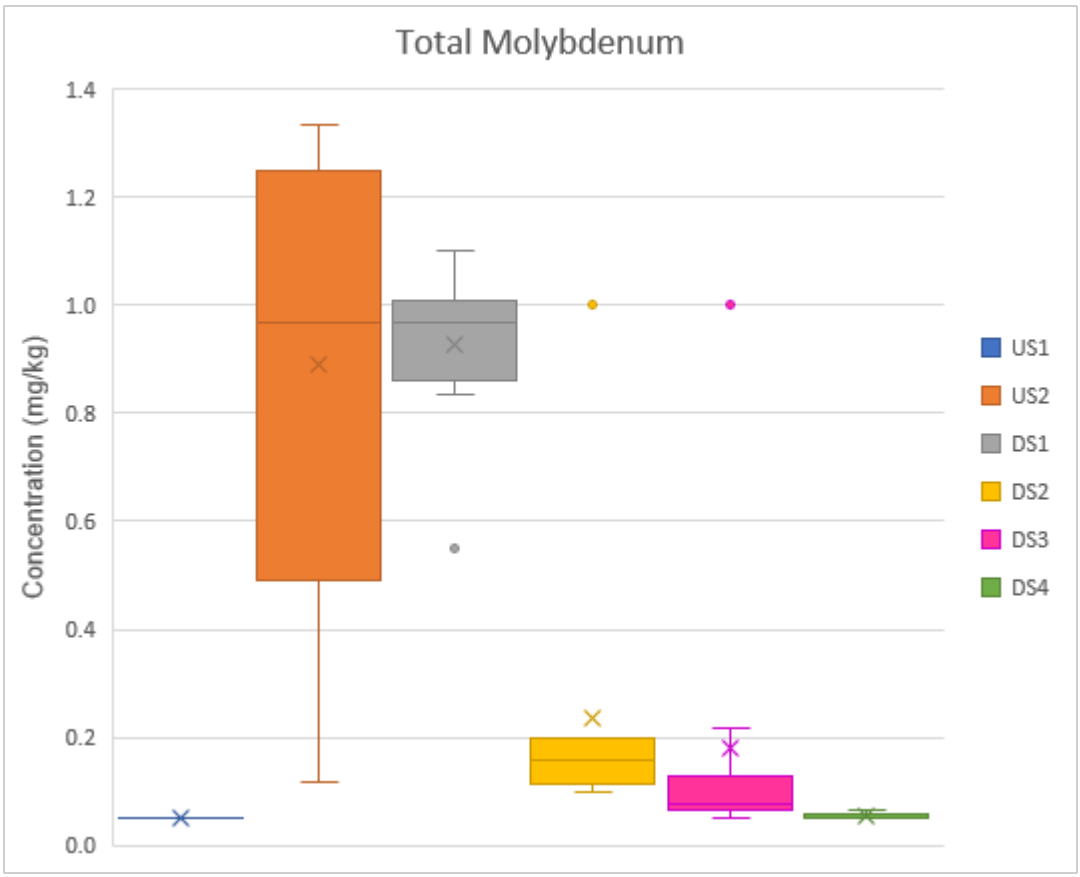

Total Copper
Concentration (mg/kg)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
US1
US2
DS1
DS2
DS3
DS4

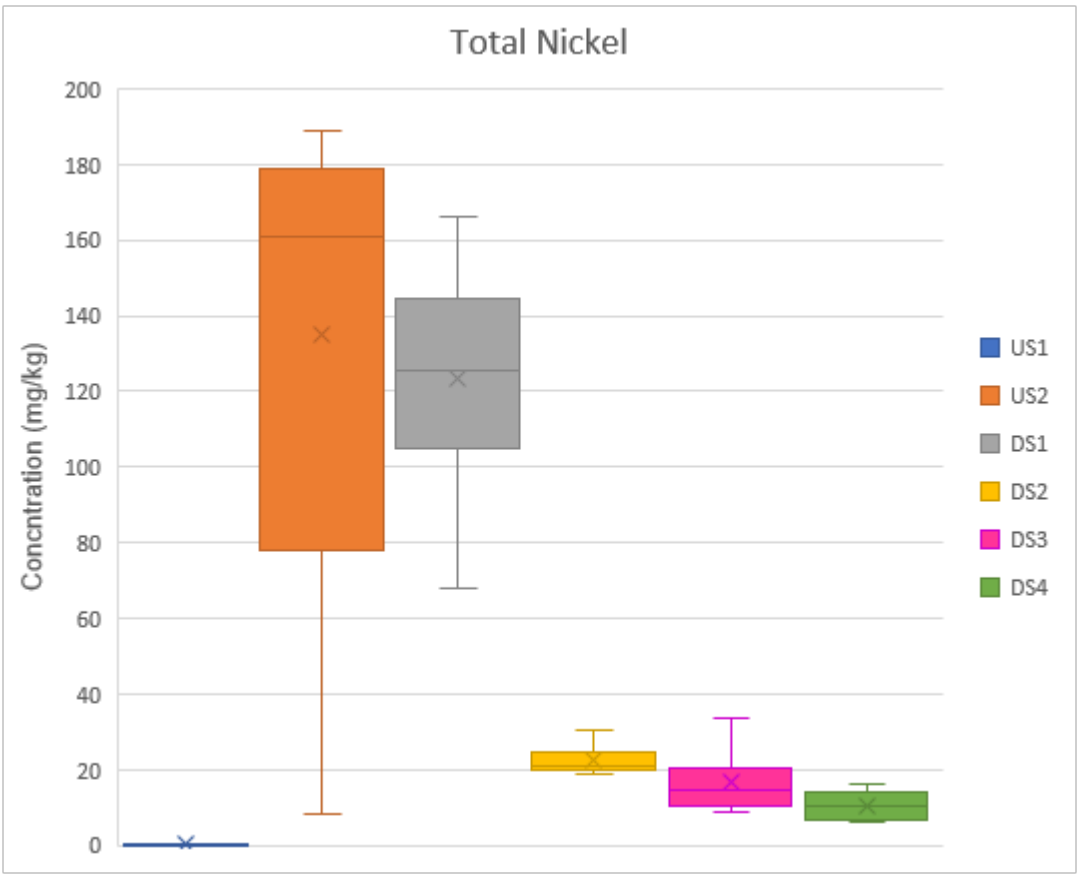

Total Iron
Concentration (mg/kg)
7000
6000
5000
4000
3000
2000
1000
0
US1
US2
DS1
DS2
DS3
DS4

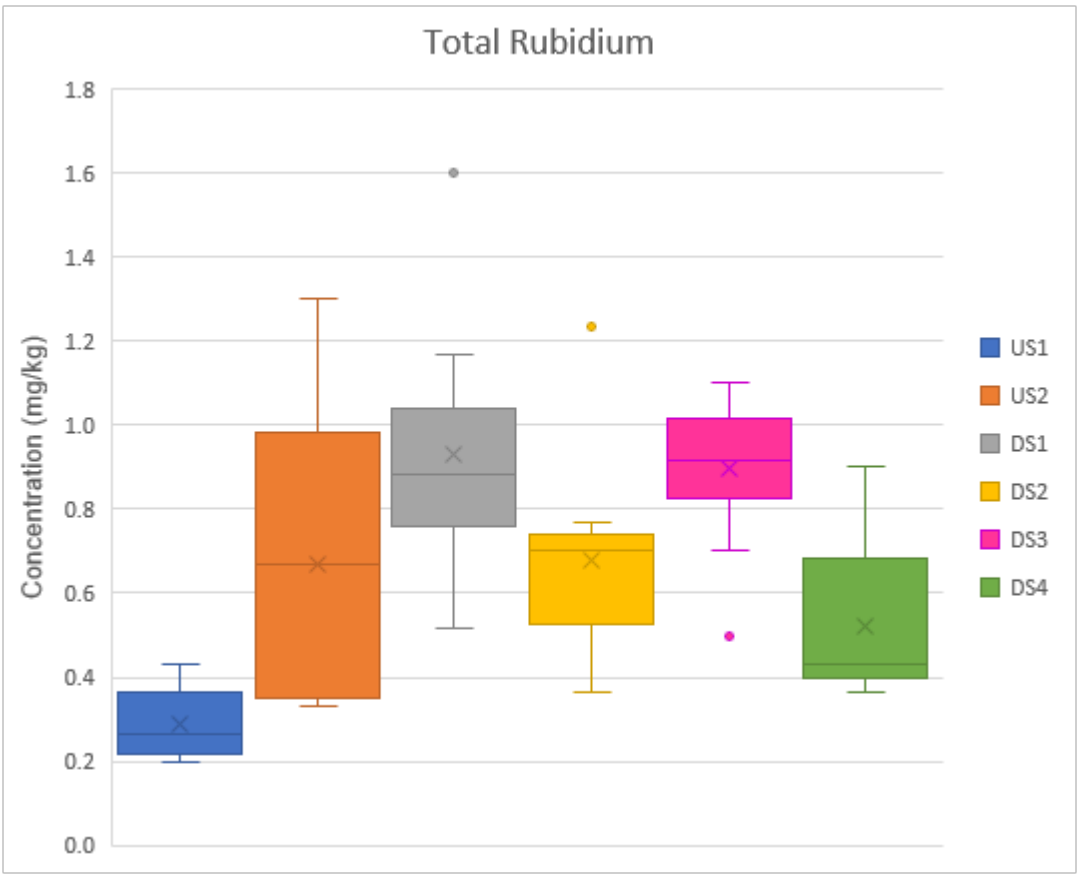

Total Lead
Concentration (mg/kg)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
US1
US2
DS1
DS2
DS3
DS4

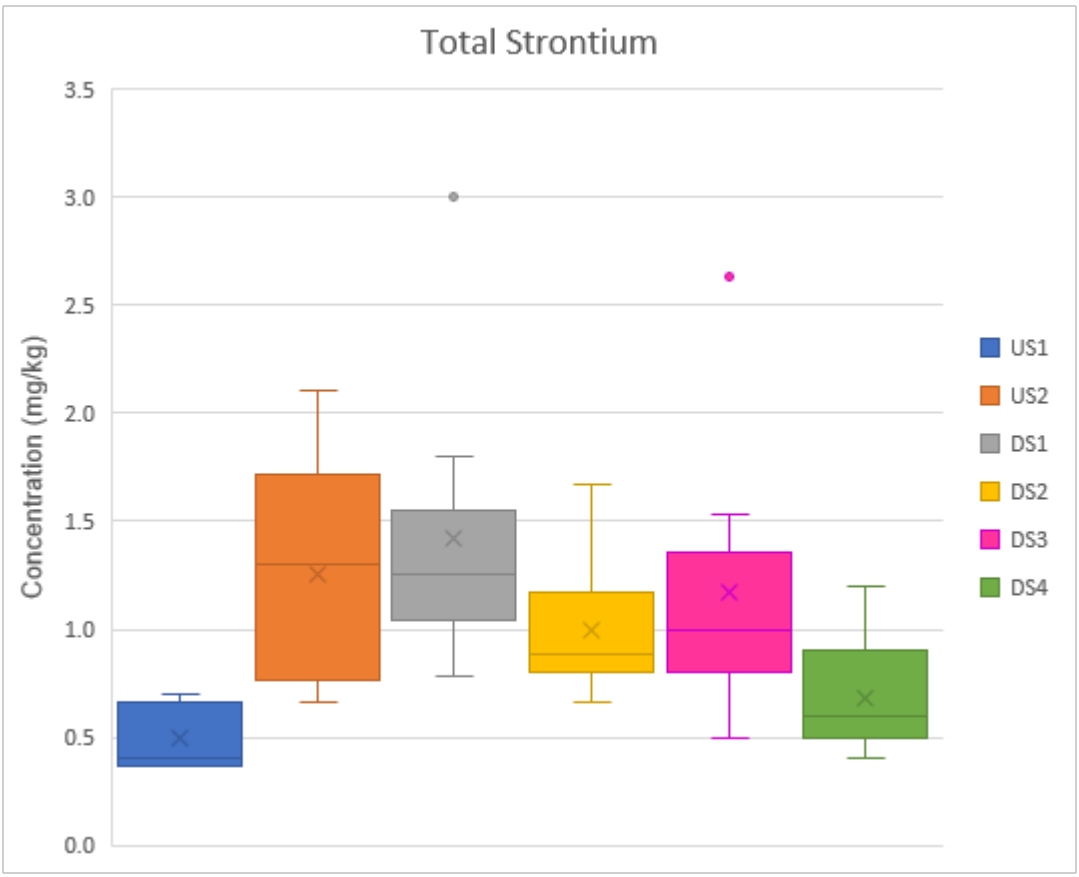

Total Lithium
Concentration (mg/kg)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
US1
US2
DS1
DS2
DS3
DS4

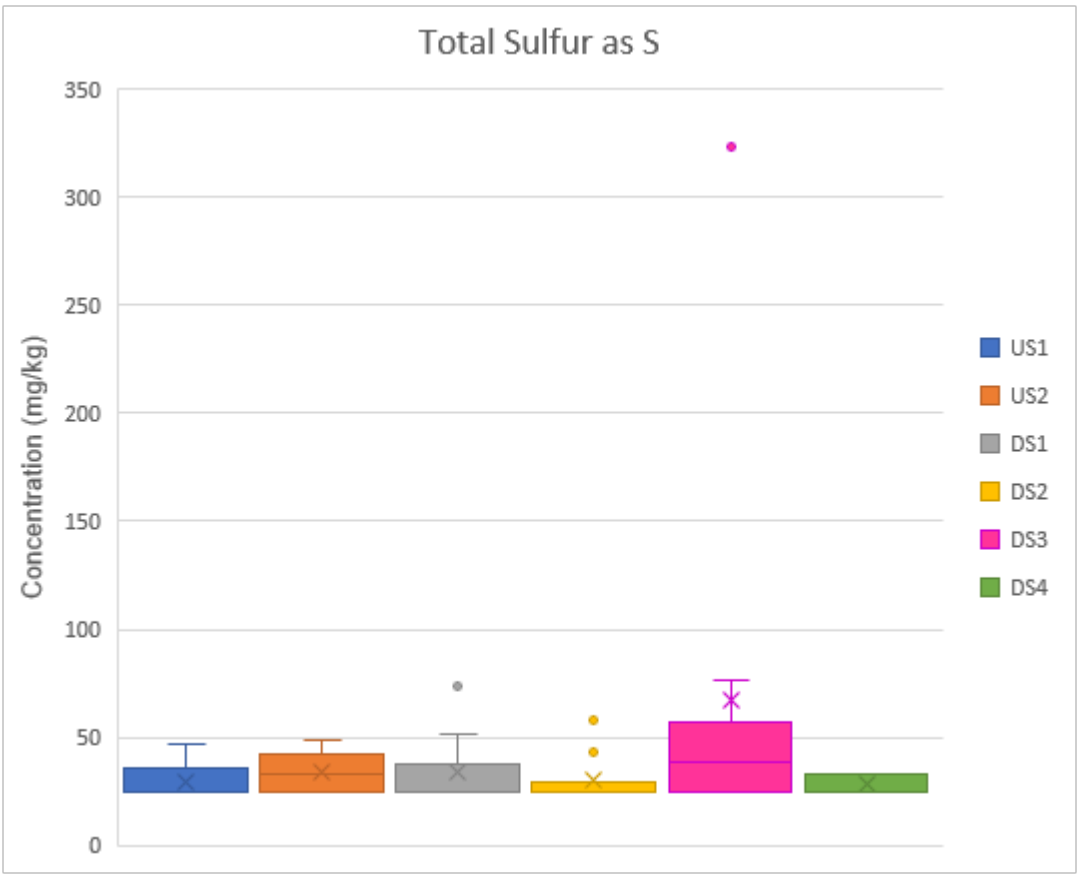

Total Manganese
Concentration (mg/kg)
2500
2000
1500
1000
500
0
US1
US2
DS1
DS2
DS3
DS4

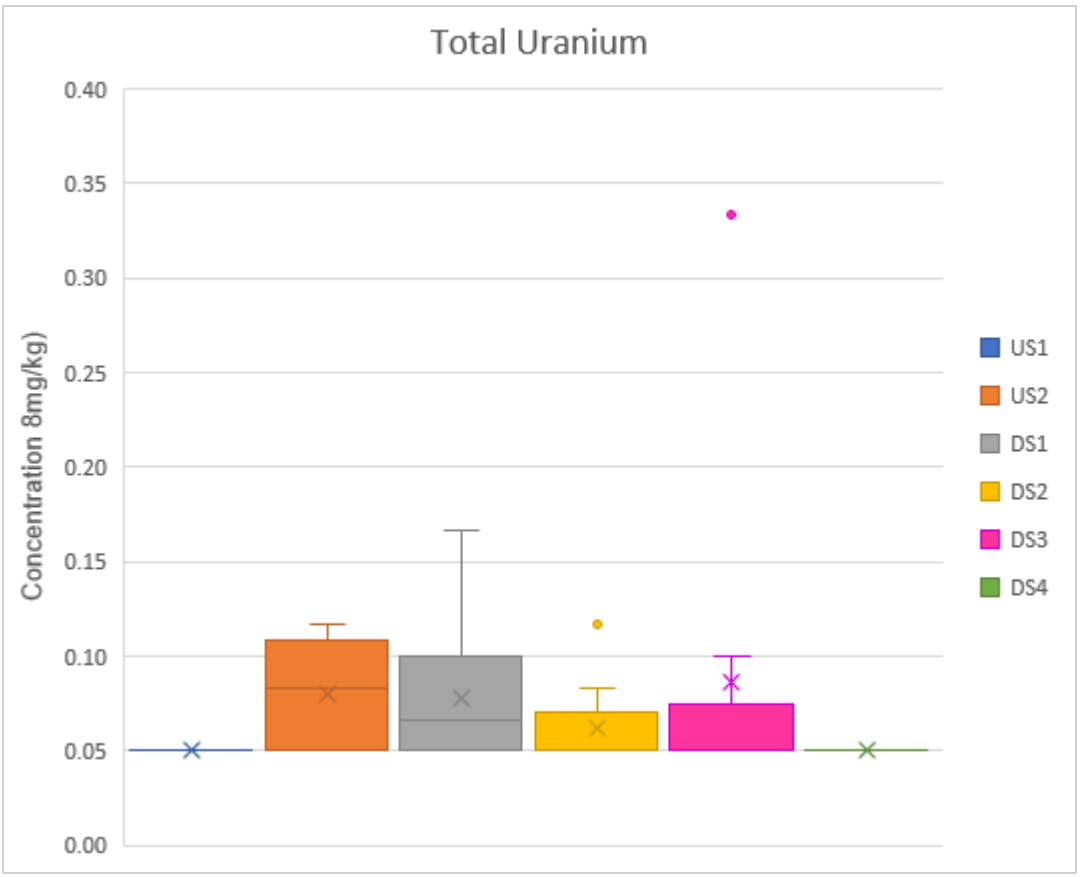

Total Molybdenum
Concentration (mg/kg)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
US1
US2
DS1
DS2
DS3
DS4

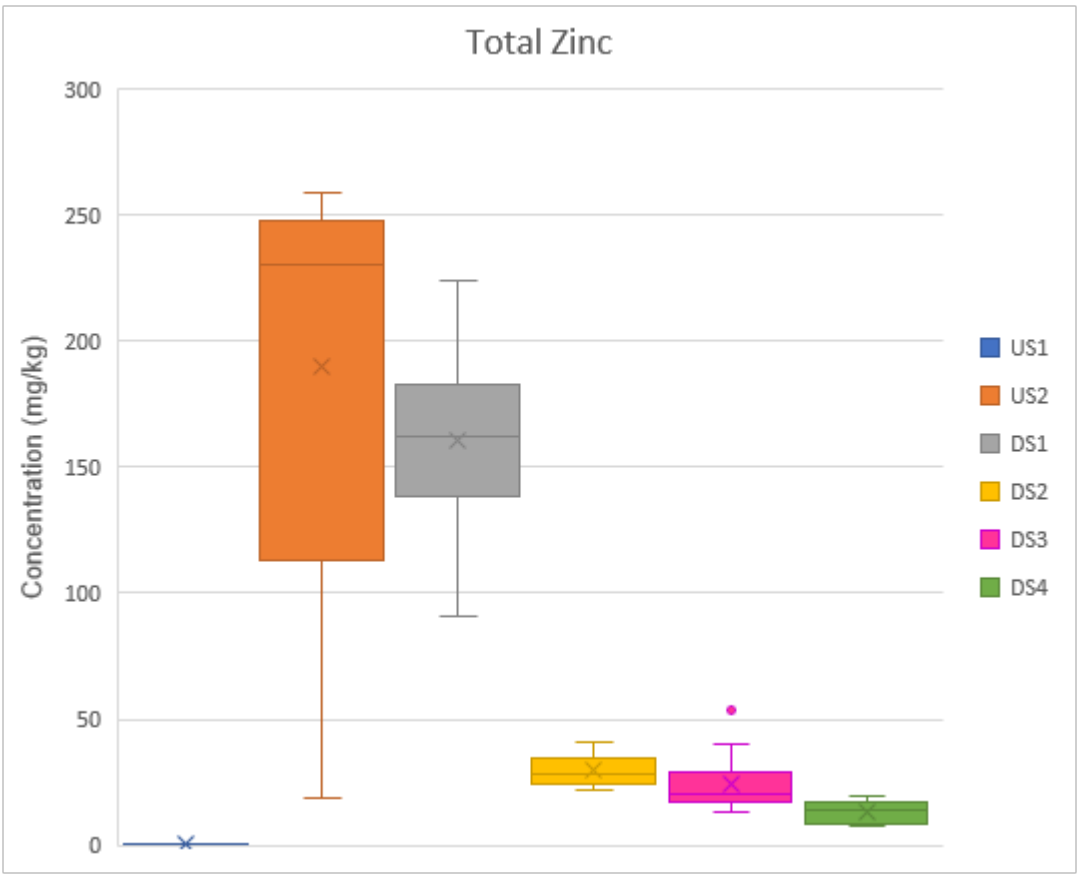

Total Nickel
Concntration (mg/kg)
200
180
160
140
120
100
80
60
40
20
0
US1
US2
DS1
DS2
DS3
DS4


Total Rubidium
Concentration (mg/kg)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
US1
US2
DS1
DS2
DS3
DS4


Total Strontium
Concentration (mg/kg)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
US1
US2
DS1
DS2
DS3
DS4


Total Sulfur as S
Concentration (mg/kg)
350
300
250
200
150
100
50
0
US1
US2
DS1
DS2
DS3
DS4


Total Uranium
Concentration 8mg/kg)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
US1
US2
DS1
DS2
DS3
DS4


Total Zinc
Concentration (mg/kg)
300
250
200
150
100
50
0
US1
US2
DS1
DS2
DS3
DS4

4.3 Petrographic Analysis

Petrographic analysis requires air drying of the sediment sub-samples, plus crushing any oversize material down to a 1mm top size. The crushed samples are then mounted in an acrylic resin, which is polished via a multistage polishing procedure to produce a suitable surface for reflected light microscopy. A point count of each sample is then conducted with the material under the crosshairs of the microscope being classified as coal, char, mineral matter or organic matter. 500 points are counted on each sample at 500x magnification. The point counts are then converted to percentages.

Appendix C provides the May, July and August 2017 Microscopic Reports prepared by ALS Laboratory for this reporting period. Updated site summary statistics (Sample Number, Minimum, Median, Mean and Standard Deviation of the Mean (SD)), are shown in **Tables 27 to 32**.

Variation in site percent coal, char, mineral matter and organic matter over time are shown in **Control Charts** below and the statistical data for all sites to date are compared in **Box Plots** following the Control Charts.

	Table 27 US1 Microscopic Summary Statistics			
	Coal (%)	**Char (%)**	**Mineral (%)**	**Organic (%)**
Sample #	15	15	15	15
Min	0	0	92	0.2
Median	0	0	97	3
Mean	0.2	0.0	96.9	2.8
SD	0.4	0.2	1.9	1.9
Max	1.0	0.6	99.6	8.0

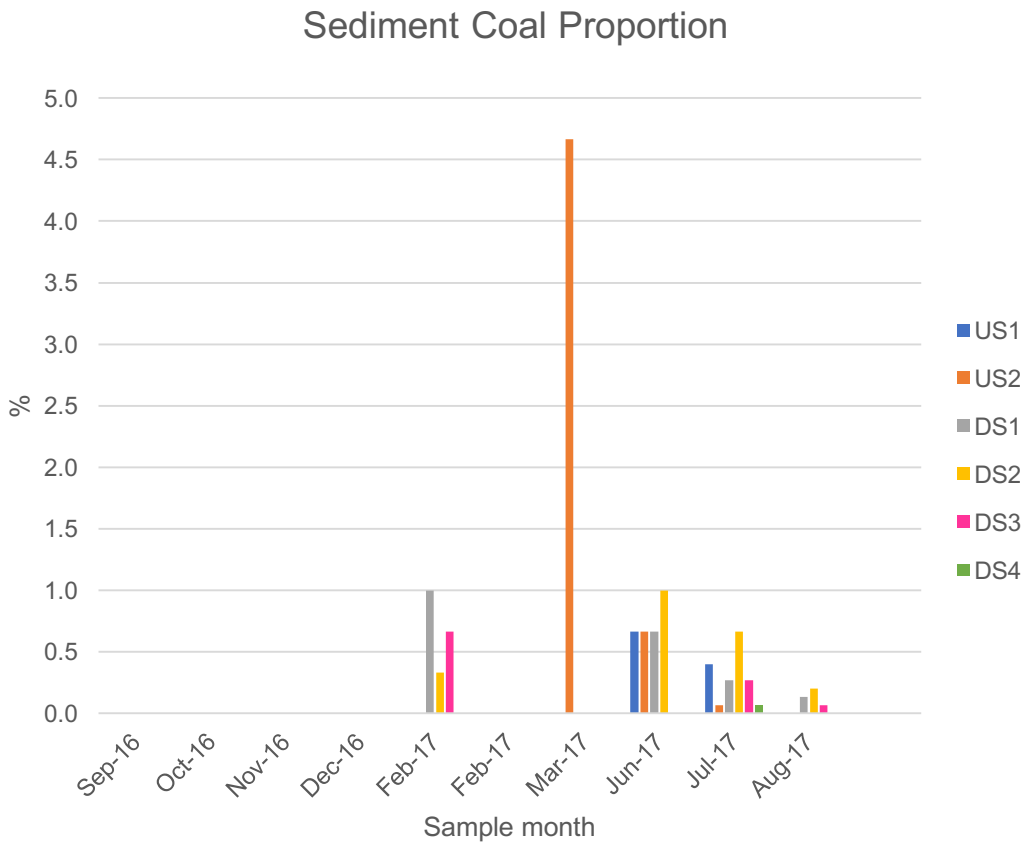
	Table 28 US2 Microscopic Summary Statistics			
	Coal (%)	**Char (%)**	**Mineral (%)**	**Organic (%)**
Sample #	15	15	15	15
Min	0	0	87	0
Median	0	0	94	3
Mean	1.1	0.0	94.6	4.3
SD	1.9	0.1	4.0	3.5
Max	6.0	0.4	100.0	13.0

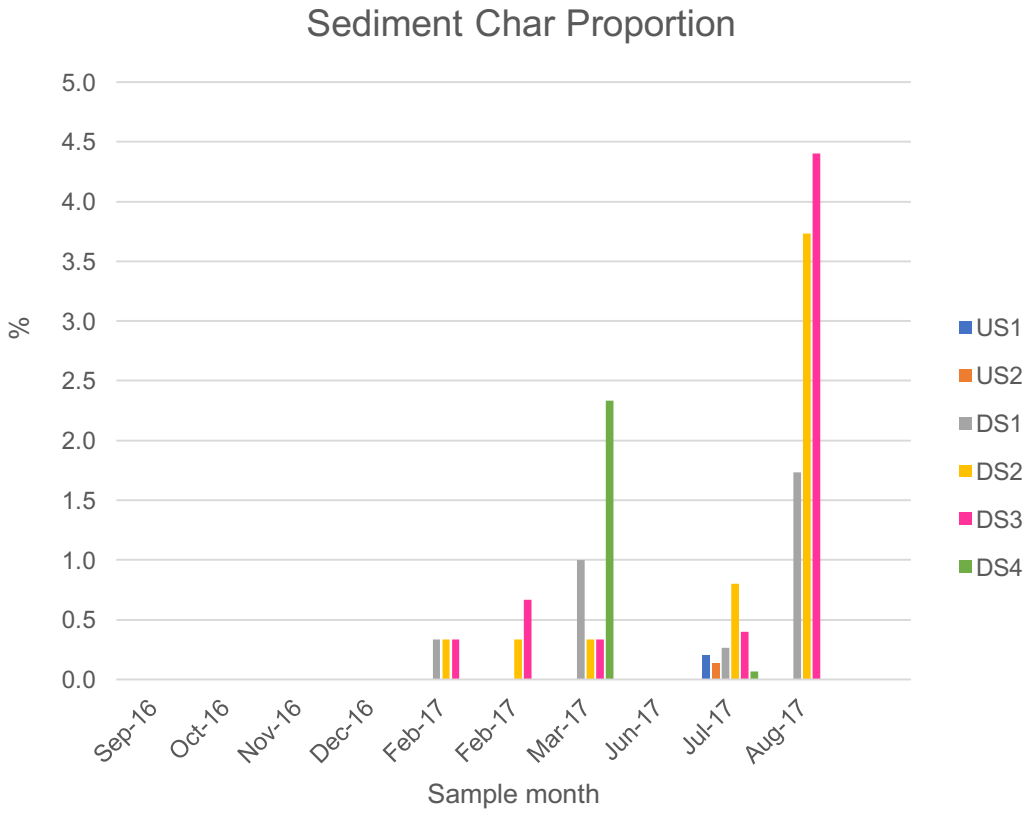
	Table 29 DS1 Microscopic Summary Statistics			
	Coal (%)	**Char (%)**	**Mineral (%)**	**Organic (%)**
Sample #	30	30	30	30
Min	0	0	84	0
Median	0	0	97	3
Mean	0.2	0.3	96.3	3.1
SD	0.5	0.8	2.9	3.0
Max	2.0	3.0	99.6	16.0

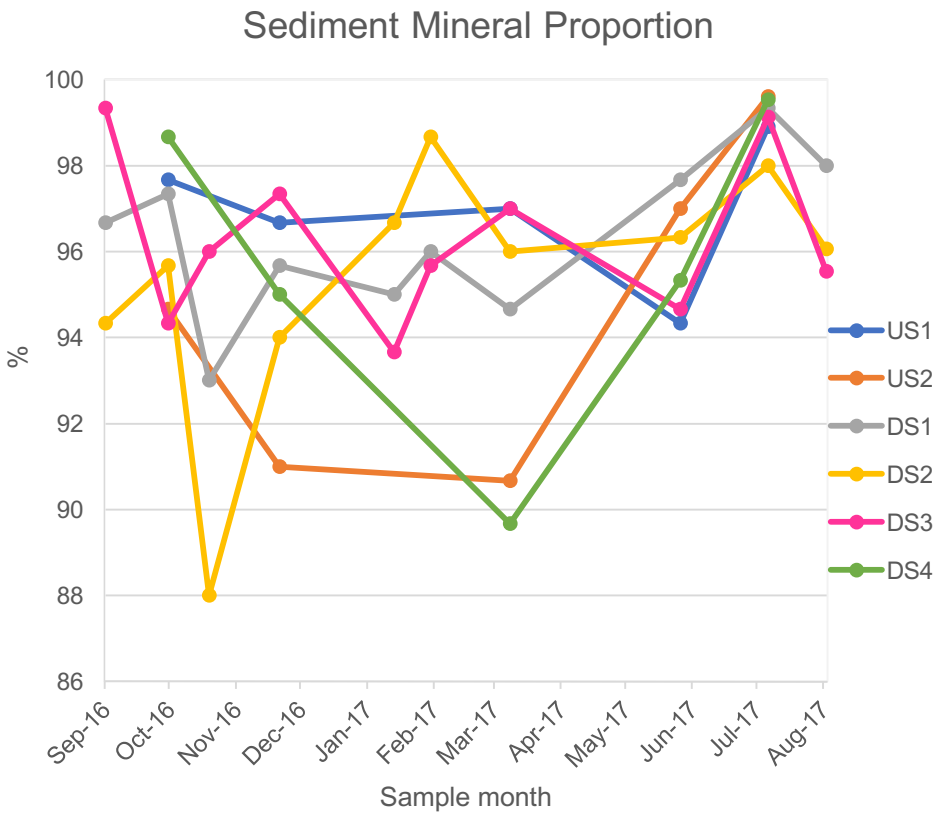
	Table 30 DS2 Microscopic Summary Statistics			
	Coal (%)	**Char (%)**	**Mineral (%)**	**Organic (%)**
Sample #	30	30	30	30
Min	0	0	78	0
Median	0	0	98	2
Mean	0.2	0.6	95.4	3.9
SD	0.5	2.0	4.9	4.9
Max	2.0	10.6	100.0	22.0

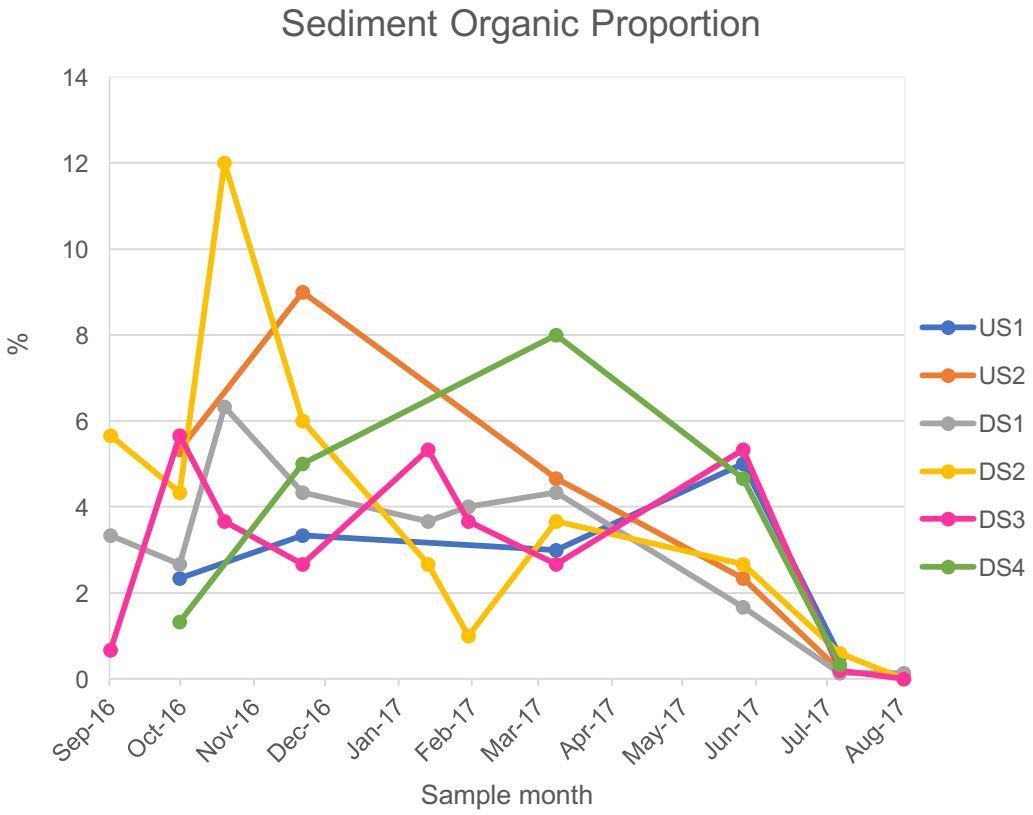
	Table 31 DS3 Microscopic Summary Statistics			
	Coal (%)	**Char (%)**	**Mineral (%)**	**Organic (%)**
Sample #	30	30	30	30
Min	0	0	85	0
Median	0	0	98	2
Mean	0.1	0.6	96.3	3.0
SD	0.3	2.3	4.1	3.6
Max	1.0	12.4	100.0	13.0

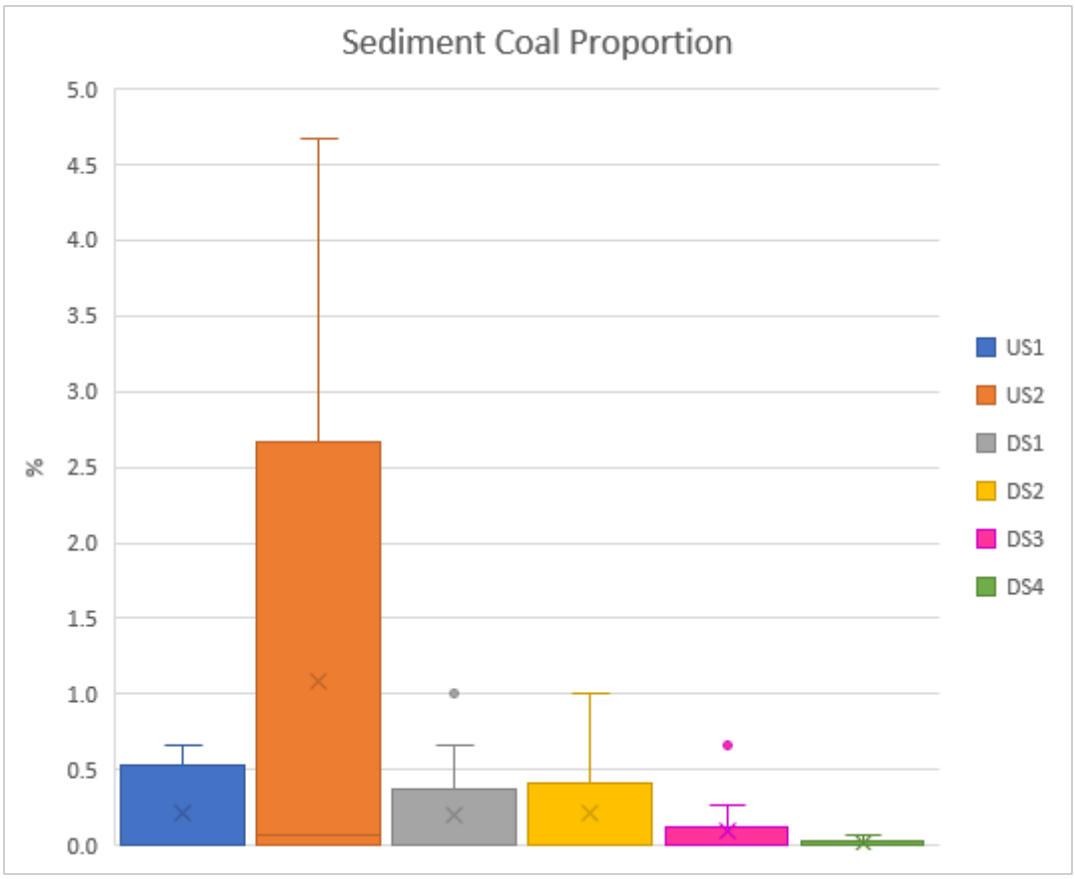
	Table 32 DS4 Microscopic Summary Statistics			
	Coal (%)	**Char (%)**	**Mineral (%)**	**Organic (%)**
Sample #	15	15	15	15
Min	0	0	88	0
Median	0	0	98	2
Mean	0.0	0.5	95.6	3.9
SD	0.1	1.1	4.4	3.7
Max	0.2	4.0	100.0	11.0

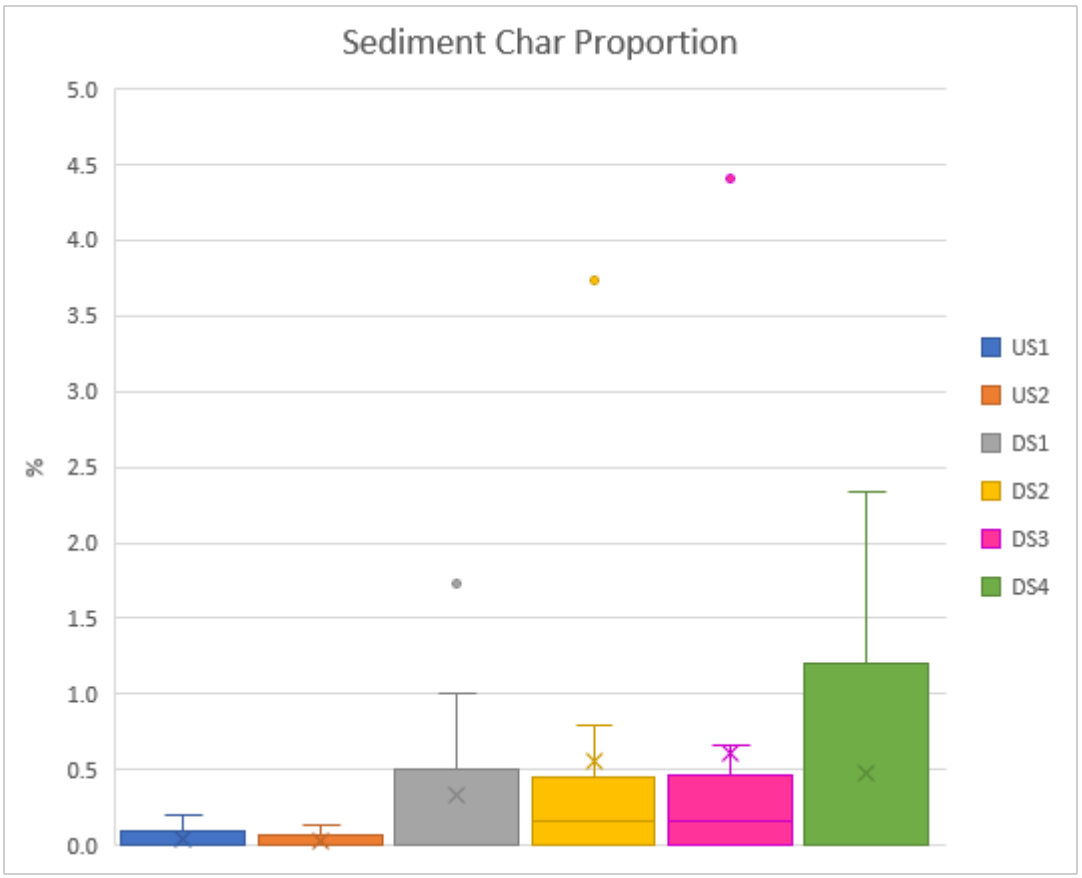

Sediment Coal Proportion
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
%
Sep-16
Oct-16
Nov-16
Dec-16
Feb-17
Feb-17
Mar-17
Jun-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

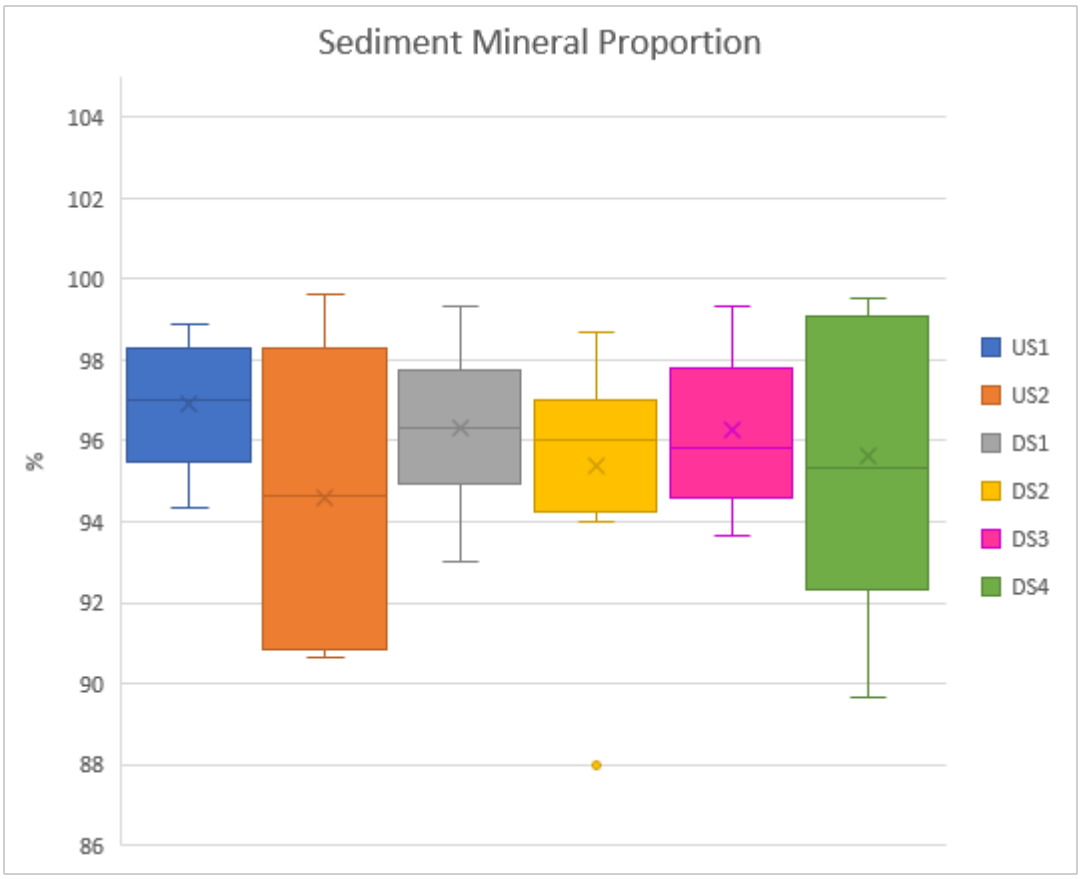

Sediment Char Proportion
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
%
Sep-16
Oct-16
Nov-16
Dec-16
Feb-17
Feb-17
Mar-17
Jun-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4

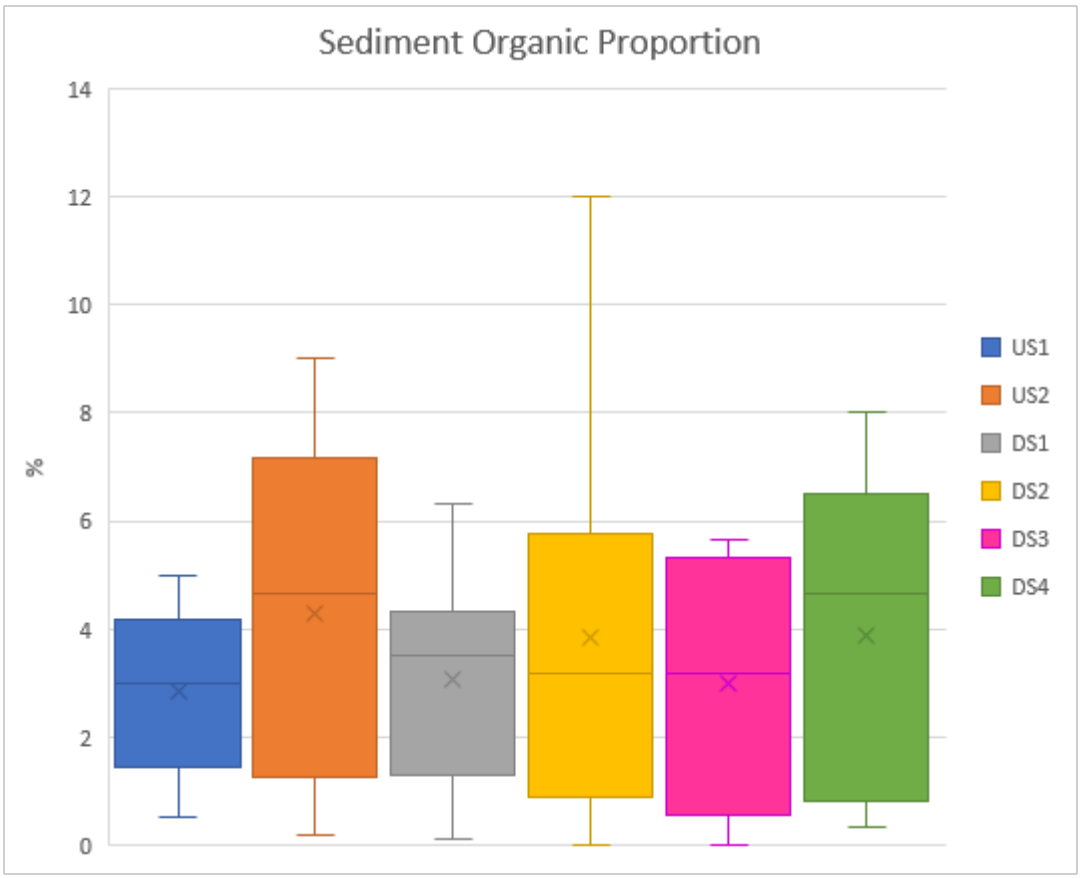

Sediment Mineral Proportion
100
98
96
94
92
90
88
86
%
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Sediment Organic Proportion
14
12
10
8
6
4
2
0
%
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sample month
US1
US2
DS1
DS2
DS3
DS4


Sediment Coal Proportion
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
%
US1
US2
DS1
DS2
DS3
DS4


Sediment Char Proportion
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
%
US1
US2
DS1
DS2
DS3
DS4


Sediment Mineral Proportion
104
102
100
98
96
94
92
90
88
86
%
US1
US2
DS1
DS2
DS3
DS4


Sediment Organic Proportion
14
12
10
8
6
4
2
0
%
US1
US2
DS1
DS2
DS3
DS4

4.4 Visual Inspections for Coal Fines

As per the sampling schedule shown in Table 1, for this six month reporting period and for the remaining study, visiual inspections for coal fines accumulations are made at sites DS1 to DS4 on a quartely basis and at DS5 on a six monthly basis.

At each sampling occasion the river sections up- and downstream of the water quality sampling sites (and/or the aquatic ecology sampling reach) are inspected for accumulated sediment drifts and the drifts are inspected for obvious coal fine contant. Sediment accumulations when found are photographed ,and a selection of photographs of the sediment accumulations up and downstream at sites DS1 to DS5 are appended at **Appendix C1**.

As per the first six-monthly report, at no point were accumulated deposits of coal fines identified for the reporting period covered by this report (March to August 2017). In places of low flow where there were accumulated sediments the sandy sediments or cobbles were covered in fine silt or slit-algae matrix cover (see Appendix C1 photographs).

5. AQUATIC ECOLOGY SAMPLING RESULTS

The EMP requires bi-annual sampling for macroinvertebrates at sites US1 to US4, annual sampling for fish using replicate bait traps for 24-hour periods at sites US1 to DS 4 and annual sampling for frogs at sites US1 to DS4.

An initial trial EMP aquatic ecology sampling program was undertaken in Autumn 2016 with the first EMP sampling undertaken in Spring 2016. A report prepared by MPR for these two sampling events was appended to the first six monthly EMP report in March 2017.

The next scheduled aquatic ecology monitoring sampling for the present six monthly EMP report period was undertaken in Autumn 2017 and the full MPR report is appended to this report as **Appendix D**.

5.1 Aquatic Ecology Methods and Data Summary

The Aquatic Ecology program includes the following stream-health sampling components undertaken at all sites (US1 to DS5):

- Site aquatic ecology habitat condition is estimated on each six-monthly sampling occasion using a modified version of the River-Creek-Environment (RCE) stream site condition index.
- A submersible water quality data logger is used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites.
- Aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment protocols known as Australian River Assessment System (AusRivAS), and sampling is undertaken at both ‘edge’ and ‘riffle’ sites where these habitats (as defined by AusRivAS) exist at the sites (i.e, sites DS1 to DS5).
- For the upper river sites US1 and US2 there are no riffle sections as defined. Accordingly only ‘*edge’* sampling is undertaken at these sites.
- Sampling and observations for fish are undertaken every six months at part of the aquatic ecology sampling program. At each aquatic ecology sampling site, four fish bait traps are set at suitable locations, left overnight and collected the next day during macroinvertebrate sampling.
- Frog searches are undertaken every six months at part of the aquatic ecology sampling program. Frog searches are undertaken twice at each site visit (i.e., when fish traps are set, and when the site is revisited to collect fish traps and undertake macroinvertebrate sampling. A dedicated frog call recorder is also deployed for overnight recording at selected sites each season.

Habitat assessment, water quality results, fish trapping and observation results and frog searches plus call results are all tabulated in the **Appendix D** report and the RCE plus water temperature and conductivity variation for the combined sites are also shown graphically.

5.2 Macroinvertebrate Monitoring Data Summary

The macroinvertebrate assemblage data comprises presence-absence data for taxa identified to the taxonomic levels specified in AusRivAS (generally to Family level). These data are used to compile the following macroinvertebrate indices – compiled for both 'edge' and 'riffle' sample results:

- Site Aquatic Habitat Condition (**RCE Index**)
- Site **Diversity index** (taxa richness).
- **SIGNAL Index** (Stream Invertebrate Grade Number Average Level).
- **EPT index**; the combined number of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddis-fly) families present per site.

These indices are tabulated and compared to previous seasonal results in cluster bar control graphs and the variation in the indices for the Autumn 2017 survey are also tested against the overall variation in each index for the previous surveys (in this case two surveys – Autumn and Spring 2016). Specifically, the test examines whether the value is lower than the range Mean – Standard Deviation (X-SD) of the former data. It should be noted that in this case comparisons against only two previous data sets does not carry much weight and will only become more meaningful once there have been at least two autumn and two spring surveys (i.e., starting autumn 2018):

- All site RCE indices were within or above the range X-SD.
- Edge Sample Diversity indices for sites US2 and DS1 were within or above the range X-SD and the rest were low. As all the Autumn 17 sample results had around 3 to 4 less taxa than the previous Spring 17 survey, this variation is regarded as a normal seasonal variation.
- All Edge SIGNAL and EPT scores were within or above the range X-SD, with the exception of site DS3. This single exception is considered a normal seasonal variation.
- All Riffle Diversity indices except DS5 were above the range X-SD. This single exception is considered a normal seasonal variation.
- Riffle SIGNAL and EPT scores were above the range X-SD for sites DS3 to DS5 and lower for the two upstream sites DS1 and DS2. The results for sites DS1 and DS2 are an artifact of having identical index results for the first two surveys resulting in an SD value of zero meaning that any result less than the original value will 'fail' the test.

It is concluded that the variations in the various stream-health and macroinvertebrate indices shown in Autumn 2017 are expressions of normal seasonal variation.

5.3 Vertebrate (Fish and Frog) Monitoring Data Summary

Mountain galaxias were the only fish caught in traps or observed in Autumn 2017 and were caught at fives site. A total of 45 were caught compared to 16 at five sites in spring 2016. Mountain galaxias have been found or sighted at all sites and it is concluded that there is no physical barrier for this species to travel between sites.

For the autumn 17 frog surveys a Red Crowded Toadlet *Pseudophryne australis* was recorded at DS4 but not sighted and no other frogs or tadpoles were seen, found, captured in macroinvertebrate nets or recorded. In Spring 16 Common Eastern Froglets *Crinea signifera,* were found and recorded at site US2, with no other frogs or tadpoles seen, found, captured in macroinvertebrate nets or recorded. *Crinea signifera* have been reported from the LDP sampling sites that are common to this survey (US1, US2 and DS1 on previous occasions.

6. DISCUSSION

This is the second interim report on the implementation and progress of the EMP and reports on monitoring undertaken and completed between March and August 2017. There were several alterations to data presentation from the first report that have been incorporated into this report:

- Daily rainfall and Mine Discharge Volume are presented in Section 2.2.
- Water quality analytical summary data have been grouped into sub-sections, Physical and Mineral analytes, Nutrients and Organics, Metals and Metalloids.
- The physical water quality results now include field-metered parameters (water temperature, conductivity, pH, dissolved oxygen as % saturation and turbidity).
- The way the data are presented in the summary tables are now determined by rule-based decisions in terms of the proportions of results below detection, and where data below detection are to be used for generating statistical results the detection limit value is halved.
- This latter 'rule' has meant that for a few analytes where detection limits were set higher for the original surveys, there are higher half detection values than those for later data. The preamble to each summary section highlights where this has occurred.
- Results for analytes that have all or most analytic results below detection are shaded in grey with no (or reduced) sample statistics calculated and no bar charts or box plots produced.
- Summary tables now include the 80th percentile values.
- Control charts now show the variation of each analytes for all sites on the one graph. Where there are many control chart results that are the same, the control charts are presented as clustered bar charts to allow better discrimination of individual site variation.
- The box plots now incorporate identification of 'outlier' values. As a consequence the 'whiskers' for the box plots only indicate maximum and minimum values when the data are all within 1.5 Inter Quartile Ranges (IQRs) either side of the IQR.
- If there are outlier data (i.e. values outside this range), they are shown as small circles located on both sides or on one side of the whiskers (depending whether the outliers are very low or very high value) and the whiskers on the sides that have outliers then show the 1.5 IQR limits for the data. Outliers will then indicate the relevant minimum or maximum value.

A review of the overall data from the point of view of redundant analytes and/or replication leads to the following recommendations:

For **water quality analysis** the concentrations of the following analytes were all less than detection (<DL) for all sites and for all sampling times to date and could be discontinued or if they are to be retained, consideration should be given to applying lower detection limits:

- TSS (<5mg/L), Hydroxide and Carbonate Alkalinity (< 1mg/L) Oil and Grease (DL < 5 mg/L), Total Phenol (DL < 0.05mg/L), Total Cyanide (DL < 0.004mg/L) and Fluoride (DL < 0.1mg/L).
- Antimony, Arsenic, Beryllium, Boron, Cadmium, Chromium, Copper, Lead and Uranium had no or a very few samples above Detection (DL generally 0.001mg/L) and should be removed from the metal analysis suite.

- Selenium concentrations were all below a higher detection limit of 0.01mg/L for all samples, and it is recommended that Selenium be retained and analysed at the lower detection limit of the other metals (0.001mg/L) before considering its exclusion for future monitoring.

For **sediment total metal analysis,** the concentrations of total Selenium, Boron and Cadmium were all less than detection (DL < 0.1 mg/kg) for all sites and for all sampling times to date and should be discontinued. Most site Antimony, Arsenic and Beryllium concentrations were below detection or just above detection and these elements should be discontinued.

The EMP required a review of the sediment data at the end of the first six month sampling period to determine the variation amongst replicates, with a view to undertake analysis of homogenised samples rather than individual replicates for future sampling. This review was delayed until this second six monthly review on the basis that there were too many variations and insufficient samples from which to decide for the previous report.

For the total survey to date there are five samples from sites US1, US2 and DS4 and ten samples from each of sites DS1, DS2 and DS3. Analysis for volatility between replicate samples was investigated by applying the following formula to each site by season triple replicate data set for each analyte:

Volatility Index = (Max Concentration – Min Concentration)/Mean Concentration

The Volatility Index (VI) varies from 0 (all values equal) to 3 (one or more values extremely different. The half -way Index value of 1.5 represents at the worst, three values at the ratio 1:3:6. **Table 33** provides a summary of the sites and metals showing the number of replicate sets that had VIs > 1.5.

Table 33 Number of replicate samples per analyte and at each site where the replicates exceeded the Volatility Index threshold of 1.5

Sites	Number samples	Lithium	Molybdenum	Sulfur as S	Uranium	Rubidium	Barium	Lead	Nickel	Strontium	Chromium	Copper	Iron	Zinc	Manganese	Cobalt	Aluminium	Total Exceeds
US1	5						1	2	1	1	1	1	2		2	2	1	10
US2	5																1	1
DS1	10								1				1	1	1	1	2	6
DS2	10						1			1	1		1					4
DS3	10					1	2	2	1	2	3	4	1	2	1	4	6	12
DS4	5								1					2	4	2		4
Total	45	0	0	0	0	1	4	4	4	4	5	5	5	5	8	9	10	
Total Sites with High VIs (per metal)						1	3	2	3	3	3	2	4	3	4	4	4	

Note that the metals recommended for elimination (above) all had VIs less than 1.5 (where there were any values) and have not been included in Table 33:

- In terms of site volatility sites DS4 and US1 had the highest VI values (12 and 10) followed by sites DS1 (6), DS2, DS4 (4 each). Site US2 had one VI >1.5.
- In terms of individual analyte volatility, Aluminium, Cobalt and Manganese were the most volatile (10, 9, 8 high VIs) with eight metals having 4 to 5 high VIs and Rubidium having a single high VI.

On the basis of these patterns it is recommended that:

- Replicate sediment samples that are collected at each site be split in the field with:
    - One set of half replicates homogenised and submitted for analysis of Total Lithium, Molybdenum, Sulphur as S, Uranium and Rubidium.
    - The other set of half replicates are to be kept intact with all replicates submitted for analysis of Total Aluminium, Barium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Nickel, Strontium and Zinc.

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Centennial Coal

Revised
Wollangambe River
Environmental Monitoring Program

5 April 2016

Appendix A

REVISED WOLLANGAMBE RIVER ENVIRONMENTAL MONITORING PROGRAM (5 APRIL 2016)

Introduction

On 25 September 2015 Clarence Colliery, in compliance with Clean up Action 6 of Clean up Notice No. 1532719, submitted a Draft Environmental Monitoring Program (14 pages).

The intent of the Draft Environmental Monitoring Program (the Draft) was *"to determine the state of the aquatic ecosystem for the Wollangambe River following the completion of the clean-up activities, for a period of time not less than 18 months, concentrating on the section of the River below where the coal fines entered the River and downstream for at least 12 kilometres".*

The Environment Protection Authority (EPA) required this monitoring program to be developed in order to be able to obtain information about the recovery of the Wollangambe River after the spill of coal fines on 2 July 2015.

Following its review of the Draft the EPA proposes changes outlined in the Revised Program based on the following:

- The importance of the sediments in the affected parts of the Wollangambe River (the River) as the sink for coal fines remaining in the River.
- The need to assess the impact of the coal fines spill for a period of not less than 18 months.
- The confounding factors relating to the impact of the non-spill factors from Clarence Colliery, such as the ongoing impact of the mine water discharge and the past accumulation of metals in the sediments of the River.
- The advice of the Greater Blue Mountains World Heritage Area Advisory Committee (GBMWHA) to Centennial Coal dated 2 December 2015. The EPA was provided a copy of this letter by the GBMWHA Advisory Committee.

Monitoring – Design of Sampling Program

Timeframe

The monitoring program should commence following the completion of the clean-up, nominally in March-April 2016 (representing the autumn sampling period for the macro-invertebrates). The EPA has required that the monitoring continue for no less than 18 months. The GBMWHA has suggested that the monitoring continue for five years.

The EPA is of the view that sampling should be for 30 months (2.5 years) from when it commences over 2016-2017-2018.

Location of Sampling Sites

The design of the monitoring program (refer to Table One) should include the selection of upstream sites in order to separate the effects, if any, on the water quality of the River of the mine water discharge (Licensed Discharge Point 2 – LDP2) from that of the spill and residual coal in the sediments.

Therefore the monitoring program should include two upstream or background sites (one upstream of the mine water discharge LDP2 and the other between LDP 2 and the spill entry point; three sampling sites within the section of the River where the coal fines were found

(either below or above the water line), one downstream within the part of the River within 12 kilometres (m) downstream of the spill entry point, and finally one site much further downstream assumed to be not impact by the spill.

The nominated sites are as follows:

1. **Upstream** – background site (OEH W1 site).
2. **Between LDP2 and spill entry (WRGDown – MPR Site)** – background site between the discharge point and the spill entry point.
3. **Downstream of spill entry** – 1 kilometre point.
4. **Downstream of spill entry** – 3.5 kilometre point.
5. **Downstream of spill entry** – 5.0 kilometre point.
6. **Downstream of spill entry** – 10.3 kilometre point.
7. **Downstream of spill entry** – 19 kilometre point (Mt Wilson) – accumulated coal fines only.

Sampling Requirements

For each of the above sites, sediment and water column, macro-invertebrates and vertebrate (fish and frog) sampling are to be undertaken. The sampling specific requirements are provided below and the sampling scheduling is provided in Table One.

Sediment Analysis

The coal fines remaining in the River after the clean-up ceases will either become mixed with the sediments or become mobilised where it may accumulate into larger deposits. The coal fines within the sediments represent the fate and assimilation into the river system over time; and, a sink for metals which make up the coal fines and over time are released from them as fluvial processes take place. Therefore to monitor these processes the EPA proposes the following for sediment samples:

1. Three replicates sampled to a depth of 10 centimetres to be collected at each site, and spaced 10 metres (m) apart along a 20 m stretch of River.
2. Petrographic analysis for each replicate.
3. Total metal analysis for each replicate.

After the first six months, the data must be reviewed to determine the variation between the replicates. If the EPA agrees there is uniformity, then the replicates should be homogenised and analysed as one sample for the remainder of the RWEMP, with these monitoring sites sampled every two months for the remaining 24 months.

The analysis of metals in the sediments needs to be the same as those selected for testing the water column. These are:

> Aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, uranium, rubidium, selenium, strontium, sulphur, zinc.

The following is relevant to the inclusion of some selected metals:

- Chromium and selenium showed slight elevations in the sediments downstream of the mine water discharge (refer to Cohen 2002).

- Beryllium is elevated in sediments downstream (refer to Cohen 2002).

- There is justification for not analysing for silver because it is below the detection level in the mine water discharge and not reported in the sediments (refer to Cohen 2002).

- Sulphur is elevated in the mine water discharge and in the sediments downstream (refer to Cohen 2002) and needs to be included as an analyte in the monitoring program.

- There is a justification for leaving tin out since it is low in the mine discharge water and was not measured in sediments by Cohen's (2002).

Water Column Analysis

The water in the River is known to be impacted by the water quality of the mine water discharge from Licensed Discharge Point 2 of Clarence Colliery. Also, knowledge about the accumulation of metals within the sediments of the River (Cohen 2002), indicates a concern about the sediments being a sink for the release of metals into the river ecosystem.

Water quality parameters (analytes) to be analysed, for both Total and Acid Extractable concentrations, include:

- Suspended solids, pH, salinity (EC), total organic carbon, total oil and grease;
- Fluoride;
- Macronutrients: calcium, magnesium, sodium, potassium.
- Aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, uranium, rubidium, selenium, strontium, sulphur, zinc.
- Anions: chloride, sulphate;
- Alkalinity (carbonate, bicarbonate and total);
- Nitrogen and phosphorus: total nitrogen, total Kheljdahl nitrogen, nitrite, nitrate, total ammonium N, total phosphorus;
- Silicon and silica (dissolved)
- Phenolic compounds (total); and
- Total cyanide.

Macro-invertebrates

Macro-invertebrates should be assessed twice a year, in autumn and spring using AusRivas protocols.

Vertebrates - Fish and Frogs

Fish diversity and abundance should be sampled once a year using the bait trapping technique for a standard 24 hour baiting period at each site.

Frog diversity and abundance should be estimated once a year using sound identification techniques and visual observations, in accordance with the relevant guidelines.

Monitoring – Identification of Accumulated Deposits of Coal Fines

The EPA recognises that some coal fines will remain in the River following the clean-up. Water flow and rainfall events over time have the potential to mobilise a portion of the remaining coal fines where they may accumulate into larger deposits.

A visual inspection of the extent of the River where coal fines were removed (nominally 5 km) should be conducted to determine the occurrence and location of any accumulated deposits of coal fines. The following is required for any accumulated coal fine deposits identified during the inspections:

1. a record of the date, time and estimate of location ie distance from spill entry into the River;
2. the GPS location; and
3. a photograph.

The EPA has defined accumulated deposits of coal fines as:

> *"black, visibly aggregated coal which can be gathered by either manual or mechanical methods for removal with minimal risk to the environment."*

A visual inspection program for the River downstream of the 5 km point needs to be implemented, and based on a selection of sites along the River where coal fines would typically deposit and accumulate.

Accumulated deposits of coal fines identified during the inspections are to be removed within one month of being identified. The weight of coal fines removed is to be recorded.

Reporting

Reports are to relate to six months of sampling and provided to the EPA one month after the completion of the sampling i.e. the first report is to be received 7 months from the commencement of the monitoring program. The report is required to include the analysis results for all sampling conducted and mapped locations of any accumulated coal fines identified, photographs and weight of any coal fines removed.

A final report must be provided to the EPA within two months of the completion of the monitoring program.

The data should be reported as outlined below, and for each monitoring site:

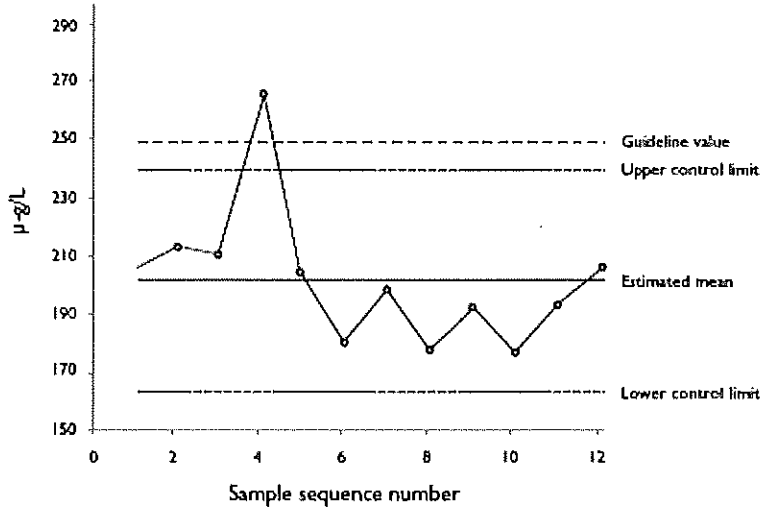
- A summary table for the concentration of each analyte monitored (including discharge/flow) over the time period of report (e.g. annual or 3 years). The reporting needs to include the sample size (n), minimum, median, mean, standard deviation, maximum. Also the reporting needs to include number of exceedances of EPA licence levels and/or ANZECC if appropriate.

- A control chart (see the example below in Diagram One) for each analyte that is monitored including discharge/flow (from LDP; assumes they are not monitoring flow in the Wollangambe but this would appear to be possible at the Dam) – e.g. see ADWG (Australian Drinking Water Guidelines 6 2011 Version 3.1 Updated March 2015). The data need to be reported over the 30 month monitoring period with the most recent data for the current reporting period identified in a different colour symbol.

- A longitudinal boxplot (see the example below in Diagram One) of water and sediment concentrations at repeated intervals (ie after a few sampling events have occurred).

Diagram One: Control Chart (top) and Longitudinal Boxplot (bottom).

Figure 13.4.1 Example of a control chart for trihalomethanes data



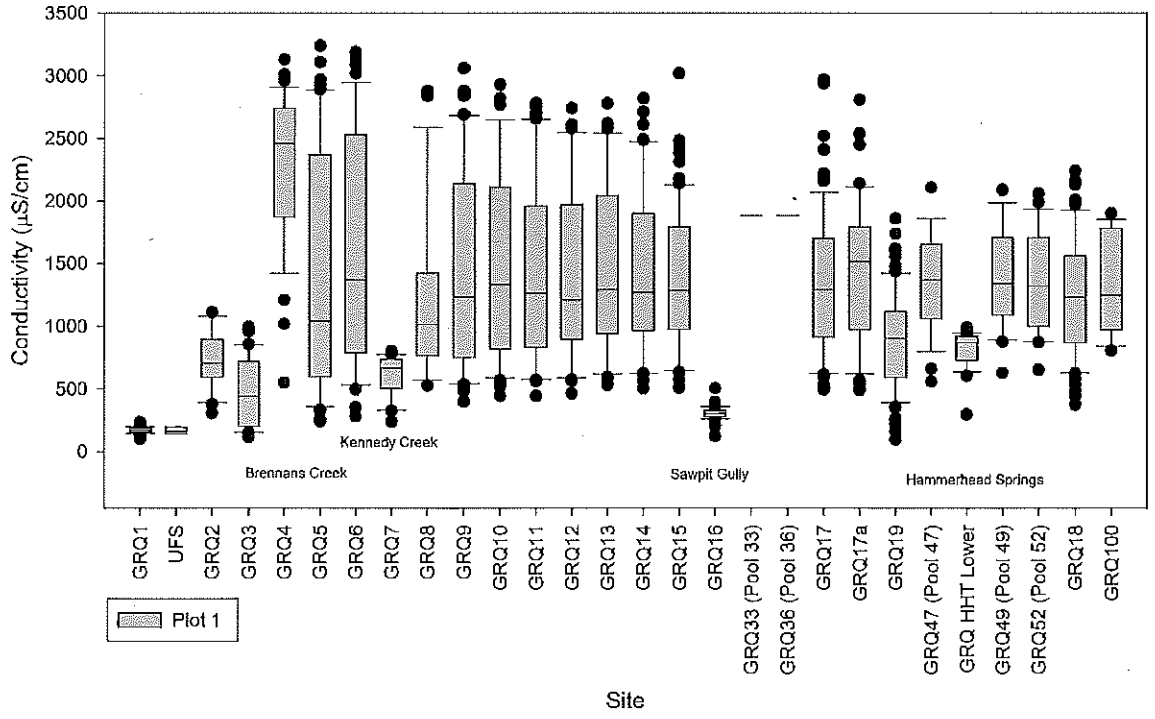


Table One: The sampling schedule of the environmental monitoring program set out for monitoring points (km = kilometre).

MONITORING SITE	SEDIMENT ANALYSIS		WATER COLUMN	MACRO-INVERTEBRATES	FISH & FROGS	ACCUMULATED COAL FINES
	PETROGRAPHIC ANALYSIS	METALS				
Upstream – background site (OEH W1 site).	Quarterly	Quarterly	Quarterly	Spring Autumn	Yearly	
Upstream – WGRDown MPR Site.	Quarterly	Quarterly	Quarterly	Spring Autumn	Yearly	
Downstream of spill entry – 1 km point.	Monthly for 6 months. Every two months for 24 months.	Monthly for 6 months. Every two months for 24 months.	Monthly for 6 months. Every two months for 24 months.	Spring Autumn	Yearly	Bi-annually then yearly for remainder.
Downstream of spill entry – 3.5 km point.	Monthly for 6 months. Every two months for 24 months.	Monthly for 6 months. Every two months for 24 months.	Monthly for 6 months. Every two months for 24 months.	Spring Autumn sample	Yearly	Bi-annually then yearly for remainder.
Downstream of spill entry – 5.0 km point.	Monthly for 6 months. Every two months for 24 months.	Monthly for 6 months. Every two months for 24 months.	Monthly for 6 months. Every two months for 24 months.	Spring Autumn	Yearly	Bi-annually then yearly for remainder.
Downstream of spill entry – 10.3 km point.	Quarterly	Quarterly	Quarterly	Spring Autumn	Yearly	Bi-annually then yearly for remainder.
Downstream of spill entry – 19 km point (Mt Wilson.	Not Required.	Not Required.	Not Required.	Not Required	Not Required	Bi-annually then yearly for remainder.

References

Belmer, N., Tippler C., Davies P.J., and Wright, I.A (2014) Impact of a coal mine waste discharge on water quality and aquatic ecosystems in the Blue Mountains World Heritage Area, in Vietz G., Rutherford, I. D. and Hughes, R. (Eds), Proceedings of the 7th Australian Stream Management Conference, Townsville, Queensland, pp. 285-291.

Cohen, D (2002) 'Best Practices Mine Water management at a Coal Mining Operation in the Blue Mountains', Master of Engineering (Honours) thesis, University of Western Sydney – Nepean.

Centennial Coal

Wollangambe Environmental Monitoring Program

ALS Analytical Reports
March to August 2017

Appendix B

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1721293**	Page	: 1 of 5
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: CLARENCE WOLLANGAMBE WATER	Date Samples Received	: 25-Aug-2017 10:00
Order number	: ----	Date Analysis Commenced	: 25-Aug-2017
C-O-C number	: ----	Issue Date	: 31-Aug-2017 10:37
Sampler	: ----		
Site	: ACIRL LITHGOW		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This 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	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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.

- ED040: It has been noted that dissolved is greater than total for silicon, however this difference is within the limits of experimental variation.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WGR DS1	WGR DS2	WGR DS3	----	----
			Client sampling date / time	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]	----	----
Compound	CAS Number	LOR	Unit	ES1721293-001	ES1721293-002	ES1721293-003	--------	--------
				Result	Result	Result	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	----	----
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	17	14	12	----	----
Total Alkalinity as CaCO3	----	1	mg/L	17	14	12	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	38	34	34	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	5.3	5.3	5.4	----	----
Silicon	7440-21-3	0.05	mg/L	2.50	2.47	2.50	----	----
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	42	40	40	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	5.0	5.1	5.0	----	----
Silicon	7440-21-3	0.05	mg/L	2.35	2.38	2.33	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	108	101	98	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	4	4	4	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	35	32	31	----	----
Magnesium	7439-95-4	1	mg/L	10	9	10	----	----
Sodium	7440-23-5	1	mg/L	4	3	4	----	----
Potassium	7440-09-7	1	mg/L	4	4	3	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	128	117	118	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	0.022	0.020	0.020	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR DS1	WGR DS2	WGR DS3	----	----
				Client sampling date / time	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]	----	----
Compound	CAS Number	LOR	Unit		ES1721293-001	ES1721293-002	ES1721293-003	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		**0.004**	**0.002**	**0.002**	----	----
Nickel	7440-02-0	0.001	mg/L		**0.023**	**0.022**	**0.023**	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**0.031**	**0.032**	**0.030**	----	----
Lithium	7439-93-2	0.001	mg/L		**0.015**	**0.015**	**0.015**	----	----
Manganese	7439-96-5	0.001	mg/L		**0.052**	**0.036**	**0.027**	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.014**	**0.012**	**0.013**	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Strontium	7440-24-6	0.001	mg/L		**0.055**	**0.050**	**0.049**	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<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	<0.05	<0.05	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	**0.01**	<0.01	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L		**0.022**	**0.021**	**0.021**	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.004**	**0.002**	**0.002**	----	----
Nickel	7440-02-0	0.001	mg/L		**0.025**	**0.026**	**0.023**	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**0.033**	**0.034**	**0.034**	----	----
Lithium	7439-93-2	0.001	mg/L		**0.018**	**0.018**	**0.017**	----	----
Manganese	7439-96-5	0.001	mg/L		**0.056**	**0.041**	**0.029**	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.001**	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.015**	**0.014**	**0.014**	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Strontium	7440-24-6	0.001	mg/L		**0.057**	**0.054**	**0.053**	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<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	<0.05	<0.05	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WGR DS1	WGR DS2	WGR DS3	----	----
			Client sampling date / time	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]	----	----
Compound	CAS Number	LOR	Unit	ES1721293-001	ES1721293-002	ES1721293-003	--------	--------
				Result	Result	Result	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	----	----
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	**0.02**	**0.02**	**0.02**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	**0.02**	**0.02**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**2.70**	**2.50**	**2.39**	----	----
Total Cations	----	0.01	meq/L	**2.84**	**2.57**	**2.62**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	<1	<1	<1	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	----	----
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1721225**	Page	: 1 of 4
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: CLARENCE WOLLANGAMBE SOIL	Date Samples Received	: 25-Aug-2017 10:00
Order number	: ----	Date Analysis Commenced	: 28-Aug-2017
C-O-C number	: ----	Issue Date	: 31-Aug-2017 13:50
Sampler	: ----		
Site	: ACIRL LITHGOW		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 9		
No. of samples analysed	: 9		

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

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

This 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*
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WGR DS1 #1	WGR DS1 #2	WGR DS1 #3	WGR DS2 #1	WGR DS2 #2
			Client sampling date / time	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]
Compound	CAS Number	LOR	Unit	ES1721225-001	ES1721225-002	ES1721225-003	ES1721225-004	ES1721225-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	19.4	22.8	37.4	29.8	28.9
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	560	1270	590	790	330
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg	700	1590	910	6610	580
Sulfur as S	63705-05-5	50	mg/kg	<50	<50	<50	90	<50
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	0.2	0.3	0.3	0.3	<0.1
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg	11.6	20.0	15.8	9.1	2.6
Beryllium	7440-41-7	0.1	mg/kg	0.1	0.3	0.1	0.1	<0.1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	125	202	170	13.5	12.3
Chromium	7440-47-3	0.1	mg/kg	0.4	0.8	0.4	4.0	0.4
Copper	7440-50-8	0.1	mg/kg	0.7	1.4	0.9	1.4	0.4
Manganese	7439-96-5	0.1	mg/kg	1020	1900	1600	120	149
Strontium	7440-24-6	0.1	mg/kg	0.9	1.5	0.8	1.7	0.5
Molybdenum	7439-98-7	0.1	mg/kg	0.6	1.1	1.2	0.2	0.1
Nickel	7440-02-0	0.1	mg/kg	62.0	133	121	18.9	16.2
Lead	7439-92-1	0.1	mg/kg	0.8	1.8	0.8	1.6	0.5
Antimony	7440-36-0	0.1	mg/kg	<0.1	0.1	0.1	0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg	<0.1	0.1	<0.1	0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg	71.4	158	174	30.0	22.0
Lithium	7439-93-2	0.1	mg/kg	1.6	3.7	4.2	1.3	0.7
Rubidium	7440-17-7	0.1	mg/kg	0.5	1.3	0.6	1.1	0.4

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WGR DS2 #3	WGR DS3 #1	WGR DS3 #2	WGR DS3 #3	----
			Client sampling date / time	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]	[23-Aug-2017]	----
Compound	CAS Number	LOR	Unit	ES1721225-006	ES1721225-007	ES1721225-008	ES1721225-009	--------
				Result	Result	Result	Result	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**29.2**	**53.7**	**28.4**	**18.7**	**----**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**750**	**3910**	**250**	**300**	**----**
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	**----**
Iron	7439-89-6	50	mg/kg	**1670**	**5370**	**770**	**3540**	**----**
Sulfur as S	63705-05-5	50	mg/kg	**60**	**920**	<50	<50	**----**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	**0.1**	**0.6**	<0.1	<0.1	**----**
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	**----**
Barium	7440-39-3	0.1	mg/kg	**6.2**	**42.4**	**2.5**	**2.6**	**----**
Beryllium	7440-41-7	0.1	mg/kg	**0.1**	**1.1**	<0.1	<0.1	**----**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	**0.1**	<0.1	<0.1	**----**
Cobalt	7440-48-4	0.1	mg/kg	**41.7**	**93.4**	**9.8**	**13.0**	**----**
Chromium	7440-47-3	0.1	mg/kg	**0.9**	**4.1**	**1.2**	**0.5**	**----**
Copper	7440-50-8	0.1	mg/kg	**1.0**	**10.2**	**0.4**	**0.4**	**----**
Manganese	7439-96-5	0.1	mg/kg	**418**	**753**	**117**	**131**	**----**
Strontium	7440-24-6	0.1	mg/kg	**1.0**	**7.0**	**0.5**	**0.4**	**----**
Molybdenum	7439-98-7	0.1	mg/kg	**0.3**	**0.5**	**0.1**	<0.1	**----**
Nickel	7440-02-0	0.1	mg/kg	**34.3**	**75.6**	**13.9**	**12.0**	**----**
Lead	7439-92-1	0.1	mg/kg	**1.1**	**8.9**	**0.6**	**0.7**	**----**
Antimony	7440-36-0	0.1	mg/kg	<0.1	**0.2**	<0.1	<0.1	**----**
Uranium	7440-61-1	0.1	mg/kg	**0.1**	**0.9**	<0.1	<0.1	**----**
Zinc	7440-66-6	0.5	mg/kg	**48.1**	**125**	**19.3**	**16.8**	**----**
Lithium	7439-93-2	0.1	mg/kg	**1.4**	**1.7**	**0.7**	**0.4**	**----**
Rubidium	7440-17-7	0.1	mg/kg	**0.7**	**2.4**	**0.5**	**0.4**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1718660**	Page	: 1 of 6
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: Clarence WOLLANGAMBE SOIL	Date Samples Received	: 28-Jul-2017 09:00
Order number	: ----	Date Analysis Commenced	: 31-Jul-2017
C-O-C number	: ----	Issue Date	: 02-Aug-2017 18:09
Sampler	: ----		
Site	: CLARENCE		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 18		
No. of samples analysed	: 18		

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

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

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- 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*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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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 no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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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.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WGR US1 #1	WGR US1 #2	WGR US1 #3	WGR US2 #1	WGR US2 #2
			Client sampling date / time	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]
Compound	CAS Number	LOR	Unit	ES1718660-001	ES1718660-002	ES1718660-003	ES1718660-004	ES1718660-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	20.0	21.3	18.8	22.6	14.4
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	650	370	230	640	440
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg	3090	1610	1150	1230	860
Sulfur as S	63705-05-5	50	mg/kg	<50	<50	<50	<50	<50
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	0.2	0.1	<0.1	0.3	0.2
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg	3.1	1.3	0.9	22.2	25.5
Beryllium	7440-41-7	0.1	mg/kg	<0.1	<0.1	<0.1	0.2	0.2
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	0.4	0.4	0.3	223	197
Chromium	7440-47-3	0.1	mg/kg	0.6	0.5	0.2	0.3	0.3
Copper	7440-50-8	0.1	mg/kg	0.5	0.2	0.2	1.0	0.8
Manganese	7439-96-5	0.1	mg/kg	45.9	44.6	26.8	1970	1760
Strontium	7440-24-6	0.1	mg/kg	0.8	0.2	0.2	0.9	1.0
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	<0.1	1.1	1.0
Nickel	7440-02-0	0.1	mg/kg	0.2	0.1	<0.1	170	153
Lead	7439-92-1	0.1	mg/kg	1.0	0.4	0.3	1.1	0.9
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	0.2	0.2
Uranium	7440-61-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg	0.6	0.8	<0.5	235	211
Lithium	7439-93-2	0.1	mg/kg	0.1	<0.1	<0.1	4.5	3.6
Rubidium	7440-17-7	0.1	mg/kg	0.3	0.2	0.1	0.4	0.3

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WGR US2 #3	WGR DS1 #1	WGR DS1 #2	WGR DS1 #3	WGR DS2 #1
				Client sampling date / time	[26-Jul-2017]	[27-Jul-2017]	[27-Jul-2017]	[27-Jul-2017]	[27-Jul-2017]
Compound	CAS Number	LOR	Unit		ES1718660-006	ES1718660-007	ES1718660-008	ES1718660-009	ES1718660-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		16.5	23.4	18.3	21.0	15.1
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		420	630	640	1950	270
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		760	880	1000	1560	680
Sulfur as S	63705-05-5	50	mg/kg		<50	<50	<50	<50	<50
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		0.2	0.2	0.2	0.3	<0.1
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg		17.6	14.6	17.3	24.5	2.3
Beryllium	7440-41-7	0.1	mg/kg		0.2	0.2	0.2	0.3	<0.1
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg		149	151	152	230	15.7
Chromium	7440-47-3	0.1	mg/kg		0.4	0.4	0.5	0.7	0.4
Copper	7440-50-8	0.1	mg/kg		0.6	1.1	1.2	1.6	0.4
Manganese	7439-96-5	0.1	mg/kg		1340	1280	1350	1930	176
Strontium	7440-24-6	0.1	mg/kg		0.7	1.6	1.5	1.3	0.4
Molybdenum	7439-98-7	0.1	mg/kg		0.8	1.0	0.8	1.3	0.1
Nickel	7440-02-0	0.1	mg/kg		119	116	124	190	16.4
Lead	7439-92-1	0.1	mg/kg		1.1	1.2	1.4	1.5	0.4
Antimony	7440-36-0	0.1	mg/kg		0.2	0.1	0.1	0.2	<0.1
Uranium	7440-61-1	0.1	mg/kg		<0.1	<0.1	0.1	0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg		177	149	145	245	25.8
Lithium	7439-93-2	0.1	mg/kg		3.1	3.9	3.3	5.1	0.6
Rubidium	7440-17-7	0.1	mg/kg		0.3	0.8	0.9	1.2	0.3

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WGR DS2 #2	WGR DS2 #3	WGR DS3 #1	WGR DS3 #2	WGR DS3 #3
			Client sampling date / time	[27-Jul-2017]	[27-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]
Compound	CAS Number	LOR	Unit	ES1718660-011	ES1718660-012	ES1718660-013	ES1718660-014	ES1718660-015
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	18.2	22.4	18.3	18.6	23.2
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	360	350	160	470	1850
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg	690	830	400	1450	1190
Sulfur as S	63705-05-5	50	mg/kg	<50	<50	<50	<50	50
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg	5.8	4.4	1.4	3.4	6.8
Beryllium	7440-41-7	0.1	mg/kg	0.1	0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	34.7	20.2	5.9	12.9	34.2
Chromium	7440-47-3	0.1	mg/kg	0.4	0.5	0.3	0.9	0.9
Copper	7440-50-8	0.1	mg/kg	0.6	0.7	0.2	0.6	1.6
Manganese	7439-96-5	0.1	mg/kg	379	188	46.8	124	246
Strontium	7440-24-6	0.1	mg/kg	0.9	0.7	0.4	0.5	1.2
Molybdenum	7439-98-7	0.1	mg/kg	0.3	0.2	<0.1	0.1	0.1
Nickel	7440-02-0	0.1	mg/kg	37.3	18.0	8.8	13.2	32.3
Lead	7439-92-1	0.1	mg/kg	1.1	0.8	0.3	0.7	1.6
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg	47.0	22.9	10.6	18.9	33.8
Lithium	7439-93-2	0.1	mg/kg	1.2	0.7	0.5	0.8	1.2
Rubidium	7440-17-7	0.1	mg/kg	0.4	0.4	0.3	0.8	1.0

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WGR DS4 #1	WGR DS4 #2	WGR DS4 #3	----	----
			Client sampling date / time	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	----	----
Compound	CAS Number	LOR	Unit	ES1718660-016	ES1718660-017	ES1718660-018	--------	--------
				Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**16.2**	**15.8**	**21.3**	**----**	**----**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**260**	**160**	**240**	**----**	**----**
Boron	7440-42-8	50	mg/kg	<50	<50	<50	**----**	**----**
Iron	7439-89-6	50	mg/kg	**930**	**560**	**640**	**----**	**----**
Sulfur as S	63705-05-5	50	mg/kg	<50	<50	<50	**----**	**----**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	**----**	**----**
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	**----**	**----**
Barium	7440-39-3	0.1	mg/kg	**2.8**	**1.6**	**1.9**	**----**	**----**
Beryllium	7440-41-7	0.1	mg/kg	<0.1	<0.1	<0.1	**----**	**----**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	**----**	**----**
Cobalt	7440-48-4	0.1	mg/kg	**12.5**	**3.9**	**3.2**	**----**	**----**
Chromium	7440-47-3	0.1	mg/kg	**0.3**	**0.2**	**0.3**	**----**	**----**
Copper	7440-50-8	0.1	mg/kg	**0.3**	**0.2**	**0.3**	**----**	**----**
Manganese	7439-96-5	0.1	mg/kg	**106**	**26.9**	**22.5**	**----**	**----**
Strontium	7440-24-6	0.1	mg/kg	**0.5**	**0.3**	**0.4**	**----**	**----**
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	<0.1	**----**	**----**
Nickel	7440-02-0	0.1	mg/kg	**12.7**	**4.0**	**2.2**	**----**	**----**
Lead	7439-92-1	0.1	mg/kg	**0.5**	**0.4**	**0.5**	**----**	**----**
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	**----**	**----**
Uranium	7440-61-1	0.1	mg/kg	<0.1	<0.1	<0.1	**----**	**----**
Zinc	7440-66-6	0.5	mg/kg	**16.1**	**4.6**	**2.6**	**----**	**----**
Lithium	7439-93-2	0.1	mg/kg	**0.7**	**0.3**	**0.2**	**----**	**----**
Rubidium	7440-17-7	0.1	mg/kg	**0.4**	**0.3**	**0.4**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1718654**	Page	: 1 of 8
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: Clarence WOLLANGAMBE WATER	Date Samples Received	: 28-Jul-2017 09:00
Order number	: ----	Date Analysis Commenced	: 28-Jul-2017
C-O-C number	: ----	Issue Date	: 03-Aug-2017 13:47
Sampler	: ----		
Site	: CLARENCE		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This 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	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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.

- ED040: 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.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WGR US1	WGR US2	WGR DS1	WGR DS2	WGR DS3
			Client sampling date / time	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]
Compound	CAS Number	LOR	Unit	ES1718654-001	ES1718654-002	ES1718654-003	ES1718654-004	ES1718654-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	5.14	6.70	6.95	7.01	7.05
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	25	284	282	266	257
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	<5	<5
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	3	18	21	17	17
Total Alkalinity as CaCO3	----	1	mg/L	3	18	21	17	17
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	<1	36	36	33	31
Silicon as SiO2	14464-46-1	0.1	mg/L	6.4	7.1	7.1	7.0	6.8
Silicon	7440-21-3	0.05	mg/L	2.99	3.32	3.33	3.25	3.20
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	1	35	34	32	31
Silicon as SiO2	14464-46-1	0.1	mg/L	5.6	6.4	6.3	6.4	6.3
Silicon	7440-21-3	0.05	mg/L	2.51	2.84	2.79	2.85	2.80
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1	106	104	100	92
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	5	3	3	3	3
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	29	29	27	24
Magnesium	7439-95-4	1	mg/L	<1	10	10	10	10
Sodium	7440-23-5	1	mg/L	5	4	3	4	3
Potassium	7440-09-7	1	mg/L	<1	4	4	4	3
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	<1	114	114	108	101
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR US1	WGR US2	WGR DS1	WGR DS2	WGR DS3
				Client sampling date / time	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]
Compound	CAS Number	LOR	Unit		ES1718654-001	ES1718654-002	ES1718654-003	ES1718654-004	ES1718654-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.007**	**0.019**	**0.020**	**0.018**	**0.018**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	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
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.006**	**0.006**	**0.003**	**0.001**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.034**	**0.037**	**0.029**	**0.023**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.044**	**0.045**	**0.040**	**0.029**
Lithium	7439-93-2	0.001	mg/L		<0.001	**0.018**	**0.017**	**0.016**	**0.015**
Manganese	7439-96-5	0.001	mg/L		**0.051**	**0.067**	**0.054**	**0.038**	**0.022**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.001**	**0.001**	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		<0.001	**0.014**	**0.014**	**0.013**	**0.012**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.004**	**0.052**	**0.052**	**0.051**	**0.045**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
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		**0.27**	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.04**	**0.02**	**0.02**	**0.01**	**0.01**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.008**	**0.020**	**0.020**	**0.019**	**0.018**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	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
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.007**	**0.006**	**0.003**	**0.002**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.037**	**0.036**	**0.030**	**0.024**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.044**	**0.044**	**0.038**	**0.028**
Lithium	7439-93-2	0.001	mg/L		<0.001	**0.018**	**0.018**	**0.016**	**0.014**
Manganese	7439-96-5	0.001	mg/L		**0.052**	**0.076**	**0.062**	**0.040**	**0.025**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.002**	**0.001**	**0.001**	<0.001
Rubidium	7440-17-7	0.001	mg/L		<0.001	**0.015**	**0.014**	**0.014**	**0.013**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR US1	WGR US2	WGR DS1	WGR DS2	WGR DS3
				Client sampling date / time	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]	[26-Jul-2017]
Compound	CAS Number	LOR	Unit		ES1718654-001	ES1718654-002	ES1718654-003	ES1718654-004	ES1718654-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.003**	**0.053**	**0.053**	**0.050**	**0.049**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
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		**0.42**	<0.05	<0.05	<0.05	<0.05
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	<0.004
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	<0.01	<0.01	<0.01	<0.01
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		**0.01**	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.01**	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
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
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**0.22**	**2.65**	**2.67**	**2.51**	**2.34**
Total Cations	----	0.01	meq/L		**0.22**	**2.55**	**2.50**	**2.45**	**2.23**
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	<1	**2**	<1	<1
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WGR DS4	----	----	----	----
			Client sampling date / time	[26-Jul-2017]	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1718654-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.03**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**226**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	----	----	----	----
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	**15**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**15**	----	----	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**27**	----	----	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**6.7**	----	----	----	----
Silicon	7440-21-3	0.05	mg/L	**3.13**	----	----	----	----
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**26**	----	----	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**6.1**	----	----	----	----
Silicon	7440-21-3	0.05	mg/L	**2.71**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**81**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**22**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**8**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**3**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**3**	----	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**88**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR DS4	----	----	----	----
				Client sampling date / time	[26-Jul-2017]	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1718654-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.016**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.018**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.025**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L		**0.012**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.034**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.010**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.041**	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.017**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.018**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.024**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L		**0.012**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.036**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.011**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR DS4	----	----	----	----
				Client sampling date / time	[26-Jul-2017]	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1718654-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.042**	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	----	----	----	----
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	----	----	----	----
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		<0.1	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**2.07**	----	----	----	----
Total Cations	----	0.01	meq/L		**1.96**	----	----	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		<1	----	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	----	----	----	----
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		<0.05	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1712212**	Page	: 1 of 4
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: Clarence WOLLANGAMBE SOIL	Date Samples Received	: 19-May-2017 10:15
Order number	: ----	Date Analysis Commenced	: 22-May-2017
C-O-C number	: ----	Issue Date	: 26-May-2017 15:37
Sampler	: ----		
Site	: ACIRL Lithgow		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 9		
No. of samples analysed	: 9		

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

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

This 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*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WGR DS1 #1	WGR DS1 #2	WGR DS1 #3	WGR DS2 #1	WGR DS2 #2
				Client sampling date / time	[18-May-2017]	[18-May-2017]	[18-May-2017]	[18-May-2017]	[18-May-2017]
Compound	CAS Number	LOR	Unit		ES1712212-001	ES1712212-002	ES1712212-003	ES1712212-004	ES1712212-005
					Result	Result	Result	Result	Result
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1	%		23.9	26.1	22.2	17.3	20.9
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		640	2490	730	1830	2360
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		920	1840	1080	4500	1110
Sulfur as S	63705-05-5	50	mg/kg		<50	50	<50	<50	80
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		0.2	0.4	0.2	0.2	0.1
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg		15.0	26.9	19.1	3.2	7.5
Beryllium	7440-41-7	0.1	mg/kg		0.2	0.4	0.2	<0.1	0.2
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg		152	239	197	7.2	27.9
Chromium	7440-47-3	0.1	mg/kg		0.5	1.1	0.5	3.5	1.2
Copper	7440-50-8	0.1	mg/kg		0.9	1.9	1.1	0.5	1.3
Manganese	7439-96-5	0.1	mg/kg		1430	2410	1720	62.5	255
Strontium	7440-24-6	0.1	mg/kg		0.9	1.7	1.3	0.9	2.0
Molybdenum	7439-98-7	0.1	mg/kg		0.8	1.1	1.1	<0.1	0.2
Nickel	7440-02-0	0.1	mg/kg		106	179	160	11.0	37.8
Lead	7439-92-1	0.1	mg/kg		1.0	2.0	1.1	1.5	1.7
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		<0.1	0.2	<0.1	<0.1	0.1
Zinc	7440-66-6	0.5	mg/kg		135	217	198	24.5	41.9
Lithium	7439-93-2	0.1	mg/kg		3.8	4.6	4.7	1.0	1.6
Rubidium	7440-17-7	0.1	mg/kg		0.8	1.3	0.9	0.8	1.0

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WGR DS2 #3	WGR DS3 #1	WGR DS3 #2	WGR DS3 #3	----
			Client sampling date / time	[18-May-2017]	[18-May-2017]	[18-May-2017]	[18-May-2017]	----
Compound	CAS Number	LOR	Unit	ES1712212-006	ES1712212-007	ES1712212-008	ES1712212-009	--------
				Result	Result	Result	Result	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	**16.8**	**21.7**	**16.0**	**26.8**	**----**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**260**	**220**	**200**	**710**	**----**
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	**----**
Iron	7439-89-6	50	mg/kg	**2610**	**370**	**160**	**5160**	**----**
Sulfur as S	63705-05-5	50	mg/kg	<50	<50	<50	<50	**----**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	**0.1**	<0.1	<0.1	**0.3**	**----**
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	**----**
Barium	7440-39-3	0.1	mg/kg	**2.2**	**5.2**	**2.2**	**3.8**	**----**
Beryllium	7440-41-7	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**----**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**----**
Cobalt	7440-48-4	0.1	mg/kg	**11.1**	**35.1**	**6.7**	**8.9**	**----**
Chromium	7440-47-3	0.1	mg/kg	**1.2**	**0.3**	**0.2**	**3.1**	**----**
Copper	7440-50-8	0.1	mg/kg	**0.4**	**0.2**	**0.4**	**0.7**	**----**
Manganese	7439-96-5	0.1	mg/kg	**113**	**249**	**86.9**	**76.2**	**----**
Strontium	7440-24-6	0.1	mg/kg	**0.5**	**0.3**	**0.5**	**0.7**	**----**
Molybdenum	7439-98-7	0.1	mg/kg	**0.1**	**0.1**	<0.1	<0.1	**----**
Nickel	7440-02-0	0.1	mg/kg	**14.2**	**20.8**	**10.7**	**9.1**	**----**
Lead	7439-92-1	0.1	mg/kg	**0.6**	**0.4**	**0.6**	**1.6**	**----**
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**----**
Uranium	7440-61-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**----**
Zinc	7440-66-6	0.5	mg/kg	**20.6**	**22.1**	**13.9**	**16.7**	**----**
Lithium	7439-93-2	0.1	mg/kg	**0.6**	**0.7**	**0.6**	**0.7**	**----**
Rubidium	7440-17-7	0.1	mg/kg	**0.3**	**0.3**	**0.5**	**0.7**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1712209**	Page	: 1 of 5
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: Clarence WOLLANGAMBE WATER	Date Samples Received	: 19-May-2017 10:15
Order number	: ----	Date Analysis Commenced	: 19-May-2017
C-O-C number	: ----	Issue Date	: 26-May-2017 17:55
Sampler	: ----		
Site	: ACIRL Lithgow		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This 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	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WGR DS2	WGR DS3	WGR DS1	----	----
			Client sampling date / time	[18-May-2017]	[18-May-2017]	[18-May-2017]	----	----
Compound	CAS Number	LOR	Unit	ES1712209-001	ES1712209-002	ES1712209-003	--------	--------
				Result	Result	Result	----	----
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	**15**	**12**	**15**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**15**	**12**	**15**	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**32**	**29**	**33**	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**5.5**	**5.3**	**5.4**	----	----
Silicon	7440-21-3	0.05	mg/L	**2.56**	**2.48**	**2.53**	----	----
ED040T: Total Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**33**	**30**	**35**	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**5.9**	**5.7**	**5.8**	----	----
Silicon	7440-21-3	0.05	mg/L	**2.75**	**2.66**	**2.70**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**78**	**73**	**93**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	**3**	**4**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**28**	**29**	**31**	----	----
Magnesium	7439-95-4	1	mg/L	**8**	**6**	**8**	----	----
Sodium	7440-23-5	1	mg/L	**3**	**3**	**3**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**3**	**4**	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**103**	**97**	**110**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	**0.018**	**0.017**	**0.020**	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.003**	**0.002**	**0.004**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.023**	**0.023**	**0.028**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WGR DS2	WGR DS3	WGR DS1	----	----
			Client sampling date / time	[18-May-2017]	[18-May-2017]	[18-May-2017]	----	----
Compound	CAS Number	LOR	Unit	ES1712209-001	ES1712209-002	ES1712209-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	**0.031**	**0.028**	**0.035**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.016**	**0.014**	**0.018**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.045**	**0.035**	**0.054**	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.004**	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.011**	**0.011**	**0.014**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Strontium	7440-24-6	0.001	mg/L	**0.051**	**0.047**	**0.055**	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<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	<0.05	<0.05	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	**0.02**	**0.02**	----	----
Antimony	7440-36-0	0.001	mg/L	**0.002**	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	**0.018**	**0.019**	**0.020**	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	**0.0001**	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.003**	**0.003**	**0.005**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.028**	**0.028**	**0.041**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	**0.047**	**0.030**	**0.040**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.017**	**0.015**	**0.017**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.040**	**0.038**	**0.058**	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.012**	**0.011**	**0.013**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Strontium	7440-24-6	0.001	mg/L	**0.050**	**0.050**	**0.051**	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L	**0.07**	<0.05	<0.05	----	----
EK026SF: Total CN by Segmented Flow Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR DS2	WGR DS3	WGR DS1	----	----
				Client sampling date / time	[18-May-2017]	[18-May-2017]	[18-May-2017]	----	----
Compound	CAS Number	LOR	Unit		ES1712209-001	ES1712209-002	ES1712209-003	--------	--------
					Result	Result	Result	----	----
EK026SF: Total CN by Segmented Flow Analyser - Continued									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	<0.004	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	<0.1	<0.1	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.02**	**0.03**	----	----
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		**0.02**	**0.02**	**0.02**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	**0.02**	**0.02**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**2.01**	**1.84**	**2.35**	----	----
Total Cations	----	0.01	meq/L		**2.29**	**2.15**	**2.44**	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		<1	<1	<1	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	----	----
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		<0.05	<0.05	<0.05	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1712002**	Page	: 1 of 4
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: Clarence WOLLANGAMBE SOIL	Date Samples Received	: 18-May-2017 10:15
Order number	: ----	Date Analysis Commenced	: 22-May-2017
C-O-C number	: ----	Issue Date	: 25-May-2017 15:27
Sampler	: ----		
Site	: ACIRL LITHGOW		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 9		
No. of samples analysed	: 9		

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

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

This 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*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WGR US1 #1	WGR US1 #2	WGR US1 #3	WGR US2 #1	WGR US2 #2
				Client sampling date / time	[17-May-2017]	[17-May-2017]	[17-May-2017]	[17-May-2017]	[17-May-2017]
Compound	CAS Number	LOR	Unit		ES1712002-001	ES1712002-002	ES1712002-003	ES1712002-004	ES1712002-005
					Result	Result	Result	Result	Result
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1	%		17.4	17.3	15.7	21.3	6.7
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		310	470	610	540	430
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		1340	1830	3580	1000	780
Sulfur as S	63705-05-5	50	mg/kg		<50	<50	<50	<50	<50
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		0.1	0.2	0.3	0.3	0.2
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg		1.6	2.9	3.4	25.2	18.6
Beryllium	7440-41-7	0.1	mg/kg		<0.1	<0.1	<0.1	0.3	0.2
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg		0.3	0.6	0.9	210	164
Chromium	7440-47-3	0.1	mg/kg		0.4	0.6	0.6	0.4	0.3
Copper	7440-50-8	0.1	mg/kg		0.3	1.0	0.8	1.1	0.8
Manganese	7439-96-5	0.1	mg/kg		27.3	54.5	93.3	2420	1820
Strontium	7440-24-6	0.1	mg/kg		0.3	0.4	0.4	1.0	0.4
Molybdenum	7439-98-7	0.1	mg/kg		<0.1	<0.1	<0.1	1.0	0.8
Nickel	7440-02-0	0.1	mg/kg		0.1	0.2	0.2	188	141
Lead	7439-92-1	0.1	mg/kg		0.5	1.1	0.8	1.2	0.7
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg		0.6	0.8	1.0	261	218
Lithium	7439-93-2	0.1	mg/kg		0.2	0.1	<0.1	4.6	3.9
Rubidium	7440-17-7	0.1	mg/kg		0.2	0.3	0.2	0.4	0.3

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WGR US2 #3	WGR DS4 #1	WGR DS4 #2	WGR DS4 #3	----
			Client sampling date / time	[17-May-2017]	[17-May-2017]	[17-May-2017]	[17-May-2017]	----
Compound	CAS Number	LOR	Unit	ES1712002-006	ES1712002-007	ES1712002-008	ES1712002-009	--------
				Result	Result	Result	Result	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	19.8	25.8	20.9	18.0	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	400	530	180	200	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	----
Iron	7439-89-6	50	mg/kg	1730	880	400	810	----
Sulfur as S	63705-05-5	50	mg/kg	<50	50	<50	<50	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	0.2	0.1	<0.1	<0.1	----
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	----
Barium	7440-39-3	0.1	mg/kg	23.8	6.4	2.2	2.3	----
Beryllium	7440-41-7	0.1	mg/kg	0.2	<0.1	<0.1	<0.1	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Cobalt	7440-48-4	0.1	mg/kg	183	22.5	12.5	4.7	----
Chromium	7440-47-3	0.1	mg/kg	0.7	0.7	0.3	0.4	----
Copper	7440-50-8	0.1	mg/kg	0.9	1.0	0.2	0.4	----
Manganese	7439-96-5	0.1	mg/kg	1890	182	118	28.0	----
Strontium	7440-24-6	0.1	mg/kg	0.6	0.8	0.2	0.8	----
Molybdenum	7439-98-7	0.1	mg/kg	0.8	0.1	<0.1	<0.1	----
Nickel	7440-02-0	0.1	mg/kg	154	21.1	12.0	4.0	----
Lead	7439-92-1	0.1	mg/kg	1.4	1.1	0.4	0.7	----
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Uranium	7440-61-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Zinc	7440-66-6	0.5	mg/kg	211	26.9	13.4	4.1	----
Lithium	7439-93-2	0.1	mg/kg	3.3	1.1	0.6	0.3	----
Rubidium	7440-17-7	0.1	mg/kg	0.4	0.8	0.3	0.3	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1711994**	Page	: 1 of 5
Client	: **ACIRL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: LITHGOW ENVIRO	Contact	: Customer Services ES
Address	: UNIT 3 16 DONALD STREET LITHGOW NSW, AUSTRALIA 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6350 7400	Telephone	: +61-2-8784 8555
Project	: Clarence WOLLANGAMBE WATER	Date Samples Received	: 18-May-2017 10:15
Order number	: ----	Date Analysis Commenced	: 18-May-2017
C-O-C number	: ----	Issue Date	: 25-May-2017 10:24
Sampler	: ----		
Site	: ACIRL LITHGOW		
Quote number	: SY/240/16 CLARENCE PLANNED EVENT		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This 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	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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.

- It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR US1	WGR US2	WGR DS4	----	----
				Client sampling date / time	[17-May-2017]	[17-May-2017]	[17-May-2017]	----	----
Compound	CAS Number	LOR	Unit		ES1711994-001	ES1711994-002	ES1711994-003	--------	--------
					Result	Result	Result	----	----
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		<1	16	12	----	----
Total Alkalinity as CaCO3	----	1	mg/L		<1	16	12	----	----
ED040F: Dissolved Major Anions									
Sulfur as S	63705-05-5	1	mg/L		<1	37	28	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L		4.7	5.3	5.4	----	----
Silicon	7440-21-3	0.05	mg/L		2.19	2.48	2.52	----	----
ED040T: Total Major Anions									
Sulfur as S	63705-05-5	1	mg/L		<1	36	28	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L		5.0	5.5	5.5	----	----
Silicon	7440-21-3	0.05	mg/L		2.33	2.56	2.55	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	122	92	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		6	4	4	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	36	25	----	----
Magnesium	7439-95-4	1	mg/L		<1	8	7	----	----
Sodium	7440-23-5	1	mg/L		3	2	2	----	----
Potassium	7440-09-7	1	mg/L		<1	4	3	----	----
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		<1	123	91	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.03	<0.01	<0.01	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L		0.008	0.019	0.017	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	0.008	0.002	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	0.034	0.018	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR US1	WGR US2	WGR DS4	----	----
				Client sampling date / time	[17-May-2017]	[17-May-2017]	[17-May-2017]	----	----
Compound	CAS Number	LOR	Unit		ES1711994-001	ES1711994-002	ES1711994-003	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.041**	**0.020**	----	----
Lithium	7439-93-2	0.001	mg/L		**0.001**	**0.018**	**0.013**	----	----
Manganese	7439-96-5	0.001	mg/L		**0.076**	**0.086**	**0.036**	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L		<0.001	**0.014**	**0.010**	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Strontium	7440-24-6	0.001	mg/L		**0.004**	**0.056**	**0.042**	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L		**0.53**	**0.05**	<0.05	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.07**	**0.05**	**0.01**	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L		**0.008**	**0.022**	**0.018**	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.008**	**0.002**	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.038**	**0.021**	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.046**	**0.024**	----	----
Lithium	7439-93-2	0.001	mg/L		<0.001	**0.019**	**0.013**	----	----
Manganese	7439-96-5	0.001	mg/L		**0.082**	**0.094**	**0.046**	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L		<0.001	**0.015**	**0.011**	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Strontium	7440-24-6	0.001	mg/L		**0.004**	**0.058**	**0.044**	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L		**0.82**	**0.09**	<0.05	----	----
EK026SF: Total CN by Segmented Flow Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WGR US1	WGR US2	WGR DS4	----	----
				Client sampling date / time	[17-May-2017]	[17-May-2017]	[17-May-2017]	----	----
Compound	CAS Number	LOR	Unit		ES1711994-001	ES1711994-002	ES1711994-003	--------	--------
					Result	Result	Result	----	----
EK026SF: Total CN by Segmented Flow Analyser - Continued									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	<0.004	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	<0.1	<0.1	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	**0.11**	<0.01	----	----
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		<0.01	<0.01	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	<0.1	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	<0.1	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**0.17**	**2.97**	**2.27**	----	----
Total Cations	----	0.01	meq/L		**0.13**	**2.64**	**1.99**	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	**1**	<1	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	----	----
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		<0.05	<0.05	<0.05	----	----

Centennial Coal

Wollangambe Environmental Monitoring Program

ALS Microscopic Analysis Reports
&
Coal Fines Inspections Site Photographs

Appendix C

Microscopic Analysis

WILLIAM CASH/CLARENCE MAY SAMPLES

June 16, 2017

Australian Laboratory Services Pty Ltd
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Contents

1. Introduction

ALS Energy – Coal Technology were contacted to conduct an analysis of some spill samples to determine the amount of coal, char (from recent bushfires), and other material were contained in the samples. 18 samples were received. Microscopic analysis was conducted on the 18 samples at the ALS Coal Petrography and Imaging Centre at Richlands.

The 18 samples were:

1. WGR US1 #1
2. WGR US1 #2
3. WGR US1 #3
4. WGR US2 #1
5. WGR US2 #2
6. WGR US2 #3
7. WGR DS1 #1
8. WGR DS1 #2
9. WGR DS1 #3
10. WGR DS2 #1
11. WGR DS2 #2
12. WGR DS2 #3
13. WGR DS3 #1
14. WGR DS3 #2
15. WGR DS3 #3
16. WGR DS4 #1
17. WGR DS4 #2
18. WGR DS4 #3

2. Procedure

After receipt of sample from ACIRL Lithgow, the sample were prepped by removing excess water by filtration (where required), then air drying the samples before crushing any oversize material down to a 1mm top size.

Samples were then prepared as per normal petrographic samples by mounting the crushed samples in an acrylic resin, which is polished via a multistage polishing procedure on a Struers Tegra polishing system to produce a suitable surface for reflected light microscopy.

A point count of each sample was conducted with the material under the crosshairs of the microscope being classified as coal, char, mineral matter or organic matter. 500 points were counted on each sample at 500x magnification. Some example images of each classified item are included below.

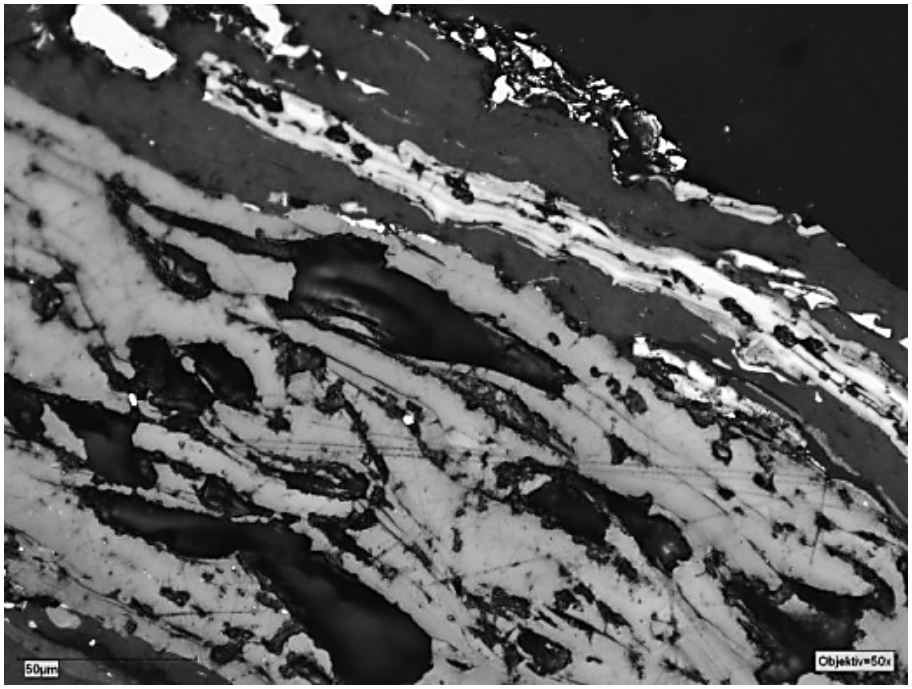

Figure 1: Coal grain; 50x objective, oil immersion, reflected white light.

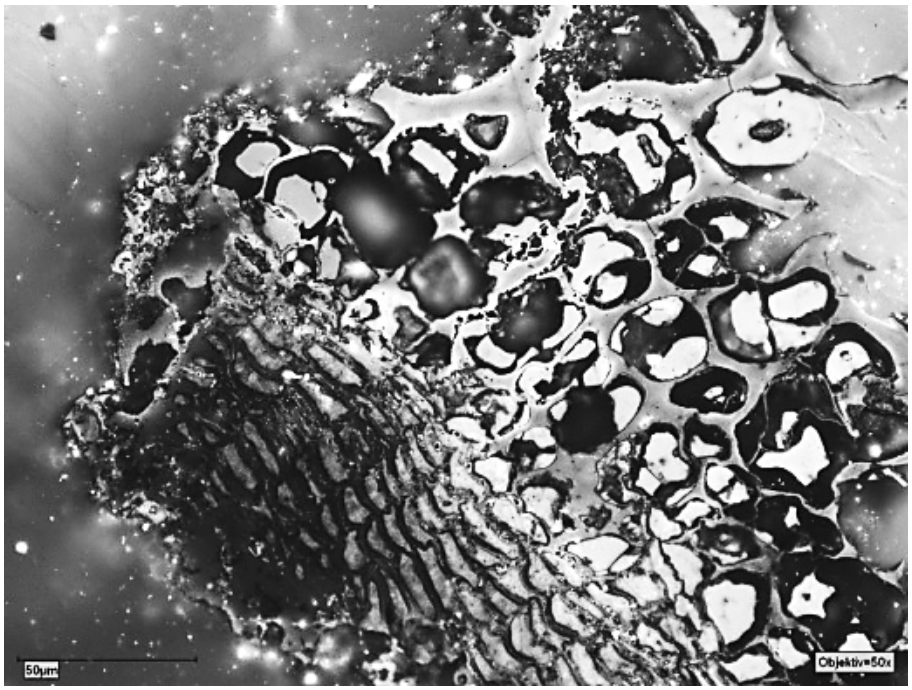

Figure 2: Organic material; 50x objective, oil immersion, reflected white light.

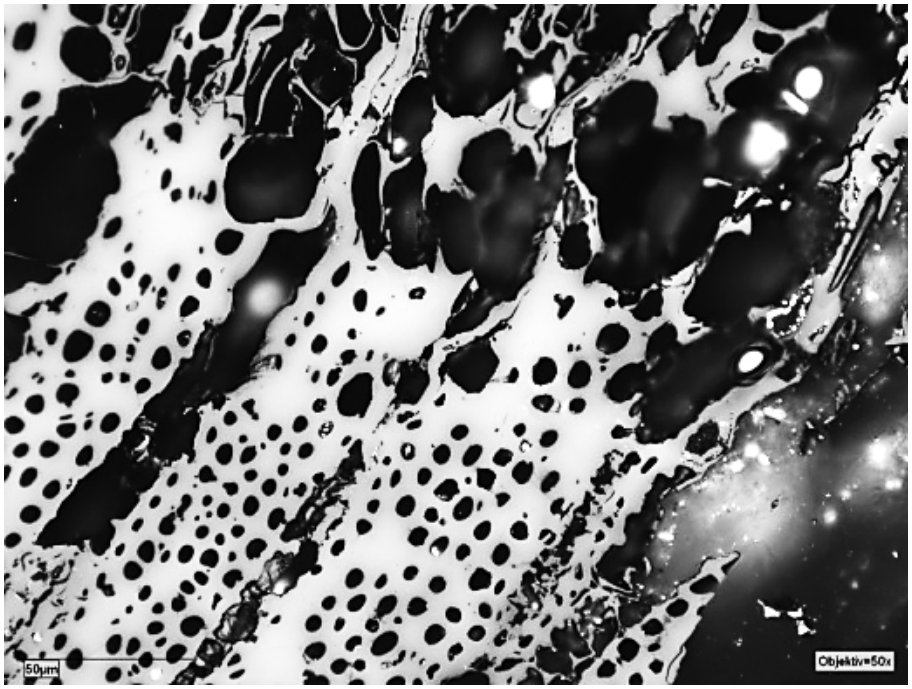

Figure 3: Organic matter; 50x objective, oil immersion, reflected white light

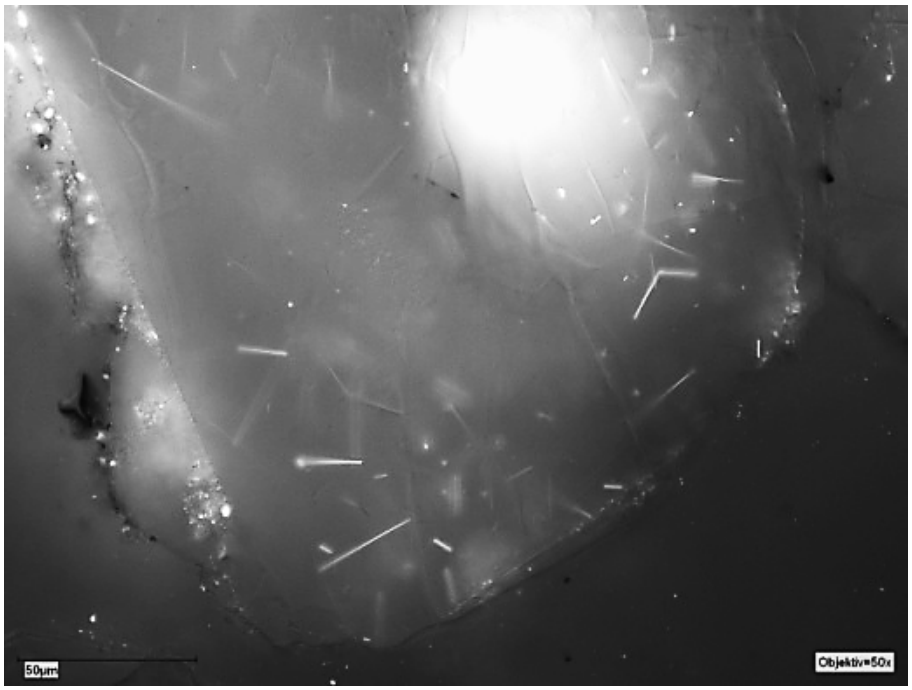

Figure 4: Mineral matter; 50x objective, oil immersion, reflected white light

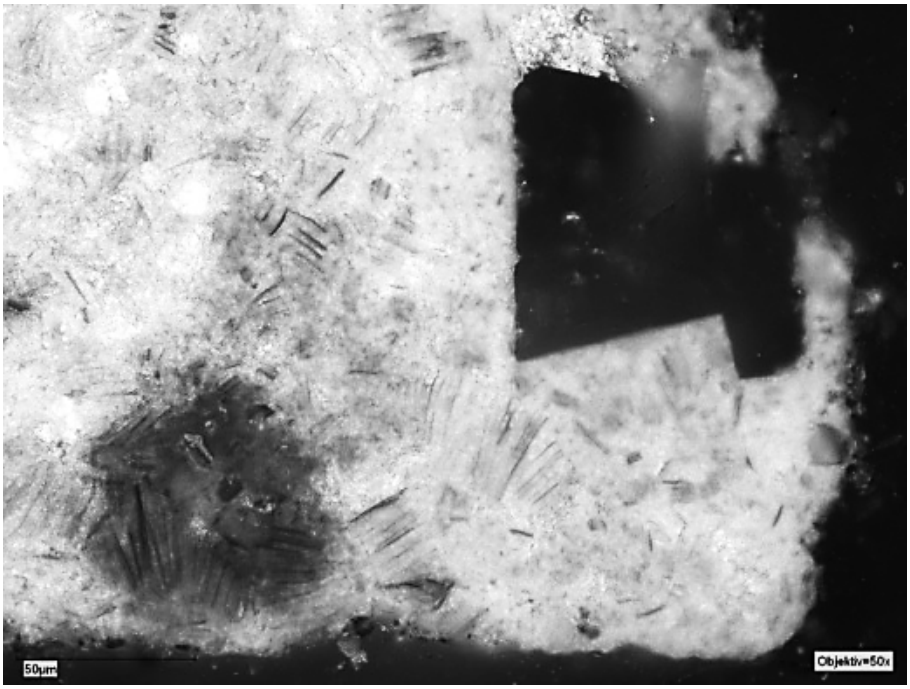

Figure 5: Char material; 50x objective, oil immersion, reflected white light

3. Results

The results of the point count are outlined in the following table:

Sample	Coal (%)	Char (%)	Mineral (%)	Organic (%)
WGR US1 #1	1	0	96	3
WGR US1 #2	1	0	95	4
WGR US1 #3	0	0	92	8
WGR US2 #1	1	0	96	3
WGR US2 #2	0	0	98	2
WGR US2 #3	1	0	97	2
WGR DS1 #1	1	0	97	2
WGR DS1 #2	1	0	97	2
WGR DS1 #3	>1	0	99	1
WGR DS2 #1	1	0	97	2
WGR DS2 #2	2	0	94	4
WGR DS2 #3	0	0	98	2
WGR DS3 #1	>1	0	96	4
WGR DS3 #2	>1	0	98	2
WGR DS3 #3	0	0	90	10
WGR DS4 #1	>1	0	89	11
WGR DS4 #2	0	0	98	2
WGR DS4 #3	0	0	99	1

All samples were made up of predominantly mineral matter (dominated by quartz). Coal was only present in very small quantities in all samples, if at all (2% or less).

Microscopic Analysis

WILLIAM CASH/CLARENCE JULY SAMPLES

September 22, 2017

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Contents

1. Introduction

ALS Energy – Coal Technology were contacted to conduct an analysis of some spill samples to determine the amount of coal, char (from recent bushfires), and other material were contained in the samples. 18 samples were received. Microscopic analysis was conducted on the 18 samples at the ALS Coal Petrography and Imaging Centre at Richlands.

The 18 samples were:

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10. WGR DS2 #1
11. WGR DS2 #2
12. WGR DS2 #3
13. WGR DS3 #1
14. WGR DS3 #2
15. WGR DS3 #3
16. WGR DS4 #1
17. WGR DS4 #2
18. WGR DS4 #3

2. Procedure

After receipt of sample from ACIRL Lithgow, the sample were prepped by removing excess water by filtration (where required), then air drying the samples before crushing any oversize material down to a 1mm top size.

Samples were then prepared as per normal petrographic samples by mounting the crushed samples in an acrylic resin, which is polished via a multistage polishing procedure on a Struers Tegra polishing system to produce a suitable surface for reflected light microscopy.

A point count of each sample was conducted with the material under the crosshairs of the microscope being classified as coal, char, mineral matter or organic matter. 500 points were counted on each sample at 500x magnification. Some example images of each classified item are included below.

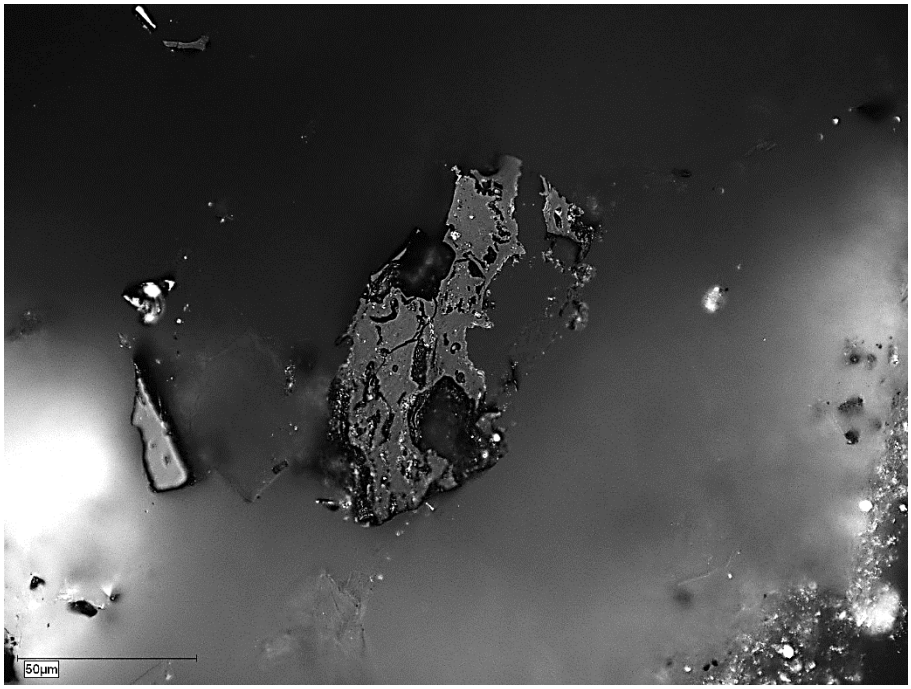

Figure 1: Coal grain; 50x objective, oil immersion, reflected white light.

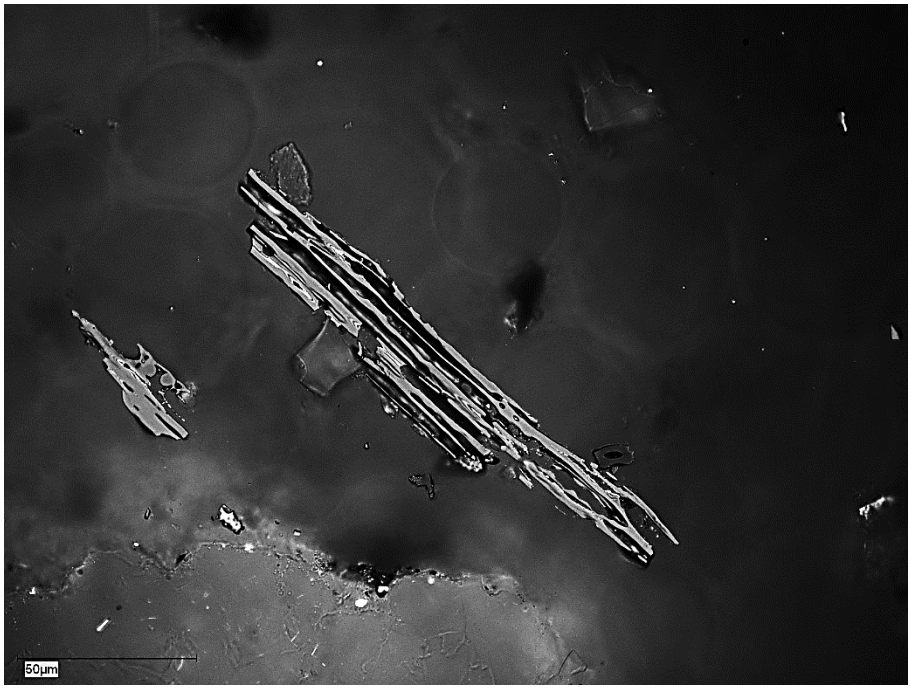

Figure 2: Organic material; 50x objective, oil immersion, reflected white light.

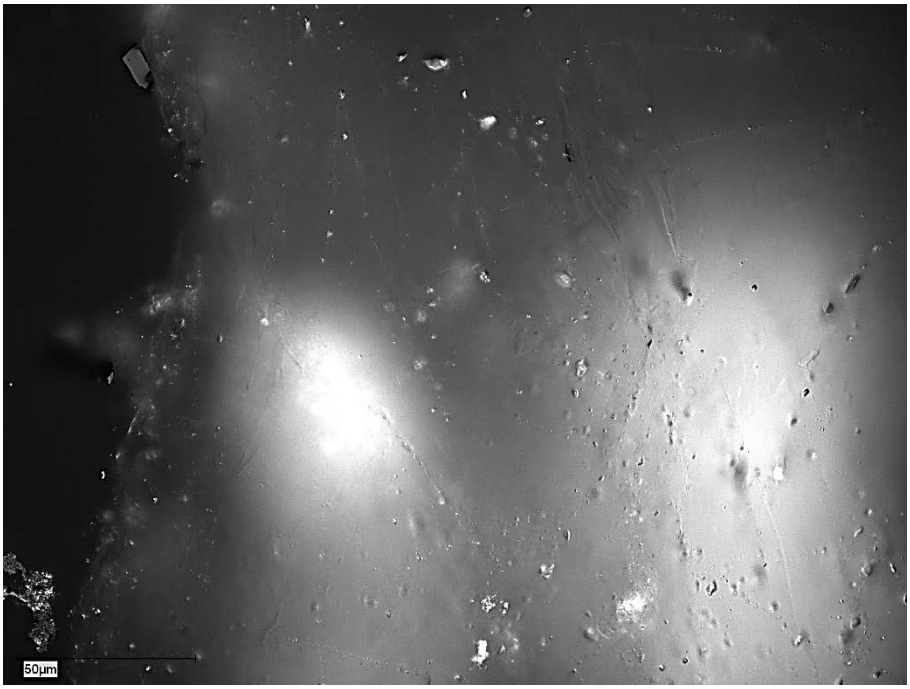

Figure 3: Mineral matter; 50x objective, oil immersion, reflected white light

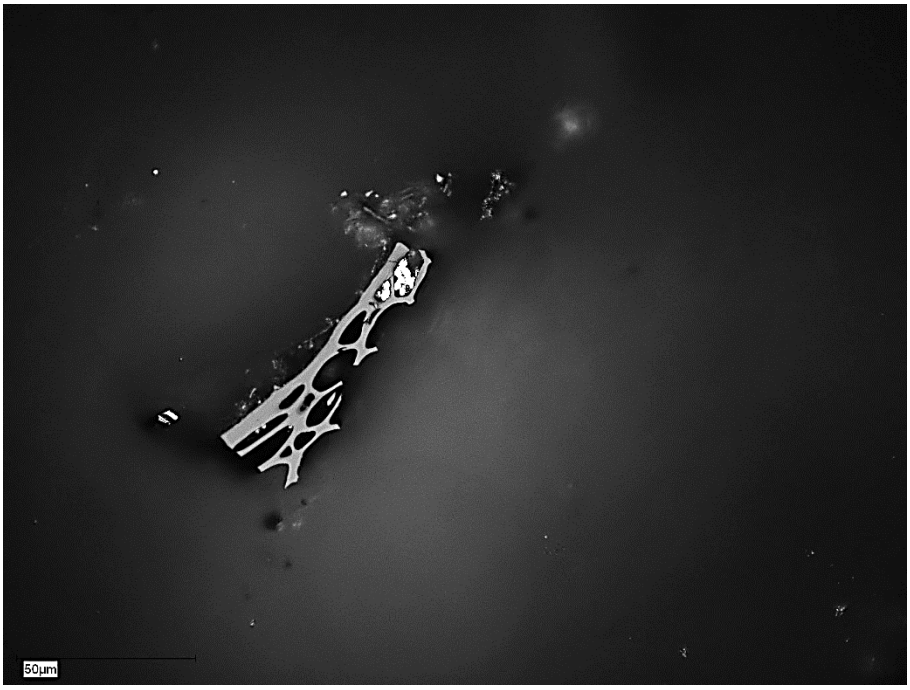

Figure 4: Char material; 50x objective, oil immersion, reflected white light

3. Results

The results of the point count are outlined in the following table:

Sample	Coal (%)	Char (%)	Mineral (%)	Organic (%)
WGR US1 #1	0	0	99.6	0.4
WGR US1 #2	0.2	0	99.6	0.2
WGR US1 #3	1	0.6	97.5	1
WGR US2 #1	0	0	100	0
WGR US2 #2	0.2	0.4	98.8	0.6
WGR US2 #3	0	0	100	0
WGR DS1 #1	0.2	0	99.6	0.2
WGR DS1 #2	0.4	0.4	99	0.2
WGR DS1 #3	0.2	0.4	99.4	0
WGR DS2 #1	0	0	100	0
WGR DS2 #2	1.6	2	95.9	0.6
WGR DS2 #3	0.4	0.4	98.1	1.2
WGR DS3 #1	0.4	0	99.4	0.2
WGR DS3 #2	0	0.4	99.4	0.2
WGR DS3 #3	0.4	0.8	98.6	0.2
WGR DS4 #1	0.2	0	99.6	0.2
WGR DS4 #2	0	0	100	0
WGR DS4 #3	0	0.2	99	0.8

All samples were made up of predominantly mineral matter. Coal was only present in very small quantities in all samples, if at all (2% or less).

Microscopic Analysis

JORDAN CHEAH/CLARENCE AUGUST SAMPLES

October 4, 2017

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Contents

1. Introduction

ALS Energy – Coal Technology were contacted to conduct an analysis of some spill samples to determine the amount of coal, char (from recent bushfires), and other material were contained in the samples. Nine samples were received. Microscopic analysis was conducted on the nine samples at the ALS Coal Petrography and Imaging Centre at Richlands.

The nine samples were:

1. WGR DS1 #1
2. WGR DS1 #2
3. WGR DS1 #3
4. WGR DS2 #1
5. WGR DS2 #2
6. WGR DS2 #3
7. WGR DS3 #1
8. WGR DS3 #2
9. WGR DS3 #3

2. Procedure

After receipt of sample from ACIRL Lithgow, the sample were prepped by removing excess water by filtration (where required), then air drying the samples before crushing any oversize material down to a 1mm top size.

Samples were then prepared as per normal petrographic samples by mounting the crushed samples in an acrylic resin, which is polished via a multistage polishing procedure on a Struers Tegra polishing system to produce a suitable surface for reflected light microscopy.

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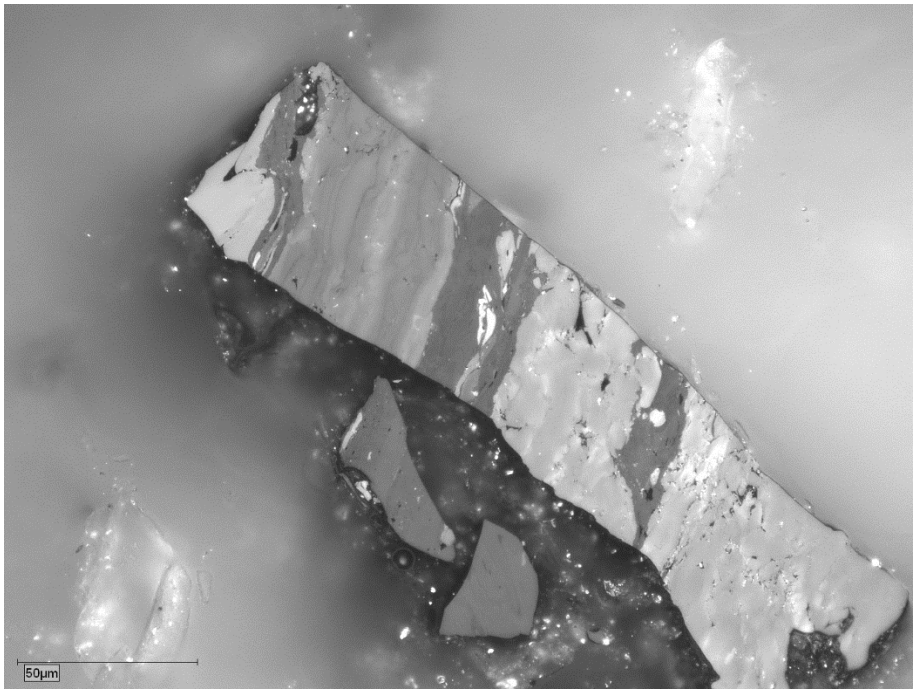


Figure 1: Coal grain; 50x objective, oil immersion, reflected white light.

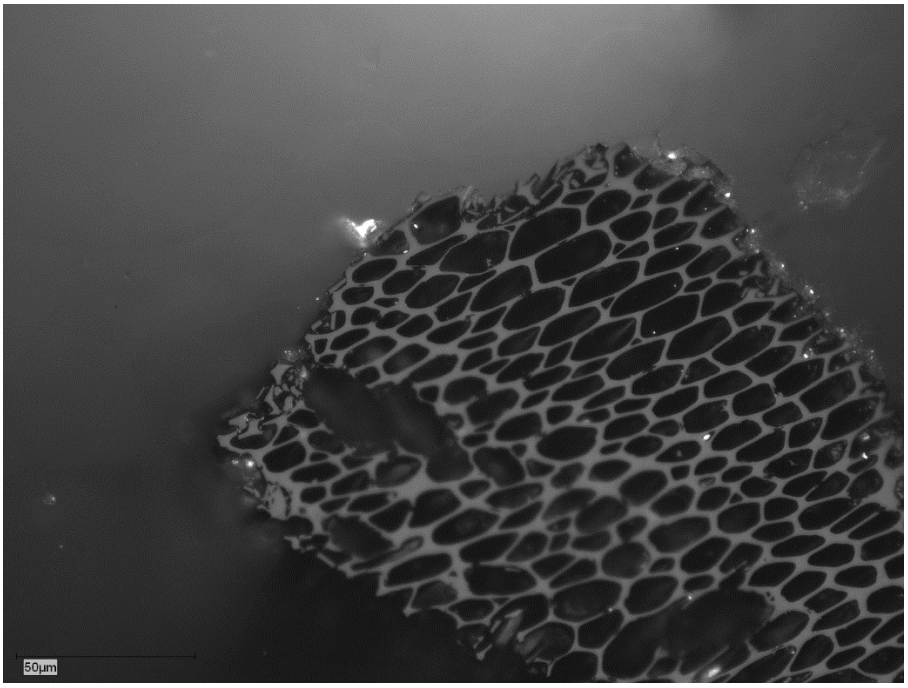


Figure 2: Organic material; 50x objective, oil immersion, reflected white light.

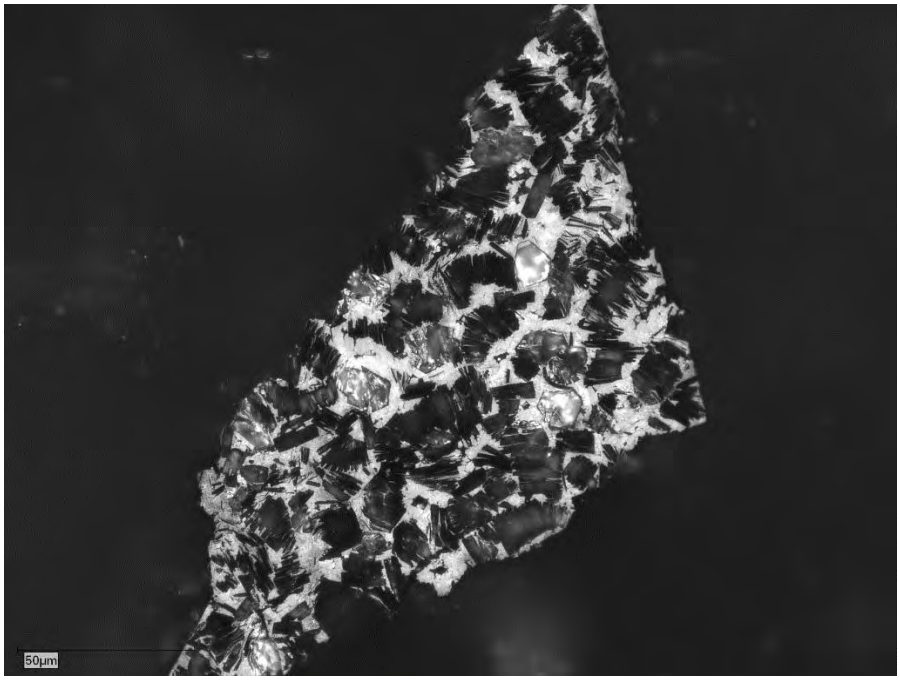


Figure 3: Mineral matter; 50x objective, oil immersion, reflected white light

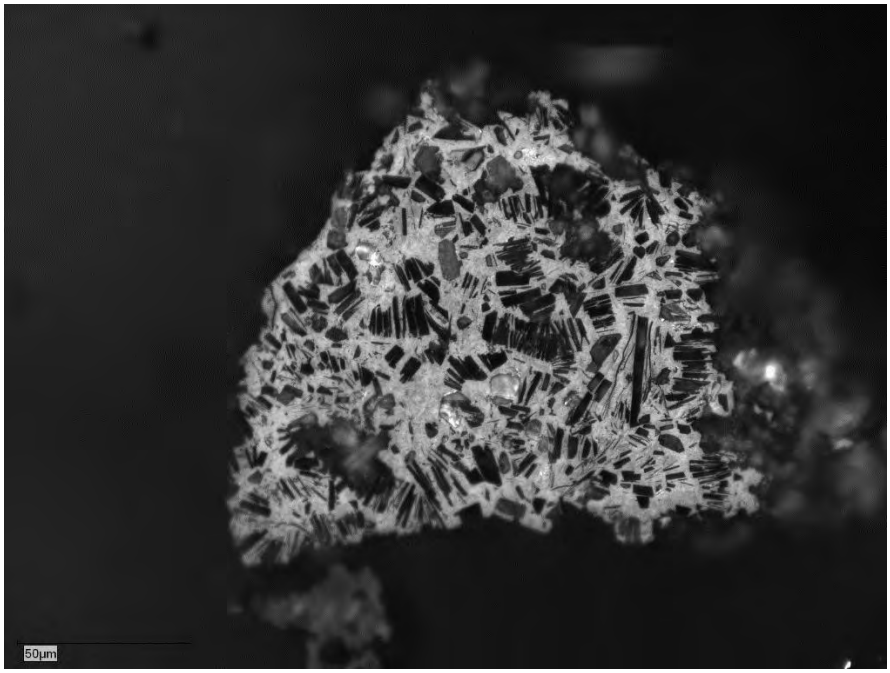


Figure 4: Mineral matter; 50x objective, oil immersion, reflected white light

3. Results

The results of the point count are outlined in the following table:

Sample	Coal (%)	Organic (%)	Mineral (%)	Char (%)
WGR DS1 #1	0	1.6	98	0.4
WGR DS1 #2	0.2	1.4	98.4	0
WGR DS1 #3	0.2	2.2	97.6	0
WGR DS2 #1	0.4	0.4	99.2	0
WGR DS2 #2	0.2	0.2	99.6	0
WGR DS2 #3	0	10.6	89.4	0
WGR DS3 #1	0	12.4	87.6	0
WGR DS3 #2	0	0.8	99.2	0
WGR DS3 #3	0.2	0	99.8	0

All samples were made up of predominantly mineral matter. Coal was only present in very small quantities in all samples, if at all (2% or less). WGR DS2 #3 / WGR DS3 #1 contained a higher quantity of organic matter as compared with the rest of the samples.

APPENDIX C-1 AUTUMN 2017 COAL FINE INSPECTIONS PHOTOGRAHS

Plate 1: Looking downstream at site DS1. The site is generally not amenable to accumulated sand drifts.

Plate 2: Another portion of Site DS1 looking downstream, showing general narrow channel width.

Plate 3: Looking downstream at DS2. There are sand accumulations in pools.

Plate 4: Looking upstream at another section of site DS2.

Plate 5: Sites upstream of site DS3 are generally cobble substratum with little accumulated sand.

Plate 6: Silt algal matrix on rocks in low flow section at Site DS3 (with Mountain Galaxias).

Plate 7: There are large sand drifts at and around site DS4 and substrates in low flow areas are covered in brown silt.

Plate 8: Sites downstream of DS4 have a mixed cobble and sand substratum with no indications of coal fines.

Plate 9: Sites up and downstream of site DS5 have large sand drifts and mixed sand plus cobble areas with no coal fines and organic matter covering substrates in low flow areas.

Plate 10: Organic Matter covering substrate at a site downstream of DS5.

Centennial Coal

Wollangambe Environmental Monitoring Program

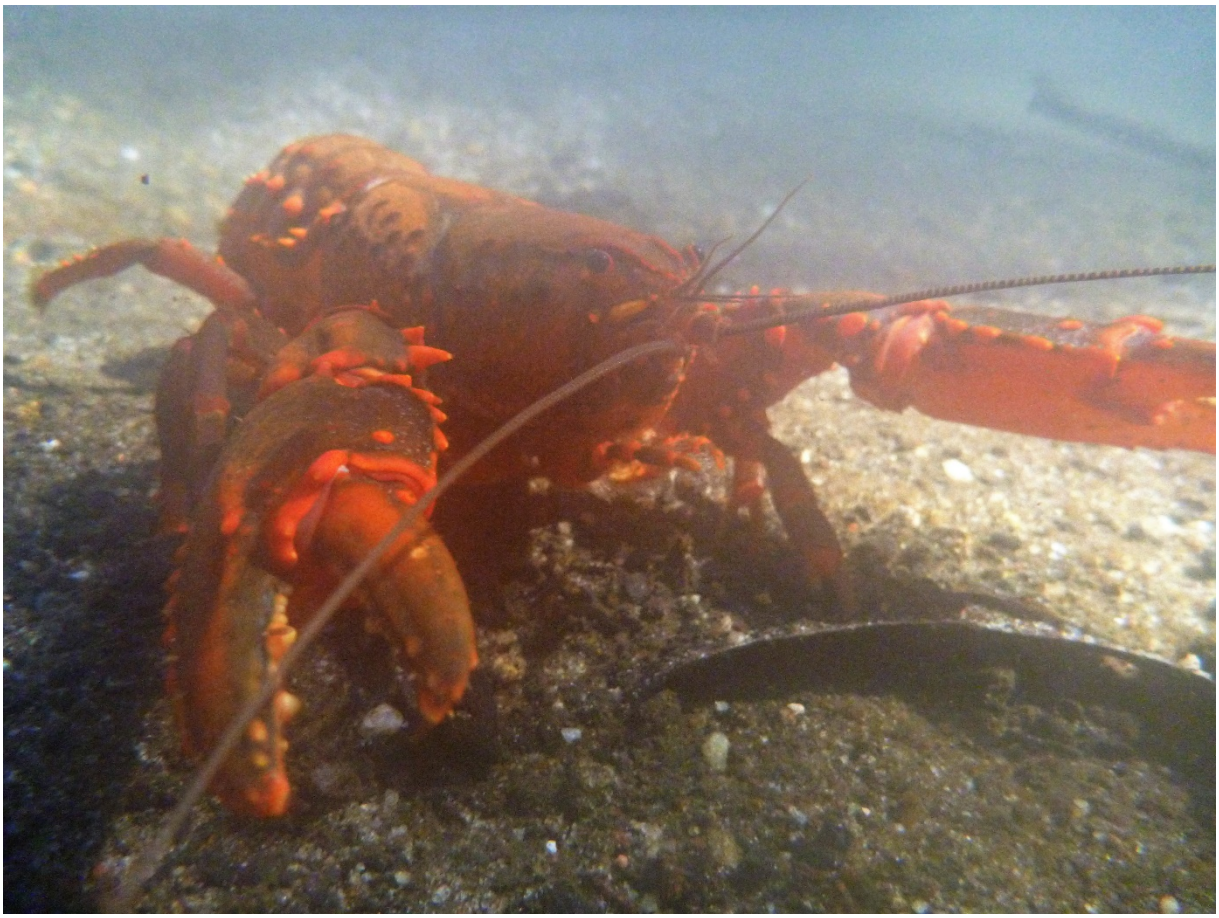
Autumn 2017
Aquatic Ecology Report

Appendix D

CENTENNIAL COAL
CLARENCE COLLIERY

WOLLANGAMBE ENVIRONMENTAL MONITORING PROGRAM REPORT - AQUATIC ECOLOGY

AUTUMN 2016 TO AUTUMN 2017



Spiny Crayfish at Site DS3

SECOND EMP DATA REPORT PREPARED FOR CLARENCE COLLIERY PTY LTD

MARINE POLLUTION RESEARCH PTY LTD
SEPTEMBER 2017

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FIGURES

TABLES

APPENDIX A

FIELD DATA AND SITE PHOTOGRAPHS AUTUMN 2017

1 INTRODUCTION

On 25 September 2015 Clarence Colliery (Clarence), in compliance with Clean Up Action 6 of Clean Up Notice No. 1532719, submitted a Draft Environmental Monitoring Program (EMP). The Environmental Protection Authority (EPA) required this monitoring program to be developed in order to be able to obtain information about the recovery of the Wollangambe River after the spill of coal fines on 2 July 2015 and following the completion of the clean-up activities, for a period of time not less than 18 months, concentrating on sections of the River below where coal fines entered the River and downstream for at least 12 kilometres.

Following its review of the Draft Program and incorporation of the EPA proposed changes, the revised program was including as a Pollution Reduction Program (PRP) within Environment Protection Licence (EPL) 726. The PRP required *inter alia,* that the Revised Wollangambe River EMP of 5 April 2016 be implemented in August 2016 with reporting every seven (7) months from 31 August 2016. On this basis, the first report was due on 31 March 2017.

Marine Pollution Research Pty Ltd (MPR) has been undertaking biannual (autumn and spring) streamhealth monitoring on behalf of Clarence Colliery since Autumn 2012, to assess the possible effects on aquatic ecology of Wollangambe River below the Clarence Colliery Licensed Discharge Point (LDP 002) and was requested by Clarence Colliery to assist in development of the EMP aquatic ecology program. A revised EMP was submitted to EPA in April 2016 and MPR undertook a preliminary EMP aquatic ecology study program at the same time as the normal LDP monitoring program for the Autumn 2016 study period, as a means of refining study logistics (site access and timing), methods and finalising site selections within the actual designated site locations:

- As the Autumn 2016 survey was undertaken prior to receipt of the final EMP program in the PRP, the lower site DS5 was sampled for aquatic ecology attributes in Autumn 2016 and has been retained for subsequent surveys.
- Fish sampling using replicate bait traps was undertaken on each sampling occasion for the LDP and EMP Autumn 16 sampling program and has been continued for subsequent surveys.

The first EMP Aquatic Ecology data report detailing the Autumn and Spring 2016 survey results was included as an appendix to the first EMP six monthly Data report submitted to EPA at the end of March 2017. This report provides the results of the third (Autumn 2017) EMP aquatic ecology survey for attachment to the second six monthly EMP report due in September 2017.

2 AQUATIC ECOLOGY SAMPLING DETAILS

There are seven sites sampled for the Clarence EPL EMP aquatic ecology survey (**Table 1**). **Figure 1** shows the location of the sample sites in relation to Wollangambe River stream order. Note that the narrowness of the river canyons at several of the sites limit access to GPS satellites, and the GPS coordinates derived from a hand-held gps device as shown in Table 1 may not coincide with the Figure 1 locations. The site descriptions in Table 1 also indicate the location of the EMP sites in relation to the Clarence LDP streamhealth sampling program. Note also that two of the sites (US2 and DS1) are common to both sampling programs and the previous LDP streamhealth sampling site WGRup was permanently relocated to the EPA preferred US1 site from Autumn 2017 onwards.

Table 1 Clarence EMP Aquatic Ecology Seasonal Sample Sites

Site	Coordinates		Stream Order	Description
	E	N		
US1 (WGRup)	243889	6295015	Middle of stream order 1 section	Site located approximately 900m up stream of original LDP site WGRup
US2 (WGR down)	245070	6294799	Upper end of stream order 2 section	EMP and LDP monitoring site, just upsteam of impact entry site and around 950m below the Main Dam weir.
DS1 (WGRX down)	245452	6293646	Lower end of stream order 2 section	Downstream EMP and LDP monitoring site around 2.6km downstream from the Main Dam.
DS2	246780	6294000	Upper end of stream order 3 section	Site around 2.6km downstream from DS1
DS3	247840	6293748	Lower end of first quarter segment of Stream Order 4 Section	Site around 2.1km downstream from DS2.
DS4	250705	6293049	Top of last quarter segment of Stream Order 4 Section	Site located around 5.4km downstream from DS3.
DS5	254440	6291750	About 5km into Stream Order 5 Section	Site located in Wollangambe River around 8.65km downstream from DS4 and below Bell Ck confluence.

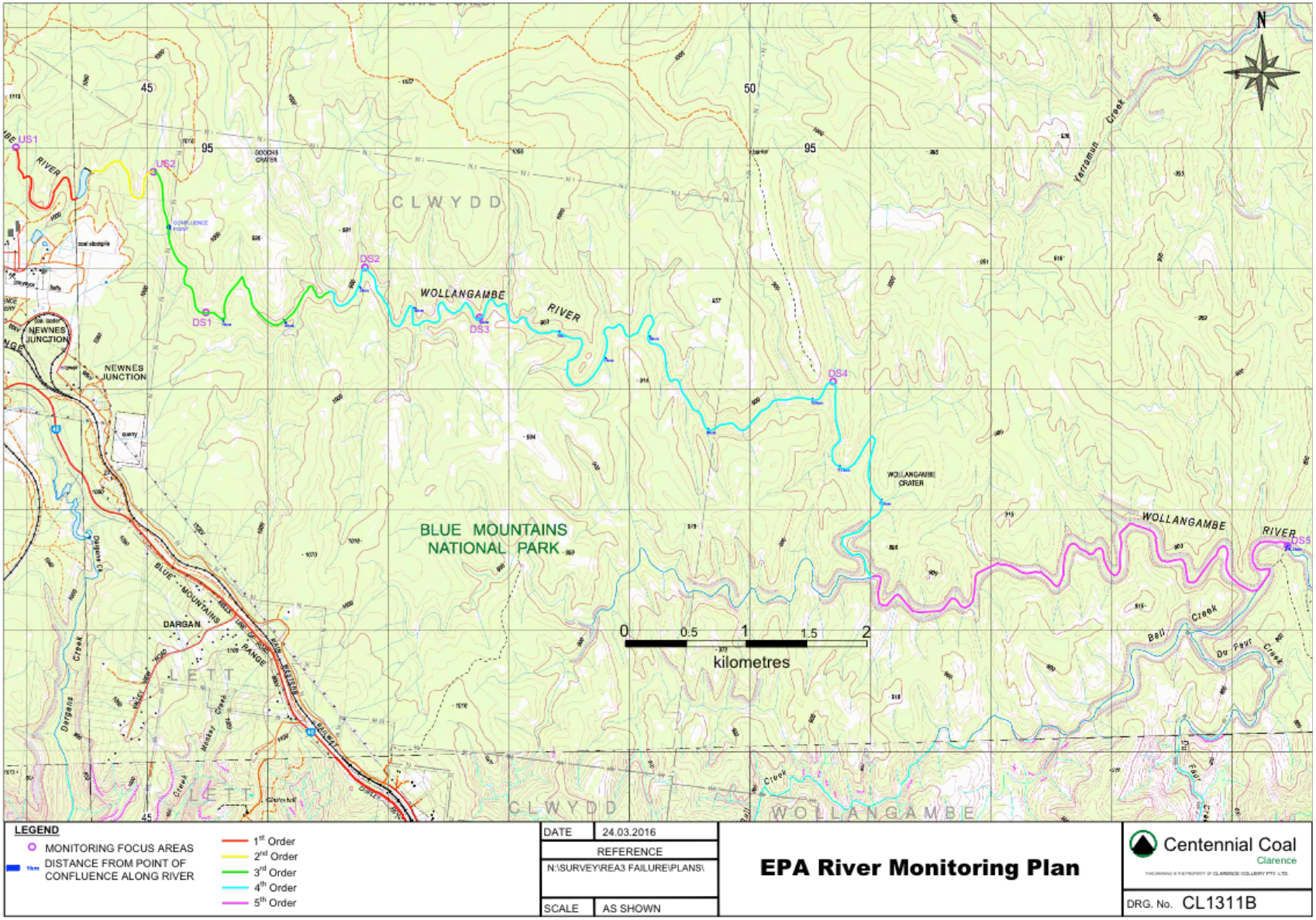

Figure 1 Portion of 1:25000 topographic maps showing Wollangambe River stream order between EMP aquatic ecology sites US1 and DS5.

2.1 Aquatic Ecology Sampling Program

2.1.1 Aquatic Habitat Condition

Site aquatic ecology habitat condition is estimated on each sampling occasion using a modified version of the River-Creek-Environment (RCE) stream site condition index, method developed by Petersen (1992), as reported by Chessman *et al* (1997). The index is compiled by giving each of 13 RCE descriptors a score between 0 and 4. The scores are then summed to reach a maximum possible score of 52 and then expressed as a percentage.

A submersible Yeo-Kal 911 water quality data logger is used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites. At some sites, depth profiles of water quality may also be made to assess layering/mixing. Observations of site condition in terms of aquatic habitat variations (e.g. evidence of recent rain/high flow events, subsequent infilling, detritus in water column or on benthos, scum or flocculates in or on water body etc.) and the presence of fresh yabbie holes are also noted.

2.1.2 Aquatic Macroinvertebrate Surveys

Aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment Manual methods (NRPMP 1994) as adapted for the National River Health Program (the AusRivAS method (Turak et al 2004, Chessman 2003b). The AusRivAS protocol provides a number of definitions of sites and habitats within sites for selection of sampling locations and recommends that, wherever possible, two habitats (riffles and edges) be sampled at each site. Sampling has conformed to the AusRivAS definitions:

- Site length of 100 m.
- Riffle habitats with cobble or boulder substratum.
- Edge habitat sampling where there is little or no current.

Ideally, a particular reach within each of the sample locations is selected on the basis of it being (i) a reach with high drought resistance (generally based on pool size, depth and riparian cover) and (ii) a reach with high aquatic habitat diversity; ideally deep pools connected by gentle riffles, abundance of stream bed litter, presence of snags, presence of aquatic vegetation and good extent of cover of overhanging riparian vegetation.

For the upper Woolangambe River EMP section above the Bell Creek confluence, site selection has been constrained by the generally narrow channel width of the river. Site pools are narrow, with mobile sand beds or rocky substratum joined together by rock boulder cascades. There were few broader pools and very few sand or log bar pool constraints. For the upper river sites US1 and US2 there are no riffle sections as defined, as the river cuts through the sediment banks and is constrained vertically by a bedrock substratum with no or only a thin veneer of sand or rock fragments. Accordingly, only '*edge'* sampling was possible at sites US1 and US2.

Macroinvertebrate assemblages are sampled using a 250 μm mesh dip or kick net over as many aquatic 'edge' and 'riffle' habitat types as could be located within each of the riffle/pool segments along the defined stream reaches. Net samples are live sorted as per AusRivAS protocols and organisms are identified (as a minimum) to the appropriate taxa level as per AusRivAS protocols.

2.1.3 Fish and Frog Surveys

At each macroinvertebrate sampling site, four fish bait traps (dimensions 250 mm by 250 mm by 400 mm, 4 - 5 mm mesh size and 50 mm diameter entrance) are set at suitable locations. These are left in the stream overnight and collected the next day during macroinvertebrate sampling. Captured fish are identified i*n situ* and immediately released. Fish caught or observed as part of the macroinvertebrate dip net sampling are also identified, noted and released.

For each survey, tadpoles (which are not macroinvertebrates but chordates) are noted and immediately released if caught in the dip nets or fish traps. Larger mobile invertebrate species such as crayfish, yabbies, prawns and shrimp are also recorded if caught in the traps or observed during the macroinvertebrate surveys and are included in the fish survey results.

Formal monitoring for frogs (Order Anura) was not included in the Autumn 2016 survey, prior to the release of the revised monitoring program, but was initiated for the Spring 2016 survey.

As most frog species are nocturnal and, under the right conditions become quite active at night, night searches are generally the preferred and most effective methods for conducting frog surveys. Unfortunately, due to the difficulty of access and the remote nature of the Wollangambe EMP sites, frog surveys have to be restricted to daylight hours. However, as active frogs also call at night they can be identified via their unique calls and the night search

restriction can be overcome by the use of dedicated recording equipment (Frog loggers).

Accordingly, frog searches are now undertaken twice at each site visit (i.e., when fish traps are set, and when the site is revisited to collect fish traps and undertake macroinvertebrate sampling):

- At each visit, the presence of frogs is first determined by listening for frog calls. If heard, the calls are recorded and a search made for the calling frog for positive identification. Frogs that are seen are not caught or handled.
- During the site macroinvertebrate sampling and following the *in situ* sorting process, specific edge searches for frogs are made of the 100m defined site stream segment. Frogs that are seen are not caught or handled, but are photographed where possible.
- A dedicated frog call recorder is deployed for overnight recording at selected sites each season. For the selected sites the logger is set to record for 15 minutes every hour between fish trap setting and retrieval (the next day).

3 MONITORING RESULTS AUTUMN 2017

Full field sampling notes for the Autumn 2017 aquatic ecology sampling are provided in **Appendix Table A1**. Sampling was spread over four days (12/5/17, 16/5/17, 18/5/17, 23/5/17).

3.1 Site Rainfall & LDP Discharge

Figure 2 shows the daily rainfall recorded at the Colliery Site and the LDP daily discharge volume since the Spring 2016 survey. Monthly rainfall over the six-month period leading up to Autumn 17 sampling was generally below average and LDP discharge during the sampling period was generally between 15 and 20ML/day:

- Late December 16 through to February 17 was relatively dry with a total of 115.8mm over the three months.
- March 17 was the only month which yielded a total rainfall (129.8mm) above the long-term average.
- Both April and May were also relatively dry months recording less than 45mm combined.
- Sampling was interrupted by rain between 19 – 22 May 17 (19mm over 3 days).

There were surface water flows noted at each of the study sites during the course of the Autumn 2017 survey and water clarity was high at all sites. Water levels were slightly lower than the Spring 16 survey levels.

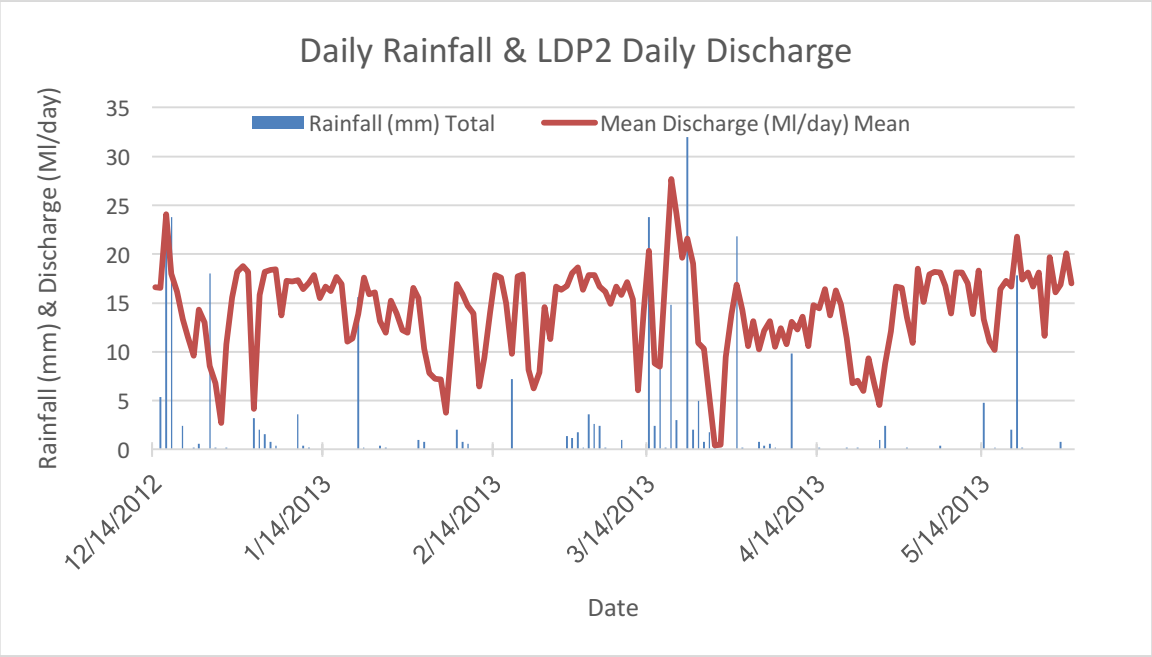

Figure 2 Daily Rainfall & Daily discharge between 15 Dec 16 – 31 May 17.

3.2 Aquatic Habitat Condition

The upper river is notable for the lack of emergent and submerged macrophytes, due primarily to the fact that there are few areas of still water or side channels, given the overall narrow floodplain. As a result, the native emergent rush *Baumea rubiginosa* was the only commonly occurring macrophyte, being recorded from all sites, and broad-leaf rush *Juncus planifolius* was noted in the upper river around site US1. There were no submerged vascular plants observed at any site, only charophytes and some small quantities of filamentous green algae.

The complete Riparian, Channel and Environment (RCE) aquatic habitat condition data are presented in **Appendix Table A-2. Table 3** below provides a summary of RCE results and **Figure 3** shows the summary results graphically.

Table 2 Summary of Site Condition (RCE) Scores

Site	US1	US2	DS1	DS2	DS3	DS4	DS5
Au 16	90.4	87.5	91.3	88.5	90.4	90.4	92.3
Sp 16	89.4	87.5	91.3	87.5	89.4	90.4	92.3
Au 17	90.4	87.5	91.3	88.5	89.4	90.4	92.3

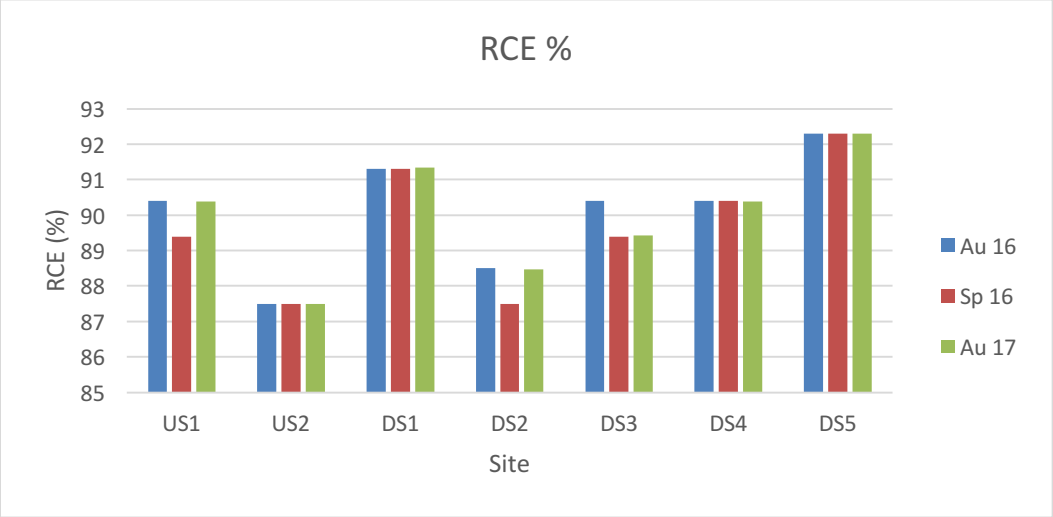

Figure 3 Site Aquatic Habitat Condition (RCE) Results

3.3 Wollangambe River Site Field Water Quality

Appendix Table A-3 provides the full results of the field metered water quality sampling (including depth profile readings) for all locations. **Table 3** provides a summary of the water temperature and conductivity (EC) data, also shown graphically in **Figures 4 and 5** below.

Results summarised below are compared to the default trigger values or ranges for protection of 95% of biota (DTV95) in slightly disturbed upland rivers in south-eastern Australia (ANZECC/ARMCANZ 2000), where applicable:

- Surface waters were well mixed at all sites and as a result there were no major variations in water quality parameters between surface and bottom readings.
- The LDP discharge waters were warmer than the upstream river waters and river temperatures declined back to upstream values by DS5.
- Water conductivity at site US1 (11 μS/cm) was below the DTV95 of 30 μS/cm, with all other site readings within the default range of 30 to 350 μS/cm.
- Water dissolved oxygen concentrations (expressed as % saturation) were all slightly below the 90% lower DTV at sites US1 through to DS4, ranging between 79.7% - 86.8%.
- Site pH was below the lower DTV at site US1 (5.61 pH).
- Turbidity was well within DTV range of 2NTU - 25 NTU for all sites.

Table 3 Metered Water Temperature and Conductivity Au 2017

Season			Temp	Cond
Site	DATE	TIME	°C	µS/cm
Autumn 16				
US1	18/05/2017	17:16	9.46	11
LDP2	12/05/2017	14:22	16.39	308
US2	16/05/2017	9:53	13.62	286
DS1	23/05/2017	13:25	14.89	268
DS2	23/05/2017	10:26	14.01	251
DS3	18/05/2017	14:26	12.96	256
DS4	16/05/2017	15:18	10.79	227
DS5	12/05/2017	10:36	9.65	181

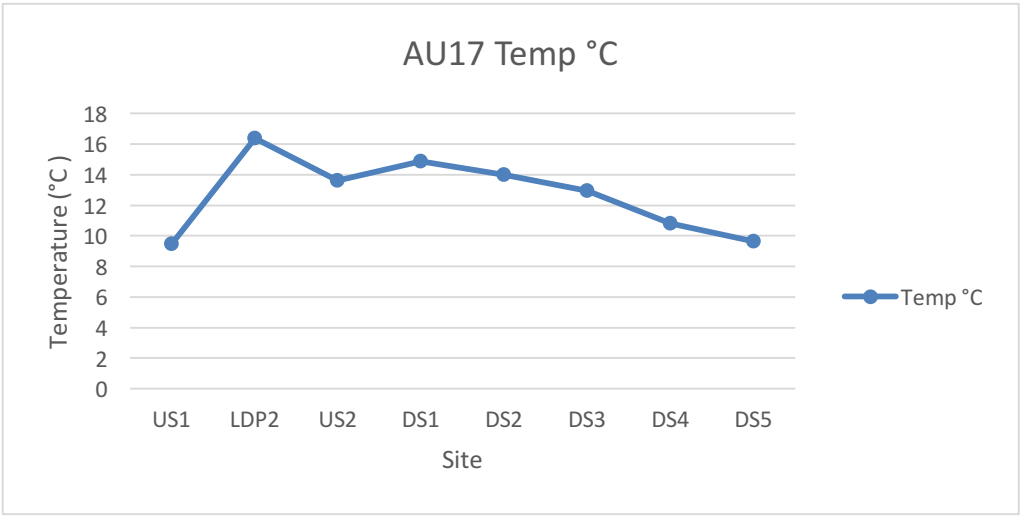

Figure 4 River Water Temperature Variation, Autumn 2017.

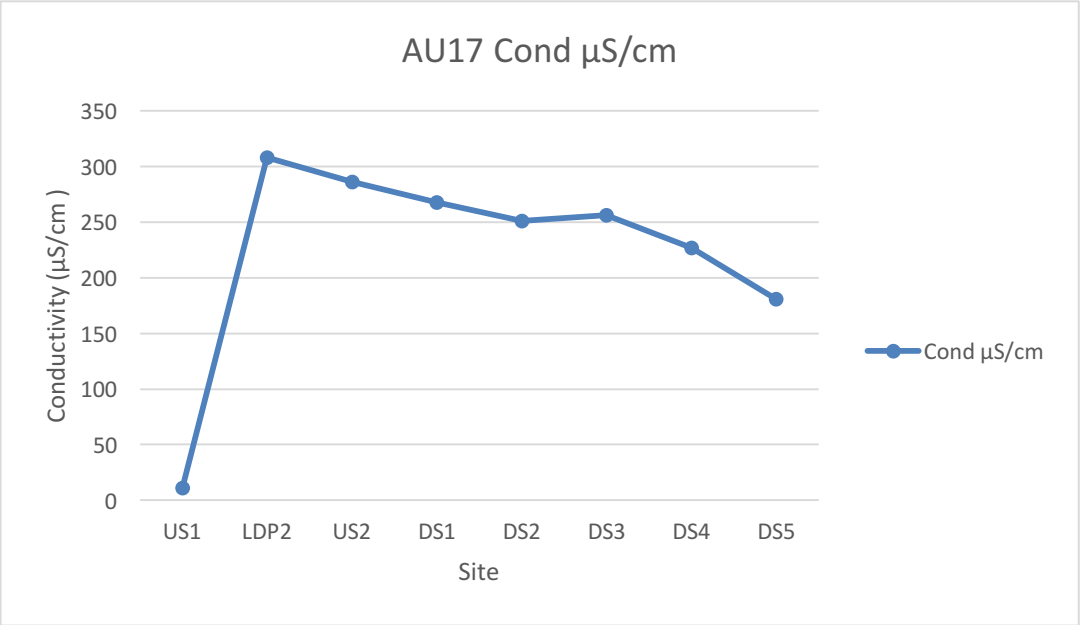

Figure 5 River Conductivity Variation, Autumn 2017

3.4 Wollangambe River Site Macroinvertebrate Survey Results

Appendix Table A-4 shows the results of taxonomic identifications to the levels required by AusRivAS, plus occurrence data for all aquatic macroinvertebrates and fish. The aquatic invertebrate assemblage for each sample site is described in terms of the **site taxa diversity** (number of individual AusRivAS taxa) and in terms of a **site SIGNAL score**. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates. The indices are derived by correlation analysis of macroinvertebrate occurrence against water chemical analysis (Chessman 1995). The water chemistry attributes generally used are temperature, turbidity, conductivity, alkalinity, pH, dissolved oxygen, total nitrogen and total phosphorus (Chessman 2003a). The combined number of Ephemoptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddis-fly) families present per site (the **EPT index**) is used to supplement the taxa richness (diversity) and SIGNAL index as an indicator of stream health.

Tables 4 and 5 provide summaries of the Site Diversity, SIGNAL and EPT Index scores for *Edge* and *Riffle* habitats for Autumn and Spring 2016 and the Site Diversity and SIGNAL scores for *Edge* and *Riffle* habitats are shown graphically in **Figures 7 to 12**.

Table 4 Clarence EPL EMP Aquatic Ecology *Edge* Site Summary Statistics							
Diversity							
Site	US1	US2	DS1	DS2	DS3	DS4	DS5
Au16	16	14	16	23	18	24	21
Sp16	16	10	15	19	19	23	22
Au17	13	11	15	16	16	21	20
SIGNAL							
Site	US1	US2	DS1	DS2	DS3	DS4	DS5
Au16	4.5	4.62	4.81	4.64	5.47	5.04	4.79
Sp16	5.38	4.33	5.47	5.47	5.06	5	5.32
Au17	5.58	4.45	5.27	4.80	4.25	5.48	4.85
EPT							
Site	US1	US2	DS1	DS2	DS3	DS4	DS5
Au16	4	2	6	4	6	7	5
Sp16	5	1	5	5	6	8	7
Au17	4	2	5	4	4	7	5

Table 5 Clarence EPL EMP Aquatic Ecology *Riffle* Site Summary Statistics							
Diversity							
Site	no US1 riffles	no US2 riffles	DS1 Riff	DS2 Riff	DS3 Riff	DS4 Riff	DS5 Riff
Au16			8	11	14	10	14
Sp16			7	12	11	13	14
Au17			7	14	14	16	11
SIGNAL							
Site	no US1 riffles	no US2 riffles	DS1 Riff	DS2 Riff	DS3 Riff	DS4 Riff	DS5 Riff
Au16			6.25	6.82	5.64	6.6	6.07
Sp16			5.57	6.42	6.36	5.54	6.43
Au17			3.86	6.14	6.43	5.94	7.00
EPT							
Site	no US1 riffles	no US2 riffles	DS1 Riff	DS2 Riff	DS3 Riff	DS4 Riff	DS5 Riff
Au16			4	7	4	6	6
Sp16			4	7	6	6	8
Au17			2	5	7	7	7

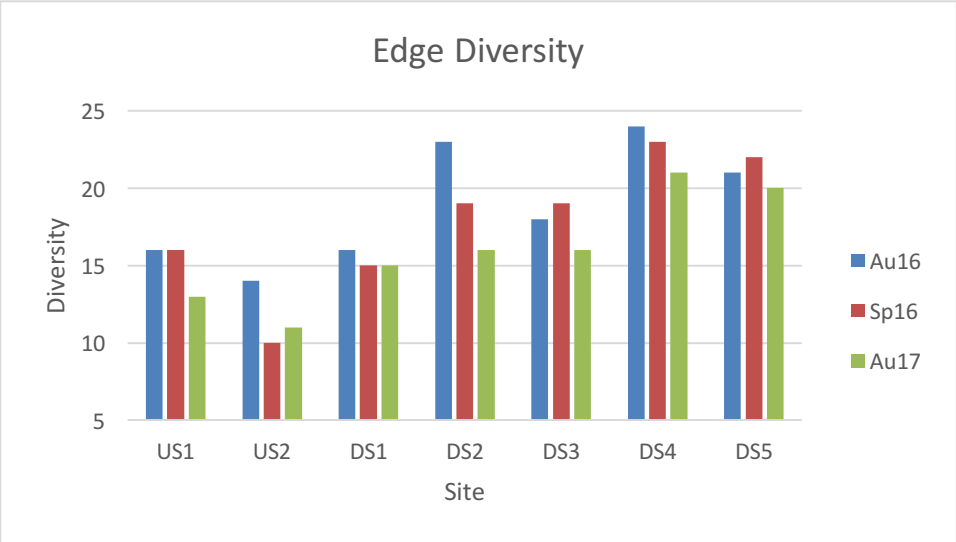

Figure 6 Variation in *Edge* Macroinvertebrate Diversity

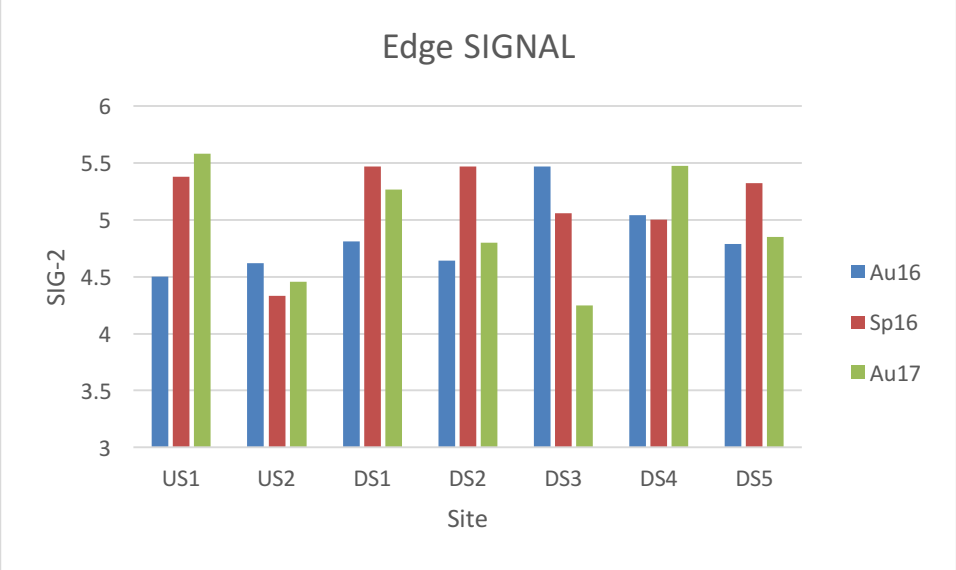

Figure 7 Variation in *Edge* Site SIGNAL Index

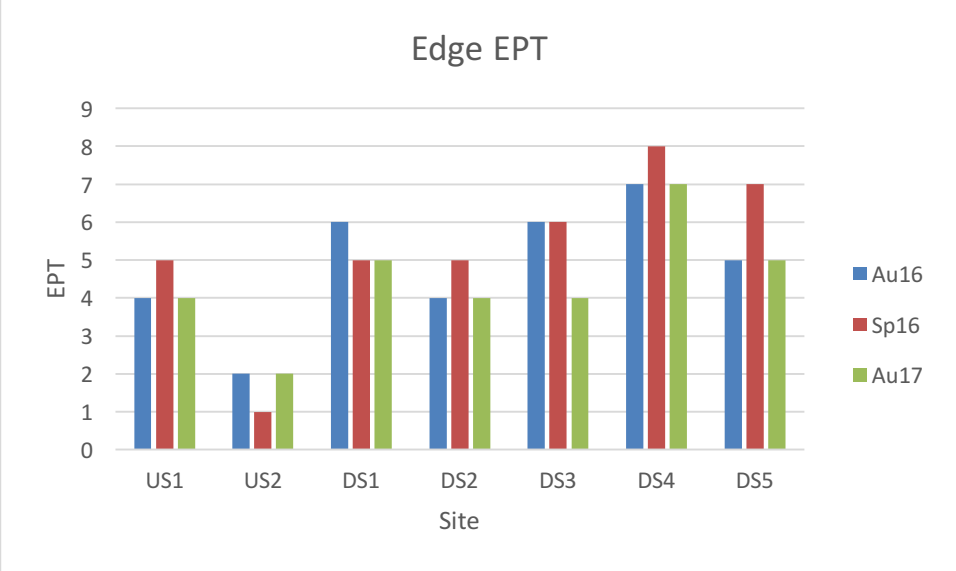

Figure 8 Variation in *Edge* Site EPT Index

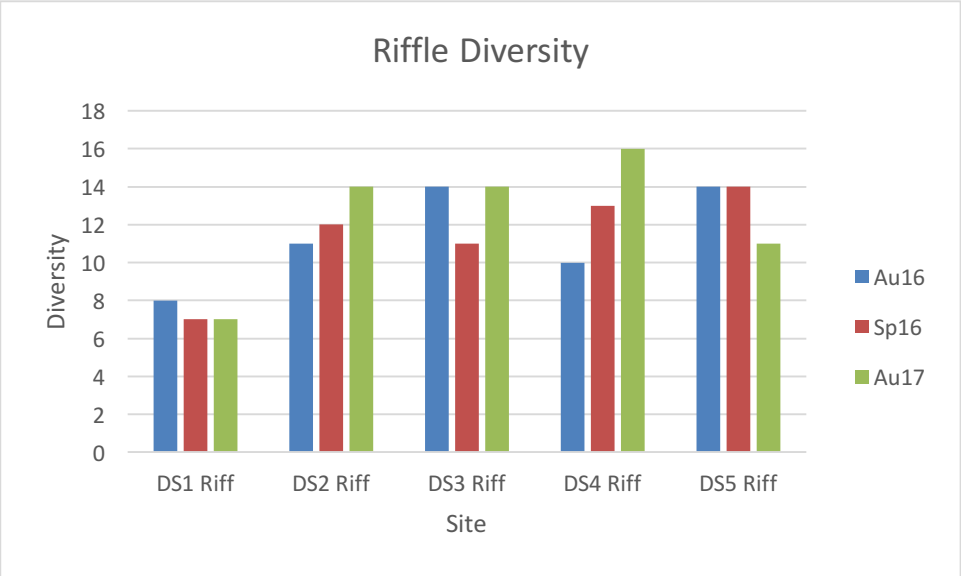

Figure 9 Variation in *Riffle* Site Diversity

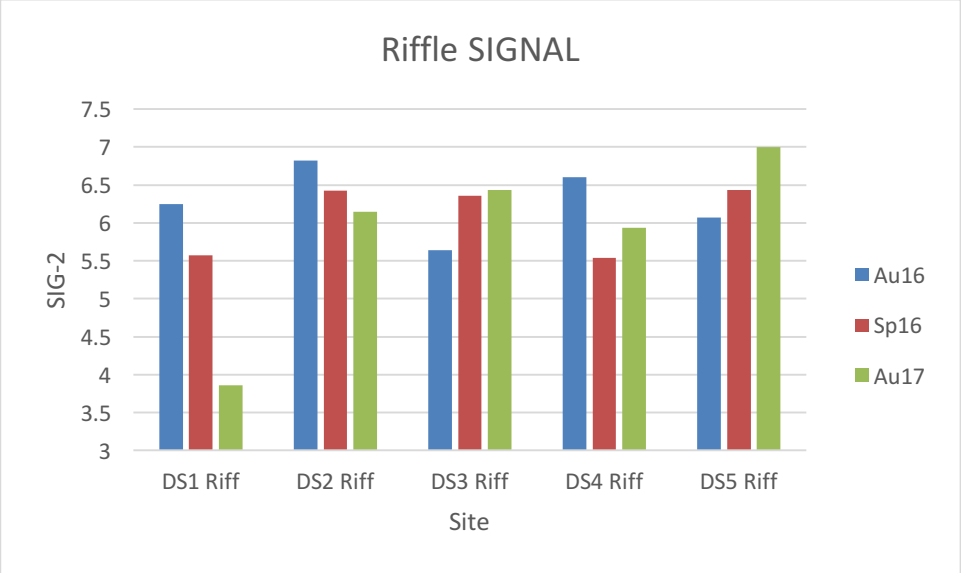

Figure 10 Variation in *Riffle* Site SIGNAL Index

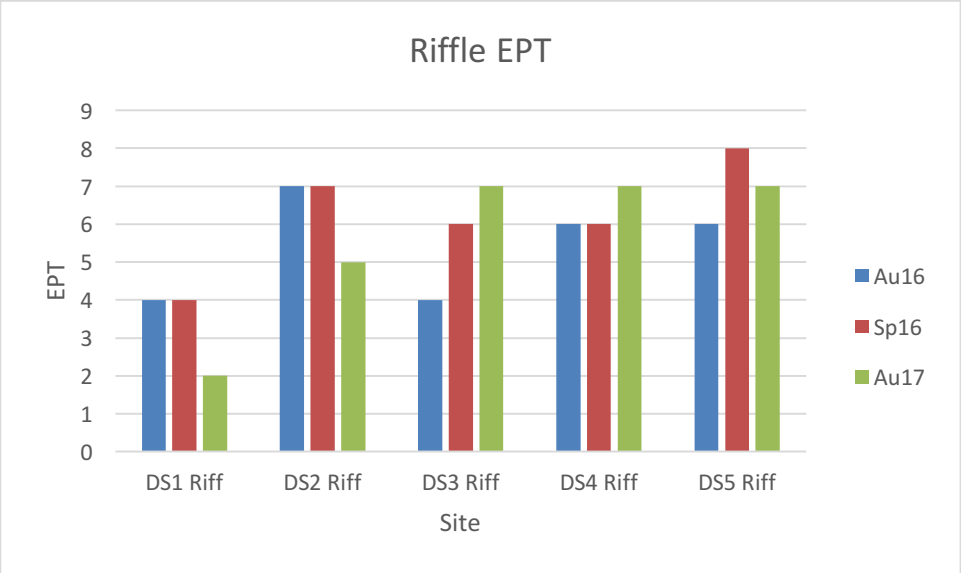

Figure 11 Variation in *Riffle* Site EPT Index

3.5 Wollangambe River Site Fish and Frog Survey Results

3.5.1 Fish Surveys

Table 6 provides results of fish bait trap sampling for Autumn 17, and **Table 7** provides a summary of fish results for the surveys to date. Over all three EMP surveys the only fish observed or caught has been the Mountain galaxias, *Galaxias olidus*.

For the Autumn 2017 survey fish traps were left in-situ for periods ranging from 14 to 20 hours:

- There were no introduced fish caught or noted in Wollangambe River for the Autumn 2017 sampling run.
- One native fish species (mountain galaxias*)* was recorded and observed at five sites, 29 at site US1, eight at DS5, eight at sites DS2 to DS4 and none at sites US2 and DS1. This contrasts with Spring 2016 where 16 specimens were caught from six of the seven sites.
- Mountain galaxias has been caught or observed at all sites except site US2 for this EMP.
- Giant Spiny Crayfish *Euastacus spinifer* is common throughout the upper Wollangambe River and there were 14 trapped or observed from all sites except US2.
- Given that Mountain Galaxias and Crayfish are found both up and downstream of site US2 they must be travelling through the site, and both have been observed for previous LDP sampling at this site.
- Site US2 is a generally narrow and deeply incised channel with fast flows. It is not ideal for setting bait traps and it is also difficult to make direct observations. It is considered that these physical constraints account for the lack of fish bait trap results from this site.

3.5.2 Frog Surveys

Table 8 provides a summary of Frog survey data to date. For the Autumn 2017 survey no tadpoles or frogs were observed during the systematic site searches and no frog calls were recorded overnight for the Autumn 2017 survey sites. However, a Red Crowded Toadlet, *Pseudophryne australis* was recorded at DS4 during the macroinvertebrate sampling, though the specimen could not be found.

Table 6 Wollangambe River Site Fish Survey Results Au 2017			Fish	Crustaceans
Site & replicate Trap	Trap Location & Field Notes	Trapping Time	Mountain galaxid	Giant Crayfish
US1-1	Middle of plunge pool		16	1
US1-2	Middle of plunge pool		2	
US1-3	Small incised channel			1
US1-4	Pool after small cascade		11	
Observed		14Hrs		
US2-1	0.5m deep, Under undercut bank			
US2-2	0.6m deep, in back eddy			
US2-3	0.5m, behind submerged log			
US2-4	0.5m, under trailing bank vegetation			
Observed		15Hrs		
DS1-1	0.5m deep, in back eddy, behind log			1
DS1-2	0.5m deep, in incised channel			
DS1-3	0.6m deep, behind fallen log			
DS1-4	0.4m deep, under undercut bank			
Observed		16Hrs		
DS2-1	50cm deep, beside submerged branch		1	
DS2-2	40cm deep, under overhanging bank vegetation			
DS2-3	60cm deep, under overhanging vegetation			
DS2-4	50cm deep, back eddies behind log			1
Observed		18Hrs		
DS3-1	0.5m overhanging Vegetation		4	
DS3-2	0.5m deep, 1m off bank			
DS3-3	0.6m deep, Boulder back eddy		1	
DS3-4	0.4m deep, Boulder back eddy	15Hrs	1	
Observed				2
DS4-1	Submerged branches, Low flow			1
DS4-2	0.6m deep, trailing bank vegetation			
DS4-3	Behind submerged log			3
DS4-4	Back eddy behind fallen log			3
Observed		20Hrs	1	
DS5-1	80cm deep, back eddy on top of boulders		5	1
DS5-2	under dead submerged branches			
DS5-3	1.2m deep, edge of boulders		1	
DS5-4	2m deep, middle of river next to log		2	
Observed		18Hrs		
Totals	Site Locations			
US1	Upstream of DLP	14	29	2
US2	950m below the Main Dam weir.	15	0	0
DS1	2.6km downstream from the Main Dam	16	0	1
DS2	2.6km downstream from DS1	18	1	1
DS3	2.1km downstream from DS2.	15	6	2
DS4	5.4km downstream from DS3.	20	1	7
DS5	8.65km downstream from DS4	18	8	1

Table 7 Summary of Native Fish Surveys Autumn 16 to Autumn 17

	Number of Mountain Galaxids trapped per season						
Site	US1	US2	DS1	DS2	DS3	DS4	DS5
Au 16*	√	x	x	x	√	√	√
Sp 16	4	0	1	4	3	2	2
Au 17	29	0	0	1	6	1	8

Notes: * Autumn 16 was observations only,

Table 8 Wollangambe River Site Frog Survey Results Sp 16 and Au17

Site	Frog Survey task	Frog Calls				Frog Searches				O/N Recording			
	Aq Ecol Task	Au 16	Sp 16	Au 17	Sp 17	Au 16	Sp 16	Au 17	Sp17	Au 16	Sp 16	Au 17	Sp 17
US1	Fish Traps in	0	0	0			0	0					
US1	Fish out & Macros	0	0	0		0	0	0					
US2	Fish Traps in	0	0	0			0	0			0	0	
US2	Fish out & Macros	0	C.s	0		0	C.s	0			0	0	
DS1	Fish Traps in	0	0	0			0	0			0		
DS1	Fish out & Macros	0	0	0		0	0	0			0		
DS2	Fish Traps in	0	0	0			0	0					
DS2	Fish out & Macros	0	0	0		0	0	0					
DS3	Fish Traps in	0	0	0			0	0				0	
DS3	Fish out & Macros	0	0	0		0	0	0				0	
DS4	Fish Traps in	0	0	0			0	0			0		
DS4	Fish out & Macros	0	0	P.a		0	0	0			?		
DS5	Fish Traps in	0	0	0			0	0				0	
DS5	Fish out & Macros	0	0	0		0	0	0				0	

Notes: ? = Heard but not identified. C.s = *Crinea signifera*, P.a = *Pseudophryne australis*

APPENDIX A

FIELD NOTES,

AND

SAMPLING DATA

AUTUMN 2017

Table A1 Field Comments – Seasonal Aquatic Ecology Monitoring Sites		
Date	Site	Comments
18/5/17	US1	Water was clear and flowing throughout site length. Dimensions similar to previous survey: Maximum width 4.5m with an average width of 1m. Maximum depth was 0.8m with an average depth of 0.3m. Orange staining was present along entire channel sections. Increased bank undercutting, especially on bends. Bank vegetation had grown slightly since previous survey. Areas sampled included: trailing bank vegetation, undercut banks, and detritus. Substrates consisted mainly of bedrock with small amounts of cobbles and pebbles. Sandy deposits were found throughout the site with soft sands and silt in the large plunge pool in the upstream sections of the site. Filamentous green algae were present in small amounts.
16/5/17	US2 (WGRdown)	Water very clear and flowing throughout entire site length. Water levels significantly lower than Spring 16 survey. Maximum depth was 1.1m with an average depth of 0.6m. Maximum width was 4m with an average width of 1.0m. No observable surface flow from WGRref creek. Bank undercutting present. Habitats sampled included: charophytes, trailing bank vegetation, undercut banks and detritus. Substrates consisted of mostly sands with pebbles, cobbles, some boulders and bedrock. Substrates were covered in dark silt. There were no filamentous green algae observed.
23/5/17	DS1 (WGRXdown)	Water was clear and flowing throughout site length. Similar site dimensions as previous survey. Water level lower than Spring 16 survey. Habitats sampled included: undercut banks, some detritus, trailing bank vegetation. Substrates were comprised of equal amounts of sand, pebbles and gravels with slightly lesser amounts of bedrock and cobbles. Greater amounts of soft sands throughout site. Sediments covered in dark silt. Filamentous green algae observed in small amounts.

23/5/17	DS2	Water very clear and flowing through entire site. Slightly lowere water level than Spring 16 survey. Maximum depth 1.3m with an average depth of 0.6m. Increased flow and passage through the inner channel. Large wood debris deposit between the two channels. Soft sands accumulated at the end of the inner channel. Evidence of flows approximately 1m higher than current. Log jams present along channel length. Habitats sampled included: undercut banks, trailing bank vegetation and detritus. Areas of lesser flow covered in dark silt. Substrates comprised mostly of pebbles, cobbles, gravels and sands with some boulders, particularly in the downstream section of the site. Filamentous green algae were present in small amounts.
18/5/17	DS3	Water very clear and flowing throughout site. Channel dimensions similar to former survey. Log jams found through downstream sections of site. Habitats sampled included: some trailing bank vegetation, undercut banks and some detritus. Substrates covered in dark silt. Sediments comprised of mostly sands, pebbles, cobbles, some boulders, and bedrock. Filamentous green algae were observed in moderate amounts.
16/5/17	DS4	Water clear and flowing throughout site. Channel dimensions same as previous survey. Larger sand/gravel bar exposed in the middle of the site. Habitats sampled included: undercut banks, some detritus, trailing bank vegetation. Substrates were the same as former surveys, comprised of mostly sand, with some pebbles, gravels and some boulders. Sediments in the upstream section of site consisted of soft deposited sands. Sediments in areas of lesser flow covered in dark silt. There were no filamentous green algae observed.
12/5/17	DS5	Water very clear and flowing throughout site. Channel dimensions similar to previous survey, maximum width 10m with an average width of 4m, maximum depth was to 1.5m with an average depth of 0.7m. Habitats sampled included: trailing bank vegetation, undercut banks, and detritus. Log jams present in the downstream sections of the site. Areas of lesser flow covered in dark silt. Filamentous green algae were absent.

Appendix Table A-2									
Modified Riparian, Channel and Environment (RCE) Inventory (after Chessman et al 1997).									
Descriptor									
	Category		AU17	AU17	AU17	AU17	AU17	AU17	AU17
	Value		US1	US2	DS1	DS2	DS3	DS4	DS5
1	Land-use pattern beyond immediate riparian zone								
	Undisturbed native vegetation	4	4	4	4	4	4	4	4
	Mixed native vegetation and pasture/exotics	3							
	Mainly pasture, crops or pine plantation	2							
	Urban, some vegetation	1							
	Industrial, little vegetation	0							
2	Width of riparian strip-of woody vegetation								
	More than 30 m	4	4	4	4	4	4	4	4
	Between 5 and 30 m	3							
	Less than 5 m	2							
	No woody vegetation	1							
	No Vegetation	0							
3	Completeness of riparian strip of woody vegetation								
	Riparian strip without breaks in vegetation	4	4	4	4	4	4	4	4
	Breaks at intervals of more than 50 m	3							
	Breaks at intervals of 10-50 m	2							
	Breaks at intervals of less than 10 m	1							
	No riparian strip at all	0							
4	Vegetation of riparian zone within 10 m of channel								
	Native tree and shrub species	4	4	4	4	4	4	4	4
	Mixed native and exotic trees and shrubs	3							
	Exotic trees and shrubs	2							
	Exotic grasses/weeds	1							
	No vegetation at all	0							
5	Stream bank structure								
	Banks fully stabilized by trees, shrubs, concrete	4	4	4	4	4	4	4	4
	Banks firm but held mainly by grass and herbs	3							
	Banks loose, partly held by sparse grass, rubble	2							
	Banks unstable, mainly loose sand or soil	1							
	Banks actively eroding	0							
6	Bank undercutting								
	None, or restricted by tree roots or man-made	4							
	Only on curves and at constrictions	3					3	3	3
	Frequent along all parts of stream	2	2	2	2.5	2.5			
	Severe; bank collapses common	1							
	Total bank collapse	0							
7	Channel form								
	Deep; width:depth ratio less than 8:1	4	4	4	4	4	4	4	4
	Medium; width:depth ratio 8:1 to 15:1	3							
	Shallow; width:depth ratio greater than 15:1	2							
	Artificial; concrete or excavated channel< 8:1	1							
	Artificial; concrete or excavated channel > 8:1	0							
8	Riffle/pool sequence								
	Frequent alternation of riffles and pools	4	4	4	4	4	4	4	4
	Long pools with infrequent short riffles	3							
	Natural channel without riffle/pool sequence	2							
	Artificial channel; some riffle/pool sequence	1							
	Artificial channel; no riffle/pool sequence	0							
9	Retention devices in stream								
	Many large boulders and/or debris dams	4							
	Rocks/logs present; limited damming effect	3	3	3	3.5	3	3.5	3.5	3.5
	Rocks/logs present but unstable; no damming	2							
	Stream or channel with few or no rocks/logs	1							
	Artificial channel; no retention devices	0							
10	Channel sediment accumulations								
	Little or no accumulation of loose sediments	4							
	Some gravel bars but little sand or silt	3							
	Bars of sand and silt common	2	2.5	2.5	2.5	2.5	2.5	2	2
	Braiding by loose sediment	1							
	Complete in-filled muddy channel	0							
11	Stream bottom								
	Mainly clean stones with obvious interstices	4	4		4				4
	Mainly stones with some cover of algae/silt	3		3		3	3	3.5	
	Bottom heavily silted but stable	2							
	Bottom mainly loose and mobile sandy sediment	1							
	Bottom mainly loose and mobile muddy sedimer	0							
12	Stream detritus								
	Mainly unsilted wood, bark, leaves	4							
	Some wood, leaves, etc. with much fine detritus	3	3.5	3	3	3	3	3	3.5
	Mainly fine detritus mixed with sediment	2							
	Little or no organic detritus, mainly sandy	1							
	No organic detritus, mainly mud	0							
13	Aquatic vegetation								
	Little or no macrophyte or algal growth	4	4	4	4	4		4	4
	Substantial algal growth; few macrophytes	3					3.5		
	Substantial macrophyte growth; little algal grow	2							
	Substantial macrophyte and algal growth	1							
	Total cover of macrophytes plus algae	0							
	RCE Score		47.0	45.5	47.5	46.0	46.5	47.0	48.0
	RCE %age		90.4	87.5	91.3	88.5	89.4	90.4	92.3

Table A3 Clarence Autumn 2017 SDL data

Site	Date	Time	Depth (M)	Temp (degC)	EC (us/cm)	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)
US1	18/05/2017	17:16	0.1	9.46	11	0	5.61	400	8.5	79.8	8.16
LDP2	12/05/2017	14:22	0.1	16.39	308	0.14	7.22	459	6.5	79.7	6.97
US2	16/05/2017	9:53	0.1	13.62	286	0.13	7.2	453	9	84.5	7.84
DS1	23/05/2017	13:25	0.1	14.89	268	0.12	7.13	477	4.8	82.5	7.45
DS2	23/05/2017	10:26	0.1	14.01	251	0.11	7.06	465	3.9	79.8	7.35
DS3	18/05/2017	14:26	0.1	12.96	256	0.11	7.37	461	2.9	84.3	7.94
DS4	16/05/2017	15:18	0.1	10.79	227	0.1	7.08	459	2.5	86.8	8.59
DS5	12/05/2017	10:36	0.1	9.65	181	0.08	7.42	463	2.1	93	9.46

Appendix Table A-4													Sample Site and Sample Date												Occurrence	SIG-2
Wollangambe River Aquatic Ecology Survey Macroinvertebrate & Fish Results - Autumn 2017									Life Stage			5/10/16	29/09/16	28/09/16	28/09/16	28/09/16	28/09/16	4/10/16	4/10/16	26/09/16	26/09/16	4/10/16	4/10/16		
Phylum	Class	Sub-class	Order	Sub-Order	Family	Sub-Family	Genus/spp	Common Name	L	N	A	US1	US2	DS1	DS1 Riff	DS2	DS2 Riff	DS3	DS3 Riff	DS4	DS4 Riff	DS5	DS5 Riff		
Arthropoda	Insecta		Coleoptera		Dytiscidae			Diving Beetles	x		x		1					1		1		1		4	2
Arthropoda	Insecta		Coleoptera		Elmidae			Riffle Bettles	x		x						1			1				2	7
Arthropoda	Insecta		Coleoptera		Gyrinidae			Whirligig Beetles	x		x	1	1	1		1						1		5	4
Arthropoda	Insecta		Coleoptera		Hydrophilidae			Scavanger Water Beetles	x		x							1			1			2	2
Arthropoda	Insecta		Coleoptera		Scirtidae			Marsh Beetles	x										1	1		1		3	6
Arthropoda	Insecta		Diptera		Ceratopogonidae			Biting Midges	x					1				1		1		1		4	4
Arthropoda	Insecta		Diptera		Chironomidae	Chironominae		Bloodworms	x							1	1	1	1		1	1	1	7	3
Arthropoda	Insecta		Diptera		Chironomidae	Orthocladiinae		Bloodworms	x				1		1	1		1						4	4
Arthropoda	Insecta		Diptera		Chironomidae	Tanypodinae		Bloodworms	x			1		1	1	1	1	1		1		1		8	4
Arthropoda	Insecta		Diptera		Simuliidae			Black flies	x				1	1	1	1	1	1	1		1			8	5
Arthropoda	Insecta		Diptera		Tipulidae			Crane Flies	x								1			1	1		1	4	5
Arthropoda	Insecta		Ephemoptera		Baetidae			Mayflies		x							1	1	1	1	1		1	6	5
Arthropoda	Insecta		Ephemoptera		Leptophlebiidae			Mayflies		x		1				1	1	1	1	1	1	1	1	9	8
Arthropoda	Insecta		Ephemoptera		Oniscigastridae			Mayflies		x													1	1	8
Arthropoda	Insecta		Hemiptera		Gerridae			Water striders												1		1		2	4
Arthropoda	Insecta		Hemiptera		Pleidae			Pygmy Back Swimmers							1							1		2	2
Arthropoda	Insecta		Hemiptera		Veliidae			Small Water Striders				1	1	1		1						1		5	3
Arthropoda	Insecta		Megaloptera		Corydalidae			Dobsonflies	x										1		1			2	7
Arthropoda	Insecta		Neuroptera		Neurorthidae			Lacewings	x					1			1		1		1		1	5	9
Arthropoda	Insecta		Odonata	Epiproctophora	Aeshnidae			Dragonflies	x					1										1	4
Arthropoda	Insecta		Odonata	Epiproctophora	Gomphidae			Dragonflies	x							1		1		1		1		4	5
Arthropoda	Insecta		Odonata	Epiproctophora	Synthemistidae			Dragonflies	x			1	1				1	1		1	1	1		7	5
Arthropoda	Insecta		Odonata	Epiproctophora	Telephlebiidae			Dragonflies	x			1	1				1		1	1	1	1	1	8	9
Arthropoda	Insecta		Odonata	Zygoptera	Lestidae			Damselflies	x				1											1	1
Arthropoda	Insecta		Odonata	Zygoptera	Megapodagrionidae			Damselflies	x							1		1						2	5
Arthropoda	Insecta		Odonata	Zygoptera	Synlestidae			Damselflies	x							1				1		1		3	7
Arthropoda	Insecta		Plecoptera		Gripopterygidae			Stoneflies		x		1	1	1		1	1		1	1	1	1	1	10	8
Arthropoda	Insecta		Plecoptera		Eustheniidae			Stoneflies		x							1		1		1		1	4	10
Arthropoda	Insecta		Trichoptera		Conoesucidae			Caddis Flies	x											1	1	1		3	7
Arthropoda	Insecta		Trichoptera		Ecnomidae			Caddis Flies	x										1	1				2	4
Arthropoda	Insecta		Trichoptera		Hydrobiosidae			Caddis Flies	x					1					1					2	8
Arthropoda	Insecta		Trichoptera		Hydropsychidae			Caddis Flies	x						1		1		1		1		1	5	6
Arthropoda	Insecta		Trichoptera		Hydroptilidae			Caddis Flies	x					1	1	1		1		1	1	1		7	4
Arthropoda	Insecta		Trichoptera		Leptoceridae			Caddis Flies	x			1	1	1		1		1		1		1	1	8	6
Arthropoda	Insecta		Trichoptera		Philopotamidae			Caddis Flies	x			1												1	8
Arthropoda	Insecta		Trichoptera		Philorheithridae			Caddis Flies	x					1										1	8
Arthropoda	Crustacea	Copepoda						Copepods				1				1								2	*
Arthropoda	Crustacea		Decapoda		Parastacidae			Freshwater crayfish				1		1		1		1		1		1		6	4
Arthropoda	Arachnida		Acarina	Hydracarina				Freshwater Mites				1		1						1				3	6
Annelida	Oligochaeta							Freshwater Worms				1	1	1	1	1	1	1	1		1	1		10	2
Nematomotpha			Gordioidea		Gordiidae			Horsehair Worms												1				1	5
Chordata	Osteichthyes				Galaxiidae		*Galaxias olidus*	Mountain Galaxias								1				1		1		3	*
							Total number of invertebrate taxa per site:					13	11	15	7	16	14	16	14	21	16	20	11	40	
Notes:	*Represents taxa for which SIGNAL grades do not apply.						Site SIGNAL2 scores:					5.58	4.45	5.27	3.86	4.80	6.14	4.25	6.43	5.48	5.94	4.85	7.00		
							Number of EPT taxa:					4	2	5	2	4	5	4	7	7	7	5	7		

AUTUMN 2017 SAMPLING SITE PHOTOGRAPHS (PLATES 1 TO 22)

Plate 1: Looking downstream at site US1 plunge pool.

Plate 2: Portion of Site US1 looking upstream.

Plate 3: Portion of Site US1 looking down-stream.

Plate 4: Portion of Site US2 looking downstream.

Plate 5: Portion of Site US2 looking upstream.

Plate 6: Another view looking upstream at site US2.

Plate 7: Looking upstream at DS1.

Plate 8: Another portion of Site DS1 looking upstream.

Plate 9: Portion of Site DS1 looking downstream.

Plate 10: Portion of Site DS1 looking downstream.

Plate 11: Looking Upstream at DS2.

Plate 12: Looking upstream at another section of site DS2.

Plate 13: Looking downstream at another section of DS2.

Plate 14: Looking downstream at site DS3.

Plate 15: Looking upstream at DS3 showing a riffle section.

Plate 16: Looking upstream at site DS3 showing a pool section.

Plate 17: Looking upstream at site DS4.

Plate 18: Another view of site DS4 showing shallow sand and rock pool section.

Plate 19: Looking downstream at DS4.

Plate 20: Looking upstream at site DS5.

Plate 21: Looking downstream at DS5.

Plate 22: Another view upstream at site DS5.

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