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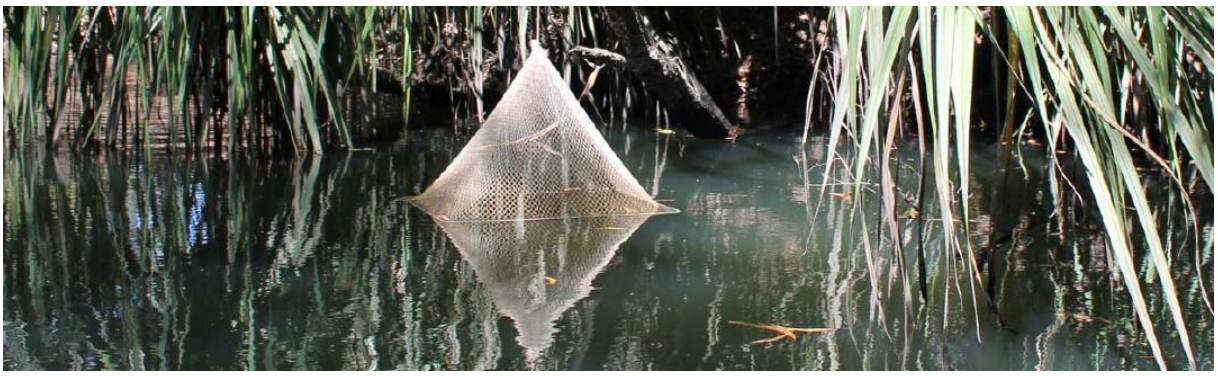

Rum Jungle Impact Assessment

Final Report

June 2016

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EXECUTIVE SUMMARY

The former Rum Jungle Mine site was mined in the 1950s-1970s then rehabilitated during the 1980s. Monitoring of landform stability and water quality has continued since that time.

A Conceptual Rehabilitation Plan was completed in May 2013. As part of this process, studies were commissioned with the objective of applying the ANZECC/ARMCANZ (2000a) water quality guidelines to:

- obtain a clear definition of environmental values, or uses;
- obtain a good understanding of links between human activity (including Indigenous uses) and environmental quality;
- set unambiguous management goals;
- identify appropriate water quality objectives (WQOs), or targets; and
- develop an effective management framework, including cooperative, regulatory, feedback and auditing mechanisms.

In 2012, Hydrobiology completed a study that described the receiving environment in terms of its key ecological and geomorphological attributes, identified environmental values (EVs) and set appropriate water quality objectives (WQOs) in accordance with the ANZECC/ARMCANZ methodology. However, in order to refine these default WQOs to locally-derived water quality objectives (LDWQOs) it was necessary to conduct an impact assessment by river zone that included wet season sampling for:

- terrestrial vertebrates surveys targeting bats, birds, reptiles and frogs (wet and dry);
- riparian vegetation (including 'bush tucker) and macrophyte surveys (wet and dry);
- aquatic Tetrapods including goannas, crocodiles and turtles (dry);
- aquatic biota including macroinvertebrates, diatoms, mussels and fishes with sample analyses that included fish, mussel and crustacean tissue analysis for metals and radionuclides (dry); and
- channel morphology (dry).

Review of DME water and sediment quality field program results were also undertaken.

Water quality data showed a clear indication of increased metal concentrations in the isolated pools in the East Branch reaches of the mine site during the dry season, which were then flushed down the system after the first flows of the season. Generally, each river zone was found to have individual exceedances of the WQOs for a number of parameters including some tributaries outside the mine. Sediment quality data also showed some exceedances of ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines (ISQG) for certain parameters (notably Cu, Ni, Pb, As, Cd and Zn) for certain river zones. Overall, there was a trend of elevated metal concentrations in Zone 2 (mine area) that declined downstream.

There were generally consistent findings for the four groups of aquatic organisms targeted which showed that there were no indications of impact in the Finniss River downstream of the East Branch. This was consistent with the findings of surveys conducted in the 1990s, except indicating further recovery of mussel populations, and general recovery of the main Finniss River after remediation of the mine site in the mid-1980s. There were also relatively consistent patterns of reductions in diversity and abundance of all four groups in the mine area and gradual improvement in diversity and abundance downstream of the mine to the Finniss River junction. Tissue metal concentrations in a number of species also indicated increased bioavailability of copper and zinc in the mine area, and cobalt and nickel either in the mine area or shortly downstream of it, with gradual reduction of bioaccumulation of those metals downstream through the East Branch, but no evidence for increased bioaccumulation of them at any of the Finniss River sites. A number of exceptions to this general pattern were noted.

Seventy-four aquatic reptiles were recorded during the aquatic reptile survey. Of particular interest, Merten's Water Monitors were found to be abundant along the Finniss River, but not present within the lower East Branch in the dry season. However, it was present in the wet season riparian fauna sampling. Mitchell's Water Monitor was also present in the lower Finniss River. Both of these species are listed as Vulnerable in the Northern Territory due to population declines associated with the introduced Cane Toad. Two species of freshwater turtles were recorded, and both Saltwater and Freshwater Crocodiles were noted particularly in the Finniss River, with freshwater crocodiles only present in the lower East Branch. The field surveys recorded a total of 123 native terrestrial vertebrate species. One species listed as Critically Endangered under the *EPBC Act* (Bare-rumped Sheath-tailed Bat) was considered likely to be present during the dry season at FR@G204, based on a partial call recording, as well as three bird species listed as Migratory under the *EPBC Act.* Overall there does not appear to have been any relationship between possible mine site drainage and the distribution of terrestrial vertebrates downstream of the mine.

The riparian fauna and bush tucker survey showed a significant difference in Riparian Condition Index between the Finniss River and the East Branch, for both wet and dry season data, but there was no difference in species richness. The ephemeral nature of the East Branch compared with the perennial main Finniss River was likely the main contributing factor and essentially prevented further assessment of the impact, if any, of the legacy mine on riparian condition and species richness. Aquatic macrophytes were generally scarce throughout the Finniss River system and meaningful analysis of distribution and abundance over time was not possible.

Analysis of radionuclides in fish, mussel and plant tissues showed that none of the patterns of radionuclide activity concentrations in fish and mussel tissues were consistent with a substantial source from the Rum Jungle mine area. There was no indication of elevated bioaccumulation in specimens in the Finniss River downstream of the East Branch, and also no indication of increased bioaccumulation downstream of the abandoned Mount Burton

mine. There was an indication of naturally higher bioavailability of ^{210}Po and ^{228}Ra in the East Branch catchment upstream of the mine.

For development of draft LDWQOs, an approach was developed that could make use of the monitoring data to develop such WQOs based on observed biodiversity, and it was trialled with the datasets compiled to date for the risk assessment. Draft LDWQOs were developed but were not regarded as being reliable as they were based on a single round of biological sampling. A second round of biological sampling has facilitated the development of more defensible LDWQOs.

Rum Jungle Impact Assessment

Final Report

June 2016

TABLE OF CONTENTS

Appendix 2 Water Quality Data 2012-2014

TABLES

FIGURES

1 INTRODUCTION

1.1 Background to Studies

The former Rum Jungle Mine site was mined in the 1950s-1970s then rehabilitated during the 1980s. Monitoring of landform stability and water quality has continued since that time. The current project (under a Partnership Agreement between the Northern Territory and Commonwealth Governments) aims to provide a more permanent reduction in environmental impacts from the site due to acid and metalliferous drainage (AMD) by adopting leading practice rehabilitation methods. A Conceptual Rehabilitation Plan was completed in May 2013 as the final output of Stage 1. As part of this process, studies were commissioned with the objective of applying the ANZECC/ARMCANZ (2000) water quality guidelines to:

- obtain a clear definition of environmental values, or uses;
- obtain a good understanding of links between human activity (including Indigenous uses) and environmental quality;
- set unambiguous management goals;
- identify appropriate water quality objectives (WQOs), or targets; and
- develop an effective management framework, including cooperative, regulatory, feedback and auditing mechanisms.

In 2012, Hydrobiology completed a study that described the receiving environment in terms of its key ecological and geomorphological attributes, identified environmental values (EVs) and set appropriate water quality objectives (WQOs) in accordance with the ANZECC/ARMCANZ (2000) methodology (Hydrobiology 2013a, 2013b). This was undertaken as a two-stage process which involved the setting of EVs and WQOs (by river zone) in Stage 1, with Stage 2 defining a monitoring plan and impact assessment that would provide support for the proposed EVs and WQOs, and inform the development of locally-derived water quality objectives (LDWQOs) in accordance with relevant frameworks and guidelines. The monitoring program (incorporating both DME routine monitoring data and special studies) would focus on water quality, aquatic biota, aquatic and riparian Tetrapoda (vertebrates other than fishes), channel processes, and riparian vegetation and aquatic macrophytes with bush food monitoring components across the biological subprograms.

For the purposes of assigning EVs and WQOs, the downstream riverine receiving environment was divided into nine zones including four in the East Branch (between upstream of the mine and the Finniss River confluence), and five in the Finniss River (from upstream of the East Branch confluence to the estuary, including the site of conservation significance). See Figure 1-1. This was undertaken because the condition, environmental values, recovery potential and therefore targets were variable along the river system. The values assigned were:

- Aquatic Ecosystems;

- Wildlife Habitats;
- Primary Recreation;
- Secondary Recreation;
- Visual Recreation;
- Cultural/Spiritual;
- Industrial Usage;
- Aquaculture;
- Drinking Water;
- Irrigation;
- Stock Water; and
- Farm Supply.

Not all values were relevant to each zone with the exception of Aquatic Ecosystems and Cultural/Spiritual, which were significant for every zone. Water quality objectives were developed for each zone for each water quality parameter by selecting the lowest trigger value identified for any environmental value for that zone. A summary of Environmental Values by zone is presented in Appendix 1.

This report describes the results of the impact assessment and the recommended LDWQOs.

1.2 Impact Assessment Components

Components of the impact assessment included analysis of routine (DME) data, and wet and dry-season field programs.

The desktop data analysis analysed and evaluated the routine surface water monitoring data for the Mine Area, East Branch and Finniss River (near the confluence), and appropriate reference locations, to assess data quality, patterns, trends and critical deficiencies. Data were analysed for the 2012-2013 year in order to identify data gaps and inform the design of the field programs, and the analysis was updated in early 2015 to include data collected during 2014. In addition to routine water quality data, sediment data collected during the dry season survey were included.

Following the initial review of 2012-2013 data, the following field programs were undertaken.

<u>2014 Wet Season Sampling (10 to 20 March 2014)</u>

- Terrestrial vertebrates surveys targeting bats, birds, reptiles and frogs. Data were collected by spotting and trapping. Field surveys were led by Mr Dane Trembath of EcOz environmental consultants with assistance from field workers from DME.
- Riparian vegetation and macrophyte surveys. Monitoring sites were visited twice during 2014, firstly at the end of the wet season (March) when vegetation growth was

at a maximum and, secondly, in the mid dry season (September) when riparian vegetation was expected to be subject to maximum stress. A number of vegetation characterisation plots were located in the riparian zone with special attention paid to 'bush-tucker'. A number of samples were analysed for metals and radionuclides. Fieldwork was led by Mr Tony Orr of Tropintel Environmental Consultancy with assistance from DME personnel.

2014 Dry Season Sampling (18th May to 6th June 2014)

- Aquatic tetrapods, including monitoring for goannas, crocodiles and turtles (led by Mr Dane Trembath).
- Aquatic biota. Field surveys were led by Drs. Ross Smith and Ross Jeffree (Hydrobiology) with assistance from multiple field workers from DME. Sampling of macroinvertebrates, diatoms, mussels and fishes was conducted. Sample analyses included fish and crustacean tissue analysis for metals and radionuclides.

2014 Late Dry Season (1st to 18th September 2014)

- Terrestrial vertebrates (as above).
- Riparian vegetation and macrophytes (as above).
- Channel processes by visual assessment. The field survey was conducted by Dr Andy Markham (Hydrobiology) in September with assistance from DME staff.

Following the completion of the 2014 fieldwork and preliminary impact assessment in early 2015, a second round of field studies was conducted during the remainder of 2015. These included:

2015 Early Dry Season (1st to 3rd April and 18th May to 5th June 2015)

- Targetted survey for Goanna and Bats including deployment of camera traps (Mr Dane Trembath and EcOz Consultants).
- Aquatic biota. Field surveys led by Dr Ross Smith (Hydrobiology) with support from DME and EcOz personnel. This survey was essentially a repeat of the equivalent 2014 survey, but utilising a refined sampling methodology.

2015 Late Dry Season (7th to 14th September 2015)

- Aquatic biota. Targeted field surveys led by Mr Dylan Sortino and Dr Ross Jeffree (Hydrobiology) with support from DME staff.

Hydrobiology also undertook a dry-season floodplain coring investigation downstream of the former Rum Jungle mine. The objectives of this study were to:

- Characterise the composition of the historic mine tailings sediments to establish a geochemical fingerprint;

- Undertake a targeted floodplain sediment coring program on the Finniss River Floodplain; and
- Compare the characteristics of floodplain and tailings sediments to determine whether there is evidence of tailings deposition on the floodplain.

The results of this study were not directly relevant to the impact assessment described here, and are not considered further.

A location map of key sampling sites and river zones is presented in Figure 1-1.

Details of field methods are contained in Hydrobiology (2015).

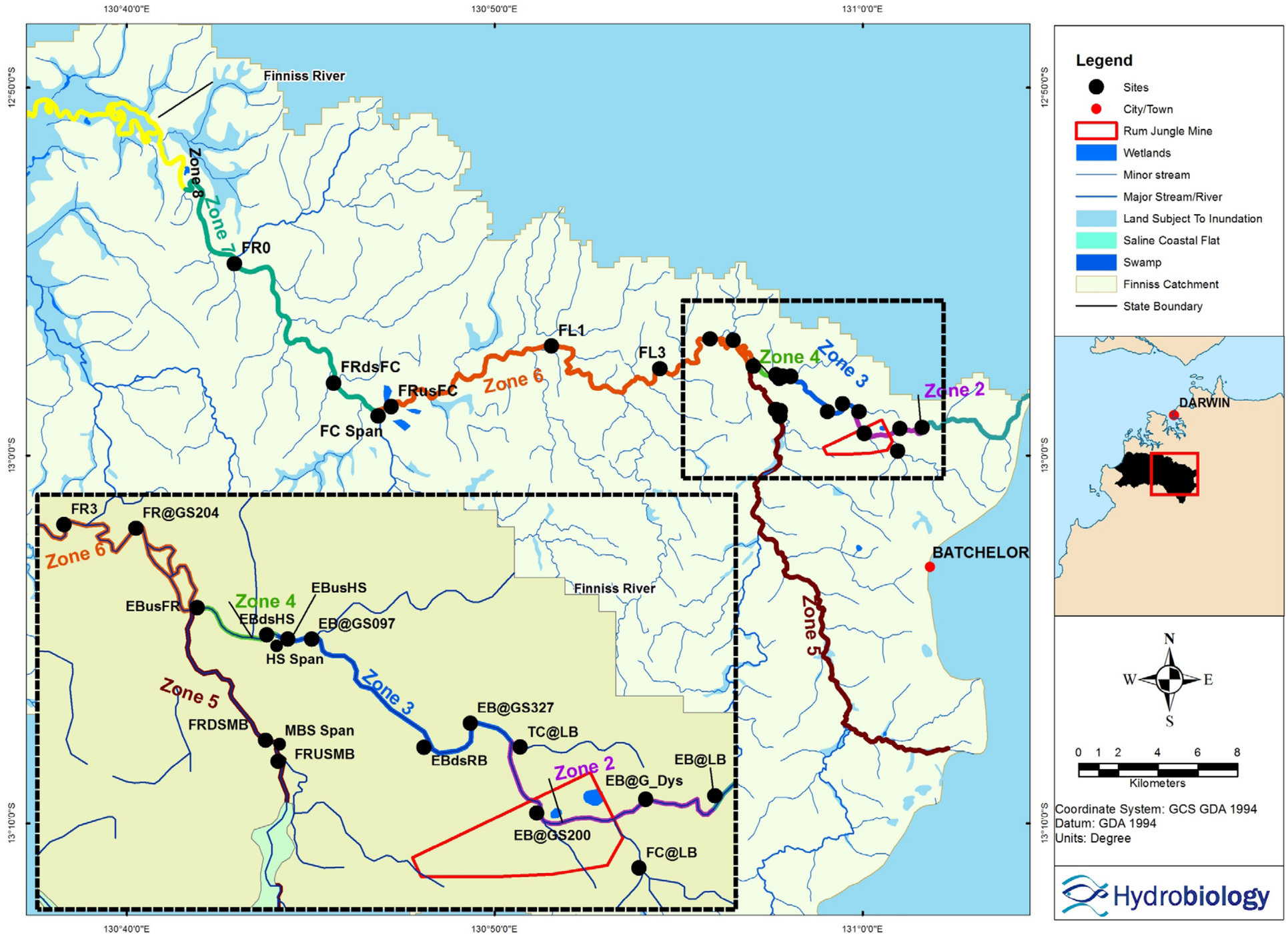


Figure 1-1 River zones and sampling sites used for this impact assessment

Table 1-1 presents a list of key sites surveyed during the various field programs. Details of the sampling protocol and methods used at each site can be found in Hydrobiology (2015).

Table 1-1 Sites surveyed during wet and dry season sampling programs

Site Code	Site Name	Zone
EB@LB	East Branch at Mine Boundary	1
FC@LB	Fitch Creek at Mine Boundary	1
EB@G_Dys	East Branch at Dyson's gauging station	2
EB@GS200	East Branch at gauging station GS8150200	2
TC@LB	Tailings Creek at Mine Boundary	2
EB@GS327	East Branch at gauging station GS8150327	3
EBdsRB	East Branch downstream of Railway Bridge	3
EB@GS097	East Branch at gauging station GS8150097	3
EBusHS	East Branch upstream of Hanna's Spring	3
HS	Hanna's Spring	3
EBdsHS	East Branch downstream of Hanna's Spring	4
EBusFR	East Branch upstream of the Finniss River Confluence	4
FRUSMB	Finniss River Upstream Mount Burton mine	5
FRDSMB	Finniss River Downstream Mount Burton mine	5
FRusEB	Finniss River upstream of East Branch confluence	5
MBS	Mount Burton Spring	5
FR@GS204	Finniss River at gauging station GS8150204	6
FR3	Finniss River 1.1 km downstream of GS8150204	6
FL3	Finniss River 4 km downstream GS8150204	6
FL1	Finniss River 2.2 km upstream of Five Mile Creek	6
FRusFC	Finniss River upstream of Florence Creek	6
FC	Florence Creek upstream of Finniss River confluence	6
FRdsFC	Finniss River downstream Florence Creek	7
FR0	Finniss River at Walker's Ford	7

2 IMPACT DATA COLLECTION

2.1 Water Quality

2.1.1 January 2014 Review

The review conducted in January 2014 included data to that month, primarily based on samples collected January to December 2013. As the dataset contained less than 24 months of monitoring data, it was not possible to use the default ANZECC/ARMCANZ (2000) approach to assess based on 95%iles of the monitoring data, individual exceedances of the water quality objectives (WQOs) were considered. For first flush measurements, the Criterion Maximum Concentration for toxicants from USEPA (2012) was used as the basis of comparison. The following overall summary was provided:

There was a clear indication of increased metal concentrations in the isolated water bodies of the mine site during the dry season, which were then flushed down the system after the first flows of the season. Increased concentrations of several toxicants were evident at the East Branch sites and Finniss River sites downstream of the mine (Zones 3, 4 and 6) during first flush sampling.

These pulses of elevated metals could be discerned in the raw data, but were illustrated in the selected graphs of Figure 2-1 to Figure 2-3, particularly for January and December 2013.

Generally, each zone was found to have individual exceedances of the WQOs for a number of parameters (Appendix 2). Elevated metal concentrations that were not related to the former Rum Jungle mine site were found for aluminium and iron associated with first flush flows in the tributaries of the East Branch upstream of the mine, and inputs from the former Mount Burton mine site into the Finniss River upstream of the East Branch.

It was noted that data availability at each site was limited by the availability of surface water at each site at the time of monthly sampling, although additional in-situ field measurements were taken between sampling rounds at several sites. Data tables in Appendix 2 provide details of data recovered for each sampling event. The seasonality of the system requires an extended period of monthly monitoring in order to provide enough data for robust calculation of percentiles for comparison with the WQOs.

With regard to the quality control/quality assurance of the water quality data, it was noted that there were a considerable number of duplicates with high relative proportional differences (RPDs). This was considered potentially of concern and warranted a review of the sampling techniques. The trace metal concentrations in the field blanks were also recommended to be investigated and the source of contamination determined or alternatively, better quality demineralised water for use as field blanks sourced.

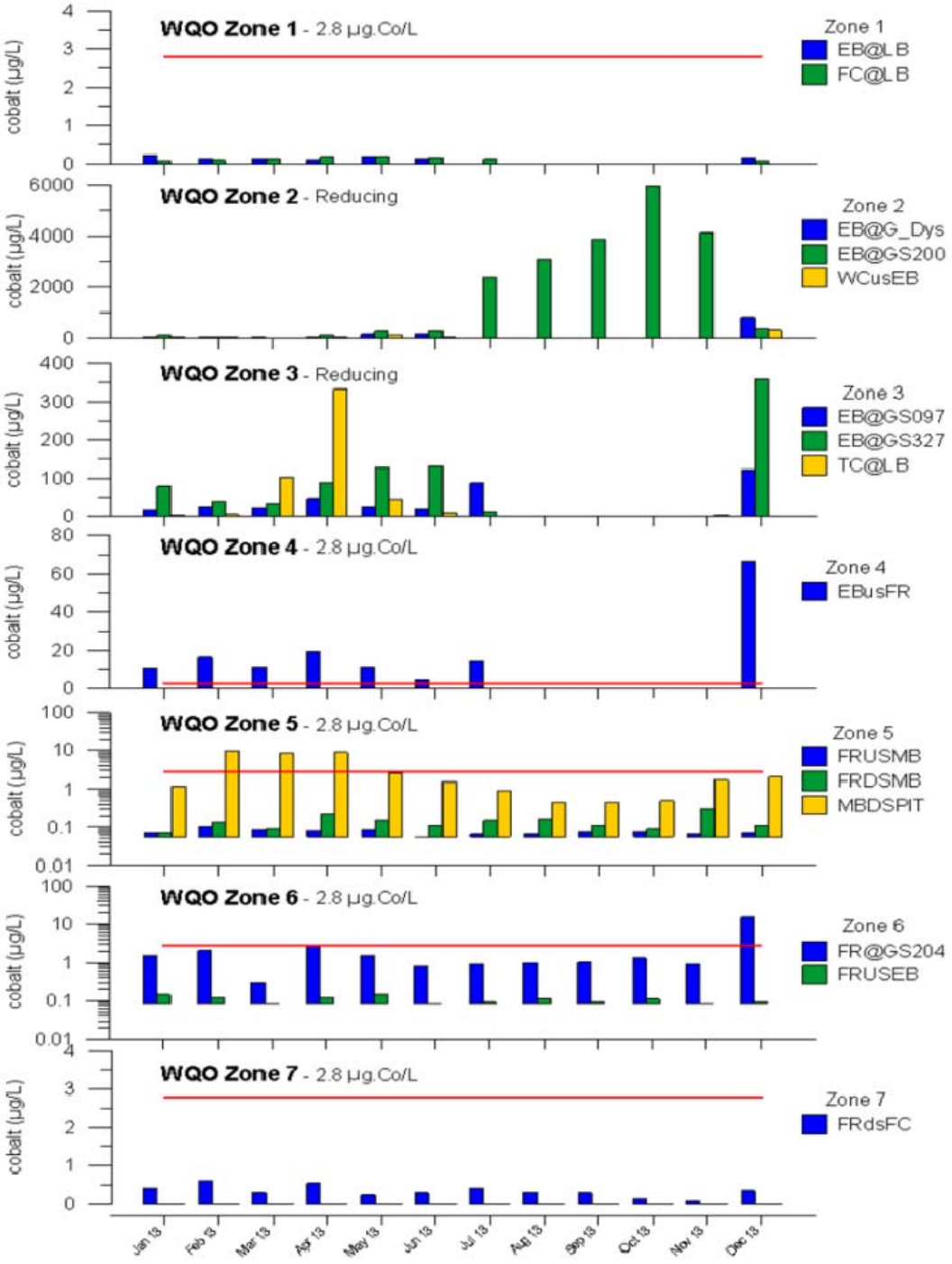


Figure 2-1 Cobalt concentrations by site, zone and month between January and December 2013. WQO for each zone shown. Note Y-axis differences.

Red horizontal lines represent the trigger values that were derived for each parameter for each environmental value for each parameter for each zone. A Water Quality Objective was developed for each zone for each parameter by selecting the lowest trigger value identified for any environmental value for that zone. Details of the method are described in Hydrobiology (2013a)

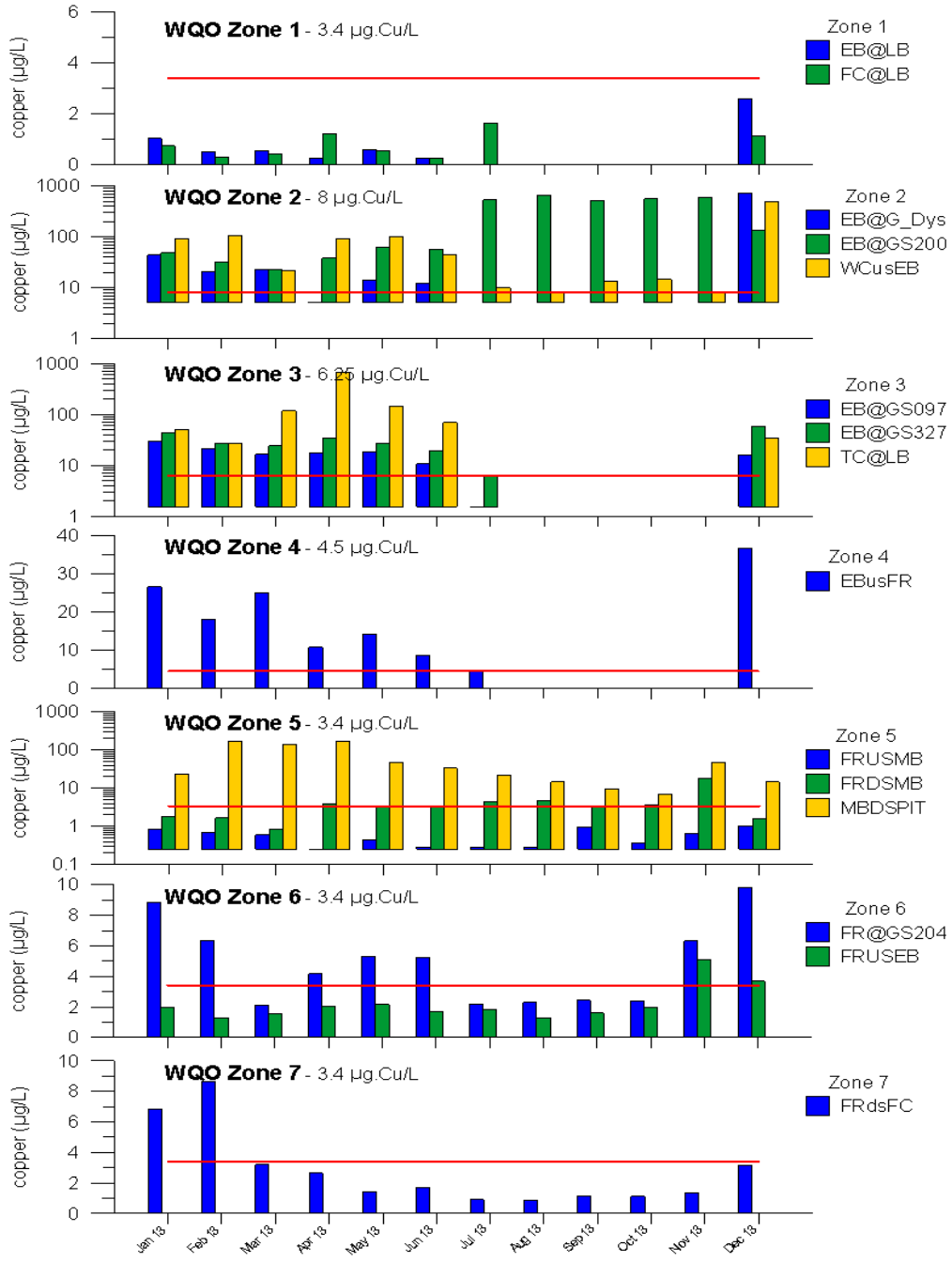


Figure 2-2 Copper concentrations by site, zone and month between January and December 2013. WQO for each zone shown. Note Y-axis differences.

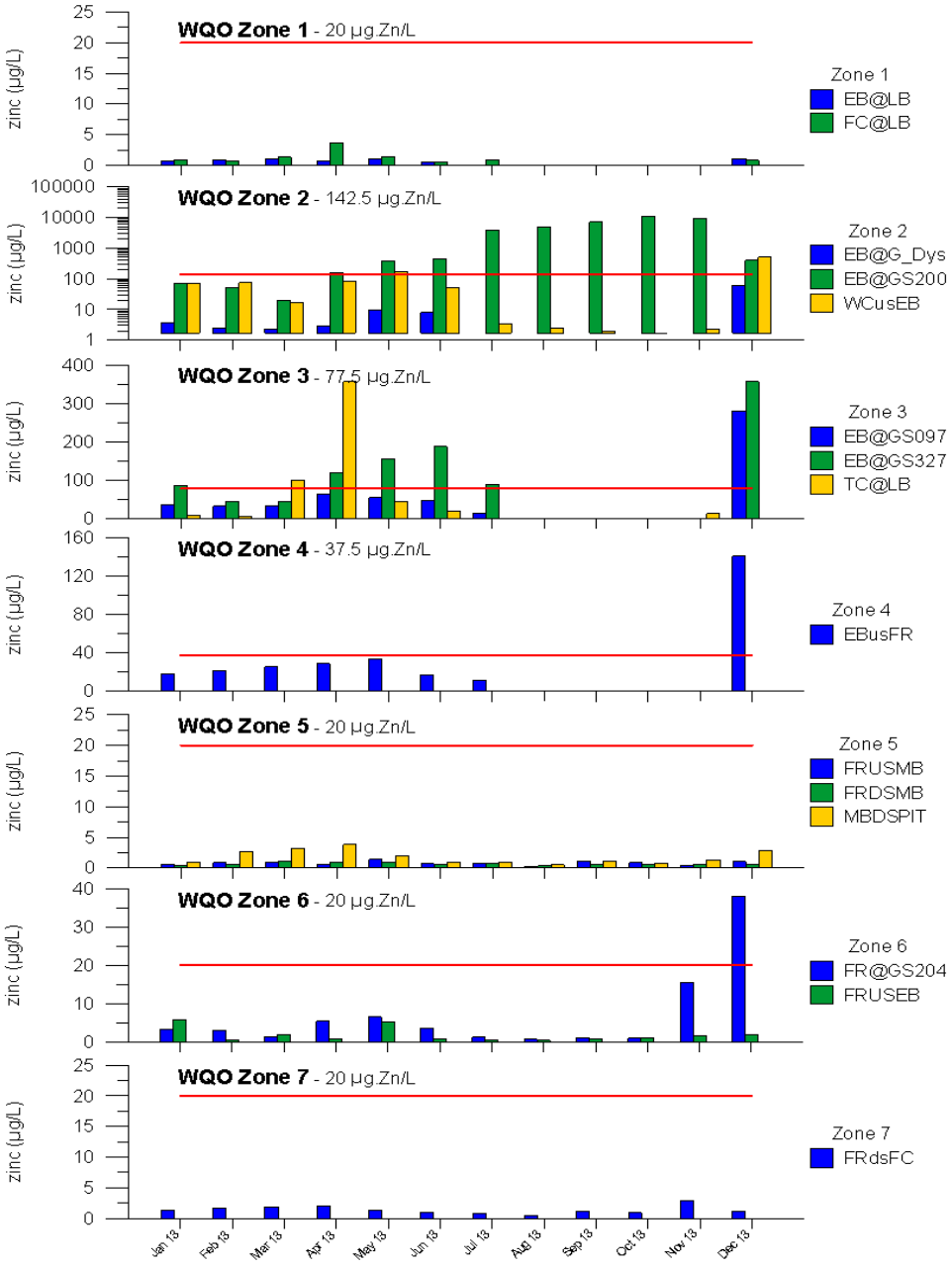


Figure 2-3 Zinc concentrations by site, zone and month between January and December 2013. WQO for each zone shown. Note Y-axis differences.

2.1.2 January 2015 Review

For the majority of sites, data were available from January 2013 to December 2014 on a monthly basis where surface water was present. Some 2012 data was available from previously established and monitored sites on the Finniss River upstream of the confluence with the East Branch (FRUSEB, FRDSMB, MBDSPIT and FRUSMB), and one site in the mine boundary (WCUSEB). A full review of the 2012-2014 data is provided in Appendix 2.

Field exposure and procedural blanks and duplicates were collected monthly during 2012 to 2014. Both field and exposure blanks were often found to contain measurable concentrations of several metals, particularly Aluminium (Al), Copper (Cu), Manganese (Mn), Nickel (Ni), Lead (Pb) and Zinc (Zn), possibly as a result of using contaminated bottles. Further, several samples showed higher concentrations of metals in the filtered sample than in the total sample analyses, which may indicate that sample bottles for analysis may have been accidently mixed/swapped in some instances.

Concentrations of Zn and Cu in the procedural blanks (both exposure and field blanks) were sometimes higher than the results found for samples from sites in Zones 1, 5, 6 and 7. This indicates that some of the contamination could be derived from the water used for the blanks or from dust exposure during sample handling in the field. Cu was found to be elevated in both the exposure and field blanks, but Zn was generally found to be higher in the field blanks than the exposure blanks. As some of the blank results were also above the WQOs for some zones it is recommended that the source of contamination be confirmed to ensure that sites are not erroneously deemed to exceed the water quality objectives.

Duplicate samples were taken from FRUSMB in 2014. Analysis of RPDs for those samples indicated a considerable number of QC exceedances, particularly for metals such as Pb and Zn.

There was a clear indication of increased metal concentrations in the isolated pools in the East Branch reaches of the mine site during the dry season, which were then flushed down the system after the first flows of the season. Increased concentrations of several metals were evident at the East Branch sites and Finniss River sites downstream of the mine (Zones 3, 4 and 6) during first flush sampling. These pulses of elevated metals can be discerned in the data in the Appendix 2, but are illustrated in Figure 2-4–Figure 2-9, particularly for December 2013 and subsequent January – March in 2014.

Generally, each zone was found to have individual exceedances of the WQOs for a number of parameters. Elevated metal concentrations that were not related to the former Rum Jungle mine site were found for aluminium and iron associated with first flush flows in the tributaries of the East Branch upstream of the mine, and inputs from the former Mount Burton mine site into the Finniss River upstream of the East Branch.

Data have been collected on a monthly basis where surface water was present at the sampling site. Additional in-situ field measurements (EC, pH, temp, DO and turbidity) have

also been collected at several sites between sampling events. The seasonality of the system requires that the current frequency of monitoring is continued in order to provide enough data for robust calculation of percentiles for comparison with the WQOs. With two distinct rounds of sampling for all sites in 2013 and 2014, at least 24 months of monitoring data were available for most sites and 95th percentiles have been calculated for each site for each.

Note that the use of logarithmic y-axes on the graphs below allows better visualisation of the results where the range of data values varies over orders of magnitude. A comprehensive discussion by zone and review of the water quality data and graphs below is provided in Appendix 2.

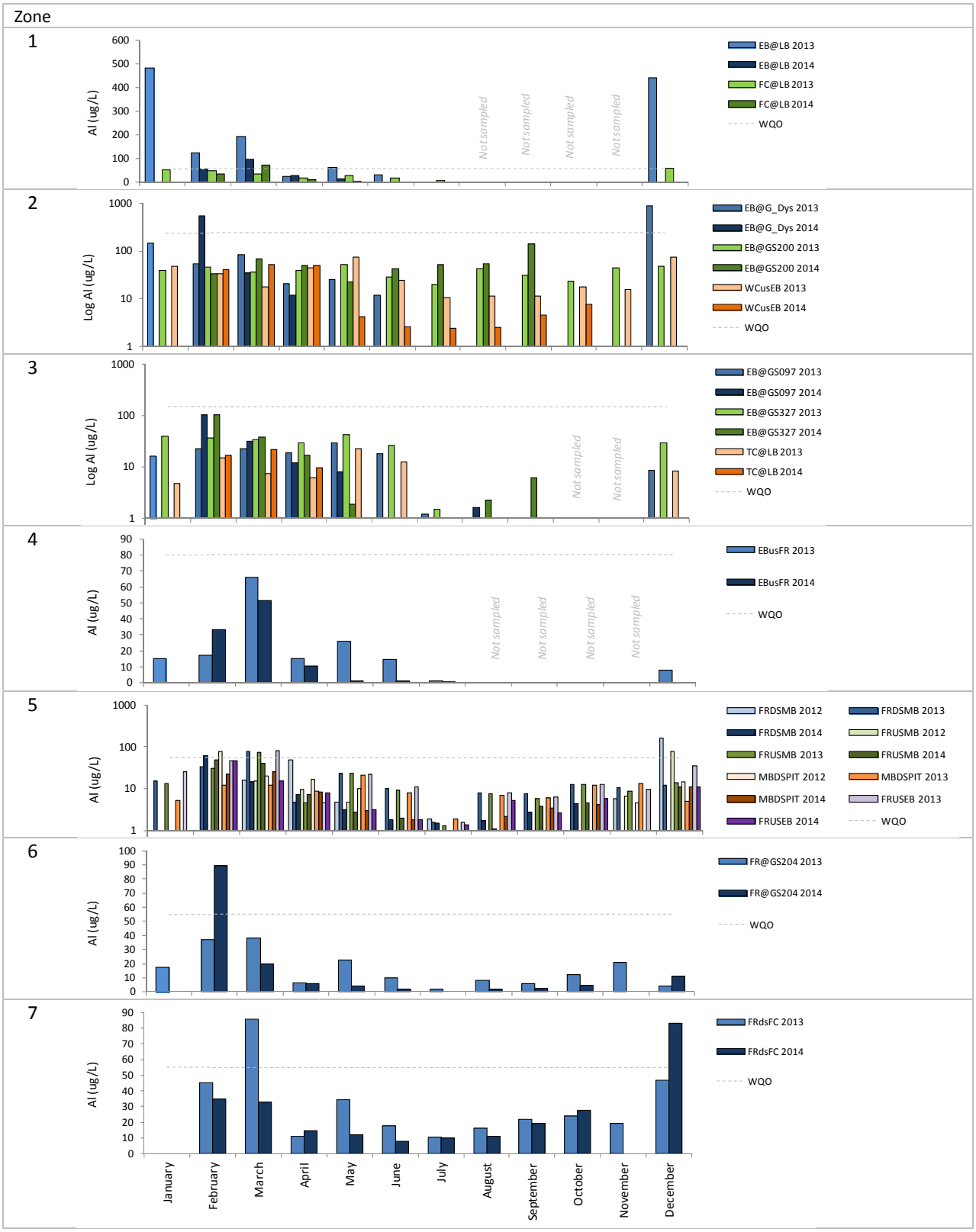


Figure 2-4 Dissolved aluminium concentrations by site, zone and months between January and December 2012 to 2014 (Note Y axis differences)

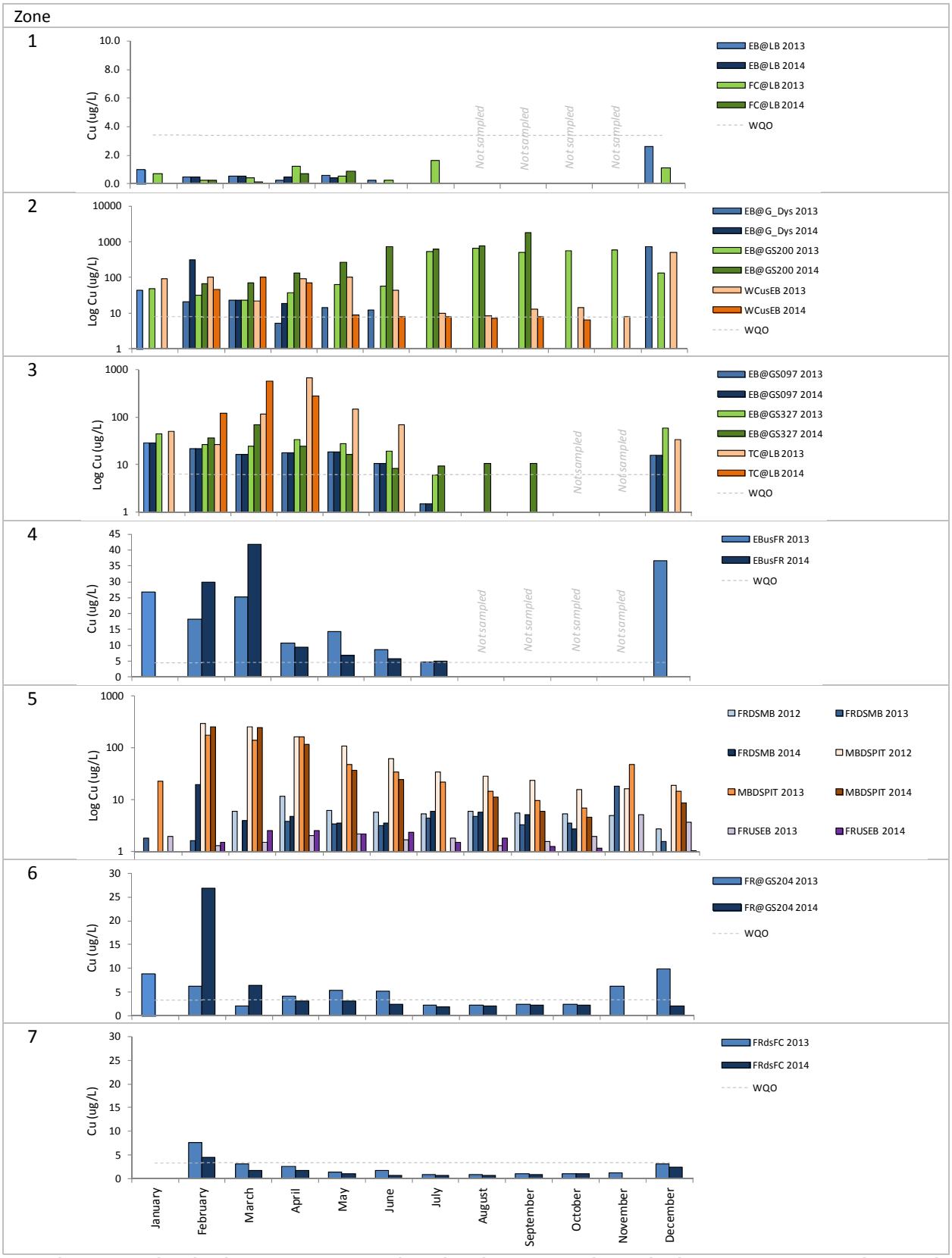


Figure 2-5 Dissolved copper concentrations by site, zone and months between January and December 2012 to 2014 (Note Y axis differences)

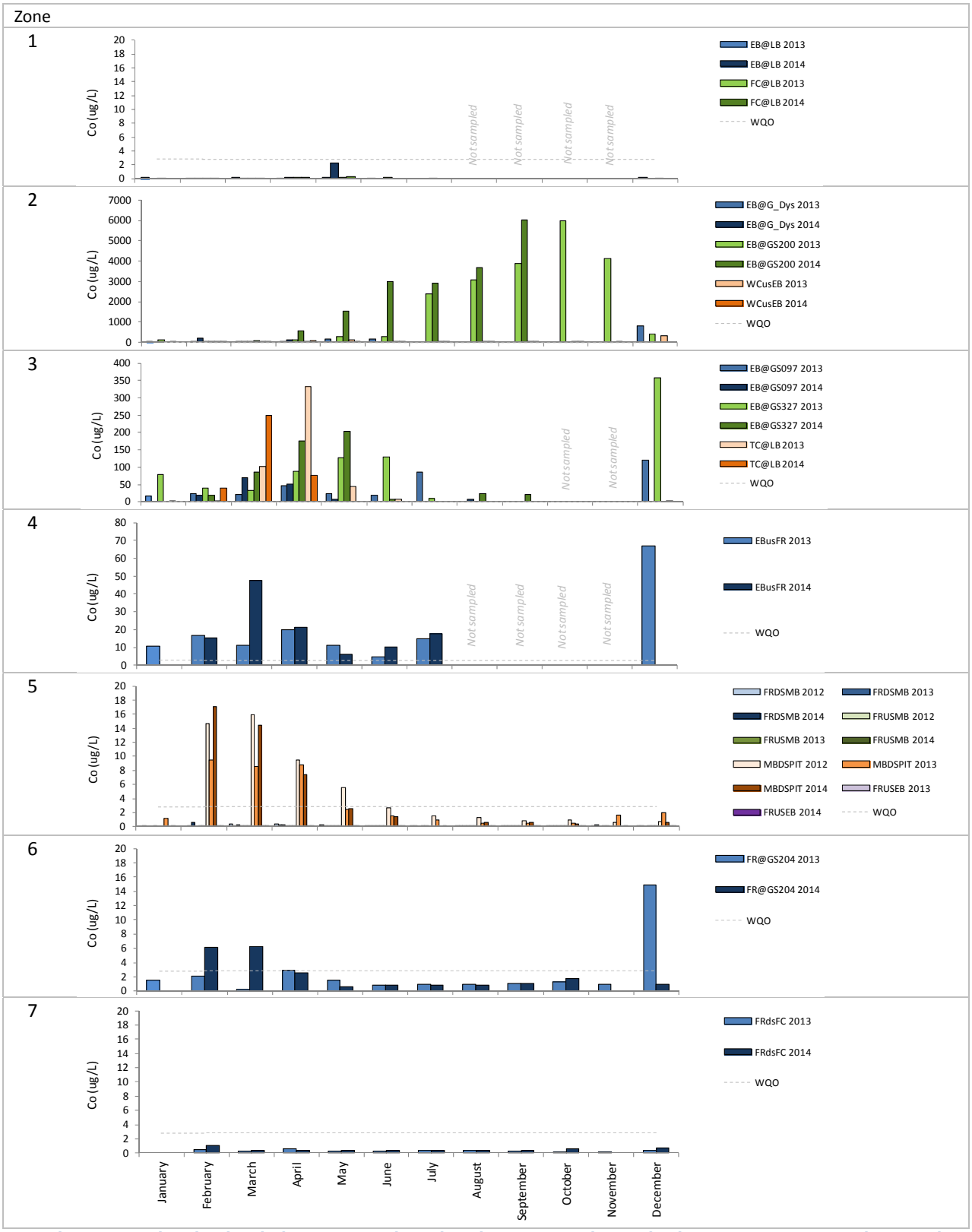


Figure 2-6 Dissolved cobalt concentrations by site, zone and months between January and December 2012 to 2014 (Note Y axis differences)

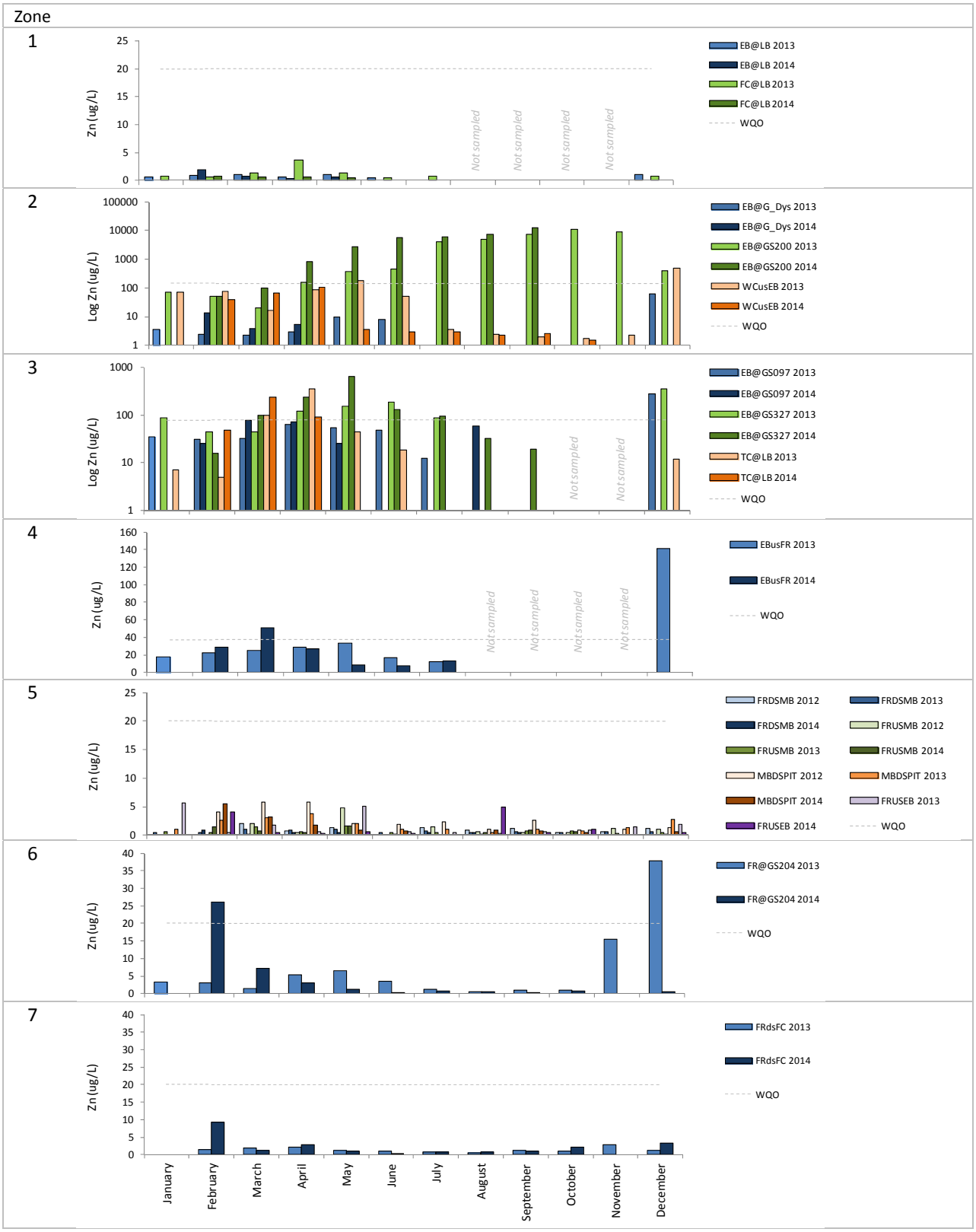


Figure 2-7 Dissolved zinc concentrations by site, zone and months between January and December 2012 to 2014 (Note Y axis differences)

**Feb 2014 in Zone 4 one sample above WQO was excluded for scale purposes though data available in table in appendices.*

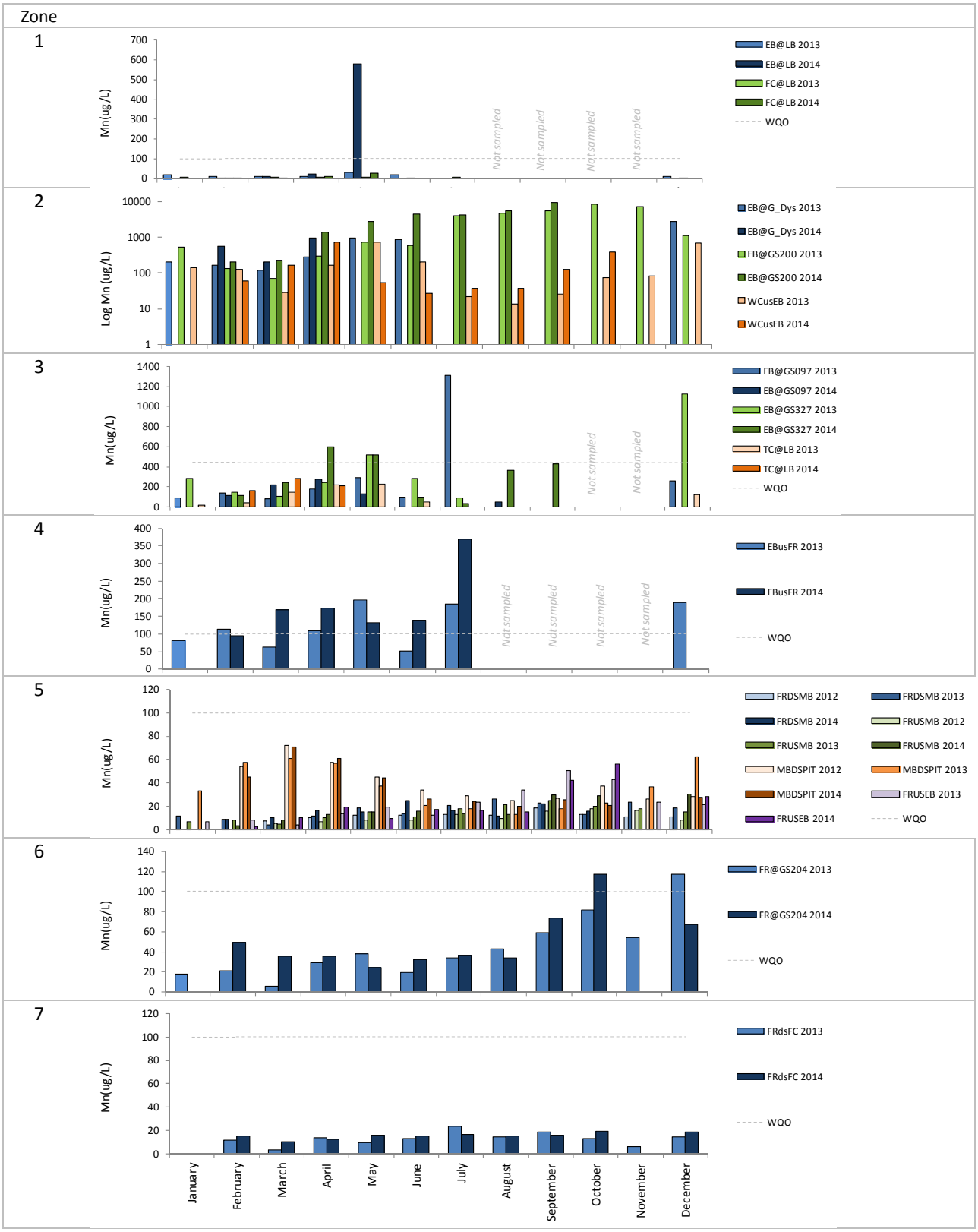


Figure 2-8 Dissolved manganese concentrations by site, zone and months between January and December 2012 to 2014 (Note Y axis differences)

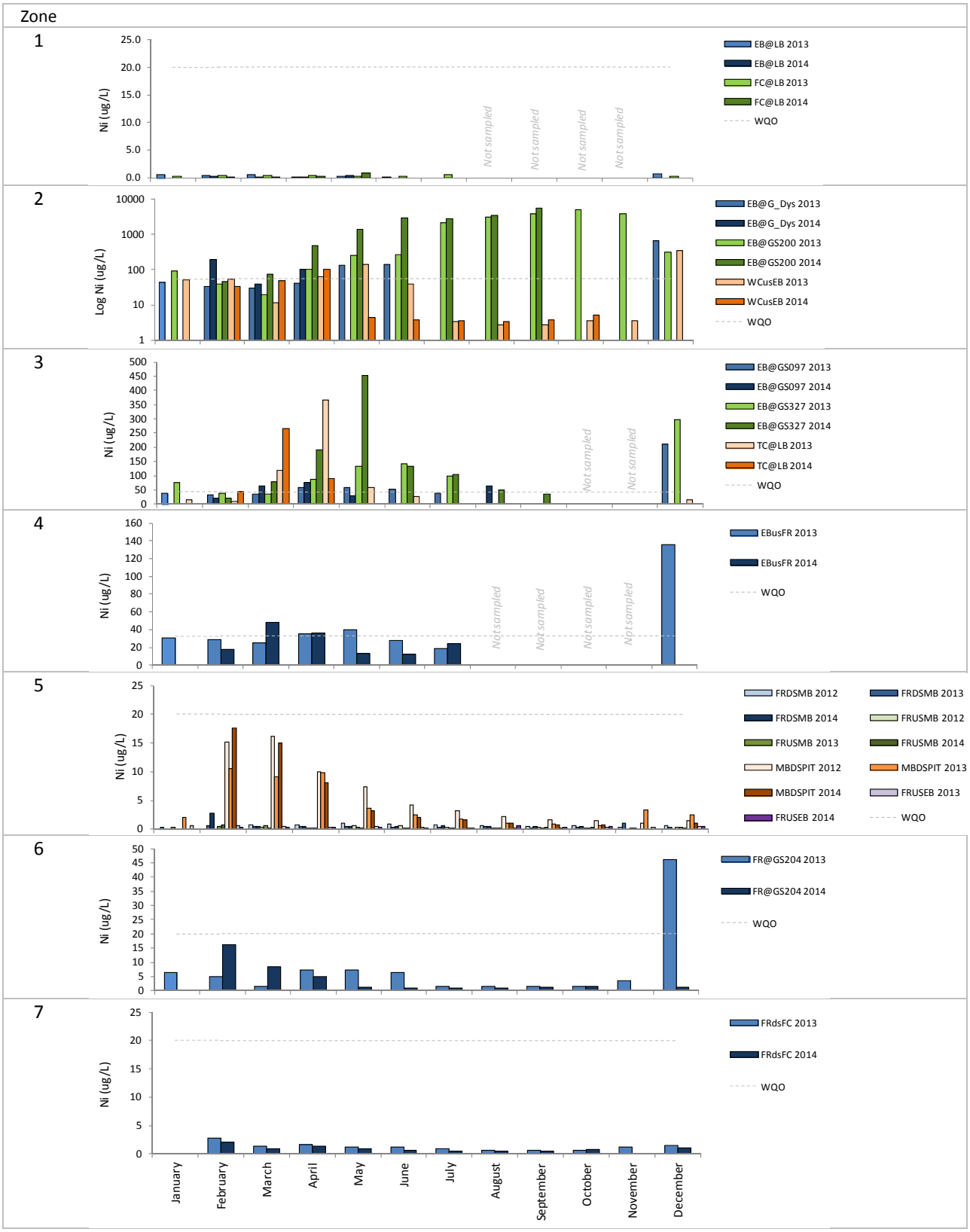


Figure 2-9 Dissolved nickel concentrations by site, zone and months between January and December 2012 and 2014 (Note Y axis differences)

2.2 Sediment Quality

Sediment samples were collected during the aquatic biology sampling in the 2014 dry season from the sites sampled for aquatic biota. The sediment sampling targeted recently deposited fine sediments in the stream channel at each site, with analysis done as total digest on the <63 µm fraction. Although only a single sample from each site was available for the assessment, the following were evident:

- Exceedances of the ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines (ISQG) were found for Cu and Ni for all zones (and all sites within each zone) except for Zone 1 and Zone 5. It was noteworthy that the majority of the samples exceeding the ISQG high value as well as the ISQG-low values;
- Pb and Zn concentrations exceeded the ISQG-low in all zones except Zones 1, 5 and 7;
    - Pb mostly exceeded the ISQG-low, but two sites in Zone 3 did not have exceedances (EB@GS097 and EBdsRB);
    - Zn demonstrated a similar pattern to Pb, but exceeded the ISQG-high in the majority of cases; and
- Some exceedances of the ISQG –low were found for As and Cd for some sites in Zones 2, 3 and 4, although the majority of the sites in Zone 3 did exhibit exceedances.

Overall, there was a trend of increased metal concentration in Zone 2 (mine site) that declined downstream. The extent of elevated concentrations downstream from the mine site differed depending on the metal, with high sediment concentrations of Cu and Ni detectable in all zones to Zone 7. High Pb and Zn sediment concentrations were detectable to Zone 6, but not at all sites in Zone 3. Zone 5, upstream of the East Branch did not show high levels of any metal in sediment. A summary of metal concentrations in sediment samples by zone is shown in Table 2-1 below. A summary of exceedances per zone for each analyte is shown in Table 2-2.

Table 2-1 Metal concentrations in sediment samples by zone.

LOR			50	0.5	0.05	0.05	10	0.2	20	0.05	0.05	0.2	0.2	0.05	0.5
ISQG-Low				20	1.5		80	65				21	50	2	200
ISQG-High				70	10		370	270				52	220	25	410
Zone	Site Code	Sample Date	Al mg/kg	As mg/kg	Cd mg/kg	Co mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Mo mg/kg	Ni mg/kg	Pb mg/kg	Sb mg/kg	Zn mg/kg
1	EB@LB	24/05/2014	2850	<0.5	<0.05	3.50	<10	9.40	4540	93.2	0.30	4.60	11.20	<0.05	4.5
1	FC@LB	23/05/2014	4000	<0.5	0.10	5.45	20	62.40	2020	28.4	0.30	13.00	13.00	<0.05	23.5
2	EB@GS200	25/05/2014	13800	7.5	2.00	160.00	40	3570.00	17600	121.0	1.15	202.00	107.00	0.25	496.0
3	EB@GS097	26/05/2014	3200	1.0	0.10	23.00	10	190.00	2780	94.0	0.10	25.60	22.40	<0.05	36.5
3	EB@GS327	29/05/2014	6400	9.0	0.30	78.70	20	394.00	13000	69.8	0.90	98.00	99.80	0.15	121.0
3	EBdsRB	26/05/2014	12500	3.0	0.10	153.00	20	434.00	12400	584.0	0.15	94.00	34.40	<0.05	93.5
3	EBusHS	27/05/2014	7950	11.0	2.50	2090.00	40	1640.00	19000	11000.0	2.15	842.00	108.00	0.15	1240.0
4	EBdsHS	28/05/2014	9900	32.0	2.10	1940.00	30	1850.00	28100	7150.0	1.50	658.00	168.00	0.20	1150.0
4	EBusFR	30/05/2014	10100	25.0	1.50	1110.00	20	1550.00	25900	3990.0	1.35	495.00	186.00	0.20	754.0
5	FRDSMB	20/05/2014	3400	1.5	<0.05	5.70	30	29.20	8600	90.7	0.20	9.60	9.20	0.10	8.5
5	FRUSMB	21/05/2014	3800	2.0	<0.05	4.95	20	10.00	11100	139.0	0.25	7.20	10.20	0.10	10.0
6	FR@GS204	1/06/2014	7500	5.5	0.25	177.00	30	373.00	12700	368.0	0.55	117.00	94.80	0.20	146.0
6	FR3	2/06/2014	17500	19.5	0.15	322.00	40	3120.00	20000	190.0	2.30	512.00	577.00	0.55	220.0
7	FRdsFC	3/06/2014	5400	2.5	0.10	42.50	20	69.40	9620	224.0	0.25	27.40	17.40	0.10	37.0

Yellow indicates ISQG-low exceedance
Red indicates ISQG-high exceedance

Table 2-2 Exceedences per zone for analytes

Zone	Site Code	No. Sample > ISQG-Low	No. Sample > ISQG-High
1	EB@LB	-	-
2	EB@GS200	Cd, Pb (1/1)	Cu, Ni, Zn (1/1)
3	EB@GS097	Cd (1/4), Cu (1/4), Ni (1/4), Pb (2/4)	Cu (3/4), Ni (3/4), Zn (1/4)
4	EBdsHS	As (2/2), Cd (1/2), Pb (2,2)	Cu (2,2), Ni (2,2), Zn (2,2)
5	FRDSMB	-	-
6	FR@GS204	Pb (1/2), Zn(1/2)	Cu (2/2), Ni (2/2), Pb (1/2)
7	FRdsFC	Cu (1/1). Ni (1/1)	-

2.3 Aquatic Biota

2.3.1 May-June 2014 Sampling

An aquatic ecosystem survey conducted in May-June 2014 was undertaken to update knowledge of the status of the aquatic ecosystems downstream of the mine, and was reported by Hydrobiology (2014). It was the first such survey since the 1990s, when post remediation surveys were first conducted after the initial mine site rehabilitation in the mid-1980s (see Jeffree and Twining 2000, Jeffree *et al.* 2001).

Specifically for this survey, the objectives were to:

- update the assessment of the status of the aquatic ecosystems downstream of the mine area since the surveys of the 1990s, with particular focus on where the patterns of aquatic ecosystem condition differed from those observed in the earlier assessments;
- provide contemporary aquatic ecosystem condition assessment and species distribution patterns that in combination with water and sediment quality monitoring data could be used to develop revised water quality objectives based on ecosystem response to contaminant concentrations; and
- investigate alternative sampling techniques that would potentially make future sampling more appropriate and/or cost effective

Fishes, macrocrustaceans, general macroinvertebrates and benthic diatoms were sampled from 18 sites in the Finniss River upstream of Walker's Ford, including the East Branch to upstream of the Rum Jungle mine area, between 18 May and 6 June 2014, where the sites still retained water at the time and were appropriate for each type of sampling. Where possible and appropriate at each site, sampling methods were designed to be comparable with methods that had been used historically, but other sampling methods were also trialled. Sites sampled were:

- FRUSMB Finniss River upstream of Mt Burton mine

- FRDSMB Finniss River downstream of Mt Burton mine
- FC@LB Fitch Creek at lease boundary
- EB@LB East Branch Finniss River at lease boundary
- EB@G_Dys East Branch at Dyson's Gauge Station
- EB@GS200 East Branch at GS8150200
- EBdsRB (EB5) East Branch downstream of historic rail bridge
- EB@GS097 East Branch at GS8150097
- EBusHS (EB3) East Branch upstream of Hannahs Spring
- EBdsHS (EB2) East Branch downstream of Hannahs Spring
- EB@GS327 East Branch at GS8150327
- EBusFR (EB1) East Branch upstream of Finniss River confluence
- FR@GS204 Finniss River at GS8150204
- FR3 Finniss River 1.1km downstream of GS8150204
- FRusFC (FR2) Finniss River upstream of Florence Creek confluence
- FRdsFC (FR1) Finniss River downstream of Florence Creek confluence
- FR0 Finniss River at Walkers Ford

2.3.1.1 Sampling method adjustment

It was demonstrated that a combination of sampling with a reduced set of floating gill nets for an abbreviated set period of 16:30-20:30 in combination with fyke netting, electrofishing and bait trapping would capture the range of fish species collected in earlier sampling and be comparable, after adjustment for set period and net area, to the full set of floating and sinking gill nets set from dusk to dawn used in earlier sampling periods. This could be achieved with greatly reduced effort, and concomitant reduction of issues with field crew fatigue for an intensive sampling program, and importantly reduce the risk of enmeshing and drowning of Freshwater Crocodiles. The populations of that species in the Finniss River system had increased markedly since the 1990s, and use of the historic methods, even with increase gill net check frequency, had resulted in the death of three crocodiles. Therefore, the modified sampling procedure was seen as being particularly advantageous.

2.3.1.2 Status of the aquatic organism assemblages

There were generally consistent findings for the four groups (fishes, macrocrustaceans, general macroinvertebrates and benthic diatoms) of aquatic organisms targeted. There were no indications of impact in the Finniss River downstream of the East Branch. This was consistent with the findings of surveys conducted in the 1990s, except that further recovery of mussel populations, and general recovery of the main Finniss River after remediation of the mine site in the mid-1980s had occurred. However, the results were in contrast to the findings of surveys in the 1970s of impacts in the Finniss River as far downstream as Florence Creek.

There were also relatively consistent patterns of reductions in diversity and abundance of all four groups in the mine area (Zone 2) and gradual improvement in diversity and abundance downstream of the mine to the Finniss River junction. Tissue metal concentrations in a number of species also indicated increased bioavailability of copper and zinc in the mine area, and cobalt and nickel either in the mine area or shortly downstream of it. There was gradual reduction of bioaccumulation of those metals downstream through the East Branch, with no evidence for increased bioaccumulation of them at any of the Finniss River sites. This was consistent with known inputs of acid drainage containing substantial quantities of those metals into the East Branch within the mine area.

The assemblages in the East Branch were improved for all three groups relative to what was found in the 1990s, despite no further remediation of the mine area. The reason for this was unclear, but was considered to potentially indicate:

i) there was a time dependency related to lag factors that have operated on the rates of recolonisation after the step reduction in contaminants loads that was measured in the 80s and 90s;

ii) annual contaminant loadings and/or their bioavailabilities had continued to reduce after the 90s allowing for more recolonisation, such as via reduction of sediment sources of contaminants over time; and/or

iii) there had been continued adaptation in the fish biota of the East Branch following their decades of exposure to contaminants, as demonstrated in the 90s for one species in the East Branch (Gale *et al.*, 2003), although the patterns of bioaccumulation by that species in 2014 were not consistent with a high level of inhibition of copper uptake persisting for the East Branch population.

Exceptions were found to the general pattern of a gradient of reducing impact in the East Branch from the mine area downstream:

- Site EBdsRB supported a diverse, abundant macroinvertebrate assemblage that was comparable to those of the Finniss River and upper East Branch control sites, despite being within the mid-reaches of Zone 3 downstream of the mine area;
- The fish assemblage at the site upstream of EBdsRB, EB@GS327, was more speciose than for other Zone 3 sites, and more comparable to the sites in Zone 4, while the assemblage at EBdsRB was more comparable to the site in the mine area, EB@GS200;
- The diatom assemblage of the East Branch, while less diverse and abundant than the sites in the Finniss River system, was dominated by species that were classified as alkalophilic or preferring circumneutral pH waters. The metal tolerances of the dominant species were not known. The observed pH preferences of the dominant species were not consistent with an impact caused by acid drainage, and this was postulated to have resulted from altered grazing pressure caused by the absence of fish and macrocrustacean algivorous species and reduced abundance of macroinvertebrate grazers; but

- The absence of fish and macrocrustacean algivores was also not able to be explained. It was postulated that it may have resulted from either greater sensitivity to increased metal bioavailability for those species compared with other feeding guilds, or to reduced quality of their algal food sources due to the observed differences in algal assemblage composition.

It was acknowledged the use of a single round of biological assessment over 20 years after previous sampling was not a strong basis for comparison, and also that the timing of the survey early in the dry season was not comparable to the later dry season sampling of the 1990s, particularly for the intermittent East Branch. Therefore it was recommended that:

- Repeat sampling in 2015 of the Finniss and East Branch using the recommended new suite of sampling methodologies. This would include a much reduced program of gill netting to improve the baseline of contemporary ecosystem condition for use for assessment of the success of further rehabilitation and be consistent with sets of multiple rounds of sampling used in the previous periods. It was recommended that this occurs in the similar early dry season period as for the 2014 sampling because this would capture the maximal spatial extent of fish species as soon as access permitted; and
- It was recommended that more effort be placed into understanding the current extent of recovery and its drivers in the East Branch by:
    - an additional sampling round later in the Dry of 2015 targeted at macroinvertebrate and diatom assemblages but with fish sampling of the East Branch only to provide a better comparison with sampling in the 90s; and
    - comparison of the presence of biota along the pollution gradient of the East Branch with ecological risk predictions of the presence of different biota based on water quality alone, including geochemical modelling of bioavailable fractions, for comparison with similar 90s assessments.

2.3.2 May-June 2015 Sampling

Sampling in May-June 2015 largely followed that used in 2014, but included the recommended abbreviated period of setting gill nets recommended in Hydrobiology (2014) of 16:30 to 20:30 in combination with fyke netting, electrofishing and bait trapping. Where the area of the waterhole permitted, the gill net set was replicated, and shorter, 10 or 15 m length nets were used in preference to the previously used longer nets to better accommodate smaller water holes in the East Branch and upper Finniss River.

2.3.3 Status of the Aquatic Ecosystems

The findings of the 2015 sampling were largely consistent with the 2014 findings, but also were indicative of a later, shorter wet season, and resulting lower metal loads and lesser ecosystem responses to them.

One diatom species which is known to be a very reliable indicator of metal contamination by its presence is *Achnanthidium minutissimum*. This species showed a clear and obvious

reduction in its abundance and its proportional contribution to communities further downstream of the mine (from May-June 2014/15 data). Furthermore, it was not present in samples from the East branch catchment upstream of the mine and largely absent from sites in zones 5 and 6 of the Finniss River. Other taxa, also noted as tolerant of high metal concentrations (e.g. Nitzschia palea) showed a similar pattern. These results appear to be very consistent with those of a study by Ferris *et al*. (2002) based on 1990s sampling, wherein a gradient of improving diatom condition was observed through the East Branch downstream from the mine lease. It was also consistent with the 2014 sampling, but more indicative of a positive response by taxa tolerant of metals downstream of the mine. In contrast to the community data, values of total abundance and species richness were not particularly useful in determining differences among and between zones.

The 2015 macroinvertebrate assessment showed that sites within and immediately downstream of the mine (i.e. zones 2 and 3) had lower values of abundance and taxonomic diversity and PET taxa richness than control sites upstream of the mine (Zones 1 and 5). The community assemblage at sites in zone 2, and several sites in zone 3, were also shown to be statistically distinct, and were typified by high proportions of chironomids (midges). In contrast, sites upstream of the mine lease, and at control sites and sites further downstream (in zones 4, 6 and 7) were composed of a more even spread of taxa, and high proportions of Caenidae (mayflies). The one exception to the above was site FRusFC (Zone 6), which was shown to be distinct from all other sites. The overall patterns of abundance, richness and community composition were broadly similar across 2014/15 sampling rounds, given that we would expect to see some level of natural variation due to the ephemeral nature of some components of the system. We also observed a similar pattern of relative abundance and richness across zones to that previously reported by Edwards (2002) (also in May/June).

For fish and macrocrustaceans there were contrasting patterns of total abundance and richness between Fyke nets and electrofishing methods. The Fyke net data showed abundances to be generally higher in the East Branch relative to the Finniss River, and the upstream control site EB@LB contained significantly higher abundances than all other sites. However, this was not reflected in species richness, as values across sites were reasonably similar (and not significantly different). Electrofishing, however, revealed a highly contrasting dataset. Abundances were particularly low upstream of the East Branch (zone 1) and within the mine lease (zone2), with consistently higher values across all other zones; whereas richness values were more consistent across East Branch sites (~7), but generally lower than the Finniss River (~10). Analysis of the community composition identified a far greater similarity between datasets. Results from both methods revealed the East Branch and Finniss River to be composed of distinctively different communities; but neither resulted in a clear distinction between up and downstream sites within each branch (e.g. East Branch or Finniss River).

Tissue metal concentrations in fish and prawn samples collected in 2015 were largely consistent with those of 2014, but the amounts of metal accumulated were typically lower than were found for the same species at the same sites in 2015. This is consistent with the

lower maximum and percentile dissolved metal concentrations observed in 2015 compared with 2014, as a result of the delayed and lower wet season flows in 2015. For cobalt, manganese and nickel there were a number of outlier specimens that had particularly high concentrations of these metals that were collected from zones 3 and 4. This is consistent with inputs of those metals from the Browns Oxide project area, and perhaps greater concentration of those inputs of bioavailable metal in the lower flows of 2015 compared with 2014.

2.3.4 Comparisons of fish sampling in the main Finniss in the 1970s, 1990s and 2010s

Fish community composition, diversity and abundance from standardised gill net sampling at sites downstream of the mine on the Finniss River were compared with unexposed sites prior to remediation and ~10 (1990s) and ~30 years post remediation (2010s). Overall we found that fish communities from sites downstream of mine inputs prior to the 1980s remediation were significantly different from unexposed sites, being depleted in abundance and diversity. However, this was not the case for samples post remediation where there appeared to have been recovery of fish communities at the exposed sites in zone 6. There was clear evidence that downstream and upstream communities were more alike post remediation. Despite this observation, abundances at zone 6 were reduced in the most recent sampling rounds (2010s) relative to the 1990s. However, flow in this reach of the Finniss River is particularly variable and is likely to be a substantial confounding factor affecting abundances.

2.3.5 September 2015 Sampling

For the September sampling round, sampling was restricted only to sites within and downstream of the mine lease. Surprisingly, values of diatom abundance and diversity were very similar to that of May-June sampling, and did not show a great deal of variation among sites; the only exception being EB@GS200 (zone 2) where species richness was noticeably reduced. The sites sampled were:

- FC@LB Fitch Creek at lease boundary
- EB@LB East Branch Finniss River at lease boundary
- EB@G_Dys East Branch at Dyson's Gauge Station
- EB@GS200 East Branch at GS8150200
- EBdsRB (EB5) East Branch downstream of historic rail bridge
- EB@GS097 East Branch at GS8150097
- EBusHS (EB3) East Branch upstream of Hannahs Spring
- EBdsHS (EB2) East Branch downstream of Hannahs Spring
- EB@GS327 East Branch at GS8150327
- EBusFR (EB1) East Branch upstream of Finniss River confluence

For macroinvertebrates, both abundances and richness appeared to show a gradient of lower values within and immediately downstream of the mine area but progressively higher towards zone 4, where values again decreased.

For fish, abundances were much reduced relative to May- June sampling, but richness was more comparable. Both metrics recorded lower values at sites closest to the mine.

Data summaries for all aquatic biota surveys are provided in Hydrobiology (2014, 2016)

2.4 Aquatic Reptiles

2.4.1 2014 Samping

In 2012, Hydrobiology (2013a) consulted with the Traditional Owners of various parts of the Finniss River. During these consultations Traditional Owners identified a number of aquatic reptiles as culturally significant. There is a large number of records of aquatic reptiles downstream of the Rum Jungle Mine, but we are not aware of any previous studies that examined distribution and abundance of this group.

An aquatic reptile survey was conducted within the vicinity of eight historical water sampling sites downstream and upstream of the former Rum Jungle Mine site during May 2014. Seventy-four aquatic reptiles were recorded during the survey. Of particular interest, Merten's Water Monitors (*Varanus mertensi*) were found to be abundant along the Finniss River, but not present within the lower East Branch in the dry season. However, it was present in the wet season riparian fauna sampling (see below). Mitchell's Water Monitor (*Varanus mitchelli*) was also present in the lower Finniss River. Both of these species are listed as Vulnerable in the Northern Territory due to population declines associated with the introduced Cane Toad *Rhinella marina*.

Freshwater turtles were recorded in the upper parts of the Finniss River. However despite a large survey effort only six individual turtles of two species were found (Northern Long-necked Turtle [*Chelodina oblonga*] and Northern Yellow Faced Turtle [*Emydura tanybaraga*]).

Saltwater (*Crocodylus porosus*) and Freshwater Crocodiles (*Crocodylus johnstoni*) were recorded along both the upper and lower parts of the Finniss River. Saltwater Crocodiles (*C. porosus*) were not recorded from the East Branch, but freshwater crocodiles were present in the lower East Branch.

The Finniss River is home to some populations of aquatic reptiles that are listed threatened species and/or culturally significant. It is recommended that some of these species be monitored during any works that could affect the water and habitat quality of the Finniss River, particularly with respect to potential increases in populations in the East Branch. Given the presence of Merten's and Mitchell's Water Monitors recorded during this survey which are listed Threatened Species in the Northern Territory and are culturally significant, it is recommended that they are a particular focus of any monitoring program. Freshwater and Saltwater Crocodiles are considered culturally significant as both a food source and

totem. As they are both present in the Finniss River and easy to survey using eye shine spotlight counts, it is recommended that both of these species are monitored.

The reasons for some species being absent from the East Branch, at least in the dry season, were not determined.

2.4.2 2015 Sampling

As the 2014 surveys had confirmed that the upper Finniss River and the East Branch were inhabited by Merten's Water Monitor (*Varanus mertensi*), but not in the dry season in the East Branch, and there was indicative evidence that the Bare-rumped Sheath-tailed Bat (*Saccolaimus saccolaimus*) might be present at FR@GS204, further wet season and dry surveys were commissioned in 2015 to see whether the pattern of wet-season only usage of the East branch by water monitors persisted and to try to better determine the identity of the bat at FR@GS204.

The surveys included active searches on foot and by boat, recording tracks, and using motion-sensitive camera traps set along river banks in areas likely to be frequented by monitors. All vertebrates observed in the course of these activities were recorded as incidental observations. Surveys were conducted in early April and early May, classified as late wet season and early dry season respectively. The camera traps were retrieved on 30 June, providing some extended dry season records.

The surveys confirmed the presence of Merten's Water Monitor (*Varanus mertensi*) in the East Branch in both the wet season and the dry season. This species was also found in the upper Finniss River, being observed at least once at every site surveyed. It was not detected at FRdsMB in the dry season. The more focused effort and the use of camera traps tripled the numbers of this species found in 2014 in the 2015 surveys. Camera traps were proven to be an effective method to monitor for this species.

Only one specimen of Mitchell's Water Monitor (*Varanus mitchelli*) was recorded from FRusMB on a camera trap. Although this species was recorded from sites further downstream (FRusFC and FRdsFC) in the 2014 sampling, it was only encountered this once in the two years of sampling in the upper catchment area.

The ambiguous finding of a Bare-rumped Sheath-tailed Bat (*Saccolaimus saccolaimus*) at FR@GS204 in 2014 was not repeated in 2015, but a feeding buzz from the related Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*) was recorded. It is most likely that the ambiguous call of 2014 was from the latter species, which is not listed.

The incidental observations from these surveys recorded a pair of the Partridge Pigeon (*Geophaps smithii*) on a dirt track to the northwest of the mine area. This species is listed as vulnerable nationally and for the Northern Territory. There was also a sighting by Ecological (2014) at a nearby site in their 2014 surveys, and there have been sporadic reportings of the species within a 10 km radius of the mine site between 1913 and 1996.

These findings demonstrate the presence of these listed species in the region, and specifically that Merten's Water Monitors do make use of the East Branch in the wet and dry seasons, at least while there is pooled water.

2.5 Riparian Fauna

Hydrobiology (2013b) recommended "a detailed survey of all terrestrial vertebrates downstream of the former Rum Jungle Mine to gain an understanding of species abundance and secondly to determine distribution in relation to the former Rum Jungle Mine be conducted". Riparian fauna surveys were undertaken to address this recommendation. The terrestrial vertebrate surveys were conducted within the vicinity of eight historical water sampling sites downstream and upstream of the former Rum Jungle Mine site during 2014.

Based on database records (i.e. IBRA Bioregions and EPBC Protected Matters Search Tool) and a review of the ecology of the Northern Territory and Commonwealth listed threatened species, approximately 19 threatened species could potentially occur in the vicinity of the project area. The field surveys recorded a total of 123 native terrestrial vertebrate species, comprising of 14 amphibians, 77 birds, 13 mammals and 19 reptiles; two introduced mammals and one introduced amphibian and reptile.

Two species listed as Vulnerable under the *Territory* Parks *and Wildlife Act* were observed during the surveys:

- Merten's Water Monitor (*Varanus mertensi*).
- Mitchell's Water Monitor (*Varanus mitchelli*).

Additionally, one species listed as Critically Endangered under the *EPBC Act* was considered likely to be present during the dry season at FR@G204:

- Bare-rumped Sheath-tailed Bat (*Saccolaimus saccolaimus*).

Also, three species listed as Migratory under the *EPBC Act* were observed during the surveys:

- White-bellied Sea-eagle (*Haliaeetus leucogaster*).
- Rainbow Bee-eater (*Merops ornatus*).
- Eastern Great Egret (*Ardea modesta*).

There were no significant differences in the mean daily diversity between sites. The highest recorded overall species diversities were at EBUSFR and FR@G204. Unfortunately most monitoring programs for terrestrial vertebrates in the Northern Territory have reported an apparent instability in species composition throughout the seasons (Woinarski *et al.* 2004; Dostine *et al.* 2013). Both of these studies found that the effort to monitor terrestrial vertebrate species must be very substantial in order to accurately detect a change for a species. As the present study was only done on a limited scale, any impacts related

specifically to the mine would be hard to confirm unless substantial effort was made. Overall there does not appear to have been any relationship between possible mine site drainage and the distribution of terrestrial vertebrates downstream of the mine.

Of particular note, was that Merten's Water Monitors were present in the wet season survey of the East Branch, but were not during the dry. It is recommended that this species is part of targeted monitoring during any works that could affect the water and habitat quality of the Finniss River.

The records of two other listed species were noteworthy and warranted further investigation, if not directly of relevance to setting water quality objectives or assessing the impacts of contaminant exports from the Rum Jungle site. Given the presence of Mitchell's Water Monitors in the lower catchment, listed as a Threatened Species in the Northern Territory, it was recommended that this species be further assessed to determine if it occurs at the upper sites as their apparent absence cannot be explained at this time. The recording of the Bare-rumped Sheathtail Bat, although not definitive, was particularly noteworthy, and it is recommended that a targeted search for this species be undertaken as if its presence is confirmed; it may require referral under the EPBC Act.

2.6 Riparian Flora and Bush Tucker

Baseline vegetation data for the Finniss River riparian zone, both upstream and downstream of the East Branch confluence, and along the East Branch itself, were found to be essentially absent from the published literature as were aquatic macrophyte survey data. The only riparian vegetation data of relevance that could be identified in the studies of Hydrobiology (2013a) were from the unpublished Area 55 NOI (Coffey Environments 2009) for a single site on the main branch of the Finniss River and two sites located on the flood levee above the East Branch confluence that may have included riparian plant assemblages.

The vegetation monitoring plan implemented during 2014 was designed to rectify these serious deficiencies by establishing a rigorous baseline for riparian vegetation prior to commencement of remedial works at the Rum Jungle mine-site. The resulting knowledge-base will be crucial to the assessment of trends in vegetation condition and biodiversity during and following the rehabilitation process.

Concerns over possible toxicity of native plant foods or 'bushtucker' collected from the Finniss River riparian zone have been expressed by Traditional Owners and other indigenous groups during stakeholder consultation meetings. The requirement for some analysis of heavy metals and other toxins that may be sequestered in fruits, tubers and other edible plant material was subsequently identified as a public health and safety issue and collection of specimens for this analysis was included in the sampling plan. The objectives of the field programs were to:

- Establish baseline riparian vegetation data for the Finniss River and the East Branch above and below the Rum Jungle Mine area, including the presence of rare and threatened native plant species in the survey area;
- Establish permanent vegetation monitoring sites within the riparian zone of the Finniss River and the East Branch, both above and below the Rum Jungle Mine area;
- Identify a methodology for determining short and long term trends in riparian vegetation condition during and following rehabilitation of the mine site;
- Allow for reporting on the spread or control of woody weeds and other invasive species along the Finniss River and the East Branch over time;
- Survey the presence and abundance of aquatic macrophytes in the fluvial environment, and record changes in abundance over time, and collect samples for heavy metal and radionuclide analysis;
- Record the presence and abundance of culturally significant plants or "bushtucker", and monitor trends in abundance over time;
- Analyse indigenous bush foods from the riparian zone to determine levels of heavy metals and their potential risk to human health, and to record over time potential trends in toxicity that may be associated with the mine rehabilitation; and
- Report results of the monitoring program and "bushtucker" heavy metal assay to stakeholders.

The riparian vegetation monitoring combined two primary methodologies developed for vegetation survey and monitoring in the Australian tropics and routinely deployed in the Top End, *i.e.* the DLRM Flora Survey Methodology (Dickinson & Kirkpatrick 1985) and the Tropical Rapid Appraisal of Riparian Condition (TRARC) (Dixon *et al.* 2006).

The flora survey techniques and data standards for vegetation analysis in the Northern Territory were first implemented during the Conservation Commission of the NT (now Department of Land Resource Management) project to map the Northern Territory vegetation from satellite imagery (Wilson *et al.* 1990). The methodology has been employed on all major vegetation surveys in the NT since that date. Vegetation is recorded for 20 m × 20 m square quadrats or 'plots', using a standard proforma that includes comprehensive attributes for location, landform, geology and soil; vegetation structure, dominant life form, projected cover and height for the canopy, mid and ground layers; and a record of projected cover and height for each species present in each layer.

The TRARC was developed by the Tropical Savannas CRC and participating agencies to facilitate assessment of the tropical riparian zone using condition indices derived from simple indicators recorded in the field. Significantly, the initial trial area for development of the TRARC concept included the Finniss River catchment. Four primary sub-indices for Plant Cover, Regeneration, Weeds and Erosion are calculated and summed to give an overall Riparian Condition index. An additional sub-index for Pressure is sometimes calculated separately but that assessment and the Erosion sub-index were not achievable during the

vegetation surveys. The complete TRARC proforma and associated score-sheets are available online (Land & Water Australia 2006).

The TRARC vegetation condition indices will provide a useful means to identify short and long term trends in vegetation condition both during and following the proposed Rum Jungle Mine rehabilitation process.

Employing the TRARC methodology showed a significant difference in Riparian Condition Index between the Finniss River and the East Branch, for both wet and dry season data. While this is encouraging it was not repeated in the analysis of species richness. The ephemeral nature of the East Branch compared with the perennial main Finniss River is likely to be a contributing factor and essentially prevents further speculation on the impact of the legacy mine on riparian condition and species richness, as indicated by low scores for sites in the East Branch catchment upstream of the mine.

The observed high variability between sites in the East Branch, particularly regarding species richness, also hampered meaningful interpretation of the 2014 data. Longer term studies that record changes in species composition at each site will potentially produce a more robust analysis. Furthermore, a complete inventory of woody species at all sites on the East Branch prior to commencement of rehabilitation works at the Rum Jungle mine-site would facilitate analysis of species diversity and should be considered a priority.

The value of retaining the lower Finniss River site FR1 in the riparian vegetation monitoring program is questionable. The site was included due to a previous biological survey and water sampling history and due to the deep expanse of slow-flowing water and steep banks it is considered unlikely to reflect any changes related to the Rum Jungle mine-site rehabilitation. Similarly the Florence Creek site contributed little to the overall analysis as none of the additional monsoon species present there were recorded at FR1 (Finniss River downstream Florence Creek confluence). The site at FR2 (Finniss River upstream Florence Creek confluence) is considered to be a good representation of the Lower Finniss riparian zone and it is recommended that FR1 and FC (Florence Creek upstream Finniss River confluence) be dropped from the monitoring program.

During the 2014 fieldwork it was observed that many 'bushtucker' species present in the riparian zone were not in season during the survey periods. Several of these are considered staples by indigenous groups in the area and should be included in the analysis. There would be some benefit to compiling a calendar of availability for those species not sampled to date and conducting a number of short visits to the catchment to acquire them.

Aquatic macrophytes were generally scarce throughout the Finniss River system and meaningful analysis of distribution and abundance over time is not possible. The only aquatic macrophytes present in any quantity in the East Branch were Olive Hymenachne (*H. amplexicaulis*), an invasive weed, and the cane grass *P. vallatoria*. Long-term analysis of these species, including heavy metal and radionuclide assay of vegetative material is likely to be

beneficial. It is recommended that regular sampling of these two species for laboratory analysis be continued during and following the Rum Jungle mine-site rehabilitation.

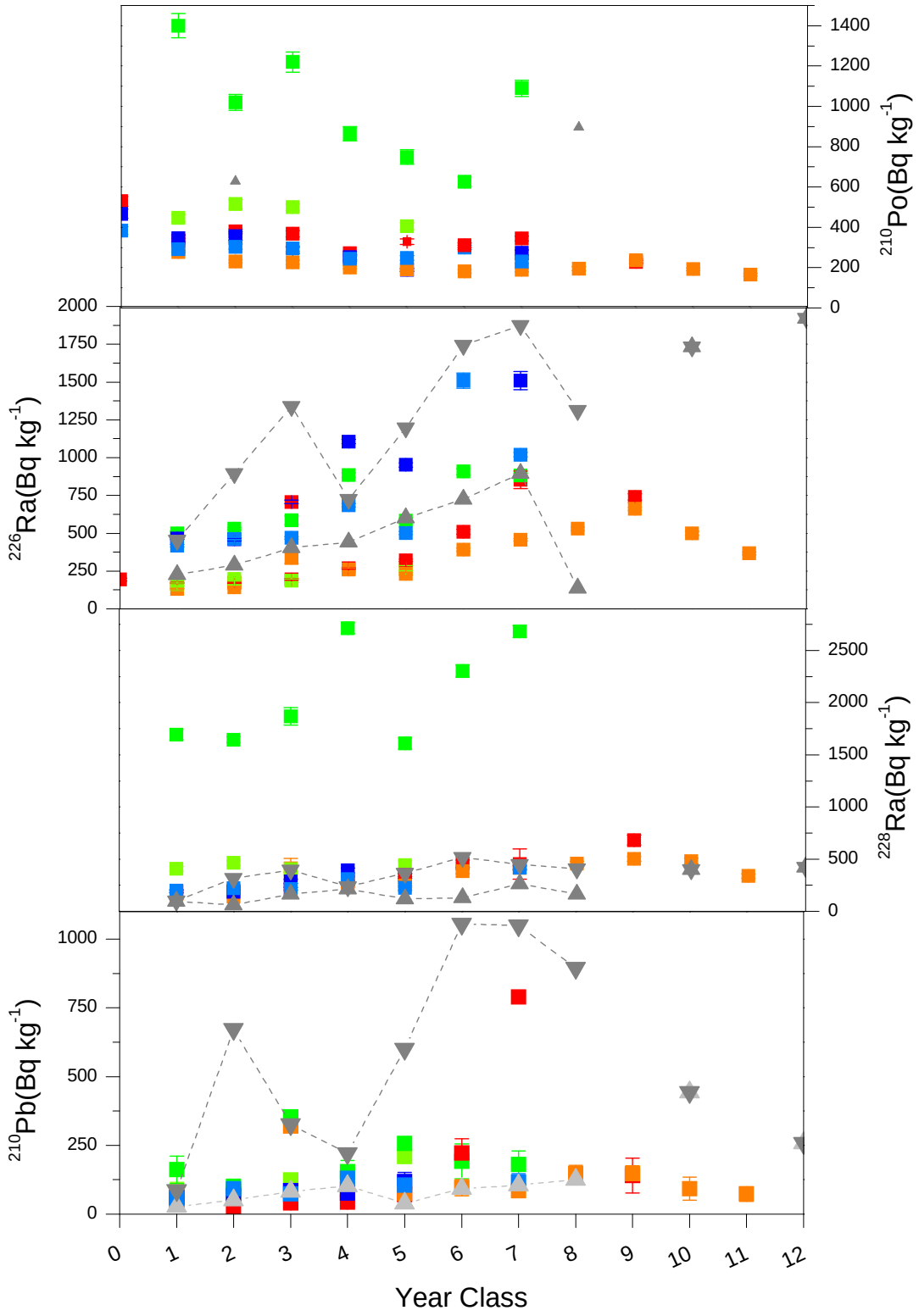
2.7 Radionuclides in Fish, Mussel and Prawn Tissues

2.7.1 2014 Sampling

Analysis and reporting of radionuclide activity concentrations in biological tissues requires several months after receipt at the laboratory. Therefore, results from the aquatic biota samples collected in May/June 2014 were only reported late in the year. The radionuclide activity concentration results now available were not reported in the Aquatic Biota sampling report and have not been previously presented.

The analysis results from mussels are illustrated in Figure 2-10. Generally the activity concentrations for mussels from the Finniss River system were within the ranges from several years of monitoring of Mudginberri Billabong on the Magela Creek floodplain (downstream of Ranger Uranium Mine) as reported by Ryan *et al.* (2005). The exception was for FC@LB, which was substantially higher than the Mudginberri year class values for ^{210}Po and ^{228}Ra. As this site was upstream of the Rum Jungle mine area, and adult mussels are unable to move upstream, this must reflect naturally elevated bioavailability of those radionuclides in the Fitch Creek sub-catchment.

Stepwise two-way analysis of variance (ANOVA) was used to compare between sites and year class for each radionuclide. The results are summarised in Table 2-3. Both the upper East Branch sub-catchment sites had higher activity concentrations than any of the Finniss River sites for^{228}Ra and ^{210}Po after taking year class into account, but there was no indication of position in the catchment being the cause of between-site differences for ^{210}Pb or ^{226}Ra.



FC@LB EB@LB FRusMB FRdsMB FR@GS204 FR3 lowest year class concentration for Mudginberri Billabong for any year from Ryan *et al.* (2005) Highest year class concentration for Mudginberri Billabong for any year from Ryan *et al.* (2005)

Figure 2-10. Activity concentrations of selected radionuclides in 2014 mussel samples

Table 2-3 ANOVA and multiple comparison test results for mussel radionuclide activity concentrations

Radionuclide	Site	Year	Site×Year	Multiple comparison
^{226}Ra	P<0.001	P<0.001	Not included	FRdsMB=EBLB=FRusMB < FRGS204=FCLB=FR3
^{228}Ra	P<0.001	P<0.001	Not included	FRdsMB=FRGS204=FRusMB=FR3 < EBLB < FCLB
^{210}Pb	P=0.018	P=0.004	P=0.023	FRusMB < FCLB, all others not different from any other
^{210}Po	P<0.001	P<0.001	Not included	FR3=FRGS204 < FRusMB=FRdsMB < EBLB < FCLB

Multiple comparison test was undertaken as part of the ANOVA. The multiple comparisons indicated if there was a significant difference between sites. = indicates no significant difference between the sites; < indicated significantly lower concentration and > indicates a significantly higher concentration between the listed sites.

As mussels were not present in the East Branch from the mine area downstream, it was not possible to examine any further the influence on bioavailability of the radionuclides from the Rum Jungle mine area. The results only demonstrated that bioavailability of ^{228}Ra and ^{210}Po was enhanced in the upper East Branch catchment relative to the other sites, presumably due to mineralisation.

Among fishes, only Barramundi *Lates calcarifer* and Bony bream *Nematalosa erebi* were collected in sufficient quantities for collection for radionuclide analysis at multiple sites due to the laboratory requirement for at least 250 g of tissue per sample, and for Bony bream only then as composite samples. The radionuclide activity concentrations in those samples are shown in Figure 2-11. The activity concentrations are compared with the averages for the same radionuclide in flesh of the same fish species from Magela Creek billabongs (downstream, of Ranger Uranium Mine) reported by Martin *et al.* (1998). Only three Barramundi specimens of sufficient size were collected in total, but importantly one of those was from the East Branch above the Finniss River junction. Those specimens all had activity concentrations of ^{210}Pb and ^{228}Ra that were substantially higher than for the Magela Creek specimens, but had lower ^{210}Po activity concentrations. Similarly, Bony bream activity concentrations above the Magela Creek averages were found for all sites for ^{210}Pb and for FR@GS204 and FR2 for ^{228}Ra.

Statistical comparisons could only be made for Bony bream. There were no significant differences between sites for ^{210}Po, ^{210}Pb, or ^{228}Ra, but there was a significant difference for ^{226}Ra, with the average for FRusMB lower than for FR@GS204 and FR2 but with no other significant differences.

None of the patterns of radionuclide activity concentrations in fish tissues were consistent with a substantial source of elevated bioavailability from the Rum Jungle mine area, although the absence of large specimens at most East Branch sites amenable to radionuclide analysis resulted in only one specimen from the East Branch downstream of the site being analysed. Certainly, there was no indication of elevated bioaccumulation in specimens in the Finniss River downstream of the East Branch, and also no indication of increased bioaccumulation downstream of the abandoned Mount Burton mine.

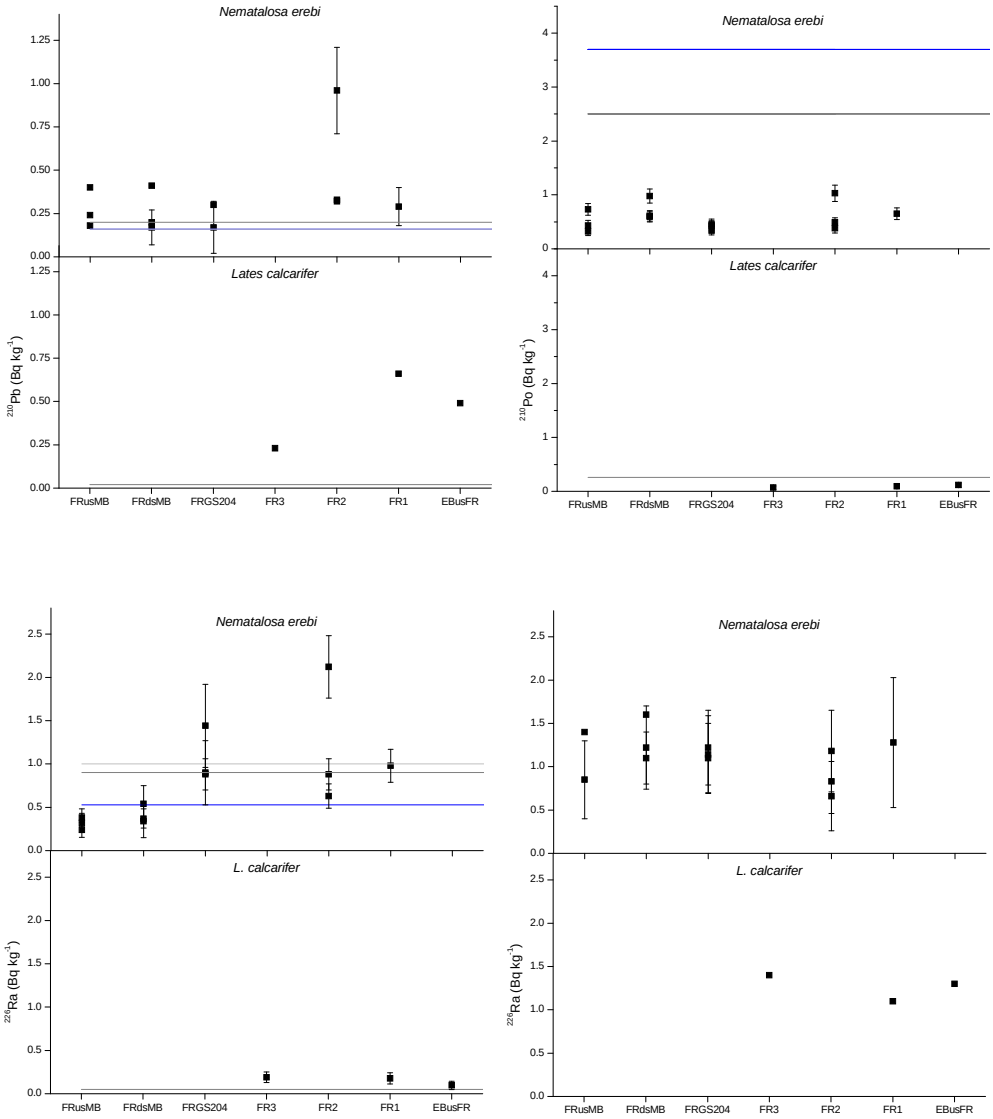


Figure 2-11 Radionuclide activity concentrations for fish flesh samples
Reference lines – blue=Georgetown Billabong, grey=Mudginberri Billabong, light grey=Gunirdul Billabong from Martin *et al.* (1998)

2.7.2 2015 Sampling

In 2015, it was decided to focus the effort devoted to examining radionuclide bioavailability to the East Branch, given the indications of no mine influence on samples from the main Finniss River in 2014. However, the lack of mussels or large bodied fishes in the East Branch, meant that another approach would be needed than the more traditional collection of large tissue samples for radiation emission counts. The lack of large-bodied fishes and mussels was confirmed for the East Branch in the 2015 sampling.

Therefore, it was decided to trial the auto-radiography technique that had been developed by Cresswell *et al*. (2015). This technique has been shown to trace the location of and relative

accumulation of tracer radioisotopes for laboratory metal bioaccumulation studies in the freshwater prawn *Macrobrachium australiense*. As the related *Macrobrachium bullatum* is a common constituent of East Branch aquatic assemblages, and mussels in the catchment were known to accumulate substantial quantities of ^{210}Po and ^{228}Ra, it was considered possible that *M. bullatum* would bioaccumulate sufficient radionuclides at East branch sites for the autoradiography technique to work. If it did, while not providing numeric activity-concentration data it would provide pictorial evidence of relative bioaccumulation. Such visual data would also be potentially useful in discussion of radionuclide bioaccumulation by aquatic organisms in the catchment with stakeholders, particularly Traditional Owner groups.

To that end, up to five specimens of *M. bullatum* were collected from each site in the main Finniss River and East Branch. The specimens were euthanised by putting on dry ice, and then immersed in Cryomatrix resin (Thermofisher) and frozen by placing on dry ice. The collected specimens were shipped on dry ice to Dr Tom Cresswell at ANSTO for further analysis. Once received the specimens were stored in a -80°C freezer until analysed. Specimens from the sites most likely to have the highest natural bioavailability of radionuclides (FC@LB, EB@LB, EB@GS200, EB@GS327) were then frozen sectioned at 20 µm in the Cryomatrix using a cryomicrotome (Cryostat Leica CM3050 S, Leica Biosystems) and then thaw mounted onto gelatin-coated glass slides. The slides were immediately dehydrated on a slide warmer at 37°C for 15 min and then covered with a thin mylar film and exposed to a phosphor plate (BASSR 2040) in the dark at room temperature for three weeks, and the resulting exposed plate imaged in a GE Typhoon FLA 7000 reader.

Although this method has been proven to work to image the location and relative amount of bioaccumulated radioisotopes in laboratory tracer studies at realistic total metal concentrations, the plates produced from the East Branch specimens failed to register any visible evidence of radioactivity. Unfortunately, since this technique did not work at the levels of radioactivity in field collected prawns, and in the absence of large bodies fishes or mussels in the East Branch that can be used for more traditional measurements of radionuclide activity concentrations, we have been unable to determine the patterns of exposure to bioavailable radionuclides at sites in the East Branch in zones 2, 3 or 4.

3 SUMMARY OF EXISTING IMPACTS

3.1 Water Quality

- Wet season first flush pulses of elevated metal concentrations have been observed in water samples from the Rum Jungle mine downstream to FRdsFC for Cu, and to FRusFC for several metals including Co, Mn, Ni and Zn in the wet season;
- Wet season flushes of elevated aluminium and iron concentrations above the WQOs that were not related to the mine area were observed at sites upstream of the mine, and there were also inputs of elevated metal concentrations originating at the Mount Burton mine site into the Finniss River upstream of the East Branch;
- During the dry season metal concentrations typically increase in the mine area in the isolated pools in streams after flow ceases, but generally dry season metal concentrations decline at sites downstream of Zone 2;
- There were quality control issues with the water quality sampling in 2012 to 2014 indicative of contamination with Al, Cu, Mn, Ni, Pb and Zn, possibly via contamination of the sample bottles. There was also high variability between duplicate samples, particularly for Pb and Zn, indicating potential problems with sample representativeness and/or analysis precision for those parameters.

3.2 Sediment Quality

- The <63 µm fraction of stream sediments were elevated above the ISQG-low in Cu and Ni from the mine area downstream to FRdsFC, Pb and Zn to FRusFC, and Cd and As at some sites to Zone 4. Often the measured concentrations were elevated above the ISQG-high;

3.3 Fauna and Flora

- There was no evidence of adverse impact to the aquatic ecosystems of the Finniss River proper at any site. This finding was consistent with the results of the sampling for fishes, macroinvertebrates and diatoms in the 1990s, except that it indicated substantial improvement for populations of mussels in the Finniss River between the East Branch and Florence Creek;
- The fish, macroinvertebrate and diatom assemblages of the East Branch had improved relative to their condition in the 1990s despite no further remediation of the mine area. The reason for this was not determined;
- Nonetheless, there were clear gradients of impact to all three groups examined in the East Branch from the mine area downstream, except for individual sites that had less impact for one or other group than the general trend would indicate.
- Tissue metal concentrations in a number of species indicated increased bioavailability of copper and zinc in the mine area, and cobalt and nickel either in the mine area or shortly downstream of it, with gradual reduction of bioaccumulation of those metals

downstream through the East Branch, and no evidence for increased bioaccumulation of metals at any of the Finniss River sites;

- No evidence was found of radionuclide bioavailability enhancement in the mine area, but the assessment was made difficult due to the lack of mussels and large fishes from Zone 2 downstream in the East Branch. Increased biovailability of ^{210}Po and ^{228}Ra was found for the sites upstream of the mine area, particularly for Fitch Creek.
- Aquatic reptile surveys indicated a general low abundance of turtles, but recorded the presence of two Territory listed water monitors in the catchment, one of which, Merten's Water Monitor, was present in the East Branch in both the wet season and dry season in 2015 and in the Finniss River in both seasons in 2014. Saltwater and freshwater crocodiles were present throughout the Finniss River survey area, but only freshwater crocodiles were recorded in the lower East Branch in both 2014 and 2015 despite habitat and food opportunities being present.
- There was no evidence for impact to the riparian fauna of the East Branch or the Finniss River downstream of the mine area other than the absences Saltwater crocodiles noted above; and
- There was no evidence for impact to the riparian flora of the East Branch or Finniss River downstream of the mine area, although the intermittency of flow in the East Branch was the strongest influence on floral composition and may have masked any other differences between sites.

4 LDWQO DEVELOPMENT

It was intended that the impact assessment would assist with further refining the water quality objectives (WQOs) developed by Hydrobiology (2013a). Although the development of the WQOs considered a range of environmental values, in practice they were all generally based on aquatic ecosystem protection levels. However, they were unable to take into account local factors that might affect the toxicity of metals or other parameters, such as greater tolerance by the local biota, or local water composition influencing bioavailability. Particularly, since it was known that the East Branch population of Black-banded rainbowfish had developed greater physiological tolerance of copper than other populations (Gale *et al*. 2003) it was possible that more relaxed WQOs might achieve the required levels of ecosystem biodiversity protection if such increased tolerance was common for the East Branch assemblages. With the availability of aquatic biota assemblage status data and companion water quality data, it was decided to investigate whether this might be the case, and if so what parameter concentrations might be tolerated to the ecosystem protection levels desired for each Zone under the WQO framework of Hydrobiology (2013a).

Although the default trigger value derived WQOs provided conservative values, in the East Branch where the intent of the rehabilitation is to achieve acceptable ecosystem health with finite resources, using the status of the aquatic ecosystems along the gradient of water quality downstream of the mine area to indicate what concentrations of each parameter would afford acceptable levels of biodiversity protection might result in higher, and therefore more affordable WQOs. This would make design and implementation of a rehabilitation strategy to meet those WQOs more practical to achieve with reasonable engineering tolerances. An approach was developed that could make use of the monitoring data to develop such WQOs based on observed biodiversity, using the monitoring data compiled for this impact assessment.

4.1 Methodology

The WQO's set by Hydrobiology (2013a) were defined in terms of the percentage of the hypothetical aquatic community at each site that would be expected to be protected, based on a global database of species sensitivity to that parameter compiled by ANZECC/ARMCANZ (2000), except for the few instances where an environmental value other than aquatic ecosystem drove the WQO. Although it would be impractical to assess the status of all ecosystem components, the aquatic biota assessment conducted for this impact assessment collected data on aquatic vertebrates, invertebrates and algae. Therefore, there was at least some representation of all trophic levels in the community, except perhaps some microbial trophic groups. Hence, the status of the taxonomic richnesses of those groups at each site would reasonably be expected to be representative of the taxonomic richness of the complete ecosystem. However, as only two rounds of sampling have been conducted to date, it would not be possible to have collected all taxa in each of those groups that could occur at each site, and so even at reference sites the observed taxonomic richness would be a subset of the total possible taxonomic richness. Further, random sampling effects would result in a different subset of the total assemblage being represented in the samples

from each site, even for reference sites that shared a consistent total assemblage. The methodology to derive LDWQOs had to take these sampling effects into account.

The total taxonomic list of each of the groups was compiled across all sampling sites for both the 2014 and 2015 May/June sampling rounds. The sampling of a limited number of sites in the East Branch in September 2015 was not included in this analysis. The proportion of the total list for each year that was collected at each site was then determined as shown in Table 4-1. This demonstrated that no site recorded 100% of the taxa recorded overall for any group. The maximum percentage for fish was 78% at FRusFC, for macroinvertebrates was 53% at FRusMB and for diatoms was 27% at EB@LB. Across all three taxonomic groups the highest percentage was 43% at FR3 and FRdsFC. Clearly, even at the reference sites a single round of sampling was not able to collect 95% of any taxonomic group, and not even 50% of all taxa.

Table 4-1 Percentage of each taxonomic group recorded at each sampling site in each year (2014/2015). Blank cells indicate group was not sampled at that site in both years. NA indicates not sampled in that year.

	Site	Number fish taxa	% of total	number macroinvertebrate taxa	% of total	number diatom taxa	% of total	% all biota
East Branch	FCLB	7/6	19/19	21/18	47/40	27/23	18/15	28/25
	EBLB	8/5	22/16	11/21	24/47	41/38	27/25	25/29
	EBDys					17/25	11/17	
	EBGS200	6/5	17/16	4/10	9/22	6/22	4/15	10/17
	EBGS327	12/11	33/34	7/8	16/18	24/12	16/8	22/20
	EBdsRB	7/9	19/28	17/9	38/20	19/17	13/11	23/20
	EBGS097	15/12	42/38	12/15	27/33	NA/17	NA/11	34/20
	EBusHS	12/12	33/38	10/14	22/31	23/21	15/14	24/28
	EBdsHS	12/14	33/44	11/8	24/18	24/18	16/12	25/24
	EBusFR	21/17	58/53	11/12	24/27	26/20	17/13	33/31
Finniss River	FRusMB	20/23	56/72	6/24	13/53	27/32	18/21	29/49
	FRdsMB	19/21	53/66	18/12	40/27	26/28	17/19	37/37
	FRGS204	21/21	58/66	21/18	47/40	31/22	21/15	42/40
	FR3	22/23	61/72	21/18	47/40	32/21	21/14	43/42
	FRusFC	25/25	69/78	18/11	40/24	21/35	14/23	41/42
	FRdsFC	24/17	67/53	19/19	42/42	29/26	19/17	43/38
	FR0			23/NA	51/NA			

A more realistic assessment of the relative taxonomic richness at any site was a comparison of the percentage of the total list of taxa in each group and overall at each potentially impacted site with those values for the relevant reference sites. This was done by calculating the average taxonomic richness for each group and overall for the reference sites, and calculating the proportion of that number found at each site downstream of the mine lease area.

The inability of fishes to reach the upper sections of the East Branch without traversing through the impacted reaches, meant that the sites upstream of the mine area could not be considered reference sites for that group or, therefore, for all groups combined. There was no evidence of any impact from the Rum Jungle mine area on the aquatic biota of the Finniss River upstream of the East Branch or downstream of Florence Creek either historically or in the 2014 sampling, and therefore, sites in Zones 5 and 7 were considered as potential reference sites. However, site FRusMB was found to have had an unusually depauperate macroinvertebrate assemblage in 2014, which was postulated to have been due to the only location that was safe to sample being a short distance from a ford. Therefore, that site was not considered to be a valid reference site for macroinvertebrates or for overall taxonomic richness for 2014 sampling. At site FR0 only macroinvertebrates were sampled and only in 2014, because other taxa had not been sampled from that site previously, and so that site was also not considered to be a reference site for fish, diatoms or all taxa combined.

The percentage of each taxonomic group at each site was then adjusted to the percentage of the average taxonomic richness for sites FRusMB, FRdsMB, and FRdsFC for fishes and diatoms, FRdsMB, FRdsFC and FR0 for macroinvertebrates and FRdsMB and FRds FC in 2014 and FRusMB, FRdsMB and FRdsFC in 2015 for all groups combined. These figures are provided in Table 4-2.

In general, the Finniss River sites were all near 95% or more of the reference site average taxonomic richness, with the exceptions being the depauperate macroinvertebrate assemblage at FRusMB in 2014 and at FRdsMB and FRusFC in 2015, somewhat lower fish diversity at FRdsMB in 2014 and FRdsFC in 2015, and lower diatom diversity in the shaded section of FRusFC that could be sampled safely in 2014, and in a similarly shaded reaches at FR@GS204 and FR3 in 2015. There was also a trend for increasing taxonomic richness downstream of the mine in the East Branch except for unusually high richness of macroinvertebrates at EBdsRB in 2014 and EB@GS097 and EBusHS in 2015, unusually high fish richness at EB@GS097 in 2014 and high diatom richness at EB@GS327 in 2014 and at the zone 2 sites, EB@G_DYS and EB@GS200, in 2015. Therefore, although a simple metric, the percentage of reference richness does seem to have mirrored the patterns of aquatic ecosystem component health that were discerned by the more thorough data analysis.

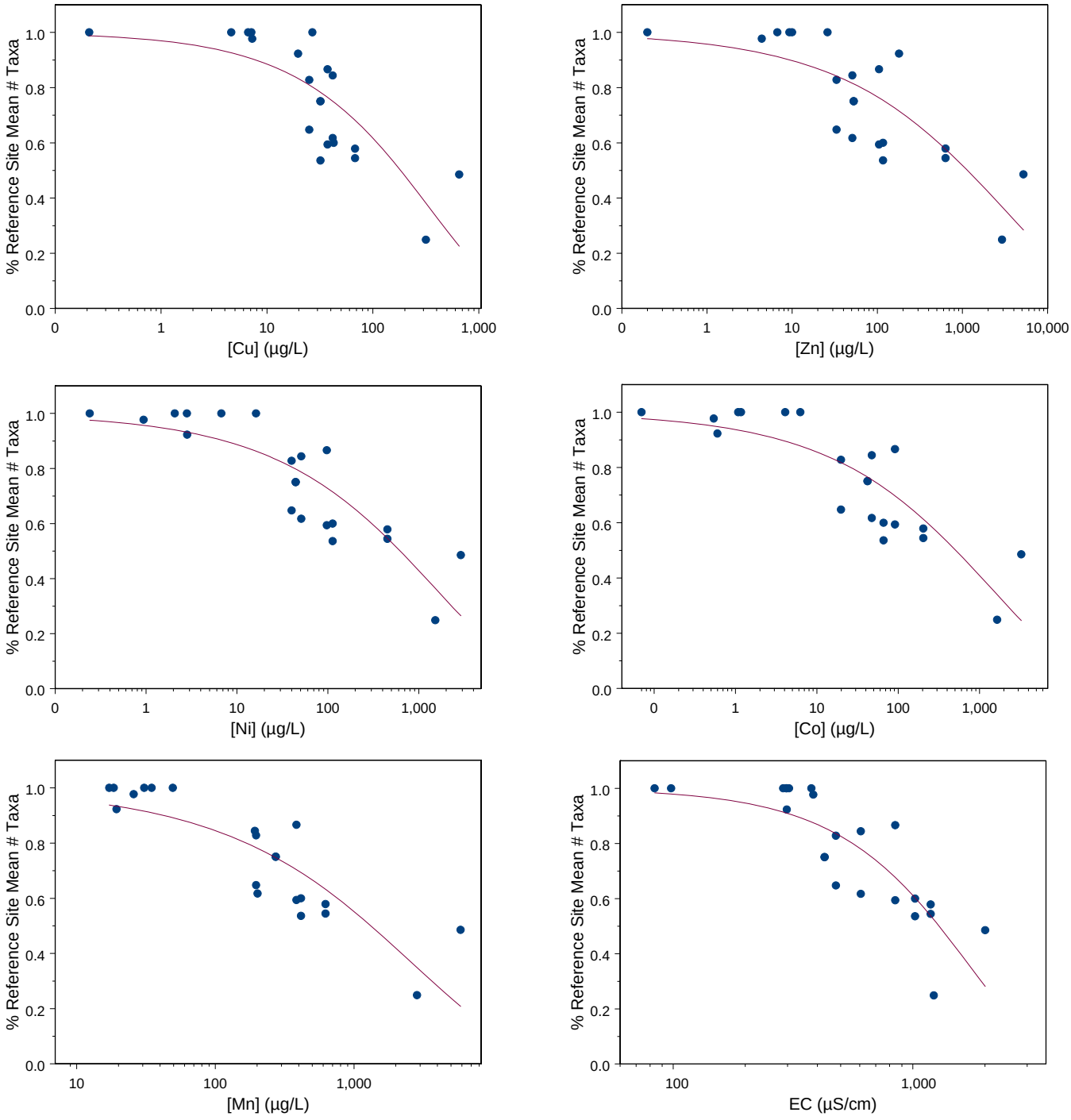
Table 4-2 Percentage of average reference site taxonomic richness at each site for each taxonomic group and for all taxa combined.
Shading: green = >95%, orange = between 95% and 80%, red = <80%

		2014				2015			
		%Fish	%Macros	%Diatoms	%All Taxa	%Fish	%Macros	%Diatoms	%All Taxa
	Site	% of Zone 5&7 mean	% of Zone 5&7 mean	% of Zone 5&7 mean	% of Zone 5&7 mean	% of Zone 5&7 mean	% of Zone 5&7 mean	% of Zone 5&7 mean	% of Zone 5&7 mean
East Branch	FC@LB	33%	114%	98%	69%	30%	116%	85%	66%
	EB@LB	38%	59%	149%	61%	25%	135%	141%	78%
	EB@G_Dys			62%				93%	
	EB@GS200	29%	22%	22%	25%	25%	65%	81%	47%
	EB@GS327	57%	38%	87%	54%	54%	52%	44%	54%
	EBdsRB	33%	92%	69%	58%	44%	58%	63%	53%
	EB@GS097	71%	65%		87%	59%	97%	63%	73%
	EBusHS	57%	54%	84%	59%	59%	90%	78%	74%
	EBdsHS	57%	59%	87%	62%	69%	52%	67%	66%
	EBusFR	100%	59%	95%	84%	84%	77%	74%	83%
Finniss River	FRusMB	95%	32%	98%	73%	113%	155%	119%	131%
	FRdsMB	90%	97%	95%	92%	103%	77%	104%	99%
	FR@GS204	100%	114%	113%	105%	103%	116%	81%	108%
	FR3	105%	114%	116%	108%	113%	116%	78%	113%
	FRusFC	119%	97%	76%	104%	123%	71%	130%	113%
	FRdsFC	114%	103%	105%	108%	84%	123%	96%	101%
	FR0		124%						

It was then possible to examine the relationships between these measurements of relative biodiversity with water quality over a number of time periods leading up to the sampling rounds in 2014 and 2015 or representative of the wet and dry season each year. The water quality summary statistics that were examined for an initial set of parameters (copper, zinc, nickel and cobalt) were the upper 95%ile concentration for each metal for all monitoring data up to the date of sampling, for all wet or dry season sampling up to the date of sampling, the maximum concentration for the 12 months of sampling leading up to the month of sampling and the maximum of the period from January to May for each year.

It was then examined whether a concentration-response relationship could be found between these summary measurements of parameter concentrations and the observed percentage of reference site taxonomic richness at each site. This was done using the 'drc' package in the R statistical computer program, using the three parameter log-logistic and the four parameter Weibull functions. In these analyses, the percentage of reference average figures were limited to an upper bound of 100%, and the dose-response fitting procedure was not suited to values above that. The best fits for each parameter were consistently for the Weibull distribution and the maximum concentration for the period January to May for each year of sampling.

Curve fits were then examined similarly using the Weibull function and the maximum (or minimum for pH) concentration for January to May sampling for all parameters for which there were available water quality measurement data for that time period for 2014 and 2015, and for which there was an overall trend between observed taxonomic richness and measured parameter concentration. The resulting curves are shown in Figure 4-1 and the data used are shown in Table 4-4.



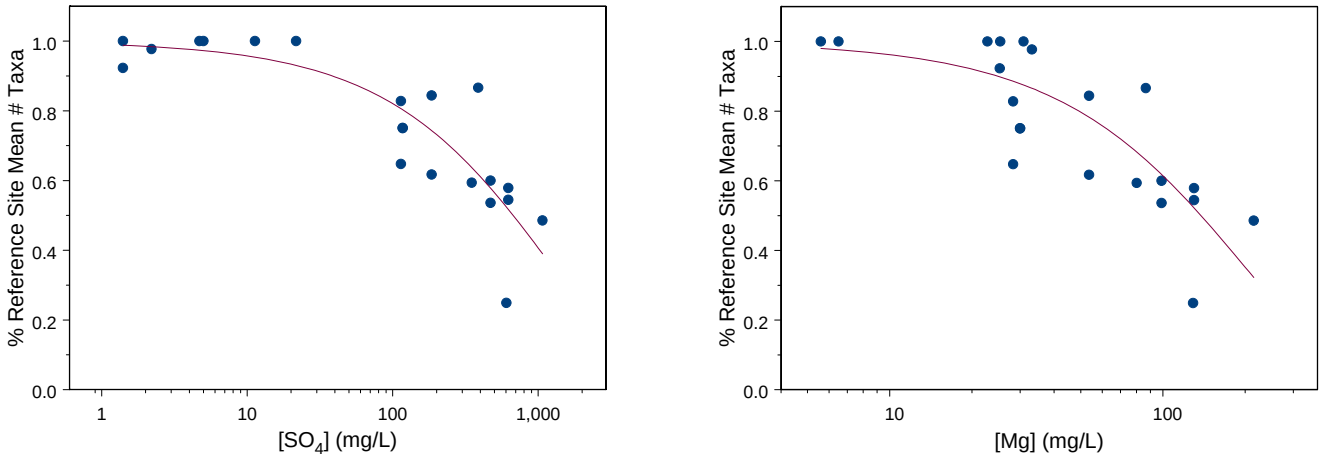


Figure 4-1 Weibull function fits for parameter concentrations versus percent of average reference site number of taxa across all groups for all parameters with a relationship

Poor fits or no decline in relative biodiversity with increasing concentration were found for aluminium, iron, cadmium, uranium and pH. As aluminium and iron are commonly substantial constituents of acid rock drainage, the threshold response method (described in the impact assessment report) was used to seek LDWQOs for those parameters, but the other parameters were not considered further and the default WQOs for them from Hydrobiology (2013) should continue to be used.

The model fits for zinc, sulphate and magnesium were significantly poor ($p<0.05$, i.e. deviated significantly from a good fit), but the relationships were nonetheless used to examine whether the fitted trend line provided higher recommended LDWQOs than either the default WQOs or the threshold approach LDWQOs.

The model fits for copper, cobalt and nickel were not significantly poor ($p>0.05$). They generated percentile effect concentrations (e.g. EC5= the concentration that would be predicted to reduce taxonomic richness by 5%) that were below the default ANZECC/ARMCANZ (2000) concentrations for low percentiles (EC5 and EC1 or in the terminology used by ANZECC/ARMCANZ (2000) the 95% protection concentration and 99% protection concentration) but were above the equivalent ANZECC/ARMCANZ (2000) concentrations for the higher effect levels/lower protection levels that had been agreed to under the Hydrobiology (2013a) WQO framework for the East Branch zones from the mine lease area downstream. This was to be expected, as the datasets used for these model fits included either sites with at or above 95% relative taxonomic richness but low metal concentrations, or sites with higher metal concentrations, but generally substantially lower than 95% relative taxonomic richness, and with no sites with metal concentrations close to the ANZECC/ARMCANZ (2000) 95% protection values. That is, the fitted curves would be expected to generate better fits for sites with lower than 95% relative taxonomic richness, but under-predict ecosystem tolerance at low effect levels.

Therefore, the pattern of predicted effect concentrations from the fitted functions matched the pattern that would be expected if the observed responses were due to ecosystem response to toxicity from copper, cobalt and nickel. The predicted EC%iles for the other metals were generally lower than those generated from toxicity data by ANZECC/ARMCANZ (2000), suggesting that those metals were not directly deriving the observed biodiversity reductions in the East branch, but were correlated with the primary drivers.

4.2 Calculated LDWQOs

LDWQOs were calculated for each parameter in each river zone using the following decision tree (illustrated in Figure 4-2):

- If a good model fit was achieved, and the percentile biodiversity response concentration for each river zone was higher than the default WQO for that zone, the Weibull function-derived figure was used;
    - If the percentile response concentration was lower than the default WQO but the threshold response value (i.e. the maximum parameter concentration associated with at least the desired relative proportion of reference biodiversity at a site) was greater than the default WQO, the threshold LDWQO was used; or else
    - The default WQO was retained
- If a poor model fit was achieved, but the Weibull function-derived concentration was higher than the default WQO, then;
    - If the percentile response concentration was greater than the threshold response concentration, the Weibull function-derived concentration was used; else
        - If the threshold response concentration was higher than both the fitted percentile response concentration and the default WQO it was used; else
        - If the default WQO was higher than the threshold response LDWQO, the default WQO was retained.

The resulting recommended LDWQOs are provided in Table 4-3.

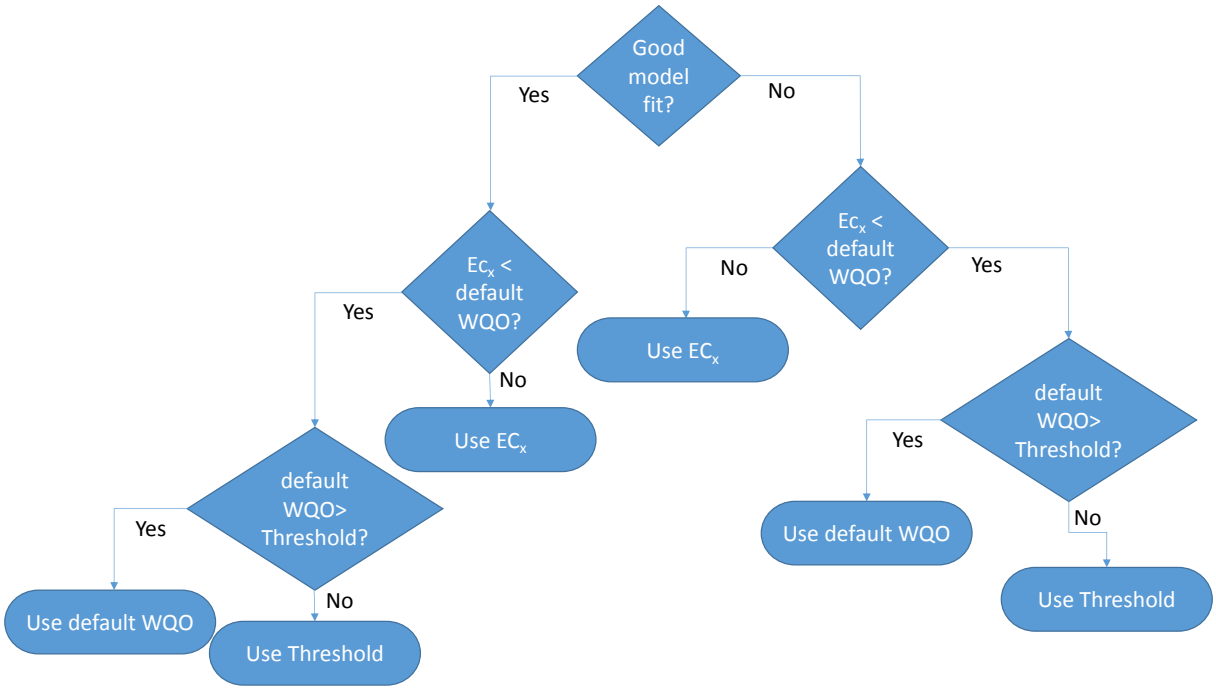


Figure 4-2 Flowchart for selecting LDWQO from fitted curves and site threshold concentrations for each parameter for each zone.

Table 4-3. Recommended Locally Derived Water Quality Objectives for each parameter.

	River Zone	Site	Parameter Cu µg/L	Zn µg/L	Ni µg/L	Co µg/L	Al µg/L	Fe µg/L	Mn µg/L	EC µS/cm	SO_4 mg/L	Mg mg/L
East Branch	1	FC@LB	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	1	EB@LB	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	2	EB@G_Dy	60.2	210.5	130.4	89	236	300	759	2985	1192	86.6
	2	EB@GS20	60.2	210.5	130.4	89	236	300	795	2985	1192	86.6
	3	EB@GS32	27.5	180	43.1	25.9	150	300	443	2985	997	86.6
	3	EBdsRB	27.5	180	43.1	25.9	150	300	443	2985	997	86.6
	3	EB@GS09	27.5	180	43.1	25.9	150	300	443	2985	997	86.6
	3	EBusHS	27.5	180	43.1	25.9	150	300	443	2985	997	86.6
	4	EBdsHS	7.86	180	32.5	3.6	117	300	228	427	761	33.2
	4	EBusFR	7.86	180	32.5	3.6	117	300	228	427	761	33.2
Finniss River	5	FRusMB	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	5	FRdsMB	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	6	FR@GS20	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	6	FR3	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	6	FRusFC	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	7	FRdsFC	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2
	7	FR0	3.4	26.1	20	2.8	117	300	140	190.7	594	33.2

NB: Black text indicates derived from a statistical curve fit (Weibull function), Red text indicates derived from maximum concentration recorded at a site with at least the desired biodiversity, and Green text indicates derived from the default water quality objectives from Hydrobiology (2013). For other parameters see Hydrobiology (2013)

Table 4-4 Maximum (or minimum) parameter concentrations for January to May and percent of average reference site number of taxa for each year for each site

Year	Site	RD=% reference average # taxa	RD bounded at 100%	Cu µg/L	Zn µg/L	Ni µg/L	Co µg/L	Al µg/L	Fe µg/L	Mn µg/L	Cd µg/L	U µg/L	pH	EC µS/cm	SO_4 mg/L	Mg mg/L	Pb µg/L
2014	EB@GS200	25%	25%	317	2920	1520	1650	67.6	100	2850	4.82	14.9	6.26	1224	604.00	129.00	0.42
2014	EB@GS327	54%	54%	68	632	453	204	103	100	625	1.44	6.29	6.23	1187	623	130	0.33
2014	EBdsRB	58%	58%	68	632	453	204	103	100	625	1.44	6.29	6.23	1187	623	130	0.33
2014	EB@GS097	87%	87%	37.4	105	97.3	91.6	103	102	385	0.32	6.73	6.03	845	387	86.6	1.35
2014	EBusHS	59%	59%	37.4	105	97.3	91.6	103	102	385	0.32	6.73	6.03	845	349	80.2	1.35
2014	EBdsHS	62%	62%	41.8	51	50.9	47.5	51.3	120	202	0.14	14.3	6.42	607	185	53.7	0.4
2014	EBusFR	84%	84%	41.8	51	50.9	47.5	51.3	120	193	0.14	14.3	6.42	607	185	53.7	0.4
2014	FRdsMB	92%	92%	19.7	180	2.84	0.6	62.4	166	19.4	0.04	1.12	7.27	298	1.4	25.3	1.32
2014	FR@GS204	105%	100%	26.9	26.1	16.2	6.28	89.7	136	49.4	0.32	2.3	6.26	297	21.7	25.4	1.32
2014	FR3	108%	100%	26.9	26.1	16.2	6.28	89.7	136	49.4	0.02	3.44	6.99	288	21.7	25.4	1.32
2014	FRusFC	104%	100%	26.9	26.1	16.2	6.28	89.7	136	49.4	0.32	2.3	6.26	297	21.7	25.4	1.32
2014	FRdsFC	108%	100%	4.61	9.3	2.07	1.08	34.7	196	17.2	0.02	0.35	5.89	98	4.7	6.5	0.4
2015	EB@GS200	49%	49%	654	5210	2900	3260	107	72	5880	8.14	14.6	6.06	2005	1070	215	0.73
2015	EB@GS327	60%	60%	42.7	117	113	66.1	68.9	62	415	0.34	6.13	6.49	1021.5	471	98.9	0.69
2015	EBdsRB	54%	54%	32	117	113	66.1	68.9	62	415	0.34	6.13	6.49	1021.5	471	98.9	0.69
2015	EB@GS097	75%	75%	32	52.9	44.2	42.1	71.1	66	273	0.14	2.66	6.52	428.2	117	30	0.49
2015	EBusHS	75%	75%	32	52.9	44.2	42.1	71.1	66	273	0.14	2.66	6.52	428.2	117	30	0.49
2015	EBdsHS	65%	65%	25.1	33.2	40	19.8	66	210	197	0.12	25.7	5.97	478	114	28.3	0.22
2015	EBusFR	83%	83%	25.1	33.2	40	19.8	66	210	197	0.12	25.7	5.97	478	114	28.3	0.22
2015	FRusMB	133%	100%	0.21	0.2	0.24	0.07	10.9	20	30.7	0.02	1.6	6.67	377.5	1.4	30.9	0.01
2015	FRdsMB	98%	98%	7.26	4.4	0.94	0.54	117	222	25.8	0.02	1.85	6.43	384.3	2.2	33.2	0.11
2015	FR@GS204	108%	100%	7.13	6.7	6.75	4.09	91.6	230	34.8	0.02	2.12	6.51	304.5	11.3	22.8	0.17
2015	FR3	112%	100%	7.13	6.7	6.75	4.09	91.6	230	34.8	0.02	2.12	6.51	304.5	11.3	22.8	0.17
2015	FRusFC	110%	100%	7.13	6.7	6.75	4.09	91.6	230	34.8	0.02	2.12	6.51	304.5	11.3	22.8	0.17
2015	FRdsFC	102%	100%	6.65	10	2.82	1.17	107	262	18.5	0.02	0.385	5.75	83.6	5	5.6	0.19

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APPENDIX 1 ENVIRONMENTAL VALUES BY ZONE

Reach	Aquatic Ecosystems	Cultural/Spiritual	Wildlife Habitat	Human Consumer	Primary Recreation	Secondary Recreation	Visual Recreation	Industrial Use	Aquaculture	Drinking Water	Irrigation	Stock Water	Farm Supply
East Branch & tributaries U/S of the Mine	SMD	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
East Branch within mine site to Old Tails Ck	H <80%	✓											
East Branch Old Tails Ck to Hannah Spring	H-80%PC	✓	✓				✓						
East Branch below Hannah Spring	H-90%PC	✓	✓	✓	✓	✓	✓					✓	
Finniss U/S EB	SMD	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Finniss EB to Florence Ck	SMD	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Finniss Florence Ck to SOCS	SMD	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
SOCS upstream limit to FW/SW interface	HCV	✓	✓	✓		✓	✓			✓	✓	✓	✓
Finniss Estuary	HCV	✓	✓	✓		✓	✓						

✓indicates value is assigned to that zone. For aquatic ecosystems, SMD indicates value assigned for classification of Slightly-Moderately Disturbed ecosystems, H-x%PC indicates value assigned for classification of Highly Disturbed ecosystem with an x% protective concentration recommended, HCV indicates value assigned for classification of High Conservation Value ecosystems.

APPENDIX 2 WATER QUALITY DATA 2012-2014

A1-1. SURFACE WATER DATA

Data have been collected from 15 sites as part of the water quality monitoring component of the impact assessment. The 15 sites were distributed across the river reach environmental zones 1 to 7 as previously defined by Hydrobiology (2013). Sample sites and zonings are presented in Table 5-1 and illustrated in Figure 5-1.

For the majority of sites, data were collected from January 2013 to December 2014 on a monthly basis where surface water was present. Some 2012 data were available from previously established and monitored sites on the Finniss River, upstream of the confluence with the East Branch (FRUSEB, FRDSMB, MBDSPIT and FRUSMB), and one site in the mine boundary (WCUSEB).

Table 5-1 Water quality sites and environmental zone

Site Code	Site Name	Longitude	Latitude	Environmental Zone
EB@LB	East Branch Finniss River at Mine Boundary	131.027	-12.9882	1
FC@LB	Fitch Creek at Mine Boundary	131.016	-12.9990	1
EB@G_Dys	East Branch Finniss River at Dyson's Gauge Station	131.017	-12.9878	2
EB@GS200	East Branch Finniss River at GS8150200	131.001	-12.9900	2
WCusEB	Wandering Creek upstream East Branch Finniss River	131.001	-12.9912	2
EB@GS097	East Branch Finniss River at GS8150097	130.968	-12.9641	3
EB@GS327	East Branch Finniss River at GS8150327	130.991	-12.9766	3
TC@LB[1]	Tailings Creek at Mine boundary	130.998	-12.9801	3
EBusFR	East Branch upstream of the Finniss River Confluence	130.951	-12.9595	4
FRDSMB	Finniss River Downstream Mount Burton mine	130.960	-12.9791	5
FRUSMB	Finniss River Upstream Mount Burton mine	130.963	-12.982	5
MBDSPIT	Mt Burton spring downstream of Pit	130.963	-12.9795	5
FR@GS204	Finniss River at GS8150204	130.942	-12.9478	6
FRUSEB	Finniss River Upstream East Branch	130.949	-12.9601	6
FRdsFC	Finniss River downstream Florence Creek	130.76	-12.9674	7

[1] Previous reports classified this site as Zone 2. It was considered to be more appropriate to Zone 3 being on the lease boundary at the point of egress from the Lease.

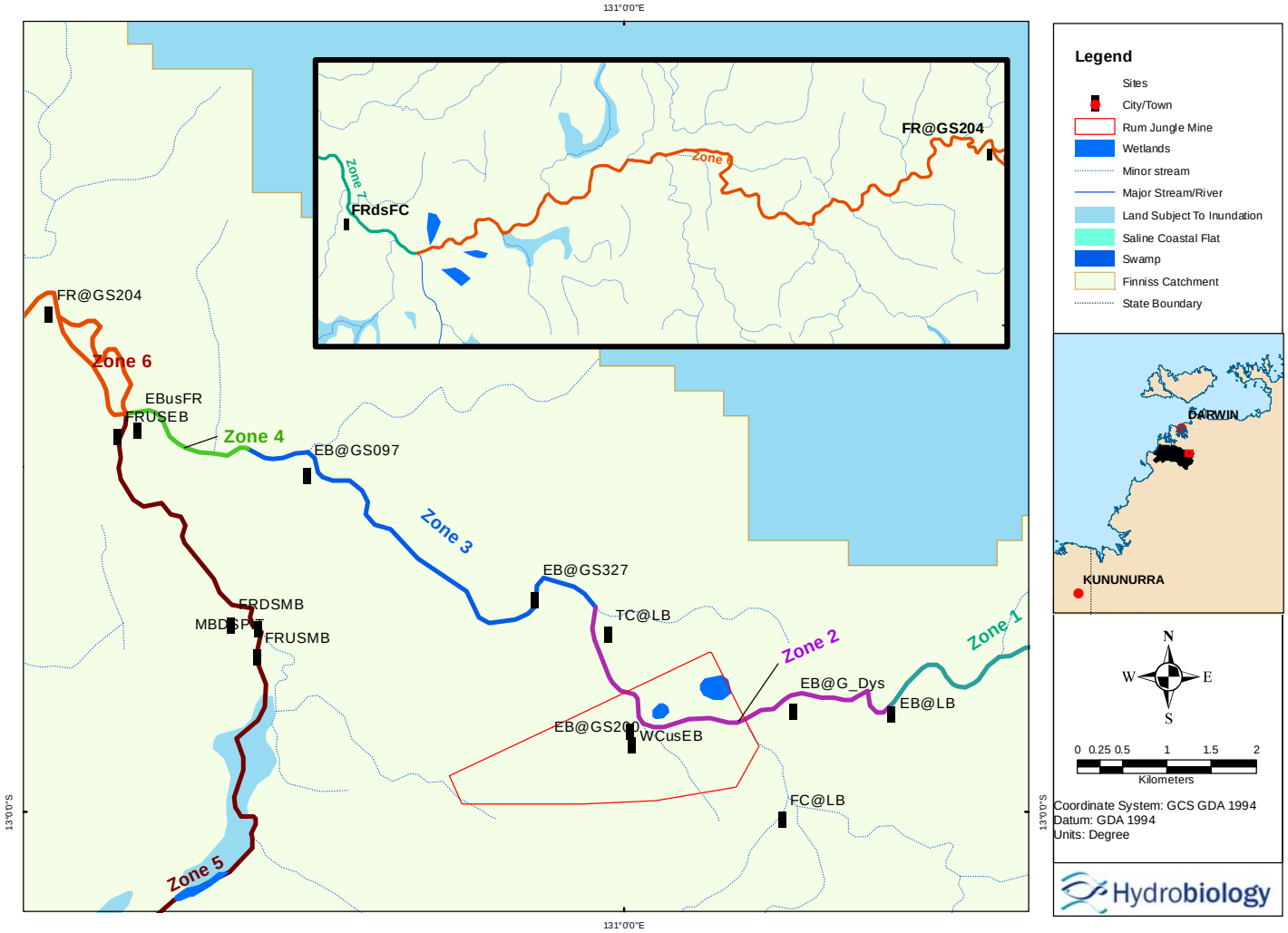

Figure 5-1 Sampling sites used in 2012/13. Inset shows the location of the furthest downstream site, FRdsFC.

Quality Control

Field procedural blanks and duplicates were collected monthly during 2012 to 2014. Blanks collected included exposure (Data Table 16) and field blanks (Data Table 17). Both field and exposure blanks were often found to contain trace concentrations of several metals, particularly Al, Cu, Mn, Ni, Pb and Zn. This may indicate contaminated bottles, potentially as a result of longer storage prior to sampling as a result of dust collection and/or leaching in bottles with preservatives. Further several samples showed high concentrations of metals in the dissolved sample compared with the total concentrations, which may indicate that sample bottles for analysis may have been accidently mixed/swapped in some instances.

Concentrations of Zn and Cu in the procedural blanks (both exposure and field blanks) were sometimes higher than the results found in Zone 1, 5, 6 and 7. This was also observed in the 2014 blank samples and indicates that some of the contamination could be derived from the water used for the blanks. Cu was found in high concentrations in both exposure and field blanks, and Zn was generally found to be higher in the field blanks compared with exposure blanks. As some of the blank results were also above the WQOs for some zones it is recommended that the source of contamination be confirmed to ensure that sites are not erroneously deemed to exceed the water quality objectives.

Duplicate samples were taken from FRUSMB. When the relative percentage difference (RPD) for detected constituents is greater than or equal to 30 percent for aqueous matrices (water), the representativeness of the sample results must be considered. Analysis of RPDs for the given data set indicated a considerable number of QC exceedances across years, particularly for metals such as Pb and Zn (see Data Table 18).

A1-2. INTERPRETATION OF DATA IN CONTEXT OF WQOS

Data summaries and comparison with WQOs for each site can be found in Section A1-4. A summary of the number of WQO exceedences for dissolved metals is shown in the table below. Note that not all parameters were always sampled for a number of sampling events.

		No. exceedences of WQOs for dissolved metals (µg/L)										
Zone	**No. Sampling Events**	**Al**	**As**	**Cd**	**Co**	**Cu**	**Fe**	**Mn**	**Ni**	**Pb**	**U**	**Zn**
1	50	9			1		7	2				
2	67	2		10		58		19	31			19
3	46					40		6	27			18
4	29				15	15		11	5			3
5	188	7		1	22	95	15					1
6	25	1			5	10	2	2	1			2
7	25	3				3	10					

Zone 1 - East Branch & tributaries U/S of the Mine

Water quality at the two sites on the mine boundary upstream from the mine site (EB@LB and FC@LB) in Zone 1 had few exceedances of the WQOs, with most metal concentrations well below the WQOs.

In 2013, the majority of measurements for dissolved aluminium were greatly elevated in regards to the WQO in the East Branch (see Figure 2-4 and Section A1-4). Dissolved aluminium (Al) results showed a distinct seasonal pattern where concentrations were highest during the first flush and decreased with subsequent recessional flow phase. This was particularly evident between January and March in 2013, and significantly elevated concentrations of Al occurred again with initial flow in December 2013. The seasonal pattern, with higher concentrations with first flush was also observed in the other zones (Figure 2-4) and may have been due to naturally acidic rainfall dissolving aluminium into first flush flow, as is known to occur in the Northern Territory (e.g. Brown et al. 1983, Hart et al. 1987, Griffin and de Lestang 1998) or mobilisation of aluminium rich colloids in these upper parts of the catchment. Determination of whether or not the aluminium was truly dissolved or colloidal would require a campaign of finer or ultra-filtration of the samples, but is probably not warranted for these sites upstream of the mine area. Note that there is no known source of acidic drainage to these upper catchment sites.

Dissolved iron (Fe) had occasional elevated results (up to 370 µg/L in May 2014) but generally concentrations were stable and below the WQO. High levels of manganese were observed in May 2014 at EB@LB, and this was not observed in 2013. Data post May 2014 was not available to determine if these concentrations have persisted.

Zone 2 - East Branch within mine site to Old Tails Ck

It was recommended by Hydrobiology (2013) that the WQOs within Zone 2 be modified to take into account ongoing management and rehabilitation and the likely continual AMD inputs into the future. Individual exceedances during the dry phase were recommended to be considered acceptable provided that the following conditions were maintained:

- The subsequent first-flush concentrations of contaminants remained compliant with the appropriate WQOs for that event, and;
- The subsequent wet season and recessional flow phase monitoring data remained in compliance.

Water quality at the three sites on the east branch within the mine site to Old Tailings Creek (EB@G-Dys, EB@GS200 and WCusEB) in Zone 2 had several dissolved metal concentrations elevated in 2013 and 2014 compared with the WQOs.

Al was not found to exceed the WQO on most occasions, though elevated concentrations were observed at EB@G-Dys associated with the first flush/flow in December 2013 and February 2014, as was observed at sites in Zone 1. This site is located furthest upstream in Zone 2, and thus continued the patterns in Al observed in Zone 1.

In Zone 2 the metals with consistently high concentrations above the WQO included cobalt (Co), copper (Cu), zinc (Zn), cadmium (Cd), manganese (Mn) and nickel (Ni) (Figure 2-6 – 7). For all sites in Zone 2, dissolved Cu concentrations exceeded the WQO for nearly all occasions. A distinct elevation of the above listed metals (above the WQO) was observed during the dry phase between May and November at EB@GS200 in both 2013 and 2014. In contrast there were fewer exceedances in EB@G_Dys and WCusEB compared with EB@GS200, though Mn and Ni exceedances were observed in the dryer months for most samples for EB@G_Dys.

Zone 3 - East Branch Old Tails Ck to Hanna Spring

Water quality data were available from three sites in Zone 3: EB@GS097; EB@GS327; and TC@LB. A number of metals (Co, Cu, Mn, Ni and Zn) were found to exceed the WQOs for Zone 3 to varying degrees. Dissolved Cu generally exceeded the WQO of 6.25 µg/L in 2013 and 2014, with the exception of one month in July 2013. Following initial flush, a distinct increase in concentrations between February/March and May of dissolved Co, Cu, Zn and Ni was evident at sites EB@GS097 and TC@LB in 2013 and 2014.

Zone 4 - East Branch below Hanna Spring

For the one site located in Zone 4, EBusFR, dissolved Co and Cu both exceeded the WQO for all samples collected. The results (2013 and 2014) showed a spike in concentrations during first flush and subsequent flow where dissolved Co (66.9 µg/L in December 2013) was nearly 20 times greater than the WQO (2.8 µg/L) and dissolved Cu (maximum value of 26.7 µg/L in January 2013) exceeded both the WQO

(4.5 µg/L) and the CMC (12.2 µg/L). Dissolved Ni slightly exceeded the WQO on a few occasions during the year and also during the first flush. However, the first flush Ni concentration (136 µg/L in December 2013) was well below the CMC (428 µg/L). Dissolved Zn exhibited a sharp increase in concentration during the first flush (141 µg/L), exceeding both the WQO (37.5 µg/L) and the CMC (107 µg/L) in 2013 with a subsequent decline in concentration in the wet period in 2014. Manganese exceeded WQO (100 µg/L) in several samples during the flow phase, though were not higher than the WHO (2000) guideline of 200 µg/L.

Zone 5 - Finniss U/S EB

The four sites located in Zone 5 (FRUSMB, MBDSPIT, FRDSMB and FRUSEB) are near-perennial and almost three complete years of monthly data were available for most of the sites.

Two of the sites in Zone 5, FRDSMB and MBDSPIT showed the influence of acid drainage from the historical Mount Burton mine with dissolved Cu consistently exceeding the WQO (3.4 µg/L). Higher concentrations were evident in February to March with a subsequent decline at MBDSPIT, whereas a more consistent pattern was in observed at the other sites. The site upstream of Mount Burton, FRUSMB, showed no such influence with all Cu concentrations below the WQO and FRUSEB, located further downstream only showed two exceedances in 2013.

Dissolved Co concentrations exceeded the WQO (2.8 µg/L) at MBDSPIT only, with a distinct peak and subsequent decline with initial flush in February/March in all sampled years (2012, 2013 and 2014). A pattern that was also observed in Zones 3 and 4 (Figure 2-6).

Dissolved Al and Fe exceeded the WQOs (55 µg/L and 200 µg/L) at all three sites although individual exceedances were few. Al concentrations across all sites showed higher concentrations during the wet phase compared with the dry phase (Figure 2-4). Dissolved Fe was occasionally elevated above the WQO (200 µg/L) at MBDSPIT and FRUSEB with higher values also generally coinciding with the wetter months.

Zone 6 - Finniss EB to Florence Ck

For the one site located in Zone 6, FR@GS204, individual exceedances of WQOs were observed for several metals.

Dissolved Al exceeded WQO in February 2014, which was a later than the December 2014 Al peaks observed at other sites/ zones. Dissolved Cu concentrations exceeded the WQO (3.4 µg/L) at initial flow at the same time as Al as well as the wetter months (November to June). Increased Cu concentrations in both the East Branch and the Finniss River downstream of Mt Burton had the potential to influence water quality at this site. Dissolved Co, Zn, Ni, Fe and Mn were occasionally elevated above the relevant WQOs, mainly coinciding with the first with first flush and wetter months.

Zone 7 - Finniss Florence Ck to SOCS

Parameters measured at FRdsFC were mostly compliant with the WQOs derived for Zone 7. Exceptions included a small number of exceedances for dissolved Cu and Al at the beginning of the wet season, which were below the CMC, and regular exceedances of dissolved Fe throughout the year with no seasonal pattern were evident.

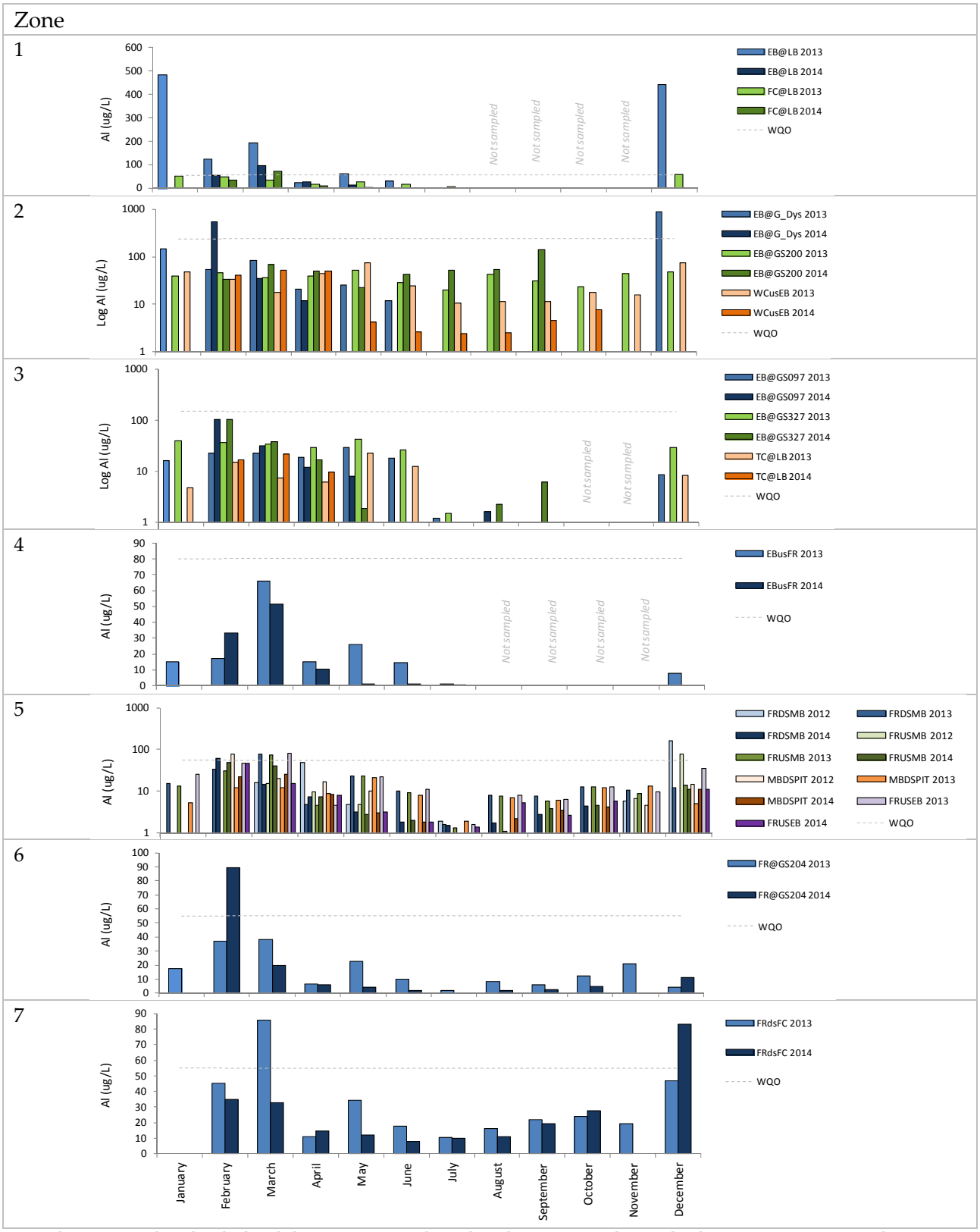

Figure 5-2 Dissolved aluminium concentrations by site, zone and months between January and December 2012 and 2014 (Note Y axis differences)

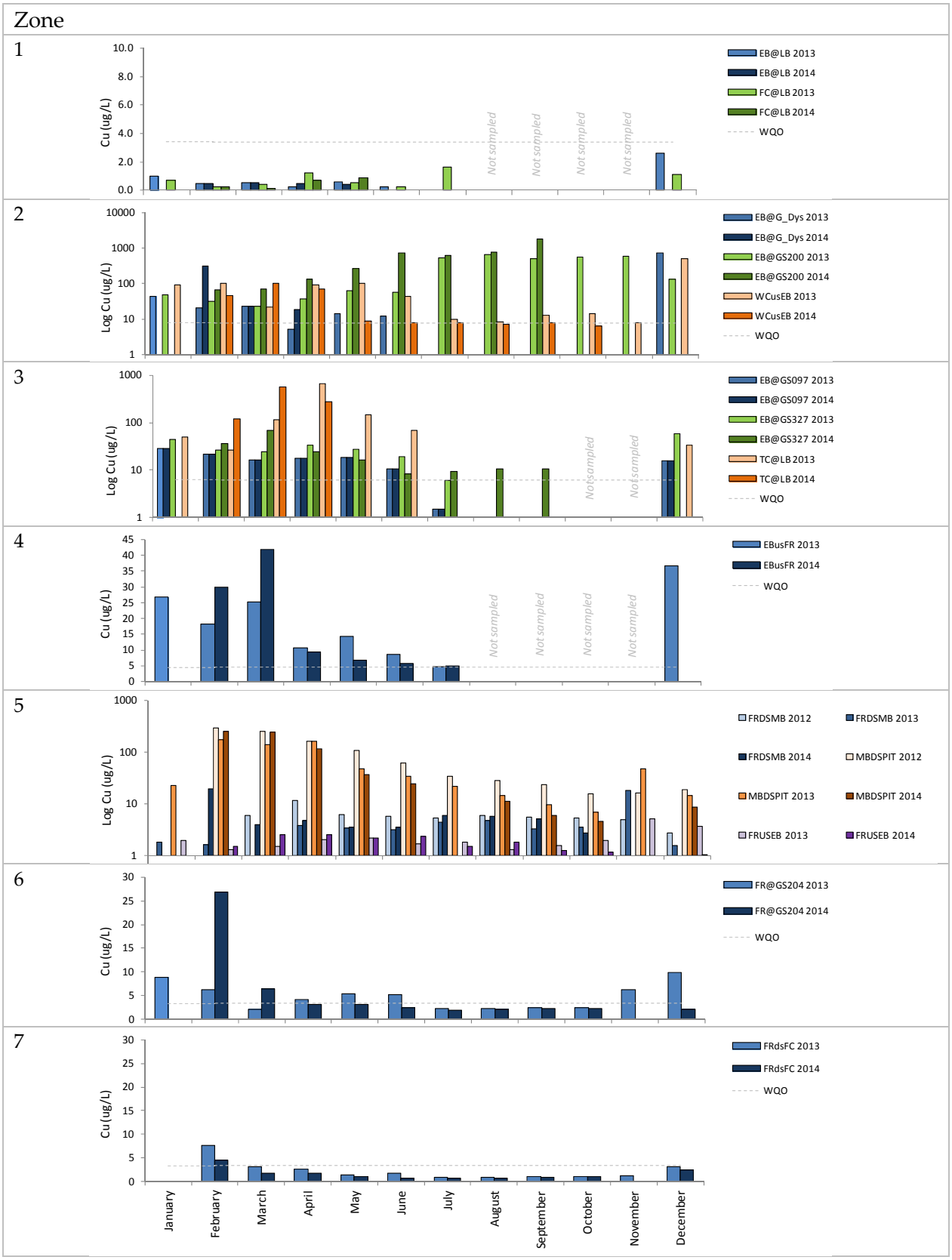

Figure 5-3 Dissolved copper concentrations by site, zone and months between January and December 2012 and 2014 (Note Y axis differences)

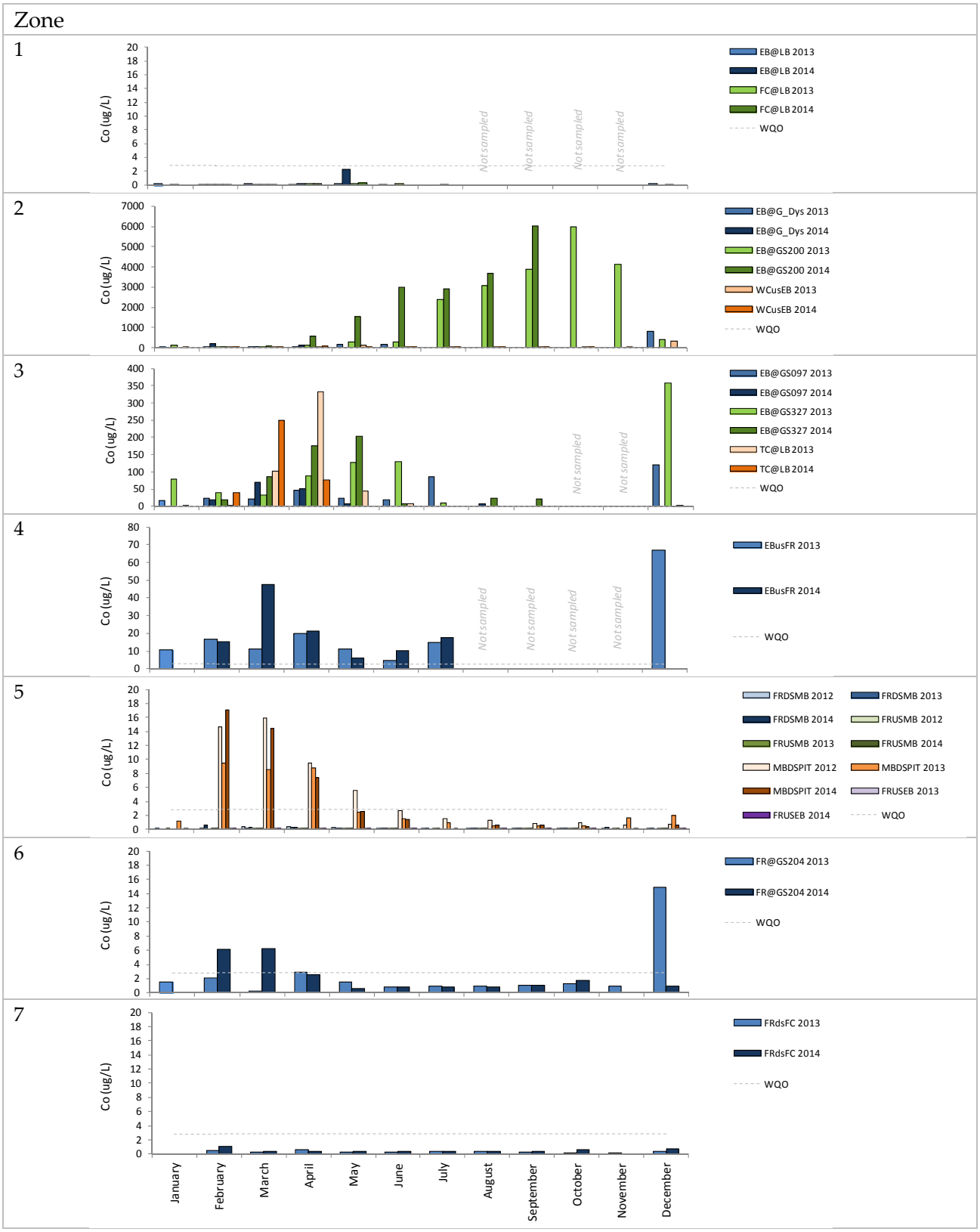

Figure 5-4 Dissolved cobalt concentrations by site, zone and months between January and December 2012 and 2014 (Note Y axis differences)

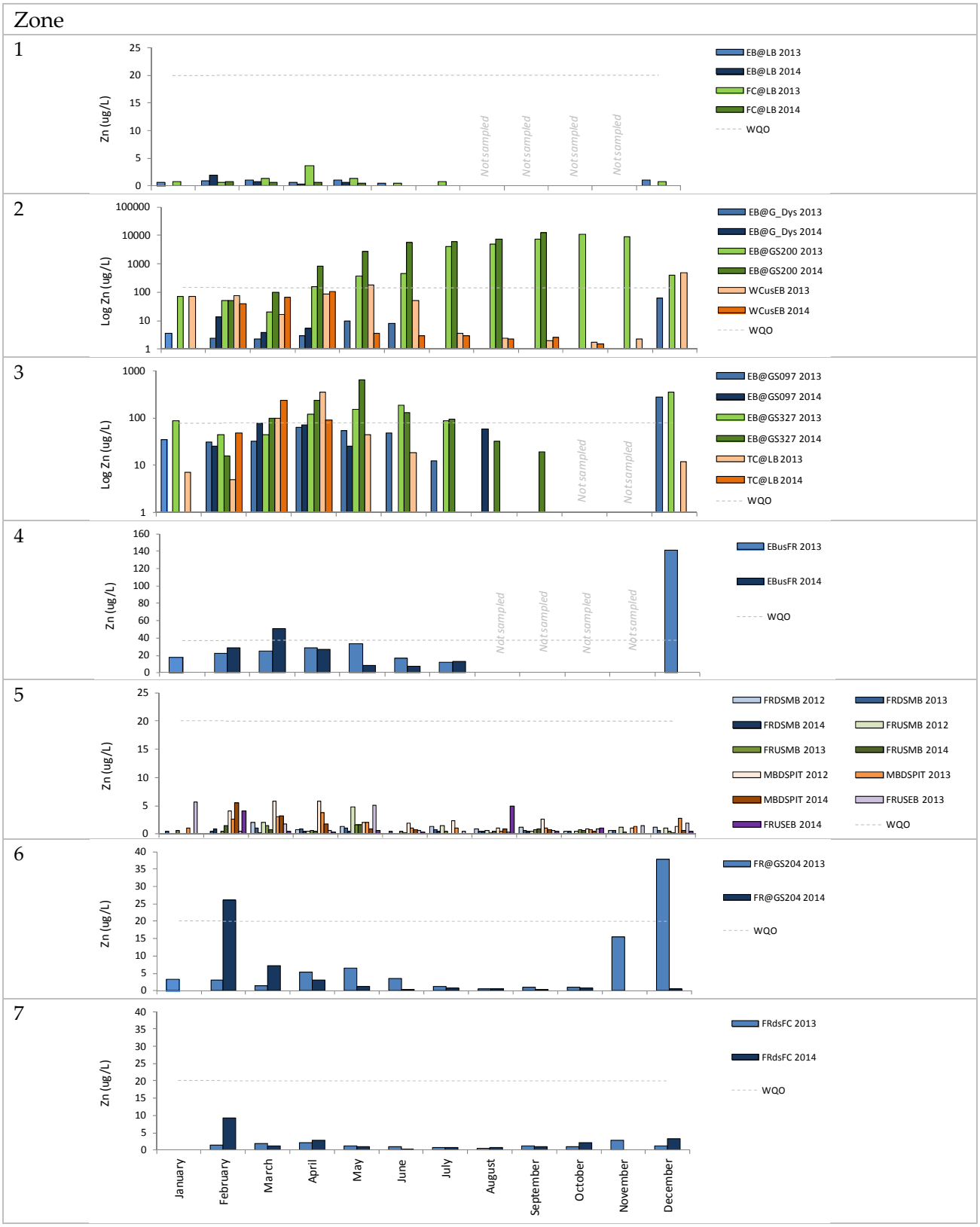

Figure 5-5 Dissolved zinc concentrations by site, zone and months between January and December 2012 and 2014 (Note Y axis differences)

**Feb 2014 in Zone 4 one sample above WQO was excluded for scale purposes though data available in section 4 data tables*

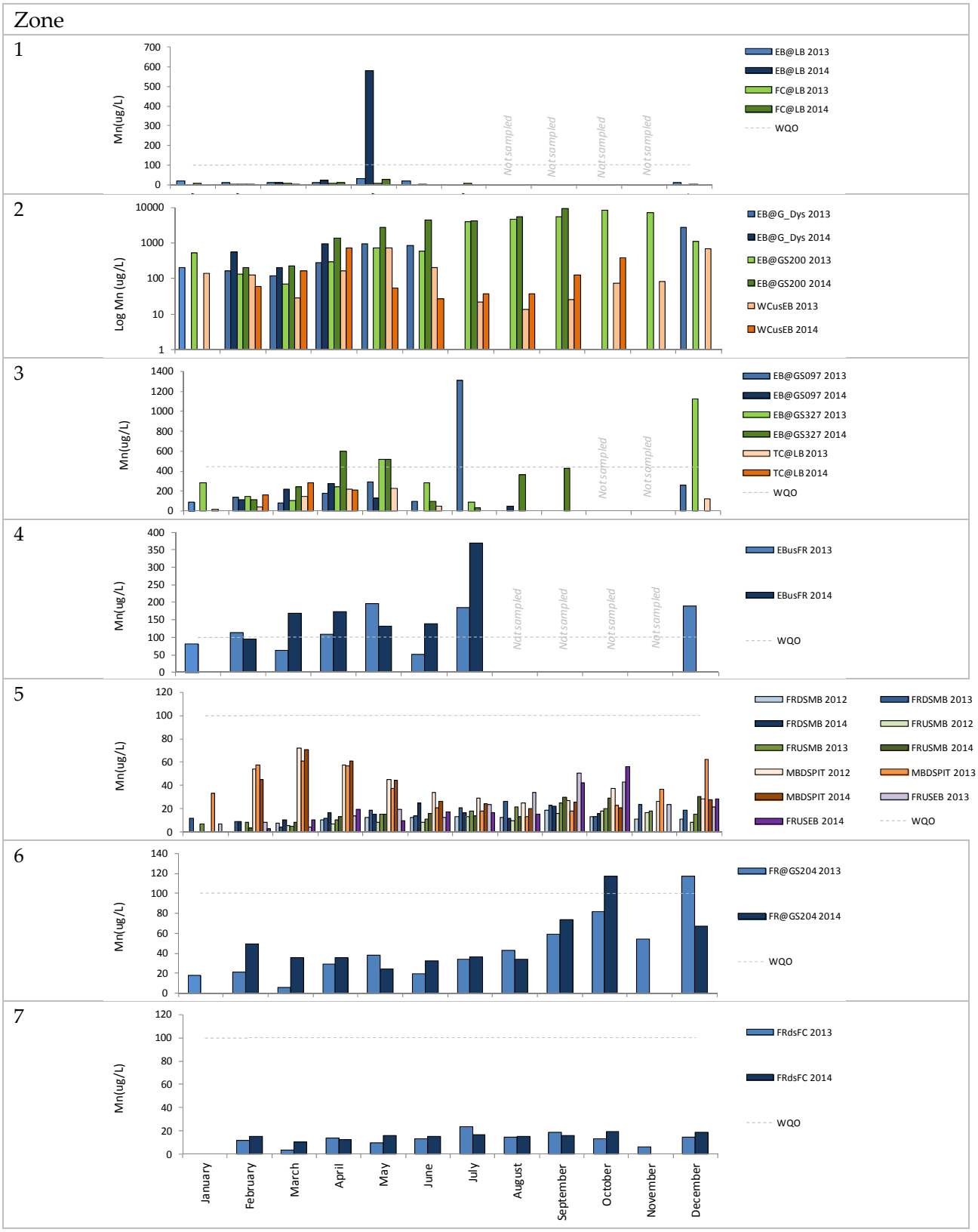

Figure 5-6 Dissolved manganese concentrations by site, zone and months between January and December 2012 and 2014 (Note Y axis differences)

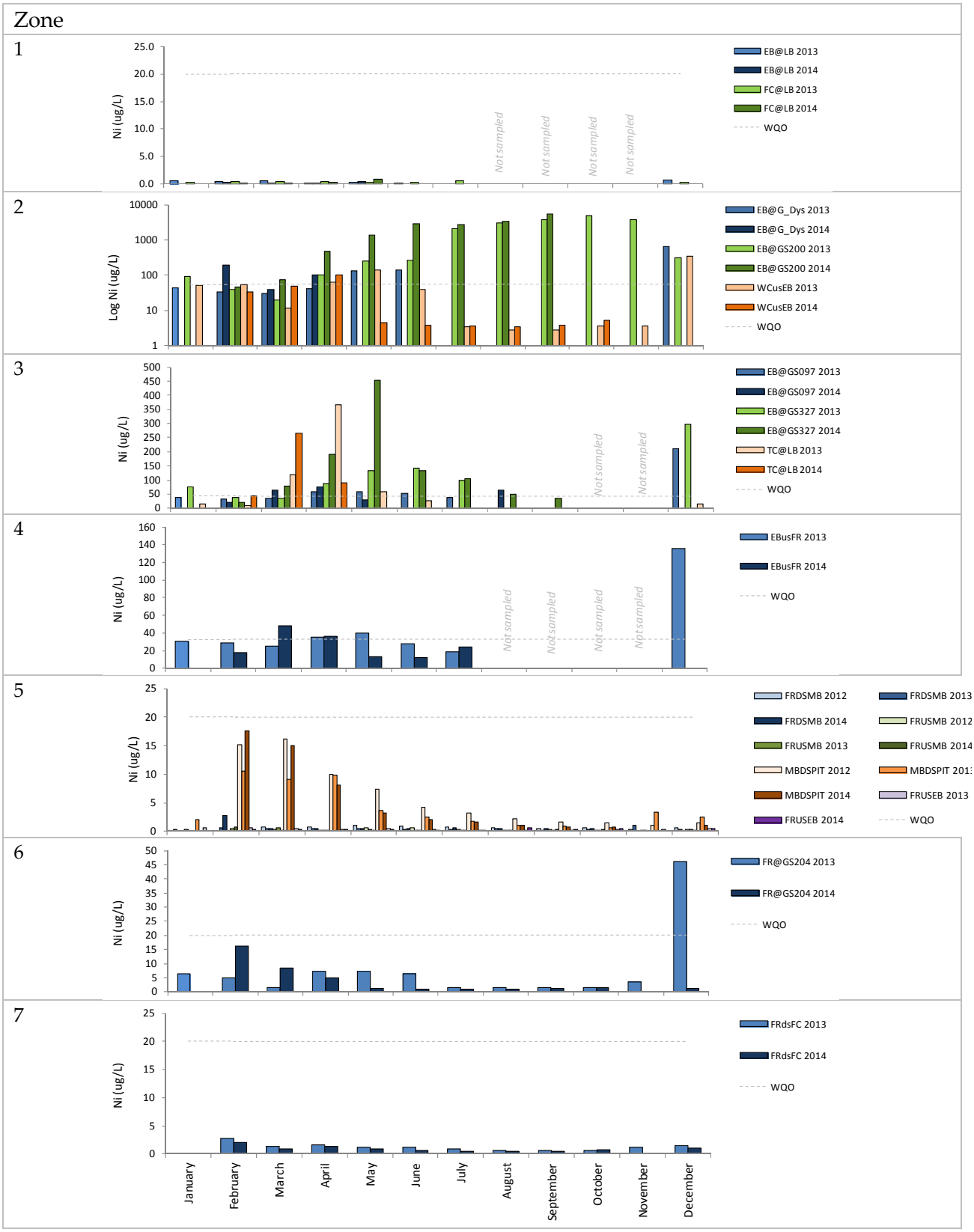

Figure 5-7 Dissolved nickel concentrations by site, zone and months between January and December 2012 and 2014 (Note Y axis differences)

A1-3. SUMMARY

There was a clear indication of increased metal concentrations in the isolated water bodies of the mine site during the dry season, which were then flushed down the system after the first flows of the season. Increased concentrations of several metals were evident at the East Branch sites and Finniss River sites downstream of the mine (Zones 3, 4 and 6) during first flush sampling. These pulses of elevated metals can be discerned in the data in the Section 4, but are illustrated in Figure 2-5–Figure 2-9, particularly for December 2013 and subsequent January – March in 2014.

Generally, each zone was found to have individual exceedances of the WQOs for a number of parameters. Elevated metal concentrations that were not related to the former Rum Jungle mine site were found for aluminium and iron associated with first flush flows in the tributaries of the East Branch upstream of the mine, and inputs from the former Mount Burton mine site into the Finniss River upstream of the East Branch.

Data have been collected on a monthly basis where surface water availability has allowed and additional in-situ field measurements (EC, pH, temp, DO and turbidity) have also been collected at several sites between sampling events. Consideration of the QA/QC aspects described above should be given to ensure robust dataset are achieved. The seasonality of the system requires a continuance of the current frequency of monitoring in order to provide enough data for robust calculation of percentiles for comparison with the WQOs. With distinct two rounds of sampling for all sites in 2013 and 2014, at least 24 months of monitoring data was available for most sites and 95th percentiles have been calculated for each site for each season (provided in Section A1-4). This will allow improvement to, and will assist in the confidence of, the water quality data. The data can provide a base for identifying zones for rehabilitation focus, taking into consideration the seasonal aspects identified above.

A1-4. DATA SUMMARY AND COMPLIANCE TABLES

Data Table 1 Zone 1 - EB@LB - East Branch Finniss River at Mine Boundary

EB@LB																	
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG		6.5-8					55	24	0.54	2.8	3.4	200	100	20	10	10	20
8/04/2013	50	6.00	30.2	7.08	5.36												
24/04/2013	56	7.95	29.3	6.46	5.14	4.00	24.40	0.20	<0.02	0.11	0.26	128	12.30	0.13	0.09	0.13	0.70
7/05/2013	90	6.63	27.5	8.90	4.39												
23/05/2013	77	7.66	27.8	6.41	6.78	4.00	61.30	0.20	<0.02	0.18	0.59	192	30.00	0.26	0.09	0.17	1.00
3/06/2013	56	7.3	26.1	7.85	7.15												
18/06/2013	60	7.26	21.3	7.85	4.76	3.00	29.00	0.10	<0.02	0.14	0.25	120	18.00	0.14	0.04	0.11	0.50
1/07/2013	94	6.74	20.7	4.60	3.61												
12/12/2013	74	6.39	32.70	5.68	36.13												
4/12/2013	64	7.34	29.90	3.23	30.16	7.00	442.00	0.15	<0.02	0.16	2.59	204	9.54	0.65	0.26	0.58	1.10
29/04/2014	90	8.12	28.30	7.10	7.37	3.00	35.20	0.25	<0.02	0.17	0.38	294	17.30	0.20	0.100	0.12	0.40
2/04/2014	74	8.30	30.00	6.46	5.54	3.00	18.60	0.15	<0.02	0.21	0.58	204	29.40	0.15	0.090	0.13	0.30
14/05/2014	139	6.54	27.60	4.94	9.02												
28/05/2014	145	6.32	25.90	2.98	10.65		2.20	0.50	<0.02	3.40	0.26	370	900.00	0.54	0.03	0.10	0.70
24/05/2014	109	6.35	24.20	3.03	10.67	4.00	22.40	0.35	<0.02	1.08	0.60	314	263.00	0.34	0.09	0.18	0.50
30/01/2013	70	7.41	31.6			6.00	483.00	0.25	<0.02	0.23	1.02	344	18.10	0.58	0.30	0.40	0.60
11/02/2013	78	6.77	31.6	6.35	11.67												
27/02/2013	49	5.87	30.8	6.70	15.50	3.00	124.00	0.15	<0.02	0.14	0.48	184	12.10	0.44	0.15	0.21	0.90
27/03/2013	44	6.15	28.6	5.69	17.80	4.00	192.00	0.15	<0.02	0.15	0.55	148	9.14	0.52	0.16	0.21	1.10
11/03/2013	53	6.97	30.2	6.89	9.42												
20/01/2014	36	7.30	28.50	6.75	24.27												
8/01/2014	73	7.01	31.30	5.68	13.40												
14/02/2014	46	6.29	29.90	6.65	8.65												
5/02/2014	22	8.18	28.10	7.26	7.41	3.00	56.10	0.10	<0.02	0.06	0.46	94	3.72	0.20	0.150	0.10	1.90
18/03/2014	57	6.50	29.00	7.24	6.32												
5/03/2014	60	8.16	31.00	6.86	6.69	3.00	95.20	0.15	<0.02	0.12	0.57	192	9.13	0.15	0.170	0.12	0.80
All Data																	
80th percentile	90	7.72	30.84	7.16	14.24	4.00	164.80	0.25	<0.02	0.22	0.60	306	29.76	0.53	0.17	0.21	1.06
95th percentile	133	8.18	31.60	7.85	29.28	6.45	458.40	0.41	<0.02	2.01	1.65	354	517.80	0.61	0.28	0.47	1.42
Min	22	5.87	20.70	2.98	3.61	3.00	2.20	0.10	<0.02	0.06	0.25	94	3.72	0.13	0.03	0.10	0.30
Max	145	8.30	32.70	8.90	36.13	7.00	483.00	0.50	<0.02	3.40	2.59	370	900.00	0.65	0.30	0.58	1.90
Mean	71	7.02	28.48	6.19	11.16	3.92	121.95	0.21	<0.02	0.47	0.66	214	102.44	0.33	0.13	0.20	0.81
Stdev	29	0.74	2.99	1.51	8.32	1.31	159.96	0.11	0.00	0.92	0.61	89	249.34	0.19	0.08	0.14	0.42
April - December																	
80th percentile	100	7.78	29.94	7.40	10.66	4.00	50.86	0.31	<0.02	0.73	0.60	306	169.80	0.46	0.10	0.18	0.88
95th percentile	141	8.18	31.08	8.22	32.25	6.10	308.76	0.45	<0.02	2.59	1.89	350	677.05	0.61	0.20	0.44	1.07
Min	50	6.00	20.70	2.98	3.61	3.00	2.20	0.10	<0.02	0.11	0.25	120	9.54	0.13	0.03	0.10	0.30
Max	145	8.30	32.70	8.90	36.13	7.00	442.00	0.50	<0.02	3.40	2.59	370	900.00	0.65	0.26	0.58	1.10
Mean	84	7.06	27.25	5.90	10.48	4.00	79.39	0.24	<0.02	0.68	0.69	228	159.94	0.30	0.10	0.19	0.65
Stdev	30	0.74	3.39	1.90	9.92	1.41	147.47	0.13	0.00	1.14	0.78	89	311.02	0.20	0.07	0.16	0.28
January - March																	
80th percentile	70	7.41	31.30	6.96	15.96	4.40	250.20	0.17	<0.02	0.17	0.66	222	13.30	0.53	0.20	0.25	1.26
95th percentile	76	8.17	31.60	7.25	21.36	5.60	424.80	0.23	<0.02	0.21	0.93	314	16.90	0.57	0.27	0.36	1.74
Min	22	5.87	28.10	5.68	6.32	3.00	56.10	0.10	<0.02	0.06	0.46	94	3.72	0.15	0.15	0.10	0.60
Max	78	8.18	31.60	7.26	24.27	6.00	483.00	0.25	<0.02	0.23	1.02	344	18.10	0.58	0.30	0.40	1.90
Mean	53	6.96	30.05	6.61	12.11	3.80	190.06	0.16	<0.02	0.14	0.62	192	10.44	0.38	0.19	0.21	1.06
Stdev	17	0.76	1.31	0.55	5.75	1.30	171.12	0.05	0.00	0.06	0.23	93	5.24	0.19	0.06	0.12	0.50

Data Table 2 Zone 1 – FC@LB - Fitch Creek at Mine Boundary

FC@LB Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG		6.5-8					55	24	0.54	2.8	3.4	200	100	20	10	10	20
8/04/2013	43	5.86	30.7	7.32	3.34												
24/04/2013	65	7.64	30.1	6.96	2.85	3.00	15.00	0.10	<0.02	0.19	1.22	66	5.76	0.35	0.10	0.21	3.60
8/05/2013	116	6.78	28.9	9.20	10.22												
23/05/2013	108	8.05	29.4	7.05	2.86	<1.00	27.80	0.10	<0.02	0.19	0.52	62	7.28	0.27	0.03	0.27	1.40
3/06/2013	63	7.14	27.1	7.90	6.29												
18/06/2013	75	7.42	23.8	8.49	2.56	2.00	18.10	<0.05	<0.02	0.17	0.26	60	4.73	0.23	0.03	0.22	0.50
1/07/2013	92	6.78	21.4	6.80	1.38												
16/07/2013	100	7.3	23	6.22	1.95	2.00	5.90	0.10	<0.02	0.13	1.62	380	6.28	0.52	0.09	0.31	0.80
4/12/2013	150	7.33	30.80	6.05	20.27	7.00	56.60	0.20	<0.02	0.09	1.14	82	2.06	0.32	0.10	0.61	0.80
12/12/2013	68	6.61	32.50	6.55	23.13												
2/04/2014	114	8.03	30.80	6.75	1.76	2.00	11.30	0.10	<0.02	0.27	0.69	78	12.00	0.26	0.03	0.26	0.80
29/04/2014	180	8.02	30.20	7.52	1.90	2.00	9.90	0.10	<0.02	0.18	0.73	76	6.17	0.25	0.02	0.45	0.50
14/05/2014	136	6.87	28.80	7.15	2.00												
23/05/2014	125	7.31	25.50	4.10	1.88	3.00	2.50	0.15	<0.02	0.37	0.9	106	27.70	0.77	0.0	0.35	0.50
30/01/2013	81	7.5	33				51.80	0.10	<0.02	0.08	0.73	86	6.91	0.23	0.15	0.41	0.80
11/02/2013	78	6.52	32.3	6.82	4.24												
27/02/2013	49	6.01	31	7.11	9.13	3.00	48.40	0.10	<0.02	0.10	0.27	84	4.84	0.36	0.08	0.32	0.60
11/03/2013	48	6.8	31.2	6.89	4.79												
27/03/2013	48	6.13	29.3	6.66	8.01	3.00	32.20	0.10	<0.02	0.13	0.43	76	5.94	0.41	0.09	0.22	1.30
8/01/2014	46	7.25	32.60	7.05	7.85												
20/01/2014	28	7.45	30.00	6.53	16.43												
5/02/2014	19	7.92	28.10	7.30	5.91	3.00	34.00	<0.05	<0.02	0.05	0.28	62	3.65	0.11	0.10	0.16	0.80
14/02/2014	32	6.92	30.90	6.87	4.16												
5/03/2014	57	8.25	31.00	7.55	6.38	3.00	71.90	0.10	<0.02	0.11	0.12	100	4.12	0.11	0.12	0.19	0.60
18/03/2014	62	6.37	30.00	7.86	3.08												
All Data																	
80th percentile	114	7.70	31.04	7.53	8.46	3.00	50.44	0.10	<0.02	0.19	1.04	94	7.13	0.39	0.10	0.39	1.10
95th percentile	146.94	8.05	32.58	8.40	19.69	4.80	62.72	0.17	<0.02	0.31	1.38	215.60	18.28	0.62	0.13	0.51	2.28
Min	19.20	5.86	21.40	4.10	1.38	1.00	2.50	<0.05	<0.02	0.05	0.12	60.00	2.06	0.11	0.02	0.16	0.50
Max	179.80	8.25	33.00	9.20	23.13	7.00	71.90	0.20	<0.02	0.37	1.62	380.00	27.70	0.77	0.15	0.61	3.60
Mean	79.31	7.13	29.30	7.03	6.35	2.83	29.65	0.10	<0.02	0.16	0.68	101.38	7.50	0.32	0.07	0.31	1.00
Stdev	40.55	0.66	3.01	0.93	5.89	1.47	21.91	0.04	0.00	0.09	0.44	84.89	6.51	0.18	0.04	0.13	0.83
April - December																	
80th percentile	129	7.79	30.74	7.67	7.86	3.00	23.92	0.13	<0.02	0.24	1.19	96	10.11	0.45	0.10	0.41	1.16
95th percentile	160.30	8.04	31.40	8.74	21.27	5.60	46.52	0.18	<0.02	0.34	1.48	284.10	22.21	0.68	0.10	0.55	2.83
Min	43.40	5.86	21.40	4.10	1.38	1.00	2.50	<0.05	<0.02	0.09	0.26	60.00	2.06	0.23	0.02	0.21	0.50
Max	179.80	8.05	32.50	9.20	23.13	7.00	56.60	0.20	<0.02	0.37	1.62	380.00	27.70	0.77	0.10	0.61	3.60
Mean	102.44	7.22	28.07	7.00	5.89	2.75	18.39	0.11	<0.02	0.20	0.88	113.75	9.00	0.37	0.05	0.33	1.11
Stdev	37.93	0.62	3.39	1.19	7.12	1.83	17.28	0.04	0.00	0.09	0.43	108.57	8.05	0.19	0.04	0.13	1.05
January - March																	
80th percentile	62	7.50	32.30	7.35	8.23	3.00	55.82	0.10	<0.02	0.11	0.49	88.80	6.13	0.37	0.13	0.34	0.90
95th percentile	79.50	8.09	32.80	7.72	13.15	3.00	67.88	0.10	<0.02	0.13	0.67	97.20	6.72	0.40	0.14	0.40	1.20
Min	19.20	6.01	28.10	6.53	3.08	3.00	32.20	<0.05	<0.02	0.05	0.12	62.00	3.65	0.11	0.08	0.16	0.60
Max	81.30	8.25	33.00	7.86	16.43	3.00	71.90	0.10	<0.02	0.13	0.73	100.00	6.91	0.41	0.15	0.41	1.30
Mean	49.86	7.01	30.85	7.06	7.00	3.00	47.66	0.09	<0.02	0.09	0.37	81.60	5.09	0.24	0.11	0.26	0.82
Stdev	19.30	0.73	1.46	0.41	3.84	0.00	16.05	0.02	0.00	0.03	0.23	13.96	1.33	0.14	0.03	0.11	0.29

Data Table 3 Zone 2 – EB@G_Dys - East Branch Finniss River at G815_DYS

EB@G_Dys																	
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG							236	na	4.3	Reducing	8	Reducing	759	55	51.6	96	142.5
24/04/2013	139	7.48	31.3	5.23	4.64	3.00	21.10	0.30	<0.02	47.90	5.14	60	282.00	42.70	<0.01	2.80	2.90
23/05/2013	258	7.18	29.8	4.89	5.25	3.00	25.70	0.35	0.04	167.00	14.30	172	969.00	133.00	<0.01	2.29	9.40
18/06/2013	228	6.65	23.70	5.82	4.40	2.00	11.80	0.25	0.04	174	12.1	446	838.00	140.00	0.13	2.24	7.90
4/12/2013	603	5.13	30.30	4.73	1.68	4.00	894.00	0.35	0.24	825	729	478	2800.00	652.00	0.15	28.80	61.70
2/04/2014	176	8.06	31.20	3.74	6.40	2.00	13.70	0.40	<0.02	74.70	8.97	86	360.00	62.80	<0.01	2.13	3.40
29/04/2014	339	7.79	28.70	4.26	11.50	3.00	11.70	0.45	0.02	129.00	18.30	84	940.00	105.00	<0.01	2.46	5.30
8/01/2014	238	6.60	31.60	3.74	16.00												
5/02/2014	168	5.45	28.70	6.77	9.49	2.00	549.00	0.15	0.06	213.00	309.00	238	574.00	195.00	0.06	19.60	13.80
5/03/2014	165	7.96	31.90	5.55	4.91	2.00	35.00	0.50	0.26	44.30	23.80	50	210.00	39.20	0.28	3.43	3.90
31/01/2013	133	7.18	33.00			5.00	145.00	0.30	<0.02	49.90	44.20	186	201	44.50	0.10	2.82	3.70
27/02/2013	108	6.09	32.00	5.74	14.40	3.00	54.00	0.30	0.02	38.10	20.90	170	168	33.30	0.09	2.38	2.40
27/03/2013	91	6.10	29.00	5.07	17.23	4.00	83.20	0.20	0.02	34.00	22.90	132	118	30.80	0.07	2.59	2.30
All Data																	
80th percentile	254	7.73	31.84	5.74	14.40	4.00	145.00	0.40	0.06	174.00	44.20	238.00	940.00	140.00	0.13	3.43	9.40
95th percentile	458	8.01	32.45	6.30	16.62	4.50	721.50	0.48	0.25	519.00	519.00	462.00	1884.50	423.50	0.22	24.20	37.75
Min	91	5.13	23.70	3.74	1.68	2.00	11.70	0.15	<0.02	34.00	5.14	50.00	118.00	30.80	<0.01	2.13	2.30
Max	603	8.06	33.00	6.77	17.23	5.00	894.00	0.50	0.26	825.00	729.00	478.00	2800.00	652.00	0.28	28.80	61.70
Mean	221	6.81	30.10	5.05	8.72	3.00	167.65	0.32	0.07	163.35	109.87	191.09	678.18	134.39	0.08	6.50	10.61
Stdev	139	0.97	2.46	0.92	5.32	1.00	287.25	0.10	0.09	228.52	223.25	146.09	772.71	180.03	0.08	9.00	17.31
April - December																	
80th percentile	339	7.79	31.20	5.23	6.40	3.00	25.70	0.40	0.04	174.00	18.30	446.00	969.00	140.00	0.13	2.80	9.40
95th percentile	537	7.99	31.28	5.67	10.23	3.75	676.93	0.44	0.19	662.25	551.33	470.00	2342.25	524.00	0.15	22.30	48.63
Min	139	5.13	23.70	3.74	1.68	2.00	11.70	0.25	<0.02	47.90	5.14	60.00	282.00	42.70	<0.01	2.13	2.90
Max	603	8.06	31.30	5.82	11.50	4.00	894.00	0.45	0.24	825.00	729.00	478.00	2800.00	652.00	0.15	28.80	61.70
Mean	291	7.05	29.17	4.78	5.65	2.83	163.00	0.35	0.06	236.27	131.30	221.00	1031.50	189.25	0.05	6.79	15.10
Stdev	168	1.06	2.85	0.73	3.26	0.75	358.16	0.07	0.09	292.70	292.85	190.78	915.42	229.91	0.07	10.79	22.97
January - March																	
80th percentile	168	7.18	32.00	5.95	16.25	4.20	225.80	0.34	0.10	82.52	97.16	196.40	282.80	74.60	0.14	6.66	5.88
95th percentile	220	7.77	32.75	6.56	16.98	4.80	468.20	0.46	0.22	180.38	256.04	227.60	501.20	164.90	0.24	16.37	11.82
Min	91	5.45	28.70	3.74	4.91	2.00	35.00	0.15	<0.02	34.00	20.90	50.00	118.00	30.80	0.06	2.38	2.30
Max	238	7.96	33.00	6.77	17.23	5.00	549.00	0.50	0.26	213.00	309.00	238.00	574.00	195.00	0.28	19.60	13.80
Mean	150	6.56	31.03	5.37	12.41	3.20	173.24	0.29	0.08	75.86	84.16	155.20	254.20	68.56	0.12	6.16	5.22
Stdev	53	0.90	1.76	1.10	5.12	1.30	214.14	0.13	0.10	76.90	126.04	70.05	182.37	70.88	0.09	7.52	4.85

Data Table 4 Zone 2 – EB@GS200 - East Branch Finniss River at GS8150200

EB@GS200																		
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG	Improved	Improved					236	na	4.3	Reducing	8	Reducing	759	55	51.6	96	142.5
24/04/2013	238	7.05	28.5	6.58	3.29	3.00	40.00	0.20	0.32	121.00	38.40	22	304.00	105.00	0.04	3.86	159.00
23/05/2013	453	7.08	27.9	6.63	5.28	3.00	51.50	0.20	0.72	294.00	63.90	6	742.00	249.00	<0.01	6.15	368.00
18/06/2013	343	6.96	22.5	7.91	4.29	2.00	28.40	0.10	0.8	307	56.9	12	585.00	262.00	<0.01	3.29	443.00
16/07/2013	1428	6.97	22.7	7.05	1.63	1.00	20.20	0.40	6.78	2370	535	4	4080.00	2070.00	0.11	18.90	3930.00
19/08/2013	1882	6.78	21.8	6.13	1.40	4.00	42.90	0.60	8.6	3090	651	4	4590.00	2990.00	1.23	28.40	4960.00
9/09/2013	2285	6.58	25.7	6.05	3.32	3.00	30.90	0.75	11.6	3880	513	<10	5430.00	3830.00	0.26	15.40	7160.00
7/10/2013	2585	58.75	30.3	5.87	2.84	2.00	23.70	0.90	14	5980	555	10	8470.00	4970.00	0.24	6.42	10800.00
5/11/2013	2032	5.48	28.1	7.06	4.53	3.00	44.70	0.65	12.6	4120	606	10	7070.00	3810.00	1.52	6.85	8920.00
4/12/2013	672	7.00	29.40	6.66	16.70	4.00	48.50	0.20	1.12	400	132	16	1100.00	314.00	0.05	11.40	397.00
2/04/2014	389	7.62	28.90	6.05	5.40	2.00	36.90	0.25	0.80	249.00	61.1	12	695.00	219.00	0.02	5.97	334.00
29/04/2014	1133	7.43	27.00	6.87	5.84	2.00	61.70	0.25	3.06	900.00	208.0	10	2090.00	746.00	0.01	9.07	1340.00
25/05/2014	1121	6.26	26.30	6.14	7.12	2.00	25.30	0.30	3.90	1420.00	222.00	10	2710.00	1180.00	0.13	11.00	2460.00
28/05/2014	1224	6.87	25.40	6.51	2.59		20.30	0.35	4.82	1650.00	317.00	<2	2850.00	1520.00	0.02	14.90	2920.00
24/06/2014	1487	6.41		6.76	2.29	2.00	41.80	0.55	8.14	2990.00	723.00	2	4480.00	2880.00	0.63	30.40	5740.00
23/07/2014	1325	6.95	18	5.60	2.31	2	52.00	0.55	8.46	2930	629.00	<2	4290.00	2770.00	0.68	25.80	6060.00
19/08/2014	1772	6.84	19.40		1.96	2.00	54.10	0.80	10.60	3690.00	791.0	4	5440.00	3360.00	0.25	24.70	7530.00
17/09/2014	2304	6.42	26.30		4.14	2.00	143.00	1.50	17.60	6040.00	1850.00	<10	9590.00	5580.00	1.26	32.40	12500.00
31/01/2013	264	7.18	29			5	38.70	0.30	0.20	118.00	48.30	80	519	91.40	0.05	3.73	71.30
27/02/2013	148	5.88	29.6	6.89	8.59	3	45.90	0.15	0.16	43.10	32.40	98	134	39.70	0.12	2.84	49.30
27/03/2013	123	6.3	27.9	5.60	12.40	4	36.80	0.25	0.08	20.50	22.70	70	69.2	20.30	0.11	1.76	19.60
8/01/2014	334	7.08	30.00	6.53	7.63												
5/02/2014	144	6.81	27.20	7.25	11.47												
5/02/2014						2.00	33.20	0.15	0.18	50.30	65.6	38	203.00	46.20	0.42	3.56	50.70
5/03/2014	226	8.20	28.80	7.18	4.33	2.00	67.60	0.15	0.30	86.80	69.60	100	231.00	74.00	0.30	4.38	100.00
All Data																	
80th percentile	1838	7.14	28.98	7.05	7.53	3.00	51.90	0.64	10.20	3570.00	624.40	34.80	5262.00	3286.00	0.59	23.54	6940.00
95th percentile	2302	8.14	29.98	7.28	12.35	4.00	67.31	0.90	13.93	5887.00	787.60	97.10	8400.00	4913.00	1.26	30.30	10706.00
Min	123	5.48	18.00	5.60	1.40	1.00	20.20	0.10	0.08	20.50	22.70	2.00	69.20	20.30	<0.01	1.76	19.60
Max	2585	58.75	30.30	7.91	16.70	5.00	143.00	1.50	17.60	6040.00	1850.00	100.00	9590.00	5580.00	1.52	32.40	12500.00
Mean	1040	9.08	26.40	6.57	5.43	2.62	44.91	0.43	5.22	1852.26	372.31	24.18	2985.10	1687.57	0.34	12.33	3468.72
Stdev	811	10.84	3.45	0.59	3.91	0.97	25.33	0.33	5.44	1965.06	425.47	31.78	2893.53	1791.73	0.45	10.02	3918.55
April - December																	
80th percentile	2002	7.07	28.50	6.91	5.38	3.00	51.90	0.73	11.40	3842.00	646.60	11.60	5438.00	3720.00	0.67	25.58	7456.00
95th percentile	2360	17.85	29.63	7.32	9.04	4.00	77.96	1.02	14.72	5992.00	1002.80	17.20	8694.00	5092.00	1.31	30.80	11140.00
Min	238	5.48	18.00	5.60	1.40	1.00	20.20	0.10	0.32	121.00	38.40	2.00	304.00	105.00	<0.01	3.29	159.00
Max	2585	58.75	30.30	7.91	16.70	4.00	143.00	1.50	17.60	6040.00	1850.00	22.00	9590.00	5580.00	1.52	32.40	12500.00
Mean	1334	9.85	25.51	6.52	4.41	2.44	45.05	0.50	6.70	2378.29	467.78	8.59	3795.06	2167.94	0.38	14.99	4471.82
Stdev	742	12.61	3.64	0.58	3.55	0.81	28.19	0.35	5.34	1942.72	441.45	5.42	2813.28	1770.46	0.50	9.91	3930.55
January - March																	
80th percentile	264	7.18	29.60	7.19	11.66	4.20	50.24	0.26	0.22	93.04	66.40	98.40	288.60	77.48	0.32	3.86	77.04
95th percentile	316	7.95	29.90	7.24	12.21	4.80	63.26	0.29	0.28	111.76	68.80	99.60	461.40	87.92	0.40	4.25	94.26
Min	123	5.88	27.20	5.60	4.33	2.00	33.20	0.15	0.08	20.50	22.70	38.00	69.20	20.30	0.05	1.76	19.60
Max	334	8.20	30.00	7.25	12.40	5.00	67.60	0.30	0.30	118.00	69.60	100.00	519.00	91.40	0.42	4.38	100.00
Mean	207	6.91	28.75	6.69	8.88	3.20	44.44	0.20	0.18	63.74	47.72	77.20	231.24	54.32	0.20	3.25	58.18
Stdev	82	0.80	1.05	0.67	3.22	1.30	13.75	0.07	0.08	38.58	20.37	25.24	172.71	28.28	0.15	1.00	29.77

Data Table 5 Zone 2 – WCusEB - Wandering Creek upstream East Branch Finniss River

WCusEB Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG							236	na	4.3	Reducing	8	Reducing	759	55	51.6	96	142.5
21/12/2011	538	7.64	30.70					0.70		1.23	7.36	318	97.30	4.73	0.47	3.93	4.30
26/04/2012	314	6.31	25.30				60.00	0.50		112.00	32.60	100	1160.00	64.20	0.30	8.72	56.00
21/05/2012	446	7.68	23.90				6.60	0.60		5.53	16.70	26	75.30	12.90	0.26	3.61	8.30
16/07/2012	521	6.75	22.50					0.45	<0.02	0.64	9.27	12	21.80	5.68	<0.01	1.94	4.00
4/12/2012	628	7.15	29.60				17.80	0.90	<0.02	1.33	12.30	68	63.20	5.64	0.81	7.39	3.20
24/04/2013	251	7.15	27.70	6.26	2.79		44.80	0.30	0.34	59.20	93.30	24	165.00	62.90	0.16	10.50	85.50
23/05/2013	588	6.62	26.7	6.36	11.21		75.80	0.50	0.64	139.00	103.00	28	719.00	140.00	0.03	20.20	174.00
18/06/2013	337	7.12	20.3	7.95	2.82		24.20	0.25	0.2	33.3	44.20	34	210.00	39.40	0.07	5.56	52.00
16/07/2013	519	7.84	20.9	7.10	0.66		10.70	0.40	<0.02	0.66	9.92	74	22.10	3.41	0.07	6.44	3.50
19/08/2013	619	7.72	19.20	6.42	1.07		11.30	0.40	<0.02	0.38	8.35	4	13.70	2.72	<0.01	4.33	2.40
10/09/2013	629	7.97	26.9	6.28	0.89		11.60	0.45	<0.02	0.59	13.20	6	25.70	2.85	<0.01	4.76	2.00
8/10/2013	582	7.33	30.8	4.77	1.28		18.00	0.80	<0.02	1.34	14.60	8	73.20	3.53	0.02	7.12	1.70
7/11/2013	539	6.71	29.3	4.29	1.03		16.00	0.75	<0.02	1.16	8.09	6	85.10	3.60	0.02	4.76	2.30
4/12/2013	1259	6.95	28.00	6.56	5.13		73.50	0.35	2.28	326	501.00	2	694.00	343.00	0.16	52.50	502.00
2/04/2014	356	7.58	27.30	6.26	6.93		83.30	0.55	0.48	148.00	89.70	110	1080.00	127.00	0.49	16.00	139.00
29/04/2014	693	7.81	25.70	6.39	4.31		14.90	0.50	0.24	50.10	51.70	28	353.00	77.50	0.10	8.65	69.10
28/05/2014	530	7.32	23.60	6.63	0.54		4.30	0.50	0.04	0.94	8.83	16	54.20	4.43	0.03	4.27	3.70
24/06/2014	553	6.74	18.00	6.16	1.69		2.60	0.55	<0.02	0.55	8.08	6	27.20	3.74	0.02	5.15	2.90
23/07/2014	535	7.03	16.4	6.33	0.06		2.40	0.45	<0.02	0.64	8.15	6	37.20	3.63	0.03	5.04	3.00
19/08/2014	642	7.25	18.10		0.68		2.50	0.50	<0.02	0.61	7.35	8	36.80	3.41	0.02	4.53	2.20
17/09/2014	603	6.90	24.30		1.45		4.60	0.60	<0.02	1.32	8.01	8	126.00	3.76	0.03	3.88	2.50
14/10/2014	590	7.20	27.50	1.75	2.01		7.60	0.80	<0.02	2.96	6.41	8	395.00	5.26	0.03	5.87	1.50
1/02/2012	147	6.98	26.00					0.25		61.70	53.40	40	67.20	44.80	0.94	1.80	47.20
29/02/2012	327	5.81	28.90														
28/03/2012	224	6.33	28.10				48.00	0.15		51.40	113.00	20	120.00	54.50	0.30	6.60	69.30
31/01/2013	380	7.15	28.3				47.50	0.25	0.28	48.30	91.60	38	140.00	52.80	0.18	9.04	70.80
27/02/2013	294	5.97	29.6	6.43	3.48		34.00	0.30	0.34	50.50	105.00	26	130.00	53.00	0.21	8.81	73.50
27/03/2013	388	7.03	29.1	5.93	8.34		17.50	0.70	0.08	9.76	22.00	18	28.90	11.70	0.37	2.83	16.40
8/01/2014	400	7.10	28.90	6.32	4.54												
5/02/2014	157	6.62	26.60	7.52	16.13		40.20	0.15	0.18	34.00	45.50	36	61.70	34.50	0.88	2.77	38.60
5/03/2014	258	7.90	28.30	6.34	2.26		53.00	0.25	0.26	50.00	102.00	150	165.00	49.20	1.29	5.36	65.00
All Data																	
80th percentile	603	7.64	28.90	6.57	5.01		48.00	0.64	0.30	54.52	92.28	51.20	267.20	57.86	0.41	8.76	69.90
95th percentile	668	7.87	30.15	7.54	11.07		75.23	0.80	0.62	144.40	109.80	134.00	935.60	134.80	0.92	18.52	160.00
Min	147	5.81	16.40	1.75	0.06		2.40	0.15	<0.02	0.38	6.41	2.00	13.70	2.72	<0.01	1.80	1.50
Max	1259	7.97	30.80	7.95	16.13		83.30	0.90	2.28	326.00	501.00	318.00	1160.00	343.00	1.29	52.50	502.00
Mean	479	7.09	25.69	6.10	3.60		28.18	0.48	0.23	41.14	54.99	42.34	215.43	42.20	0.25	8.01	51.93
Stdev	212	0.55	4.01	1.29	3.97		25.09	0.20	0.47	68.98	93.72	63.91	308.20	68.69	0.33	9.42	97.27
April - December																	
80th percentile	626	7.67	27.94	6.57	4.01		47.84	0.68	0.28	57.38	50.20	61.20	386.60	63.94	0.24	8.71	66.48
95th percentile	690	7.84	30.65	7.36	7.79		76.18	0.80	0.80	147.55	102.52	109.50	1061.95	139.35	0.49	19.99	172.25
Min	251	6.31	16.40	1.75	0.06		2.40	0.25	<0.02	0.38	6.41	2.00	13.70	2.72	<0.01	1.94	1.50
Max	1259	7.97	30.80	7.95	11.21		83.30	0.90	2.28	326.00	501.00	318.00	1160.00	343.00	0.81	52.50	502.00
Mean	558	7.22	24.67	5.97	2.62		24.63	0.54	0.23	40.34	48.28	40.91	251.58	41.97	0.14	8.87	51.14
Stdev	195	0.45	4.32	1.44	2.88		26.96	0.17	0.53	79.11	105.63	69.45	346.82	78.88	0.21	10.61	111.73
January - March																	
80th percentile	383	7.12	28.98	6.65	9.90		48.00	0.29	0.29	51.22	104.40	39.60	138.00	52.96	0.93	8.37	70.50
95th percentile	395	7.60	29.40	7.30	14.57		51.75	0.58	0.33	58.61	110.60	117.00	157.50	54.05	1.19	8.97	72.69
Min	147	5.81	26.00	5.93	2.26		17.50	0.15	0.08	9.76	22.00	18.00	28.90	11.70	0.18	1.80	16.40
Max	400	7.90	29.60	7.52	16.13		53.00	0.70	0.34	61.70	113.00	150.00	165.00	54.50	1.29	9.04	73.50
Mean	286	6.77	28.20	6.51	6.95		40.03	0.29	0.23	43.67	76.07	46.86	101.83	42.93	0.60	5.32	54.40
Stdev	97	0.65	1.18	0.60	5.61		12.90	0.19	0.10	17.01	35.32	46.32	49.50	15.39	0.44	2.97	21.27

Data Table 6 Zone 3 – EB@GS097 - East Branch Finniss River at GS097

EB@GS097																	
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG		6.00-8.00					150	na	2.16	Reducing	6.25	Reducing	443	42.5	37.6	62	77.5
23/04/2013	214	7.27	28.40	6.07	2.13	2.00	19.10	0.25	0.16	45.60	17.40	18.00	176.00	57.20	0.04	2.00	62.90
22/05/2013	369	6.33	27.50	5.18	4.85	1.00	29.70	0.30	0.16	24.50	18.70	10.00	296.00	58.30	<0.01	1.89	53.50
17/06/2013	297	6.66	21.30	7.49	1.89	2.00	18.30	0.20	0.12	18.5	10.7	12.00	99.60	52.00	<0.01	2.49	47.20
15/07/2013	408	7.08	22.80	1.39	2.44	2.00	1.20	1.25	<0.02	86.8	1.53	92.00	1310.00	37.70	<0.01	1.83	12.50
3/12/2013	638	6.95	28.60	5.92	11.33	3.00	8.60	0.35	0.56	121	15.9	6.00	262.00	211.00	0.04	0.81	281.00
1/04/2014	416	7.90	28.40	5.54	3.69	2.00	18.00	0.25	0.32	91.60	18.20	8.00	385.00	97.30	<0.01	4.62	105.00
28/04/2014	640	7.92	28.60	5.71	2.53	3.00	5.70	0.35	0.20	11.90	9.09	<2.00	160.00	52.90	<0.01	5.95	35.30
26/05/2014	845	6.65	28.20	6.62	1.48	3.00	7.90	0.40	0.10	8.43	10.40	6.00	130.00	29.40	0.02	6.73	25.60
23/06/2014	751	6.52	19.50	6.02	2.07												
18/08/2014	1407	6.56	21.60		2.71	4.00	1.60	0.30	0.14	6.70	9.82	<2.00	47.00	63.30	0.02	19.80	57.70
31/01/2013		7.04	29.20			4.00	16.30	0.35	0.10	16.60	28.90	38.00	87.50	39.60	0.06	1.97	34.80
26/02/2013	192	5.94	30.60	6.22	11	3.00	22.80	0.25	0.12	24.20	21.40	58.00	138.00	33.30	0.08	1.87	31.40
26/03/2013	202	6.08	28.60	6.51	3.36	3.00	22.60	0.25	0.12	20.20	16.50	52.00	82.90	34.00	0.05	1.68	31.90
7/01/2014	325	6.03	29.40	5.30	4.75												
4/02/2014	75	6.92	27.90	5.83	10.33	3.00	103.00	0.20	0.04	19.40	37.40	102.00	116.00	19.70	1.35	1.77	25.50
4/03/2014	241	8.26	29.40	7.26	2.75	2.00	32.10	0.25	0.22	69.10	37.20	12.00	222.00	63.90	0.07	3.06	76.90
All Data																	
80th percentile	662	7.27	29.20	6.55	5.95	3.00	25.56	0.35	0.21	76.18	24.40	54.40	275.60	63.54	0.06	5.15	68.50
95th percentile	1014	8.01	29.70	7.34	11.10	4.00	56.92	0.70	0.40	101.89	37.27	95.50	708.75	137.10	0.52	11.30	166.60
Min	75	5.94	19.50	1.39	1.48	1.00	1.20	0.20	<0.02	6.70	1.53	<2.00	47.00	19.70	<0.01	0.81	12.50
Max	1407	8.26	30.60	7.49	11.33	4.00	103.00	1.25	0.56	121.00	37.40	102.00	1310.00	211.00	1.35	19.80	281.00
Mean	468	6.88	26.88	5.79	4.49	2.64	21.92	0.35	0.17	40.32	18.08	29.86	250.86	60.69	0.13	4.03	62.94
Stdev	343	0.69	3.45	1.43	3.45	0.84	25.25	0.26	0.13	36.69	10.42	33.69	318.83	47.39	0.35	4.86	67.22
April - December																	
80th percentile	770	7.40	28.44	6.29	3.92	3.00	18.62	0.37	0.25	88.72	17.72	14.40	331.60	76.90	0.03	6.26	79.74
95th percentile	1154	7.91	28.60	7.14	8.41	3.60	25.46	0.91	0.46	109.24	18.50	62.40	940.00	165.52	0.04	14.57	210.60
Min	214	6.33	19.50	1.39	1.48	1.00	1.20	0.20	<0.02	6.70	1.53	<2.00	47.00	29.40	<0.01	0.81	12.50
Max	1407	7.92	28.60	7.49	11.33	4.00	29.70	1.25	0.56	121.00	18.70	92.00	1310.00	211.00	0.04	19.80	281.00
Mean	598	6.98	25.49	5.55	3.51	2.44	12.23	0.41	0.20	46.11	12.42	17.33	318.40	73.23	0.02	5.12	75.63
Stdev	350	0.56	3.70	1.70	2.91	0.88	9.56	0.32	0.16	42.88	5.63	28.44	386.29	54.98	0.01	5.87	81.34
January - March																	
80th percentile	258	7.04	29.40	6.66	10.46	3.20	46.28	0.27	0.14	33.18	37.24	66.80	154.80	44.46	0.33	2.19	43.22
95th percentile	308	7.96	30.30	7.11	10.87	3.80	88.82	0.33	0.20	60.12	37.36	93.20	205.20	59.04	1.10	2.84	68.48
Min	75	5.94	27.90	5.30	2.75	2.00	16.30	0.20	0.04	16.60	16.50	12.00	82.90	19.70	0.05	1.68	25.50
Max	325	8.26	30.60	7.26	11.00	4.00	103.00	0.35	0.22	69.10	37.40	102.00	222.00	63.90	1.35	3.06	76.90
Mean	207	6.71	29.18	6.22	6.44	3.00	39.36	0.26	0.12	29.90	28.28	52.40	129.28	38.10	0.32	2.07	40.10
Stdev	91	0.90	0.90	0.74	3.93	0.71	36.02	0.05	0.06	22.08	9.34	32.91	56.45	16.17	0.57	0.56	20.85

Data Table 7 Zone 3 – EB@GS327 - East Branch Finniss River at GS327

EB@GS327																		
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG	2985	6.0-8.0					150	na	2.16	Reducing	6.25	Reducing	443	42.5	37.6	62	77.5
23/04/2013	227	7.24	28.60	6.05	2.79	2.00	29.80	0.25	0.30	89.20	34.10	20.00	246.00	86.90	0.04	2.89	118.00
22/05/2013	437	6.28	27.40	5.45	6.6	<1.00	41.90	0.25	0.38	128.00	27.50	6.00	517.00	132.00	<0.01	4.02	155.00
17/06/2013	337	6.85	21.50	7.54	3.98	2.00	26.60	0.15	0.36	130.00	19.4	20.00	288.00	141.00	<0.01	3.69	187.00
15/07/2013	629	7.22	22.50	5.82	1.56	2.00	1.50	0.20	0.24	10.10	6.00	<2.00	90.00	99.20	<0.01	3.71	86.60
3/12/2013	604	6.86	28.60	5.62	15.47	4.00	29.50	0.30	1.00	358.00	58.7	20.00	1120.00	298.00	0.06	3.69	357.00
1/04/2014	452	7.63	28.50	6.38	3.05	2.00	23.70	0.25	0.56	181.00	36.50	8.00	575.00	165.00	<0.01	5.35	217.00
28/04/2014	752	7.50	28.40	5.21	4.32	3.00	10.30	0.35	0.72	171.00	12.50	8.00	625.00	215.00	<0.01	6.29	261.00
27/05/2014	1187	6.58	26.20	6.68	0.98		1.90	0.25	1.44	204.00	16.60	2.00	520.00	453.00	0.02	2.99	632.00
23/06/2014	1083	6.99	21.50	6.82	4.03	2.00	0.60	0.25	0.34	7.56	8.33	<2.00	95.00	132.00	<0.01	9.45	132.00
22/07/2014	1162	7.52	18.8	5.74	4.92	2	0.90	0.25	0.22	2.01	9.45	<2	31.00	105.00	<0.01	15.70	93.10
16/09/2014		7.67	27.70		8.44	4.00	2.30	0.40	0.12	23.20	10.50	2.00	362.00	50.70	0.02	23.70	32.80
13/10/2014	1988	7.46	29.80	3.95	7.55	5.00	6.20	0.60	0.06	20.90	10.50	4.00	431.00	35.50	0.02	27.70	19.10
31/01/2013	294	7.18	29.10			4.00	39.50	0.25	0.24	78.90	43.80	66.00	286.00	74.60	0.08	4.14	86.00
26/02/2013	162	5.87	29.70	6.52	10.55	3.00	36.00	0.20	0.14	38.90	26.70	76.00	145.00	38.50	0.11	2.47	44.30
26/03/2013	177	5.99	27.90	6.29	4.00	3.00	34.60	0.20	0.14	32.10	24.30	80.00	103.00	34.10	0.08	2.34	44.30
7/01/2014	352	6.23	29.80	5.62	6.63												
4/02/2014	76	7.39	28.00	6.55	9.87	2.00	103.00	0.15	0.04	18.40	35.70	100.00	111.00	19.60	0.33	1.78	16.00
4/03/2014	232	8.40	29.20	7.81	3.01	2.00	37.50	0.20	0.28	86.90	68.00	14.00	242.00	77.80	0.07	3.36	97.40
All Data																	
80th percentile	1017	7.51	29.16	6.68	8.26	4.00	37.20	0.29	0.52	162.80	36.34	56.80	519.40	160.20	0.08	8.82	211.00
95th percentile	1347	7.78	29.80	7.61	11.53	4.25	54.12	0.44	1.09	234.80	60.56	84.00	724.00	329.00	0.15	24.50	412.00
Min	76	5.87	18.80	3.95	0.98	<1.00	0.60	0.15	0.04	2.01	6.00	<2.00	31.00	19.60	<0.01	1.78	16.00
Max	1988	8.40	29.80	7.81	15.47	5.00	103.00	0.60	1.44	358.00	68.00	100.00	1120.00	453.00	0.33	27.70	632.00
Mean	597	7.05	26.84	6.13	5.75	2.69	25.05	0.26	0.39	92.95	26.39	25.41	340.41	126.94	0.05	7.25	151.68
Stdev	502	0.66	3.36	0.93	3.73	1.08	25.43	0.11	0.37	94.85	18.03	32.74	274.55	110.45	0.08	7.73	154.10
April - December																	
80th percentile	1162	7.52	28.58	6.68	7.36	4.00	28.92	0.34	0.69	179.00	32.78	17.60	564.00	205.00	0.02	14.45	252.20
95th percentile	1588	7.65	29.14	7.18	11.60	4.50	35.25	0.49	1.20	273.30	46.49	20.00	847.75	367.75	0.05	25.50	480.75
Min	227	6.28	18.80	3.95	0.98	<1.00	0.60	0.15	0.06	2.01	6.00	<2.00	31.00	35.50	<0.01	2.89	19.10
Max	1988	7.67	29.80	7.54	15.47	5.00	41.90	0.60	1.44	358.00	58.70	20.00	1120.00	453.00	0.06	27.70	632.00
Mean	805	7.15	25.79	5.93	5.31	2.64	14.60	0.29	0.48	110.41	20.84	8.00	408.33	159.44	0.02	9.10	190.88
Stdev	514	0.44	3.68	0.95	3.91	1.21	14.72	0.12	0.40	107.82	15.69	7.58	300.13	116.53	0.02	8.60	168.63
January - March																	
80th percentile	294	7.39	29.70	6.80	10.01	3.20	52.20	0.21	0.25	80.50	48.64	84.00	250.80	75.24	0.15	3.52	88.28
95th percentile	337	8.15	29.78	7.56	10.41	3.80	90.30	0.24	0.27	85.30	63.16	96.00	277.20	77.16	0.29	3.98	95.12
Min	76	5.87	27.90	5.62	3.01	2.00	34.60	0.15	0.04	18.40	24.30	14.00	103.00	19.60	0.07	1.78	16.00
Max	352	8.40	29.80	7.81	10.55	4.00	103.00	0.25	0.28	86.90	68.00	100.00	286.00	77.80	0.33	4.14	97.40
Mean	215	6.84	28.95	6.56	6.81	2.80	50.12	0.20	0.17	51.04	39.70	67.20	177.40	48.92	0.13	2.82	57.60
Stdev	99	0.99	0.82	0.79	3.38	0.84	29.62	0.04	0.09	30.14	17.61	32.21	82.10	25.89	0.11	0.93	33.45

Data Table 8 Zone 3 – TC@LB - Tailings Creek at mine boundary

TC@LB																	
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG							150	na	2.16	Reducing	6.25	Reducing	443	42.5	37.6	62	77.5
24/04/2013	279	7.42	29	7.55	1.47	3.00	6.10	0.25	0.86	332.00	663.00	20	216.00	366.00	0.25	1.73	356.00
23/05/2013	454	7.59	28.3	7.43	1.52	<1.00	22.80	0.40	0.16	43.80	145.00	4	229.00	57.70	0.02	6.50	44.80
18/06/2013	164	8.07	21.1	10	0.59	1.00	12.70	0.30	0.06	7.66	68.7	6	52.40	27.90	0.03	7.17	18.70
4/12/2013	208	7.11	28.60	7.68	5.81	5.00	8.30	0.30	0.04	3.27	33.6	8	124.00	16.50	0.03	0.55	11.70
2/04/2014	484	7.81	29.90	7.35	2.31	2.00	10.10	0.30	0.38	133.00	411.00	28	258.00	146.00	0.14	2.83	150.00
29/04/2014	373	7.90	26.70	7.37	1.78	3.00	8.90	0.35	0.10	20.90	150.00	8	160.00	34.50	0.03	4.27	29.00
31/01/2013	215	7.11	32.4			3.00	4.70	0.40	0.02	1.03	49.40	4	15.2	13.70	0.04	0.66	7.10
27/02/2013	116	6.06	30.6	8.5	10.93	2.00	15.10	0.20	0.04	3.50	26.90	32	42.4	10.20	0.06	0.70	4.90
27/03/2013	281	6.34	29.8	6.8	6.4	3.00	7.50	0.25	0.26	103.00	117.00	14	150	119.00	0.08	1.85	100.00
8/01/2014	228	6.21	31.10	7.95	4.56												
5/02/2014	132	7.40	28.20	7.67	6.10	2.00	16.50	0.20	0.10	39.50	119.00	26	160.00	44.90	0.23	0.63	48.70
5/03/2014	238	7.88	30.60	8.36	1.70	3.00	22.10	0.20	0.62	249.00	572.00	36	287.00	265.00	0.24	1.47	238.00
All Data																	
80th percentile	355	7.87	30.60	8.36	6.10	3.00	16.50	0.35	0.38	133.00	411.00	28.00	229.00	146.00	0.23	4.27	150.00
95th percentile	468	7.98	31.69	9.25	8.67	4.00	22.45	0.40	0.74	290.50	617.50	34.00	272.50	315.50	0.25	6.84	297.00
Min	116	6.06	21.10	6.80	0.59	<1.00	4.70	0.20	0.02	1.03	26.90	4.00	15.20	10.20	0.02	0.55	4.90
Max	484	8.07	32.40	10.00	10.93	5.00	22.80	0.40	0.86	332.00	663.00	36.00	287.00	366.00	0.25	7.17	356.00
Mean	264	7.24	28.86	7.88	3.92	2.55	12.25	0.29	0.24	85.15	214.15	16.91	154.00	100.13	0.10	2.58	91.72
Stdev	118	0.70	2.88	0.85	3.15	1.13	6.19	0.07	0.27	111.70	226.19	11.95	90.00	117.16	0.09	2.39	113.63
April - December																	
80th percentile	454	7.90	29.00	7.68	2.31	3.00	12.70	0.35	0.38	133.00	411.00	20.00	229.00	146.00	0.14	6.50	150.00
95th percentile	477	8.03	29.68	9.42	4.94	4.50	20.28	0.39	0.74	282.25	600.00	26.00	250.75	311.00	0.22	7.00	304.50
Min	164	7.11	21.10	7.35	0.59	<1.00	6.10	0.25	0.04	3.27	33.60	4.00	52.40	16.50	0.02	0.55	11.70
Max	484	8.07	29.90	10.00	5.81	5.00	22.80	0.40	0.86	332.00	663.00	28.00	258.00	366.00	0.25	7.17	356.00
Mean	327	7.65	27.27	7.90	2.25	2.50	11.48	0.32	0.27	90.11	245.22	12.33	173.23	108.10	0.08	3.84	101.70
Stdev	131	0.35	3.20	1.04	1.83	1.52	5.95	0.05	0.32	127.77	243.75	9.50	76.58	134.71	0.09	2.63	134.55
January - March																	
80th percentile	238	7.40	31.10	8.39	7.31	3.00	17.62	0.28	0.33	132.20	209.60	32.80	185.40	148.20	0.23	1.55	127.60
95th percentile	270	7.76	32.08	8.47	10.02	3.00	20.98	0.37	0.55	219.80	481.40	35.20	261.60	235.80	0.24	1.77	210.40
Min	116	6.06	28.20	6.80	1.70	2.00	4.70	0.20	0.02	1.03	26.90	4.00	15.20	10.20	0.04	0.63	4.90
Max	484	8.07	29.90	10.00	5.81	5.00	22.80	0.40	0.86	332.00	663.00	28.00	258.00	366.00	0.25	7.17	356.00
Mean	339	6.52	23.36	7.23	2.95	2.92	13.22	0.29	0.43	161.40	366.09	16.64	173.33	180.38	0.13	4.62	176.41
Stdev	160	3.04	10.41	3.21	1.99	1.59	7.05	0.13	0.31	123.07	238.75	9.56	89.72	131.81	0.09	2.71	129.48

Data Table 9 Zone 4 – EBusFR - East Branch upstream of the Finniss River Confluence at road crossing

EBusFR																	
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQO	427	6.5-7.5					80	na	1.08	2.8	4.5	300	100	32.5	22.4	32.9	37.5
8/04/2013	161	6.51	30.10	7.15	4.74												
23/04/2013	207	7.5	29.80	7.41	3.00	2.00	15.30	0.40	0.10	19.80	10.80	14	109.00	35.00	0.05	2.05	28.90
7/05/2013	432	7.11	29.30	7.34	1.19												
22/05/2013	374	6.83	28.40	6.17	2.90	5.00	26.30	0.45	0.12	11.40	14.20	12	197.00	40.00	0.01	2.17	33.20
3/06/2013	235	7.3	26.20	7.15	3.46												
17/06/2013	302	7.08	23.10	9.92	1.32	2.00	14.90	0.40	0.06	4.82	8.57	18	51.20	28.20	<0.01	3.04	17.00
1/07/2013	373	7.67	21.80	6.8	1.04												
15/07/2013	342	7.2	25.00	6.58	1.36	1.00	1.00	0.65	0.04	14.9	4.86	8	186.00	18.50	<0.01	7.26	11.80
3/12/2013	707	6.61	29.50	6.38	9.90	4.00	7.80	0.60	0.36	66.9	36.7	42	189.00	136.00	1.34	1.31	141.00
12/12/2013	381	6.78	32.60	6.49	10.30												
1/04/2014	340	7.02	29.80	7.17	4.01	2.00	14.10	0.40	0.14	34.60	10.80	12	193.00	50.90	<0.01	3.44	42.50
28/04/2014	548	6.90	28.80	7.48	3.35	2.00	6.40	0.65	0.06	7.89	8.16	14	156.00	20.60	0.01	8.23	11.20
14/05/2014	543	7.32	27.80	7.78	2.69												
27/05/2014	607	7.51	27.30	6.71			1.30	0.60	0.04	6.24	6.71	6	133.00	13.20	0.02	14.30	8.40
10/06/2014	478	7.80	22.60	5.89	3.41												
23/06/2014	393	7.57	24.90	7.65	0.95	2.00	1.10	0.60	<0.02	10.10	5.71	6	140.00	11.90	<0.01	25.70	7.30
7/07/2014	385	6.12	19.30	8.03	10.83												
22/07/2014	326.4	7.18	20.7	6.38	6.33	2	0.90	0.45	0.04	17.7	5.11	2	370.00	24.30	0.01	7.06	13.50
30/01/2013	307	7.22	31.60			4.00	15.00	0.60	0.06	10.70	26.70	46	80.8	30.90	0.06	2.40	17.90
11/02/2013	362	7.08	32.10	6.56	2.21												
26/02/2013	190	5.97	31.60	6.69	14.43	3.00	17.20	0.35	0.10	16.70	18.10	46	113	28.50	0.06	1.90	21.90
11/03/2013	159	7.11	29.70	6.9	9.80												
26/03/2013	193	6.33	28.90	6.56	5.18	3.00	66.00	0.30	0.10	11.30	25.10	210	62.8	25.40	0.22	1.67	25.30
7/01/2014	292	7.55	31.30	7.60	7.09												
20/01/2014	158	7.14	28.80	6.62	14.30												
4/02/2014	74	7.30	28.30	7.05	8.27	2.00	33.20	0.20	0.06	15.20	30.00	68	95.50	17.50	0.40	1.50	29.20
14/02/2014	152	6.90	30.00	7.07	9.57												
4/03/2014	204	6.42	30.70	7.65	4.27	2.00	51.30	0.30	0.14	47.50	41.80	120	169.00	48.20	0.22	2.60	51.00
18/03/2014	218	6.67	30.50	7.43	3.43												
All Data																	
80th percentile	408	7.39	30.58	7.55	9.75	3.40	27.68	0.60	0.12	22.76	27.36	50.40	189.80	41.64	0.22	7.45	35.06
95th percentile	583	7.63	31.90	7.94	13.26	4.35	55.71	0.65	0.21	53.32	38.23	147.00	248.90	76.43	0.68	17.72	78.00
Min	74	5.97	19.30	5.89	0.95	1.00	0.90	0.20	<0.02	4.82	4.86	2.00	51.20	11.90	<0.01	1.31	7.30
Max	707	7.80	32.60	9.92	14.43	5.00	66.00	0.65	0.36	66.90	41.80	210.00	370.00	136.00	1.34	25.70	141.00
Mean	326	7.02	27.95	7.09	5.53	2.57	18.12	0.46	0.10	19.72	16.89	41.60	149.69	35.27	0.16	5.64	30.67
Stdev	151	0.46	3.56	0.77	4.03	1.09	19.16	0.14	0.08	17.18	12.21	56.26	77.57	30.19	0.34	6.60	33.02
April - December																	
80th percentile	517	7.51	29.68	7.58	6.01	2.80	14.98	0.61	0.12	22.76	11.48	14.80	193.80	42.18	0.03	9.44	35.06
95th percentile	622	7.69	30.48	8.31	10.41	4.60	21.35	0.65	0.26	52.37	26.58	31.20	292.15	97.70	0.76	20.57	96.67
Min	161	6.12	19.30	5.89	0.95	1.00	0.90	0.40	<0.02	4.82	4.86	2.00	51.20	11.90	<0.01	1.31	7.30
Max	707	7.80	32.60	9.92	10.83	5.00	26.30	0.65	0.36	66.90	36.70	42.00	370.00	136.00	1.34	25.70	141.00
Mean	396	7.11	26.50	7.14	4.16	2.44	8.91	0.52	0.10	19.44	11.16	13.40	172.42	37.86	0.15	7.46	31.48
Stdev	140	0.44	3.75	0.91	3.28	1.24	8.56	0.11	0.10	18.80	9.45	11.12	83.08	36.59	0.42	7.54	40.24
January - March																	
80th percentile	292	7.22	31.60	7.46	10.70	3.20	54.24	0.40	0.11	22.86	32.36	138.00	124.20	34.36	0.26	2.44	33.56
95th percentile	334	7.43	31.85	7.63	14.37	3.80	63.06	0.55	0.13	41.34	39.44	192.00	157.80	44.74	0.36	2.56	46.64
Min	74	5.97	28.30	6.56	2.21	2.00	15.00	0.20	0.06	10.70	18.10	46.00	62.80	17.50	0.06	1.50	17.90
Max	362	7.55	32.10	7.65	14.43	4.00	66.00	0.60	0.14	47.50	41.80	210.00	169.00	48.20	0.40	2.60	51.00
Mean	210	6.88	30.32	7.01	7.86	2.80	36.54	0.35	0.09	20.28	28.34	98.00	104.22	30.10	0.19	2.01	29.06
Stdev	82	0.48	1.28	0.42	4.26	0.84	21.99	0.15	0.03	15.43	8.69	69.53	40.66	11.31	0.14	0.47	12.96

Data Table 10 Zone 5 – FRDSMB - Finnis River Downstream Mount Burton

FRDSMB Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQO	374	6.5-7.5					55	na	0.54	2.8	3.4	200	100	20	10	10	20
24/04/2012	219	6.23	27.70				47.60	0.60		0.43	11.40	420	10.80	0.74	0.09	0.57	0.70
23/05/2012	274	7.23	28.40				4.80	0.45		0.29	6.28	64	12.50	1.05	0.02	0.80	1.40
19/06/2012	473	7.58	27.50					0.50		0.16	5.78	166	12.40	0.89	0.03	1.06	
16/07/2012	374	8.13	25.40					0.60	<0.02	0.17	4.67	26	16.10	0.84	<0.01	1.28	1.60
25/07/2012	355	7.89	22.30				1.90	0.70	<0.02	0.20	5.95	34	11.20	0.62	0.01	1.42	1.00
14/08/2012	347	7.86	22.40					0.65	<0.02	0.19	5.95	48	12.70	0.56	<0.01	1.42	0.90
10/09/2012	392	7.80	26.60					0.95	<0.02	0.15	5.55	82	18.70	0.50	<0.01	1.41	1.20
11/10/2012	453	7.29	30.20					1.30	<0.02	0.13	5.31	26	13.00	0.56	0.02	1.36	0.50
6/11/2012	443	8.32	30.20				5.80	1.50	<0.02	0.12	4.85	26	11.3	0.39	0.02	1.25	0.60
4/12/2012	113	7.45	30.80				165.00	0.60	<0.02	0.11	2.71	242	10.9	0.68	0.14	0.39	1.20
8/04/2013	104	6.85	29.40	6.32	9.14												
23/04/2013	148	7.34	28.80	5.94	6.57	4.00	4.80	0.50	<0.02	0.22	3.83	140	12.10	0.45	0.04	0.39	0.90
7/05/2013	250	7.74	28.60	6.36	3.32												
22/05/2013	223	7.60	27.80	5.17	8.71	5.00	22.80	0.60	<0.02	0.15	3.46	150	18.70	0.47	0.04	0.66	1.00
3/06/2013	238	7.72	25.80	6.15	7.22												
17/06/2013	276	7.98	23.90	7.51	3.44	2.00	9.90	0.60	<0.02	0.11	3.22	218	14.00	0.36	0.02	1.11	0.50
1/07/2013	308	8.32	22.70	6.28	3.62												
15/07/2013	330	7.96	24.90	6.25	2.99	1.00	1.60	0.70	<0.02	0.15	4.41	36	21.20	0.38	0.02	1.70	0.70
29/07/2013	393	8.14	24.70	7.08	2.08												
19/08/2013	428	7.90	22.50	5.92	2.22	1.00	7.90	0.95	<0.02	0.16	4.83	36	26.30	0.42	0.03	1.64	0.40
26/08/2013	425	7.89	26.70	5.7	2.88												
9/09/2013	442	7.73	27.70	5.61	2.72	2.00	7.60	1.00	<0.02	0.11	3.23	54	23.00	0.25	<0.01	1.59	0.60
23/09/2013	466	7.21	30.00	5.88	11.78												
7/10/2013	428	7.86	30.50	4.91	3.5	2.00	12.80	1.50	<0.02	0.09	3.53	24	13.60	0.27	<0.01	1.40	0.50
21/10/2013	461	7.12	31.80	4.8	3.54												
5/11/2013	403	7.58	30.70	5.38	16.87	4.00	10.60	1.60	<0.02	0.3	17.8	22	23.80	0.98	0.04	2.33	0.60
18/11/2013	115	6.73	28.60	4.46	25.43												
3/12/2013	174	7.24	29.70	5.00	12.57	5.00	12.30	0.85	<0.02	0.11	1.59	242	19.00	0.38	0.12	0.47	0.60
12/12/2013	130	7.36	32.10	4.80	18.23												
1/04/2014	205	8.21	29.30	6.57	4.72	2.00	7.20	0.45	<0.02	0.31	4.99	108	14.60	0.49	0.02	0.50	0.20
28/04/2014	246	7.58	28.50	5.90	9.04	3.00	7.20	0.65	<0.02	0.24	4.68	166	19.40	0.48	0.03	0.69	0.30
14/05/2014	243	7.68	27.10	6.64	5.92												
20/05/2014	296	7.27	27.20	6.76	3.55	2.00	4.00	0.60	<0.02	0.15	3.18	116	15.40	0.43	0.03	1.04	0.50
27/05/2014	298	7.76	27.20	5.96			2.20	0.65	<0.02	0.16	3.95	80	15.70	0.42	0.02	1.12	0.50
10/06/2014	319	7.09	24.30	6.26	5.35												
23/06/2014	320	8.22	23.90	5.74	3.41	1.00	1.80	0.60	<0.02	0.17	3.48	30	25.00	0.54	<0.01	1.58	0.40
7/07/2014	368	7.04	20.20	7.33	4.25												
22/07/2014	337.5	7.99	21.4	6.12	2.68	1	1.50	0.90	<0.02	0.19	5.90	24	16.70	0.58	<0.01	1.50	0.50
5/08/2014	397	7.77	19.80	5.99	3.43												
18/08/2014	387	7.67	23.30		2.21	2.00	1.70	1.05	<0.02	0.19	5.65	34	12.20	0.49	0.01	1.45	0.50
1/09/2014	423	8.14	23.80	9.14	2.77												
16/09/2014		8.08	28.20		4.51	2.00	2.70	1.20	<0.02	0.20	5.07	30	22.50	0.44	0.01	1.49	0.50
13/10/2014	474	8.09	31.50	5.22	3.45	4.00	4.40	1.40	<0.02	0.10	2.70	16	16.00	0.40	0.02	1.51	0.40
27/03/2012	102	6.36	27.40				16.00	<0.50		0.40	5.90	180	7.60	0.70	<0.10	0.28	2.00
3/01/2013	235	7.24	32.20				10.50	0.80	<0.02	0.07	1.99	148	16.7	0.31	0.06	0.37	0.40
30/01/2013	150	7.71	30.30			5.00	19.80	0.60	<0.02	0.07	1.65	210	6.74	0.43	0.09	0.57	0.50
11/02/2013	143	7.55	31.00	5.43	20.07												
26/02/2013	93	6.13	30.70	6.22	17.03	4.00	33.80	0.40	<0.02	0.13	1.64	254	8.82	0.57	0.09	0.41	0.50
11/03/2013	60	6.93	28.40	6.57	41.27												
26/03/2013	47	6.13	27.20	6.23	56.67	5.00	76.40	0.30	<0.02	0.09	0.85	192	4.33	0.52	0.11	0.21	1.10
7/01/2014	132	7.56	30.50	5.52	12.77												
20/01/2014	52	7.46	27.50	6.23	34.53												
4/02/2014	59	7.41	28.10	6.18	15.80	5.00	62.40	0.55	0.04	0.60	19.70	150	9.19	2.84	1.32	0.26	180.00
14/02/2014	60	7.49	28.90	6.57	40.83												
4/03/2014	123	8.58	30.00	6.69	10.52	3.00	14.50	0.40	<0.02	0.27	3.97	158	10.40	0.50	0.13	0.32	0.90
18/03/2014	126	7.37	30.20	6.24	10.12												
All Data																	
80th percentile	407	7.98	30.20	6.57	16.66	4.80	20.40	1.01	0.02	0.25	5.90	182.40	19.08	0.68	0.09	1.49	1.04
95th percentile	463	8.25	31.58	7.33	40.52	5.00	70.10	1.50	0.02	0.41	13.32	245.60	24.16	1.00	0.13	1.66	1.74
Min	47	6.13	19.80	4.46	2.08	1.00	1.50	0.30	<0.02	0.07	0.85	16.00	4.33	0.25	<0.01	0.21	0.20
Max	474	8.58	32.20	9.14	56.67	5.00	165.00	1.60	0.04	0.60	19.70	420.00	26.30	2.84	1.32	2.33	180.00
Mean	271	7.55	27.44	6.07	10.99	2.95	19.38	0.78	0.02	0.19	5.13	112.91	14.93	0.60	0.08	1.02	6.00
Stdev	135	0.54	3.15	0.84	12.30	1.50	32.94	0.35	0.00	0.11	3.90	93.53	5.34	0.43	0.22	0.54	30.75
April - December																	
80th percentile	427	8.04	29.88	6.57	8.97	4.00	11.62	1.14	<0.02	0.21	5.85	159.60	20.48	0.66	0.04	1.51	0.98
95th percentile	466	8.22	31.43	7.42	17.48	5.00	45.12	1.50	<0.02	0.31	9.61	242.00	24.58	0.95	0.11	1.68	1.34
Min	104	6.23	19.80	4.46	2.08	1.00	1.50	0.45	<0.02	0.09	1.59	16.00	10.80	0.25	<0.01	0.39	0.20
Max	474	8.32	32.10	9.14	25.43	5.00	165.00	1.60	<0.02	0.43	17.80	420.00	26.30	1.05	0.14	2.33	1.60
Mean	321	7.64	26.84	6.04	6.32	2.53	15.13	0.84	<0.02	0.18	5.14	95.00	16.39	0.54	0.03	1.18	0.69
Stdev	110	0.46	3.27	0.94	5.41	1.37	34.13	0.35	0.00	0.08	3.05	95.01	4.65	0.20	0.03	0.47	0.35
January - March																	
80th percentile	138	7.56	30.62	6.57	40.92	5.00	56.68	0.59	0.02	0.37	5.51	206.40	10.16	0.67	0.13	0.40	1.82
95th percentile	184	8.06	31.48	6.64	49.74	5.00	72.20	0.74	0.04	0.54	15.56	240.80	14.81	2.20	0.96	0.52	126.60
Min	47	6.13	27.20	5.43	10.12	3.00	10.50	0.30	<0.02	0.07	0.85	148.00	4.33	0.31	0.06	0.21	0.40
Max	235	8.58	32.20	6.69	56.67	5.00	76.40	0.80	0.04	0.60	19.70	254.00	16.70	2.84	1.32	0.57	180.00
Mean	106	7.22	29.42	6.19	25.96	4.40	33.34	0.51	0.02	0.23	5.10	184.57	9.11	0.84	0.27	0.35	26.49
Stdev	54	0.69	1.59	0.42	16.17	0.89	26.01	0.16	0.01	0.20	6.67	38.26	3.88	0.89	0.46	0.12	67.70

Data Table 11 Zone 5 – FRUSMB - Finniss River Upstream Mount Burton

FRUSMB Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG	374	6.5-7.5					55	na	0.54	2.8	3.4	200	100	20	10	10	20
24/04/2012	207	6.17	27.80				9.80	0.35		0.02	0.28	60	7.25	0.18	<0.01	0.46	0.50
23/05/2012	251	7.11	27.00				4.80	0.30		0.08	0.29	70	8.33	0.61	0.02	0.74	4.80
19/06/2012	300	7.12	22.60					0.35		0.04	0.40	170	8.33	0.58	0.08	1.00	
16/07/2012	368	7.16	25.60					0.40	<0.02	0.06	0.31	24	13.10	0.50	<0.01	1.32	1.60
25/07/2012	327	7.39	21.10					0.40	<0.02	0.08	0.31			0.24	0.05	1.51	1.30
14/08/2012	320	6.92	20.60					0.40	<0.02	0.05	0.78	26	9.79	0.18	<0.01	1.56	0.60
10/09/2012	384	7.53	27.00					0.65	<0.02	0.10	1.20	80	16.40	0.26	<0.01	1.53	0.50
11/10/2012	443	7.63	30.90					0.90	<0.02	0.06	1.08	34	18.10	0.24	0.02	1.52	0.50
6/11/2012	424	7.55	30.10				6.70	1.15	<0.02	0.07	0.33	34	16.9	0.15	0.03	1.39	1.20
4/12/2012	81	6.65	29.10				78.60	0.55	<0.02	0.07	0.91	202	8.44	0.39	0.22	0.32	1.10
8/04/2013	100	6.94	29.20	6.36	9.65												
23/04/2013	150	7.80	29.00	5.96	5.32	3.00	4.60	0.35	<0.02	0.09	0.23	154	10.8	0.17	0.04	0.33	0.60
7/05/2013	233	7.78	28.60	6.74	3.06												
22/05/2013	212	7.82	27.70	5.42	10.62	4.00	23.40	0.45	<0.02	0.08	0.44	162	15.4	0.31	0.04	0.63	1.60
3/06/2013	226	7.86	25.80	6.25	6.8												
17/06/2013	260	7.70	23.90	7.69	3.37	2.00	9.10	0.40	<0.02	0.06	0.27	166	11.1	0.12	0.01	1.08	0.40
1/07/2013	294	8.37	22.50	6.59	3.13												
15/07/2013	317	8.02	25.00	6.37	2.85	1.00	1.30	0.45	<0.02	0.06	0.28	38	18	0.11	0.01	1.82	0.40
29/07/2013	366	8.18	24.00	7.32	3.3												
19/08/2013	408	7.92	22.50	6.2	2.33	3.00	7.80	0.55	<0.02	0.07	0.32	32	21.80	0.13	<0.01	1.87	0.20
26/08/2013	399	7.80	26.20	5.96	1.79												
9/09/2013	440	7.89	26.90	5.41	2.21	2.00	5.70	0.80	<0.02	0.07	0.67	34	25.3	0.10	0.01	1.68	0.80
23/09/2013	456	7.61	29.10	5.75	20.8												
7/10/2013	415	8.00	30.60	5.54	1.86	3.00	12.50	1.15	<0.02	0.08	0.38	40	19.90	0.20	0.01	1.56	0.70
21/10/2013	438	7.47	30.40	5.79	2.21												
5/11/2013	421	7.80	30.70	6.2	1.97	4.00	8.70	1.30	<0.02	0.06	0.65	28	18.10	0.14	<0.01	1.46	0.30
18/11/2013	84	7.15	28.70	4.68	26.57												
3/12/2013	170	7.31	29.70	5.60	18.70	5.00	13.80	0.85	<0.02	0.07	1.03	290	15.10	0.31	0.08	0.34	0.40
12/12/2013	116	7.60	32.10	5.41	18.77												
1/04/2014	190	8.06	29.20	6.72	5.17	2.00	6.90	0.40	<0.02	0.08	1.81	104	12.20	0.16	0.01	0.45	0.20
28/04/2014	220	7.68	28.40	6.09	4.88	2.00	7.60	0.45	<0.02	0.08	0.46	164	15.00	0.20	0.03	0.66	0.70
14/05/2014	228	7.82	27.30	7.30	4.72												
21/05/2014	283	6.85	27.40	6.42	3.32	2.00	3.20	0.45	<0.02	0.08	0.50	70	16.60	0.26	0.30	1.09	2.00
27/05/2014	281	7.25	27.50	6.21			2.30	0.45	<0.02	0.07	0.29	62	14.3	0.18	0.02	1.06	1.10
10/06/2014	300	7.96	24.00	6.16	9.19												
23/06/2014	311	8.24	24.00	5.74	2.39	2.00	2.00	0.40	<0.02	0.06	0.27	30	16.10	0.12	<0.01	1.67	0.20
7/07/2014	341	7.71	19.70	7.27	3.79												
22/07/2014	313	8.09	21.6	6.27	1.73	2	0.90	0.45	<0.02	0.07	0.30	22	13.90	0.11	<0.01	1.75	0.20
5/08/2014	394	7.76	21.00	5.78	2.89												
18/08/2014	369	7.26	24.00		1.97	3.00	1.10	0.55	<0.02	0.08	0.27	32	13.50	0.12	<0.01	1.86	0.40
1/09/2014	429	7.69	23.40	9.14	4.69												
16/09/2014		8.06	28.90		4.67	3.00	3.80	0.80	0.04	0.15	1.16	40	29.60	0.26	0.09	1.69	0.90
13/10/2014	459	8.02	31.60	6.67	8.00	3.00	4.50	1.35	<0.02	0.12	0.49	30	29.40	0.30	0.04	1.93	0.60
11/11/2014	497	8.61	20.80	6.02	3.29												
10/12/2014	448	8.01	30.50	5.42	2.18	3.00	10.90	1.45	<0.02	0.07	0.21	20	30.70	0.24	0.01	1.60	0.20
27/03/2012	101	6.02	27.50				15.00	<0.50		<0.10	0.50	180	5.50	0.30	<0.10	0.24	2.00
3/01/2013	201	7.39	31.10				10.90	0.65	<0.02	0.07	0.71	152	7.4	0.34	0.09	0.35	0.70
30/01/2013	150	7.72	30.80			5.00	15.60	0.50	<0.02	0.08	0.83	180	6.33	0.41	0.08	0.56	0.40
11/02/2013	140	7.53	30.90	5.65	20.3												
26/02/2013	87	6.21	30.60	6.26	17.4	4.00	31.30	0.40	<0.02	0.10	0.67	256	8.69	0.54	0.09	0.39	0.40
11/03/2013	56	6.90	28.40	6.51	49.33												
26/03/2013	44	6.24	27.30	5.65	54.5	5.00	75.20	0.30	<0.02	0.09	0.65	210	4.68	0.55	0.15	0.21	1.50
7/01/2014	131	7.61	30.60	5.77	12.33												
20/01/2014	38	7.57	27.40	6.06	41.63												
4/02/2014	51	7.72	27.60	5.62	16.90	5.00	48.80	0.30	<0.02	0.10	1.03	154	3.62	0.71	0.11	0.14	1.50
14/02/2014	60	7.49	28.90	6.74	31.33												
4/03/2014	120	8.03	29.70	6.69	11.54	3.00	41.00	0.40	<0.02	0.09	0.23	288	8.66	0.22	0.11	0.26	0.80
18/03/2014	119	7.44	30.10	6.35	9.99												
All Data																	
80th percentile	407	7.98	30.28	6.68	17.92	4.00	17.16	0.80	0.02	0.09	0.83	172.00	18.10	0.39	0.09	1.67	1.34
95th percentile	450	8.19	30.93	7.32	40.09	5.00	63.32	1.31	0.02	0.11	1.17	265.60	29.46	0.59	0.17	1.86	2.00
Min	38	6.02	19.70	4.68	1.73	1.00	0.90	0.30	<0.02	0.02	0.21	20.00	3.62	0.10	<0.01	0.14	0.20
Max	497	8.61	32.10	9.14	54.50	5.00	78.60	1.45	0.04	0.15	1.81	290.00	30.70	0.71	0.30	1.93	4.80
Mean	263	7.54	27.15	6.23	10.76	3.09	15.59	0.60	0.02	0.08	0.57	103.94	14.24	0.28	0.05	1.06	0.89
Stdev	135	0.54	3.29	0.75	12.70	1.16	20.16	0.32	0.00	0.02	0.36	82.89	7.00	0.16	0.06	0.61	0.86
April - December																	
80th percentile	422	8.01	29.30	6.70	8.48	3.00	10.46	0.87	0.02	0.08	0.83	158.80	19.18	0.30	0.04	1.68	1.16
95th percentile	455	8.23	30.86	7.47	19.48	4.15	22.44	1.33	0.02	0.11	1.18	190.80	29.53	0.55	0.17	1.87	1.86
Min	81	6.17	19.70	4.68	1.73	1.00	0.90	0.30	<0.02	0.02	0.21	20.00	7.25	0.10	<0.01	0.32	0.20
Max	497	8.61	32.10	9.14	26.57	5.00	78.60	1.45	0.04	0.15	1.81	290.00	30.70	0.61	0.30	1.93	4.80
Mean	311	7.63	26.53	6.26	6.12	2.72	10.00	0.64	0.02	0.07	0.55	79.21	16.19	0.24	0.04	1.24	0.86
Stdev	112	0.48	3.42	0.83	6.15	0.96	15.80	0.34	0.00	0.02	0.39	69.88	6.41	0.13	0.07	0.53	0.91
January - March																	
80th percentile	136	7.68	30.72	6.55	43.17	5.00	47.24	0.50	<0.02	0.10	0.81	246.80	8.41	0.55	0.11	0.38	1.50
95th percentile	170	7.84	30.98	6.72	52.17	5.00	67.28	0.61	<0.02	0.10	0.97	278.40	8.68	0.66	0.14	0.51	1.85
Min	38	6.02	27.30	5.62	9.99	3.00	10.90	0.30	<0.02	0.07	0.23	152.00	3.62	0.22	0.08	0.14	0.40
Max	201	8.03	31.10	6.74	54.50	5.00	75.20	0.65	<0.02	0.10	1.03	288.00	8.69	0.71	0.15	0.56	2.00
Mean	100	7.22	29.30	6.13	26.53	4.40	33.97	0.44	<0.02	0.09	0.66	202.86	6.41	0.44	0.10	0.31	1.04
Stdev	49	0.66	1.50	0.44	16.56	0.89	23.12	0.12	0.00	0.01	0.25	51.87	1.95	0.17	0.02	0.14	0.62

Data Table 12 Zone 5 – MBDSPIT - Mt Burton downstream of Pit

MBDSPIT Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG	374	6.5-7.5					55	na	0.54	2.8	3.4	200	100	20	10	10	20
24/04/2012	454	6.51	28.90				17.00	2.55		9.46	160.00	60	57.80	9.94	0.19	2.04	5.80
23/05/2012	486	7.22	30.30				10.20	2.05		5.56	107.00	6	45.10	7.44	0.04	1.42	2.10
19/06/2012	317	8.23	22.90					1.80		2.65	61.60	44	34.20	4.26	0.06	0.97	1.90
16/07/2012	476	7.92	28.60					1.85	<0.02	1.50	33.80	6	29.30	3.16	<0.01	0.84	2.30
14/08/2012	413	7.45	25.90					1.65	<0.02	1.26	28.70	10	25.00	2.23	0.01	0.87	1.10
10/09/2012	455	7.63	28.90					1.80	<0.02	0.87	23.90	54	26.90	1.55	0.05	0.84	2.70
11/10/2012	510	7.64	30.60					2.15	<0.02	1.00	15.50	10	37.20	1.44	0.01	0.90	0.90
6/11/2012	254	8.12	30.50				4.50	2.00	<0.02	0.62	16.00	46	26.70	1.06	0.06	0.82	1.10
4/12/2012	532	7.28	31.10				14.30	2.20	<0.02	0.73	19.10	10	28.50	1.51	0.03	0.99	1.30
23/04/2013	417	6.88	29.40	5.1	1.62		8.70	2.50	0.04	8.82	164.00	52	56.60	9.81	0.11	1.77	3.80
22/05/2013	495	7.38	29.00	5.2	1.88		21.00	2.35	<0.02	2.44	47.60	10	37.50	3.58	<0.01	1.18	2.00
17/06/2013	453	7.64	26.30	6.44	1.22		8.10	1.85	<0.02	1.53	33.40	8	20.80	2.50	<0.01	1.01	1.00
15/07/2013	427	7.78	26.60	5.55	1.41		1.90	1.90	<0.02	0.92	21.60	6	18.40	1.79	<0.01	1.03	1.00
19/08/2013	490	7.61	23.50	5.44	1.72		7.10	1.85	<0.02	0.45	14.40	8	13.20	1.02	0.02	0.87	0.50
9/09/2013	496	7.32	27.70	5.22	0.67		6.10	1.85	<0.02	0.45	9.65	10	18.40	0.89	<0.01	0.69	1.10
7/10/2013	442	7.18	29.30	4.77	1.87		11.90	2.15	<0.02	0.5	6.99	4	22.80	0.65	0.02	0.80	0.80
5/11/2013	449	6.67	27.30	4.81	6.92		13.10	2.65	<0.02	1.68	48.10	76	36.90	3.41	0.12	2.36	1.30
3/12/2013	452	7.31	29.10	4.76	20.70		5.10	2.65	<0.02	2.02	14.50	12	62.70	2.46	0.05	5.88	2.80
1/04/2014	172	7.90	29.20	5.72	1.84		9.30	2.55	0.04	9.99	152.00	52	66.90	10.60	0.10	1.54	2.00
28/04/2014	467	7.76	29.60	5.38	3.22		7.60	2.45	<0.02	4.86	79.00	24	54.70	5.63	0.04	1.28	1.40
27/05/2014	465	7.49	28.80	5.17	0.48		3.00	2.10	<0.02	2.54	36.90	8	44.30	3.24	0.02	1.11	0.90
23/06/2014	399	7.54	17.60	4.89	1.48		1.80	1.80	<0.02	1.43	24.10	4	26.40	2.05	<0.01	0.93	0.70
22/07/2014	411	6.88	24.5	5.12	0.3		1.70	1.70	<0.02	1.02	18.30	4	24.20	1.59	<0.01	0.77	0.90
18/08/2014	452	7.41	26.70		0.74		2.20	1.60	<0.02	0.64	11.00	4	20.30	1.00	<0.01	0.83	0.90
16/09/2014		7.71	29.60		7.49		3.40	1.90	<0.02	0.57	5.91	8	25.60	0.78	0.05	1.03	0.70
13/10/2014	495	7.62	30.00	5.23	4.93		4.10	1.95	<0.02	0.40	4.56	8	20.80	0.71	0.02	0.82	0.40
11/11/2014	526	8.08	27.30	4.28	1.70												
10/12/2014	516	7.90	29.50	5.10	1.50		11.10	2.35	<0.02	0.61	8.54	8	27.60	1.00	0.01	0.95	0.60
28/02/2012	371	7.14	29.70				79.00	2.50		14.70	294.00	320	53.90	15.10	1.30	2.15	4.00
27/03/2012	360	6.55	27.20				20.00	2.30		15.90	252.00	182	72.30	16.10	0.54	2.08	5.80
3/01/2013	546	7.50	30.90				7.40	2.15	<0.02	0.66	15.40	10	25.20	1.36	0.01	0.83	0.70
30/01/2013	483	6.88	29.20				3.00	2.45	<0.02	1.71	30.20	20	41.20	2.64	0.01	1.03	1.30
26/02/2013	435	6.63	30.00				11.90	2.70	0.04	9.48	172.00	134	57.80	10.50	0.62	2.28	2.70
26/03/2013	475	7.18	28.70	5.41	2.68		12.10	2.85	0.04	8.58	138.00	146	60.80	9.10	0.35	2.57	3.10
7/01/2014	454	7.32	29.20	5.31	9.90												
4/02/2014	188	7.57	29.70	5.70	16.30		22.40	1.75	0.04	17.10	254.00	134	45.00	17.60	1.48	2.15	5.50
4/03/2014	402	8.23	29.40	5.92	2.81		25.40	2.60	0.04	14.40	240.00	236	70.70	15.00	0.62	1.87	3.20
All Data																	
80th percentile	495	7.78	29.70	5.55	6.12		14.84	2.51	0.03	8.95	153.60	63.20	56.84	9.84	0.13	2.05	2.86
95th percentile	528	8.14	30.66	5.92	15.66		24.05	2.67	0.04	15.06	252.60	198.20	68.04	15.40	0.82	2.42	5.59
Min	172	6.51	17.60	4.28	0.30		1.70	1.60	<0.02	0.40	4.56	4.00	13.20	0.65	<0.01	0.69	0.40
Max	546	8.23	31.10	6.44	20.70		79.00	2.85	0.04	17.10	294.00	320.00	72.30	17.60	1.48	5.88	5.80
Mean	434	7.43	28.18	5.26	4.06		11.81	2.16	0.02	4.20	73.19	49.54	38.16	4.93	0.17	1.41	1.95
Stdev	86	0.46	2.64	0.46	5.20		14.26	0.35	0.01	5.09	84.72	74.08	17.06	5.06	0.35	0.96	1.51
April - December																	
80th percentile	495	7.78	29.60	5.44	4.25		11.90	2.45	0.02	2.65	61.60	46.00	45.10	4.26	0.06	1.42	2.10
95th percentile	522	8.11	30.57	5.90	9.47		17.00	2.63	0.04	9.30	158.00	58.50	61.48	9.91	0.12	2.28	3.55
Min	172	6.51	17.60	4.28	0.30		1.70	1.60	<0.02	0.40	4.56	4.00	13.20	0.65	<0.01	0.69	0.40
Max	532	8.23	31.10	6.44	20.70		21.00	2.65	0.04	9.99	164.00	76.00	66.90	10.60	0.19	5.88	5.80
Mean	439	7.49	27.75	5.19	3.34		7.72	2.07	0.02	2.46	44.52	20.92	33.89	3.24	0.04	1.29	1.59
Stdev	81	0.42	2.93	0.48	4.80		5.35	0.32	0.01	2.86	48.22	21.98	15.12	2.99	0.04	1.02	1.18
January - March																	
80th percentile	478	7.53	29.82	5.79	12.46		24.20	2.66	0.04	15.42	253.20	214.40	66.74	15.70	1.03	2.23	4.90
95th percentile	521	7.97	30.54	5.89	15.34		60.24	2.80	0.04	16.68	280.00	290.60	71.74	17.08	1.42	2.47	5.70
Min	188	6.55	27.20	5.31	2.68		3.00	1.75	<0.02	0.66	15.40	10.00	25.20	1.36	0.01	0.83	0.70
Max	546	8.23	30.90	5.92	16.30		79.00	2.85	0.04	17.10	294.00	320.00	72.30	17.60	1.48	2.57	5.80
Mean	413	7.22	29.33	5.59	7.92		22.65	2.41	0.03	10.32	174.45	147.75	53.36	10.93	0.62	1.87	3.29
Stdev	102	0.52	1.01	0.28	6.52		24.01	0.35	0.01	6.37	105.81	103.03	15.79	6.20	0.54	0.61	1.80

Data Table 13 Zone 5 – FRUSEB - Finniss River Upstream East Branch

FRUSEB Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQG	135.3842292	6.5-7.5					55	na	0.54	2.8	3.4	200	100	20	10	10	20
24/04/2012	454	6.51	28.90				17.00	2.55		9.46	160.00	60	57.80	9.94	0.19	2.04	5.80
23/05/2012	486	7.22	30.30				10.20	2.05		5.56	107.00	6	45.10	7.44	0.04	1.42	2.10
19/06/2012	317	8.23	22.90					1.80		2.65	61.60	44	34.20	4.26	0.06	0.97	1.90
16/07/2012	476	7.92	28.60					1.85	<0.02	1.50	33.80	6	29.30	3.16	<0.01	0.84	2.30
14/08/2012	413	7.45	25.90					1.65	<0.02	1.26	28.70	10	25.00	2.23	0.01	0.87	1.10
10/09/2012	455	7.63	28.90					1.80	<0.02	0.87	23.90	54	26.90	1.55	0.05	0.84	2.70
11/10/2012	510	7.64	30.60					2.15	<0.02	1.00	15.50	10	37.20	1.44	0.01	0.90	0.90
6/11/2012	254	8.12	30.50				4.50	2.00	<0.02	0.62	16.00	46	26.70	1.06	0.06	0.82	1.10
4/12/2012	532	7.28	31.10				14.30	2.20	<0.02	0.73	19.10	10	28.50	1.51	0.03	0.99	1.30
23/04/2013	417	6.88	29.40	5.1	1.62		8.70	2.50	0.04	8.82	164.00	52	56.60	9.81	0.11	1.77	3.80
22/05/2013	495	7.38	29.00	5.2	1.88		21.00	2.35	<0.02	2.44	47.60	10	37.50	3.58	<0.01	1.18	2.00
17/06/2013	453	7.64	26.30	6.44	1.22		8.10	1.85	<0.02	1.53	33.40	8	20.80	2.50	<0.01	1.01	1.00
15/07/2013	427	7.78	26.60	5.55	1.41		1.90	1.90	<0.02	0.92	21.60	6	18.40	1.79	<0.01	1.03	1.00
19/08/2013	490	7.61	23.50	5.44	1.72		7.10	1.85	<0.02	0.45	14.40	8	13.20	1.02	0.02	0.87	0.50
9/09/2013	496	7.32	27.70	5.22	0.67		6.10	1.85	<0.02	0.45	9.65	10	18.40	0.89	<0.01	0.69	1.10
7/10/2013	442	7.18	29.30	4.77	1.87		11.90	2.15	<0.02	0.5	6.99	4	22.80	0.65	0.02	0.80	0.80
5/11/2013	449	6.67	27.30	4.81	6.92		13.10	2.65	<0.02	1.68	48.10	76	36.90	3.41	0.12	2.36	1.30
3/12/2013	452	7.31	29.10	4.76	20.70		5.10	2.65	<0.02	2.02	14.50	12	62.70	2.46	0.05	5.88	2.80
1/04/2014	172	7.90	29.20	5.72	1.84		9.30	2.55	0.04	9.99	152.00	52	66.90	10.60	0.10	1.54	2.00
28/04/2014	467	7.76	29.60	5.38	3.22		7.60	2.45	<0.02	4.86	79.00	24	54.70	5.63	0.04	1.28	1.40
27/05/2014	465	7.49	28.80	5.17	0.48		3.00	2.10	<0.02	2.54	36.90	8	44.30	3.24	0.02	1.11	0.90
23/06/2014	399	7.54	17.60	4.89	1.48		1.80	1.80	<0.02	1.43	24.10	4	26.40	2.05	<0.01	0.93	0.70
22/07/2014	411	6.88	24.5	5.12	0.3		1.70	1.70	<0.02	1.02	18.30	4	24.20	1.59	<0.01	0.77	0.90
18/08/2014	452	7.41	26.70		0.74		2.20	1.60	<0.02	0.64	11.00	4	20.30	1.00	<0.01	0.83	0.90
16/09/2014		7.71	29.60		7.49		3.40	1.90	<0.02	0.57	5.91	8	25.60	0.78	0.05	1.03	0.70
13/10/2014	495	7.62	30.00	5.23	4.93		4.10	1.95	<0.02	0.40	4.56	8	20.80	0.71	0.02	0.82	0.40
11/11/2014	526	8.08	27.30	4.28	1.70												
10/12/2014	516	7.90	29.50	5.10	1.50		11.10	2.35	<0.02	0.61	8.54	8	27.60	1.00	0.01	0.95	0.60
28/02/2012	371	7.14	29.70				79.00	2.50		14.70	294.00	320	53.90	15.10	1.30	2.15	4.00
27/03/2012	360	6.55	27.20				20.00	2.30		15.90	252.00	182	72.30	16.10	0.54	2.08	5.80
3/01/2013	546	7.50	30.90				7.40	2.15	<0.02	0.66	15.40	10	25.20	1.36	0.01	0.83	0.70
30/01/2013	483	6.88	29.20				3.00	2.45	<0.02	1.71	30.20	20	41.20	2.64	0.01	1.03	1.30
26/02/2013	435	6.63	30.00				11.90	2.70	0.04	9.48	172.00	134	57.80	10.50	0.62	2.28	2.70
26/03/2013	475	7.18	28.70	5.41	2.68		12.10	2.85	0.04	8.58	138.00	146	60.80	9.10	0.35	2.57	3.10
7/01/2014	454	7.32	29.20	5.31	9.90												
4/02/2014	188	7.57	29.70	5.70	16.30		22.40	1.75	0.04	17.10	254.00	134	45.00	17.60	1.48	2.15	5.50
4/03/2014	402	8.23	29.40	5.92	2.81		25.40	2.60	0.04	14.40	240.00	236	70.70	15.00	0.62	1.87	3.20
All Data																	
80th percentile	495	7.78	29.70	5.55	6.12		14.84	2.51	0.03	8.95	153.60	63.20	56.84	9.84	0.13	2.05	2.86
95th percentile	528	8.14	30.66	5.92	15.66		24.05	2.67	0.04	15.06	252.60	198.20	68.04	15.40	0.82	2.42	5.59
Min	172	6.51	17.60	4.28	0.30		1.70	1.60	<0.02	0.40	4.56	4.00	13.20	0.65	<0.01	0.69	0.40
Max	546	8.23	31.10	6.44	20.70		79.00	2.85	0.04	17.10	294.00	320.00	72.30	17.60	1.48	5.88	5.80
Mean	434	7.43	28.18	5.26	4.06		11.81	2.16	0.02	4.20	73.19	49.54	38.16	4.93	0.17	1.41	1.95
Stdev	86	0.46	2.64	0.46	5.20		14.26	0.35	0.01	5.09	84.72	74.08	17.06	5.06	0.35	0.96	1.51
April - December																	
80th percentile	495	7.78	29.60	5.44	4.25		11.90	2.45	0.02	2.65	61.60	46.00	45.10	4.26	0.06	1.42	2.10
95th percentile	522	8.11	30.57	5.90	9.47		17.00	2.63	0.04	9.30	158.00	58.50	61.48	9.91	0.12	2.28	3.55
Min	172	6.51	17.60	4.28	0.30		1.70	1.60	<0.02	0.40	4.56	4.00	13.20	0.65	<0.01	0.69	0.40
Max	532	8.23	31.10	6.44	20.70		21.00	2.65	0.04	9.99	164.00	76.00	66.90	10.60	0.19	5.88	5.80
Mean	439	7.49	27.75	5.19	3.34		7.72	2.07	0.02	2.46	44.52	20.92	33.89	3.24	0.04	1.29	1.59
Stdev	81	0.42	2.93	0.48	4.80		5.35	0.32	0.01	2.86	48.22	21.98	15.12	2.99	0.04	1.02	1.18
January - March																	
80th percentile	478	7.53	29.82	5.79	12.46		24.20	2.66	0.04	15.42	253.20	214.40	66.74	15.70	1.03	2.23	4.90
95th percentile	521	7.97	30.54	5.89	15.34		60.24	2.80	0.04	16.68	280.00	290.60	71.74	17.08	1.42	2.47	5.70
Min	188	6.55	27.20	5.31	2.68		3.00	1.75	<0.02	0.66	15.40	10.00	25.20	1.36	0.01	0.83	0.70
Max	546	8.23	30.90	5.92	16.30		79.00	2.85	0.04	17.10	294.00	320.00	72.30	17.60	1.48	2.57	5.80
Mean	413	7.22	29.33	5.59	7.92		22.65	2.41	0.03	10.32	174.45	147.75	53.36	10.93	0.62	1.87	3.29
Stdev	102	0.52	1.01	0.28	6.52		24.01	0.35	0.01	6.37	105.81	103.03	15.79	6.20	0.54	0.61	1.80
Mean	442	7.41	28.10	5.21	3.54	#DIV/0!	10.95	2.16	0.02	3.50	62.66	41.33	36.97	4.25	0.12	1.38	1.81
Stdev	77	0.45	2.69	0.45	4.68	#DIV/0!	14.38	0.35	0.01	4.31	74.98	66.72	16.53	4.30	0.26	0.97	1.39
January - March																	
80th percentile	514	8.19	30.28	5.92	16.04	#NUM!	24.86	2.64	<0.04	16.28	253.44	220.88	69.64	16.72	1.22	2.31	5.55
95th percentile	540	8.23	30.95	6.26	19.16	#NUM!	60.24	2.79	<0.04	17.10	280.00	290.60	71.74	17.60	1.48	4.67	5.73
Min	86	0.46	2.64	0.46	0.30	0.00	1.70	0.35	<0.01	0.40	4.56	4.00	13.20	0.65	0.01	0.69	0.40
Max	546	8.23	31.10	6.44	20.70	0.00	79.00	2.85	<0.04	17.10	294.00	320.00	72.30	17.60	1.48	5.88	5.80
Mean	356	6.79	24.87	4.94	8.89	#DIV/0!	24.18	2.06	<0.03	10.29	169.58	134.88	47.66	10.76	0.63	2.18	3.35
Stdev	180	2.62	9.98	1.92	7.52	#DIV/0!	23.46	0.82	0.01	6.50	105.85	108.07	23.48	6.57	0.59	1.61	2.07

Data Table 14 Zone 6 – FR@GS204 - Finniss River at GS8150204

FR@GS204																	
Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQO	374	6.5-7.5					55	na	0.54	2.8	3.4	200	100	20	10	10	20
23/04/2013	150	7.31	28.00	5.72	5.35	3.00	6.60	0.45	<0.02	2.89	4.16	90	28.90	7.18	0.03	0.76	5.30
22/05/2013	227	6.17	27.50	4.92	8.89	<1.00	22.50	0.50	0.02	1.53	5.32	110	38.00	7.23	0.05	0.84	6.50
17/06/2013	256	6.89	22.20	6.59	2.79	2.00	10.10	0.55	<0.02	0.82	5.24	136	19.90	6.27	0.02	1.78	3.50
15/07/2013	302	7.78	23.60	5.38	2.13	1.00	2.10	0.65	<0.02	0.94	2.21	20	34.20	1.56	0.02	2.83	1.20
19/08/2013	398	7.48	20.30	4.07	2.26	4.00	8.10	0.80	<0.02	0.99	2.31	14	42.60	1.42	0.01	3.34	0.60
9/09/2013	415	6.82	25.10	4.9	2.07	3.00	6.10	1.15	<0.02	1.03	2.44	22	58.90	1.46	<0.01	3.16	1.00
7/10/2013	397	7.00	28.10	2.28	2.4	3.00	12.20	1.70	<0.02	1.31	2.40	54	81.50	1.62	0.05	3.13	0.90
5/11/2013	398	6.32	27.00	3.14	3.58	4.00	20.80	1.75	0.02	0.94	6.34	82	54.00	3.41	0.54	3.07	15.40
3/12/2013	552	6.19	28.60	4.87	10.47	4.00	4.40	0.75	0.1	14.90	9.84	40	117.00	46.30	0.02	0.66	37.80
1/04/2014	220	7.93	27.70	6.46	5.67	2.00	5.40	0.55	<0.02	4.42	4.26	136	44.20	8.49	0.05	1.20	5.10
28/04/2014	247	7.95	28.30	5.91	5.49	3.00	6.00	0.55	<0.02	0.80	2.22	36	27.40	1.70	0.01	1.30	0.80
27/05/2014	297	7.55	26.30	5.58	1.90		4.10	0.50	<0.10	0.64	3.13	18	24.10	1.13	0.05	2.30	1.30
23/06/2014	310	6.49	22.80	4.99	3.76	2.00	1.70	0.65	<0.02	0.83	2.38	14	32.70	0.89	<0.01	2.82	0.40
22/07/2014	315	7.38	19.5	5.87	2.92	2	1.50	0.65	<0.02	0.85	1.98	10	36.70	0.91	0.01	3.24	0.70
18/08/2014	352	7.09	20.20		2.62	2.00	1.60	0.70	<0.02	0.78	2.20	16	34.40	0.88	0.01	3.26	0.60
16/09/2014		7.52	25.80		3.73	2.00	2.50	1.15	<0.02	1.08	2.30	26	73.40	1.12	0.02	3.49	0.40
13/10/2014	445	6.88	28.20	2.74	4.79	2.00	4.90	1.65	<0.02	1.76	2.29	52	117.00	1.43	0.05	4.32	0.80
11/11/2014	491	6.78	26.70	2.36	4.86												
10/12/2014	430	7.48	29.30	3.24	3.78	5.00	11.10	2.05	<0.02	0.93	2.15	74.00	67.10	1.20	0.07	3.28	0.50
30/01/2013	175	6.35	28.90			5.00	17.20	0.65	<0.02	1.55	8.85	156	17.6	6.43	0.10	1.08	3.20
26/02/2013	110	5.91	29.40	6.21	18.53	5.00	37.10	0.50	0.02	2.05	6.35	214	21	4.87	0.12	0.67	3.00
26/03/2013	80	6.36	27.50	6.08	47.73	5.00	38.30	0.40	<0.02	0.30	2.13	216	5.72	1.52	0.11	0.28	1.40
7/01/2014	160	6.26	29.70	5.07	11.30												
4/02/2014	87	6.58	27.70	4.01	6.97	3.00	89.70	0.40	0.04	6.12	26.90	134	49.40	16.20	1.32	1.30	26.10
4/03/2014	141	7.71	28.90	6.55	10.91	3.00	19.50	0.70	0.32	6.28	6.38	110	35.50	8.37	0.37	0.98	7.10
All Data																	
80th percentile	405	7.53	28.66	6.05	9.52	4.00	20.28	1.15	0.02	2.55	6.35	135.20	63.82	7.21	0.11	3.25	6.02
95th percentile	484	7.90	29.38	6.55	17.45	5.00	38.18	1.75	0.10	6.26	9.74	208.20	113.45	15.43	0.52	3.48	25.03
Min	80	5.91	19.50	2.28	1.90	1.00	1.50	0.40	<0.02	0.30	1.98	10.00	5.72	0.88	<0.01	0.28	0.40
Max	552	7.95	29.70	6.59	47.73	5.00	89.70	2.05	0.32	14.90	26.90	216.00	117.00	46.30	1.32	4.32	37.80
Mean	290	6.97	26.29	4.86	7.29	3.00	14.50	0.84	0.04	2.34	4.95	77.39	46.14	5.72	0.13	2.13	5.37
Stdev	133	0.61	3.08	1.38	9.49	1.27	19.46	0.49	0.07	3.20	5.30	63.83	28.89	9.62	0.29	1.21	9.22
April - December																	
80th percentile	424	7.53	28.14	5.84	5.41	3.80	10.70	1.45	<0.02	1.67	4.85	86.80	70.88	6.82	0.05	3.27	5.22
95th percentile	500	7.93	28.67	6.49	9.05	4.20	21.06	1.80	<0.10	5.99	6.86	136.00	117.00	14.16	0.14	3.61	18.76
Min	150	6.17	19.50	2.28	1.90	1.00	1.50	0.45	<0.02	0.64	1.98	10.00	19.90	0.88	<0.01	0.66	0.40
Max	552	7.95	29.30	6.59	10.47	5.00	22.50	2.05	<0.10	14.90	9.84	136.00	117.00	46.30	0.54	4.32	37.80
Mean	345	7.11	25.54	4.65	4.18	2.65	7.32	0.93	<0.03	2.08	3.51	52.78	51.78	5.23	0.06	2.49	4.60
Stdev	105	0.56	3.15	1.42	2.30	1.11	6.13	0.51	0.03	3.33	2.07	42.29	29.29	10.57	0.12	1.11	9.08
January - March																	
80th percentile	160	6.58	29.40	6.28	24.37	5.00	48.58	0.66	0.10	6.15	12.46	214.40	38.28	9.94	0.56	1.12	10.90
95th percentile	171	7.43	29.63	6.48	41.89	5.00	79.42	0.69	0.26	6.25	23.29	215.60	46.62	14.63	1.13	1.26	22.30
Min	80	5.91	27.50	4.01	6.97	3.00	17.20	0.40	0.02	0.30	2.13	110.00	5.72	1.52	0.10	0.28	1.40
Max	175	7.71	29.70	6.55	47.73	5.00	89.70	0.70	0.32	6.28	26.90	216.00	49.40	16.20	1.32	1.30	26.10
Mean	125	6.53	28.68	5.58	19.09	4.20	40.36	0.53	0.08	3.26	10.12	166.00	25.84	7.48	0.40	0.86	8.16
Stdev	39	0.62	0.90	1.04	16.55	1.10	29.24	0.14	0.13	2.76	9.69	47.60	16.92	5.48	0.52	0.40	10.25

Data Table 15 Zone 7 – FRdsFC - Finniss River downstream Florence Creek

FRdsFC Sample Date	EC_fd (uS/cm)	pH_fd (unit)	T_fd (oC)	DO_fd (mg/L)	Turb_fd (NTU)	DOC (mg/L)	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
WQO	374	6.5-7.5					55	na	0.54	2.8	3.4	200	100	20	10	10	20
26/04/2013	82	5.62	57.60	5.53	4.41	3.00	10.90	0.45	<0.02	0.55	2.64	208	14.10	1.57	0.08	0.25	2.10
24/05/2013	92	7.22	26.60	5.79	11.66	4.00	34.40	0.40	<0.02	0.25	1.41	164	9.66	1.12	0.05	0.29	1.30
19/06/2013	82	6.26	20.20	5.89	3.01	3.00	17.80	0.35	<0.02	0.30	1.70	206	13.60	1.20	0.05	0.25	1.00
17/07/2013	61	7.26	23.50	6.23	2.75	1.00	10.50	0.30	<0.02	0.40	0.93	158	23.80	0.93	0.04	0.17	0.80
20/08/2013	49	5.52	20.80	5.79	1.76	3.00	16.20	0.30	<0.02	0.32	0.86	148	15.00	0.58	0.04	0.16	0.50
10/09/2013	36	6.50	26.40	5.3	2.26	2.00	21.80	0.40	<0.02	0.30	1.15	218	19.10	0.65	0.07	0.13	1.20
8/10/2013	41	6.21	29.30	4.22	1.84	3.00	24.20	0.60	<0.02	0.14	1.12	354	13.40	0.68	0.1	0.14	0.90
7/11/2013	95	5.66	30.00	4.29	2.64	3.00	19.10	0.60	<0.02	0.10	1.33	310	6.09	1.13	0.12	0.39	2.90
5/12/2013	71	5.88	28.80	5.18	25.53	5.00	46.70	1.00	<0.02	0.36	3.16	412	14.80	1.54	0.62	0.29	1.20
4/04/2014	98	6.53	29.40	5.43	4.09	3.00	14.60	0.40	<0.02	0.38	1.71	158	12.90	1.32	0.05	0.29	2.90
1/05/2014	97	6.71	28.50	5.67	4.30	2.00	16.80	0.45	<0.02	0.32	1.30	198	15.00	1.02	0.06	0.35	1.30
31/05/2014	68	5.89	25.60	6.01	2.69	2.00	7.00	0.40	<0.02	0.37	0.86	164	17.20	0.67	0.03	0.28	0.60
25/06/2014	55	5.91	23.40	6.75	2.33	2.00	7.90	0.25	<0.02	0.37	0.76	138	15.40	0.60	0.02	0.32	0.40
24/07/2014	59	6.35	20.1	4.83	1.87	2	10.20	0.25	<0.02	0.37	0.74	142	16.50	0.53	0.04	0.31	0.80
19/08/2014	39	6.38	24.60		1.98	2.00	11.00	0.25	<0.02	0.43	0.79	174	15.20	0.50	0.05	0.19	0.70
17/09/2014	28	7.60	30.00		3.60	2.00	19.30	0.40	<0.02	0.43	0.90	196	16.20	0.52	0.07	0.11	0.90
14/10/2014	22	7.31	31.80	5.25	3.18	2.00	27.60	0.45	<0.02	0.56	1.15	236	19.20	0.71	0.10	0.10	2.20
13/11/2014	21	8.61	25.50	4.02	5.07												
11/12/2014	34	5.46	30.70	3.65	10.62	7.00	82.90	0.55	<0.02	0.71	2.43	298.00	18.50	0.98	0.11	0.15	3.30
1/02/2013	119	6.73	29.60			5.00	26.50	0.70	<0.02	0.43	6.83	282	14.20	2.74	0.16	0.48	1.40
28/02/2013	59	5.87	28.90			5.00	63.70	0.65	0.02	0.62	8.61	320	9.73	2.90	0.21	0.49	1.70
28/03/2013	23	6.03	27.80	5.86	30.57	5.00	85.70	0.30	0.02	0.30	3.21	182	3.88	1.29	0.14	0.22	1.90
9/01/2014	93	6.39	30.70	3.49	9.58												
10/02/2014	32	6.03	28.00	6.70	16.60	4.00	34.70	0.45	0.02	1.08	4.61	196	15.20	2.07	0.40	0.24	9.30
6/03/2014	42	7.21	27.50	6.56	30.70	4.00	33.00	0.35	<0.02	0.36	1.74	142	10.60	0.94	0.10	0.13	1.20
All Data																	
80th percentile	92	7.21	30.00	6.01	11.24	4.60	34.58	0.58	0.02	0.50	2.95	291.60	16.92	1.45	0.13	0.32	2.16
95th percentile	98	7.54	31.58	6.70	30.07	5.00	80.98	0.70	0.02	0.70	6.61	350.60	19.19	2.67	0.38	0.47	3.26
Min	21	5.46	20.10	3.49	1.76	1.00	7.00	0.25	<0.02	0.10	0.74	138.00	3.88	0.50	<0.02	0.10	0.40
Max	119	8.61	57.60	6.75	30.70	7.00	85.70	1.00	0.02	1.08	8.61	412.00	23.80	2.90	0.62	0.49	9.30
Mean	60	6.45	28.21	5.35	7.96	3.22	27.93	0.45	0.02	0.41	2.17	217.57	14.32	1.14	0.12	0.25	1.76
Stdev	28	0.75	6.97	0.96	9.16	1.44	22.24	0.18	0.00	0.20	2.02	75.84	4.32	0.66	0.14	0.11	1.83
April - December																	
80th percentile	86	7.24	30.00	5.87	4.67	3.00	26.24	0.51	<0.02	0.43	1.71	273.20	17.98	1.17	0.10	0.30	2.16
95th percentile	97	7.70	34.38	6.33	13.05	5.30	52.13	0.66	<0.02	0.58	2.72	362.70	19.89	1.54	0.19	0.35	2.96
Min	21	5.46	20.10	3.65	1.76	1.00	7.00	0.25	<0.02	0.10	0.74	138.00	6.09	0.50	<0.02	0.10	0.40
Max	98	8.61	57.60	6.75	25.53	7.00	82.90	1.00	<0.02	0.71	3.16	412.00	23.80	1.57	0.62	0.39	3.30
Mean	59	6.47	28.04	5.28	5.03	2.83	22.16	0.43	<0.02	0.37	1.39	215.67	15.31	0.90	0.09	0.23	1.39
Stdev	26	0.82	8.01	0.84	5.67	1.38	18.14	0.18	0.00	0.14	0.70	78.36	3.83	0.35	0.13	0.09	0.90
January - March																	
80th percentile	93	6.73	29.60	6.62	30.62	5.00	68.10	0.66	0.02	0.71	7.19	289.60	14.40	2.77	0.25	0.48	3.38
95th percentile	112	7.09	30.43	6.68	30.68	5.00	81.30	0.69	0.02	0.99	8.25	312.40	15.00	2.87	0.36	0.49	7.82
Min	23	5.87	27.50	3.49	9.58	4.00	26.50	0.30	<0.02	0.30	1.74	142.00	3.88	0.94	0.10	0.13	1.20
Max	119	7.21	30.70	6.70	30.70	5.00	85.70	0.70	0.02	1.08	8.61	320.00	15.20	2.90	0.40	0.49	9.30
Mean	61	6.38	28.75	5.65	21.86	4.60	48.72	0.49	0.02	0.56	5.00	224.40	10.72	1.99	0.20	0.31	3.10
Stdev	37	0.51	1.23	1.49	10.53	0.55	25.15	0.18	0.00	0.32	2.76	73.91	4.47	0.86	0.12	0.16	3.48

A1-5. DATA QA/QC

Data Table 16: Exposure Blank samples collected in 2012 to 2014 sampling rounds

Sample Date	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
4/02/2014	0.2	<0.05	<0.02	<0.01	0.56	2	0.02	<0.01	0.02	<0.001	1.2
5/02/2014	0.5	<0.05	<0.02	<0.01	1.02	<2	0.05	0.04	0.06	<0.001	2.1
4/03/2014	8.1	<0.05	<0.02	<0.01	0.90	<2	<0.01	<0.01	0.06	<0.001	2.5
5/03/2014	9	<0.05	<0.02	<0.01	1.11	<2	0.01	<0.01	0.09	<0.001	2.2
1/04/2014	3.8	<0.05	<0.02	<0.01	1.01	<2	<0.01	<0.01	<0.01	0.001	1.7
2/04/2014	5.8	<0.05	<0.02	<0.01	0.52	<2	<0.01	<0.01	0.01	<0.001	1.8
28/04/2014	8	<0.05	<0.02	0.01	0.51	4	0.24	0.28	0.10	0.007	6.1
29/04/2014	6.1	<0.05	<0.02	<0.01	0.20	<2	<0.01	0.02	<0.01	<0.001	2.3
27/05/2014	0.4	<0.05	<0.02	<0.01	0.79	<2	0.01	0.04	0.02	0.004	1.4
28/05/2014	0.7	<0.05	<0.02	<0.01	1.36	<2	0.05	0.03	0.04	<0.001	1.7
23/06/2014	<0.1	<0.05	<0.02	<0.01	1.01	<2	<0.01	0.10	0.04	<0.001	2.9
24/06/2014	<0.1	<0.05	<0.02	<0.01	0.32	<2	<0.01	0.01	<0.01	<0.001	0.6
18/08/2014	0.6	<0.05	<0.02	0.01	1.64	2	0.06	0.34	0.05	<0.001	1.4
16/09/2014	2.8	<0.05	<0.02	0.01	0.13	6	0.09	0.41	0.01	<0.001	0.6
17/09/2014	1.6	<0.05	<0.02	<0.01	0.14	2	0.06	0.07	0.01	<0.001	0.2
13/10/2014	3.1	<0.05	<0.02	<0.01	0.10	4	0.08	0.16	0.02	<0.001	0.7
14/10/2014	3.6	<0.05	<0.02	<0.01	0.11	4	0.10	0.11	0.02	0.002	0.6
11/11/2014	4.2	<0.05	<0.02	<0.01	0.21	4	0.11	0.11	0.03	<0.001	1.4
12/11/2014	3.9	<0.05	<0.02	<0.01	0.19	4	0.06	0.08	0.02	0.002	0.4
10/12/2014	9.7	<0.05	<0.02	<0.01	0.19	4	0.07	0.09	0.01	<0.001	0.4
11/12/2014	10.2	<0.05	<0.02	<0.01	0.15	4	0.09	0.10	0.01	<0.001	0.4
6/01/2015	32.3	<0.05	<0.02	0.01	0.85	4	0.12	0.09	0.05	<0.001	1.7
7/01/2015	30.0	<0.05	<0.02	0.02	0.91	6	0.13	0.13	0.06	<0.001	1.8

Red indicates samples for which filtered concentrations exceeded total concentrations. Shaded cells indicate very high blank values.

Data Table 17: Field blank samples collected in 2012 to 2014 sampling rounds

Sample Date	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
27/03/2012	5.2	<0.05	<0.02	<0.01	0.42	<2	0.12	0.09	0.02	<0.001	4.9
28/03/2012	4.7	<0.05	<0.02	<0.01	0.10	<2	0.31	0.18	0.02	<0.001	1.9
24/04/2012	7.1	<0.05	<0.02	<0.01	0.73	<2	0.54	0.09	0.01	<0.001	1.0
23/05/2012	7.2	<0.05	0.36	0.03	0.33	8	0.44	0.53	0.01	<0.001	65.7
19/06/2012		<0.05	<0.02	0.01	0.41	<2	0.13	0.55	0.01	<0.001	1.7
16/07/2012		<0.05	<0.02	<0.01	0.20	<2	0.04	0.36	<0.01	0.006	1.3
14/08/2012		<0.05	<0.02	<0.01	1.00	<2	0.10	0.07	<0.01	<0.001	0.4
10/09/2012		<0.05	<0.02	<0.01	0.15	<2	0.02	0.11	<0.01	<0.001	0.9
11/10/2012		<0.05	<0.02	<0.01	0.73	2	0.06	0.10	0.01	<0.001	1.1
6/11/2012	2.9	<0.05	<0.02	<0.01	0.05	<2	0.01	0.03	<0.01	<0.001	0.9
4/12/2012	10.8	<0.05	<0.02	0.01	0.15	<2	0.13	0.11	0.08	<0.001	1.2
3/01/2013	4.8	<0.05	<0.02	<0.01	0.64	2	0.31	0.06	0.03	<0.001	2.4
31/01/2013	0.3	<0.05	<0.02	<0.01	0.73	<2	<0.01	0.07	<0.01	<0.001	0.6
31/01/2013	0.6	<0.05	<0.02	<0.01	0.51	<2	0.10	0.06	<0.01	<0.001	1.2
26/02/2013	0.5	<0.05	0.02	<0.01	1.76	2	0.37	0.29	0.01	<0.001	0.9
27/02/2013	0.5	<0.05	<0.02	<0.01	0.06	2	0.16	0.23	0.02	<0.001	0.7
26/03/2013	0.5	<0.05	0.02	0.02	1.94	2	0.35	0.26	0.02	<0.001	3.2
27/03/2013	0.5	<0.05	<0.02	<0.01	1.37	2	0.37	0.26	0.03	<0.001	3.6
23/04/2013	4.1	<0.05	<0.02	<0.01	0.11	<2	0.17	0.01	<0.01	0.001	1.0
24/04/2013	1.0	<0.05	<0.02	<0.01	0.12	<2	0.17	<0.01	<0.01	0.001	1.0
22/05/2013	19.1	<0.05	<0.02	<0.01	3.22	<2	0.03	0.06	<0.01	<0.001	1.3
23/05/2013	18.6	<0.05	<0.02	<0.01	0.27	<2	0.08	0.04	<0.01	<0.001	1.4
17/06/2013	6.6	<0.05	<0.02	<0.01	0.35	<2	<0.01	<0.01	<0.01	<0.001	0.9
18/06/2013	7.4	<0.05	<0.02	<0.01	0.30	<2	0.23	0.01	0.02	<0.001	1.0
15/07/2013	0.2	<0.05	<0.02	<0.01	1.59	<2	0.09	0.03	<0.01	<0.001	0.5
16/07/2013	0.3	<0.05	<0.02	<0.01	2.69	<2	0.20	0.01	<0.01	<0.001	1.5
16/07/2013	0.3	<0.05	<0.02	<0.01	0.14	<2	0.03	<0.01	0.02	<0.001	1.7
19/08/2013	<0.1	<0.05	<0.02	<0.01	1.42	<2	0.04	0.01	<0.01	<0.001	0.3
20/08/2013	7.5	<0.05	<0.02	<0.01	1.72	<2	0.11	<0.01	<0.01	<0.001	0.5
9/09/2013	4.6	<0.05	<0.02	<0.01	0.06	<2	0.03	0.01	<0.01	0.003	0.5
10/09/2013	6.6	<0.05	<0.02	<0.01	0.52	<2	0.07	0.01	<0.01	<0.001	0.8
7/10/2013	11.3	<0.05	<0.02	0.01	0.29	<2	0.06	0.04	0.03	0.019	1.4
8/10/2013	12.0	<0.05	<0.02	<0.01	0.36	<2	0.03	0.02	<0.01	0.001	1.0
5/11/2013	9.8	<0.05	<0.02	0.02	5.46	<2	1.25	0.37	0.09	<0.001	6.1
7/11/2013	8.9	<0.05	<0.02	<0.01	3.20	<2	1.35	<0.01	0.03	<0.001	0.6
3/12/2013	4.8	<0.05	<0.02	0.03	0.63	<2	0.45	0.43	0.13	0.003	23.9

Sample Date	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
4/12/2013	5.4	<0.05	<0.02	<0.01	1.05	<2	0.07	0.03	<0.01	<0.001	1.6
7/01/2014	<0.1	<0.05	<0.02	<0.01	1.00	<2	0.03	<0.01	<0.01	<0.001	1.0
8/01/2014	<0.1	<0.05	<0.02	<0.01	0.39	<2	<0.01	<0.01	<0.01	<0.001	0.1
4/02/2014	1.6	<0.05	<0.02	0.01	0.85	<2	0.12	0.14	0.08	<0.001	4.2
5/02/2014	9.7	<0.05	<0.02	0.05	2.00	6	0.77	0.55	0.93	0.006	32.2
4/03/2014	7.9	<0.05	<0.02	<0.01	0.30	8	0.12	<0.01	0.07	<0.001	1.4
5/03/2014	9.1	<0.05	<0.02	<0.01	0.16	<2	0.02	<0.01	0.05	<0.001	1.8
1/04/2014	5	<0.05	<0.02	0.01	2.98	<2	0.35	0.28	0.07	0.003	3.8
2/04/2014	5	<0.05	<0.02	<0.01	0.67	<2	0.10	0.04	0.03	<0.001	0.9
28/04/2014	3.9	<0.05	<0.02	<0.01	0.28	<2	0.02	0.01	<0.01	<0.001	1.8
29/04/2014	5.2	<0.05	<0.02	<0.01	0.30	<2	0.01	<0.01	<0.01	<0.001	1.1
27/05/2014	0.2	<0.05	<0.02	<0.01	1.03	<2	0.04	0.02	0.02	<0.001	1.7
28/05/2014	0.5	<0.05	<0.02	<0.01	1.26	<2	0.04	0.02	0.03	0.002	1.4
23/06/2014	0.3	<0.05	<0.02	<0.01	0.33	<2	<0.01	0.03	<0.01	<0.001	0.6
24/06/2014	<0.1	<0.05	<0.02	<0.01	0.23	<2	<0.01	<0.01	<0.01	<0.001	0.6
18/08/2014	0.8	<0.05	<0.02	0.03	2.47	4	0.12	0.82	0.08	<0.001	0.9
19/08/2014	1.1	<0.05	<0.02	0.01	1.96	<2	0.05	0.24	0.08	<0.001	1.7
16/09/2014	1.2	<0.05	0.04	0.04	0.24	<2	0.08	0.09	0.04	0.001	0.5
17/09/2014	1.5	<0.05	0.02	0.04	0.23	2	0.27	0.09	0.03	0.002	0.3
13/10/2014	3.3	<0.05	<0.02	<0.01	1.63	4	0.11	0.15	0.09	0.001	1.3
14/10/2014	3.7	<0.05	<0.02	<0.01	0.08	4	0.11	0.12	0.02	0.002	0.4
11/11/2014	3.6	<0.05	<0.02	<0.01	0.15	12	0.18	0.07	0.04	<0.001	0.3
10/12/2014	10	<0.05	<0.02	<0.01	0.66	4	0.09	0.08	0.07	<0.001	1.5

Data Table 18: Relative percent Difference (RDP) result on duplicate data for 2013 and 2014

Site Code	Sample Date	Al_f (ug/L)	As_f (ug/L)	Cd_f (ug/L)	Co_f (ug/L)	Cu_f (ug/L)	Fe_f (ug/L)	Mn_f (ug/L)	Ni_f (ug/L)	Pb_f (ug/L)	U_f (ug/L)	Zn_f (ug/L)
FRdsFC	17/07/2013	-29.51	0.00	0.00	9.52	-2.17	-24.11	-0.42	-20.12	-66.67	0.00	11.76
FRUSMB	26/02/2013	-28.02	-11.76	0.00	0.00	-5.80	-7.52	-0.57	-8.85	-20.00	-2.55	-111.11
FRUSMB	26/03/2013	-25.22	0.00	0.00	11.76	14.88	-9.09	0.21	0.00	14.29	3.44	100.00
FRUSMB	23/04/2013	0.00	-13.33	0.00	25.00	-16.00	0.00	-1.83	-5.71	0.00	-2.98	18.18
FRUSMB	22/05/2013	-4.59	0.00	0.00	-11.76	-4.44	-8.28	0.00	3.28	-22.22	-3.15	28.57
FRUSMB	17/06/2013	-4.30	-11.76	0.00	18.18	-10.53	-8.09	-1.79	-34.48	-66.67	0.00	-85.71
FRUSMB	15/07/2013	-26.67	11.76	0.00	-15.38	0.00	0.00	-1.10	-66.67	-66.67	-2.17	-85.71
FRUSMB	19/08/2013	-1.27	-8.70	0.00	15.38	20.69	-27.03	-1.37	8.00	0.00	1.08	-40.00
FRUSMB	9/09/2013	-5.13	6.45	0.00	-13.33	-61.86	-16.22	-1.96	-46.15	-142.86	-1.18	-60.87
FRUSMB	7/10/2013	-1.59	-4.26	0.00	13.33	11.11	16.22	1.52	5.13	0.00	1.94	-35.29
FRUSMB	5/11/2013	4.71	8.00	0.00	-15.38	-4.51	24.00	1.67	-13.33	0.00	-2.03	-50.00
FRUSMB	3/12/2013	-8.33	12.50	0.00	0.00	0.00	2.09	0.00	6.67	0.00	-2.58	-123.81
FRUSMB	7/01/2014											
FRUSMB	4/02/2014	-4.18	0.00	0.00	-10.53	1.92	1.29	1.64	-5.80	-20.00	5.76	12.50
FRUSMB	4/03/2014	-97.10	-13.33	0.00	-25.00	-13.95	-59.46	-3.53	-4.65	0.00	-0.39	11.76
FRUSMB	1/04/2014	2.86	0.00	0.00	-13.33	-5.10	5.61	-2.49	17.14	66.67	-1.33	0.00
FRUSMB	28/04/2014	-5.41	0.00	0.00	11.76	-11.49	0.00	0.00	-22.22	-40.00	2.26	-54.55
FRUSMB	27/05/2014	4.44	0.00	0.00	15.38	-84.00	-36.84	8.76	25.00	0.00	-4.61	75.00
FRUSMB	23/06/2014	-50.00	0.00	0.00	0.00	7.14	33.33	-0.62	0.00	0.00	0.00	85.71
FRUSMB	22/07/2014											
FRUSMB	18/08/2014	16.67	8.70	0.00	-13.33	-11.76	-6.45	-0.74	8.00	0.00	-3.28	-28.57
FRUSMB	16/09/2014	-45.16	-6.45	-66.67	-40.00	-109.33	-5.13	2.01	-36.36	-100.00	0.00	-76.92
FRUSMB	13/10/2014	-2.25	0.00	0.00	-8.70	-13.04	0.00	-4.17	3.28	22.22	-0.52	0.00
FRUSMB	11/11/2014											
FRUSMB	10/12/2014	-3.60	3.51	0.00	-13.33	0.00	-75.00	-1.62	-4.08	-142.86	3.82	-85.71

A1-6. REFERENCES

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