Appendix 9. Aquatic Baseline Characterisation Report – Fountain Head and Hayes Creek Zinc, Gold and Silver Projects

AQUATIC BASELINE CHARACTERISATION REPORT

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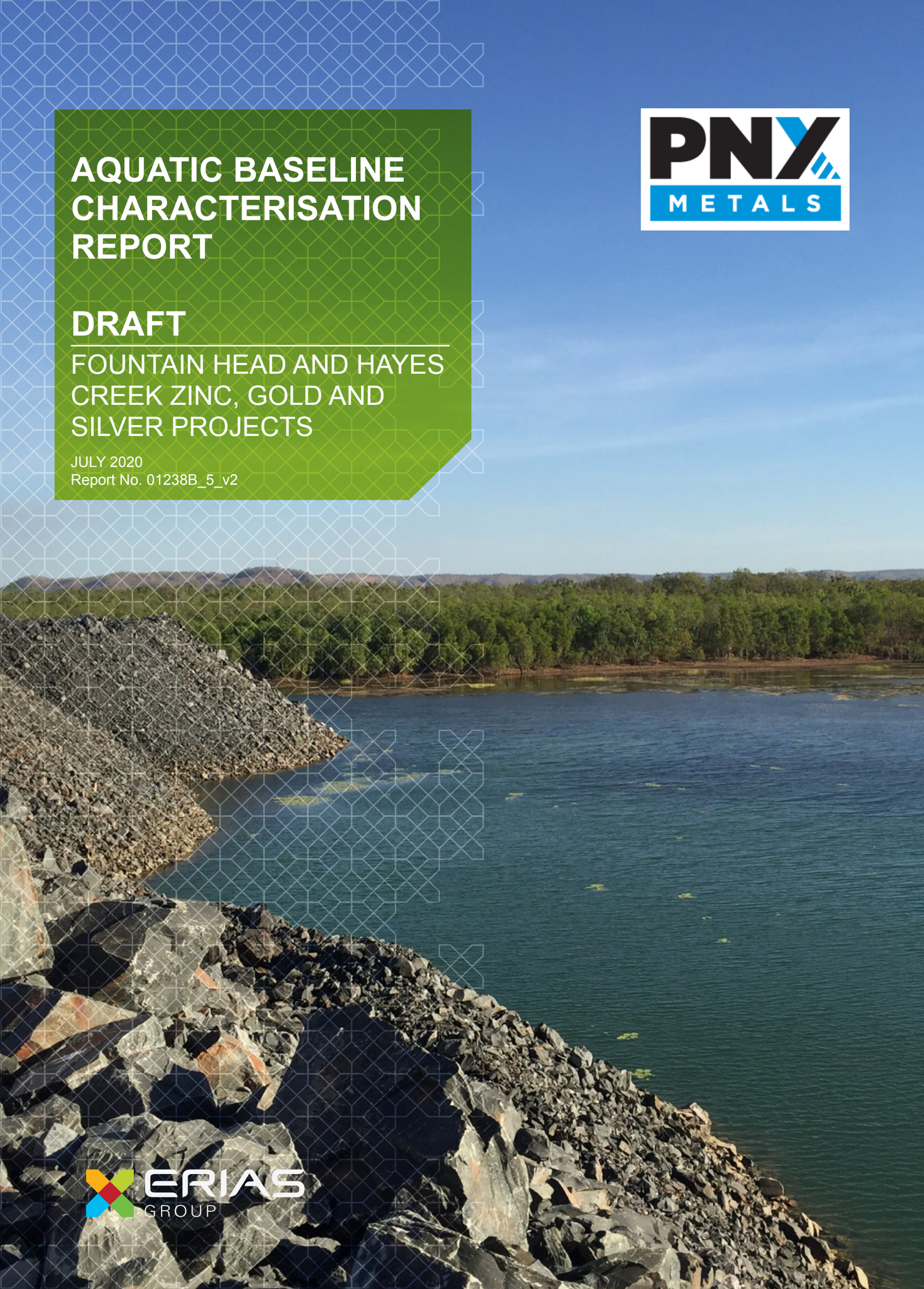
FOUNTAIN HEAD AND HAYES CREEK ZINC, GOLD AND SILVER PROJECTS

JULY 2020
Report No. 01238B_5_v2



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PNX Metals Ltd

Fountain Head and Hayes Creek Zinc, Gold and Silver Projects

Aquatic Baseline Characterisation Report

July 2020
(Report No. 01238B_5_v2)

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1. Introduction

1.1 Project Overview

Mt Bonnie, Iron Blow and Fountain Head are existing, non-operational mine sites located near Hayes Creek, 170 km south of Darwin, Northern Territory and approximately 6 km east of the Stuart Highway. The Fountain Head lease area falls within the Ban Ban Springs pastoral lease, and the Iron Blow and Mt Bonnie lease areas fall within the Douglas pastoral lease. Historic mining activities occurred at both Mt Bonnie and Iron Blow between 1912 and 1916 and a second phase of mining occurred between 1983 and 1985 when an open cut mine was established. In 2014, PNX Metals acquired 13 mining leases (MLs) containing Iron Blow and Mt Bonnie polymetallic deposits and entered into a separate agreement with Newmarket Gold Australia to utilise the four MLs on which the Fountain Head site are located.

In 2018, exploration drilling was undertaken to determine additional gold resources at the Fountain Head site. PNX Metals proposes to mine and process ore at the Fountain Head site for approximately three years (the Fountain Head Gold Project) prior to mining polymetallic ore over eight years for the Hayes Creek Zinc, Gold and Silver Project.

A staged approach to the development of both projects will be undertaken which will include:

- Stage 1 – Fountain Head Gold Project (approximately three year operation).
  - Dewatering of the existing Fountain Head pit and construction of an evaporation dam.
  - Expansion of the existing open pit.
  - Expansion of the existing waste rock stockpile.
  - Processing of ore from the Fountain Head pit.
  - Construction of processing related heap leach pads, solution ponds, crushing facilities and gold processing plant.
  - Construction of supporting infrastructure i.e., workshops, power station, roads and offices.
- Stage 2 and 3 – Hayes Creek Zinc, Gold and Silver Project.
  - Mining of polymetallic ore body at Mt Bonnie open cut (two year operation).
  - Mining of polymetallic ore body at Iron Blow underground (six to eight year operation).
  - Once processing of ore at the Fountain head site is complete, a separate processing plant will be established to process ore from Mt Bonnie and Iron Blow.
  - Deposit tailings from processing of Mt Bonnie and Iron Blow ore sub-aqueously into the Fountain Head pit.

1.2 Study and Objectives

An aquatic study was commissioned for the Hayes Creek Zinc, Gold and Silver Project, which included the Fountain Head Gold Project area. This report describes the findings of the aquatic baseline characterisation undertaken by ERIAS Group Pty Ltd (ERIAS Group) and describes the existing aquatic environment of the Margaret River and its tributaries in the vicinity of Mt Bonnie, Iron Blow and Fountain Head. The aquatic baseline characterisation was undertaken to understand the existing conditions and to identify potentially sensitive aquatic habitats and flora and fauna species within the study area. This information will be used to inform an environmental impact statement and other approvals required for the development of the Fountain Head Gold Project and Hayes Creek Zinc, Gold and Silver Project.

2. Methods

2.1 Study Approach

The approach to the study was to use a combination of existing available information and data collected in the field to characterise the existing aquatic conditions in the study area (Section 2.2).

A bibliographic review was undertaken to identify gaps in existing information to inform the scope of the field study. Limited existing information was available with no known prior aquatic surveys undertaken in the vicinity of Mt Bonnie, Iron Blow and Fountain Head. Some information is available for nearby areas and downstream aquatic environments. As such, the description of the existing aquatic environment provided in this report relies almost entirely on the results of the field survey.

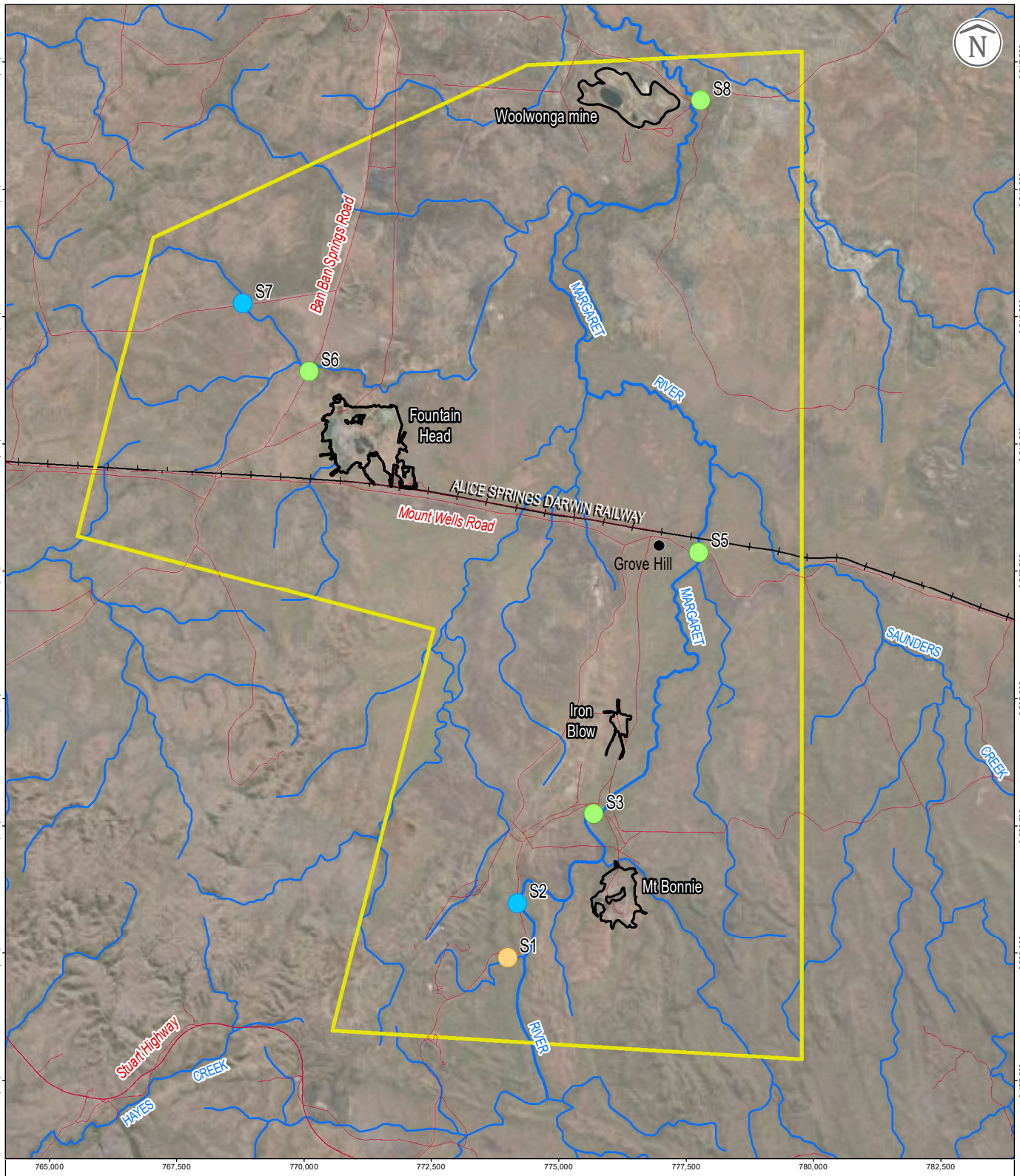
2.2 Study Area

The study area for the aquatic baseline characterisation is shown in Figure 2.1. Aquatic survey sites were selected within the Margaret River and small tributary creeks located within the study area to investigate a variety of aquatic habitats.

AQUATIC SURVEY STUDY AREA AND SAMPLING LOCATIONS

Fountain Head and Hayes Creek Zinc, Gold and Silver Projects | Aquatic Baseline Characterisation Report

FIGURE 2.1



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0 1.25 2.5 5 KM

GDA 1994 MGA Zone 52

- Railway
- Road
- Watercourse
- Mine site
- Study area

Aquatic survey sample location and type

- Water quality
- Water quality, fish and macrocrustaceans
- Water quality, macroinvertebrates, fish and macrocrustaceans

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Figure Number: 01238B_5_F02.1_GIS_v1

DATA SOURCES:
Aquatic survey sample location data from ERIAS Group, 2019.

2.3 Field Surveys

ERIAS Group aquatic ecology specialists conducted field surveys from 2 to 4 April 2019. A total of seven locations were investigated during the survey. A list of sampling locations and their coordinates is provided in Table 2.1 and shown in Figure 2.1. One additional survey site was planned (site S4) but could not be accessed due to the presence of thick vegetation preventing access. This site was located on the Margaret River, downstream of Iron Blow, 3 km downstream of site S3 and 4.2 km upstream of site S5. While this site was not surveyed, sufficient information was obtained from other sites within the Margaret River to characterise the existing aquatic biodiversity of the study area.

Table 2.1 – Aquatic Sampling Locations

Sampling Location	Description	Latitude	Longitude
S1	Tributary creek of the Margaret River, upstream of Mt Bonnie	-13.556428	131.531733
S2	Margaret River west of Mt Bonnie, upstream of Iron Blow	-13.546721	131.533358
S3	Margaret River road crossing downstream of Mt Bonnie, upstream of Iron Blow	-13.530739	131.547064
S5	Margaret River downstream of Iron Blow at Grove Hill	-13.484182	131.565601
S6	Tributary creek of the Margaret River, downstream of Fountain Head along Ban Ban Springs Road	-13.452777	131.494643
S7	Creek downstream of Fountain Head and upstream of S6*	-13.440845	131.482538
S8	Margaret River east of the Woolwonga mine site and downstream of Mt Bonnie and Iron Blow	-13.404039	131.565161

Coordinates are in WGS84 Zone 52 L.
* Localised backflow was observed at this sampling site in April 2019 under low flow conditions.

Water quality samples were collected and in situ measurements of water quality parameters were taken at all sampling locations (see Section 2.3.1).

Aquatic biodiversity surveys were undertaken at five of the seven sampling locations and included the following three components:

- Fish and macrocrustacean assessment.
- Macroinvertebrate assessment (at four of the sites).
- Stream assessment.

Table 2.2 shows the sampling effort undertaken at each sampling location. Further detail regarding the approach to the water quality and biodiversity assessment is provided in the following sections.

Table 2.2 – Sampling Effort Per Sampling Location

Site	Water Quality	Macroinvertebrates	Fish and Macrocrustaceans	Stream Assessment
S1	✔	NA	✔ (EF, FN, BT)	✔
S2	✔	NA	NA	NA
S3	✔	✔	✔ (EF, FN, BT)	✔
S5	✔	✔	✔ (FN x2, BT)	✔
S6	✔	✔	✔ (EF)	✔
S7	✔	NA	NA	NA
S8	✔	✔	✔ (EF, BT)	✔

Note: NA = not assessed. EF = electrofishing (900 seconds), FN = Fyke net (overnight), BT = bait traps (5 traps per site).

Due to the different conditions (e.g., stream width and depth) encountered at each sampling location, aquatic biodiversity sampling methods were not the same for each sampling location. The objective of the survey was to understand the occurrence, distribution and abundance of aquatic biodiversity in the study area using rapid assessment methods rather than to quantitatively compare the aquatic biodiversity between sampling locations; however, survey methods were standardised to allow some comparison between sites where the same methods were employed.

At site S6, there was insufficient water depth to deploy fyke nets or bait traps and at site S8 there was insufficient depth for fyke nets to be deployed. While conditions at site S5 were suitable for electrofishing, large numbers of fish were obtained from the fyke net deployments, and electrofishing was considered unlikely to yield additional useful results.

2.3.1 Surface Water Quality

Ambient surface water sampling and analysis was undertaken to understand existing water quality conditions. Water samples were collected directly into a clean, laboratory-supplied sampling bottle and decanted into sampling containers appropriate to the analyses being undertaken. Samples were sent to Intertek in Darwin and ALS in Melbourne for laboratory analysis.

Intertek completed the following analyses:

- *E. coli.*
- Total coliforms.
- Thermotolerant coliforms.
- Turbidity.
- Nutrients (nitrate, nitrite, ammonia, total nitrogen, total phosphorous, reactive phosphorous).

Analyses undertaken by ALS included:

- Total suspended solids (TSS).
- Major anions and cations (including alkalinity and hardness).
- Total mercury and dissolved arsenic, cadmium, chromium, copper, lead, nickel and zinc.
- Dissolved/total organic carbon (DOC/TOC).
- Total recoverable hydrocarbons (TRH).
- Benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN).

Samples collected for dissolved metals and DOC were field filtered using a laboratory-supplied 0.45 µm filter and disposable syringe. Once collected, all samples were stored on ice in cool boxes prior to dispatch to the laboratory.

In situ physicochemical parameters were also measured at each site using a YSI ProPlus water quality instrument. The parameters measured included pH, temperature, dissolved oxygen (DO) and electrical conductivity (EC). The instrument was allowed sufficient time for parameters to stabilise before measurements were recorded. Three readings were taken approximately one minute apart and then averaged.

A quality assurance and quality control program (QA/QC) was included in the sampling and analytical program. This included maintaining appropriate records concerning samples (including chain-of-custody procedures), calibration and maintenance of sampling instruments and equipment, and sample handling, storage and transport to maintain sample integrity. The following quality control analyses were also performed:

- Field duplicate, collected as part of the field QA/QC program.
- Laboratory blanks, duplicates and spiked samples, analysed as part of the laboratory QA/QC program.

Laboratory results are provided in Attachment 1.

2.3.2 Aquatic Biodiversity

The sampling approach for each component of the aquatic biodiversity survey is described in the following sections. All sampling was conducted in accordance with Special Permit No. S17/3469, issued by the Northern Territory Department of Primary Industry and Resources on 14 March 2019.

2.3.2.1 Macroinvertebrates

Aquatic macroinvertebrates, which includes aquatic insects and other invertebrates dwelling within stream environments, were collected using adapted Australian River Assessment Scheme (AusRivAs) methods for the Northern Territory, described in Lloyd and Cook (no date listed).

Samples were collected from edge habitats using a triangular dip-net (30x30 cm; mesh size 0.25 mm) and cultivator rake (Plate 2.1). The rake was used to agitate the sediment and edge habitat while the net operator, using a sweeping motion, collecting the dislodged material. Sampling was conducted over a standardised 10 m reach over approximately 10 minutes. Where

a continuous stretch of edge habitat was not available, edge habitat was sampled from separate locations but to a total length of 10 m.

Plate 2.1 – Macroinvertebrate Sampling at Site S3

Material collected in the net was sieved in the field through a pair of nested sieves (2.0 mm and 0.25 mm) to form two size fractions: 0.25 to 2.0 mm and ≥2.0 mm. Fauna in the ≥2.0 mm fraction was separated from detrital and inorganic material using tweezers and a pipette was used to sort the 0.25 mm to 2.0 mm fraction. Specimens were placed into a 250 mL screw top container and subsequently preserved using 70% ethanol solution.

Fauna from the two size fractions were pooled to form a single sample. Fauna from the samples were sent to John Gooderham at the Waterbug Company and identified to the lowest possible taxonomic level, i.e., morpho-species, and counted.

2.3.2.2 Fish and Macrocrustaceans

A variety of sampling techniques were used to sample as much of the fish and macrocrustacean fauna community as possible. Sampling techniques were tailored to the available conditions at each sampling location. Sampling techniques included:

- Electrofishing using a Smith-Root LR20B backpack electrofisher (Plate 2.2). Sampling was undertaken where conditions were suitable, targeting pools, runs, riffles and beneath overhanging vegetation. Fishing effort (pulse time) was 900 seconds at each site. A variety of available habitat types were targeted at each sampling location during the 900 seconds. Output power was adjusted according to water conductivity to ensure that only enough power was used to temporarily stun fish. Pulsed direct current (DC) was fixed at a pulse rate of between 40 and 70 Hz and a duty cycle of between 10 and 20%, voltage was adjusted slightly according to water conductivity (200 to 500 volts). Backpack electrofishing was restricted to shallow areas (less than 1m water depth) due to safety issues of operating equipment in deeper waters and crocodile risk. Fish were collected using a dip net and were

retained in temporary storage buckets until all electrofishing was completed to avoid potential recapture.

Plate 2.2 – Electrofishing at Site S3

- Two different sized fyke nets (deployed overnight):
  - One large 4 mm mesh size net with a 0.6 m drop and five separate size class chambers with a single 0.6 x 5 m wing (Plate 2.3).
  - One smaller 4 mm mesh size net with a 0.48 m drop and five separate size class chambers with two 0.48 x 2.5 m wings (Plate 2.4).

Plate 2.3 – Large Fyke Net at Site S3

Plate 2.4 – Smaller Fyke Net at Site S5

- Baited box traps (3 mm mesh size) to sample small-bodied fish and crustaceans. Five collapsible baitfish traps were deployed within a range of microhabitat types present within the site for a minimum period of two hours (Plate 2.5). Dried cat food was placed in a secure compartment in each trap to attract fish and macrocrustaceans to enter the trap.

Plate 2.5 – Baited Box Trap at Site S3 (Prior to Deployment)

All captured fish and macrocrustaceans were retained for identification. Where positive identification was possible in the field, captured specimens were released at the point of capture. In the event that a captured species was unable to be identified within the field, specimens were retained for later identification. Representative fish species that were positively identified in the field were also retained for identification quality control. Identification of retained specimens was undertaken by Dr Michael Hammer, the curator of fishes at the Museum and Art Gallery of the Northern Territory (MAGNT). Voucher specimens were also lodged with MAGNT (S.10310-001 to S.18310-006 and S.18311-001).

Catch data were used to generate a variety of metrics (e.g., richness, abundance, diversity and size) that describe biodiversity values of fish and macrocrustaceans at each site.

2.3.2.3 Stream Assessment

A rapid assessment of habitat characteristics and aquatic vegetation was conducted for a 100 m reach at each site surveyed for aquatic biodiversity. Along the surveyed reach, stream width and bank-to-bank measurements were recorded at five locations, approximately 25 m apart. At each location, four representative water depths were recorded and observations made regarding substrate type, water velocities, vegetation and water colour/clarity.

Photographs were taken facing upstream and downstream at each sampling location (Attachment 2).

2.4 Limitations

The following limitations are noted in relation to the aquatic characterisation survey:

- The field survey was limited to a rapid assessment and provides a snapshot of existing aquatic biodiversity values and water quality and does not account for seasonal or inter-annual variability.
- Diversity and abundance of riparian vegetation was not recorded. Observations of riparian vegetation were limited to high-level observations. Riparian vegetation has the potential to include threatened, endemic or range restricted species of flora; however, this was outside the scope of the aquatic survey.
- The selection of survey sites was limited to areas accessible by existing roads or tracks, with large parts of the study area being inaccessible by vehicle. Notwithstanding, the field survey did collect representative information on various aquatic environments within the study area. It is however possible that the sites surveyed may have been in areas more likely impacted from existing activities in comparison to less accessible areas which could be expected to be less disturbed.
- The 2019 wet season was the hottest on record for the Northern Territory and the driest in 27 years, with total rainfall in the Northern Territory being two thirds of the average. As a result, water levels were lower than usual which may have affected the survey results. Larger migratory species such as mullet, barramundi and tarpon may therefore be under-represented by the current survey, as they would likely have already migrated further downstream. A larger than usual dieback of fish species is expected to have occurred in 2019 due to reduced flow and water retention. While there was below average wet season rainfall in 2018/2019, the preceding wet season in 2017/2018 experienced above average rainfall.

3. Study Results

3.1 Surface Water Quality

3.1.1 Assessment Framework

Assessment of surface water quality has been undertaken considering the following relevant guidelines:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018; ANZECC/ARMCANZ, 2000[1]).
- Darwin Harbour Water Quality Objectives (DHWQO) for freshwater rivers and streams provided in DNRETAS (2010).

Although the study area is outside of the Darwin Harbour catchment, the Margaret River flows through the study area and reports to the Adelaide River and the Adelaide River coastal floodplain and eventually Adam Bay. As such, in lieu of other catchment specific water quality objectives, the DHWQO were considered appropriate water quality objectives for water quality assessment.

3.1.2 Physicochemical Parameters

Table 3.1 presents the averaged values for in situ measurements of temperature, DO, EC and pH, and laboratory results for turbidity and TSS (not averages).

Table 3.1 – Physicochemical Parameters

Site	Temperature* (°C)	Dissolved oxygen* (mg/L)	Electrical conductivity* (µS/cm)	pH*	Turbidity (NTU#)	Total Suspended Solids (mg/L)
S1	25.4	4.17	345.6	7.11	4	<1
S2	25.8	2.29	149.0	7.09	12	<1
S3	26.8	3.80	178.4	7.08	5	<1
S5	29.4	3.02	177.8	6.90	5	<1
S6	29.2	4.91	65.5	6.14	34	2
S7	27.3	2.87	130.7	7.06	56	29
S8	29.2	3.30	82.0	6.81	34	8

* Values are an average of three recorded measurements.
# Nephelometric turbidity units.

Temperature ranged from 25.4 to 29.4°C, with differences likely explained by the amount of shading provided by riparian vegetation and the time samples were collected. Daily fluctuations in temperature would be expected, particularly in shallow waterbodies such as those sampled.

1 While the ANZG (2018) replace the previous ANZECC/ARMCANZ (2000) guidelines, default guideline values for the Timor Sea drainage division where the Project is located have not yet been published, therefore the regional default guidelines values from ANZECC/ARMCANZ (2000) have been used.

Dissolved oxygen concentrations ranged from 2.29 to 4.91 mg/L and was notably lower at sites S2 and S7. Stagnant pools in intermittent streams naturally experience low levels of dissolved oxygen (DNRETAS, 2010). Minimal flow was noted at site S2, while site S7 had some water flow but it was highly turbid and adjacent grazing pasture that could potentially cause elevated oxygen demand due to faecal matter entering the water.

Electrical conductivity ranged from 65.5 to 345.6 µS/cm and was highest at site S1 and lowest at sites S6 and S8. Site S1 is located on a tributary stream of the Margaret River upstream of Mt Bonnie, while site S8 was the furthest downstream sampling location along the Margaret River and S6 was a small tributary stream downstream of Fountain Head. Apart from site S1, electrical conductivity was within the range for default trigger values for upland and lowland rivers in tropical Australia of 20 to 250 µS/cm (ANZECC/ARMCANZ, 2000) and below the DHWQO of less than 200 µS/cm.

The pH ranged from very slightly acidic (pH 6.14) to very slightly alkaline (pH 7.11). All values were within the default trigger value range of pH 6.0 to 8.0 for lowland rivers in tropical Australia (ANZECC/ARMCANZ, 2000) and within the DHWQO range of pH 6.0 to 7.5 for freshwater rivers and streams. .

Turbidity varied considerably between sites, being lowest at sites S1 to S5 where it was between 4 and 12 NTU, and highest at sites S6 to S8 where it was between 34 and 56 NTU. Turbidity at sites S6 to S8 was above the default trigger value range for upland and lowland rivers in tropical Australia of 2 to 15 NTU (ANZECC/ARMCANZ, 2000) and above the DHWQO for freshwater rivers and streams of less than 20 NTU. Total suspended solids concentrations were also low at sites S1 to S5 (less than 1 mg/L). The highest TSS level was measured at site S7 (29 mg/L), which also had the highest turbidity. Total suspended solids levels were above the DHWQO for freshwater rivers and streams of less than 5 mg/L at S7 and S8.

3.1.3 Nutrients

Table 3.2 presents the nutrient results and the applicable guideline values (where available), adopted from ANZECC/ARMCANZ (2000) default trigger values for tropical Australia and the DHWQO. Exceedances of applicable guideline values are indicated with respective colour shading. The DHWQO are below ANZECC/ARMCANZ (2000) for all analytes; as such, an exceedance of ANZECC/ARMCANZ (2000) also represents an exceedance of the DHWQO.

Table 3.2 – Nutrient Concentrations (mg/L)

Analyte	Guideline Value		Site						
	ANZECC/ ARMCANZ (2000)	DHWQO[†]	S1	S2	S3	S5	S6	S7	S8
Total nitrogen	0.5*	<0.23	0.12	0.23	0.19	0.46	0.40	0.64	0.53
Nitrate (NO_3)	0.7[#]	NA	0.015	0.005	<0.005	0.015	0.015	<0.005	0.015
Nitrite (NO_2)	NA*	NA	<0.005	<0.005	<0.005	0.005	0.005	0.005	0.01
Nitrate + nitrite (NO_x)	0.1*	<0.008	0.015	0.01	<0.005	0.025	0.02	0.01	0.025

Table 3.2 – Nutrient Concentrations (mg/L) (cont'd)

Analyte	Guideline Value		Site						
	ANZECC/ ARMCANZ (2000)	DHWQO†	S1	S2	S3	S5	S6	S7	S8
Ammonia (NH_3)	0.9#	NA	0.03	0.175	0.055	0.14	0.055	0.145	0.06
Total phosphorous	0.05*	<0.01	0.03	0.02	0.015	0.025	0.03	0.045	0.035
Phosphate (PO_4)	NA*	NA	0.02	<0.005	<0.005	0.005	<0.005	<0.005	<0.005

Notes: Coloured shading indicates an exceedance of the applicable guideline value.
NA no guideline available.
* Default trigger value for lowland rivers in tropical Australia.
# Trigger value for slightly to moderately disturbed ecosystems.
† Values for freshwater rivers and streams.

Total nitrogen concentrations were higher in the downstream part of the study area, and highest at site S7, located in an active cattle and buffalo grazing area. Total nitrogen at sites S7 and S8 were above the ANZECC/ARMCANZ (2000) guideline value of 0.5 mg/L and exceeded the DHWQO of 0.23 mg/L at sites S2, S5 and S6. The majority of nitrogen was organically bound, rather than occurring as inorganic components such as nitrate, nitrite and ammonia (except at site S2).

Nitrate and nitrite concentrations were below the ANZECC/ARMCANZ (2000) guideline value at all sites, but exceeded the DHWQO of 0.008 mg/L at sites S1 and S5, with concentrations of 0.015 and 0.025 mg/L respectively.

All other nutrient concentrations were below the applicable ANZECC/ARMCANZ (2000) and DHWQO guideline values.

3.1.4 Metals and Organic Carbon

Table 3.3 presents results from dissolved metal analyses, with comparison made to the ANZECC/ARMCANZ (2000) trigger values for slightly to moderately disturbed ecosystems (which are the same values referred to in DHWQO). This level of protection (i.e., slightly to moderately disturbed ecosystems) is considered most appropriate given the long history of mining and agriculture in the study area. Table 3.3 also provides organic carbon concentrations, as the bioavailability of heavy metals is reduced in the presence of dissolved organic carbon, i.e., organic carbon binds dissolved metals thereby reducing their bioavailability. The adopted trigger values for cadmium, copper, lead nickel and zinc shown in Table 3.3 are based on a water hardness of 30 mg/L. Water hardness was less than 30 mg/L at sites S6, S7 and S8, and ranged from 37 to 137 mg/L at the remaining sites (see Section 4.2.6). Toxicity of these metals decreases with water hardness; therefore, adopting the default trigger values for a water hardness of 30 mg/L is a conservative approach for sites S1 to S5.

Due to difficulties in field filtering some samples due to high amounts of suspended material, total organic carbon (TOC) was analysed in placed of dissolved organic carbon (DOC) for sites S1, S2, S7 and S8; however, for comparison, where DOC was analysed (sites S3, S5, S6), TOC was also analysed. As shown in Table 3.3, DOC values were equal to TOC values in these instances, indicating that organic carbon is predominantly present in dissolved form. Organic carbon

concentrations were similar at Sites S2 to S8 ranging from 4 to 5 mg/L, but were slightly lower at site S1, with a concentration of 1 mg/L. This indicates that dissolved metals at sites S2 to S8 are likely to have reduced bioavailability, compared to site S1.

Table 3.3 – Dissolved Metal (µg/L) and Organic Carbon (mg/L) Concentrations

	Guideline	Site						
Analyte	ANZECC/ARMCANZ (2000) Trigger Value for Slightly to Moderately Disturbed System	S1	S2	S3	S5	S6	S7	S8
Arsenic	13*	59.5	4.3	4.7	4.9	0.8	1.7	2.4
Cadmium##	0.2	<0.05	<0.05	0.12	0.07	<0.05	<0.05	<0.05
Chromium	1#	<0.2	0.2	<0.2	<0.2	1.3	0.6	0.5
Copper##	1.4	<0.5	<0.5	0.6	1.1	1.3	1.1	1.3
Lead##	3.4	<0.1	0.2	0.2	0.2	0.4	0.3	0.2
Mercury**	0.06†	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nickel##	11	<0.5	<0.5	<0.5	0.8	0.9	1	0.7
Zinc##	8.0	<1	<1	2	3	1	<1	6
Total organic carbon	No value provided	1	4	4	5	4	4	5
Dissolved organic carbon	No value provided	NM	NM	4	5	4	NM	NM

NM. Not measured.
* Value is for As(V).
# Value is for Cr(VI).
† Value is for inorganic mercury.
** Results are for total mercury, i.e., inorganic and organic mercury.
Adopted trigger values based on a water hardness of 30 mg/L for all sites.

Dissolved arsenic concentrations (comprised of arsenic species As(III) and AS(V)) exceeded the ANZECC/ARMCANZ (2000) trigger value of 13 µg/L for As(V) at site S1, where it was 59.5 µg/L and was over ten times higher than the other sampled locations. Speciated arsenic analyses were not undertaken, therefore it is not known if the As(V) fraction of the arsenic result exceeded 13 µg/L; however, for the purpose of this assessment an exceedance of this value has been assumed. Arsenic can be naturally elevated in the vicinity of gold deposits due to their geological association, as both are hosted in iron-sulfide minerals such as pyrite, marcasite and arsenopyrite (Xing et al., 2019). Arsenic concentrations were higher around Mt Bonnie and Iron Blow than further downstream in the Margaret River and in the small creek north of Fountain Head.

The dissolved chromium concentration (comprised of chromium species Cr(VI) and Cr(III)) exceeded the ANZECC/ARMCANZ (2000) trigger value of 1 µg/L for Cr(VI) at site S6, where it was 1.3 µg/L and was slightly higher than at other sample locations where concentrations ranged from less than 0.2 to 0.6 ug/L. Speciated chromium analyses were not undertaken, therefore it is unknown if the Cr(VI) fraction of the chromium result at site S6 exceeded 1 µg/L; however, for the purpose of this assessment an exceedance of this value has been assumed.

Dissolved copper concentrations were just below the ANZECC/ARMCANZ (2000) trigger value of 1.4 µg/L at sites S6 and S8, with a concentration of 1.3 µg/L reported at these sites. Similarly, zinc at site S8 was also slightly below the trigger value of 8.0 µg/L, with a concentration of 6 µg/L reported.

3.1.5 Coliforms

Table 3.4 presents the results for microbial analyses for *E. coli*, total coliforms and faecal coliforms.

Table 3.4 – Microbial Analysis Results

Site	*E. Coli* (MPN*/100 mL)	Total Coliforms (MPN/100 mL)	Faecal Coliforms (MPN/100 mL)
S1	67	>2,400	330
S2	77	>2,400	291
S3	36	>2,400	235
S5	365	>2,400	163
S6	205	>2,400	980
S7	435	>2,400	548
S8	81	>2,400	236

* Most probable number.

The DHWQO guideline for *E. coli* in a singe sample of <201/100mL was exceeded at sites S5, S6 and S7. Total coliforms were above 2,400 MPN/100mL at all sites, while faecal coliforms ranged from 163 MPN/100mL at site S5 to 980 MPN/100 mL at site S6. Manure from cattle and buffalo grazing is likely the major source of coliforms in the study area.

3.1.6 Hydrocarbons

Total recoverable hydrocarbons and BTEXN concentrations were below the laboratory reporting limits of reporting (Attachment 1) in all samples indicating no evidence of existing hydrocarbon contamination. A surface film was observed at site S3 (Plate 3.1) but as there was no detectable odour or sheen this was likely due to natural organic material rather than anthropogenic petroleum hydrocarbons.

Plate 3.1 – Film Observed at Site S3

3.1.7 Major Ions, Water Hardness and Alkalinity

Results for major ions, water hardness and alkalinity are presented in Table 3.5.

Table 3.5 – Major Ions, Water Hardness and Alkalinity (mg/L)

Parameter	Site						
	S1	S2	S3	S5	S6	S7	S8
Major Cations							
Calcium	17	5	6	6	<1	3	1
Magnesium	23	6	8	6	<1	5	2
Sodium	10	6	8	7	6	5	5
Potassium	1	2	2	3	<1	3	1
Hardness (as $CaCO_3$)	137	37	48	40	<1	28	11
Major Anions							
Sulfate	6	2	5	2	1	2	4
Chloride	3	2	2	4	2	3	2
Alkalinity							
Hydroxide Alkalinity (as $CaCO_3$)	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (as $CaCO_3$)	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (as $CaCO_3$)	192	79	89	87	32	64	36
Total Alkalinity (as $CaCO_3$)	192	79	89	87	32	64	36

No cation was present in dominant proportions. Major cations (calcium, magnesium, sodium and potassium) concentrations were low at sites S2 to S8, ranging from less than 1 mg/L to 8 mg/L.

Calcium, magnesium and sodium concentrations were all higher at site S1 than the remaining sites with concentrations of 17, 23 and 10 mg/L respectively. The results indicate that properties of water from site S1, a tributary of the Margaret River near the headwaters at Mt Bonnie, were distinctly different than at the remaining sites. Water hardness at site S1 (137 mg $CaCO_3$/L) is classified as hard whereas it is classified to be soft at all other sites.

Alkalinity at all sites was dominated by bicarbonate which was the dominant anion and accounted for 100% of alkalinity at all sampling locations and ranged from 32 mg/L at site S6, to 192 mg/L at site S1. Sulfate and chloride concentrations were low and generally similar between sites, ranging from 1 to 6 mg/L.

3.1.8 Quality Assurance and Quality Control

3.1.8.1 Field Duplicate

One intra-laboratory field duplicate (DUP1) and corresponding primary sample was collected at site S1. Results are provided in Attachment 3. Intra-laboratory duplicates provide an indication of the precision and reproducibility of the field sampling techniques and analytical results. Duplicate results were assessed by calculating their relative percent difference (RPD), with a target RPD of less than 50%.

Ninety six percent (96%) of the results met the data quality objective of a RPD less than 50%. The two exceptions were ammonia and TOC. Both of these results were less than 10 times the limit of reporting, where high analytical variability is not unusual. The RPDs for both of these analytes were less than 100%, which is considered within an acceptable range given the results were less than 10 times the limit of reporting.

Overall the field duplicate results indicate good precision and reproducibility for the sampling and analyses.

3.1.8.2 Laboratory Quality Assurance and Quality Control Program

The laboratory QA/QC program included analysis of laboratory duplicates, method blanks, laboratory controls, matrix spikes and surrogate spikes. The results of the laboratory QA/QC program were all within the laboratory acceptance criteria.

Despite the samples being submitted within the holding time requirements for all analytes, there were some minor holding time breaches for TSS (sites S5, S6, S7 and S8) and major cations for all samples.

Overall, the laboratory quality control analyses indicate that the analytical methods employed provided acceptable results and give confidence in the quality of the data obtained from the survey.

3.2 Aquatic Biodiversity

3.2.1 Aquatic Habitats

The surface waters of the study area include both intermittent streams, which have flowing water for all or most of the wet season but are dry during the drier months and ephemeral streams,

which flow briefly following rainfall and are dry for most of the year. There are no permanent flowing surface water bodies in the study area.

A variety of aquatic habitats were encountered in the study area and within sampling locations, which included:

- Low gradient sections of the main Margaret River channel and its tributaries, characterised by shallow, slow moving or stagnant, slightly turbid water with cobbles, boulders and sandy substrate.
- Moderate gradient sections of the main Margaret River channel characterised by relatively clear water, flowing over a boulder and cobble substrate.
- Deeper pools, characterised by slow moving or stagnant, slightly turbid water with a predominantly sandy substrate, with water depths typically between 0.5 to 1 m.
- Low gradient tributary creeks, characterised by slow to moderate flow velocities, moderate to high turbidity and a narrow channel.

Details of the aquatic habitats at each site are provided in Table 3.6.

Table 3.6 – Aquatic Habitat Characteristics per Sampling Location

Site	Mean Bank-to bank Width (m)	Mean Stream Width (m)	Mean Stream Depth (cm)	Substrate and Channel Type	Vegetation
S1	8.8	4.7	29.8	Silty sand with cobles and boulders and abundant organic matter	No macrophytes or reeds. Stream banks lined with large trees and grasses, with substantial shading provided by overhanging vegetation. Steep sloping banks
S2	Not recorded due to the sighting of a crocodile at this site during the survey			Mostly sandy with some cobble	No macrophytes or reeds. Stream banks lined with large trees, river pandanas (*Pandanas aquaticus*) and grasses, with substantial shading provided by overhanging vegetation. Gentle to moderate sloping banks
S3	8.4	3.5	12.7	Predominantly boulders and cobbles with some sand and gravel. Sand bank in the middle of the channel and sandy substrate in deeper pools	No macrophytes or reeds. Stream banks lined with large trees, shrubs and grasses, with substantial shading provided by overhanging vegetation. Moderate sloping banks
S5	8.3	1.9	16.9	Sand and gravel riverbed with some cobbles	No macrophytes or reeds. Stream banks lined with large trees, river pandanas (*Pandanas aquaticus*), bamboo and grasses, with substantial shading provided by overhanging large trees. Moderate to steep sloping banks

Table 3.6 – Aquatic Habitat Characteristics per Sampling Location (cont'd)

Site	Mean Bank-to bank Width (m)	Mean Stream Width (m)	Mean Stream Depth (cm)	Substrate and Channel Type	Vegetation
S6	9.0	3.4	8.6	Mostly sandy with some cobble	No macrophytes or reeds. Stream banks lined with large trees, and grasses, with some shading provided by overhanging vegetation. Left-hand bank (facing downstream) gently sloping, right-hand bank (facing downstream) steep sloping
S8	16.7	7.0	13.2	Predominantly cobbles and boulders. Sand and silt in deeper sections	No macrophytes or reeds. Stream banks lined with large trees, shrubs, bamboo and grasses, with substantial shading provided by overhanging vegetation. Left-hand bank (facing downstream) gently sloping, right-hand bank (facing downstream) moderate to steep sloping

3.2.2 Aquatic Fauna

3.2.2.1 Macrocrustaceans

Freshwater prawns were common at all sites surveyed for aquatic biodiversity. Species recorded included northwest Australian river prawn (*Macrobrachium bullatum*), cherabin (*Macrobrachium spinipes*) (Plate 3.2) as well as large numbers of small individuals that were either observed during the survey but not captured or captured but not identified due to their sheer numbers. Freshwater prawns were collected using all sampling methods including electrofishing, fyke nets, bait traps and macroinvertebrate sampling methods.

Plate 3.2 – *Macrobrachium* Species of the Study Area

(a) Northwest Australian river prawn (*Machrobrachium bullatum*)

(b) Cherabin (*Macrobrachium spinipes*)

Freshwater prawns occurred in high abundance at sites S1 and S3 where hundreds of small (less than 5 cm carapace length) prawns were observed while electrofishing, but not captured as they were too numerous to count. At site S3, 169 (*Macrobrachium bullatum*) were also captured in the

fyke net. Larger prawns with a carapace length of 5 to 10 cm were only found at site S5 (three northwest Australian river prawn) and at site S3 (one *cherabin*).

The northwest Australian river prawns (*Macrobrachium bullatum*) has a widespread distribution in northwestern Australia, occurring in a wide range of freshwater habitats including permanent creeks and streams as well as billabongs, seasonal watercourses, man-made reservoirs and lakes (De Grave et al., 2013a).

Cherabin (*Macrobrachium spinipes*) has a widespread distribution throughout northern Australia and the Indo-west Pacific in Indonesia, Papua New Guinea and the Philippines and is found in lowland rivers and streams that have connectivity to the sea (De Grave et al., 2013b).

One freshwater crab species, the river swimming crab (*Veruna litterata*), was recorded at sites S3, S5 and S8, (Plate 3.3) and was captured from electrofishing, fyke nets and bait traps. The river swimming crab was most abundant at sites S3 and S5 with 11 and 20 individuals recorded respectively. The river swimming crab is a euryhaline species, i.e., able to survive in a range of salinities. It is found throughout the Indo-west Pacific, including South Africa, India, Vietnam, Taiwan, Indonesia, Papua New Guinea, New Caledonia and Australia (Davie, 2002; Waltham et al., 2014). In Australia, it is found from the north of the Northern Territory and along the Queensland coast, down into northern New South Wales (Mos et al., 2017).

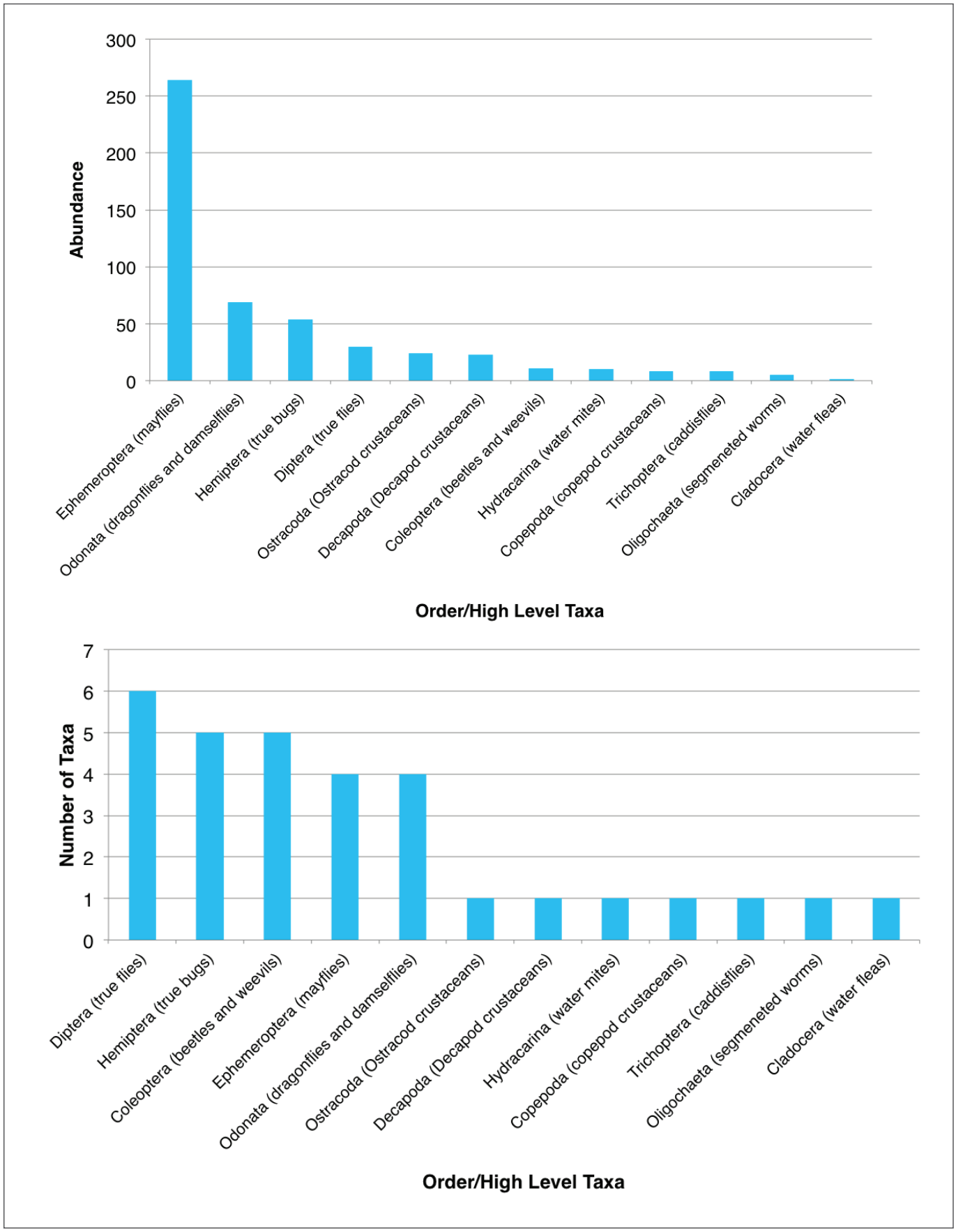
Plate 3.3 –River Swimming Crab (*Veruna Litterata*)

(a) Female (b) Male

3.2.2.2 Macroinvertebrates

A total of 507 individuals from at least 12 orders, 26 families and 31 taxa were identified (Figure 3.1).

FIGURE 3.1


Abundance
300
250
200
150
100
50
0
Ephemeroptera (mayflies)
Odonata (dragonflies and damselflies)
Hemiptera (true bugs)
Diptera (true flies)
Ostracoda (Ostracod crustaceans)
Decapoda (Decapod crustaceans)
Coleoptera (beetles and weevils)
Hydracarina (water mites)
Copepoda (copepod crustaceans)
Trichoptera (caddisflies)
Oligochaeta (segmeneted worms)
Cladocera (water fleas)
Order/High Level Taxa
Number of Taxa
7
6
5
4
3
2
1
0
Diptera (true flies)
Hemiptera (true bugs)
Coleoptera (beetles and weevils)
Ephemeroptera (mayflies)
Odonata (dragonflies and damselflies)
Ostracoda (Ostracod crustaceans)
Decapoda (Decapod crustaceans)
Hydracarina (water mites)
Copepoda (copepod crustaceans)
Trichoptera (caddisflies)
Oligochaeta (segmeneted worms)
Cladocera (water fleas)
Order/High Level Taxa

Macroinvertebrate assemblages were numerically dominated by:

- Ephemeroptera (mayflies) (4 taxa, 264 individuals) (Plate 3.4a).
- Odonata (dragonflies and damselflies) (4 taxa, 69 individuals) (Plate 3.4b).
- Hemiptera (true bugs) (5 taxa, 54 individuals) (Plate 3.5).

Plate 3.4 – Examples of Most Abundant Macroinvertebrates Orders

(a) Ephemeroptera (mayflies)

(b) Odonata (dragonflies and damselflies)

Plate 3.5 – Example of Hemiptera (True Bugs) from the Study Area (*Nychia* sp.)

These three orders accounted for 76% of total abundance across the surveyed sites. Caenidae (small square-gill mayflies) was the most numerically dominant family (146 individuals), followed by Baetidae (mayflies, 113 individuals), which together accounted for 51% of all observed macroinvertebrates. Other relatively abundant families included Coenagrionidae (narrow-winged

damselflies) and Corixidae (water boatmen) with 39 and 38 individuals recorded, respectively (Figure 3.1). The remaining 22 families accounted for only 33% of all observations.

Immature Corixidae (water boatmen), Chironomidae (non-biting midges) and Caenidae (small square-gill mayflies) were common across all sites, while Baetidae (mayflies) were common to all sites except site S5.

Diptera (true flies), Hemiptera (true bugs) and Coleoptera (beetles and weevils), Ephemeroptera (mayflies) and Odonata (dragonflies and damselflies) were the most taxonomically rich orders, with six, five, five, four and four taxa recorded respectively. There was only one taxa recorded for each of the remaining seven orders/taxonomic groups.

Total abundance varied considerably between sites, with notably higher abundance recorded at site S3 with 305 individuals recorded and notably lower abundance recorded at site S5, with only 18 individuals recorded (Figure 3.2). Ephemeroptera (mayflies) and Odonata (dragonflies and damselflies) were particularly abundant at site S3. Odonata were not recorded at sites S5 or S8 and only four individuals were recorded at site S6, in comparison to 65 at site S3. Hemiptera (true bugs) were notably more abundant at site S6 compared to the other sites.

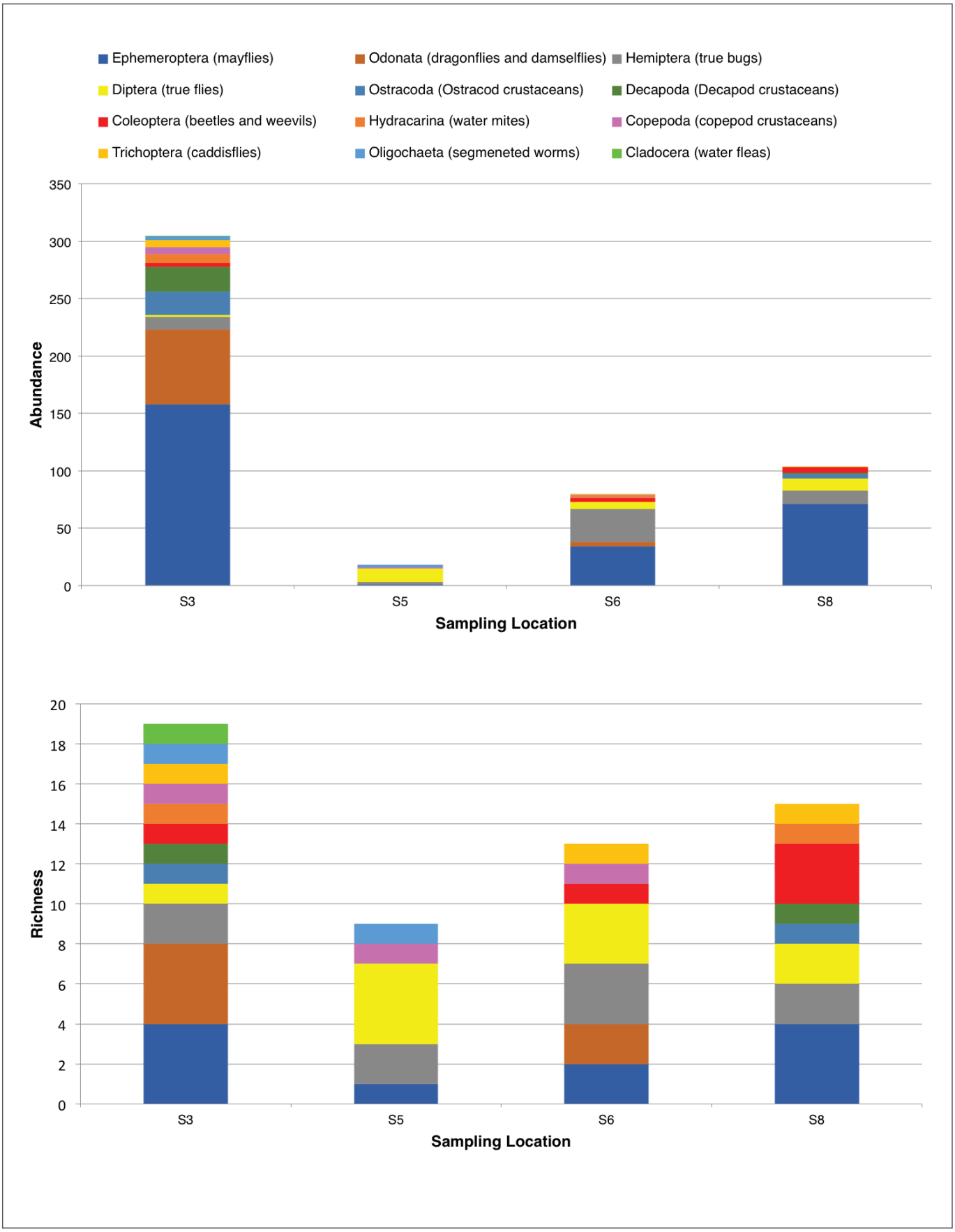
The number of taxa ranged from nine at site S5 to 19 at site S3 (Figure 3.2). While there were notable differences in total abundance of macroinvertebrates between sites, the number of taxa showed less variability at the site level. While abundance was notably higher at site S3, the majority of these individuals were from a limited number of taxa, rather than from a range of different taxa. The general makeup of macroinvertebrate taxa was different between sites.

The stream invertebrate grade number-average level (SIGNAL 2) was calculated for each site based on family level taxa in accordance with the procedure described in Chessman (2001), except for Oligochaeta for which a score for this subclass was used, as macroinvertebrates from this subclass were not identified to family level. A SIGNAL score provides an indication of water quality in the aquatic environment sampled, where rivers with high SIGNAL scores are likely to have low levels of salinity, turbidity and nutrients such as nitrogen and phosphorous (Chessman, 2001). When considered in conjunction with macroinvertebrate richness, SIGNAL can also provide an indication of the types of pollution and other physical and chemical stressors in the aquatic environment (Chessman, 2001).

Figure 3.3 shows a plot of the number of macroinvertebrate family taxa versus the calculated SIGNAL 2 score per site, with raw calculations provided in Attachment 4. The quadrant borders shown are based on the default values provided in Chessman (2001). Due to the variability of macroinvertebrate assemblages at the site level, it is usually preferable to collect three replicate samples per site; however, the results of a single sample from the rapid assessment are still considered to provide some further context for the characterisation of the existing environment.

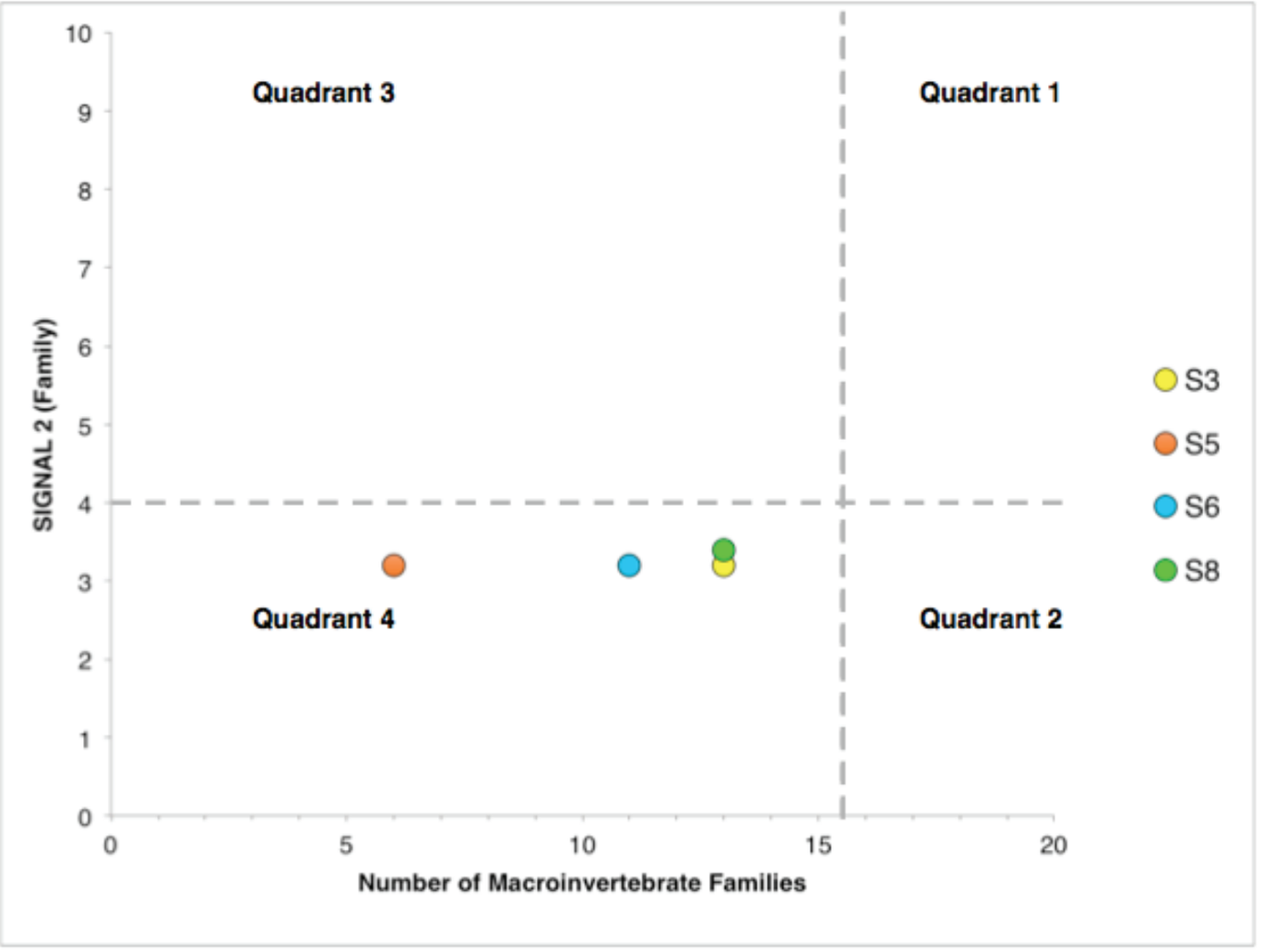
Macroinvertebrate assemblages from all four sites were placed within quadrant four. Results in this quadrant represent low values for both the SIGNAL 2 score and the number of invertebrate types. Typically, sites falling within this quadrant indicate urban, industrial or agricultural pollution or downstream effects of dams (Chessman, 2001). This is further supported by the water quality results which indicated elevated nutrient concentrations, low dissolved oxygen levels and elevated microbial contaminants at some or all sampling locations.

FIGURE 3.2


Ephemeroptera (mayflies)
Odonata (dragonflies and damselflies)
Hemiptera (true bugs)
Diptera (true flies)
Ostracoda (Ostracod crustaceans)
Decapoda (Decapod crustaceans)
Coleoptera (beetles and weevils)
Hydracarina (water mites)
Copepoda (copepod crustaceans)
Trichoptera (caddisflies)
Oligochaeta (segmeneted worms)
Cladocera (water fleas)
Abundance
0
50
100
150
200
250
300
350
S3
S5
S6
S8
Sampling Location
Richness
0
2
4
6
8
10
12
14
16
18
20
S3
S5
S6
S8
Sampling Location

Number of Macroinvertebrate Families Versus SIGNAL 2 Score per Sampling Location – All Surveyed Sites

FIGURE 3.3



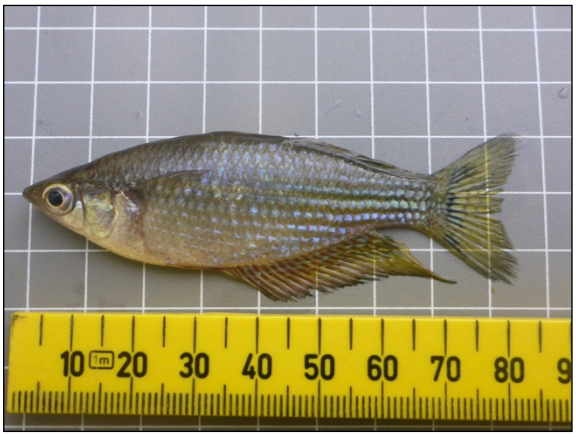
3.2.2.3 Fish

A total of 998 individuals represented by seven species were recorded across the five sites surveyed for aquatic biodiversity (based on pooling the data from all survey techniques). Fish assemblages were composed of:

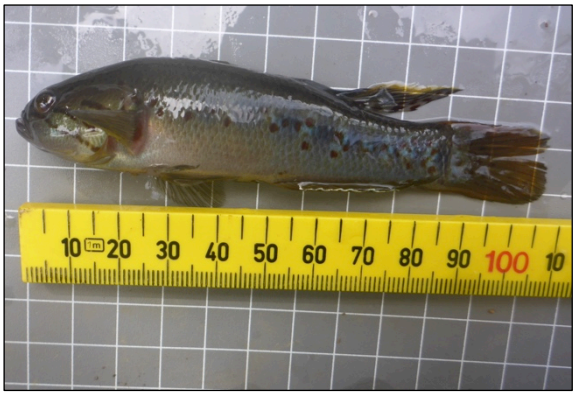
- Northwest glassfish (*Ambassis* sp., 756 individuals, Plate 3.6a).
- Eastern rainbowfish (*Melanotaenia splendida*, 123 individuals, Plate 3.6b).
- Northern trout gudgeon (*Mogurnda mogurnda*, 87 individuals, Plate 3.6c).
- Hyrtl's catfish (*Neosilurus hyrtlii*, 24 individuals, Plate 3.6d).
- Spangled perch (*Leiopotherapon unicolor*, six individuals, Plate 3.6e).
- Black catfish (*Neosilurus ater,* one individual, Plate 3.6f).
- Sleepy cod (*Oxyeleotris lineolata*, one individual, Plate 3.6g).

Plate 3.6 – Fish Species of the Study Area

(a) Northwest glassfish (*Ambassis* sp.)



(b) Eastern rainbowfish (*Melanotaenia splendida*)



(c) Northern trout gudgeon (*Mogurnda mogurnda*)

(d) Hyrtl's catfish (*Neosilurus hyrtlii*)

Plate 3.6 – Fish Species of the Study Area (cont'd)

(e) Spangled perch (*Leiopotherapon unicolor*)

(f) Black catfish (*Neosilurus ater*)

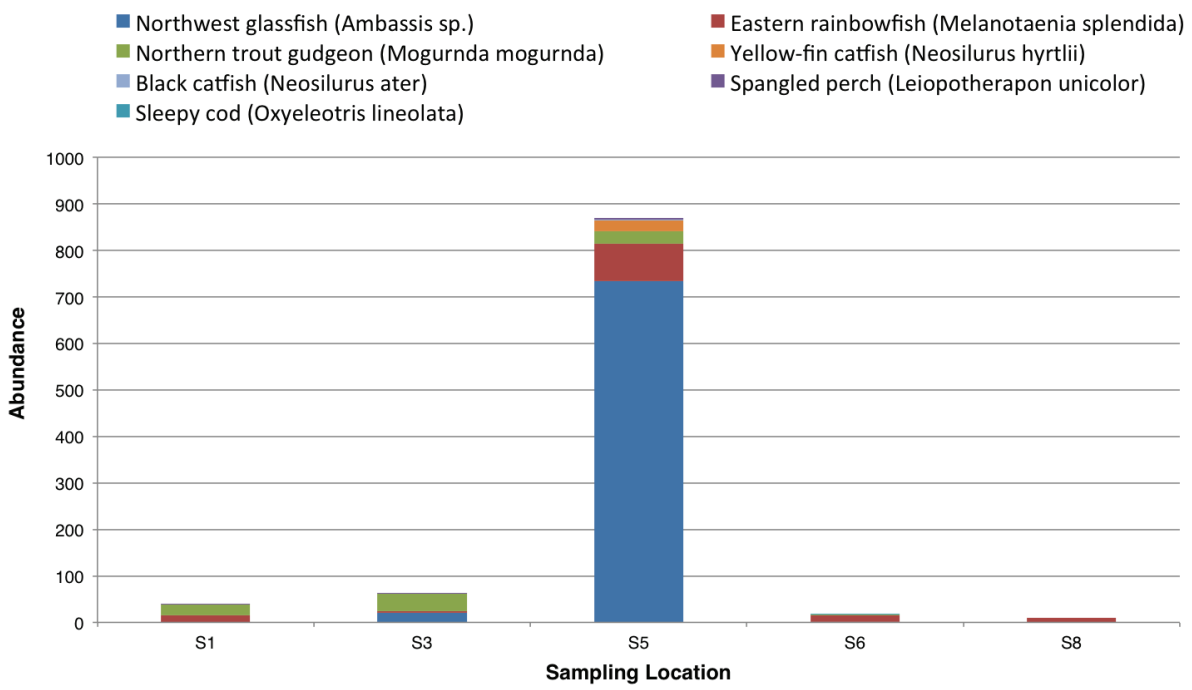
(g) Sleepy cod (*Oxyeleotris lineolata*)

The northwest glassfish (*Ambassis* sp.) accounted for 76% of all fish observations, while the eastern rainbowfish (*Melanotaenia splendida*) and northern trout gudgeon (*Mogurnda mogurnda*) represented 12% and 8% of individual fish, respectively. The remaining four species accounted for only 3% of all individuals. The northwest glassfish was the most abundant fish species in the study area, observed at three of the five sites (not observed at sites S1 or S8). While less abundant, the eastern rainbowfish was common across all sites and the northern trout gudgeon was found at all sites except one (site S8) (Figure 3.4). The sleepy cod was only recorded at site S6, with a single individual recorded.

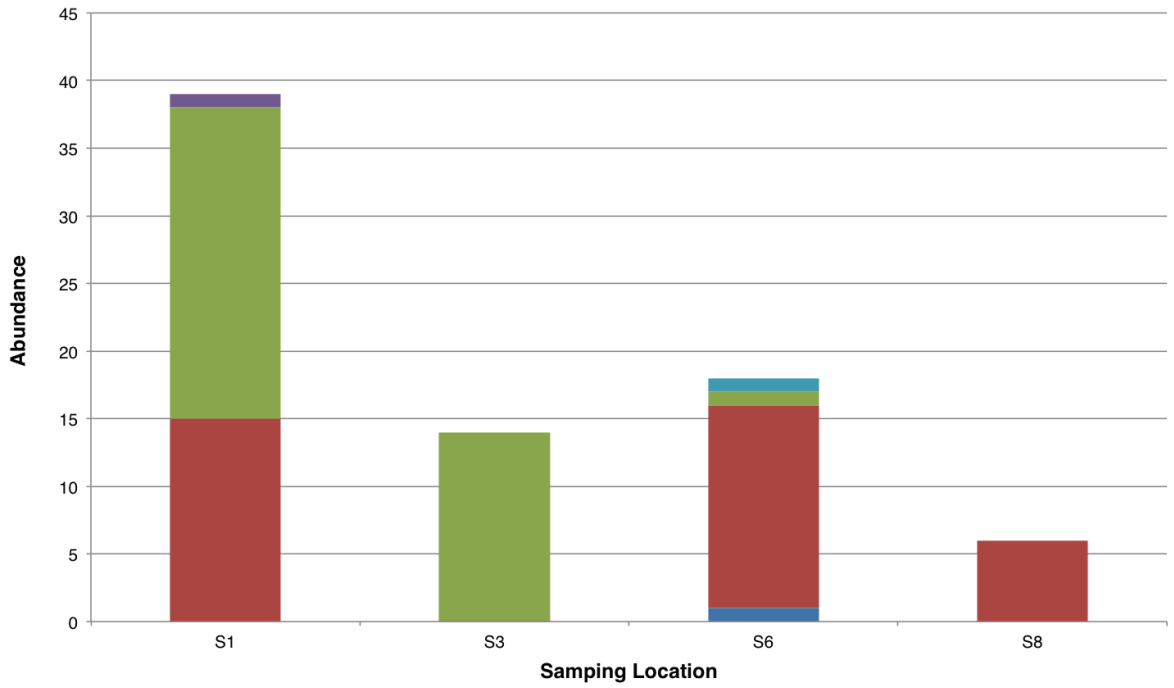
Overall fish abundance and richness was highest at site S5, with fish from this site accounting for 87% of all fish recorded (869 individuals), represented by six of the seven recorded species in the study area (Figure 3.4). In comparison, the number of individuals recorded at sites S1, S3, S6 and S8 were 39, 63, 18 and nine, respectively. Most of the fish at site S5 (705 individuals) were captured from a deep-water pool indicating that such habitat provides important refuge for fish fauna. It is however unknown whether this pool permanently holds water.

FIGURE 3.4

All Fishing Methods



Electrofishing



The majority of fish recorded at site S5 were captured in fyke nets (814 of 869 individuals); however, fyke nets could not be deployed at sites S6 or S8 due to insufficient water depth at these sites. As such, the differences in abundance and diversity between sites shown in Figure 3.4 may be in part due to this differing survey effort. The differences in abundance and diversity may also be indicative of more preferential habitat conditions being available at some sites such as deeper water habitats.

Figure 3.4 also shows the number of individuals captured per sampling location by electrofishing, to allow for comparison between sites since electrofishing fishing effort was standardised across all sites (900 seconds fishing time). Electrofishing was not conducted at site S5 due to the large amount of fish captured using fyke nets. Electrofishing was considered unlikely to yield additional useful results in terms of understanding the fish assemblages at this site.

The highest abundance of individuals recorded during electrofishing was observed at site S1 (39 individuals represented by three species). At sites S3 and S8, only one species was captured during electrofishing, being the northern trout gudgeon and eastern rainbowfish respectively. The most number of species were recorded at site S6 (four species), and this was the only site where the sleepy cod was recorded. Based on the fyke net catches at site S5, it would be expected that abundance and richness of fish assemblages from electrofishing at this sampling location would likely have been higher than the other sampling locations.

Eastern rainbowfish (*Melanotaenia splendida*) were used to compare fish lengths between sites due to their widespread occurrence across the study area (present at all five sampling sites) (Figure 3.5). Two size classes were identified, 0 cm to 5 cm, and 5 cm to 10 cm. Individuals of 0 to 5 cm were recorded across all sites; however, larger individuals (5 cm to 10 cm) were only recorded at two sampling locations, sites S1 and S5. While the northwest glassfish (*Ambassis* sp.) was the most abundant species recorded, 97% of the 756 individuals were caught at site S5, with 86% of those between 0 cm to 5 cm length.

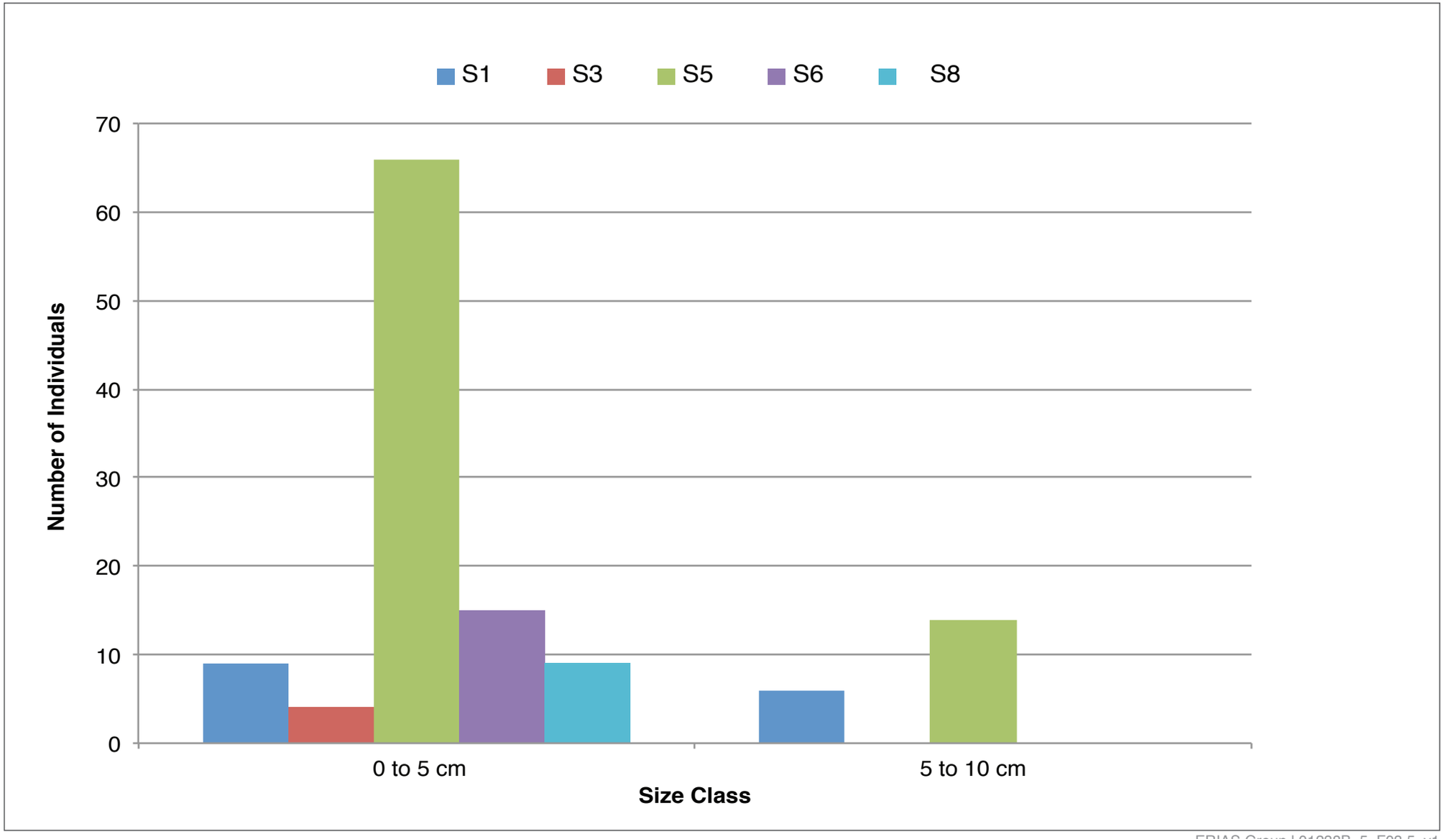
All the species recorded during the April 2019 survey are known to occur throughout northern Australia, with the most abundant species, northwest glassfish (*Ambassis* sp.), eastern rainbowfish (*Melanotaenia splendida*), and northern trout gudgeon (*Mogurnda mogurnda*), consistent with findings of a recent study into the distribution of 111 freshwater fishes throughout northern Australia, which reported these species as being some of the most abundant in northern Australia (Pusey et al., 2017).

Overall, the results indicate that northwest glassfish (*Ambassis* sp.) is the most abundant fish species within the study area, while eastern rainbowfish (*Melanotaenia splendida*) and northern trout gudgeon (Mogurnda mogurnda) are the most widespread. Species richness is considered low, with only seven species recorded. The study area appears to provide suitable habitat for other species of catfish (Ariidae), gobies (*Glossogobius* sp.), sooty grunter (H*ephaestus fuliginosus*), tarpons (*Megalops sp.*) and barramundi (*Lates calcarifer*) and also includes the known distribution of these fishes. The absence of these species is likely indicative of the time of year and/or low water levels observed during the survey period. A list of all fish species with potential to occur in the study area, based on Pusey et al. (2017), is provided in Attachment 5. This includes 38 species of bony fish and 3 elasmobranchs.

Eastern rainbowfish (*Melanotaenia splendida*) Size Comparison Between Sampling Locations – All Surveyed Sites

Fountain Head and Hayes Creek Zinc, Gold and Silver Projects I Aquatic Baseline Characterisation Report

FIGURE 3.5



3.2.3 Sensitive Species, Ecosystems and Habitat Features

Sensitive aquatic species are considered to be those listed as threatened under the IUCN Red List, on federal (*Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*) or State (*Territory Parks and Wildlife Conservation Act 1976*) lists, and species considered to be endemic or to have restricted ranges. A list of threatened, endemic and restricted range species with potential to occur within the study area is provided in Table 3.7, with the likelihood of occurrence described. The remaining 38 fish species with potential to occur in the study area identified in Attachment 5 are not listed as threatened on the IUCN Red List or on federal or state lists. None of the species identified with potential to occur in the study area are considered restricted range species or endemic to the study area.

Table 3.7 – Listed Aquatic Species with Potential to Occur in the Study Area

Common Name	Scientific Name	IUCN Status	National Status	NT Status	Likelihood/Reason
Largetooth Sawfish	*Pristis pristis*	CR	VU	VU	Unlikely, usually found in water depths greater than 1 m and adults are primarily a marine/estuarine species while juveniles spend the first three to four years in freshwater. Known to the Adelaide River drainage
Northern river shark	*Glyphis garricki*	CR	EN	EN	Possible, considered rare in Northern Territory but previously recorded just downstream of the confluence of the Margaret River and the Adelaide River (Ward and Larson, 2012a)
Speartooth shark	*Glyphis glyphis*	EN	CR	VU	Possible, distribution not well known, but known to occur in the Adelaide River coastal floodplain and juveniles are not uncommon in the upper reaches of the Adelaide River system (DNRETAS, 2019; Ward and Larson, 2012b)

*CR = Critically Endangered, EN = Endangered, LC = Least Concern, VU = Vulnerable,

Listed species with potential to occur within the study area are all elasmobranchs (Table 3.7), of which none were recorded during the April 2019 survey. The presence of the freshwater sawfish in the study area is considered unlikely, although they are known to occur downstream in the Adelaide River drainage and could feasibly migrate upstream during an above average wet season and reside in deep water pools. Threatened sharks could occur in the study area, although the water depths observed during the April 2019 survey were generally too shallow to allow passage upstream from the Adelaide River and its upper reaches where they are known to occur.

Sensitive ecosystems and habitat features are considered to be those listed as threatened ecological communities and/or wetlands of international importance under the *EPBC* Act and the 67 conservation sites identified by the Northern Territory Department of Land Resource

Management. No such sensitive ecosystems have been identified in the study area. Downstream of the study area, the Margaret River converges with the Adelaide River that then reports to Adam Bay. This area includes the Adelaide River coastal floodplain, one of the Northern Territory's designated conservation sites.

The Adelaide River coastal floodplain is seasonally inundated with freshwater and is traversed by a major and permanent tidal river (DNRETAS, 2019). The floodplain includes both tidal and seasonal wetland habitats and is dominated by grass and sedge communities with open woodland and pockets of monsoon forest found along the fringe (DNRETAS, 2019). This habitat supports a large number of waterbirds including internationally significant numbers of species such as magpie goose (*Anseranas semipalmata*) and whistling ducks (*Dendrocygna* spp.) (DNRETAS, 2019). The mangroves in the lower reaches of the Adelaide River support the largest waterbird breeding colony in the Northern Territory, supporting around 30,000 birds (DNRETAS, 2019). Migratory shorebirds use the inland wetland areas of the floodplain, such as Lake Finniss.

Overall, 14 threatened species have been recorded in the Adelaide River coastal floodplain, including four plant and 10 vertebrate species (DNRETAS, 2019). With respect to threatened aquatic species, freshwater sawfish (*Pristis microdon*), northern river shark (*glyphis garricki*) and speartooth shark (*Glyphis glyphis*) have all been recorded, i.e., while these species are unlikely to occur within the study area, they have been recorded in the downstream receiving environment.

3.2.4 Introduced and Invasive Species

No introduced or invasive aquatic fauna species were recorded during the April 2019 survey. Much of northern Australia remains free of introduced and invasive species, with known incursions generally limited to isolated areas (Pusey et al., 2017) and the majority of incursions eradicated prior to establishment. There are nine declared aquatic weed species in the Northern Territory, this includes:

- Alligator weed (*Alternanthera philoxeroides*).
- Amazon frogbit (*Limnobium laevigatum*).
- Cabomba (*Cabomba caroliniana*).
- Limnocharis (*Limnocharis flava*).
- Pistia (*Pistia stratiotes*).
- Sagittaria (*Sagittaria platyphylla*).
- Salvinia (*Salvinia molesta*).
- Water hyacinth (*Eichhornia crassipes*).
- Water mimosa (*Neptunia plena*).

There have isolated infestations of alligator weed, water hyacinth and water mimosa, but these have been successfully eradicated. Pistia is believed to be native to the Northern Territory, but is considered a threat to other states in Australia. There are known infestations of cabomba in the Darwin River, and salvinia is also found in the Northern Territory, widely planted as an ornamental

in garden ponds and found in still or slow moving water with high nutrient levels and is able to survive temperatures up to 43 degrees and tolerate salinities one tenth that of sea water (NT Government, 2020). There are no other known occurances of the listed aquatic weed species in the Northern Territory.

The invasive Siamese fighting fish (*Betta splendens*), native to central Thailand, has been recently identified in large numbers in the Adelaide River and floodplains near Darwin, downstream of the study area. Its presence is likely a result of being released into the wild from residential ponds or aquariums (Lyons, 2019). This species has the potential to establish within the study area, with eradication from the Adelaide River and the nearby area considered unlikely.

No other introduced or invasive aquatic fauna species are known to, or are considered likely to, occur in the study area.

4. Summary of Findings

4.1 Surface Water Quality

Physicochemical water quality parameters were generally typical of ephemeral inland freshwater systems of northern Australia. Dissolved oxygen levels were low, which is not uncommon in such systems, particularly when there is intermittent, low or no flow. Electrical conductivity was mostly within the ranges provided by applicable guidelines, with the exception of site S1, where it was slightly elevated. The pH was circumneutral and within applicable guideline limits at all sites. Turbidity levels varied between locations and was elevated in the tributary creek north of Fountain Head and at the most downstream sampling location in the Margaret River.

Nutrient concentrations were generally below applicable guidelines, with the exception of total nitrogen that exceed the ANZECC/ARMCANZ (2000) guidelines and DHWQO at some sampling locations in the downstream part of the study area. Nitrate and nitrite concentrations also exceeded the DHWQO at two sampling locations, with one location being the most upstream site in a tributary of the Margaret River (site S1) and the other location being in the middle of the study area in the Margaret River (site S5).

Dissolved metal concentrations were below ANZECC/ARMCANZ (2000) trigger values for slightly to moderately disturbed freshwater ecosystems, with the exception of arsenic which was notably elevated at site S1 (upstream of Mt Bonnie) and chromium, which was slightly elevated at site S6 in a tributary creek downstream of Fountain Head.

There was evidence of microbial contamination throughout the study area with faecal coliforms, *E. coli* present at all sites and at levels above the DHWQO at some sampling locations.

There was no evidence of petroleum hydrocarbon contamination in the study area with all measurements below the laboratory limit of reporting.

4.2 Aquatic Biodiversity

A range of aquatic habitats occur in the study area, with areas of standing pools and flowing water encountered at stream sampling locations. Water velocities were generally low or stagnant at all sampling locations. The aquatic habitats in the study area are largely seasonal with water at many of the surveyed sites expected to dry up before the end of the dry season.

Several species of freshwater prawn and one species of crab were recorded in the study area. Prawns were common to all surveyed sampling locations and particularly abundant at site S1, a tributary of the Margaret River, and site S3, within the main Margaret River channel. The river swimming crab (*Veruna litterata*) was found at some, but not all, sampling locations. All recorded macrocrustacean species are common and widespread in northern Australia.

A total of 507 macroinvertebrates from 31 taxa were identified in the study area. Macroinvertebrate assemblages were numerically dominated by Ephemeroptera (mayflies), Odonata (dragonflies and damselflies) and Hemiptera (true bugs). The abundance of macroinvertebrates was highest at site S3 and notably low at site S5. Overall, abundance and richness of macroinvertebrates was low in the study area. The calculated SIGNAL 2 score,

together with the surface water quality results, indicate some degree of existing impacts on the aquatic environment.

A total of 998 fish were recorded in the study area. The abundance and diversity of fish fauna is low, with only seven species recorded. A further 31 species of fish and three elasmobranchs have been identified with potential to occur based on previous studies and the presence of potentially suitable habitat for these species in the study area.

Fish abundance was notably highest at site S5 where nearly 90% of all fish recorded in the study area were captured, most from a large deep-water pool. While it is unknown whether this pool holds water permanently, it indicates that such habitat provides important refuge for fish fauna after the wet season. Abundance of fish was low at all other sampling locations.

No ecosystems or habitat features occur within the study area. The Margaret River does however report to the downstream Adelaide River coastal floodplain, which is a designated conservation site in the Northern Territory. None of the fish species known to, or with potential to, occur in the study area are considered threatened. The three elasmobranch species identified with potential to occur based on previous studies (freshwater sawfish, northern river shark and speartooth shark) are either listed as threatened on national, state and/or international conservations lists. These species have been previously recorded further downstream in the Adelaide River catchment; however, are considered unlikely to occur within the study area.

No introduced or invasive aquatic species were recorded during the survey nor are they expected to be present in the study area.

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Attachment 1.
Laboratory Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1905192**	Page	: 1 of 7
Client	: **ERIAS GROUP**	Laboratory	: Environmental Division Melbourne
Contact	: DAVID BROWNE	Contact	: Customer Services EM
Address	: Suite 9, 13/25 Church St HAWTHORN VIC 3122	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +61-3-8549 9600
Project	: 01238B_Hayes Creek	Date Samples Received	: 08-Apr-2019 13:45
Order number	:	Date Analysis Commenced	: 09-Apr-2019
C-O-C number	: ----	Issue Date	: 16-Apr-2019 18:07
Sampler	: KS, SB		
Site	: Hayes Creek, Northern Teritory		
Quote number	: ME/231/19 V2		
No. of samples received	: 8		
No. of samples analysed	: 8		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- Ionic Balance out of acceptable limits for sample #1 and 2 due to analytes not quantified in this report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- Samples have been received with limited time to adhere to recommended analytical holding times for EA025H and ED093F. Results should be scrutinised accordingly.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP_1	S1	S2	S3	S5
				Client sampling date / time	03-Apr-2019 00:00	03-Apr-2019 00:00	03-Apr-2019 00:00	03-Apr-2019 00:00	02-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EM1905192-001	EM1905192-002	EM1905192-003	EM1905192-004	EM1905192-005
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		<1	<1	<1	<1	<1
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		141	137	37	48	40
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		197	192	79	89	87
Total Alkalinity as CaCO3	----	1	mg/L		197	192	79	89	87
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		6	6	2	5	2
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		3	3	2	2	4
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		17	17	5	6	6
Magnesium	7439-95-4	1	mg/L		24	23	6	8	6
Sodium	7440-23-5	1	mg/L		10	10	6	8	7
Potassium	7440-09-7	1	mg/L		1	1	2	2	3
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Arsenic	7440-38-2	0.2	µg/L		59.2	59.5	4.3	4.7	4.9
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	0.12	0.07
Chromium	7440-47-3	0.2	µg/L		<0.2	<0.2	0.2	<0.2	<0.2
Copper	7440-50-8	0.5	µg/L		<0.5	<0.5	<0.5	0.6	1.1
Lead	7439-92-1	0.1	µg/L		<0.1	<0.1	0.2	0.2	0.2
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	0.8
Zinc	7440-66-6	1	µg/L		<1	<1	<1	2	3
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		4.14	4.04	1.68	1.94	1.89
Total Cations	----	0.01	meq/L		3.28	3.20	1.06	1.36	1.17
Ionic Balance	----	0.01	%		11.6	11.6	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		----	----	----	4	5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP_1	S1	S2	S3	S5
				Client sampling date / time	03-Apr-2019 00:00	03-Apr-2019 00:00	03-Apr-2019 00:00	03-Apr-2019 00:00	02-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EM1905192-001	EM1905192-002	EM1905192-003	EM1905192-004	EM1905192-005
					Result	Result	Result	Result	Result
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		2	1	4	4	5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		93.3	93.8	94.7	93.5	93.7
Toluene-D8	2037-26-5	2	%		94.0	94.2	94.6	96.5	95.0
4-Bromofluorobenzene	460-00-4	2	%		91.3	92.0	92.2	94.0	93.0

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	S6	S7	S8	----	----
				Client sampling date / time	02-Apr-2019 00:00	02-Apr-2019 00:00	02-Apr-2019 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1905192-006	EM1905192-007	EM1905192-008	--------	--------
					Result	Result	Result	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		2	29	8	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		<1	28	11	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		32	64	36	----	----
Total Alkalinity as CaCO3	----	1	mg/L		32	64	36	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		1	2	4	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		2	3	2	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	3	1	----	----
Magnesium	7439-95-4	1	mg/L		<1	5	2	----	----
Sodium	7440-23-5	1	mg/L		6	5	5	----	----
Potassium	7440-09-7	1	mg/L		<1	3	1	----	----
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.005	µg/L		<0.005	<0.005	<0.005	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Arsenic	7440-38-2	0.2	µg/L		0.8	1.7	2.4	----	----
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	----	----
Chromium	7440-47-3	0.2	µg/L		1.3	0.6	0.5	----	----
Copper	7440-50-8	0.5	µg/L		1.3	1.1	1.3	----	----
Lead	7439-92-1	0.1	µg/L		0.4	0.3	0.2	----	----
Nickel	7440-02-0	0.5	µg/L		0.9	1.0	0.7	----	----
Zinc	7440-66-6	1	µg/L		1	<1	6	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		0.72	1.40	0.86	----	----
Total Cations	----	0.01	meq/L		0.26	0.86	0.46	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		4	----	----	----	----
EP005: Total Organic Carbon (TOC)									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	S6	S7	S8	----	----
				Client sampling date / time	02-Apr-2019 00:00	02-Apr-2019 00:00	02-Apr-2019 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1905192-006	EM1905192-007	EM1905192-008	--------	--------
					Result	Result	Result	----	----
EP005: Total Organic Carbon (TOC) - Continued									
Total Organic Carbon	----	1	mg/L		**4**	**4**	**5**	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**92.4**	**94.7**	**89.3**	----	----
Toluene-D8	2037-26-5	2	%		**95.3**	**96.0**	**92.3**	----	----
4-Bromofluorobenzene	460-00-4	2	%		**93.1**	**96.3**	**91.8**	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EM1905192**	Page	: 1 of 7
Client	: **ERIAS GROUP**	Laboratory	: Environmental Division Melbourne
Contact	: DAVID BROWNE	Contact	: Customer Services EM
Address	: Suite 9, 13/25 Church St HAWTHORN VIC 3122	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +61-3-8549 9600
Project	: 01238B_Hayes Creek	Date Samples Received	: 08-Apr-2019
Order number	:	Date Analysis Commenced	: 09-Apr-2019
C-O-C number	: ----	Issue Date	: 16-Apr-2019
Sampler	: KS, SB		
Site	: Hayes Creek, Northern Teritory		
Quote number	: ME/231/19 V2		
No. of samples received	: 8		
No. of samples analysed	: 8		

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

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

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

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

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 2286119)									
EM1905192-005	S5	EA025: Suspended Solids (SS)	----	1	mg/L	<1	<1	0.00	No Limit
EM1905068-001	Anonymous	EA025: Suspended Solids (SS)	----	1	mg/L	16	15	6.45	0% - 50%
ED037P: Alkalinity by PC Titrator (QC Lot: 2287191)									
EM1905197-002	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	926	944	1.91	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	926	944	1.91	0% - 20%
EM1905172-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	701	692	1.24	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	701	692	1.24	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2284564)									
EM1905192-001	DUP_1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	6	6	0.00	No Limit
EM1905073-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	46	46	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 2284562)									
EM1905073-011	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	17	17	0.00	0% - 50%
EM1905073-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	17	20	14.2	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2288185)									
EM1905181-002	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	92	95	2.76	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	11	12	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	1290	1320	2.10	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	87	90	3.09	0% - 20%
EM1905192-008	S8	ED093F: Calcium	7440-70-2	1	mg/L	1	1	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	2	2	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED093F: Dissolved Major Cations (QC Lot: 2288185) - continued									
EM1905192-008	S8	ED093F: Sodium	7440-23-5	1	mg/L	5	5	0.00	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.00	No Limit
EG035T: Total Mercury by FIMS (QC Lot: 2290986)									
EM1905192-001	DUP_1	EG035T-UT: Mercury	7439-97-6	0.005	µg/L	<0.005	<0.005	0.00	No Limit
ES1910789-004	Anonymous	EG035T-UT: Mercury	7439-97-6	0.005	µg/L	<0.005	<0.005	0.00	No Limit
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QC Lot: 2290792)									
EM1905192-001	DUP_1	EG094A-F: Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EG094A-F: Lead	7439-92-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG094A-F: Arsenic	7440-38-2	0.2	µg/L	59.2	59.8	0.936	0% - 20%
		EG094A-F: Chromium	7440-47-3	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG094A-F: Copper	7440-50-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-F: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-F: Zinc	7440-66-6	1	µg/L	<1	<1	0.00	No Limit
EP1903275-001	Anonymous	EG094A-F: Cadmium	7440-43-9	0.05	µg/L	<0.00005 mg/L	<0.05	0.00	No Limit
		EG094A-F: Lead	7439-92-1	0.1	µg/L	<0.0001 mg/L	<0.1	0.00	No Limit
		EG094A-F: Arsenic	7440-38-2	0.2	µg/L	0.0045 mg/L	4.4	2.50	0% - 20%
		EG094A-F: Chromium	7440-47-3	0.2	µg/L	<0.0002 mg/L	<0.2	0.00	No Limit
		EG094A-F: Copper	7440-50-8	0.5	µg/L	0.0013 mg/L	1.2	14.4	No Limit
		EG094A-F: Nickel	7440-02-0	0.5	µg/L	0.0026 mg/L	2.5	4.73	No Limit
		EG094A-F: Zinc	7440-66-6	1	µg/L	0.003 mg/L	3	0.00	No Limit
EP002: Dissolved Organic Carbon (DOC) (QC Lot: 2293297)									
EM1905192-004	S3	EP002: Dissolved Organic Carbon	----	1	mg/L	4	3	0.00	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 2293296)									
EM1905192-001	DUP_1	EP005: Total Organic Carbon	----	1	mg/L	2	2	0.00	No Limit
EM1905214-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	14	9	42.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 2292630)									
EM1905062-008	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EM1905192-003	S2	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 2292630)									
EM1905062-008	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EM1905192-003	S2	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 2292630)									
EM1905062-008	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP080: BTEXN (QC Lot: 2292630) - continued									
EM1905192-003	S2	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 2286119)								
EA025: Suspended Solids (SS)	----	1	mg/L	<1	150 mg/L	100	90	114
ED037P: Alkalinity by PC Titrator (QCLot: 2287191)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	95.7	88	112
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2284564)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	108	86	115
				<1	100 mg/L	95.4	86	115
ED045G: Chloride by Discrete Analyser (QCLot: 2284562)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	102	86	120
				<1	1000 mg/L	106	86	120
ED093F: Dissolved Major Cations (QCLot: 2288185)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	5 mg/L	107	92	113
ED093F: Magnesium	7439-95-4	1	mg/L	<1	5 mg/L	102	87	114
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	104	88	113
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	99.8	87	112
EG035T: Total Mercury by FIMS (QCLot: 2290986)								
EG035T-UT: Mercury	7439-97-6	0.005	µg/L	<0.005	0.1 µg/L	91.7	85	115
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QCLot: 2290792)								
EG094A-F: Arsenic	7440-38-2	0.2	µg/L	<0.2	10 µg/L	108	79	121
EG094A-F: Cadmium	7440-43-9	0.05	µg/L	<0.05	10 µg/L	106	87	111
EG094A-F: Chromium	7440-47-3	0.2	µg/L	<0.2	10 µg/L	103	80	122
EG094A-F: Copper	7440-50-8	0.5	µg/L	<0.5	10 µg/L	101	83	117
EG094A-F: Lead	7439-92-1	0.1	µg/L	<0.1	10 µg/L	104	74	118
EG094A-F: Nickel	7440-02-0	0.5	µg/L	<0.5	10 µg/L	102	86	118
EG094A-F: Zinc	7440-66-6	1	µg/L	<1	10 µg/L	108	83	121
EP002: Dissolved Organic Carbon (DOC) (QCLot: 2293297)								
EP002: Dissolved Organic Carbon	----	1	mg/L	<1	100 mg/L	98.8	83	115
EP005: Total Organic Carbon (TOC) (QCLot: 2293296)								
EP005: Total Organic Carbon	----	1	mg/L	<1	100 mg/L	97.6	81	109
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2285156)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	4030 µg/L	91.0	50	129
EP071: C15 - C28 Fraction	----	100	µg/L	<100	15600 µg/L	99.2	55	132
EP071: C29 - C36 Fraction	----	50	µg/L	<50	7820 µg/L	96.6	55	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2292630)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2292630) - continued								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	360 µg/L	99.4	65	126
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2285156)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	5960 µg/L	92.0	53	129
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	20700 µg/L	97.0	56	131
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	1520 µg/L	99.4	53	136
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2292630)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	450 µg/L	94.8	64	124
EP080: BTEXN (QCLot: 2292630)								
EP080: Benzene	71-43-2	1	µg/L	<1	20 µg/L	101	69	123
EP080: Toluene	108-88-3	2	µg/L	<2	20 µg/L	104	73	124
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	20 µg/L	100	71	125
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	40 µg/L	102	72	129
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	20 µg/L	104	76	129
EP080: Naphthalene	91-20-3	5	µg/L	<5	5 µg/L	98.6	70	125

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2284564)							
EM1905073-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	100 mg/L	76.3	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 2284562)							
EM1905073-002	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	82.2	70	130
EG035T: Total Mercury by FIMS (QCLot: 2290986)							
EM1905192-002	S1	EG035T-UT: Mercury	7439-97-6	0.1 µg/L	79.2	70	130
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QCLot: 2290792)							
EM1905192-002	S1	EG094A-F: Arsenic	7440-38-2	50 µg/L	101	70	130
		EG094A-F: Cadmium	7440-43-9	12.5 µg/L	99.7	70	130
		EG094A-F: Chromium	7440-47-3	50 µg/L	97.1	70	130
		EG094A-F: Copper	7440-50-8	50 µg/L	95.6	70	130
		EG094A-F: Lead	7439-92-1	50 µg/L	97.4	70	130
		EG094A-F: Nickel	7440-02-0	50 µg/L	96.7	70	130
		EG094A-F: Zinc	7440-66-6	50 µg/L	95.9	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP002: Dissolved Organic Carbon (DOC) (QCLot: 2293297)							
EM1905192-005	S5	EP002: Dissolved Organic Carbon	----	100 mg/L	98.9	75	117
EP005: Total Organic Carbon (TOC) (QCLot: 2293296)							
EM1905192-002	S1	EP005: Total Organic Carbon	----	100 mg/L	100	80	114
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2292630)							
EM1905062-009	Anonymous	EP080: C6 - C9 Fraction	----	280 µg/L	82.1	43	125
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2292630)							
EM1905062-009	Anonymous	EP080: C6 - C10 Fraction	C6_C10	330 µg/L	78.3	44	122
EP080: BTEXN (QCLot: 2292630)							
EM1905062-009	Anonymous	EP080: Benzene	71-43-2	20 µg/L	104	68	130
		EP080: Toluene	108-88-3	20 µg/L	103	72	132

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1905192**	Page	: 1 of 9
Client	: **ERIAS GROUP**	Laboratory	: Environmental Division Melbourne
Contact	: DAVID BROWNE	Telephone	: +61-3-8549 9600
Project	: 01238B_Hayes Creek	Date Samples Received	: 08-Apr-2019
Site	: Hayes Creek, Northern Teritory	Issue Date	: 16-Apr-2019
Sampler	: KS, SB	No. of samples received	: 8
Order number	:	No. of samples analysed	: 8

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA025: Total Suspended Solids dried at 104 ± 2°C						
Clear Plastic Bottle - Natural						
S5, S6, S7, S8	----	----	----	10-Apr-2019	09-Apr-2019	**1**
EA065: Total Hardness as CaCO3						
Clear Plastic Bottle - Natural						
S5, S6, S7, S8	----	----	----	11-Apr-2019	09-Apr-2019	**2**
Clear Plastic Bottle - Natural						
DUP_1, S1, S2, S3	----	----	----	11-Apr-2019	10-Apr-2019	**1**
ED093F: Dissolved Major Cations						
Clear Plastic Bottle - Natural						
S5, S6, S7, S8	----	----	----	11-Apr-2019	09-Apr-2019	**2**
Clear Plastic Bottle - Natural						
DUP_1, S1, S2, S3	----	----	----	11-Apr-2019	10-Apr-2019	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	0	14	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	0	14	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025) S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**10-Apr-2019**	09-Apr-2019	×
Clear Plastic Bottle - Natural (EA025) DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**10-Apr-2019**	10-Apr-2019	✓
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Natural (ED093F) S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**11-Apr-2019**	09-Apr-2019	×
Clear Plastic Bottle - Natural (ED093F) DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**11-Apr-2019**	10-Apr-2019	×
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**10-Apr-2019**	16-Apr-2019	✓
Clear Plastic Bottle - Natural (ED037-P) DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**10-Apr-2019**	17-Apr-2019	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**09-Apr-2019**	30-Apr-2019	✓
Clear Plastic Bottle - Natural (ED041G) DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**09-Apr-2019**	01-May-2019	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**09-Apr-2019**	30-Apr-2019	✓
Clear Plastic Bottle - Natural (ED045G) DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**09-Apr-2019**	01-May-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F) S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**11-Apr-2019**	09-Apr-2019	×
Clear Plastic Bottle - Natural (ED093F) DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**11-Apr-2019**	10-Apr-2019	×

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Mercury by FIMS							
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG035T-UT)							
S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**11-Apr-2019**	30-Apr-2019	✓
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG035T-UT)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**11-Apr-2019**	01-May-2019	✓
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS							
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG094A-F)							
S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**11-Apr-2019**	29-Sep-2019	✓
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG094A-F)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**11-Apr-2019**	30-Sep-2019	✓
EP002: Dissolved Organic Carbon (DOC)							
Amber DOC Filtered- Sulfuric Preserved (EP002)							
S5, S6	**02-Apr-2019**	**----**	----	----	**12-Apr-2019**	30-Apr-2019	✓
Amber DOC Filtered- Sulfuric Preserved (EP002)							
S3	**03-Apr-2019**	**----**	----	----	**12-Apr-2019**	01-May-2019	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005)							
S5, S6, S7, S8	**02-Apr-2019**	**----**	----	----	**12-Apr-2019**	30-Apr-2019	✓
Amber TOC Vial - Sulfuric Acid (EP005)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**----**	----	----	**12-Apr-2019**	01-May-2019	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
S5, S6, S7, S8	**02-Apr-2019**	**09-Apr-2019**	09-Apr-2019	✓	**11-Apr-2019**	19-May-2019	✓
Amber Glass Bottle - Unpreserved (EP071)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**10-Apr-2019**	10-Apr-2019	✓	**11-Apr-2019**	20-May-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
S5, S6, S7, S8	**02-Apr-2019**	**12-Apr-2019**	16-Apr-2019	✓	**12-Apr-2019**	16-Apr-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**12-Apr-2019**	17-Apr-2019	✓	**12-Apr-2019**	17-Apr-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
S5, S6, S7, S8	**02-Apr-2019**	**09-Apr-2019**	09-Apr-2019	✓	**11-Apr-2019**	19-May-2019	✓
Amber Glass Bottle - Unpreserved (EP071)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**10-Apr-2019**	10-Apr-2019	✓	**11-Apr-2019**	20-May-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
S5, S6, S7, S8	**02-Apr-2019**	**12-Apr-2019**	16-Apr-2019	✓	**12-Apr-2019**	16-Apr-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**12-Apr-2019**	17-Apr-2019	✓	**12-Apr-2019**	17-Apr-2019	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
S5, S6, S7, S8	**02-Apr-2019**	**12-Apr-2019**	16-Apr-2019	✓	**12-Apr-2019**	16-Apr-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
DUP_1, S1, S2, S3	**03-Apr-2019**	**12-Apr-2019**	17-Apr-2019	✓	**12-Apr-2019**	17-Apr-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Organic Carbon	EP002	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids	EA025	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Ultra-trace	EG035T-UT	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	14	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Organic Carbon	EP002	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids	EA025	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Ultra-trace	EG035T-UT	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Organic Carbon	EP002	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids	EA025	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Ultra-trace	EG035T-UT	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Organic Carbon	EP002	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Ultra-trace	EG035T-UT	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	14	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids	EA025	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS - Ultra-trace	EG035T-UT	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020 Samples are 0.45µm filtered prior to analysis. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Organic Carbon	EP002	WATER	In house: Referenced to APHA 5310 B. This method is compliant with NEPM (2013) Schedule B(3) . Samples are combusted at high termperature in the presence of an oxidative catalyst. The evolved carbon dioxide is quantified using an IR detector.
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

ANALYTICAL TEST REPORT

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JOB NUMBER	**NT50139**
PO NUMBER	
PROJECT	Quote: 19017 v1
CHAIN OF CUSTODY	01238B_Hayes Creek 02-04/2019
DATE RECEIVED	3/04/19
DATE REPORTED	10/04/19
NO. SAMPLES	8 Water/Solution(s) for Analysis

COMMENTS

> Results required for compliance may be compromised by:

1. Use of non-laboratory supplied sample containers
2. Holding time breaches
3. Field related preparation or preservation techniques
4. Laboratory Measurement Uncertainty

Potentially affected results are coloured.

> Samples will be discarded one month from final report date.

> * Indicates test is not listed on NATA Scope of Accreditation

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RESULTS AUTHORISED BY

NAME **Fiona Dunbar-Smith**
POSITION Intertek NTEL signatory

Accredited for compliance with ISO/IEC17025 - Testing
Accreditation Number 14610
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REPORT CODE: **NT50139**
Methodology:

Analysis Code	Description	Method Reference	Analytical Scheme	Technique / Instrument	Detection Limit	Data Units
Micro*	Drinking Water Micro Status	WWM38	MICRO	MICRO	0	
E. Coli*	E. Coli	WWM38	MICRO	MICRO	1	MPN/100mL
T Coli*	Total Coliforms	WWM38	MICRO	MICRO	1	MPN/100mL
TT Coli*	Thermotolerant Coliforms	WWM38	MICRO	MICRO	1	MPN/100mL
Turbidity	Turbidity	WWM15	TURB1	UV/VIS	1	NTU
NO2_N	Nitrite as Nitrogen	WWM22	FIAS_4	FIA	0.005	mg/L
NOx_N	Oxidised Nitrogen	WWM22	FIAS_4	FIA	0.005	mg/L
NO3_N	Nitrate as Nitrogen	WWM22	FIAS_4	FIA	0.005	mg/L
PO4_P	Reactive/ortho Phosphate as P	WWM25	FIAS_4	FIA	0.005	mg/L
NH3_N	Ammonium as Nitrogen	WWM22	NH3_N	FIA	0.005	mg/L
Total N	Total Nitrogen	WWM22	N3	FIA	0.01	mg/L
Total P	Total Phosphorous	WWM25	P3	FIA	0.005	mg/L

REPORT CODE: **NT50139** **COC** **01238B_Hayes Creek 02-04/2019**

Element:	Micro*	E. Coli*	T Coli*	TT Coli*	Turbidity	NO2_N	NOx_N	NO3_N	PO4_P
Units:		MPN/100mL	MPN/100mL	MPN/100mL	NTU	mg/L	mg/L	mg/L	mg/L
Method:	MICRO	MICRO	MICRO	MICRO	TURB1	FIAS_4	FIAS_4	FIAS_4	FIAS_4
Detection Limit	0	1	1	1	1	0.005	0.005	0.005	0.005
Analysis Date:	3/04/19	3/04/19	3/04/19	3/04/19	4/04/19	8/04/19	8/04/19	8/04/19	8/04/19
Sample ID									
DUP1 02/04/19	FAIL	79	>2400	308	4	<0.005	0.020	0.015	0.020
S1 03/04/19	FAIL	67	>2400	330	4	<0.005	0.015	0.015	0.020
S2 03/04/19	FAIL	77	>2400	291	12	<0.005	0.010	0.005	<0.005
S3 03/04/19	FAIL	36	>2400	235	5	<0.005	<0.005	<0.005	<0.005
S5 02/04/19	FAIL	365	>2400	163	5	0.005	0.025	0.015	0.005
S6 02/04/19	FAIL	205	>2400	980	34	0.005	0.020	0.015	<0.005
S7 02/04/19	FAIL	435	>2400	548	56	0.005	0.010	<0.005	<0.005
S8 02/04/19	FAIL	81	>2400	236	34	0.010	0.025	0.015	<0.005

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REPORT CODE: **NT50139** **COC** **01238B_Hayes Creek 02-04/2019**

Element:	NH3_N	Total N	Total P						
Units:	mg/L	mg/L	mg/L						
Method:	NH3_N	N3	P3						
Detection Limit	0.005	0.01	0.005						
Analysis Date:	9/04/19	8/04/19	8/04/19						
Sample ID									
DUP1 02/04/19	0.075	0.15	0.035						
S1 03/04/19	0.030	0.12	0.030						
S2 03/04/19	0.175	0.23	0.020						
S3 03/04/19	0.055	0.19	0.015						
S5 02/04/19	0.140	0.46	0.025						
S6 02/04/19	0.055	0.40	0.030						
S7 02/04/19	0.145	0.64	0.045						
S8 02/04/19	0.060	0.53	0.035						

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SAMPLE RECEIPT ADVICE

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Total Quality. Assured.

JOB # **NT50139**

CUSTOMER	**Erias Group**
CONTACT	**David Browne -**
DATE RECEIVED	**3/04/19**
TIME RECEIVED	**3:45 PM**
DELIVERED BY	**AJ COURIERS**
DELIVERY REF	**141386**

SAMPLE DETAILS

PACKAGES RECIVED	**2 x Cooler Bags**
TOTAL ITEMS RECEIVED	**16**
TEMPERATURE ON RECEIPT	**CHILLED**
SAMPLE TYPE/S	**WATER**
SAMPLES LISTED RECEIVED	**8**
SAMPLES LISTED NOT RECEIVED	**-**
SAMPLES RECEIVED NOT LISTED	**-**
HOLDING TIME BREACHES	**NO**
SUBCONTRACTING REQUIRED	**NO**

ANALYSIS AND REPORTING

CUSTOMER REFERENCE	**01238B_Hayes Creek 01238B_Hayes Creek 02-04/2019**
QUOTE #	**19017**
ANALYTICAL REQUEST	**E.Coli, TT.Coli, Turbidity, Nuts**
TURN AROUND REQUESTED	**STANDARD = 5-10 Work Days**
ESTIMATED REPORT DATE	**18/04/19**
RESULTS TO	**scott.breschkin/kate.sinai@eriasgroup.com**
INVOICE TO	**scott.breschkin/kate.sinai@eriasgroup.com**

NOTES

>Payment is required prior to processing your samples. Payment can be made by Visa, Mastercard or electronic funds transfer if you have not already made a payment arrangement. We do not accept cash or cheques.
Banking details are located on your invoice - Reports will not be released until payment is confirmed.

> Please note that samples received after 15:00 will be treated as received the following working day.

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AUSTRALIA

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Lab Manager	Janine Steven
Advice Issued	**3/04/19**
Advice Issuer	Janny Fenech

Attachment 2.
Photographs of Sampling Locations

Table 1 – Photographs of Aquatic Sampling Locations

Site	Facing Upstream	Facing Downstream
S1		
S2		
S3		
S5		

S6		
S7		
S8		

Attachment 3.
Field Duplicate Results

Table 1 – Field Duplicate Results

Parameter	Unit	Limit of Reporting	S1 (Primary Sample)	DUP1 (Duplicate Sample)	Relative Percent Difference
E. Coli	MPN*/100mL	1	79	67	16
Total coliforms	MPN*/100mL	1	>2400	>2400	0
Thermotolerant coliforms	MPN*/100mL	1	308	330	-7
Turbidity	NTU	1	4	4	0
NO_2 as N	mg/L	0.005	<0.005	<0.005	0
NO_x as N	mg/L	0.005	0.02	0.015	29
NO_3 as N	mg/L	0.005	0.015	0.015	0
PO_4 as P	mg/L	0.005	0.02	0.02	0
NH_3 as N	mg/L	0.005	0.075	0.03	**86**
Total N	mg/L	0.01	0.15	0.12	22
Total P	mg/L	0.005	0.035	0.03	15
Total suspended solids	mg/L	1	<1	<1	0
Total hardness as $CaCO_3$	mg/L	1	141	137	3
Hydroxide alkalinity as $CaCO_3$	mg/L	1	<1	<1	0
Carbonate Alkalinity as $CaCO_3$	mg/L	1	<1	<1	0
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	197	192	3
Total alkalinity as $CaCO_3$	mg/L	1	197	192	3
Sulfate as SO_4	mg/L	1	6	6	0
Chloride	mg/L	1	3	3	0
Calcium	mg/L	1	17	17	0
Magnesium	mg/L	1	24	23	4
Sodium	mg/L	1	10	10	0
Potassium	mg/L	1	1	1	0
Mercury	µg/L	0.005	<0.005	<0.005	0
Arsenic	µg/L	0.2	59.2	59.5	-1
Cadmium	µg/L	0.05	<0.05	<0.05	0
Chromium	µg/L	0.2	<0.2	<0.2	0
Copper	µg/L	0.5	<0.5	<0.5	0
Lead	µg/L	0.1	<0.1	<0.1	0
Nickel	µg/L	0.5	<0.5	<0.5	0
Zinc	µg/L	1	<1	<1	0
Total anions	meq/L	0.01	4.14	4.04	2
Total cations	meq/L	0.01	3.28	3.2	2
Ionic balance	%	0.01	11.6	11.6	0
Total organic carbon	mg/L	1	2	1	**67**

Table 1 – Field Duplicate Results (cont'd)

Parameter	Unit	Limit of Reporting	S1 (Primary Sample)	DUP1 (Duplicate Sample)	Relative Percent Difference
TPH C6 to C9 fraction	µg/L	20	<20	<20	0
TPH C10 to C14 fraction	µg/L	50	<50	<50	0
TPH C15 to C28 fraction	µg/L	100	<100	<100	0
TPH C29 to C36 fraction	µg/L	50	<50	<50	0
TPH C10 to C36 fraction (sum)	µg/L	50	<50	<50	0
TRH C6 to C10 fraction	µg/L	20	<20	<20	0
TRH C6 to C10 fraction minus BTEX (F1)	µg/L	20	<20	<20	0
TRH >C10 to C16 fraction	µg/L	100	<100	<100	0
TRH >C16 to C34 fraction	µg/L	100	<100	<100	0
TRH >C34 to C40 fraction	µg/L	100	<100	<100	0
TRH >C10 to C40 Fraction (sum)	µg/L	100	<100	<100	0
TRH >C10 to C16 fraction minus naphthalene (F2)	µg/L	100	<100	<100	0
Benzene	µg/L	1	<1	<1	0
Toluene	µg/L	2	<2	<2	0
Ethylbenzene	µg/L	2	<2	<2	0
meta- & para-xylene	µg/L	2	<2	<2	0
ortho-Xylene	µg/L	2	<2	<2	0
Total xylenes	µg/L	2	<2	<2	0
Sum of BTEX	µg/L	1	<1	<1	0
Naphthalene	µg/L	5	<5	<5	0

Notes: **bold** indicates an RPD value above 50%.
* Most probable number.

Attachment 4. Macroinvertebrate SIGNAL 2 Score Calculations

Table 1 – SIGNAL 2 Calculations for Site S3

Phylum	Class	Higher Taxa	Family Taxa	Lowest Identification Level	SIGNAL 2 Score	Abundance	Weight Factor	SIGNAL 2 x Weight Factor
Annelida	Clitellata	Oligochaeta	Unknown	Oligochaeta	2	3	2	4
Arthropoda	Malacostraca	Decapoda	Atyidae/Palaemonidae	Atyidae/Palaemonidae (Immature)	4	22	5	20
Arthropoda	Insecta	Hemiptera	Corixidae	Corixidae (Immature)	2	3	2	4
Arthropoda	Insecta	Hemiptera	Corixidae	*Micronecta* sp.	2	5	2	4
Arthropoda	Insecta	Hemiptera	Notonectidae	Notonectidae (Immature)	1	1	1	1
Arthropoda	Insecta	Hemiptera	Notonectidae	*Nychia* sp.	1	2	1	1
Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetidae (Immature)	5	76	5	25
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Cloeon* sp.	5	18	4	20
Arthropoda	Insecta	Ephemeroptera	Caenidae	Caenidae (Immature)	4	51	5	20
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Tasmanocoenis arcuata*	4	10	3	12
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Tasmanocoenis* sp 1	4	1	1	4
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	*Atalophlebia* sp.	8	2	1	8
Arthropoda	Insecta	Trichoptera	Leptoceridae	Leptoceridae (Immature)	6	6	3	18
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Laccophilus* sp. (Adult)	2	2	1	2
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Laccophilus* sp. (Larva)	2	1	1	2
Arthropoda	Insecta	Diptera	Chironomidae	Chironomidae Pupa	3	2	1	3
Arthropoda	Insecta	Odonata	Coenagrionidae	Coenagrionidae (Immature)	2	32	5	10
Arthropoda	Insecta	Odonata	Coenagrionidae	*Pseudagrion* sp.	2	3	2	4
Arthropoda	Insecta	Odonata	Corduliidae/Libellulidae	Corduliidae/Libellulidae (Immature)	5	29	5	25
Arthropoda	Insecta	Odonata	Austrocorduliidae	*Hesperocordulia berthoudi*	10	1	1	10
						TOTAL	62	197
						SIGNAL 2	3.2	

Table 2 – SIGNAL 2 Calculations for Site S5

Phylum	Class	Higher Taxa	Family Taxa	Lowest Identification Level	SIGNAL 2 Score	Abundance	Weight Factor	SIGNAL 2 x Weight Factor
Annelida	Clitellata	Oligochaeta	Unknown	Oligochaeta	2	2	1	2
Arthropoda	Insecta	Hemiptera	Veliidae	*Petrovelia* sp.	3	1	1	3
Arthropoda	Insecta	Hemiptera	Corixidae	Corixidae (Immature)	2	1	1	2
Arthropoda	Insecta	Ephemeroptera	Caenidae	Caenidae (Immature)	4	1	1	4
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodiinae - Chrionomidae	4	6	3	12
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae - Chrionomidae	3	1	1	3
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae - Chrionomidae	4	1	1	4
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogonidae	4	4	2	8
						TOTAL	12	38
						SIGNAL 2	3.2	

Table 3 – SIGNAL 2 Calculations for Site S6

Phylum	Class	Higher Taxa	Family Taxa	Lowest Identification Level	SIGNAL 2 Score	Abundance	Weight Factor	SIGNAL 2 x Weight Factor
Arthropoda	Insecta	Hemiptera	Gerridae	Gerridae (Immature)	4	3	2	8
Arthropoda	Insecta	Hemiptera	Gerridae	*Calyptobates jourama*	4	6	3	12
Arthropoda	Insecta	Hemiptera	Corixidae	Corixidae (Immature)	2	11	4	8
Arthropoda	Insecta	Hemiptera	Corixidae	*Micronecta* sp.	2	8	3	6
Arthropoda	Insecta	Hemiptera	Notonectidae	Notonectidae (Immature)	1	1	1	1
Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetidae (Immature)	5	12	4	20
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Cloeon* sp.	5	6	3	15
Arthropoda	Insecta	Ephemeroptera	Caenidae	Caenidae (Immature)	4	5	2	8
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Tasmanocoenis arcuata*	4	11	4	16
Arthropoda	Insecta	Trichoptera	Leptoceridae	Oecetis sp.	6	1	1	6
Arthropoda	Insecta	Coleoptera	Dytiscidae	Dytiscidae Larva (Immature)	2	2	1	2
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Hyphydrus elegans* (Adult)	2	1	1	2
Arthropoda	Insecta	Diptera	Chironomidae	Chironomidae Pupa	3	4	2	6
Arthropoda	Insecta	Diptera	Culicidae	Culicidae	1	1	1	1
Arthropoda	Insecta	Diptera	Tipulidae	Tipulidae	5	1	1	5
Arthropoda	Insecta	Odonata	Coenagrionidae	Coenagrionidae (Immature)	2	1	1	2
Arthropoda	Insecta	Odonata	Coenagrionidae	*Pseudagrion* sp.	2	3	2	4
						TOTAL	38	122
						SIGNAL 2	3.2	

Table 4 – SIGNAL 2 Calculations for Site S8

Phylum	Class	Higher Taxa	Family Taxa	Lowest Identification Level	SIGNAL 2 Score	Abundance	Weight Factor	SIGNAL 2 x Weight Factor
Arthropoda	Malacostraca	Decapoda	Atyidae	Atyidae (Immature)	3	1	1	3
Arthropoda	Insecta	Hemiptera	Veliidae	*Petrovelia* sp.	3	1	1	3
Arthropoda	Insecta	Hemiptera	Corixidae	Corixidae (Immature)	2	3	2	4
Arthropoda	Insecta	Hemiptera	Corixidae	*Micronecta* sp.	2	7	3	6
Arthropoda	Insecta	Hemiptera	Pleidae	*Paraplea brunni*	2	1	1	2
Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetidae (Immature)	5	1	1	5
Arthropoda	Insecta	Ephemeroptera	Caenidae	Caenidae (Immature)	4	56	5	20
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Tasmanocoenis arcuata*	4	8	3	12
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Tasmanocoenis* sp 1	4	3	2	8
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	*Atalophlebia* sp.	8	3	2	16
Arthropoda	Insecta	Trichoptera	Leptoceridae	Leptoceridae (Immature)	6	1	1	6
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Sternopriscus* sp. (Adult)	2	1	1	2
Arthropoda	Insecta	Coleoptera	Scirtidae	Scirtidae	6	1	1	6
Arthropoda	Insecta	Coleoptera	Hydrophilidae	*Hydrochus* sp.	2	3	2	4
Arthropoda	Insecta	Diptera	Chironomidae	Chironomidae Pupa	3	6	3	9
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodiinae - Chrionomidae	4	3	2	8
Arthropoda	Insecta	Diptera	Culicidae	Culicidae	1	1	1	1
						TOTAL	34	115
						SIGNAL 2	3.4	

Attachment 5.
List of Fish and Elasmobranchs with Potential to Occur in the Study Area

Table 1 – Fish and Elasmobranchs Known to or with Potential to Occur in the Study Area

Common Name	Scientific Name	Comment On Occurrence
Northern saratoga	*Scleropages jardinii*	Widely distributed in parts of the NT and northern Queensland
Oxeye herring	*Megalops cyprinoides*	Widely distributed in northern Australia, and known to the Margaret River catchment
Bony bream	*Nematalosa erebi*	Widely distributed in northern Australia (and the rest of Australia)
Highfin catfish	*Neoarius berneyi*	Patchy distribution, most commonly known from the southern and northern Gulf of Carpentaria region and western Cape York Peninsula, known to the neighbouring Daly River catchment
Blue catfish	*Neoarius graeffii*	Widely distributed throughout northern Australia
Boofhead catfish	*Neoarius leptaspis*	Widely distributed throughout northern Australia
Midgley's catfish	*Neoarius midgelyorum*	Restricted to a few rivers in the western drainages of northern Australia, including the neighbouring Daly River catchment and nearby areas
Toothless catfish	*Anodontiglanis dahli*	Uncommon, but widely distributed species found in most river systems of northern Australia
Hyrtl's catfish	*Neosilurus hyrtlii*	Recorded in the study area and widespread in northern Australia
Black catfish	*Neosilurus ater*	Recorded in the study area and widely distributed across northern Australia
Rendahl's catfish	*Porochilus rendahli*	Widely distributed across northern Australia
Obbe's catfish	*Porochilus obbesi*	Infrequently collected, but recorded in other tributaries of the Adelaide River
Freshwater longtom	*Strongylura kreffti*	Widely distributed across northern Australia
Flyspecked hardyhead	*Craterocephalus stercusmuscarum*	Widely distributed across northern Australia
Western rainbowfish	*Melanotaenia australis*	Widely distributed within drainages of the Timor Sea, known to the drainages to the south and west of the study area
Exquisite rainbowfish	*Melanotaenia exquisita*	Limited distribution in northern Australia but known to occur east of the study area
Blackbanded rainbowfish	*Melanotaenia nigrans*	Widespread in the north of the NT from Darwin east to Nhulunbuy
Eastern rainbowfish	*Melanotaenia splendida*	Recorded in the study area and widely distributed across northern Australian from the Adelaide River east

Table 1 – Fish and Elasmobranchs Known to or with Potential to Occur in the Study Area (cont'd)

Common Name	Scientific Name	Comment On Occurrence
Diamond mullet	*Liza ordensis*	Most common in drainages of the Timor Sea and known to the Daly River catchment and the lower reaches of the Adelaide River
Northwest glassfish	*Ambassis sp.*	Recorded in the study area and widely distributed across the Timor Sea and Gulf of Carpentaria drainages
Macleay's glassfish	*Ambassis macleayi*	Widely distributed across northern Australia
Pennyfish	*Denariusa bandata*	Occurs mostly in wetland habitats and is disjunctly distributed across northern Australia. There are records from nearby downstream environments of the study area
Barramundi	*Lates calcarifer*	Widely distributed throughout northern Australia
Barred grunter	*Amniataba percoides*	Extremely widespread throughout northern Australia
Spangled perch	*Leiopotherapon unicolor*	Recorded in the study area and the most widely distributed of Australia's freshwater fishes, found in perennial and intermittent streams and floodplain wetlands
Sooty grunter	*Hephaestus fuliginosus*	Widely distributed throughout northern Australia
Sharpnose grunter	*Syncomistes butleri*	Restricted to drainages of the Timor Sea, known to the Daly River catchment and other locations close to the study area
Mouth almighty	*Glossamia aprion*	Extremely widespread throughout northern Australia
Sevenspot archerfish	*Toxotes chatareus*	Extremely widespread throughout northern Australia
Primitive archerfish	*Toxotes lorentzi*	Restricted to a small number of basins within the Timor Sea drainage division, known to the Daly River catchment and the lowlands of the Adelaide River
Freshwater sole	*Brachirus selheimi*	Unlikely to occur in the study area, but known from downstream in the Adelaide River and in the Daly River catchment
Tailed sole/many-scaled sole	*Leptachirus darwinensis/polylepis*	Very limited distribution but known to the downstream Adelaide River and it's tributaries
Golden flathead goby	*Glossogobius aureus*	Widespread across northern Australia
Squareblotched goby	*Glossogobius munroi*	Unlikely to occur in the study area, widely, but patchily distributed across northern Australia, known to the neighbouring Mary River catchment to the northeast

Table 1 – Fish and Elasmobranchs Known to or with Potential to Occur in the Study Area (cont'd)

Common Name	Scientific Name	Comment On Occurrence
Empire gudgeon	*Hypseleotris compressa*	Widely distributed across northern Australia, mostly collected in the lower reaches of rivers within 100 km of the coast. Nearby records from a tributary of the Daly River
Northern trout gudgeon	*Mogurnda mogurnda*	Recorded in the study area, widely distributed and common across northern Australia
Sleepy cod	*Oxyeleotris lineolata*	Recorded in the study area, widely distributed across northern Australia
Blackbanded gudgeon	*Oxyeleotris selheimi*	Widely distributed across northern Australia and often found in the same locations as *O. lineolata*
Largetooth Sawfish	*Pristis pristis*	Potentially found in all large rivers of northern Australia from the Fitzroy River, Western Australia to the western side of Cape York Peninsula, Queensland, mainly confined to the main channels of large rivers. Juveniles found in freshwater (to around three to four years) while adults are found primarily in marine/estuarine environments
Northern river shark	*Glyphis garricki*	Distribution not well known, potential to occur across northern Australia from Fitzroy River, Western Australia to the Gove Peninsula in Northern Territory, previously recorded near the confluence of the Margaret and Adelaide rivers
Speartooth shark	*Glyphis glyphis*	Known only to tidal rivers and estuaries within the Northern Territory and Queensland and known to occur in the Adelaide River coastal floodplain

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