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CONSULTANTS

Ardmore Phosphate Project

Baseline Aquatic Ecology Survey - Wet
Season 2018

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prepared for

Centrex Phosphate Pty Ltd

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Executive Summary

Site conditions for the 2018 baseline survey

This report outlines the results of the 2018 baseline wet season receiving environmental monitoring program (REMP) conducted from 20 to 21 March 2018 within the Ardmore mining lease (ML5542). Three of the eleven monitoring sites contained surface water and one site contained sufficient water for macroinvertebrate sampling. Two sites with small pools deep enough for surface water sampling were located on Split Creek, while macroinvertebrate samples were taken from a tributary thereof.

Surface water quality

Water quality was only sampled at three sites; all others were dry. Sites sampled during the 2018 wet season baseline survey showed some exceedances of published guideline values; however, the water was of good quality. Dissolved oxygen was expectedly low at all sites as a result of stagnation. Nitrates and nitrites were below the limit of reporting (LOR) at all sites. Filterable reactive phosphorus was present in low concentrations in surface water, likely due to the naturally high phosphate content in bedrock in the upper reaches of some streams.

Metal concentrations were generally below the LOR; however, in the case of uranium the LOR was higher than the guideline value. While this was flagged as an exceedance, uranium concentrations were still below the LOR. The only actual exceedance of guideline values was for total aluminium, which exceeded the ANZECC (2000) guideline value at ARD5. This isolated result is likely caused by minor point-source pollution upstream but should be monitored in future surveys.

Stream sediment quality

There were no exceedances above guideline values for the whole sediment fraction at any site during the current survey. The fine fraction sediments lack guideline values; therefore, downstream concentrations were compared to upstream sites. Total Kjeldahl phosphorus levels were very high at some sites, likely indicative of erosion of phosphate-rich minerals upstream, and thus indicative of natural processes at Ardmore. Concentrations of water soluble phosphorous (orthophosphate), which represent the reactive component of phosphorus implicated in eutrophication, were comparatively very low. Future interpretation of results will therefore be based on temporal and spatial trends with respect to mining infrastructure.

Aquatic macroinvertebrate assemblage analysis

Macroinvertebrates were only sampled at one site during the 2018 wet season survey. Site ARD5, on a tributary of Split Creek, contained sufficient water for macroinvertebrate sampling. The habitat score attributed to this site was 90, which is interpreted as 'good'; however, the

macroinvertebrate assemblage was poor in richness and composition. No sensitive or PET taxa were recorded and only eight taxa were present in samples. The depauperate macroinvertebrate assemblage can likely be attributed to the highly ephemeral nature of the watercourses at Ardmore—very little time is available for macroinvertebrates to establish before pools dry up. High nitrogen and phosphorus levels are unlikely to have affected the species composition as the majority of these were in non-reactive forms, and thus not contaminants. Continued monitoring of the same sites over time will provide more robust results and allow for comparisons.

Introduction

1. Background

The Ardmore Phosphate Project is a high-grade phosphate rock deposit located 128km south of the City of Mount Isa in North West Queensland. Centrex Phosphate Pty Ltd contracted Northern Resource Consultants Pty Limited (NRC) to conduct a baseline aquatic ecology survey as part of a suite of environmental studies to support environmental approvals for development of the Mining Lease (ML)5542. The baseline aquatic ecology survey within the proposed Ardmore project area involves the sampling of aquatic macroinvertebrates, surface water and stream sediments at 11 sites to assess stream health. This survey obtained baseline data on the current physical, chemical and biological conditions of waterways within the proposed project area. The dataset is of specific relevance to the development of a receiving environment monitoring program (REMP) during the construction and operation phases of the project and provides important baseline data in that regard.

2. Baseline survey

2.1 Objectives

The objective of this technical report was to establish and assess baseline data for the receiving environment of the proposed Ardmore Phosphate Project obtained during the 2018 baseline survey.

The objective of this aquatic ecology survey was to determine the current condition of aquatic ecosystems within the proposed receiving environment by assessing aquatic macroinvertebrate assemblages, in conjunction with surface water and stream sediment quality results.

To achieve the objectives of this survey, aquatic macroinvertebrate, surface water and stream sediment samples were collected from 11 sites at Ardmore during the 2018 baseline survey.

2.2 Climate

Ardmore is located in the Northwest Highlands Bioregion of Queensland, which is characterised by hot summers and mild winters. Meteorological data is available for a number of weather stations in the area. Long-term and recent rainfall data were sourced from The Monument Airport Station (station number 037034), approximately 66km from Ardmore.

The Northwest Highlands region typically experiences short, intense rainfall events that primarily occur in the wet season, from October to March (Bureau of Meteorology [BoM], 2018, Figure 1). Annual wet season rainfall can vary significantly, as shown in Figure 1, which depicts the high variability of precipitation since 2001. Mean annual wet season precipitation over this period is 245mm and mean dry season precipitation is 57mm. Over the 2017/2018 wet season, the

Ardmore region received 304mm of precipitation, which was slightly above the average annual wet season precipitation recorded for The Monument Airport Station (Figure 2). The majority of wet season rain fell during March, which recorded the highest monthly rainfall in the 17 years recorded at The Monument. A notable rainfall event of 104.4mm occurred over a 24-hour period on 3 March 2018. This rainfall event resulted in flow events for the waterways within the project area and instigated the 2018 baseline survey.

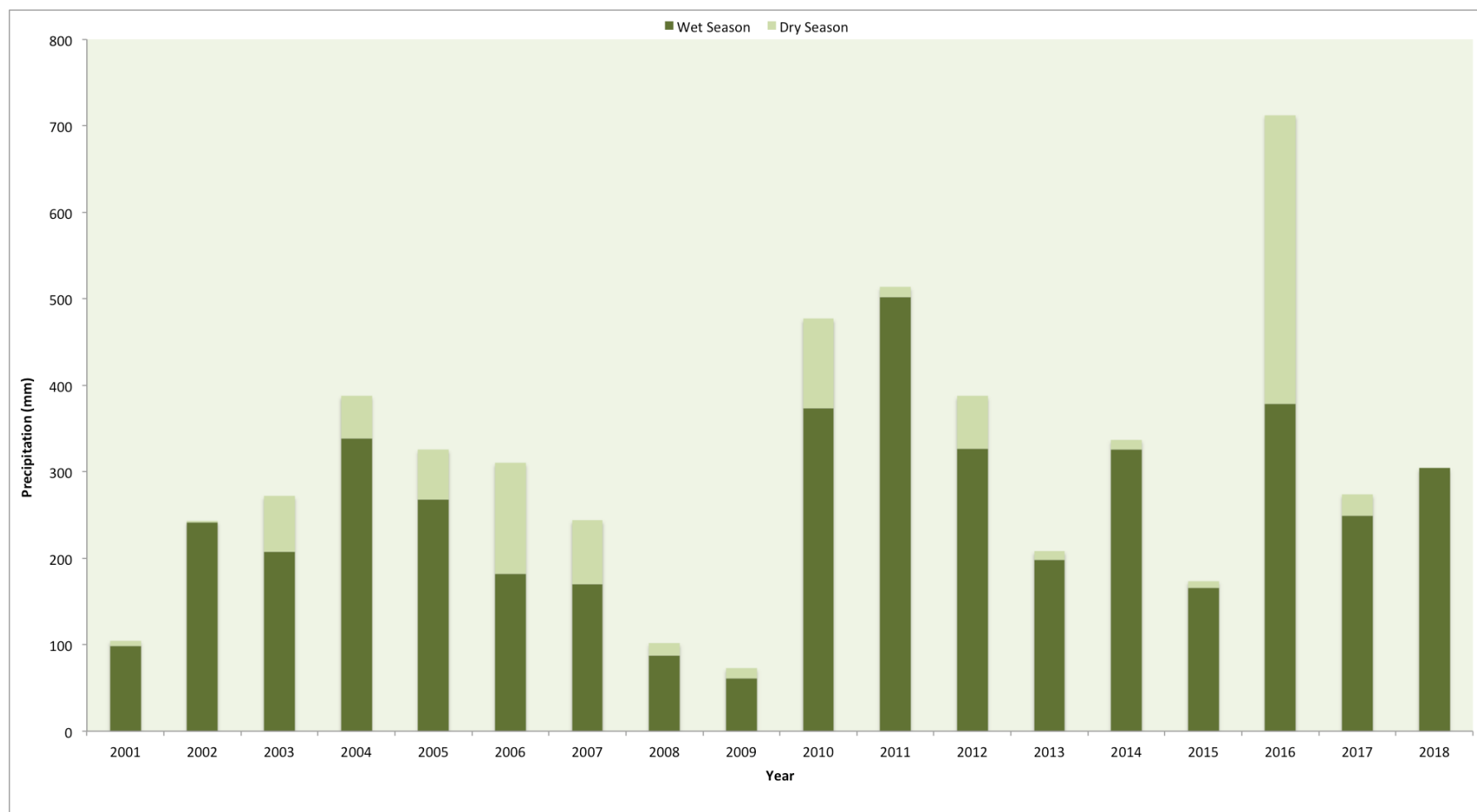


Figure 1: Annual precipitation (2001–2018) divided between wet and dry season records from The Monument airport weather station (BoM, 2018)

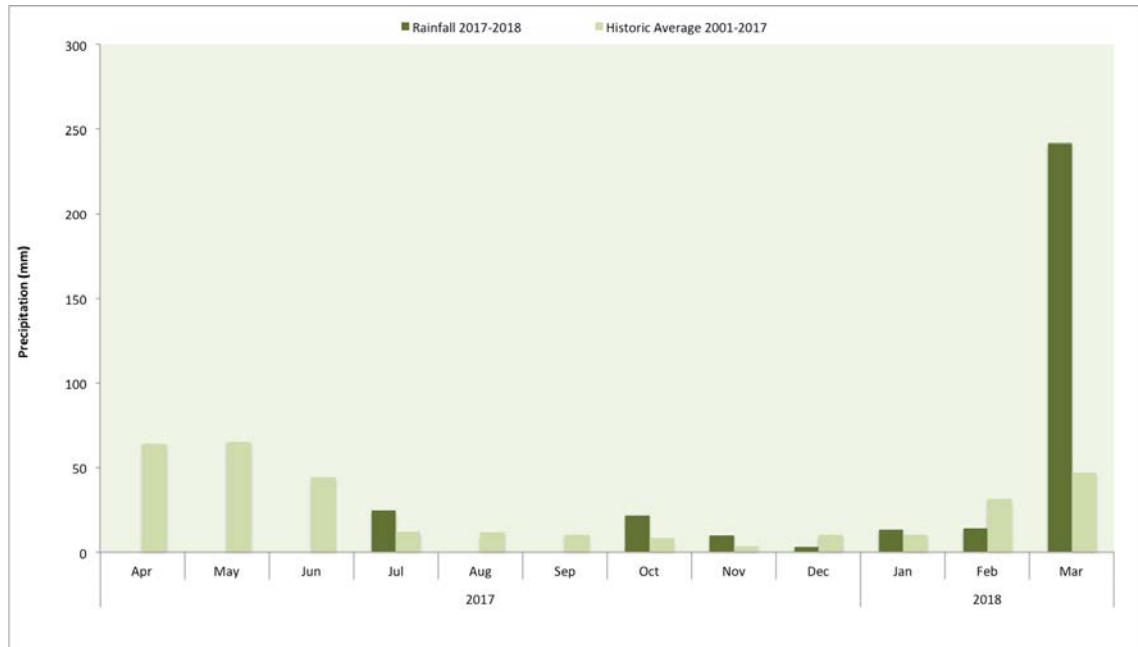


Figure 2: Mean monthly and current precipitation recorded from The Monument airport weather station from 2001 to 2017 (BoM, 2018)

2.3 Description of receiving waters

The proposed Ardmore project area is located in northwest Queensland, approximately 128km south of Mount Isa. The average elevation of the landscape is approximately 320m above sea level with the surrounding area characterised by flat terrain interspersed by limestone mesas. Watercourses are generally shallow, wide and highly ephemeral, with sandy beds.

Ardmore is intersected by one major watercourse, Split Creek, which flows east to west through the site and eventually feeds into the Georgina River. The majority of smaller creeks on the Ardmore ML are tributaries of Split Creek; however, two other catchment areas fall within the site. One of these is the Sulieman Creek catchment, of which one tributary occurs on the southern end of the site. Sulieman Creek feeds south into the Burke River. The other is the Horse Creek catchment, tributaries of which occupy the northeastern corner of the site. Horse Creek is a tributary of Briar Creek that, via Jayah and Moonah Creeks, feeds into Georgina River near the Split Creek confluence.

The Burke River flows into Eyre Creek, which is a tributary of the Georgina River. During significant rainfall events across its catchment, the Georgina River flows into Lake Eyre.

Methodology

1. Baseline 2018 sampling event

Sampling was conducted after the first flush event for the 2018 wet season, which occurred on 3 March 2018. Sampling was conducted three weeks after the flush event, from 20 to 21 March 2018. During this time, streams had ceased to flow and were either dry or reduced to pools. These pools created suitable habitat for macroinvertebrates. At the time of sampling, one of the sampling sites at Ardmore contained enough water for macroinvertebrate sweep sampling (described below).

2. Sample sites

The sites sampled during the 2018 baseline survey are depicted in the monitoring locations map in Appendix A and described in Table 1. Survey site descriptions, habitat assessments, sketches and datasheets have been compiled and are provided in Appendix B.

Table 1: Aquatic ecology monitoring locations for the baseline 2018 survey

SITE	STREAM	DESCRIPTION	EASTING	NORTHING
ARD1	Horse Creek	On Horse Creek, 600m downstream of a cattle dam.	320382	7604247
ARD2	Split Creek	On a tributary of Split Creek, 70m upstream of the access track.	322245	7601917
ARD3	Split Creek	On a tributary of Split Creek, 600m downstream of ARD2.	322157	7601318
ARD4	Split Creek	Upstream site on Split Creek, immediately upstream of a large tributary.	323350	7601159
ARD5	Split Creek	On a tributary of Split Creek immediately upstream of its confluence. Tributary merges with Split Creek 900m downstream of ARD4.	322481	7601085
ARD6	Split Creek	On Split Creek, downstream of the tributaries represented by ARD2/ARD3 and ARD7/ARD5, 1.4km downstream of ARD4.	321953	7601163
ARD7	Split Creek	On a tributary of Split Creek, approximately 5.5km upstream of its confluence with Split Creek. The confluence is 1.8km downstream of ARD6.	323598	7597905
ARD8	Split Creek	On a tributary of Split Creek that meets the tributary containing ARD7 prior to joining Split Creek.	322180	7597254
ARD9	Split Creek	On a tributary of Split Creek, 1.6km upstream of ARD8.	321935	7595807
ARD10	Sulieman Creek	On a tributary of Sulieman Creek, downstream of potential mining impacts.	324497	7594684
ARD11	Sulieman Creek	On a tributary of Sulieman Creek, upstream of potential mining impacts and 1.1km upstream of ARD10.	323577	7594287

Coordinates provided in GDA94, 55K

3. Surface water quality

3.1 Field collection

Field collection of surface water was conducted in accordance with the Monitoring and Sampling Manual 2009 (Department of Environment and Heritage Protection [EHP], 2009a). *In-situ* physico-chemical water quality data was recorded for each sample site, where sufficient water was available. Water temperature, pH, electrical conductivity (EC), dissolved oxygen (DO) and turbidity were recorded using a multi-parameter water quality meter, according to the manufacturer's specifications.

Sampling methods followed those outlined in the Monitoring and Sampling Manual 2009 (EHP, 2009a) and are summarised below:

1. Operators familiarised themselves with site locations and issues relating to sampling prior to the sampling event.
2. Photographs were taken of each site, facing upstream and downstream.
3. An *in-situ* use water quality meter was used to take field physico-chemical parameters, and was used according to the manufacturer's instructions, while also ensuring the meter was properly maintained and calibrated.
4. When wading into the water, substrate disturbance was kept to a minimum.
5. Operators stood at the sample location and submerged the water quality meter into the water, in an upstream direction.
6. Operators waited until physico-chemical parameters stabilised. These data were recorded on the field datasheet.

Water quality samples were taken at the same time as the *in-situ* measurements and sent to the laboratory for processing of further water quality information. Water samples were taken directly from the water column while wearing clean disposable gloves, facing upstream, in sample containers provided by NATA accredited laboratory, SGS Australia Pty Ltd (SGS). Field filtered water samples were collected for dissolved metals using 0.45µm polyethersulfone filters. Samples were placed on ice for preservation, until received by the SGS laboratory in Cairns.

3.2 Laboratory analysis

The water samples were analysed by the SGS NATA accredited laboratory in Cairns for pH and EC, total suspended solids, major cations and anions, water hardness (as calcium carbonate), calcium, magnesium, sodium, potassium, sulfate, fluoride, alkalinity, total Kjeldahl nitrogen (TKN), nitrates/nitrites, total Kjeldahl phosphorous (TKP), filterable reactive phosphorous (FRP), and total and dissolved metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, nickel, uranium, zinc and mercury). A copy of the chain of custody form, laboratory receipt and analytical report can be found in Appendices G, H and I, respectively.

3.3 Guideline values

Water quality data were compared to guideline values to assess water quality at each site and to assist in the interpretation of macroinvertebrate results. Water quality data from the baseline 2018 REMP were compared to the following guidelines:

- QWQG EC percentiles for Queensland Salinity Zones (Table G.1 – 75th rateable percentile for the Lake Eyre system; EHP, 2009b),
- Australian and New Zealand Environmental Conservation Council (ANZECC, 2000) trigger values for heavy metals (recognised as toxicants in ANZECC) for the protection of slightly to moderately disturbed systems (95% protection for aquatic organisms),
- Australian and New Zealand Environmental Conservation Council (ANZECC, 2000) default trigger values for physico-chemical parameters, as no QWQG values currently exist for the Lake Eyre region,
- ANZECC low reliability trigger values for heavy metals that do not have a recognised trigger value for protection of aquatic ecosystems in Australia (ANZECC, 2000).

Where concentrations were elevated above ANZECC (2000) guideline values, hardness modified trigger values (HMTVs) were calculated where applicable as per Table 3.4.3 in ANZECC (2000). Comparison of water quality data against HMTVs can provide a more accurate indication of the bioavailable metal concentration, as the toxicity of some metals is influenced by water hardness. HMTVs can be calculated for cadmium, chromium, copper, lead, nickel and zinc.

Analysis of toxicants in aquatic ecosystems is focused on interpretation of dissolved metal concentrations. Dissolved metal concentrations are considered more pertinent to the management of water quality as they are more bioavailable to uptake by organisms; therefore, emphasis was given to comparison of dissolved heavy metals in water samples (ANZECC, 2000).

3.4 Quality assurance for surface water

For the purpose of quality assurance, a duplicate water sample was collected from one site to confirm the analytical reliability of laboratory results (site ARD4). This sample was collected following the same methodology as above; however, duplicate sample bottles were labelled QA to ensure the laboratory did not know which site was used for the quality assurance samples. The quality assurance site was recorded on the field datasheet.

Interpretation was based on the reproducibility assessment method, which provides a measure of precision. The analytical values from the sample and its replicate are compared by calculating the relative per cent difference (RPD) for each parameter as follows:

$$RPD (\%) = \frac{[X]_{sample} - [X]_{replicate}}{[X]_{mean \text{ of sample and replicate}}} \times 100$$

The RPD then uses the limit of reporting (LOR) to identify thresholds for valid reproducibility. These include:

- Mean of sample and replicate $<10\times$ LOR: There is no RPD limit (i.e. reproducibility is valid).
- $10\times$ LOR $<$ Mean of sample and replicate $<20\times$ LOR: The RPD range limit is 0%–50% for a valid duplicate.
- Mean of sample and replicate $>20\times$ LOR: The RPD range limit is 0%–20% for a valid duplicate.

A blank water sample was also taken to confirm that contamination was not introduced during field handling. Results of the quality assurance and blank water sample analyses are provided in Appendix F of this report.

4. Stream sediment quality

4.1 Field collection

Field collection of stream sediments was completed in accordance with the sediment quality assessment guidelines outlined in Simpson *et al.* (2005) and the Australian Standard (AS/NZS 5667.12:1999) for *Surface Water Sampling*. Stream sediment samples were collected from the streambed at each monitoring site and analysed in the laboratory for physical and chemical properties. Surface sediments were taken from the top 10cm, where most biological activity occurs (Simpson *et al.*, 2005) and composite samples taken along a streambed length of 10m using a hand trowel. Approximately 500g of sediment was taken from each site. The composite sample was mixed and collected into a sediment sample bag. The potential for cross contamination between sample sites was minimised by the cleaning of sampling equipment with deionised water and sample site water between each site.

4.2 Laboratory analysis

Stream sediment samples were analysed by SGS for chemical and physical properties. Chemical analyses were undertaken on nitrites, nitrates, TKN, nitrates/nitrites, water-soluble phosphorous (WSP), TKP, and the whole ($<2\text{mm}$) and fine ($<63\mu\text{m}$) sediment fractions for arsenic, cadmium, chromium, copper, lead, nickel, silver, zinc and mercury. The particle size distribution was determined for each sample to describe the proportions of stream sediments that occur across the sediment size classes (Table 2). The particle size distribution at each site was used to interpret the potential effects of contaminants on aquatic organisms. The fine sediment fraction represents the most bioavailable component of the stream sediments and analysis of the fine sediment fraction is considered the most accurate representation of materials that are likely to be ingested by aquatic organisms (Minshall, 1984; Simpson *et al.*, 2013). A copy of the chain of custody form, laboratory receipt and analytical report can be found in Appendices G, H and I, respectively.

Table 2: Sediment fraction size ranges for particle size distribution

SIZE CLASS	FRACTION SIZE RANGE
Gravel	>2mm
Coarse sand	600µm–2mm
Large medium sand	300– 600µm
Small medium sand	212–300µm
Fine sand	63–212µm
Silt and clay	<63µm (fine fraction for metals analysis)

Guideline values

Chemical results were compared to relevant sediment quality guidelines to provide an indication of sediment quality at the time of sampling. Results were compared to Interim Sediment Quality Guidelines (ISQG) (ANZECC, 2000; updated by Simpson *et al.*, 2008) for the whole (<2mm) sediment fraction. Two ISQG values were used for interpretation of sediment quality: ISQG-low and ISQG-high. The ISQG-low values are considered trigger values and concentrations of contaminants below this value are expected to cause a very low frequency of adverse biological effects. All concentrations above the ISQG-low trigger values were reported as exceedances. The ISQG-high value represents a concentration above which adverse biological effects are expected to occur more frequently. Where exceedances occurred, this value was used to interpret the likelihood that the observed concentrations would cause biological harm. ISQG-low and ISQG-high values correspond to the effects range low and median values outlined in Long *et al.* (1995).

Since fine sediments are considered more bio-available to aquatic macroinvertebrates, analysis of toxicants focussed primarily on the fine sediment fraction. There are no published guidelines for the fine fraction sediment; therefore, the results of downstream sites were compared to upstream site values.

4.3 Quality assurance for stream sediment

For the purpose of quality assurance, a duplicate sediment sample was collected from one site to confirm analytical reliability of laboratory results (site ARD4). The QA sediment was collected in the usual manner, except approximately 1kg of sediment was collected, mixed thoroughly, one of the corners of the sample bag was cut and the sediment was poured into a cone shape on clean paper, flattened and divided into quarters with a clean trowel. The top left and bottom right quarters were extracted into a clean sediment bag and labelled with the site name, while the top right and bottom left quarters were extracted into a clean sediment bag and labelled 'QA'. The quality assurance site was recorded on the field datasheet. Results were interpreted using the reproducibility assessment method as described in Section 3.4. Results of the quality assurance analyses are provided in Appendix F.

5. Aquatic macroinvertebrates

Macroinvertebrates are organisms that lack a backbone (invertebrate) and can easily be seen with the naked eye (macro). These animals include insects, crustaceans, molluscs, arachnids and annelids. They inhabit all types of running waters for all or part of their lives and their survival is related to the quality of the water they inhabit. Aquatic macroinvertebrates are easily sampled due to their limited functional mobility and are typically used to provide an integrated measure of stream health in favour of other aquatic organisms. Macroinvertebrate assemblages may be influenced by the quality of the surrounding habitat at sampling sites (Connolly *et al.*, 2007). An integrated approach considering habitat quality in conjunction with macroinvertebrate indices is therefore the most robust method for assessing macroinvertebrate assemblages and stream health. The sections below outline the methodology used to assess habitat quality and calculate macroinvertebrate indices for this report.

5.1 Stream and habitat assessment

At each site, a stream assessment was undertaken prior to sampling of sites to determine the most suitable location for macroinvertebrate sampling. Habitat characteristics at sampling sites may have a strong influence on the quality of the water resource and the condition of the resident aquatic macroinvertebrates. To determine the influence of physical habitat structure on assemblage structure and macroinvertebrate indices, a habitat assessment was undertaken at all sites containing sufficient water for macroinvertebrate sampling (Table 3). This assessment considers the variety and quality of the substrate, channel morphology, bank structure and riparian vegetation. Individual scores are given to each habitat variable and summed to calculate the overall habitat assessment score. Habitat assessment scores are given out of a maximum score of 135 and divided into four habitat categories: poor, fair, good and excellent, based on Department of Natural Resources and Mines (DNRM, 2001) methodology. A high score indicates a stream with a complex habitat structure typically favoured by aquatic macroinvertebrates, while a low score represents a very simple unfavourable stream habitat (Table 4). This information, used in conjunction with water quality and stream sediment quality results, can help interpret aquatic macroinvertebrate results.

Table 3: Variables evaluated and scoring systems for the habitat assessment

HABITAT VARIABLE	CATEGORY			
	Excellent	Good	Fair	Poor
1. Bottom substrate/ available cover	Greater than 50% rubble, gravel, submerged logs, undercut banks or other stable habitat.	30–50% rubble, gravel or other stable habitat.	10–30% rubble, gravel, or other stable habitat. Habitat availability less than desirable.	Less than 10% rubble, gravel or stable habitat. Lack of habitat is obvious.
	20, 19, 18, 17, 16	15, 14, 13, 12, 11	10, 9, 8, 7, 6	5, 4, 3, 2, 1

HABITAT	CATEGORY			
2. Embeddedness	Gravel, cobble and boulder particles are between 0% and 25% surrounded by fine sediment.	Gravel, cobble and boulder particles are between 25% and 50% surrounded by fine sediment.	Gravel, cobble and boulder particles are between 50% and 75% surrounded by fine sediment.	Gravel, cobble and boulder particles are between 75% and 100% surrounded by fine sediment.
	20, 19, 18, 17, 16	15, 14, 13, 12, 11	10, 9, 8, 7, 6	5, 4, 3, 2, 1
3. Velocity/depth category	Slow deep (<0.3m/s & >0.5m/s), slow shallow, fast deep, fast shallow, habitats all present.	Only 3 of the 4 habitat categories present (missing riffles/runs receive lower score).	Only 2 of the 4 habitat categories present (missing riffles/runs receive lower score).	Dominating by one velocity/depth category (usually pool).
	20, 19, 18, 17, 16	15, 14, 13, 12, 11	10, 9, 8, 7, 6	5, 4, 3, 2, 1
4. Channel alteration	Little or no enlargement of islands or point bars and/or no channelisation.	Some new increase in bar formation mostly from coarse gravel, and/or some channelisation present.	Moderate deposition of new gravel, coarse sand on old and new bars, pools partly filled with silt, and/or embankments on both banks.	Heavy deposits of fine materials increased bar development, most pools filled with silt, and/or extensive channelisation.
	15, 14, 13, 12	11, 10, 9, 8	7, 6, 5, 4	3, 2, 1, 0
5. Bottom scouring and deposition	Less than 5% of the bottom affected by scouring and deposition.	5–30% affected. Scours at constrictions and where grades steepen, some deposition in pools.	30–50% affected. Deposits and scours at obstructions and bends. Some deposition in pools.	More than 50% of the bottom changing nearly year long. Pools almost absent due to deposition. Only large rocks in riffle exposed.
	15, 14, 13, 12	11, 10, 9, 8	7, 6, 5, 4	3, 2, 1, 0
6. Pool/riffle, run/band ratio	0–7 Variety of habitat. Deep riffles and pools.	7–15 Adequate depth in pools and riffles. Bends provide habitat.	15–25 Occasional riffle/bend. Bottom contours provide habitat.	>25 Essentially a straight stream. All flat water. Poor habitat.
	15, 14, 13, 12	11, 10, 9, 8	7, 6, 5, 4	3, 2, 1, 0

HABITAT	CATEGORY			
7. Bank stability	Stable, no evidence of erosion or bank failure. Side slopes generally <30%. Little potential for future problem.	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes to 40% on bank.	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes to 60% on banks.	Unstable. Many eroded areas. Side slopes >60% common. 'Raw' areas frequent along straight sections and bends.
	10, 9	8, 7, 6	5, 4, 3	2, 1, 0
8. Bank vegetative stability	Over 80% of the streambank surfaces covered by vegetation or boulders and cobble.	50–79% of the streambank surfaces covered by vegetation, gravel or larger material.	25–49% of the streambank covered by vegetation, gravel or larger material.	<35% of the streambank surfaces covered by vegetation, gravel or larger material.
	10, 9	8, 7, 6	5, 4, 3	2, 1, 0
9. Streamside cover	Dominant vegetation is of tree form.	Dominant vegetation is shrub.	Dominant vegetation is grass, sedge, ferns.	>50% stream bank = no vegetation.
	10, 9	8, 7, 6	5, 4, 3	2, 1, 0

Table 4: Key to AusRivAS habitat assessment scores (DNRM, 2001)

HABITAT ASSESSMENT SCORE	INTERPRETATION
0–35	Habitat quality is poor There is limited availability for in-stream habitat. There is little variation in velocity and depth of water, and the creek bed is dominated by fine sediment types. The water body typically consists of a small, shallow pool. Streamside vegetation, if present, consists of grasses and sedges. There is moderate to significant bank erosion.
36–70	Habitat quality is fair There is some availability of rubble, gravel or other stable habitat. The streamside vegetation consists mainly of grasses and sedges. There is moderate evidence of bank erosion and the percentage of vegetation cover on banks is less than 50 per cent.

HABITAT ASSESSMENT SCORE	INTERPRETATION
71–105	Habitat quality is good The bank is moderately stable, there is variety in depth and velocity categories within the water body, and the substrate type is variable and tending towards gravel, cobble and boulders. Streamside vegetation dominated by shrubs, adding to bank stability. The percentage of streamside cover of vegetation is between 50% and 79%.
106–135	Habitat quality is excellent There is no bank erosion and the dominant vegetation is in the tree form. There is great variability in depth and velocity, and the habitat is relatively complex, offering favourable conditions for macroinvertebrates. Habitat usually contains submerged logs, undercut banks or other stable habitat.

5.2 Field collection

Approach

AusRivAS standardised assessments in Queensland use bed and edge habitat of streams to monitor freshwater macroinvertebrates (DNRM, 2001). However, in ephemeral streams, edge habitat is typically unavailable or only available for short periods of time at the peak of the wet season. To overcome a number of obstacles relating to the use of this AusRivAS sampling methodology in north Queensland stream environments, NRC implements an alternative methodology using replicate bed samples.

Two replicate kick samples within bed habitats were collected from each site where sufficient water was present. Sampling within a bed habitat requires disturbance of the substratum by kicking with the feet. If the stream is flowing, the net is held downstream with the mouth facing the disturbed area. If there is no flow, a short sweeping action of the net is used to capture any macroinvertebrates that have been disturbed from the substrate. The suspended benthic animals are captured as the net sweeps through the cloud of suspended matter.

Aquatic macroinvertebrates were collected from each site and were live picked in the field by appropriately trained personnel. Samples were collected using the following methods:

1. Each site was located using GPS and the coordinates provided.
2. Each site was photographed (upstream and downstream).
3. Water and stream sediment samples were collected following the methodology provided within the relevant sections of this report.
4. Aquatic macroinvertebrate samples were taken from two bed locations, keeping samples separate. Each kick sample was undertaken for two minutes over a length of 10m, keeping the net (250µm mesh aperture) downstream of the plume to collect dislodged macroinvertebrates.

5. The material collected from each kick sample was emptied into separate white sorting trays.
6. The two macroinvertebrate samples were live picked in the field for at least 30 minutes. Samples were transferred from the sorting trays to a solution of 100% ethanol.
7. For quality assurance purposes, the residuals of two bed samples at one site were collected after live picking and placed in 100% ethanol for validation of the sampling to quantify any missed taxa.
8. The rapid biophysical assessment datasheets were completed for each of the two bed habitats sampled at each site and included data such as water depth, substrate composition, flow, occurrence of overhanging and trailing riparian vegetation, along with longitudinal and cross-section diagrams taken of the 100m stream reach. This information assists with interpretation of macroinvertebrate assemblage post laboratory identification.
9. All macroinvertebrate and quality assurance samples were sent to Benthic Australia Pty Ltd for identification to appropriate taxa level.

Quality assurance

The quality assurance process for aquatic macroinvertebrate sampling includes taking residual samples from the live picking tray of each sampler. Residual samples contain the macroinvertebrate kick sample material remaining in each tray at the end of live picking. For the 2018 baseline survey, these residual samples were taken at site ARD5. The residual samples were assessed by qualified staff at Benthic Australia Pty Ltd, with all macroinvertebrates present recorded. This process was used to verify the live picking capability of each operator and the likelihood of errors generated. Results of the residual analyses are provided in Appendix F.

5.3 Data analysis

Macroinvertebrate indices

Guidelines for assessment of macroinvertebrate assemblages in Queensland are based on several sensitivity indices, which are outlined in Table 5. Comparison of indices between sites and years can provide an indication of stream health; however, differences in habitat characteristics amongst sites should be considered when interpreting indices. To limit interpretational errors based on the sole use of a particular index, a variety of indices were calculated for each macroinvertebrate sample and considered in conjunction with habitat scores. These indices were used to interpret macroinvertebrate results from the 2018 baseline survey.

Table 5: Overview of indices used to assess macroinvertebrate assemblages

INDEX	DESCRIPTION
Taxa richness	Taxa richness is the number of aquatic macroinvertebrate taxa collected within a sample. Changes in taxa richness are likely the result of some change in the condition of a site or some change from reference condition.
PET taxa richness	PET taxa richness refers to the number of taxa of Plecoptera (Stoneflies), Ephemeroptera (Mayflies) and Trichoptera (Caddisflies) taxa within a sample. These three orders of insects are considered sensitive to changes in their environment, and therefore PET taxa richness can be used as an indication of stream health.
% Sensitive/ tolerant taxa	The relative percentage of tolerant and sensitive taxa within a sample can be an indication of water quality. Taxa are categorized as sensitive if they have a sensitivity grade of 8–10, and tolerant if they have a sensitivity grade of 1–3 (EHP, 2009b). Taxa with a sensitivity grade of 4–7 are considered neither tolerant nor sensitive. The percentages of tolerant and sensitive taxa were calculated for each macroinvertebrate assemblage at each site.
SIGNAL 2 Scores	<p>The SIGNAL (Stream Invertebrate Grade Number - Average Level) score can be used as an indicator of water quality (Chessman, 2003; EHP, 2009b). Each macroinvertebrate family has been allocated a sensitivity grade based on relative sensitivity to pollutants and other physico-chemical factors. SIGNAL scores were calculated by taking the average sensitivity scores of taxa present within a sample, and weighting this by the abundance of each taxon using a weight factor as follows:</p> $\frac{\sum (\text{SIGNAL grade} \times \text{weight factor})}{\text{total weight factor}}$ <p>Further information on the calculation of SIGNAL 2 scores (weighted for abundance) can be found in Chessman (2003).</p>

Guideline values

Aquatic macroinvertebrates have been used throughout Australia to biologically assess stream health. Department of Environment and Science (DES) guidelines for macroinvertebrate assessments are still in their developmental stages for a number of regions within Queensland. Ardmore is located within the Lake Eyre region, for which macroinvertebrate assemblage guideline values are not available. Methodologies within the *SIGNAL 2 scoring system for macroinvertebrates (water bugs) in Australian Waters* (Chessman, 2003) have been used to analyse and interpret the results of the 2018 baseline survey.

Statistical analysis

As only one site contained sufficient water for macroinvertebrate sampling, comparative analyses of macroinvertebrate assemblage indices were not undertaken.

Results

1. Surface water quality

Three of the eleven sites visited had sufficient water for surface water sampling, two on Split Creek and a third on one of its tributaries. Surface water quality results from *in-situ* sampling and laboratory analysis are provided in Appendix C and are compared to the most relevant published guidelines.

Physico-chemical parameters

The following surface water results were noted for sites on Split Creek:

- pH was above the ANZECC (2000) guideline range at ARD4.
- EC was above the QWQG salinity guideline at ARD4.
- DO was below ANZECC (2000) guideline range at all of the three sites sampled.
- FRP was above the ANZECC (2000) guideline at all of the three sites sampled.

Metals

The following metals exceeded ANZECC (2000) guideline values:

- Total aluminium concentration was elevated above the ANZECC (2000) guideline value at ARD5.
- Total and dissolved uranium concentrations were below the LOR at all sites; however, the LOR was higher than the relevant guideline value.

All other physico-chemical parameters and metal concentrations were below published guideline values.

2. Stream sediment quality

2.1 Particle size distribution

Sediment at most sites was dominated by coarse and large-medium sand (300µm–2mm), with these fractions on average accounting for two thirds (67%) of stream sediment (Figure 3). With the exception of ARD10, fine fraction sediment (<63µm) represented less than 10% of the sediment at each site.

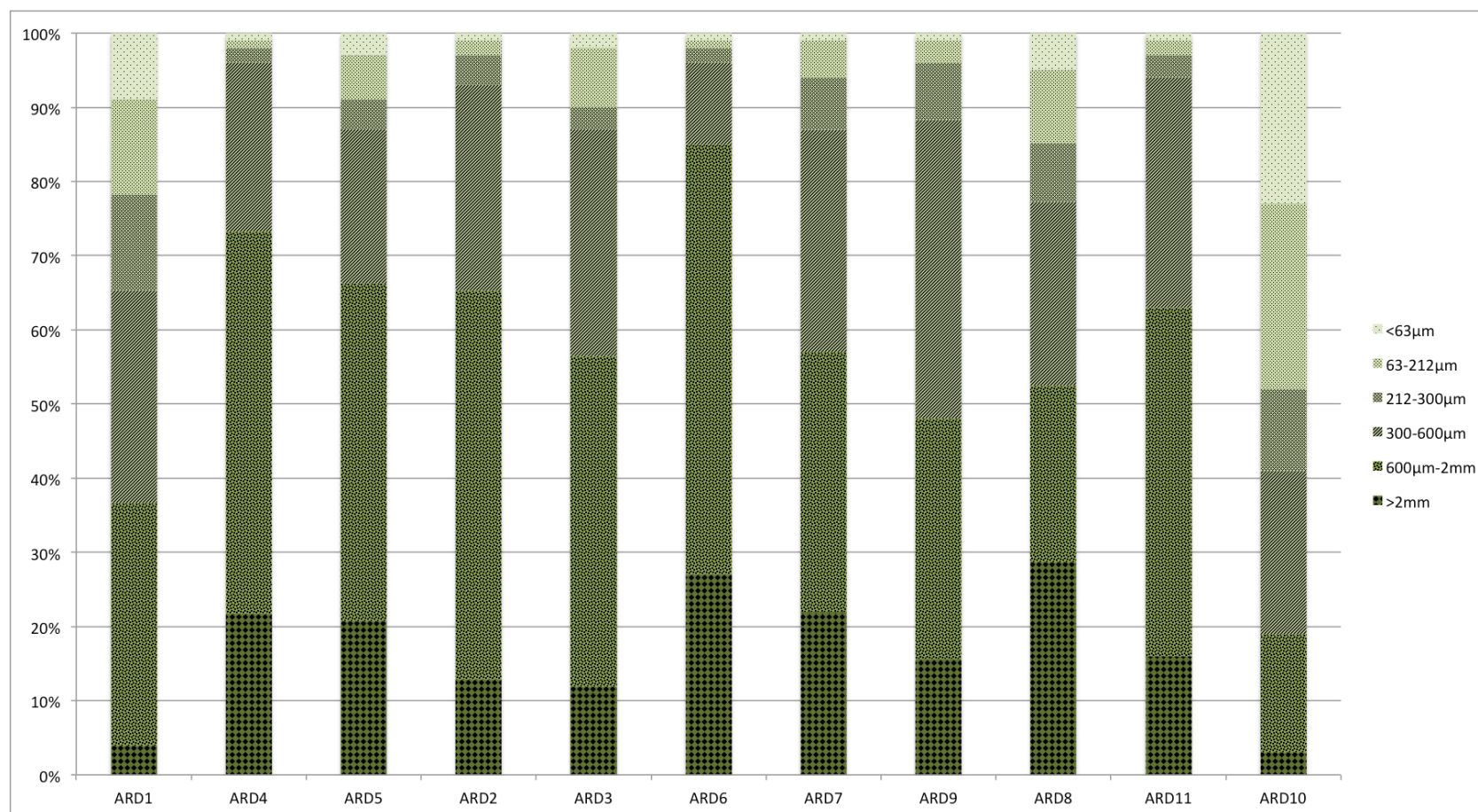


Figure 3: Particle size distribution of stream sediments at Ardmore REMP sites

2.2 Metal analysis

Laboratory results of stream sediment quality are provided in Appendix D and are compared to ANZECC (2000) ISQG trigger values for the whole (<2mm) sediment fraction. There were no instances where metals exceeded guideline values; however, concentrations of some metals varied considerably between sites.

2.3 Nitrogen and phosphorus

Laboratory results indicate significant variation in stream sediment nitrogen and phosphorus concentrations between sites; however, no ISQG guidelines currently exist for these analytes. Particular variation was noted for TKP, which varied by two orders of magnitude between the highest and lowest concentrations: 170mg/kg at site ARD4 and 17,000mg/kg at ARD7.

3. Aquatic macroinvertebrates

3.1 Habitat assessment

Only one site contained sufficient water for the collection of aquatic macroinvertebrates during the 2018 baseline survey. Site ARD5 received a habitat score of 90 (Table 6), which is classified as 'good' in accordance with the DNRM habitat quality criteria (Table 4). The site represented the only body of water in the local vicinity of adequate size for cattle to utilise as a drinking point and cattle disturbance was evident. The pool was shallow, with a maximum depth of approximately 0.5m. Bottom cover was variable, with significant protruding bedrock and larger rocks presenting habitat for macroinvertebrates; however, some fine sediment was noted during sampling in the form of plume. A habitat assessment sheet and photographs of the site are provided in Appendix B.

Table 6: Habitat assessment scores for sample sites

SITE	STREAM	HABITAT SCORE	INTERPRETATION
ARD5	Split Creek	90	Good

3.2 Macroinvertebrate assemblage

Abundance in collected samples

A comprehensive list of aquatic macroinvertebrate taxa that were collected during the 2018 baseline survey is provided in Appendix E of this report. A total of 977 individuals from 8 taxa were collected during the survey (Figure 4). The macroinvertebrate assemblage tended to be dominated by water fleas (Cladocera) and copepods (Copepoda), which accounted for 83% of

the total macroinvertebrates recorded. The remaining taxa occurred in much lower abundances, with many taxa represented by less than 20 individuals.

Macroinvertebrate indices

Taxa and PET taxa richness

Taxa richness was low, with a total of eight taxa recorded (from pooled data) between the two bed samples collected at ARD5. No PET taxa were recorded.

Sensitive and tolerant taxa

Macroinvertebrate abundance was dominated by moderate to very tolerant taxa, with no sensitive taxa recorded. The average SIGNAL 2 score was 3.55 during the 2018 baseline survey (Table 7).

Table 7: Macroinvertebrate indices at Ardmore

MACROINVERTEBRATE INDEX	ARD5 SCORE
SIGNAL 2 Score	3.55
Taxa Richness	8
PET Richness	0
% Sensitive Taxa	0
%Tolerant Taxa	100

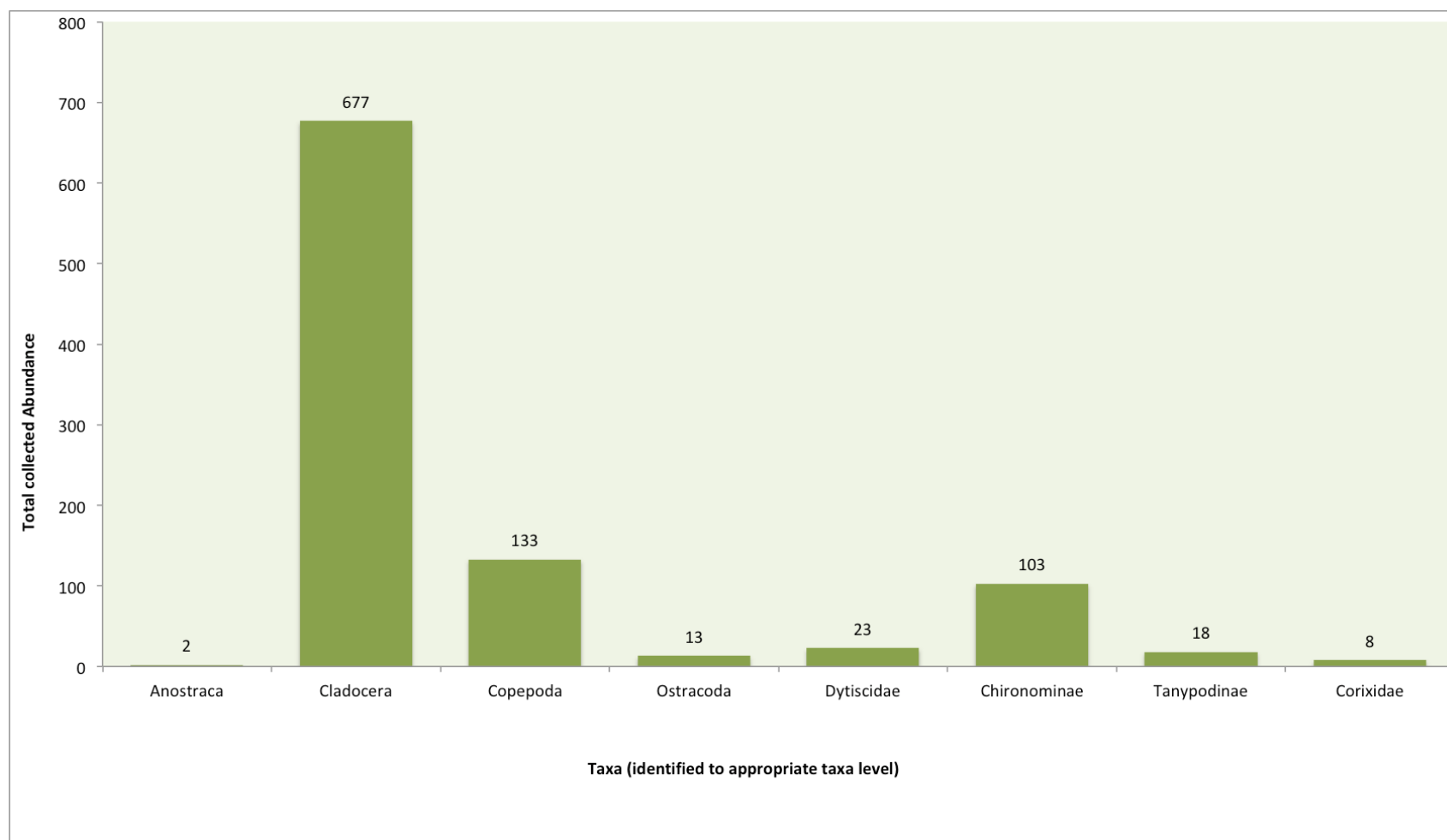


Figure 4: Abundance of taxa collected at site ARD5 during the 2018 baseline survey

Discussion and Recommendations

1. Surface water quality

Water quality at sites sampled during the 2018 baseline survey showed some exceedances of published guideline values. DO reported below the ANZECC (2000) trigger value at all three sites, ranging from 6.8% to 69.1%. The water in Split Creek was not flowing at the time of sampling and it is noted in the QWQG that *“DO guidelines (% saturation) for freshwaters should only be applied to flowing waters, including those with significant sub-surface flows. Stagnant pools in intermittent streams naturally experience values of DO below 50% saturation”*.

High concentrations of TKN were recorded at all sites; however, nitrates and nitrites were below the LOR. These are the biologically active components of total nitrogen, and thus the high TKN does not represent a concern for aquatic biota. TKN concentrations were especially high at ARD5, where cattle disturbance was noted. It is possible that cattle regularly utilise this site for drinking water, depositing dung high in nitrates. In the broader region, cattle farming may be contributing to high levels of nitrogen in surface water. Contamination is likely exacerbated by evapoconcentration effects as flows cease and surface water is reduced to small pools.

FRP also exceeded ANZECC (2000) guideline values. In light of very high inorganic phosphate levels in stream sediments, it is likely that high reactive phosphorus concentrations are the result of geologically abundant phosphates at Ardmore and that these levels represent local natural conditions.

Few exceedances in metals concentrations were recorded during the 2018 wet season baseline survey. Total aluminium exceeded ANZECC (2000) guideline values at ARD5. This may be the result of point source pollution upstream; this should be monitored in future surveys and, if persistent, the source of pollution investigated. However, as this concentration was recorded during baseline conditions, it is likely that this concentration represents the natural conditions at this site.

The ANZECC (2000) guideline value for uranium (95% protection) is 0.5µg/L, while the LOR for uranium under the tests conducted is 1µg/L. Hence the test used is not sensitive enough to test for concentrations below the guideline value. It can, however, be reasonably inferred by the lack of detectable uranium at all sites that significant concentrations of uranium are not present at Ardmore.

2. Stream sediment quality

There were no exceedances of guideline values for the whole sediment fraction at any site during the present survey. Some variation in metals concentrations between sites was

identified, particularly at site ARD7 that reported many above-average metals concentrations. ARD7 also contained by far the highest TKP concentration of any site sampled, at 17,000mg/kg. Concentrations near or above 1,000mg/kg were not uncommon, however, and these values likely indicate natural conditions in these watercourses. While phosphorus levels were high, very little of this was water soluble, and thus phosphorus is unlikely to affect aquatic biota on site. Fine fraction metals are currently without ISQG-low or ISQG-high values; therefore, concentrations must be assessed based on spatial and temporal changes. Collection of data over time will allow temporal comparisons at each site to be made and potential future changes due to mining-related activities identified.

Results of the particle size distribution analyses indicate low bioavailability of sediment contaminants in watercourses at Ardmore.

3. Aquatic macroinvertebrate assemblage

Due to the highly ephemeral nature of the watercourses around Ardmore, macroinvertebrates could only be sampled at one location (ARD5) during the current survey, as watercourses were largely dry. While no relevant guideline values are available, macroinvertebrate index scores were low. All the macroinvertebrate taxa found at ARD5 had low- to mid-range SIGNAL 2 scores, indicating moderate to high tolerance to environmental stressors. No PET taxa were recorded and taxa richness was low. The habitat score, at 90, is considered an indication of 'good' habitat for macroinvertebrates. High nitrogen levels in the surface water at this site are unlikely to have affected the macroinvertebrate community, as active components (nitrates and nitrites) were below detectable levels. It is likely that the major influence on richness is the highly ephemeral nature of watercourses within the broader landscape. Creeks in the area do not hold water for a sufficient length of time to allow many taxa to reproduce, which may prove a selective pressure for many taxa and lead to naturally low aquatic macroinvertebrate diversity. The survey was also undertaken approximately three weeks after the initial flush event, which is less than the four- to six-week period recommended to allow for the establishment of aquatic macroinvertebrates. The survey was conducted early in anticipation of the rapid disappearance of surface water characteristic of the region. It is likely that, with the exception of particularly wet years, creeks at Ardmore never hold water for long enough to allow the full diversity of aquatic macroinvertebrates to assemble.

4. Recommendations

Water quality, sediments and macroinvertebrates should be monitored bi-annually in the wet and dry seasons. A monitoring schedule should be developed to provide sufficient data in a suitable timeframe to derive site-specific trigger values for the area. Surface water monitoring will likely need to be conducted outside the macroinvertebrate sampling schedule (which typically occurs approximately four weeks after a flow event), due to the lack of water persisting at most sites. Continued monitoring of the same sites will allow accurate comparisons of changes in the receiving environment conditions over time and will provide an indication of the nature and extent of any future impacts.

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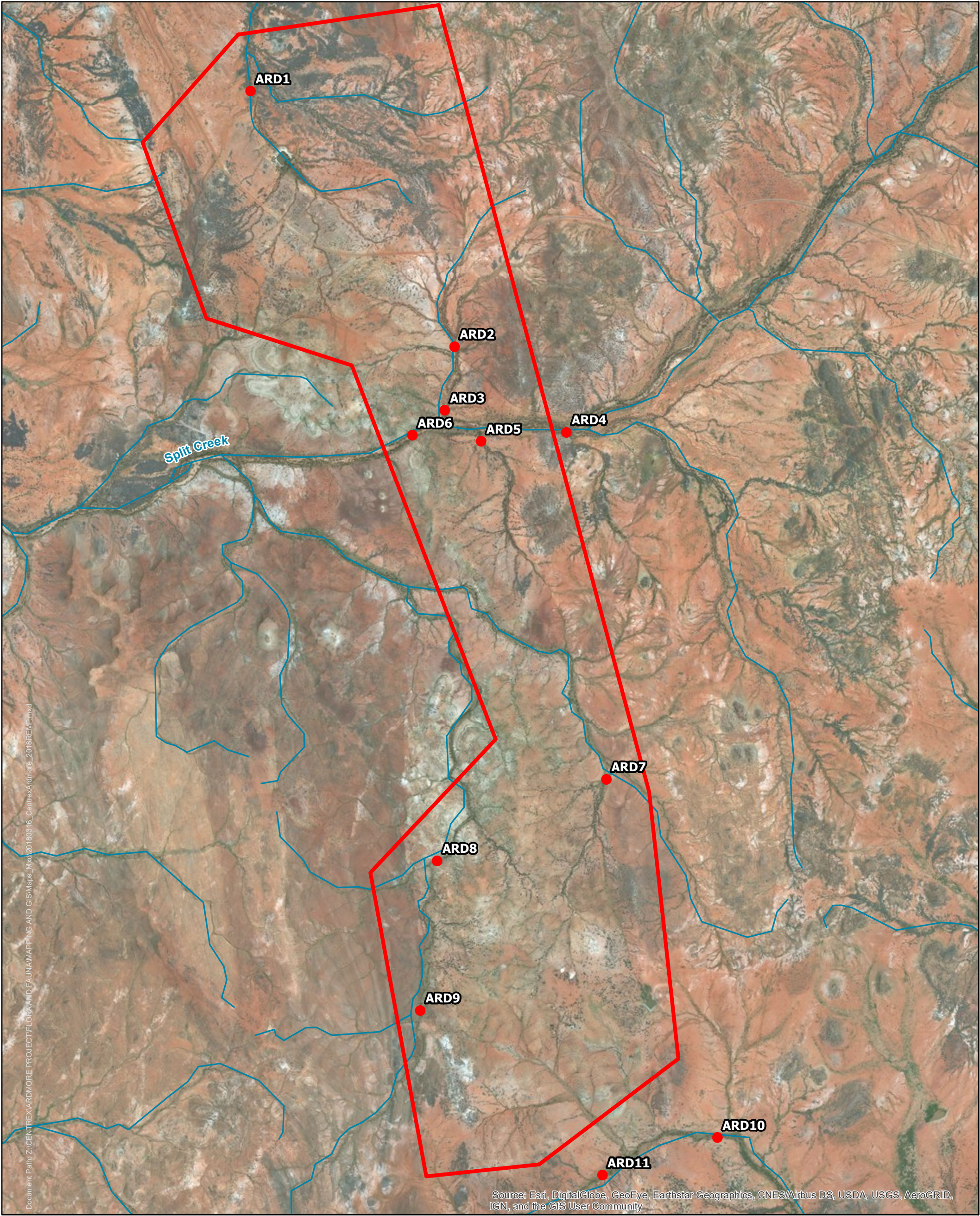
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Appendix summary

Appendix A	Maps
Appendix B	Site Descriptions and Datasheets
Appendix C	Surface Water Data
Appendix D	Stream Sediment Data
Appendix E	Aquatic Macroinvertebrate Data
Appendix F	Quality Assurance Assessment
Appendix G	Chain of Custody Forms
Appendix H	Laboratory Sample Receipts
Appendix I	Analytical Reports

Appendix A

Maps



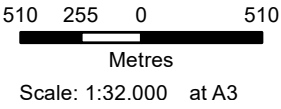
CENTREX - ARDMORE PHOSPHATE PROJECT

ARDMORE PHOSPHATE PROJECT - 2018 REMP

- Legend**
-  Mining Lease
 -  REMP 2018
 -  Vegetation Management Watercourse/Drainage Feature

Credits:
Mine Lease boundary
Watercourse, Lot and Plan
© State of Queensland
(Department of Natural
Resources and Mines) 2016.

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994
Date: 02-May-18



Appendix B

Site Descriptions and Datasheets

HORSE CREEK – ARD1

UPSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

DOWNSTREAM



LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <i>Armore</i>	
Site name/number: <i>ARD1</i>	Collected by: <i>Scott Icam</i>
Date: <i>21/03/18</i>	
Photos: Upstream: <i>142</i>	Downstream: <i>143</i>
Time: <i>7:25</i>	
QA sample taken: (circle) YES ☒ NO ☒	sediment water quality macroinvertebrates
Rain in the past week:	
Weather: no rain showers heavy rain <i>sunny</i> some cloud overcast calm strong wind	
Flow: <i>nil</i> low moderate high	Bars: %
Bank erosion: <i>nil</i> <i>low</i> moderate high	
BED 1	BED 2
Velocity Min: Max:	Velocity Min: Max:
Mean depth:	Mean depth:
Mean channel width:	Mean channel width:
Canopy Cover: %	Canopy Cover: %
Width of riparian zone	Width of riparian zone
Left Bank: Right Bank:	Left Bank: Right Bank:
Composition of riparian zone	Composition of riparian zone
Native: % Exotic: %	Native: % Exotic: %
Riparian Vegetation	Riparian Vegetation
Grass: % Shrubs: %	Grass: % Shrubs: %
Trees: <10m: % >10m: %	Trees: <10m: % >10m: %
Substrate Description	Substrate Description
Bedrock %	Bedrock %
Boulder (>256mm) %	Boulder (>256mm) %
Cobble (64-256mm) %	Cobble (64-256mm) %
Pebble (16-64mm) %	Pebble (16-64mm) %
Gravel (4-16mm) %	Gravel (4-16mm) %
Sand (1-4mm) %	Sand (1-4mm) %
Silt/Clay (<1mm) %	Silt/Clay (<1mm) %
Substrate Cover	Substrate Cover
Periphyton 0 1 2 3 4	Periphyton 0 1 2 3 4
Moss 0 1 2 3 4	Moss 0 1 2 3 4
Filamentous algae 0 1 2 3 4	Filamentous algae 0 1 2 3 4
Detritus 0 1 2 3 4	Detritus 0 1 2 3 4
Macrophytes 0 1 2 3 4	Macrophytes 0 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%
Bank Overhang Vegetation	Bank Overhang Vegetation
nil slight mod extensive	nil slight mod extensive
Trailing Bank Vegetation? tick	Trailing Bank Vegetation? tick
nil slight mod extensive	nil slight mod extensive
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour:	Impact from animals:
Water foaming:	Human activity:
Plume:	Aquatic animal life:
Sediment oils:	Additional notes:
Sediment odour:	

SPLIT CREEK – ARD2

UPSTREAM



DOWNSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <u>Ardmore</u>	
Site name/number: <u>ARD2</u>	Collected by: <u>Scott/Cam</u>
Date: <u>21/03/18</u>	
Photos: Upstream: <u>144</u>	Downstream: <u>145</u>
Time: <u>8:00</u>	
QA sample taken: (circle) YES ☒ NO ☐ sediment water quality macroinvertebrates	
Rain in the past week:	
Weather: no rain showers heavy rain <u>sunny</u> some cloud overcast calm strong wind	
Flow: <u>nil</u> low moderate high	Bars: %
Bank erosion: <u>nil</u> <u>low</u> moderate high	
BED 1	
Velocity Min: Max:	
Mean depth:	
Mean channel width:	
Canopy Cover: %	
Width of riparian zone	
Left Bank:	Right Bank:
Composition of riparian zone	
Native: %	Exotic: %
Riparian Vegetation	
Grass: %	Shrubs: %
Trees: <10m: %	>10m: %
Substrate Description	
Bedrock %	
Boulder (>256mm) %	
Cobble (64-256mm) %	
Pebble (16-64mm) %	
Gravel (4-16mm) %	
Sand (1-4mm) %	
Silt/Clay (<1mm) %	
Substrate Cover	
Periphyton 0 1 2 3 4	
Moss 0 1 2 3 4	
Filamentous algae 0 1 2 3 4	
Detritus 0 1 2 3 4	
Macrophytes 0 1 2 3 4	
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	
Bank Overhang Vegetation	
nil slight mod extensive	
Trailing Bank Vegetation? tick	
nil slight mod extensive	
BED 2	
Velocity Min: Max:	
Mean depth:	
Mean channel width:	
Canopy Cover: %	
Width of riparian zone	
Left Bank:	Right Bank:
Composition of riparian zone	
Native: %	Exotic: %
Riparian Vegetation	
Grass: %	Shrubs: %
Trees: <10m: %	>10m: %
Substrate Description	
Bedrock %	
Boulder (>256mm) %	
Cobble (64-256mm) %	
Pebble (16-64mm) %	
Gravel (4-16mm) %	
Sand (1-4mm) %	
Silt/Clay (<1mm) %	
Substrate Cover	
Periphyton 0 1 2 3 4	
Moss 0 1 2 3 4	
Filamentous algae 0 1 2 3 4	
Detritus 0 1 2 3 4	
Macrophytes 0 1 2 3 4	
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	
Bank Overhang Vegetation	
nil slight mod extensive	
Trailing Bank Vegetation? tick	
nil slight mod extensive	
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour:	Impact from animals:
Water foaming:	Human activity:
Plume:	Aquatic animal life:
Sediment oils:	Additional notes:
Sediment odour:	

SPLIT CREEK – ARD3

UPSTREAM



DOWNSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <i>Ardmore</i>	
Site name/number: <i>ARD3</i>	Collected by: <i>Scott / Cam</i>
Date: <i>20/03/18</i>	
Photos: Upstream: <i>138</i>	Downstream: <i>139</i>
Time: <i>16:25</i>	
QA sample taken: (circle) YES ☒ NO ☒	sediment water quality macroinvertebrates
Rain in the past week:	
Weather: no rain showers heavy rain <i>sunny</i> some cloud overcast calm strong wind	
Flow: <i>nil</i> low moderate high	Bars: %
Bank erosion: <i>nil</i> low moderate high	
BED 1	BED 2
Velocity Min: Max:	Velocity Min: Max:
Mean depth:	Mean depth:
Mean channel width:	Mean channel width:
Canopy Cover: %	Canopy Cover: %
Width of riparian zone	Width of riparian zone
Left Bank: Right Bank:	Left Bank: Right Bank:
Composition of riparian zone	Composition of riparian zone
Native: % Exotic: %	Native: % Exotic: %
Riparian Vegetation	Riparian Vegetation
Grass: % Shrubs: %	Grass: % Shrubs: %
Trees: <10m: % >10m: %	Trees: <10m: % >10m: %
Substrate Description	Substrate Description
Bedrock %	Bedrock %
Boulder (>256mm) <i>Dry</i> %	Boulder (>256mm) <i>Dry</i> %
Cobble (64-256mm) <i>Sediment</i> %	Cobble (64-256mm) <i>Sediment</i> %
Pebble (16-64mm) <i>taken only</i> %	Pebble (16-64mm) <i>Sediment taken</i> %
Gravel (4-16mm) %	Gravel (4-16mm) <i>only</i> %
Sand (1-4mm) %	Sand (1-4mm) %
Silt/Clay (<1mm) %	Silt/Clay (<1mm) %
Substrate Cover	Substrate Cover
Periphyton 0 1 2 3 4	Periphyton 0 1 2 3 4
Moss 0 1 2 3 4	Moss 0 1 2 3 4
Filamentous algae 0 1 2 3 4	Filamentous algae 0 1 2 3 4
Detritus 0 1 2 3 4	Detritus 0 1 2 3 4
Macrophytes 0 1 2 3 4	Macrophytes 0 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%
Bank Overhang Vegetation	Bank Overhang Vegetation
nil slight mod extensive	nil slight mod extensive
Trailing Bank Vegetation? tick	Trailing Bank Vegetation? tick
nil slight mod extensive	nil slight mod extensive
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour:	Impact from animals:
Water foaming:	Human activity:
Plume:	Aquatic animal life:
Sediment oils:	Additional notes:
Sediment odour:	

SPLIT CREEK – ARD4

UPSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

DOWNSTREAM



LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <i>Ardmore</i>	
Site name/number: <i>ARD4</i>	Collected by: <i>Scott / cam</i>
Date: <i>20/03/18</i>	
Photos: Upstream: <i>134</i>	Downstream: <i>135</i>
Time: <i>14:15</i>	
QA sample taken: (circle) <i>YES</i>	NO <i>sediment</i> <i>water quality</i> <i>macroinvertebrates</i>
Rain in the past week:	
Weather: no rain showers heavy rain <i>sunny</i> some cloud overcast calm strong wind	
Flow: <i>nil</i> low moderate high	Bars: <i>95</i> %
Bank erosion: <i>nil</i> low moderate high	
BED 1	BED 2
Velocity Min: Max:	Velocity Min: Max:
Mean depth:	Mean depth:
Mean channel width:	Mean channel width:
Canopy Cover: %	Canopy Cover: %
Width of riparian zone	Width of riparian zone
Left Bank: Right Bank:	Left Bank: Right Bank:
Composition of riparian zone	Composition of riparian zone
Native: % Exotic: %	Native: % Exotic: %
Riparian Vegetation	Riparian Vegetation
Grass: % Shrubs: %	Grass: % Shrubs: %
Trees: <10m: % >10m: %	Trees: <10m: % >10m: %
Substrate Description	Substrate Description
Bedrock %	Bedrock %
Boulder (>256mm) %	Boulder (>256mm) %
Cobble (64-256mm) %	Cobble (64-256mm) %
Pebble (16-64mm) %	Pebble (16-64mm) %
Gravel (4-16mm) %	Gravel (4-16mm) %
Sand (1-4mm) %	Sand (1-4mm) %
Silt/Clay (<1mm) %	Silt/Clay (<1mm) %
Substrate Cover	Substrate Cover
Periphyton 0 1 2 3 4	Periphyton 0 1 2 3 4
Moss 0 1 2 3 4	Moss 0 1 2 3 4
Filamentous algae 0 1 2 3 4	Filamentous algae 0 1 2 3 4
Detritus 0 1 2 3 4	Detritus 0 1 2 3 4
Macrophytes 0 1 2 3 4	Macrophytes 0 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%
Bank Overhang Vegetation	Bank Overhang Vegetation
nil slight mod extensive	nil slight mod extensive
Trailing Bank Vegetation? tick	Trailing Bank Vegetation? tick
nil slight mod extensive	nil slight mod extensive
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour: <i>some oils on water surface</i>	Impact from animals: <i>Roos/cows</i>
Water foaming: <i>surface</i>	Human activity: <i>trails</i>
Plume: <i>trails</i>	Aquatic animal life: <i>trails</i>
Sediment oils: <i>trails</i>	Additional notes: <i>very small/shallow pool</i>
Sediment odour: <i>trails</i>	

SPLIT CREEK – ARD5

UPSTREAM



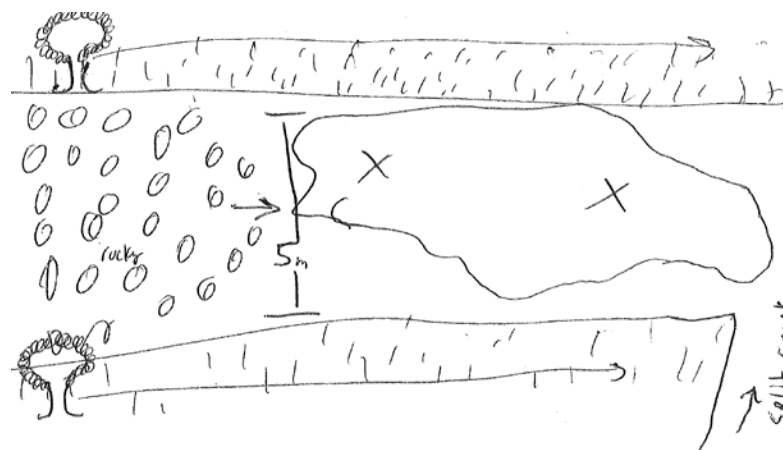
DOWNSTREAM



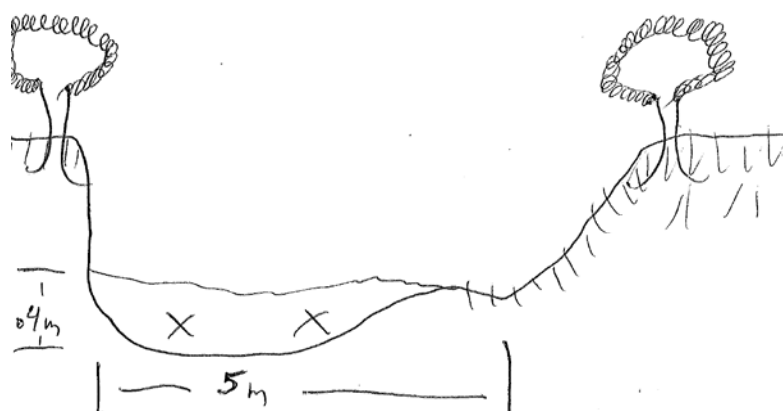
HABITAT ASSESSMENT

HABITAT VARIABLE	CATEGORY	SCORE
1. Bottom substrate/ available cover	Good	13
2. Embeddedness	Good	15
3. Velocity/depth category	Fair	7
4. Channel alteration	Good	11
5. Bottom scouring and deposition	Good	8
6. Pool/riffle, run/band ratio	Good	10
7. Bank stability	Good	8
8. Bank vegetative stability	Excellent	9
9. Streamside cover	Excellent	9
Total Score	Good	90

LONGITUDINAL SKETCH



CROSS-SECTION SKETCH



Project Name: Armore

Site name/number: ARD5 Collected by: Scott/cam Date: 20103118

Photos: Upstream: 136 Downstream: 137 Time: 15:10

QA sample taken: (circle) YES NO sediment X water quality X macroinvertebrates X

Rain in the past week:

Weather: no rain showers heavy rain sunny some cloud overcast calm strong wind

Flow: (nil) low moderate high Bars: 50 %

Bank erosion: nil low moderate high

BED 1		BED 2	
Velocity Min: <u>—</u> Max: <u>—</u>	Velocity Min: <u>—</u> Max: <u>—</u>	Mean depth: <u>40</u>	Mean depth: <u>50</u>
Mean channel width: <u>5m</u>	Mean channel width: <u>5m</u>	Canopy Cover: <u>60</u> %	Canopy Cover: <u>50</u> %
Width of riparian zone		Width of riparian zone	
Left Bank: <u>2m</u>	Right Bank: <u>2m</u>	Left Bank: <u>2m</u>	Right Bank: <u>2m</u>
Composition of riparian zone		Composition of riparian zone	
Native: <u>50</u> %	Exotic: <u>50</u> %	Native: <u>50</u> %	Exotic: <u>50</u> %
Riparian Vegetation		Riparian Vegetation	
Grass: <u>40</u> %	Shrubs: <u>5</u> %	Grass: <u>40</u> %	Shrubs: <u>5</u> %
Trees: <u><10m: 10</u> %	<u>>10m: 45</u> %	Trees: <u><10m: 10</u> %	<u>>10m: 45</u> %
Substrate Description		Substrate Description	
Bedrock	<u>15</u> %	Bedrock	<u>—</u> %
Boulder (>256mm)	<u>10</u> %	Boulder (>256mm)	<u>—</u> %
Cobble (64-256mm)	<u>10</u> %	Cobble (64-256mm)	<u>20</u> %
Pebble (16-64mm)	<u>20</u> %	Pebble (16-64mm)	<u>10</u> %
Gravel (4-16mm)	<u>20</u> %	Gravel (4-16mm)	<u>10</u> %
Sand (1-4mm)	<u>15</u> %	Sand (1-4mm)	<u>40</u> %
Silt/Clay (<1mm)	<u>10</u> %	Silt/Clay (<1mm)	<u>20</u> %
Substrate Cover		Substrate Cover	
Periphyton	<u>0</u> 1 2 3 4	Periphyton	<u>0</u> 1 2 3 4
Moss	<u>0</u> 1 2 3 4	Moss	<u>0</u> 1 2 3 4
Filamentous algae	<u>0</u> 1 2 3 4	Filamentous algae	<u>0</u> 1 2 3 4
Detritus	<u>0</u> 1 2 3 4	Detritus	<u>0</u> 1 2 3 4
Macrophytes	<u>0</u> 1 2 3 4	Macrophytes	<u>0</u> 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%		0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	
Bank Overhang Vegetation		Bank Overhang Vegetation	
nil	<u>0</u> slight mod extensive	nil	<u>0</u> slight mod extensive
Trailing Bank Vegetation? tick		Trailing Bank Vegetation? tick	
<u>(nil)</u>	slight mod extensive	<u>(nil)</u>	slight mod extensive
Adjacent land use: <u>Pastoral</u>			
Upstream land use: <u>Pastoral</u>			
Percent of habitats in 100m reach			
Riffle: % Run: % Pool (rocky): <u>20</u> % Pool (sandy): <u>30</u> % Dry: <u>50</u> % Edge: % Macrophytes: %			
Water odour: <u>—</u>		Impact from animals: <u>cows / roos</u>	
Water foaming: <u>—</u>		Human activity: <u>—</u>	
Plume: <u>moderate</u>		Aquatic animal life: <u> Tadpoles</u>	
Sediment oils: <u>—</u>		Additional notes: <u>lots of lannias, only drinking</u>	
Sediment odour: <u>—</u>		<u>50mce around - DS-disturbance from cattle</u>	

SPLIT CREEK – ARD6

UPSTREAM



DOWNSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <i>Ardmore</i>	
Site name/number: <i>ARD6</i>	Collected by: <i>Scott/Can</i>
Date: <i>20/03/18</i>	
Photos: Upstream: <i>140</i>	Downstream: <i>141</i>
Time: <i>16:40</i>	
QA sample taken: (circle) YES ☒ NO ☐	sediment water quality macroinvertebrates
Rain in the past week:	
Weather: no rain showers heavy rain <i>sunny</i> some cloud overcast calm strong wind	
Flow: <i>nil</i> low moderate high	Bars: <i>95</i> %
Bank erosion: <i>nil</i> low moderate high	
BED 1	BED 2
Velocity Min: Max:	Velocity Min: Max:
Mean depth:	Mean depth:
Mean channel width:	Mean channel width:
Canopy Cover: %	Canopy Cover: %
Width of riparian zone	Width of riparian zone
Left Bank: Right Bank:	Left Bank: Right Bank:
Composition of riparian zone	Composition of riparian zone
Native: % Exotic: %	Native: % Exotic: %
Riparian Vegetation	Riparian Vegetation
Grass: % Shrubs: %	Grass: % Shrubs: %
Trees: <10m: % >10m: %	Trees: <10m: % >10m: %
Substrate Description	Substrate Description
Bedrock %	Bedrock %
Boulder (>256mm) %	Boulder (>256mm) %
Cobble (64-256mm) %	Cobble (64-256mm) %
Pebble (16-64mm) %	Pebble (16-64mm) %
Gravel (4-16mm) %	Gravel (4-16mm) %
Sand (1-4mm) %	Sand (1-4mm) %
Silt/Clay (<1mm) %	Silt/Clay (<1mm) %
Substrate Cover	Substrate Cover
Periphyton 0 1 2 3 4	Periphyton 0 1 2 3 4
Moss 0 1 2 3 4	Moss 0 1 2 3 4
Filamentous algae 0 1 2 3 4	Filamentous algae 0 1 2 3 4
Detritus 0 1 2 3 4	Detritus 0 1 2 3 4
Macrophytes 0 1 2 3 4	Macrophytes 0 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%
Bank Overhang Vegetation	Bank Overhang Vegetation
nil slight mod extensive	nil slight mod extensive
Trailing Bank Vegetation? tick	Trailing Bank Vegetation? tick
nil slight mod extensive	nil slight mod extensive
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour: —	Impact from animals: <i>Cows / Trees</i>
Water foaming: —	Human activity: —
Plume: —	Aquatic animal life: <i>Frogpoles</i>
Sediment oils: —	Additional notes: <i>fanning</i>
Sediment odour: —	

HORSE CREEK – ARD7

UPSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

DOWNSTREAM



LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <i>Arndmore</i>	
Site name/number: <i>ARD7</i>	Collected by: <i>Scott/Cam</i>
Date: <i>20/03/18</i>	
Photos: Upstream: <i>132</i>	Downstream: <i>133</i>
Time: <i>13:15</i>	
QA sample taken: (circle) YES ☒ NO ☐	sediment water quality macroinvertebrates
Rain in the past week:	
Weather: no rain showers heavy rain sunny some cloud overcast calm strong wind	
Flow: <i>nil</i> low moderate high	Bars: %
Bank erosion: <i>nil</i> low moderate high	
BED 1	
Velocity Min: Max:	Velocity Min: Max:
Mean depth:	Mean depth:
Mean channel width:	Mean channel width:
Canopy Cover: %	Canopy Cover: %
Width of riparian zone	
Left Bank:	Right Bank:
Composition of riparian zone	
Native: %	Exotic: %
Riparian Vegetation	
Grass: %	Shrubs: %
Trees: <10m: %	>10m: %
Substrate Description	
Bedrock %	Bedrock %
Boulder (>256mm) %	Boulder (>256mm) %
Cobble (64-256mm) %	Cobble (64-256mm) %
Pebble (16-64mm) %	Pebble (16-64mm) %
Gravel (4-16mm) %	Gravel (4-16mm) %
Sand (1-4mm) %	Sand (1-4mm) %
Silt/Clay (<1mm) %	Silt/Clay (<1mm) %
Substrate Cover	
Periphyton 0 1 2 3 4	Periphyton 0 1 2 3 4
Moss 0 1 2 3 4	Moss 0 1 2 3 4
Filamentous algae 0 1 2 3 4	Filamentous algae 0 1 2 3 4
Detritus 0 1 2 3 4	Detritus 0 1 2 3 4
Macrophytes 0 1 2 3 4	Macrophytes 0 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	
Bank Overhang Vegetation	
nil slight mod extensive	nil slight mod extensive
Trailing Bank Vegetation? tick	
nil slight mod extensive	nil slight mod extensive
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour:	Impact from animals:
Water foaming:	Human activity:
Plume:	Aquatic animal life:
Sediment oils:	Additional notes:
Sediment odour:	

SPLIT CREEK – ARD8

UPSTREAM



DOWNSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <i>Arndmore</i>																																																																																																																													
Site name/number: <i>ARD 8</i>	Collected by: <i>Scott/cam</i>																																																																																																																												
Date: <i>20/03/18</i>																																																																																																																													
Photos: Upstream: <i>130</i>	Downstream: <i>131</i>																																																																																																																												
Time: <i>12:00</i>																																																																																																																													
QA sample taken: (circle) YES ☒ NO ☐ sediment water quality macroinvertebrates																																																																																																																													
Rain in the past week:																																																																																																																													
Weather: no rain showers heavy rain <i>sunny</i> some cloud overcast calm strong wind																																																																																																																													
Flow: <i>6</i> low moderate high	Bars: %																																																																																																																												
Bank erosion: nil <i>low</i> moderate high																																																																																																																													
<table border="1"> <thead> <tr> <th colspan="2">BED 1</th> <th colspan="2">BED 2</th> </tr> </thead> <tbody> <tr> <td>Velocity Min:</td> <td>Max:</td> <td>Velocity Min:</td> <td>Max:</td> </tr> <tr> <td>Mean depth:</td> <td></td> <td>Mean depth:</td> <td></td> </tr> <tr> <td>Mean channel width:</td> <td></td> <td>Mean channel width:</td> <td></td> </tr> <tr> <td>Canopy Cover: %</td> <td></td> <td>Canopy Cover: %</td> <td></td> </tr> <tr> <td colspan="2">Width of riparian zone</td> <td colspan="2">Width of riparian zone</td> </tr> <tr> <td>Left Bank:</td> <td>Right Bank:</td> <td>Left Bank:</td> <td>Right Bank:</td> </tr> <tr> <td colspan="2">Composition of riparian zone</td> <td colspan="2">Composition of riparian zone</td> </tr> <tr> <td>Native: %</td> <td>Exotic: %</td> <td>Native: %</td> <td>Exotic: %</td> </tr> <tr> <td colspan="2">Riparian Vegetation</td> <td colspan="2">Riparian Vegetation</td> </tr> <tr> <td>Grass: %</td> <td>Shrubs: %</td> <td>Grass: %</td> <td>Shrubs: %</td> </tr> <tr> <td>Trees: <10m: %</td> <td>>10m: %</td> <td>Trees: <10m: %</td> <td>>10m: %</td> </tr> <tr> <td colspan="2">Substrate Description</td> <td colspan="2">Substrate Description</td> </tr> <tr> <td>Bedrock %</td> <td></td> <td>Bedrock %</td> <td></td> </tr> <tr> <td>Boulder (>256mm) %</td> <td></td> <td>Boulder (>256mm) %</td> <td></td> </tr> <tr> <td>Cobble (64-256mm) %</td> <td></td> <td>Cobble (64-256mm) %</td> <td></td> </tr> <tr> <td>Pebble (16-64mm) %</td> <td></td> <td>Pebble (16-64mm) %</td> <td></td> </tr> <tr> <td>Gravel (4-16mm) %</td> <td></td> <td>Gravel (4-16mm) %</td> <td></td> </tr> <tr> <td>Sand (1-4mm) %</td> <td></td> <td>Sand (1-4mm) %</td> <td></td> </tr> <tr> <td>Silt/Clay (<1mm) %</td> <td></td> <td>Silt/Clay (<1mm) %</td> <td></td> </tr> <tr> <td colspan="2">Substrate Cover</td> <td colspan="2">Substrate Cover</td> </tr> <tr> <td>Periphyton 0 1 2 3 4</td> <td></td> <td>Periphyton 0 1 2 3 4</td> <td></td> </tr> <tr> <td>Moss 0 1 2 3 4</td> <td></td> <td>Moss 0 1 2 3 4</td> <td></td> </tr> <tr> <td>Filamentous algae 0 1 2 3 4</td> <td></td> <td>Filamentous algae 0 1 2 3 4</td> <td></td> </tr> <tr> <td>Detritus 0 1 2 3 4</td> <td></td> <td>Detritus 0 1 2 3 4</td> <td></td> </tr> <tr> <td>Macrophytes 0 1 2 3 4</td> <td></td> <td>Macrophytes 0 1 2 3 4</td> <td></td> </tr> <tr> <td colspan="2">0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%</td> <td colspan="2">0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%</td> </tr> <tr> <td colspan="2">Bank Overhang Vegetation</td> <td colspan="2">Bank Overhang Vegetation</td> </tr> <tr> <td>nil slight mod extensive</td> <td></td> <td>nil slight mod extensive</td> <td></td> </tr> <tr> <td colspan="2">Trailing Bank Vegetation? tick</td> <td colspan="2">Trailing Bank Vegetation? tick</td> </tr> <tr> <td>nil slight mod extensive</td> <td></td> <td>nil slight mod extensive</td> <td></td> </tr> </tbody> </table>		BED 1		BED 2		Velocity Min:	Max:	Velocity Min:	Max:	Mean depth:		Mean depth:		Mean channel width:		Mean channel width:		Canopy Cover: %		Canopy Cover: %		Width of riparian zone		Width of riparian zone		Left Bank:	Right Bank:	Left Bank:	Right Bank:	Composition of riparian zone		Composition of riparian zone		Native: %	Exotic: %	Native: %	Exotic: %	Riparian Vegetation		Riparian Vegetation		Grass: %	Shrubs: %	Grass: %	Shrubs: %	Trees: <10m: %	>10m: %	Trees: <10m: %	>10m: %	Substrate Description		Substrate Description		Bedrock %		Bedrock %		Boulder (>256mm) %		Boulder (>256mm) %		Cobble (64-256mm) %		Cobble (64-256mm) %		Pebble (16-64mm) %		Pebble (16-64mm) %		Gravel (4-16mm) %		Gravel (4-16mm) %		Sand (1-4mm) %		Sand (1-4mm) %		Silt/Clay (<1mm) %		Silt/Clay (<1mm) %		Substrate Cover		Substrate Cover		Periphyton 0 1 2 3 4		Periphyton 0 1 2 3 4		Moss 0 1 2 3 4		Moss 0 1 2 3 4		Filamentous algae 0 1 2 3 4		Filamentous algae 0 1 2 3 4		Detritus 0 1 2 3 4		Detritus 0 1 2 3 4		Macrophytes 0 1 2 3 4		Macrophytes 0 1 2 3 4		0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%		0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%		Bank Overhang Vegetation		Bank Overhang Vegetation		nil slight mod extensive		nil slight mod extensive		Trailing Bank Vegetation? tick		Trailing Bank Vegetation? tick		nil slight mod extensive		nil slight mod extensive	
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Sediment oils:	Additional notes:																																																																																																																												
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SPLIT CREEK – ARD9

UPSTREAM



DOWNSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <u>Armore</u>	
Site name/number: <u>ARD 9</u>	Collected by: <u>Scott / Cam</u>
Date: <u>20/03/18</u>	
Photos: Upstream: <u>128</u>	Downstream: <u>129</u>
Time: <u>11:20</u>	
QA sample taken: (circle) YES <u>NO</u>	sediment water quality macroinvertebrates
Rain in the past week:	
Weather: no rain showers heavy rain <u>sunny</u> some cloud overcast calm strong wind	
Flow: <u>(nil)</u> low moderate high	Bars: %
Bank erosion: <u>nil</u> <u>low</u> moderate high	
BED 1	BED 2
Velocity Min: Max:	Velocity Min: Max:
Mean depth:	Mean depth:
Mean channel width:	Mean channel width:
Canopy Cover: %	Canopy Cover: %
Width of riparian zone	Width of riparian zone
Left Bank: Right Bank:	Left Bank: Right Bank:
Composition of riparian zone	Composition of riparian zone
Native: % Exotic: %	Native: % Exotic: %
Riparian Vegetation	Riparian Vegetation
Grass: % Shrubs: %	Grass: % Shrubs: %
Trees: <10m: % >10m: %	Trees: <10m: % >10m: %
Substrate Description	Substrate Description
Bedrock %	Bedrock %
Boulder (>256mm) %	Boulder (>256mm) %
Cobble (64-256mm) %	Cobble (64-256mm) %
Pebble (16-64mm) %	Pebble (16-64mm) %
Gravel (4-16mm) %	Gravel (4-16mm) %
Sand (1-4mm) %	Sand (1-4mm) %
Silt/Clay (<1mm) %	Silt/Clay (<1mm) %
Substrate Cover	Substrate Cover
Periphyton 0 1 2 3 4	Periphyton 0 1 2 3 4
Moss 0 1 2 3 4	Moss 0 1 2 3 4
Filamentous algae 0 1 2 3 4	Filamentous algae 0 1 2 3 4
Detritus 0 1 2 3 4	Detritus 0 1 2 3 4
Macrophytes 0 1 2 3 4	Macrophytes 0 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%
Bank Overhang Vegetation	Bank Overhang Vegetation
nil slight mod extensive	nil slight mod extensive
Trailing Bank Vegetation? tick	Trailing Bank Vegetation? tick
nil slight mod extensive	nil slight mod extensive
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour:	Impact from animals:
Water foaming:	Human activity:
Plume:	Aquatic animal life:
Sediment oils:	Additional notes:
Sediment odour:	

SULIEMAN CREEK – ARD10

UPSTREAM



DOWNSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <u>Armore</u>		Collected by: <u>Scott/Kam</u>		Date: <u>20/03/18</u>	
Site name/number: <u>ARD 10</u>		Upstream: <u>124</u>		Downstream: <u>125</u>	
Photos:		Time: <u>10:35</u>			
QA sample taken: (circle) YES ☒ NO ☐		sediment		water quality	
Rain in the past week:					
Weather: no rain showers heavy rain <u>sunny</u> some cloud overcast calm strong wind					
Flow: <u>(nil)</u> low moderate high		Bars: %			
Bank erosion: <u>nil</u> low moderate high					
BED 1			BED 2		
Velocity Min: Max:			Velocity Min: Max:		
Mean depth:			Mean depth:		
Mean channel width:			Mean channel width:		
Canopy Cover: %			Canopy Cover: %		
Width of riparian zone			Width of riparian zone		
Left Bank: Right Bank:			Left Bank: Right Bank:		
Composition of riparian zone			Composition of riparian zone		
Native: % Exotic: %			Native: % Exotic: %		
Riparian Vegetation			Riparian Vegetation		
Grass: % Shrubs: %			Grass: % Shrubs: %		
Trees: <10m: % >10m: %			Trees: <10m: % >10m: %		
Substrate Description			Substrate Description		
Bedrock %			Bedrock %		
Boulder (>256mm) %			Boulder (>256mm) %		
Cobble (64-256mm) %			Cobble (64-256mm) %		
Pebble (16-64mm) %			Pebble (16-64mm) %		
Gravel (4-16mm) %			Gravel (4-16mm) %		
Sand (1-4mm) %			Sand (1-4mm) %		
Silt/Clay (<1mm) %			Silt/Clay (<1mm) %		
Substrate Cover			Substrate Cover		
Periphyton 0 1 2 3 4			Periphyton 0 1 2 3 4		
Moss 0 1 2 3 4			Moss 0 1 2 3 4		
Filamentous algae 0 1 2 3 4			Filamentous algae 0 1 2 3 4		
Detritus 0 1 2 3 4			Detritus 0 1 2 3 4		
Macrophytes 0 1 2 3 4			Macrophytes 0 1 2 3 4		
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%			0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%		
Bank Overhang Vegetation			Bank Overhang Vegetation		
nil slight mod extensive			nil slight mod extensive		
Trailing Bank Vegetation? tick			Trailing Bank Vegetation? tick		
nil slight mod extensive			nil slight mod extensive		
Adjacent land use:					
Upstream land use:					
Percent of habitats in 100m reach					
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %					
Water odour:			Impact from animals:		
Water foaming:			Human activity:		
Plume:			Aquatic animal life:		
Sediment oils:			Additional notes:		
Sediment odour:					

SULIEMAN CREEK – ARD11

UPSTREAM



DOWNSTREAM



HABITAT ASSESSMENT

This site did not contain sufficient water for macroinvertebrate sampling, so a habitat assessment was not conducted.

LONGITUDINAL AND CROSS-SECTION SKETCH

This site did not contain sufficient water for macroinvertebrate sampling, so sketches were not produced.

Project Name: <i>Ardmare</i>	
Site name/number: <i>ARD11</i>	Collected by: <i>Scott / Cam</i>
Date: <i>20/03/18</i>	
Photos: Upstream: <i>126</i>	Downstream: <i>127</i>
Time: <i>10:55</i>	
QA sample taken: (circle) YES ☒ NO ☐	sediment water quality macroinvertebrates
Rain in the past week:	
Weather: no rain showers heavy rain ☒ sunny some cloud overcast calm strong wind	
Flow: ☒ nil low moderate high	Bars: %
Bank erosion: ☒ nil low moderate high	
BED 1	BED 2
Velocity Min: Max:	Velocity Min: Max:
Mean depth:	Mean depth:
Mean channel width:	Mean channel width:
Canopy Cover: %	Canopy Cover: %
Width of riparian zone	Width of riparian zone
Left Bank: Right Bank:	Left Bank: Right Bank:
Composition of riparian zone	Composition of riparian zone
Native: % Exotic: %	Native: % Exotic: %
Riparian Vegetation	Riparian Vegetation
Grass: % Shrubs: %	Grass: % Shrubs: %
Trees: <10m: % >10m: %	Trees: <10m: % >10m: %
Substrate Description	Substrate Description
Bedrock %	Bedrock %
Boulder (>256mm) %	Boulder (>256mm) %
Cobble (64-256mm) %	Cobble (64-256mm) %
Pebble (16-64mm) %	Pebble (16-64mm) %
Gravel (4-16mm) %	Gravel (4-16mm) %
Sand (1-4mm) %	Sand (1-4mm) %
Silt/Clay (<1mm) %	Silt/Clay (<1mm) %
Substrate Cover	Substrate Cover
Periphyton 0 1 2 3 4	Periphyton 0 1 2 3 4
Moss 0 1 2 3 4	Moss 0 1 2 3 4
Filamentous algae 0 1 2 3 4	Filamentous algae 0 1 2 3 4
Detritus 0 1 2 3 4	Detritus 0 1 2 3 4
Macrophytes 0 1 2 3 4	Macrophytes 0 1 2 3 4
0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%	0=<10% 1=10-35% 2=35-65% 3=65-90% 4=>90%
Bank Overhang Vegetation	Bank Overhang Vegetation
nil slight mod extensive	nil slight mod extensive
Trailing Bank Vegetation? tick	Trailing Bank Vegetation? tick
nil slight mod extensive	nil slight mod extensive
Adjacent land use:	
Upstream land use:	
Percent of habitats in 100m reach	
Riffle: % Run: % Pool (rocky): % Pool (sandy): % Dry: % Edge: % Macrophytes: %	
Water odour:	Impact from animals:
Water foaming:	Human activity:
Plume:	Aquatic animal life:
Sediment oils:	Additional notes:
Sediment odour:	

Appendix C

Surface Water Data

Table 8: *In-situ* and laboratory surface water quality results from the wet season 2018 baseline survey

ANALYTE		UNIT	SPLIT CREEK CATCHMENT					
			GV*	ARD4	GV*	ARD5	GV*	ARD6
pH		pH unit	6.0 – 7.5 ¹	7.61	6.0 – 7.5 ¹	6.89	6.0 – 7.5 ¹	7.33
Electrical Conductivity		µS/cm	200 ²	398	200 ²	105	200 ²	196
Dissolved Oxygen		% Sat	90 – 120 ¹	69.1	90 – 120 ¹	6.8	90 – 120 ¹	20.9
Temperature		°C	-	31.90	-	28.54	-	26.85
Turbidity		NTU	50 ¹	8.3	50 ¹	15	50 ¹	1.4
TSS		mg/L	-	38	-	24	-	26
Alkalinity		mg/L	-	170	-	49	-	170
Fluoride		µg/L	-	0.1	-	0.1	-	0.1
Sulfate		mg/L	-	1.3	-	3.5	-	1.2
TKN		mg/L	-	1.2	-	1.3	-	1.2
NOx		mg/L	0.03 ¹	<0.005	0.03 ¹	<0.005	0.03 ¹	<0.005
TKP		mg/L	-	0.10	-	0.32	-	0.09
FRP		mg/L	0.005 ¹	0.016	0.005 ¹	0.049	0.005 ¹	0.015
Calcium		mg/L	-	38	-	11	-	38
Potassium		mg/L	-	13	-	7.8	-	13
Sodium		mg/L	-	27	-	3.2	-	27
Magnesium		mg/L	-	14	-	3.1	-	14
Hardness		mgCaCO ₃ /L	-	120	-	38	-	130
Aluminium	Total	mg/L	0.055 ¹	<0.02	0.055 ¹	0.15	0.055 ¹	<0.02
	Dissolved	mg/L	0.055 ¹	<0.02	0.055 ¹	<0.02	0.055 ¹	<0.02
Arsenic	Total	mg/L	13 ¹	<0.003	13 ¹	<0.003	13 ¹	<0.003
	Dissolved	mg/L	13 ¹	<0.003	13 ¹	<0.003	13 ¹	<0.003
Cadmium	Total	mg/L	0.2 ¹	<0.0001	0.2 ¹	<0.0001	0.2 ¹	0.0001
	Dissolved	mg/L	0.2 ¹	<0.0001	0.2 ¹	<0.0001	0.2 ¹	<0.0001
Chromium	Total	mg/L	3.3 ¹	<0.001	3.3 ¹	<0.001	3.3 ¹	<0.001
	Dissolved	mg/L	3.3 ¹	<0.001	3.3 ¹	<0.001	3.3 ¹	<0.001
Cobalt	Total	mg/L	2.8 ³	0.003	2.8 ³	0.003	2.8 ³	0.004
	Dissolved	mg/L	2.8 ³	0.002	2.8 ³	0.002	2.8 ³	0.003
Copper	Total	mg/L	1.4 ¹	0.003	1.4 ¹	0.002	1.4 ¹	0.002
	Dissolved	mg/L	1.4 ¹	0.002	1.4 ¹	0.001	1.4 ¹	0.001
Lead	Total	mg/L	3.4 ¹	0.002	3.4 ¹	0.003	3.4 ¹	0.002
	Dissolved	mg/L	3.4 ¹	0.001	3.4 ¹	<0.001	3.4 ¹	0.001
Mercury	Total	mg/L	0.6 ³	<0.00005	0.6 ³	<0.00005	0.6 ³	<0.00005
	Dissolved	mg/L	0.6 ³	<0.00005	0.6 ³	<0.00005	0.6 ³	<0.00005
Nickel	Total	mg/L	11 ¹	0.002	11 ¹	0.002	11 ¹	0.001
	Dissolved	mg/L	11 ¹	0.002	11 ¹	0.001	11 ¹	0.001
Uranium	Total	µg/L	0.5 ³	<1	0.5 ³	<1	0.5 ³	<1
	Dissolved	µg/L	0.5 ³	<1	0.5 ³	<1	0.5 ³	<1
Zinc	Total	mg/L	8 ¹	<0.005	8 ¹	<0.005	8 ¹	<0.005
	Dissolved	mg/L	8 ¹	<0.005	8 ¹	<0.005	8 ¹	<0.005

¹ Australian and New Zealand Environmental Conservation Council (ANZECC, 2000) Trigger values for toxicants for the protection of slightly to moderately disturbed systems (95% protection for aquatic ecosystems) used for total and dissolved metals. Where values exceeded this guideline, they were hardness modified according to ANZECC (2000). ANZECC 2000 aquatic ecosystem (Tropical Australia for upland rivers) default trigger values used for physico-chemical parameters (except EC) as no QWQG guidelines for the Lake Eyre basin currently exist.

² QWQG (EHP, 2009b) Lake Eyre salinity zone (75th percentile) used for EC as salinity zones are defined differently to other parameters in the QWQG.

³ Indicates where ANZECC (2000) low reliability trigger values were used.

* GV = Guideline value

Guideline exceedances are highlighted in red. Cases in which the value is below the LOR, but the LOR is above the guideline value, are highlighted in yellow.

Appendix D

Stream Sediment Data

Table 9: Stream sediment results from the wet season 2018 baseline survey

PARAMETER	FRACTION	UNITS	ISQG TRIGGER VALUE		HORSE CREEK	SPLIT CREEK CATCHMENT									SULIEMAN CREEK	
			Low	High		ARD1	ARD4	ARD5	ARD2	ARD3	ARD6	ARD7	ARD9	ARD8	ARD11	ARD10
Nitrate/Nitrite	Whole	mg/kg	-	-	1.7	0.4	0.8	<0.1	<0.1	0.6	<0.1	<0.1	0.9	0.4	17	
TKN	Whole	mg/kg	-	-	300	35	130	44	68	34	100	49	250	54	420	
WSP	Whole	mg/kg	-	-	0.47	1.2	2.7	2.0	1.4	1.5	7.6	1.9	3.4	0.47	1.2	
TKP	Whole	mg/kg	-	-	220	170	3700	580	790	240	17000	990	6700	200	1700	
Arsenic	Whole	mg/kg	20	70	2.1	0.8	2.2	1.9	1.4	0.5	11	1.3	1.9	1.4	2.2	
	Fine	mg/kg	-	-	5.1	4.5	4.8	5.1	5.2	5.7	7.2	2.9	4.2	2.7	3.8	
Cadmium	Whole	mg/kg	1.5	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	
	Fine	mg/kg	-	-	0.3	<0.1	<0.1	<0.1	<0.1	0.1	0.2	<0.1	0.2	<0.1	<0.1	
Chromium	Whole	mg/kg	80	370	12	6.6	13	7.7	9.8	5.5	24	22	22	11	15	
	Fine	mg/kg	-	-	21	25	23	34	27	22	26	48	33	35	26	
Copper	Whole	mg/kg	65	270	6.5	3.2	6.4	4.9	5.9	3.1	19	12	22	6.1	13	
	Fine	mg/kg	-	-	21	33	25	22	23	31	26	46	38	30	24	
Lead	Whole	mg/kg	50	220	3.8	2.4	6.0	5.7	25	2.5	16	5.8	6.9	3.4	5.7	
	Fine	mg/kg	-	-	19	50	28	85	28	59	25	29	20	21	12	
Mercury	Whole	mg/kg	0.15	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	
	Fine	mg/kg	-	-	<0.01	<0.01	0.04	<0.01	<0.01	0.04	0.03	0.01	0.03	0.02	0.02	
Nickel	Whole	mg/kg	21	52	8.3	2.4	7.4	4.1	5.4	2.2	12	14	15	7.5	11	
	Fine	mg/kg	-	-	27	18	18	21	20	17	16	31	23	21	17	
Silver	Whole	mg/kg	1	3.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
	Fine	mg/kg	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Zinc	Whole	mg/kg	200	410	15	7.2	22	12	16	7.1	45	32	40	11	21	
	Fine	mg/kg	-	-	47	56	57	58	53	56	46	68	65	38	33	

Appendix E

Aquatic Macroinvertebrate Data

Table 10: Macroinvertebrate taxa record for the 2018 baseline survey

HIGHER ORDER	TAXA	SIGNAL 2	SPLIT CREEK		TOTAL
			ARD5		
			Bed 1	Bed 2	
Anostraca	Anostraca	1	0	2	2
Conchostraca	Cladocera	5	648	29	677
Copepoda	Copepoda	4	27	106	133
Ostracoda	Ostracoda	4	3	10	13
Coleoptera	Dytiscidae	2	20	3	23
Diptera	Chironominae	3	79	24	103
Diptera	Tanypodinae	4	16	2	18
Hemiptera	Corixidae	2	6	2	8
TOTAL			799	178	977

Appendix F

Quality Assurance Assessment

Surface water

Reproducibility

Replicate water quality data and corresponding precision estimates are provided in Table 11. All parameters reported valid reproducibility, indicating that sampling methods and laboratory testing procedures were accurate and repeatable.

Table 11: Reproducibility of surface water quality assurance data

PARAMETERS		UNITS	LOR	SAMPLE ARD4	QA (REPLICATE) SAMPLE	RPD (%)	THRESHOLD VALUE	REPRODUCIBILITY
TSS		mg/L	5	38	26	37.5	NO THRESHOLD	OK
Alkalinity		mg/L	5	170	170	0.0	NO THRESHOLD	OK
Fluoride		mg/L	0.1	0.1	0.1	0.0	NO THRESHOLD	OK
Sulphur		mg/L	0.5	1.3	1.2	8.0	NO THRESHOLD	OK
TKN		mg/L	0.05	1.2	1.2	0.0	NO THRESHOLD	OK
Nitrate/nitrite		mg/L	0.005	<0.005	<0.005	0.0	NO THRESHOLD	OK
TKP		mg/L	0.02	0.1	0.1	10.5	NO THRESHOLD	OK
FRP		mg/L	0.005	0.016	0.015	6.5	NO THRESHOLD	OK
Calcium		mg/L	0.05	38	38	0.0	NO THRESHOLD	OK
Potassium		mg/L	0.05	13	13	0.0	NO THRESHOLD	OK
Sodium		mg/L	0.5	27	27	0.0	NO THRESHOLD	OK
Magnesium		mg/L	0.05	14	14	0.0	NO THRESHOLD	OK
Hardness		mg/L	1	120	130	8.0	0-20%	OK
Aluminium	Total	mg/L	0.02	0.02	0.02	0.0	NO THRESHOLD	OK

PARAMETERS		UNITS	LOR	SAMPLE ARD4	QA (REPLICATE) SAMPLE	RPD (%)	THRESHOLD VALUE	REPRODUCIBILITY
	Dissolved	mg/L	0.02	0.02	0.02	0.0	NO THRESHOLD	OK
Arsenic	Total	mg/L	0.003	0.003	0.003	0.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.003	0.003	0.003	0.0	NO THRESHOLD	OK
Cadmium	Total	mg/L	0.0001	0.0001	0.0001	0.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.0001	0.0001	0.0001	0.0	NO THRESHOLD	OK
Chromium	Total	mg/L	0.001	0.001	0.001	0.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.001	0.001	0.001	0.0	NO THRESHOLD	OK
Cobalt	Total	mg/L	0.001	0.003	0.002	40.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.001	0.002	0.002	0.0	NO THRESHOLD	OK
Copper	Total	mg/L	0.001	0.003	0.003	0.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.001	0.002	0.003	40.0	NO THRESHOLD	OK
Lead	Total	mg/L	0.001	0.002	0.002	0.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.001	0.001	0.001	0.0	NO THRESHOLD	OK
Mercury	Total	mg/L	0.00005	0.0001	0.0001	0.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.00005	0.0001	0.0001	0.0	NO THRESHOLD	OK
Nickel	Total	mg/L	0.001	0.002	0.002	0.0	NO THRESHOLD	OK
	Dissolved	mg/L	0.001	0.002	0.002	0.0	NO THRESHOLD	OK
Uranium	Total	µg/L	1	1	1	0.0	NO THRESHOLD	OK
	Dissolved	µg/L	1	1	1	0.0	NO THRESHOLD	OK
Zinc	Total	mg/L	0.005	0.005	0.005	0.0	NO THRESHOLD	OK

PARAMETERS		UNITS	LOR	SAMPLE ARD4	QA (REPLICATE) SAMPLE	RPD (%)	THRESHOLD VALUE	REPRODUCIBILITY
	Dissolved	mg/L	0.005	0.005	0.005	0.0	NO THRESHOLD	OK

Stream sediments

Replicate sediment data and corresponding precision estimates are provided in Table 12. All parameters reported valid reproducibility, indicating that sampling and laboratory procedures were accurate and repeatable.

Table 12: Reproducibility of stream sediment quality assurance data

ANALYTE	PARTICLE SIZE	UNITS	LOR	SAMPLE ARD4	QA (REPLICATE) SAMPLE	RPD (%)	THRESHOLD VALUE	RPD
Nitrate/Nitrite	Whole	mg/kg	0.1	0.4	0.5	22.2	NO THRESHOLD	OK
TKN	Whole	mg/kg	5	35	43	20.5	NO THRESHOLD	OK
WSP	Whole	mg/kg	0.05	1.2	0.8	40.0	0–50%	OK
TKP	Whole	mg/kg	2	170	170	0.0	NO THRESHOLD	OK
Arsenic	Whole	mg/kg	0.5	0.8	0.7	13.3	NO THRESHOLD	OK
	Fine	mg/kg	0.5	4.5	4.4	2.2	NO THRESHOLD	OK
Cadmium	Whole	mg/kg	0.1	0.1	0.1	0.0	NO THRESHOLD	OK
	Fine	mg/kg	0.1	0.1	0.1	0.0	NO THRESHOLD	OK
Chromium	Whole	mg/kg	0.5	7	5	27.6	0–50%	OK
	Fine	mg/kg	0.5	25	22	12.8	0–20%	OK
Copper	Whole	mg/kg	0.5	3.2	3	3.2	NO THRESHOLD	OK
	Fine	mg/kg	0.5	33	33	0.0	NO THRESHOLD	OK
Lead	Whole	mg/kg	0.5	2.4	2.4	0.0	NO THRESHOLD	OK
	Fine	mg/kg	0.5	50	58	14.8	0–20%	OK

ANALYTE	PARTICLE SIZE	UNITS	LOR	SAMPLE ARD4	QA (REPLICATE) SAMPLE	RPD (%)	THRESHOLD VALUE	RPD
Mercury	Whole	mg/kg	0.01	0.01	0.01	0.0	NO THRESHOLD	OK
	Fine	mg/kg	0.01	0.01	0.03	100.0	NO THRESHOLD	OK
Nickel	Whole	mg/kg	0.5	2.4	2.1	13.3	NO THRESHOLD	OK
	Fine	mg/kg	0.5	18	16	11.8	0-20%	OK
Silver	Whole	mg/kg	0.2	0.2	0.2	0.0	NO THRESHOLD	OK
	Fine	mg/kg	0.2	0.2	0.2	0.0	NO THRESHOLD	OK
Zinc	Whole	mg/kg	0.5	7.2	7.2	0.0	NO THRESHOLD	OK
	Fine	mg/kg	0.5	56	52	7.4	0-20%	OK

Aquatic macroinvertebrates

Analyses of the residual samples at site ARD5 revealed that all families present in the residual samples were collected during live picking.

Table 13: Live picking error data at the residual sample site

SITE	SAMPLE	NUMBER OF TAXA COLLECTED	NUMBER OF TAXA MISSED	% ERROR
ARD5	Bed 1	8	0	0.00%
ARD5	Bed 2	8	0	0.00%

Information provided by Benthic Australia Pty Ltd.

Appendix G

Chain of Custody Forms

SGS Cairns Environmental



CE132730 COC
Received: 03-Apr-2018

USTODY & ANALYSIS REQUEST

Job Reference Number: **CE132730**

Page 1 of 1

CE132730 COC Received: 03 - Apr - 2018			Sample Date	Matrix			Preservation Method				Analysis Required:							Comments:
S O I L	W A T E R	O T H E R		N O N E	I C E	A C I D	O T H E R	Particle Size	As, Cd, Cr	Cu, Hg, Pb	Ni, Zn, Ag	FRP	AN8					
1	ARD1	21/3/18	X				X					X	X	X	X	X		PSD Fractions: 2.00mm, 600µm, 300µm, 212µm, 63µm Please perform metals analysis of 63µm and <2mm fraction for all samples.
2	ARD2	21/3/18	X				X					X	X	X	X	X		
3	ARD3	20/3/18	X				X					X	X	X	X	X		
4	ARD4	20/3/18	X				X					X	X	X	X	X		
5	ARD5	20/3/18	X				X					X	X	X	X	X		
6	ARD6	20/3/18	X				X					X	X	X	X	X		
7	ARD7	20/3/18	X				X					X	X	X	X	X		
8	ARD8	20/3/18	X				X					X	X	X	X	X		
9	ARD9	20/3/18	X				X					X	X	X	X	X		
10	ARD10	20/3/18	X				X					X	X	X	X	X		
11	ARD11	20/3/18	X				X					X	X	X	X	X		
12	QA	20/3/18	X				X					X	X	X	X	X		

Company Name: Northern Resource Consultants	Client Order Number: 17 191	Laboratory Contact: Cameron Talbot
Address: 12 Cannan Street, South Townsville	Project Name: Ardmore REMPS SED	
Contact Name: Scott Harte, Cameron de Jong	Project Number:	Total Number of Containers/Bottles: 12
Email address: scott@northres.com.au, cameron@northres.com.au, labresults@northres.com.au	Results Required By:	12 X Soil
Telephone: 47726500 Facsimile:		Total Number of Samples/Sites: 11 + QA

Relinquished by: C. Harte Date: 26/3/18 Time: 12:30 Received by: [Signature] Date: 26/3/18 Time:

Relinquished by: Date: Time: Received by: Date: Time:

* Circle whichever is applicable

Sample Cooler Sealed: YES/NO* <u>YES</u>	Samples Intact: YES/NO* <u>YES</u>	Correct Sample Bottles Used: YES/NO* <u>YES</u>	Temperature: AMBIENT/CHILLED* <u>AMBIENT</u>
Comments including subcontracting details:			Please provide client with details Consent given for subcontracting

SGS Terms and Conditions are available at www.au.sgs.com

SGS Australia Pty Ltd
ABN 44 000 964 278

Environmental Services Unit 2, 58 Comport Street, PORTSMITH QLD 4870 www.sgs.com
t +61(0)7 4035 5111. f +61(0)7 4035 5122 e-mail: shey.goddard@sgs.com

Member of the SGS Group



CE132675 COC

Received: 28 - Mar - 2018

F CUSTODY & ANALYSIS REQUEST

Job Reference Number:

(SGS use only)

CE132675

Page 1 of 1

CE132675 COC

Received: 28 ~ Mar ~ 2018

SAMPLE ID	Sample Date	Matrix				Preservation Method					Analysis Required:											Comments:
		S O I L	W A T E R	O T H E R		N O N E	I C E	A C I D	O T H E R		WQ3	TSS	Fluoride	Tot & Diss-Al	As, Cd, Cr, Co	Cu, Pb, Hg	Ni, U, Z	AN8 Nutrients	Hardness	FRP		
1	ARD4	20/3/18	X				X				X	X	X	X	X	X	X	X	X	X		
2	ARD5	20/3/18	X				X				X	X	X	X	X	X	X	X	X	X		
3	ARD6	20/3/18	X				X				X	X	X	X	X	X	X	X	X	X		
4	QA	20/3/18	X				X				X	X	X	X	X	X	X	X	X	X		
5																						
6																						
7																						
8																						

Company Name: Northern Resource Consultants

Address: 12 Cannan Street, South Townsville

Contact Name: Scott Harte, Cameron de Jong

Email address: scott@northres.com.au, cameron@northres.com.au, labresults@northres

Telephone: 47726500 Facsimile:

Client Order Number: 17 191

Project Name: Ardmore REMP SW

Project Number:

Results Required By:

Laboratory Contact: Cameron Talbot

Total Number of Containers/Bottles: 12

Total Number of Samples/Sites: 3 + QA

Relinquished by: Cutyg Date: 26/3/18 Time: 12:30Received by: 3090 Date: 28/3/18 Time: 1pm

Relinquished by: _____ Date: _____ Time: _____

Received by: _____ Date: _____ Time: _____

* Circle whichever is applicable

Sample Cooler Sealed: YES/NO*	Samples Intact: YES/NO*	Correct Sample Bottles Used: YES/NO*	Temperature: AMBIENT/CHILLED*
-------------------------------	-------------------------	--------------------------------------	-------------------------------

Comments including subcontracting details:

4 X 500 NP 4 X 125 AW ① 4 X 125 AW ①

Please provide client with details X

Consent given for subcontracting

Appendix H

Laboratory Sample Receipts



SAMPLE RECEIPT ADVICE

CE132730

CLIENT DETAILS

Contact Cameron de Jong
Client NORTHERN RESOURCE CONSULTANTS PTY LTD
Address 12 CANNAN STREET
SOUTH TOWNSVILLE QLD 4810

Telephone 61 7 4772 6500
Facsimile 61 7 4772 2441
Email labresults@northres.com.au

Project **17_191- Ardmore REMP SED**
Order Number (Not specified)
Samples 36

LABORATORY DETAILS

Manager Jon Dicker
Laboratory SGS Cairns Environmental
Address Unit 2, 58 Comport St
Portsmith QLD 4870

Telephone +61 07 4035 5111
Facsimile +61 07 4035 5122
Email AU.Environmental.Cairns@sgs.com

Samples Received Tue 3/4/2018
Report Due Tue 17/4/2018
SGS Reference **CE132730**

SUBMISSION DETAILS

This is to confirm that 36 samples were received on Tuesday 3/4/2018. Results are expected to be ready by COB Tuesday 17/4/2018. Please quote SGS reference CE132730 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	ice bricks
Samples received in correct containers	Yes	Sample counts by matrix	12x Soil
Date documentation received	3/4/2018	Type of documentation received	COC
Number of eskies/boxes received	1	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	Chilled
Sufficient sample for analysis	Yes	Turnaround time requested	Standard

Unless otherwise instructed, water and bulk samples will be held for one month from date of report, and soil samples will be held for two months.

COMMENTS

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CLIENT DETAILS

Client NORTHERN RESOURCE CONSULTANTS PTY LTD

Project 17_191- Ardmore REMP SED

SUMMARY OF ANALYSIS

No.	Sample ID	Mercury in Soil	Moisture Content	Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto	Particle sizing of soils by sieving	Total Kjeldahl Nitrogen and Total Nitrogen in	Total Phosphorus by Kjeldahl Digestion DA in	Total Recoverable Elements in Soil/Waste	Water Soluble ortho Phosphorus in Soil
001	ARD1	-	1	2	10	3	1	-	1
002	ARD2	-	1	2	10	3	1	-	1
003	ARD3	-	1	2	10	3	1	-	1
004	ARD4	-	1	2	10	3	1	-	1
005	ARD5	-	1	2	10	3	1	-	1
006	ARD6	-	1	2	10	3	1	-	1
007	ARD7	-	1	2	10	3	1	-	1
008	ARD8	-	1	2	10	3	1	-	1
009	ARD9	-	1	2	10	3	1	-	1
010	ARD10	-	1	2	10	3	1	-	1
011	ARD11	-	1	2	10	3	1	-	1
012	QA	-	1	2	10	3	1	-	1
013	ARD1_<2mm	1	-	-	-	-	-	7	-
014	ARD2_<2mm	1	-	-	-	-	-	7	-
015	ARD3_<2mm	1	-	-	-	-	-	7	-
016	ARD4_<2mm	1	-	-	-	-	-	7	-
017	ARD5_<2mm	1	-	-	-	-	-	7	-
018	ARD6_<2mm	1	-	-	-	-	-	7	-
019	ARD7_<2mm	1	-	-	-	-	-	7	-
020	ARD8_<2mm	1	-	-	-	-	-	7	-
021	ARD9_<2mm	1	-	-	-	-	-	7	-
022	ARD10_<2mm	1	-	-	-	-	-	7	-
023	ARD11_<2mm	1	-	-	-	-	-	7	-
024	QA_<2mm	1	-	-	-	-	-	7	-

CONTINUED OVERLEAF

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.

The numbers shown in the table indicate the number of results requested in each package.

Please indicate as soon as possible should your request differ from these details .

Testing as per this table shall commence immediately unless the client intervenes with a correction .



SAMPLE RECEIPT ADVICE

CE132730

CLIENT DETAILS

Client **NORTHERN RESOURCE CONSULTANTS PTY LTD**

Project **17_191- Ardmore REMP SED**

SUMMARY OF ANALYSIS

No.	Sample ID	Mercury in Soil	Total Recoverable Elements in Soil/Waste
025	ARD1_<63um	1	7
026	ARD2_<63um	1	7
027	ARD3_<63um	1	7
028	ARD4_<63um	1	7
029	ARD5_<63um	1	7
030	ARD6_<63um	1	7
031	ARD7_<63um	1	7
032	ARD8_<63um	1	7
033	ARD9_<63um	1	7
034	ARD10_<63um	1	7
035	ARD11_<63um	1	7
036	QA_<63um	1	7

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.

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Please indicate as soon as possible should your request differ from these details .

Testing as per this table shall commence immediately unless the client intervenes with a correction .



SAMPLE RECEIPT ADVICE

CE132675

CLIENT DETAILS

Contact **Marty Costello**
Client **NORTHERN RESOURCE CONSULTANTS PTY LTD**
Address **12 CANNAN STREET
SOUTH TOWNSVILLE QLD 4810**

Telephone **61 7 4772 6500**
Facsimile **61 7 4772 2441**
Email **labresults@northres.com.au**

Project **Ardmore REMP SW**
Order Number **17_191**
Samples **4**

LABORATORY DETAILS

Manager **Jon Dicker**
Laboratory **SGS Cairns Environmental**
Address **Unit 2, 58 Comport St
Portsmith QLD 4870**

Telephone **+61 07 4035 5111**
Facsimile **+61 07 4035 5122**
Email **AU.Environmental.Cairns@sgs.com**

Samples Received **Wed 28/3/2018**
Report Due **Tue 10/4/2018**
SGS Reference **CE132675**

SUBMISSION DETAILS

This is to confirm that 4 samples were received on Wednesday 28/3/2018. Results are expected to be ready by COB Tuesday 10/4/2018. Please quote SGS reference CE132675 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice
Samples received in correct containers	Yes	Sample counts by matrix	4 x water
Date documentation received	28/3/2018	Type of documentation received	COC
Number of eskies/boxes received	1	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	Chilled
Sufficient sample for analysis	Yes	Turnaround time requested	Standard

Unless otherwise instructed, water and bulk samples will be held for one month from date of report, and soil samples will be held for two months.

COMMENTS

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SAMPLE RECEIPT ADVICE

CE132675

CLIENT DETAILS

Client **NORTHERN RESOURCE CONSULTANTS PTY LTD**

Project **Ardmore REMP SW**

SUMMARY OF ANALYSIS

No.	Sample ID	Alkalinity	Calculation of Anion-Cation Balance	Chloride by Discrete Analyser in Water	Conductivity and TDS by Calculation - Water	Fluoride by Ion Selective Electrode in Water	Metals in Water (Total) by ICPOES	Metals in Water (Dissolved) by ICPOES	pH in water	Total and Volatile Suspended Solids (TSS /
001	ARD4	4	3	1	1	1	7	5	1	1
002	ARD5	4	3	1	1	1	7	5	1	1
003	ARD6	4	3	1	1	1	7	5	1	1
004	QA	4	3	1	1	1	7	5	1	1

CONTINUED OVERLEAF

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .



SAMPLE RECEIPT ADVICE

CE132675

CLIENT DETAILS

Client **NORTHERN RESOURCE CONSULTANTS PTY LTD**

Project **Ardmore REMP SW**

SUMMARY OF ANALYSIS

No.	Sample ID	Mercury (dissolved) in Water	Mercury (total) in Water	Metals in Water (Dissolved) by	Metals in Water (Total) by ICPOES-USN	Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto	Nitrite in Water	TKN Kjeldahl Digestion by Discrete Analyser	Total Phosphorus by Kjeldahl Digestion DA in
001	ARD4	1	1	7	7	2	1	3	1
002	ARD5	1	1	7	7	2	1	3	1
003	ARD6	1	1	7	7	2	1	3	1
004	QA	1	1	7	7	2	1	3	1

CONTINUED OVERLEAF

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.

The numbers shown in the table indicate the number of results requested in each package.

Please indicate as soon as possible should your request differ from these details .

Testing as per this table shall commence immediately unless the client intervenes with a correction .



SAMPLE RECEIPT ADVICE

CE132675

CLIENT DETAILS

Client **NORTHERN RESOURCE CONSULTANTS PTY LTD**

Project **Ardmore REMP SW**

SUMMARY OF ANALYSIS

No.	Sample ID	Filterable Reactive Phosphorus (FRP)	Trace Metals (Dissolved) in Water by ICPMS	Trace Metals (Total) in Water by ICPMS
001	ARD4	1	1	1
002	ARD5	1	1	1
003	ARD6	1	1	1
004	QA	1	1	1

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

Appendix I

Analytical Reports

CLIENT DETAILS

Contact Cameron de Jong
Client NORTHERN RESOURCE CONSULTANTS PTY LTD
Address 12 CANNAN STREET
SOUTH TOWNSVILLE QLD 4810

Telephone 61 7 4772 6500
Facsimile 61 7 4772 2441
Email labresults@northres.com.au
Project 17_191- Ardmore REMP SED
Order Number (Not specified)
Samples 36

LABORATORY DETAILS

Manager Jon Dicker
Laboratory SGS Cairns Environmental
Address Unit 2, 58 Comport St
Portsmith QLD 4870
Telephone +61 07 4035 5111
Facsimile +61 07 4035 5122
Email AU.Environmental.Cairns@sgs.com
SGS Reference CE132730 R0
Date Received 03 Apr 2018
Date Reported 27 Apr 2018

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(3146).

SIGNATORIES



Anthony Nilsson
Operations Manager



Jon Dicker
Manager Northern QLD



Maristela Ganzan
Metals Team Leader

Parameter	Units	LOR	Sample Number	CE132730.001	CE132730.002	CE132730.003	CE132730.004
			Sample Matrix	Soil	Soil	Soil	Soil
			Sample Date	21 Mar 2018	21 Mar 2018	20 Mar 2018	20 Mar 2018
			Sample Name	ARD1	ARD2	ARD3	ARD4

Moisture Content Method: AN002 Tested: 4/4/2018

% Moisture	%w/w	0.5	0.8	0.9	<0.5	4.5
------------	------	-----	-----	-----	------	-----

Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	96	87	88	78
Retained 2.00mm	%w/w	1	4	13	12	22
Passing 600µm	%w/w	1	63	34	43	26
Retained 600µm	%w/w	1	33	53	45	52
Passing 300µm	%w/w	1	35	6	12	3
Retained 300µm	%w/w	1	29	28	31	23
Passing 212µm	%w/w	1	22	2	10	1
Retained 212µm	%w/w	1	13	4	3	2
Passing 63µm	%w/w	1	9	<1	2	<1
Retained 63µm	%w/w	1	13	2	8	1

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	1.7	<0.1	<0.1	0.4
------------------------------------	-------	-----	-----	------	------	-----

Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	300	44	68	35
Total Nitrogen	mg/kg	10	300	44	68	36

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 17/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	0.47	2.0	1.4	1.2
------------------------------------	-------	------	------	-----	-----	-----

Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 16/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	220	580	790	170
---------------------------------------	-------	---	-----	-----	-----	-----

Parameter	Sample Number		CE132730.001	CE132730.002	CE132730.003	CE132730.004
	Sample Matrix		Soil	Soil	Soil	Soil
	Sample Date		21 Mar 2018	21 Mar 2018	20 Mar 2018	20 Mar 2018
	Sample Name		ARD1	ARD2	ARD3	ARD4
Units	LOR					

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 20/4/2018

Silver, Ag	mg/kg	0.2	-	-	-	-
Arsenic, As	mg/kg	0.5	-	-	-	-
Cadmium, Cd	mg/kg	0.1	-	-	-	-
Chromium, Cr	mg/kg	0.5	-	-	-	-
Copper, Cu	mg/kg	0.5	-	-	-	-
Nickel, Ni	mg/kg	0.5	-	-	-	-
Lead, Pb	mg/kg	0.5	-	-	-	-
Zinc, Zn	mg/kg	0.5	-	-	-	-

Mercury in Soil Method: AN312 Tested: 19/4/2018

Mercury	mg/kg	0.01	-	-	-	-
---------	-------	------	---	---	---	---

Parameter	Units	LOR	Sample Number	CE132730.005	CE132730.006	CE132730.007	CE132730.008
			Sample Matrix	Soil	Soil	Soil	Soil
			Sample Date	20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
			Sample Name	ARD5	ARD6	ARD7	ARD8

Moisture Content Method: AN002 Tested: 4/4/2018

% Moisture	%w/w	0.5	7.5	4.7	<0.5	0.6
------------	------	-----	-----	-----	------	-----

Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	79	73	79	72
Retained 2.00mm	%w/w	1	21	27	22	29
Passing 600µm	%w/w	1	33	15	43	48
Retained 600µm	%w/w	1	46	58	35	24
Passing 300µm	%w/w	1	12	4	13	23
Retained 300µm	%w/w	1	21	11	30	25
Passing 212µm	%w/w	1	9	1	6	15
Retained 212µm	%w/w	1	4	2	7	8
Passing 63µm	%w/w	1	3	<1	<1	5
Retained 63µm	%w/w	1	6	1	5	10

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	0.8	0.6	<0.1	0.9
------------------------------------	-------	-----	-----	-----	------	-----

Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	130	34	100	250
Total Nitrogen	mg/kg	10	130	34	100	250

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 17/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	2.7	1.5	7.6	3.4
------------------------------------	-------	------	-----	-----	-----	-----

Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 16/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	3700	240	17000	6700
---------------------------------------	-------	---	------	-----	-------	------

Parameter	Sample Number		CE132730.005	CE132730.006	CE132730.007	CE132730.008
	Sample Matrix		Soil	Soil	Soil	Soil
	Sample Date		20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
	Sample Name		ARD5	ARD6	ARD7	ARD8
Units	LOR					

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 20/4/2018

Silver, Ag	mg/kg	0.2	-	-	-	-
Arsenic, As	mg/kg	0.5	-	-	-	-
Cadmium, Cd	mg/kg	0.1	-	-	-	-
Chromium, Cr	mg/kg	0.5	-	-	-	-
Copper, Cu	mg/kg	0.5	-	-	-	-
Nickel, Ni	mg/kg	0.5	-	-	-	-
Lead, Pb	mg/kg	0.5	-	-	-	-
Zinc, Zn	mg/kg	0.5	-	-	-	-

Mercury in Soil Method: AN312 Tested: 19/4/2018

Mercury	mg/kg	0.01	-	-	-	-
---------	-------	------	---	---	---	---

Parameter	Units	LOR	Sample Number	CE132730.009	CE132730.010	CE132730.011	CE132730.012
			Sample Matrix	Soil	Soil	Soil	Soil
			Sample Date	20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
			Sample Name	ARD9	ARD10	ARD11	QA

Moisture Content Method: AN002 Tested: 4/4/2018

% Moisture	%w/w	0.5	0.6	9.6	<0.5	5.5
------------	------	-----	-----	-----	------	-----

Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	84	97	84	80
Retained 2.00mm	%w/w	1	16	3	16	20
Passing 600µm	%w/w	1	52	81	37	38
Retained 600µm	%w/w	1	33	16	47	42
Passing 300µm	%w/w	1	11	59	6	13
Retained 300µm	%w/w	1	41	22	31	25
Passing 212µm	%w/w	1	3	49	3	10
Retained 212µm	%w/w	1	8	11	3	3
Passing 63µm	%w/w	1	<1	23	1	<1
Retained 63µm	%w/w	1	3	25	2	10

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	<0.1	17	0.4	0.5
------------------------------------	-------	-----	------	----	-----	-----

Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	49	420	54	43
Total Nitrogen	mg/kg	10	49	440	54	43

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 17/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	1.9	1.2	0.47	0.80
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Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 16/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	990	1700	200	170
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Parameter	Units	LOR	Sample Number	CE132730.009	CE132730.010	CE132730.011	CE132730.012
			Sample Matrix	Soil	Soil	Soil	Soil
			Sample Date	20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
			Sample Name	ARD9	ARD10	ARD11	QA

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 20/4/2018

Silver, Ag	mg/kg	0.2	-	-	-	-
Arsenic, As	mg/kg	0.5	-	-	-	-
Cadmium, Cd	mg/kg	0.1	-	-	-	-
Chromium, Cr	mg/kg	0.5	-	-	-	-
Copper, Cu	mg/kg	0.5	-	-	-	-
Nickel, Ni	mg/kg	0.5	-	-	-	-
Lead, Pb	mg/kg	0.5	-	-	-	-
Zinc, Zn	mg/kg	0.5	-	-	-	-

Mercury in Soil Method: AN312 Tested: 19/4/2018

Mercury	mg/kg	0.01	-	-	-	-
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		Sample Number	CE132730.013	CE132730.014	CE132730.015	CE132730.016
		Sample Name	ARD1_<2mm	ARD2_<2mm	ARD3_<2mm	ARD4_<2mm
Parameter	Units	LOR				

Moisture Content Method: AN002 Tested: 6/4/2018

% Moisture	%w/w	0.5	-	-	-	-
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Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	-	-	-	-
Retained 2.00mm	%w/w	1	-	-	-	-
Passing 600µm	%w/w	1	-	-	-	-
Retained 600µm	%w/w	1	-	-	-	-
Passing 300µm	%w/w	1	-	-	-	-
Retained 300µm	%w/w	1	-	-	-	-
Passing 212µm	%w/w	1	-	-	-	-
Retained 212µm	%w/w	1	-	-	-	-
Passing 63µm	%w/w	1	-	-	-	-
Retained 63µm	%w/w	1	-	-	-	-

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	-	-	-	-
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Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	-	-	-	-
Total Nitrogen	mg/kg	10	-	-	-	-

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 18/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	-	-	-	-
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Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 20/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	-	-	-	-
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		Sample Number	CE132730.013	CE132730.014	CE132730.015	CE132730.016
		Sample Name	ARD1_<2mm	ARD2_<2mm	ARD3_<2mm	ARD4_<2mm
Parameter	Units	LOR				

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 13/4/2018

Silver, Ag	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2
Arsenic, As	mg/kg	0.5	2.1	1.9	1.4	0.8
Cadmium, Cd	mg/kg	0.1	0.1	<0.1	<0.1	<0.1
Chromium, Cr	mg/kg	0.5	12	7.7	9.8	6.6
Copper, Cu	mg/kg	0.5	6.5	4.9	5.9	3.2
Nickel, Ni	mg/kg	0.5	8.3	4.1	5.4	2.4
Lead, Pb	mg/kg	0.5	3.8	5.7	25	2.4
Zinc, Zn	mg/kg	0.5	15	12	16	7.2

Mercury in Soil Method: AN312 Tested: 19/4/2018

Mercury	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01
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Sample Number	CE132730.017	CE132730.018	CE132730.019	CE132730.020
Sample Name	ARD5_<2mm	ARD6_<2mm	ARD7_<2mm	ARD8_<2mm
Parameter	Units	LOR		

Moisture Content Method: AN002 Tested: 6/4/2018

% Moisture	%w/w	0.5	-	-	-	-
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Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	-	-	-	-
Retained 2.00mm	%w/w	1	-	-	-	-
Passing 600µm	%w/w	1	-	-	-	-
Retained 600µm	%w/w	1	-	-	-	-
Passing 300µm	%w/w	1	-	-	-	-
Retained 300µm	%w/w	1	-	-	-	-
Passing 212µm	%w/w	1	-	-	-	-
Retained 212µm	%w/w	1	-	-	-	-
Passing 63µm	%w/w	1	-	-	-	-
Retained 63µm	%w/w	1	-	-	-	-

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	-	-	-	-
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Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	-	-	-	-
Total Nitrogen	mg/kg	10	-	-	-	-

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 18/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	-	-	-	-
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Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 20/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	-	-	-	-
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Sample Number	CE132730.017	CE132730.018	CE132730.019	CE132730.020
Sample Name	ARD5_<2mm	ARD6_<2mm	ARD7_<2mm	ARD8_<2mm
Parameter	Units	LOR		

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 13/4/2018

Silver, Ag	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2
Arsenic, As	mg/kg	0.5	2.2	0.5	11	1.9
Cadmium, Cd	mg/kg	0.1	<0.1	<0.1	0.1	<0.1
Chromium, Cr	mg/kg	0.5	13	5.5	24	22
Copper, Cu	mg/kg	0.5	6.4	3.1	19	22
Nickel, Ni	mg/kg	0.5	7.4	2.2	12	15
Lead, Pb	mg/kg	0.5	6.0	2.5	16	6.9
Zinc, Zn	mg/kg	0.5	22	7.1	45	40

Mercury in Soil Method: AN312 Tested: 19/4/2018

Mercury	mg/kg	0.01	<0.01	<0.01	0.01	<0.01
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Sample Number	CE132730.021	CE132730.022	CE132730.023	CE132730.024
Sample Name	ARD9_<2mm	ARD10_<2mm	ARD11_<2mm	QA_<2mm
Parameter	Units	LOR		

Moisture Content Method: AN002 Tested: 6/4/2018

% Moisture	%w/w	0.5	-	-	-	-
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Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	-	-	-	-
Retained 2.00mm	%w/w	1	-	-	-	-
Passing 600µm	%w/w	1	-	-	-	-
Retained 600µm	%w/w	1	-	-	-	-
Passing 300µm	%w/w	1	-	-	-	-
Retained 300µm	%w/w	1	-	-	-	-
Passing 212µm	%w/w	1	-	-	-	-
Retained 212µm	%w/w	1	-	-	-	-
Passing 63µm	%w/w	1	-	-	-	-
Retained 63µm	%w/w	1	-	-	-	-

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	-	-	-	-
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Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	-	-	-	-
Total Nitrogen	mg/kg	10	-	-	-	-

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 18/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	-	-	-	-
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Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 20/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	-	-	-	-
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Sample Number	CE132730.021	CE132730.022	CE132730.023	CE132730.024
Sample Name	ARD9_<2mm	ARD10_<2mm	ARD11_<2mm	QA_<2mm
Parameter	Units	LOR		

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 13/4/2018

Silver, Ag	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2
Arsenic, As	mg/kg	0.5	1.3	2.2	1.4	0.7
Cadmium, Cd	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1
Chromium, Cr	mg/kg	0.5	22	15	11	5.0
Copper, Cu	mg/kg	0.5	12	13	6.1	3.1
Nickel, Ni	mg/kg	0.5	14	11	7.5	2.1
Lead, Pb	mg/kg	0.5	5.8	5.7	3.4	2.4
Zinc, Zn	mg/kg	0.5	32	21	11	7.2

Mercury in Soil Method: AN312 Tested: 19/4/2018

Mercury	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01
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Sample Number	CE132730.025	CE132730.026	CE132730.027	CE132730.028
Sample Name	ARD1_<63um	ARD2_<63um	ARD3_<63um	ARD4_<63um
Parameter	Units	LOR		

Moisture Content Method: AN002 Tested: 6/4/2018

% Moisture	%w/w	0.5	-	-	-	-
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Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	-	-	-	-
Retained 2.00mm	%w/w	1	-	-	-	-
Passing 600µm	%w/w	1	-	-	-	-
Retained 600µm	%w/w	1	-	-	-	-
Passing 300µm	%w/w	1	-	-	-	-
Retained 300µm	%w/w	1	-	-	-	-
Passing 212µm	%w/w	1	-	-	-	-
Retained 212µm	%w/w	1	-	-	-	-
Passing 63µm	%w/w	1	-	-	-	-
Retained 63µm	%w/w	1	-	-	-	-

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	-	-	-	-
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Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	-	-	-	-
Total Nitrogen	mg/kg	10	-	-	-	-

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 18/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	-	-	-	-
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Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 20/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	-	-	-	-
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Sample Number	CE132730.025	CE132730.026	CE132730.027	CE132730.028
Sample Name	ARD1_<63um	ARD2_<63um	ARD3_<63um	ARD4_<63um
Parameter	Units	LOR		

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 13/4/2018

Silver, Ag	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2
Arsenic, As	mg/kg	0.5	5.1	5.1	5.2	4.5
Cadmium, Cd	mg/kg	0.1	0.3	<0.1	<0.1	<0.1
Chromium, Cr	mg/kg	0.5	21	34	27	25
Copper, Cu	mg/kg	0.5	21	22	23	33
Nickel, Ni	mg/kg	0.5	27	21	20	18
Lead, Pb	mg/kg	0.5	19	85	28	50
Zinc, Zn	mg/kg	0.5	47	58	53	58

Mercury in Soil Method: AN312 Tested: 23/4/2018

Mercury	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01
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Sample Number	CE132730.029	CE132730.030	CE132730.031	CE132730.032
Sample Name	ARD5_<63um	ARD6_<63um	ARD7_<63um	ARD8_<63um
Parameter	Units	LOR		

Moisture Content Method: AN002 Tested: 6/4/2018

% Moisture	%w/w	0.5	-	-	-	-
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Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	-	-	-	-
Retained 2.00mm	%w/w	1	-	-	-	-
Passing 600µm	%w/w	1	-	-	-	-
Retained 600µm	%w/w	1	-	-	-	-
Passing 300µm	%w/w	1	-	-	-	-
Retained 300µm	%w/w	1	-	-	-	-
Passing 212µm	%w/w	1	-	-	-	-
Retained 212µm	%w/w	1	-	-	-	-
Passing 63µm	%w/w	1	-	-	-	-
Retained 63µm	%w/w	1	-	-	-	-

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	-	-	-	-
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Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	-	-	-	-
Total Nitrogen	mg/kg	10	-	-	-	-

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 18/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	-	-	-	-
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Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 20/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	-	-	-	-
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Sample Number	CE132730.029	CE132730.030	CE132730.031	CE132730.032
Sample Name	ARD5_<63um	ARD6_<63um	ARD7_<63um	ARD8_<63um
Parameter	Units	LOR		

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 13/4/2018

Silver, Ag	mg/kg	0.2	<0.2	0.2	<0.2	<0.2
Arsenic, As	mg/kg	0.5	4.8	5.7	7.2	4.2
Cadmium, Cd	mg/kg	0.1	<0.1	0.1	0.2	0.2
Chromium, Cr	mg/kg	0.5	23	22	26	33
Copper, Cu	mg/kg	0.5	25	31	26	38
Nickel, Ni	mg/kg	0.5	18	17	16	23
Lead, Pb	mg/kg	0.5	28	59	25	20
Zinc, Zn	mg/kg	0.5	57	56	46	65

Mercury in Soil Method: AN312 Tested: 23/4/2018

Mercury	mg/kg	0.01	0.04	0.04	0.03	0.03
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Sample Number	CE132730.033	CE132730.034	CE132730.035	CE132730.036
Sample Name	ARD9_<63um	ARD10_<63um	ARD11_<63um	QA_<63um
Parameter	Units	LOR		

Moisture Content Method: AN002 Tested: 6/4/2018

% Moisture	%w/w	0.5	-	-	-	-
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Particle sizing of soils by sieving Method: AN005 Tested: 27/4/2018

Passing 2.00mm	%w/w	1	-	-	-	-
Retained 2.00mm	%w/w	1	-	-	-	-
Passing 600µm	%w/w	1	-	-	-	-
Retained 600µm	%w/w	1	-	-	-	-
Passing 300µm	%w/w	1	-	-	-	-
Retained 300µm	%w/w	1	-	-	-	-
Passing 212µm	%w/w	1	-	-	-	-
Retained 212µm	%w/w	1	-	-	-	-
Passing 63µm	%w/w	1	-	-	-	-
Retained 63µm	%w/w	1	-	-	-	-

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 16/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.1	-	-	-	-
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Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: AN281 Tested: 16/4/2018

Total Kjeldahl Nitrogen	mg/kg	5	-	-	-	-
Total Nitrogen	mg/kg	10	-	-	-	-

Water Soluble ortho Phosphorus in Soil Method: AN278 Tested: 18/4/2018

Water Soluble ortho Phosphorus, P*	mg/kg	0.05	-	-	-	-
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Total Phosphorus by Kjeldahl Digestion DA in Soil Method: AN279/AN293(Sydney only) Tested: 20/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/kg	2	-	-	-	-
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Sample Number	CE132730.033	CE132730.034	CE132730.035	CE132730.036
Sample Name	ARD9_<63um	ARD10_<63um	ARD11_<63um	QA_<63um
Parameter	Units	LOR		

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 13/4/2018

Silver, Ag	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2
Arsenic, As	mg/kg	0.5	2.9	3.8	2.7	4.4
Cadmium, Cd	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1
Chromium, Cr	mg/kg	0.5	48	26	35	22
Copper, Cu	mg/kg	0.5	46	24	30	33
Nickel, Ni	mg/kg	0.5	31	17	21	16
Lead, Pb	mg/kg	0.5	29	12	21	58
Zinc, Zn	mg/kg	0.5	68	33	38	52

Mercury in Soil Method: AN312 Tested: 23/4/2018

Mercury	mg/kg	0.01	0.01	0.02	0.02	0.03
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MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Mercury in Soil Method: ME-(AU)-[ENV]AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB055607	mg/kg	0.01	<0.01	0%	102%	95%
	LB055735	mg/kg	0.01	<0.01	0%	102%	

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: ME-(AU)-[ENV]AN248

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Nitrate/Nitrite Nitrogen, NOx as N	LB055469	mg/kg	0.1	<0.1	0 - 8%	106 - 107%

Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges Method: ME-(AU)-[ENV]AN281

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Kjeldahl Nitrogen	LB055465	mg/kg	5	<5	5 - 6%	93 - 95%

Total Phosphorus by Kjeldahl Digestion DA in Soil Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Phosphorus (Kjeldahl Digestion)	LB055465	mg/kg	2	<2	1%	98 - 100%

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: ME-(AU)-[ENV]AN040/AN320

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Silver, Ag	LB055415	mg/kg	0.2	<0.2	0%	108%
	LB055416	mg/kg	0.2	<0.2	0%	95%
Arsenic, As	LB055415	mg/kg	0.5	<0.5	21%	102%
	LB055416	mg/kg	0.5	<0.5	10%	102%
Cadmium, Cd	LB055415	mg/kg	0.1	<0.1	0%	101%
	LB055416	mg/kg	0.1	<0.1	0%	102%
Chromium, Cr	LB055415	mg/kg	0.5	<0.5	1%	102%
	LB055416	mg/kg	0.5	<0.5	0%	104%
Copper, Cu	LB055415	mg/kg	0.5	<0.5	3%	103%
	LB055416	mg/kg	0.5	<0.5	2%	104%
Nickel, Ni	LB055415	mg/kg	0.5	<0.5	1%	99%
	LB055416	mg/kg	0.5	<0.5	1%	101%
Lead, Pb	LB055415	mg/kg	0.5	<0.5	6%	100%
	LB055416	mg/kg	0.5	<0.5	1%	100%
Zinc, Zn	LB055415	mg/kg	0.5	<0.5	2%	102%
	LB055416	mg/kg	0.5	<0.5	0%	97%

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Water Soluble ortho Phosphorus in Soil Method: ME-(AU)-[ENV]AN278

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Water Soluble ortho Phosphorus, P*	LB055498	mg/kg	0.05	<0.05	1 - 2%	94%

METHOD

METHODOLOGY SUMMARY

AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN005	The particle size distribution of a soil is determined by wet sieving, using a maximum of 900 mL of deionised water to sieve all fractions down to 75 µm. Referenced to AS1289.3.6.1 and AS1141.11.
AN040/AN320	A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.
AN248	Nitrate / Nitrite in extract by Auto Analyser: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Reference APHA 4500-NO ₃ - F.
AN278	Reactive Phosphorus in extract by DA: Orthophosphate reacts with ammonium molybdate (Mo VI) and potassium antimonyl tartrate (Sb III) in acid medium to form an antimony-phosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue colour and the absorbance is read at 880 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-P G
AN281	The sample is heated in the presence of Sulphuric acid, K ₂ SO ₄ and CuSO ₄ for two and half hours using a temperature controlled digestion block. Amino Nitrogen of many organic materials is converted to ammonium ion. Free ammonia also is converted to ammonium. The digest is cooled and placed on the Aquakem 250 discrete analyser for Ammonia determination.
AN312	Mercury by Cold Vapour AAS in Soils: After digestion with nitric acid, hydrogen peroxide and hydrochloric acid, mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
		-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.

Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the "Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.

Note that in terms of units of radioactivity:

- 1 Bq is equivalent to 27 pCi
- 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : <http://www.sgs.com.au/~media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf>

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Project **Ardmore REMP SW**
 Order Number **17_191**
 Samples **4**

LABORATORY DETAILS

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SGS Reference **CE132675 R0**
 Date Received **28 Mar 2018**
 Date Reported **12 Apr 2018**

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(3146).

Uranium subcontracted to SGS Sydney, Unit 16 33 Maddox St Alexandria NSW 2015, NATA Accreditation Number: 2562, Site Number: 4354, SE
 For determination of soluble metals, filtered sample was not received so samples were laboratory filtered on receipt. This may give soluble metals results that do not represent the concentrations present at the time of sampling.

SIGNATORIES



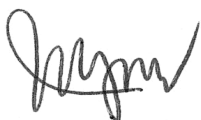
Anthony Nilsson
 Operations Manager



Jon Dicker
 Manager Northern QLD



Leanne Orsmond
 Quality & Microbiology Coordinator



Maristela Ganzan
 Metals Team Leader

Parameter	Units	LOR	Sample Number	CE132675.001	CE132675.002	CE132675.003	CE132675.004
			Sample Matrix	Water	Water	Water	Water
			Sample Date	20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
			Sample Name	ARD4	ARD5	ARD6	QA

pH in water Method: AN101 Tested: 29/3/2018

pH**	pH Units	0.1	7.8	7.0	7.4	8.0
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Conductivity and TDS by Calculation - Water Method: AN106 Tested: 29/3/2018

Conductivity @ 25 C	µS/cm	5	380	110	190	390
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Alkalinity Method: AN135 Tested: 29/3/2018

Total Alkalinity as CaCO ₃	mg/L	5	170	49	120	170
Bicarbonate Alkalinity as CaCO ₃	mg/L	5	170	49	120	170
Carbonate Alkalinity as CaCO ₃	mg/L	5	<5	<5	<5	<5
Hydroxide Alkalinity as CaCO ₃	mg/L	5	<5	<5	<5	<5

Chloride by Discrete Analyser in Water Method: AN274 Tested: 3/4/2018

Chloride, Cl	mg/L	1	23	4	9	23
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Total and Volatile Suspended Solids (TSS / VSS) Method: AN114 Tested: 9/4/2018

Total Suspended Solids Dried at 103-105°C	mg/L	5	38	24	10	26
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Fluoride by Ion Selective Electrode in Water Method: AN141 Tested: 29/3/2018

Fluoride by ISE	mg/L	0.1	0.1	0.1	0.1	0.1
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Parameter	Units	LOR	Sample Number	CE132675.001	CE132675.002	CE132675.003	CE132675.004
			Sample Matrix	Water	Water	Water	Water
			Sample Date	20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
			Sample Name	ARD4	ARD5	ARD6	QA

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser Method: AN248 Tested: 9/4/2018

Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
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TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 3/4/2018

Total Kjeldahl Nitrogen	mg/L	0.05	1.2	1.3	0.73	1.2
Total Nitrogen (calc)	mg/L	0.05	1.2	1.3	0.73	1.2
Organic Nitrogen (calc)	mg/L	0.05	-	-	-	-

Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293(Sydney only) Tested: 3/4/2018

Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	0.10	0.32	0.11	0.09
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Filterable Reactive Phosphorus (FRP) Method: AN278 Tested: 6/4/2018

Filterable Reactive Phosphorus	mg/L	0.005	0.016	0.049	0.016	0.015
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Metals in Water (Dissolved) by ICPOES Method: AN320 Tested: 10/4/2018

Aluminium, Al	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
Calcium, Ca	mg/L	0.2	26	10	15	29
Magnesium, Mg	mg/L	0.1	14	3.0	5.7	14
Zinc, Zn	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Total Hardness by Calculation	mg CaCO3/L	1	120	38	61	130

Metals in Water (Total) by ICPOES Method: AN022/AN320 Tested: 10/4/2018

Total Aluminium	mg/L	0.02	<0.02	0.15	<0.02	<0.02
Total Calcium	mg/L	0.05	38	11	15	38
Total Magnesium	mg/L	0.05	14	3.1	5.7	14
Total Potassium	mg/L	0.05	13	7.8	9.3	13
Total Sodium	mg/L	0.5	27	3.2	9.7	27
Total Sulphur as Sulfate, SO4	mg/L	0.5	1.3	3.5	2.4	1.2
Total Zinc	mg/L	0.005	<0.005	<0.005	<0.005	<0.005

Parameter	Units	LOR	Sample Number	CE132675.001	CE132675.002	CE132675.003	CE132675.004
			Sample Matrix	Water	Water	Water	Water
			Sample Date	20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
			Sample Name	ARD4	ARD5	ARD6	QA

Metals in Water (Dissolved) by ICPOES-USN Method: AN320/AN322 Tested: 10/4/2018

Arsenic, As	mg/L	0.003	<0.003	<0.003	<0.003	<0.003
Cadmium, Cd	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium, Cr	mg/L	0.001	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt, Co	mg/L	0.001	0.002	0.002	0.003	0.002
Copper, Cu	mg/L	0.001	0.002	0.001	0.001	0.003
Lead, Pb	mg/L	0.001	0.001	<0.001	0.001	<0.001
Nickel, Ni	mg/L	0.001	0.002	0.001	0.001	0.002

Metals in Water (Total) by ICPOES-USN Method: AN320/AN322 Tested: 10/4/2018

Total Arsenic, As	mg/L	0.003	<0.003	<0.003	<0.003	<0.003
Total Cadmium, Cd	mg/L	0.0001	<0.0001	<0.0001	0.0001	<0.0001
Total Chromium, Cr	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Total Cobalt, Co	mg/L	0.001	0.003	0.003	0.004	0.002
Total Copper, Cu	mg/L	0.001	0.003	0.002	0.002	0.003
Total Lead, Pb	mg/L	0.001	0.002	0.003	0.002	0.002
Total Nickel, Ni	mg/L	0.001	0.002	0.002	0.001	0.002

Mercury (dissolved) in Water Method: AN311(Perth)/AN312 Tested: 4/4/2018

Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005
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Mercury (total) in Water Method: AN311(Perth) /AN312 Tested: 4/4/2018

Total Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005
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Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 29/3/2018

Uranium, U	µg/L	1	<1	<1	<1	<1
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Trace Metals (Total) in Water by ICPMS Method: AN022/AN318 Tested: 29/3/2018

Total Uranium	µg/L	1	<1	<1	<1	<1
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Parameter	Sample Number		CE132675.001	CE132675.002	CE132675.003	CE132675.004
	Sample Matrix		Water	Water	Water	Water
	Sample Date		20 Mar 2018	20 Mar 2018	20 Mar 2018	20 Mar 2018
	Sample Name		ARD4	ARD5	ARD6	QA
Units	LOR					

Calculation of Anion-Cation Balance (SAR Calc) Method: AN121 Tested: 12/4/2018

Sum of Cation Milliequivalents*	meq/L	-	3.95	1.11	1.89	4.10
Sum of Anion Milliequivalents*	meq/L	-	4.05	1.18	2.61	4.11
Anion-Cation Balance	%	-100	-1.2	-	-	-0.2

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Alkalinity Method: ME-(AU)-[ENV]AN135

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Alkalinity as CaCO ₃	LB054935	mg/L	5	<5	1%	102%
Bicarbonate Alkalinity as CaCO ₃	LB054935	mg/L	5	<5		
Carbonate Alkalinity as CaCO ₃	LB054935	mg/L	5	<5		
Hydroxide Alkalinity as CaCO ₃	LB054935	mg/L	5	<5		

Chloride by Discrete Analyser in Water Method: ME-(AU)-[ENV]AN274

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Chloride, Cl	LB055009	mg/L	1	<1	0 - 2%	97 - 101%

Conductivity and TDS by Calculation - Water Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity @ 25 C	LB054935	µS/cm	5	<5	0 - 2%	99%

Filterable Reactive Phosphorus (FRP) Method: ME-(AU)-[ENV]AN278

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Filterable Reactive Phosphorus	LB055133	mg/L	0.005	<0.005	2 - 5%	98 - 99%

Fluoride by Ion Selective Electrode in Water Method: ME-(AU)-[ENV]AN141

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Fluoride by ISE	LB054935	mg/L	0.1	<0.1	96%

Mercury (dissolved) in Water Method: ME-(AU)-[ENV]AN311(Perth)/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB055061	mg/L	0.00005	<0.00005 - <5	0%	107 - 118%	108 - 117%

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Mercury (total) in Water Method: ME-(AU)-[ENV]AN311(Perth) /AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Mercury	LB055060	mg/L	0.00005	<5e-005	0%	97 - 108%	96 - 106%

Metals in Water (Total) by ICPOES Method: ME-(AU)-[ENV]AN022/AN320

Parameter	QC Reference	Units	LOR	DUP %RPD	LCS %Recovery	MS %Recovery
Total Aluminium	LB055239	mg/L	0.02	0%	97%	110%
Total Calcium	LB055239	mg/L	0.05	1%	98%	105%
Total Magnesium	LB055239	mg/L	0.05	1%	96%	105%
Total Potassium	LB055239	mg/L	0.05	1%	101%	118%
Total Sodium	LB055239	mg/L	0.5	1%	100%	107%
Total Sulphur as Sulfate, SO4	LB055239	mg/L	0.5	1%	97%	NA
Total Zinc	LB055239	mg/L	0.005	0%	106%	114%

Metals in Water (Dissolved) by ICPOES Method: ME-(AU)-[ENV]AN320

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium, Al	LB055238	mg/L	0.02	<0.02	0%	97%	107%
Calcium, Ca	LB055238	mg/L	0.2	<0.2	1%	98%	104%
Magnesium, Mg	LB055238	mg/L	0.1	<0.1	1%	96%	105%
Zinc, Zn	LB055238	mg/L	0.005	<0.005	0%	105%	112%
Total Hardness by Calculation	LB055238	mg CaCO3/L	1	<1			

Metals in Water (Dissolved) by ICPOES-USN Method: ME-(AU)-[ENV]AN320/AN322

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Arsenic, As	LB055240	mg/L	0.003	<0.003	0%	97%	108%
Cadmium, Cd	LB055240	mg/L	0.0001	<0.0001	0%	106%	107%
Chromium, Cr	LB055240	mg/L	0.001	<0.0010	0%	106%	114%
Cobalt, Co	LB055240	mg/L	0.001	<0.001	3%	106%	109%
Copper, Cu	LB055240	mg/L	0.001	<0.001	9%	102%	
Lead, Pb	LB055240	mg/L	0.001	<0.001	0%	108%	109%
Nickel, Ni	LB055240	mg/L	0.001	<0.001	14%	105%	107%

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Metals in Water (Total) by ICPOES-USN Method: ME-(AU)-[ENV]AN320/AN322

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Arsenic, As	LB055242	mg/L	0.003	<0.003	0%	95%	105%
Total Cadmium, Cd	LB055242	mg/L	0.0001	<0.0001	0%	105%	98%
Total Chromium, Cr	LB055242	mg/L	0.001	<0.001	0%	105%	104%
Total Cobalt, Co	LB055242	mg/L	0.001	<0.001	7%	103%	97%
Total Copper, Cu	LB055242	mg/L	0.001	<0.001	4%	103%	
Total Lead, Pb	LB055242	mg/L	0.001	<0.001	0%	106%	102%
Total Nickel, Ni	LB055242	mg/L	0.001	<0.001	2%	102%	100%

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser Method: ME-(AU)-[ENV]AN248

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Nitrate/Nitrite Nitrogen, NOx as N	LB055148	mg/L	0.005	<0.005	0 - 9%	101 - 103%

pH in water Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH**	LB054935	pH Units	0.1	5.2	0 - 1%	101%

TKN Kjeldahl Digestion by Discrete Analyser Method: ME-(AU)-[ENV]AN281

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Kjeldahl Nitrogen	LB055004	mg/L	0.05	<0.05	1 - 7%	97 - 99%

Total and Volatile Suspended Solids (TSS / VSS) Method: ME-(AU)-[ENV]AN114

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Suspended Solids Dried at 103-105°C	LB055198	mg/L	5	<5	0 - 4%	93%	87 - 95%

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Total Phosphorus by Kjeldahl Digestion DA in Water Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Phosphorus (Kjeldahl Digestion)	LB055004	mg/L	0.02	<0.02	0 - 7%	112%

Trace Metals (Dissolved) in Water by ICPMS Method: ME-(AU)-[ENV]AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD
Uranium, U	LB054960	µg/L	1	<1	0%

Trace Metals (Total) in Water by ICPMS Method: ME-(AU)-[ENV]AN022/AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD
Total Uranium	LB054961	µg/L	1	<1	0%

METHOD

METHODOLOGY SUMMARY

AN022/AN318	Following acid digestion of un filtered sample, determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN022/AN320	Total (acid soluble) Metals by ICP-OES: Samples are digested in nitric or nitric and hydrochloric acids prior to analysis for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as $\mu\text{mhos/cm}$ or $\mu\text{S/cm}$ @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
AN106	Salinity may be calculated in terms of NaCl from the sample conductivity. This assumes all soluble salts present, measured by the conductivity, are present as NaCl.
AN114	Total Suspended and Volatile Suspended Solids: The sample is homogenised by shaking and a known volume is filtered through a pre-weighed GF/C filter paper and washed well with deionised water. The filter paper is dried and reweighed. The TSS is the residue retained by the filter per unit volume of sample. Reference APHA 2540 D. Internal Reference AN114
AN121	This method is used to calculation the balance of major Anions and Cations in water samples and converts major ion concentration to milliequivalents and then summed. Anions sum and Cation sum is calculated as a difference and expressed as a percentage.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135
AN141	Determination of Fluoride by ISE: A fluoride ion selective electrode and reference electrode combination, in the presence of a pH/complexation buffer, is used to determine the fluoride concentration. The electrode millivolt response is measured logarithmically against fluoride concentration. Reference APHA F- C.
AN248	Nitrate / Nitrite by Auto Analyser: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Reference APHA 4500-NO ₃ - F.
AN274	Chloride by Aquakem DA: Chloride reacts with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference APHA 4500Cl-
AN278	Filterable Reactive Phosphorus by DA (determined on filtered sample): Orthophosphate reacts with ammonium molybdate (Mo VI) and potassium antimonyl tartrate (Sb III) in acid medium to form an antimony-phosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue colour and the absorbance is read at 880 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-P F

METHOD

METHODOLOGY SUMMARY

AN279/AN293(Sydney)	The sample is digested with Sulphuric acid, K ₂ SO ₄ and CuSO ₄ . All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis.
AN281	An unfiltered water or soil sample is first digested in a block digester with sulfuric acid, K ₂ SO ₄ and CuSO ₄ . The ammonia produced following digestion is then measured colourimetrically using the Aquakem 250 Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample.
AN311(Perth) /AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions taken from unfiltered sample are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN311(Perth)/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN320	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.
AN320	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.
AN320/AN322	ICP-OES (Ultrasonic Nebuliser): After preservation with 10% nitric acid, a wide range of metals and some non-metals in solution can be measured by ICP- Ultrasonic nebulisation. Solutions are aspirated using an ultrasonic nebuliser into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.
AN320/AN322	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B
AN322	ICP-OES (Ultrasonic Nebuliser): After preservation with 10% nitric acid, a wide range of metals and some non-metals in solution can be measured by ICP- Ultrasonic nebulisation. Solutions are aspirated using an ultrasonic nebuliser into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.
AN322	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B
Calculation	Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO ₂ D.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
		-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.

Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the "Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.

Note that in terms of units of radioactivity:

- 1 Bq is equivalent to 27 pCi
- 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : <http://www.sgs.com.au/~media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf>

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