MOOREBANK PRECINCT EAST STAGE 2: BIODIVERSITY MONITORING IN ANZAC CREEK

SPRING 2024 SURVEY

Final Report Prepared for
ARCADIS

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BIO-ANALYSIS Pty Ltd
Marine & Freshwater Ecology
2/1 Botham Close, Charmhaven, NSW 2263
(Mobile) 0414 477 066; (Email) info@bioanalysis.com.au

Document Information

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Prepared for	Arcadis Australia Pacific
Prepared by	Dr Sharon Cummins
Reviewed by	Dr Dan Roberts
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Contact Information

Dr Sharon Cummins
Telephone: 043 811 2962
Email: cumminssharon@bigpond.com

Dr Dan Roberts
Telephone: 0414 477 066
Email: dan@bioanalysis.com.au

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EXECUTIVE SUMMARY

Introduction

The Sydney Intermodal Terminal Alliance (SIMTA) received approval for the construction and operation of Stage 2 (the Project) of the Moorebank Precinct East (MPE) Project, which comprises the second stage of development under the MPE Concept Approval (MP10_0193) and approved under Development Approval SSD 7628.

SIMTA was the original applicant for Stage 1 (SSD 6766) and Stage 2 (SSD 7628), under the MPE Concept Approval. The applicant for the SSD 7628 has been updated to "The Trust Company Limited" (ACN 004 027 749). In 2022, LOGOS Property took over the management of the warehouse and distribution facilities, as well as the overall management of the Moorebank Intermodal East and West Precincts. In July 2024, ESR Group acquired the remaining interest in LOGOS, and overall management of the MIP East Precinct, is now the responsibility of ESR Australia & NZ (ESR). Qube Logistics will continue to maintain responsibility for the IMEX and the Rail Link.

The MPE site, including the Project site, is located approximately 27 km south-west of the Sydney Central Business District (CBD) and approximately 26 km west of Port Botany and includes the former Defence National Storage and Distribution Centre (DNSDC) site. The MPE site is situated within the Liverpool Local Government Area (LGA), in Sydney's Southwest subregion, approximately 2.5 km from the Liverpool City Centre.

The MPE Project involves the development of an intermodal facility including warehouse and distribution facilities, freight village (ancillary site and operational services), stormwater infrastructure, landscaping, servicing and associated works on the eastern side of Moorebank Avenue. Stage 2 of the MPE Project (MPES2) involves the construction and operation of warehousing and distribution facilities on the MPE site and upgrades to approximately 2.1 kilometres of Moorebank Avenue.

Water during construction will be managed in accordance with the currently approved Construction Environmental Management Plan (CEMP) and will be discharged into the sediment (SED) Basins and into Anzac Creek (via DP5 and DP7).

It was also considered likely that runoff from some areas of the MPES2 site would be collected by a vegetated dam situated within Commonwealth Department of Defence land. Flow from this dam enters Anzac Creek upstream of Site AQ14 via a culvert.

A Baseline Aquatic Ecological Monitoring Program (BAEMP) was developed by Biosis Pty Ltd for Arcadis in March 2018, to address CoC B106. The purpose of the BAEMP was to establish baseline stream health and water quality conditions within selected sites along Anzac Creek prior to commencement of Early Works. This was undertaken in autumn 2018. Construction activities commenced soon after.

The baseline monitoring forms the basis for the ongoing Biodiversity Monitoring Strategy (BMS) to assess stream health in accordance with CoC B106, to determine any change in stream health or water quality throughout the life of the Project and to ascertain whether these changes can be attributed to the Project works. The BMS outlines monitoring requirements and includes the Stormwater Monitoring Strategy required by CoC B43 and B44.

BIO-ANALYSIS Pty Ltd was commissioned by Arcadis on behalf of Tactical Group to assess stream health and water quality at six monitoring sites along Anzac Creek (the Study Area) in spring 2024, in accordance with the BMS.

Methods

The BMS focusses on four main indicators: i) aquatic habitat, including riparian habitat, aquatic macrophytes and fish habitat; ii) surface water quality and sediment characteristics; iii) aquatic macroinvertebrates sampled using the Australian River Assessment System (AUSRIVAS) protocol; and iv) fish sampled using a backpack electro-fisher.

The primary aim of monitoring is to determine whether any change in stream health or water quality occur throughout the life of the MPE Project in accordance with the BMS and to ascertain whether these changes can be attributed to the Project works. Should an indicator variable deteriorate below the range for its baseline value, a stream health investigation protocol is to be initiated under the BAEMPs Adaptive Management Plan.

The sampling design included six sites (approximately 100 m in length). Site AQ1 is situated upstream of the MPE Project. Sites AQ4, AQ8, AQ12, AQ13 and AQ14 are situated at increasing distances downstream of the MPE Project. Stream health monitoring is to be done on two occasions within each of autumn and spring.

The results of the spring 2024 monitoring event were compared with those obtained in autumn 2018 (baseline), spring 2018, autumn and spring 2019, autumn and spring 2020, autumn and spring 2021, autumn and spring 2022, autumn and spring 2023 and autumn 2024 (during construction).

Results

This report presents the results of i) spring 2024 surveys 1 and 2 and ii) comparisons of the findings of the current survey with the Baseline survey (autumn 2018) and subsequent surveys done each autumn and spring.

Within the current reporting period (spring 2024), no construction discharges occurred. Extensive cover by vegetation within the riparian zone and stream channel contribute stability to the refuge pool and the majority of Anzac Creek.

Concentrations of lead in sediments collected at Site AQ1 (range = 21 to 130 mg/kg) continue to exceed the guideline value (50 mg/kg), including at the time of the baseline (91 mg/kg) survey. Copper, nickel and zinc have occasionally exceeded guideline values, but total petroleum hydrocarbons and poly-fluoroalkyl substances (e.g. PFAS and PFOS), continue to comply. Site AQ1 is situated upstream of potential inputs from the Project, so no additional testing at this site is considered necessary.

Reduced dissolved oxygen levels, elevated nitrogen, aluminium and copper measured at the refuge pool (Site AQ12), including prior to commencement of the Project, have consistently suggested that aquatic habitat and biota within Anzac Creek are influenced by various types of anthropogenic disturbance. Importantly, the data collected to date indicate that there has been no further degradation of water quality since the Project related construction work began.

Over the course of the monitoring programme, the diversity of aquatic macroinvertebrates, Australian River Assessment System (AUSRIVAS) and Stream Invertebrate Grade Number Average Level (SIGNAL2) scores have been relatively low, indicating that the aquatic macroinvertebrate fauna have experienced one or more forms of human impact. Despite this, some pollution tolerant taxa have commonly been identified, including dragonfly, caddis fly and mayfly families. Importantly, comparison of the AUSRIVAS and SIGNAL2 scores between the baseline and construction phase continue to indicate an overall stability in aquatic health.

Altogether, ten species of fish have been collected from within the refuge pool: three native species of gudgeon, two native species of eel, one native galaxiid species, one native cat-fish species and three introduced species (Gambusia, Goldfish and Oriental weatherloach), confirming that the creek does provide some habitat for native species of fish. All of the species caught are common within NSW. No threatened species of fish listed under the *NSW Fisheries Management Act, 1994* or the *Environment Protection and Biodiversity Conservation Act, 1999* have been recorded.

Conclusions

Examination of the results from the spring 2024 monitoring event found no evidence of changes in the indicator variables (bed and bank stability, surface water and sediment quality, assemblages of aquatic macroinvertebrates and fish) that could be attributed to the Project works. Thus, in accordance with the Biodiversity Monitoring Strategy, no adaptive management contingency measure was triggered.

Recommendations

It is recommended that the stream health monitoring programme is continued using the methods employed for baseline and operation phase surveys, to ensure continuity of the program. In addition, it is recommended that Land Managers focus on containment and on-going suppression of the Alligator Weed infestation at Site AQ1 and downstream habitats, and the aquarium plant, Egeria, detected within the refuge pool at Site AQ12. Signage and public information at popular points of entry by the public to the creek and other local waterways may reduce the chance of unintentional human-assisted introductions (e.g. by using live bait, or by being released by aquaria) of aquatic plants and fish.

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1.0 INTRODUCTION

The Sydney Intermodal Terminal Alliance (SIMTA) received approval for the construction and operation of Stage 2 (the Project) of the Moorebank Precinct East (MPE) Project, which comprises the second stage of development under the MPE Concept Approval (MP10_0193) and approved under Development Approval SSD 7628.

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The MPE Project involves the development of an intermodal facility including warehouse and distribution facilities, freight village (ancillary site and operational services), stormwater infrastructure, landscaping, servicing and associated works on the eastern side of Moorebank Avenue. Stage 2 of the MPE Project involves the construction and operation of warehousing and distribution facilities on the MPE site and upgrades to approximately 2.1 kilometres of Moorebank Avenue. Warehouses 1, 3, 4, 5, 7a and 7b are now operational. The next warehouse to be constructed is WH2, which is currently planned for Q4 2025. Water during construction will continue to be managed in accordance with the currently approved CEMP and will be discharged into the sediment (SED) Basins and discharged into Anzac Creek (via DP5 and DP7).

BIO-ANALYSIS Pty Ltd has been commissioned by Arcadis on behalf of Tactical Group to assess stream health and water quality along Anzac Creek (the Study Area) in spring 2024.

Monitoring is to be done in accordance with a Biodiversity Monitoring Strategy (BMS) developed by Biosis (2018) to satisfy the Minister's Conditions of Consent (CoC) B106. The BMS also includes the Stormwater Monitoring Strategy required by CoC B43 and B44.

The primary aim of monitoring is to determine whether any change in stream health or water quality occur throughout the life of the MPE Stage 2 (MPES2) Project in accordance with the BMS and to ascertain whether these changes can be attributed to the Project works. Sampling commenced in autumn 2018 (Biosis, 2018).

2.0 METHODS

2.1 Study Area

Anzac Creek is a small tributary of the Georges River and lies entirely within the Liverpool Local Government Area. The catchment covers an area of approximately 10.6 km^2 (Figure 1).

The headwaters of Anzac Creek lie within the Commonwealth Department of Defence Lands in Moorebank. The creek is approximately 4 km long and highly urbanised: it flows past the suburb of Wattle Grove, underneath the M5 and Heathcote Road intersection, through the Moorebank Industrial Area and underneath Newbridge Road.

While predominantly ephemeral, Anzac Creek has been noted to hold permanent water in isolated pools (Arcadis, 2016). An unnamed first order tributary of Anzac Creek flows from south to north along the eastern boundary of the MPE Project area (GHD, 2016).

Surface water from the MPES2 site was expected to enter Anzac Creek as a licensed discharge between Site AQ4 and AQ8 (Figure 1). It was also considered likely that runoff from some areas of the MPES2 site would be collected by a vegetated dam situated within Commonwealth Department of Defence land (Biosis, 2018). Flow from this dam enters Anzac Creek upstream of Site AQ14 via a culvert (Figure 1).

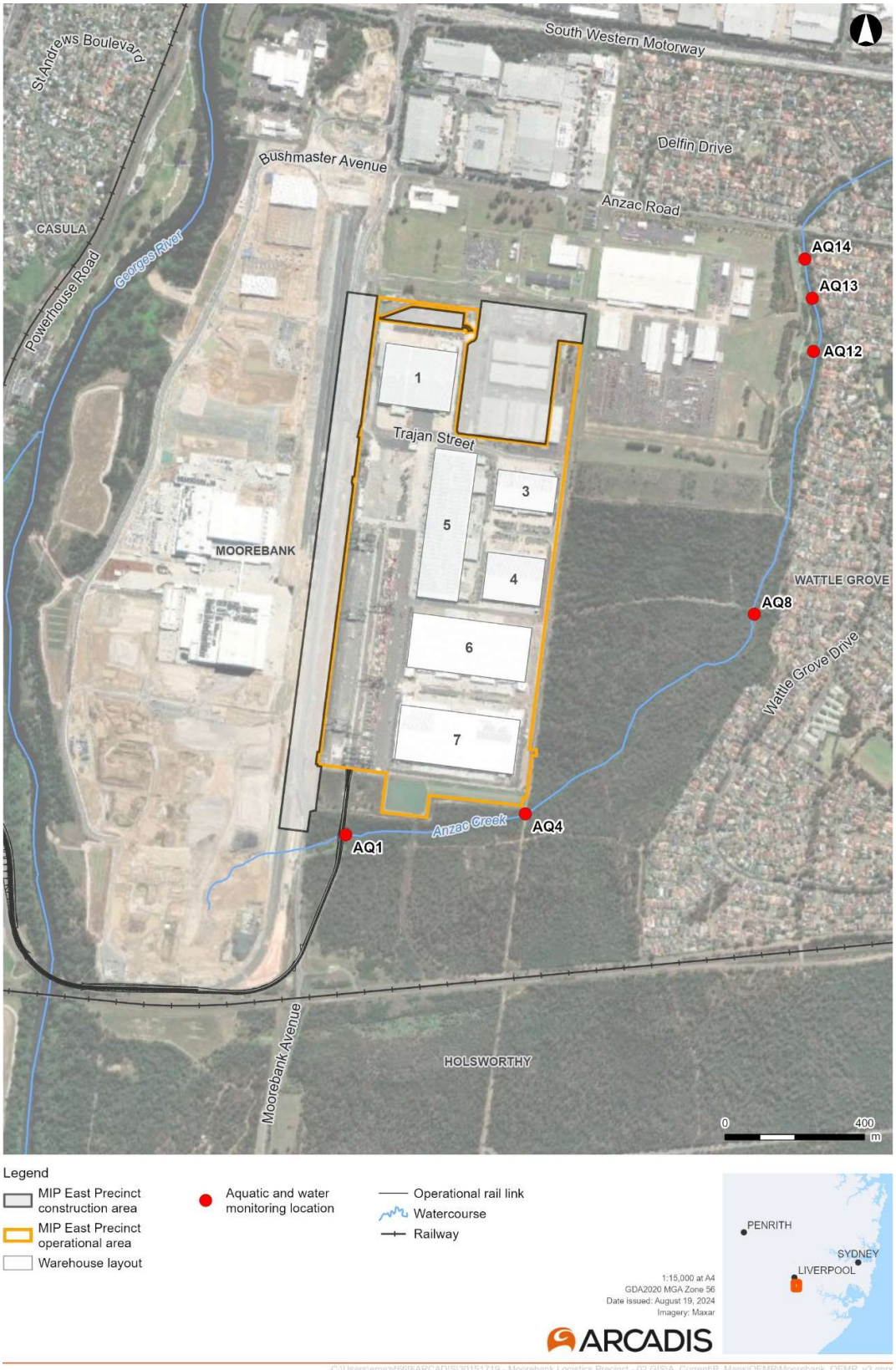

Figure 1. Project Location

2.2 Sampling Dates

The dates and phases of the stream health monitoring program for the MPES2 Project are outlined in Table 1.

Table 1. Date and information on aquatic ecology monitoring completed for the Project.

Project Phase	Event	Dates	Comments
Baseline	Autumn 2018	12&19 April 2018	Only one Baseline survey was able to be sampled in autumn 2018, due to the May 2018 bushfire.
Construction	Spring 2018	6&12 December 2018	
Construction	Autumn 2019	14&30 May 2019	Construction of culvert upstream of Site AQ1 largely completed on 30 May 2019. Site AQ12 was inaccessible to undertake Survey 2 due to restricted access.
Construction	Spring 2019	24 September 2019 21 November 2019	Warehouses 3 and 4 under construction. Moorebank Ave upgrade works ongoing.
Construction /Operation	Autumn 2020	25 May 2020 2 September 2020	Sampling required for the autumn 2020 survey season was unable to commence until late May 2020 due to COVID-19 related delays. The second survey was further delayed due to the time taken to receive parts required to repair the Electrofisher. Warehouses 3 and 4 were operational whilst Warehouse 5 was under construction. Moorebank Ave upgrade works ongoing.
Construction /Operation	Spring 2020	11&30 November 2020	Warehouses 3, 4 and 5 were operational. No further warehouses were being constructed at the time of monitoring
Construction /Operation	Autumn 2021	28 April 2021 11 June 2021	Warehouses 3, 4 and 5 are now operational and the location of Warehouses 6-8 have been left as compacted pads. Any water sheets off into the SED Basin and discharges into ANZAC Creek (via DP5 and DP7). No warehouses were being constructed at the time of monitoring.
Construction /Operation	Spring 2021	21 September 2021 8 November 2021	As above
Construction /Operation	Autumn 2022	5 & 31 May 2022	As above
Construction /Operation	Spring 2022	10 October 2022 30 November 2022	Following a redesign of MPE, only Warehouses 6 and 7 will be constructed within the area designated for Warehouses 6-8. Warehouse 8 will no longer be constructed. Warehouses 6&7 earthworks commenced on 9/06/22.
Construction /Operation	Autumn 2023	18 May & 3 July 2023	Warehouses 6&7 earthworks completed. It is expected that these warehouses will become operational in Q3 of 2023.

Table 2. (Cont'd)

Project Phase	Event	Dates	Comments
Construction /Operation	Spring 2023	20 September & 15 November 2023	Warehouse 7a is now operational. Operation of Warehouse 6 and 7b are expected to commence in Quarter 4 of 2023 and Quarter 2 2024.
Construction /Operation	Autumn 2024	8 & 28 May 2024	Operation of Warehouse 7b and 7a and 6 commenced in Quarter 4 of 2023 and Quarter 3 2024, respectively. The final warehouse to be constructed is WH2, likely to occur in late 2025.
Construction /Operation	Spring 2024	24 September & 19 November 2024	The final warehouse to be constructed is WH2, likely to occur in Q4 2025.

2.3 Performance Measures and Indicators

No instream or riparian works are being undertaken as part of the Project. Alteration to hydrology (increased stormwater inputs from both the stormwater network and surface flows from increases in non-permeable surfaces) and earthworks that have the potential to mobilise sediments into Anzac Creek were identified as potential impacts associated with the construction phase of the project (Biosis, 2018).

Biosis (2018) indicated that increased stormwater inputs to Anzac Creek could result in:

- Bed and bank scour as a result of increased volume and velocity of water during rainfall events;
- Alterations in vegetation structure as a result of altered hydrological regime;
- Introduction of sediments and pollutants via stormwater, with common pollutants including nitrogen, phosphorous, copper, aluminium and zinc.

Water Sensitive Urban Design (WSUD) measures such as onsite detention basins and rainwater gardens were incorporated into designs for the Project to mitigate impacts. A key outcome of this monitoring program was to determine whether these measures functioned as intended. Six monitoring sites (Sites AQ1, AQ4, AQ8, AQ12, AQ13 and AQ14 (Figure 1) are to be assessed in accordance with the BMS to satisfy the CoC B43, B44 and B106 (Table 2). The assessment types to be applied at each site are outlined in Table 2.

Should an indicator variable deteriorate below the range for its baseline value, a stream health investigation protocol is to be initiated under the BAEMPs Adaptive Management (Table 3).

Baseline values are presented in Table 4, Table 5 and Table 6 (Results).

Table 3. Assessment types recommended for each monitoring site (Biosis, 2018).

Assessment Type	Assessment Protocol/ Indicator Variable	AQ1	AQ4	AQ8	AQ12	AQ13	AQ14
Visual	DPI Classification	√	√	√	√	√	√
	NSW AUSRIVAS	√	√	√	√	√	√
	HABSCORE	√	√	√	√	√	√
	Ephemeral Stream Assessment	√	√	√	√	√	√
Surface Water & Sediment Quality Monitoring	*In situ* water quality				√		
	Nutrient, dissolved metal & PFAS				√		
	Sediment & PFAS	√	√				√
Aquatic Macroinvertebrates	NSW AUSRIVAS & Signal2				√		
Fish	Assemblage structure				√		

Table 4. Indicator variables and adaptive management contingency measures.

Result	Potential Problem	Contingency measure
Increases in results of water quality parameters	Introduction or exacerbation of pollutants entering Anzac Creek.	Identify source and undertake corrective measures.
Reduction in results of biological monitoring	Subtle effects of construction and operation are influencing stream health within Anzac Creek.	Identify components causing decline. Assess feasibility of suitable corrective actions. If corrective measures can be implemented, these aspects are to be the focus of future monitoring. If corrective measures cannot be implemented, regulatory authority to be notified of change.
Increase scour of bed and banks of waterways	Reduction in bed and bank stability or loss of instream vegetation.	Identify point source/s of increased flow velocities or changes in stream hydraulics and discuss with project engineers to determine best methods for flow reduction or rectification of stream hydraulics

2.4 Field Methods

To fulfil the requirements of the BMS, monitoring is to be undertaken at 6 sites along Anzac Creek (Figure 1) four times annually during the pre-construction and construction phases of the Project, with the frequency reduced to twice annually during the operational phase of the Project. Surveys should take place during autumn and spring (Biosis, 2018). Sites are to be assessed using the methods outlined below, in accordance with Table 2.

2.4.1 Visual Stream Assessments

A visual assessment was undertaken at each site regardless of the availability of aquatic habitat (i.e. wet or dry). The condition of aquatic habitat at each site was assessed according to the *NSW Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management* (DPI NSW, 2013). The two key indices were habitat *type* and *class*.

Information on stream characteristics was recorded at each site in accordance with the New South Wales (NSW) Australian River Assessment System (AUSRIVAS) protocol (Turak et al., 2004). Characteristics recorded included a visual assessment of surrounding landforms, instream features, presence, extent and type of aquatic vegetation, stream substratum, potential areas of refuge during low flow periods, presence of fish habitat, presence of barriers to fish movement, indicators of point source and diffuse pollution.

HABSCORE assessments were also completed at each site, based on the presence and condition of pool substratum characteristics, pool variability, channel flow status, bank vegetation and stability, width of riparian zone, and epifaunal substrate/cover. The *CSIRO Ephemeral Stream Assessment* guideline was also used to provide an assessment of the geomorphic integrity of each site and to identify the processes operating within each site.

Each site was photographed and the locations recorded with a hand-held GPS (satellite-based Global Positioning System).

2.4.2 Surface Water Quality & Sediment Monitoring

Where sufficient amounts of water were present, *in situ* water quality was measured using a Yeo-Kal 618 probe. Physico-chemical properties measured included electrical conductivity (µS/cm), dissolved oxygen (% saturation and mg/L), pH (pH units), temperature (ºC) and turbidity (NTU). Three replicate measures of each variable were collected from just below the water surface at each site.

Alkalinity was also determined in the field at Site AQ12, using a CHEMetrics' total alkalinity field kit.

As required by the BMS, water chemical and sediment sampling were undertaken for a range of nutrients, metals and hydrocarbons:

- Total Phosphorus (surface water only);
- Total Kjeldahl Nitrogen (TKN) (Total Organic Nitrogen + Total Ammonia) (surface water only);
- Total Nitrogen (TKN + (Nitrate + Nitrite) (surface water only);
- Dissolved metals (standard 19 relevant to aquatic assessment) (surface water);
- Total metals (standard 19 relevant to aquatic assessment) (sediment only);
- Total petroleum hydrocarbons, BTEX (benzene, toluene, ethylbenzene, trimethylbenzenes and three xylene isomers) hydrocarbons;
- PFAS: Poly-fluoroalkyl substances (including Perfluorohexane sulfonate PFHxS).

Samples were sent to the National Measurement Institute (NMI) laboratory (a NATA accredited laboratory) for analysis.

Construction Discharges

Construction of the warehouses are now complete. No construction discharges occurred via DP5 or DP 7 within the reporting period (after December 2023) (as per communication with Tactical).

2.4.3 Aquatic Macroinvertebrates

Aquatic macroinvertebrates were required to be collected by the BMS at Site AQ12 (Biosis, 2018) using the NSW AUSRIVAS protocol (Turak et al., 2004). Biosis (2018) considered this large pool to provide reliable and valuable aquatic habitat. Stream edge habitats were sampled using a 250 µm dip net.

The contents of each net sample were placed into a white sorting tray and animals collected for a minimum period of 30 minutes. Thereafter, removals were done in 10-minute periods, up to a total of one hour (Turak et al., 2004). If no new taxa were found within a 10-minute period, removals ceased (Turak et al., 2004). The animals were collected and placed inside a labelled container and preserved with 70 % alcohol.

In the laboratory, taxa were identified to family level with the exception of Acarina (to order), Chironomidae (to sub-family), Nematoda (to phylum), Nemertea (to phylum), Oligochaeta (to class), Ostracoda (to subclass) and Polychaeta (to class). Some families of Anisoptera (dragonfly larvae) were identified to species, because they could potentially include threatened aquatic species.

2.4.4 Fish Community Survey

Fish sampling is done at Site AQ12 using a Smith Root LR-24 backpack electrofisher. The Electrofisher is used to stun fish in open water, around the edge of the pool, around snags and aquatic vegetation and any overhanging banks. All fish caught were identified and the length of up to 30 individuals of each species measured. Incidental observations such as evidence of disease were also noted before native fish species were returned to the water.

2.4.5 Data Analysis

Water quality measurements were used to assess health of the aquatic ecosystem by comparison with guideline values recommended by ANZECC[1] and ARMCANZ[2] (2000) for the protection of lowland streams (i.e. systems at < 150 m altitude) in south-east Australia.

[1] ANZECC – Australian and New Zealand Environment and Conservation Council
[2] ARMCANZ – Agriculture and Resource Management Council of Australia and New Zealand

For aquatic macroinvertebrates, data were analysed using the appropriate AUSRIVAS predictive models developed for NSW. The ecological health of a waterway was assessed by comparing the macroinvertebrates collected at a site (i.e. Observed) to those predicted to occur (Expected) as if the site was in an undisturbed or 'reference' condition.

The principal outputs of the AUSRIVAS model include:

- Observed to Expected ratio (OE50): the ratio of the number of macroinvertebrate families collected at a site which had a predicted probability of occurrence of greater than 50 % (i.e. Observed) to the sum of the probabilities of all of the families predicted with greater than a 50 % chance of occurrence (i.e. Expected) (Ransom et al., 2004);
- BAND: for each model, the OE50 taxa ratios were divided into bands representing different levels of impairment. Band X represents a more diverse assemblage of macroinvertebrates than control sites; Band A was considered equivalent to reference condition; Band B represents sites below reference condition (i.e. significantly impaired); Band C represents sites well below reference condition (i.e. severely impaired); and Band D represents impoverished sites (i.e. extremely impaired) (Ransom et al., 2004).

The SIGNAL2 biotic index (Stream Invertebrate Grade Number Average level) developed by Chessman (2003) was also used to give an indication of water quality at the sites sampled. The SIGNAL score for a macroinvertebrate sample was calculated by averaging the pollution sensitivity grade numbers of the families present, which may range from 10 (most sensitive) to 1 (most tolerant). The SIGNAL2 scores from samples collected between autumn 2018 and spring 2023 were presented graphically to provide an indication of changes over time.

2.4.6 Quality Assurance/Quality Control (QA/QC)

Data collected in the field were checked for accuracy and completeness before leaving each site. In the office, field data and other records were incorporated into appropriate excel data sheets and checked. Spreadsheets were locked prior to analysis to prevent accidental over-writes or corruption.

In the laboratory, macroinvertebrate samples were identified by an appropriately qualified staff member. Data for each sample were entered into an excel spreadsheet and then checked.

3.0 RESULTS

For the spring 2024 monitoring event, sites were sampled on 24 September 2024 (Survey 1) and 19 November 2024 (Survey 2). Each site was approximately 100 m in length with their GPS co-ordinates listed in Appendix A. Collections of fish and macroinvertebrates were completed in accordance with Section 37 of the *NSW Fisheries Management Act 1994* using Scientific Collection Permit Number FP23/124.

3.1 Aquatic Habitat Characteristics

The section of Anzac Creek within the study area was not mapped as Key Fish Habitat (KFH) under the NSW DPI Key Fish Habitat mapping for the Sydney LGA (DPI 2007; Appendix A). Nevertheless, this section of Anzac Creek is ranked as TYPE 1 KFH according to the DPI (2013) classification scheme due to the presence of native aquatic plants and snags. According to the waterway CLASS scheme, a permanent pool with freshwater aquatic vegetation situated at Site AQ12 is considered CLASS 2 KFH. The remaining reaches of Anzac Creek within the Study Area were considered to be CLASS 3 KFH despite the presence of aquatic vegetation, due to the ephemeral nature of any pools that were present (DPI, 2013).

Vegetation within the channel and banks of Anzac Creek has been classified as Parramatta Red Gum woodland in high condition (GHD, 2016).

Within the two months prior to the 2024 spring Survey 1 (24 September 2024) and 2024 autumn Survey 2 (19 November 2025), a total of 49.2 mm and 93.8 mm rainfall was recorded respectively by the meteorological station situated near Holsworthy Aerodrome AWS Rainfall Station (Station ID: 66161) (Figure 2).

All warehouses are now operational (except warehouse 2, which is proposed for Q4 2025). No construction discharges occurred within the reporting period.

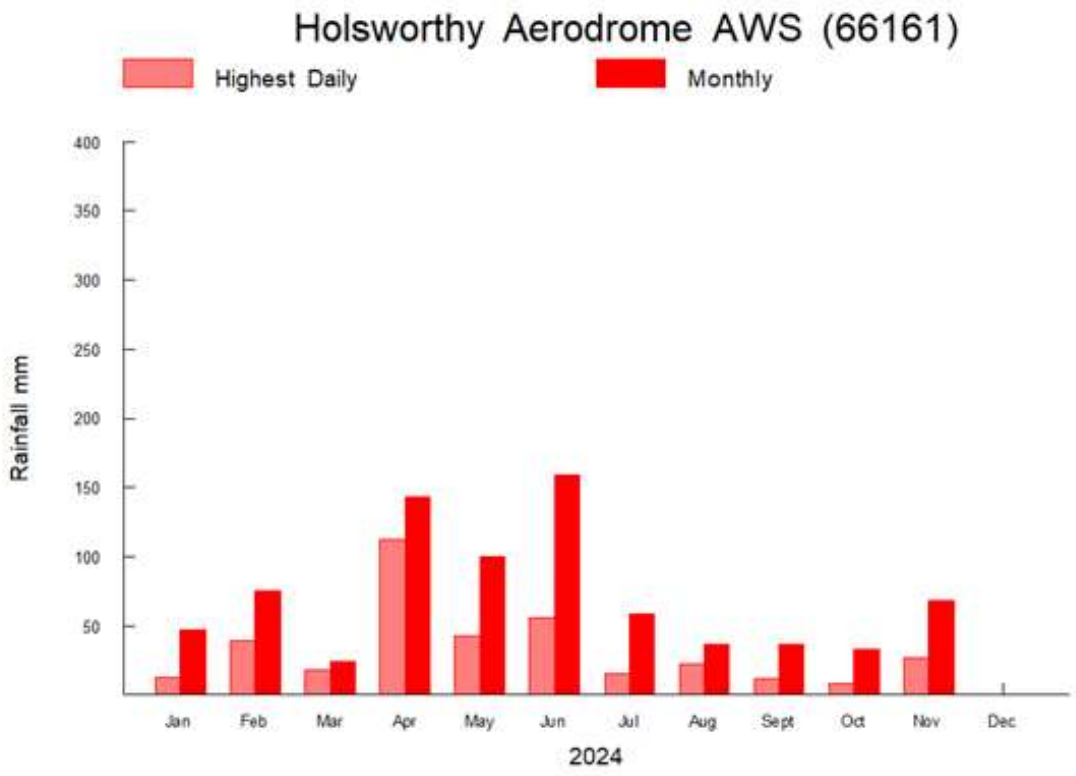

Figure 2. Rainfall (mm) measured at Holsworthy Aerodrome AWS Rainfall Station (66161) between 1 January and 31 November 2024.

Site AQ1

Site AQ1 was situated approximately 750 m downstream of the source of Anzac Creek (Figure 1), and approximately 100 m downstream of a culvert built across Anzac Creek as part of the MPE Stage 1 project. The culvert is composed of box culverts to a length of 15 m and supports one rail track and a maintenance access footway. Construction of the culvert was completed by CPB and handed over to the proponent, Qube Holdings Limited, in July 2019.

There was no flowing water at the time of the spring 2024 surveys, although the channel was almost full-to-bank (up to approximately 0.4 m deep) at the time of the second survey (Plates 1&2). The active channel zone at this site remains stable (i.e., no signs of active erosion), due to the absence of flow, cover of aquatic plants and the relatively intact woody riparian vegetation (Appendix 2). The channel bed consisted of fine sediment, the upper layers of which were anoxic.

There has been a notable increase in cover of the introduced wetland shrub, *Ludwigia peruviana* (Ludwigia), on either side of the stream channel since autumn 2024 (Plate 2). This plant is an introduced, fast-growing wetland shrub that grows to 3 m tall. Slender knotweed (*Persicaria decipiens*) occupied a large proportion of the stream channel and Alligator Weed (*Alternanthera philoxeroides*) is still common, particularly at the time of the second survey (Plates 1&2). Native plant species included Marsh Club-rush (*Bolboschoenus fluviatilis*), Typha (*Typha* sp.), and *Myriophyllum variifolium*. The tree canopy was mostly comprised of *Melaleuca* spp. and *Eucalyptus* spp. (Plates 1&2).

Plate 1: AQ1 – View downstream (24/09/24)

Plate 2: AQ1 – View upstream (19/11/24)

Site AQ4

Site AQ4 was situated approximately 400 m downstream of Site AQ1 (Figure 1).

The stream channel at Site AQ4 has occasionally been dry, including at the time of the Baseline survey (i.e. autumn 2018). Surface water (up to approximately 0.4 m deep) has mostly been present since the autumn 2020 surveys, although very shallow and there was no evidence of flow at the time of spring 2024 surveys (Plates 3&4).

Since the baseline survey, stands of the emergent macrophyte, Jointed Twig Rush (*Baumea articulata*) and Twig Rush (*Baumea rubiginosa*) have colonised a large proportion of the stream channel (Plates 3&4). Typha and Slender Knotweed were also present.

The active channel zone, composed of fine sediments, was up to approximately 4 m wide (Plates 3&4). No indicators of significant erosion were observed suggesting that Anzac Creek continues to be relatively stable at this site, particularly since colonisation by dense stands of emergent macrophytes and little flow along this section of the creek since spring 2022 (Plate 3&4, Appendix 2).

Plate 3: AQ4 – View across-stream (24/09/24)

Plate 4: AQ4 – View downstream (19/11/24)

Site AQ8

Site AQ8 was situated approximately 1 km downstream of Site AQ4 (Figure 1). At the time of Survey 2, surface water was present up to a depth of approximately 0.1 m deep in places.

Most notably, taller species of emergent macrophyte, including Tall Spikerush (*Eleocharis sphacelata*) and Jointed Twig Rush and have encroached upon habitat previously dominated by Heron Bristle Sedge (*Chorizandra cymbaria*) (Plates 5&6). Other shorter plants, including Frogsmouth (*Philydrum lanuginosum*), Slender Knotweed and the introduced species, Umbrella Sedge (*Cyperus eragrostis*) have also declined in abundance. Riparian vegetation continues to be dominated by *Casuarina* trees. Common Reed/Phragmites (*Phragmites australis*) and Typha were present at the downstream end of the site. Blackberry (*Rubus fruticosus*), which is listed as a weed of national significance, has increased its distribution at the upstream end of this site.

The stream channel at Site AQ8 (up to approximately 20 m wide) continues to be classified as stable, mostly due to the dense cover by emergent macrophytes in addition to a relatively intact, woody riparian zone (Appendix 2). Very little aquatic habitat was present within the study channel at the time of the spring 2024 surveys.

Plate 5: Site AQ8 – view upstream (24/09/24)

Plate 6: Site AQ8 – view downstream (19/11/24)

Site AQ12

Site AQ12 was situated approximately 750 km downstream of Site AQ8 (Figure 1). Similar to the findings of biodiversity surveys done since autumn 2018, a large pool (approximately 20 m wide) and a relatively diverse assemblage of aquatic plants, including submerged species, were present (Plates 7&8). The pool substratum was composed primarily of fine sediment with a considerable cover of detritus. Green filamentous macro-algae continues to be present and was relatively abundant at the time of the spring 2024 surveys.

Water level in the pool was up to approximately 0.7 m deep at the time of the second survey. Flow was apparent at the downstream end of the pool at the time of both surveys. Water clarity was considered good. Extensive cover of vegetation within the riparian zone contributes stability to the edges of the pool at Site AQ12. An area of active erosion has been apparent at the downstream end of the pool since autumn 2020, associated with heavy rainfall and bank overflows, including at the time of the spring 2024 surveys.

The submerged macrophyte, *Vallisneria* sp. (Ribbonweed), was common, in addition to Slender Knotweed and dense stands of Typha, Phragmites and Tall Spike Rush (Plate 7). *Nymphoides geminata* (Entire Marshwort), with mostly floating leaves continues to be abundant in areas close to the shore (Plates 7&8).

Also noted was the native perennial, *Utricularia* sp., which occurs on wet soil and in freshwater as terrestrial or aquatic species, and the small native fern, *Azolla*. Egeria (*Egeria densa*), which was collected close to the left-bank (facing downstream) of the pool in spring 2020, continues to be present. Riparian vegetation included Casuarina, Eucalyptus and Melaleuca trees and Spiny-head Mat-rush/Basket Grass (*Lomdandra longifolia*) (Plates 7&8).

Plate 7: Site AQ12 – view upstream (24/09/24)

Plate 8: Site AQ12 – view across stream (19/11/24)

Site AQ13

Site AQ13 was situated approximately 200 m downstream of Site AQ12 (Figure 1). This site was located approximately 150 m downstream from an overflow channel that enters the creek from Wattle Grove. Water to a depth of approximately 0.5 m was present at Site AQ13 at the time of the second survey and flow was apparent at the time of both surveys (Plates 9&10).

A large proportion of the stream channel and edges were colonised by Typha and Slender Knotweed. The aquatic weed, *Sagittaria platyphylla* (Sagittaria) continued to expand its distribution at the edges of the creek channel. River Clubrush (*Schoenoplectus validus*) was also common. The stream channel appeared stable (Appendix 2).

Plate 9: Site AQ13 – view upstream (24/09/24)

Plate 10: Site AQ13 – view downstream (19/11/24)

Site AQ14

Site AQ14 was situated approximately 150 m downstream of Site AQ13 and immediately downstream of the culvert that links the dam within Commonwealth Department of Defence land to Anzac Creek (Figure 1). Flow was apparent at the time of both autumn 2024 surveys (Plates 11&12).

Typha, Slender Knotweed, River Clubrush and Whorled Pennywort/Shield Pennywort continue to be common (Plates 11&12). Sagittaria continued to expand its distribution within the channel of the creek (Plates 11&12). This section of Anzac Creek remains mostly stable due to dense instream vegetation and vegetated banks (Appendix 2). Water visibility was 'good' at the time of both surveys (Plates 11&12).

Plate 11: Site AQ14 – view downstream (24/09/24)

Plate 12: Site AQ14 – view downstream (19/11/24)

3.2 Water & Sediment Characteristics

3.2.1 Water Quality

Physico-chemical measurements were collected at Site AQ12 in accordance with the requirements of the BMS (cf Biosis, 2018) and at sampling sites where sufficient water was present to submerge a water quality instrument probe. The data were compared to the default trigger values (DTVs) recommended by ANZECC/ARMCANZ (2000) for the protection of slightly disturbed lowland river ecosystems in southeast Australia (Table 4).

Results from the 2024 spring surveys 1 and 2 indicated that:

- Water temperature ranged between 13.8 to 28.8 °C;
- pH (range = 5.2 to 8.3) was within the recommended DTV at site AQ12 at the time of both surveys;
- Conductivity (range = 189 to 367 µS/cm) was within the recommended DTVs at all the sites sampled;
- Dissolved oxygen (DO) measurements (range = 29 to 99 % saturation) were below the lower DTV at all sites during Survey 1 and Survey 2, except Site AQ1 during Survey 2 (i.e. 99 %);
- Turbidity levels were within the recommended DTV at all sites during spring 2024 (range = 2.4 to 35.8 NTU);
- Concentrations of total phosphorous (range = <0.05 mg/L) were within the recommended DTV (0.05 mg/L) at Site AQ12;
- Total nitrogen (range = 0.30 – 1.20 mg/L) was above the upper DTV (0.5 mg/L) at Site AQ12 during Survey 1. Nitrogen levels have commonly exceeded the upper limit, including at the time of the baseline survey (see Table 4);
- Total Kjeldahl Nitrogen (TKN) (Total Organic Nitrogen + Ammonia) measured at AQ12 during both surveys was similar to the Total Nitrogen (TKN + (Nitrate + Nitrite) values, indicating that the source of nitrogen within the refuge pool was most likely organic (e.g. algae or decomposing plant material) rather than inorganic (e.g. fertilizer);
- A range of toxicants were also measured in the water between autumn 2018 (baseline) and spring 2024 (during construction) within the vicinity of Site AQ12 (Table 5&6) in accordance with the BMS (cf Biosis, 2018).

Results indicated that:

- Aluminium commonly exceeded the DTV (80 µg/L) (i.e. 15 of 24 surveys), including at the time of the baseline survey (260 µg/L), and at the time of the current survey (Spring 2024 Survey 1: 360 µg/L; Survey 2: 290 µg/L);
- Cadmium exceeded the DTV (0.4 µg/L) at Site AQ12 in autumn 2019 (Survey 1: 0.49 µg/L; Survey 2: 0.41 µg/L) and autumn 2021 Survey 1 (3.8 µg/L), but not subsequently;
- Copper has commonly exceeded the DTV (1.8 µg/L) (i.e. 15 of 24 surveys, including the baseline survey (2 µg/L) and spring 2024 (Survey 2: 2.6 µg/L);
- Zinc exceeded the DTV during autumn 2021 (Survey 2: 20 µg/L) and autumn 2023 (Survey 2: 53 µg/L) (Table 5);
- BTEX compounds and total recoverable hydrocarbons were not detected (Table 6);
- PFOA (perfluoro-octanoic acid) has been occasionally detected but has always been well within the recommended DTV, including at the time of the spring 2024 surveys (Table 6);
- PFOS has commonly been detected, including during spring 2024 (Survey 1: 0.093 µg/L; Survey 2: 0.039 µg/L) but continues to be within the recommended DTV (Table 6).

Table 5. Mean (± SE) physico-chemical water quality and nutrient values recorded at the time of the Baseline (autumn 2018, *n* = 1) and the spring 2024 (*n* = 3) surveys and the appropriate Default Trigger Values (DTV). Values highlighted in bold type indicate where results were outside the recommended DTV.

Indicator Variable	DTV*	Baseline[A]	Survey 1 (24/09/24)					
			AQ1	AQ4	AQ8	AQ12	AQ13	AQ14
Temperature °C (*n* =3)	-	-	I/A	I/A	I/A	19.0 (0.0)	15.5 (0.0)	13.8 (0.0)
pH (*n* =3)	**6.5-8.0**	7.01	I/A	I/A	I/A	6.8 (0.0)	6.9 (0.0)	7.0 (0.0)
Conductivity (µS/cm) (*n* = 3)	**125-2200**	354	I/A	I/A	I/A	320 (4.4)	367 (4.4)	274 (6.6)
Dissolved Oxygen (%) (*n* = 3)	**85-110**	**62**	I/A	I/A	I/A	**29.3** (0.7)	**57.4** (0.4)	**39.6** (0.0)
Turbidity (NTU) (*n* = 3)	**<50**	**91**	I/A	I/A	I/A	35.8 (0.7)	25.6 (0.4)	14.7 (0.0)
Alkalinity (mg/L) *(n* = 1)	-	-	N/R	N/R	N/R	16	N/R	N/R
Total Phosphorous (mg/L) *(n* = 1)	**0.05**	**0.58**	N/R	N/R	N/R	<0.01	N/R	N/R
Total Nitrogen (mg/L) *(n* = 1)	**0.5**	**8.2**	N/R	N/R	N/R	**1.20**	N/R	N/R
Total Kjeldahl (mg/L) *(n* = 1)	-	-	N/R	N/R	N/R	1.20	N/R	N/R
Indicator Variable	**DTV***	**Baseline[A]**	**Survey 2 (19/11/24)**					
			AQ1	**AQ4**	**AQ8**	**AQ12**	**AQ13**	**AQ14**
Temperature °C (*n* =3)	-	-	28.8 (0.0)	I/A	19.5 (0.0)	N/R	N/R	N/R
pH (*n* =3)	**6.5-8.0**	7.01	**5.2** (0.0)	I/A	**5.7** (0.0)	8.3 (0.0)	6.5 (0.0)	6.5 (0.0)
Conductivity (µS/cm) (*n* = 3)	**125-2200**	354	542 (0.0)	I/A	264 (0.0)	203 (0.9)	203 (0.9)	189 (0.3)
Dissolved Oxygen (%) (*n* = 3)	**85-110**	**62**	98.8 (0.1)	I/A	**60.0** (0.0)	**80.3** (0.3)	**70.3** (0.5)	**67.7** (0.3)
Turbidity (NTU) (*n* = 3)	**<50**	**91**	6.1 (0.1)	I/A	2.4 (0.0)	13.0 (0.3)	13.1 (0.5)	8.5 (0.3)
Alkalinity (mg/L) *(n* = 1)	-	-	N/R	N/R	N/R	10	N/R	N/R
Total Phosphorous (mg/L) *(n* = 1)	**0.05**	**0.58**	N/R	N/R	N/R	<0.05	N/R	N/R
Total Nitrogen (mg/L) *(n* = 1)	**0.5**	**8.2**	N/R	N/R	N/R	0.34	N/R	N/R
Total Kjeldahl (mg/L) *(n* = 1)	-	-	N/R	N/R	N/R	0.30	N/R	N/R

*ANZECC/ARMCANZ (2000) – slightly disturbed systems

[A] Baseline values for pH, conductivity, dissolved oxygen and turbidity were obtained from Site AQ12, whilst baseline data for phosphorous and total nitrogen were obtained from Site AQ11 (Biosis, 2018)

I/A: Insufficient Aquatic Habitat; N/R: Not Required; I/M: Instrument Malfunction. Samples were collected in the field and measured at the laboratory.

Table 6. Summary of dissolved metal compound results for Site AQ12 between autumn 2018 (Baseline) and spring 2024 (*n* = 1).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Autumn 2019 Site AQ12		Spring 2019 Site AQ12	
		April 2018	14/05/19	30/05/19	24/09/19	21/11/19
Aluminium pH >6.5	**80**	**260**	**150**	68	**2730**	**280**
Aluminium pH <6.5	**-**	**-**	**-**	-	**-**	-
Arsenic Total (µg/L)	**42**	<1	<1	<1	1.1	<1
Barium	**-**	2	55	34	21	32
Beryllium	**-**	<1	<1	<1	<1	<1
Boron	**680**	<50	20	17	14	14
Cadmium (µg/L)	**0.4**	<0.1	**0.49**	**0.41**	<0.1	<0.1
Chromium	**6**	<1	<1	<1	2.3	<1
Cobalt	**-**	<1	<1	<1	<1	<1
Copper (µg/L)	**1.8**	**2**	**2**	1.1	**3**	**2.3**
Iron	**-**	450	300	100	1650	900
Lead (µg/L)	**5.6**	<1	<1	<1	2.6	<1
Manganese	**2500**	3	33	6.2	60	47
Mercury (µg/L)	**1.9** [A]	<0.1	<0.1	<0.1	0.12	<0.1
Molybdenum	**-**	<1	<1	<1	<1	<1
Nickel (µg/L)	**13**	<1	<1	N/R	1.7	1.1
Selenium Total	**18**	<10	<2	<1	<1	<1
Strontium	**-**	52	120	120	73	53
Vanadium	**-**	<10	<1	<1	3.8	1.4
Zinc (µg/L)	**15**	<5	6.8	N/R	13	14

*ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection)
[A] = inorganic mercury; N/R: not recorded

Table 5 (Cont'd). Summary of dissolved metal compound results for Site AQ12 (*n* = 1).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Autumn 2020 Site AQ12		Spring 2020 Site AQ12	
		April 2018	25/05/20	2/09/20	11/11/20	30/11/20
Aluminium pH >6.5	**80**	**260**	**230**	70	**230**	**100**
Aluminium pH <6.5	**-**	**-**	-	**-**	**-**	-
Arsenic Total (µg/L)	**42**	<1	<1	<1	<1	<1
Barium	**-**	2	31	19	36	39
Beryllium	**-**	<1	<1	<1	<1	<1
Boron	**680**	<50	21	<5	32	31
Cadmium (µg/L)	**0.4**	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	**6**	<1	<1	<1	<1	<1
Cobalt	**-**	<1	<1	<1	<1	<1
Copper (µg/L)	**1.8**	**2**	**1.9**	<1	**2**	1.3
Iron	**-**	450	620	270	460	280
Lead (µg/L)	**5.6**	<1	1.5	<1	<1	<1
Manganese	**2500**	3	19	8.8	6.9	12
Mercury (µg/L)	**1.9** [A]	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	**-**	<1	1.3	<1	<1	1.1
Nickel (µg/L)	**13**	<1	1.1	<1	1.1	<1
Selenium Total	**18**	<10	<1	<1	<1	<1
Strontium	**-**	52	120	140	120	130
Vanadium	**-**	<10	<1	<1	<1	<1
Zinc (µg/L)	**15**	<5	8.5	3.6	5.7	2.9

*ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection)
[A] = inorganic mercury; N/R: not recorded

Table 5 (Cont'd). Summary of dissolved metal compound results for Site AQ12 (*n* = 1).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Autumn 2021 Site AQ12		Spring 2021 Site AQ12	
		April 2018	28/04/21[3]	11/06/21	21/9/21	8/11/21
Aluminium pH >6.5	**80**	**260**	**150**	**1260**	62	**200**
Aluminium pH <6.5	**-**	**-**				
Arsenic Total (µg/L)	**42**	<1	<1	<1	<1	<1
Barium	**-**	2	29	<1	31	13
Beryllium	**-**	<1	<1	<1	<1	<1
Boron	**680**	<50	20	10	20	15
Cadmium (µg/L)	**0.4**	<0.1	**3.8**	<0.1	<0.1	<0.1
Chromium	**6**	<1	<1	1.5	<1	<1
Cobalt	**-**	<1	<1	<1	<1	<1
Copper (µg/L)	**1.8**	**2**	**2.1**	**3.3**	1.7	**3.2**
Iron	**-**	450	160	420	150	180
Lead (µg/L)	**5.6**	<1	<1	<1	<1	<1
Manganese	**2500**	3	6.9	4.7	10	2
Mercury (µg/L)	**1.9** [A]	<0.1	<0.1	<0.1	<0.1	0.15
Molybdenum	**-**	<1	<1	<1	<1	<1
Nickel (µg/L)	**13**	<1	1.1	<1	<1	<1
Selenium Total	**18**	<10	<1	<1	<1	<1
Strontium	**-**	52	130	46	110	40
Vanadium	**-**	<10	<1	2.7	<1	1.9
Zinc (µg/L)	**15**	<5	9	**20**	8.3	12

*ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection)
[A] = inorganic mercury; N/R: not recorded

[3] NB Data reported here for autumn 2021 Survey 1 and Survey 2 differ from those reported in the autumn 2021 report. Data had been entered incorrectly in the autumn 2021 report but have since been corrected.

Table 5 (Cont'd). Summary of dissolved metal compound results for Site AQ12 (*n* = 1).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Autumn 2022 Site AQ12		Spring 2022 Site AQ12	
		April 2018	5/05/22	31/05/22	10/10/2022	30/11/2022
Aluminium pH >6.5	**80**	**260**		**200**	**1400**	**93**
Aluminium pH <6.5	**-**	**-**	70			
Arsenic Total (µg/L)	**42**	<1	<1	<1	<1	<1
Barium	**-**	2	18	19	15	28
Beryllium	**-**	<1	<1	<1	<1	<1
Boron	**680**	<50	21	18	26	29
Cadmium (µg/L)	**0.4**	<0.1	<0.1	0.13	<0.1	<0.1
Chromium	**6**	<1	<1	<1	1.1	<1
Cobalt	**-**	<1	<1	<1	<1	<1
Copper (µg/L)	**1.8**	**2**	1.4	1.5	**2.6**	<1
Iron	**-**	450	560	320	1500	350
Lead (µg/L)	**5.6**	<1	<1	<1	2.3	<1
Manganese	**2500**	3	99	5.9	9.1	16
Mercury (µg/L)	**1.9** [A]	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	**-**	<1	<1	<1	<1	<1
Nickel (µg/L)	**13**	<1	<1	<1	<1	<1
Selenium Total	**18**	<10	<1	<1	<1	<1
Strontium	**-**	52	93	56	35	99
Vanadium	**-**	<10	<1	<1	2.2	<1
Zinc (µg/L)	**15**	<5	8	6.7	12	5.2

*ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection)
[A] = inorganic mercury; N/R: not recorded

Table 5 (Cont'd). Summary of dissolved metal compound results for Site AQ12 (*n* = 1).

Indicator Variable (µg/L)	DTV*(µg/L)	Baseline Site AQ11	Autumn 2023 Site AQ12		Spring 2023 Site AQ12	
		April 2018	18/05/23	3/07/23	20/09/23	15/11/23
Aluminium pH >6.5	**80**	**260**	37	**160**	30	42
Aluminium pH <6.5	**-**	**-**				
Arsenic Total (µg/L)	**42**	<1	<1	<1	<1	<1
Barium	**-**	2	19	21	20	12
Beryllium	**-**	<1	<1	<1	<1	<1
Boron	**680**	<50	19	22	19	24
Cadmium (µg/L)	**0.4**	<0.1	0.25	0.27	<0.1	<0.1
Chromium	**6**	<1	<1	<1	<1	<1
Cobalt	**-**	<1	<1	<1	<1	<1
Copper (µg/L)	**1.8**	**2**	1.7	**2.5**	**2.7**	**2.5**
Iron	**-**	450	220	400	170	120
Lead (µg/L)	**5.6**	<1	<1	<1	<1	<1
Manganese	**2500**	3	20	40	120	11
Mercury (µg/L)	**1.9** [A]	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	**-**	<1	<1	<1	<1	<1
Nickel (µg/L)	**13**	<1	<1	<1	<1	<1
Selenium Total	**18**	<10	<1	<1	<1	<1
Strontium	**-**	52	67	88	74	66
Vanadium	**-**	<10	<1	<1	<1	<1
Zinc (µg/L)	**15**	<5	13	**53**	11	2

*ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection)
[A] = inorganic mercury; N/R: not recorded

Table 5 (Cont'd). Summary of dissolved metal compound results for Site AQ12 (*n* = 1).

Indicator Variable (µg/L)	DTV*(µg/L)	Baseline Site AQ11	Autumn 2024 Site AQ12		Spring 2024 Site AQ12	
		April 2018	8/05/24	28/05/24	24/09/24	19/11/24
Aluminium pH >6.5	**80**	**260**	37	**170**	**360**	**290**
Aluminium pH <6.5	**-**	**-**				
Arsenic Total (µg/L)	**42**	<1	<1	<1	<1	<1
Barium	**-**	2	23	18	32	18
Beryllium	**-**	<1	<1	<1	<1	<1
Boron	**680**	<50	38	32	32	25
Cadmium (µg/L)	**0.4**	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	**6**	<1	<1	<1	<1	<1
Cobalt	**-**	<1	<1	<1	<1	<1
Copper (µg/L)	**1.8**	**2**	1.4	1.1	1.4	**2.6**
Iron	**-**	450	310	420	1890	670
Lead (µg/L)	**5.6**	<1	<1	<1	<1	<1
Manganese	**2500**	3	5.2	19	95	36
Mercury (µg/L)	**1.9** [A]	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	**-**	<1	<1	<1	<1	<1
Nickel (µg/L)	**13**	<1	<1	<1	<1	<1
Selenium Total	**18**	<10	<1	<1	<1	<1
Strontium	**-**	52	78	82	94	58
Vanadium	**-**	<10	<1	<1	2.1	1.2
Zinc (µg/L)	**15**	<5	13	10	12	10

*ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection)
[A] = inorganic mercury; N/R: not recorded

Table 7. Summary of BTEX and perfluoronated compound results (*n* = 1).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Spring 2018 Site AQ12		Autumn 2019 Site AQ12	
		April 2018	6/12/18	12/12/18	14/05/19	30/05/19
BTEXN (µg/L)						
Benzene (µg/L)	**1300**	<1	<1	<1	<1	<1
Toluene (µg/L)	**-**	<2	<1	<1	<1	<1
Ethylbenzene (µg/L)	**-**	<2	<1	<1	<1	<1
Ortho-Xylene (µg/L)	**470**	<2	<1	<1	<1	<1
Perfluoronated Compounds (µg/L)						
PFHxS (µg/L)	**-**	0.02	0.02	0.12	0.039	0.039
PFOS (µg/L)	**0.13**	0.03	0.043	0.070	0.068	0.069
PFOA (µg/L)	**220**	<0.01	<0.01	0.011	0.011	0.010
Sum of PFHxS and PFOS	**-**	0.05	0.063	0.19	0.107	0.108
Sum of PFAS (WA DER List)[B]	**-**	0.05	0.128[C]	0.185[C]	0.188[C]	0.19[C]
Indicator Variable	**DTV* (µg/L)**	**Baseline Site AQ11**	**Spring 2019 Site AQ12**		**Autumn 2020 Site AQ12**	
		April 2018	**24/9/19**	**21/11/19**	**25/5/20**	**2/9/20**
BTEXN (µg/L)						
Benzene (µg/L)	**1300**	<1	<1	<1	<1	<1
Toluene (µg/L)	**-**	<2	<1	<1	<1	<1
Ethylbenzene (µg/L)	**-**	<2	<1	<1	<1	<1
Ortho-Xylene (µg/L)	**470**	<2	<1	<1	<1	<1
PFHxS (µg/L)	**-**	0.02	0.091	0.025	0.044	0.068
PFOS (µg/L)	**0.13**	0.03	0.084	0.057	0.055	0.076
PFOA (µg/L)	**220**	<0.01	<0.01	0.013	<0.01	<0.01
Sum of PFHxS and PFOS	**-**	0.05	0.175	0.082	0.099	0.144
Sum of PFAS (WA DER List)[B]	**-**	0.05	0.252[C]	0.164[C]	0.178[C]	0.219[C]

*BTEXN: ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection); PFAS suite: DEE (2016) – Freshwater (95 % species protection – slightly to moderately disturbed ecosystems).

[B] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS.

[C] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01).

Table 6 (Cont'd).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Spring 2020 Site AQ12		Autumn 2021 Site AQ12	
		April 2018	11/11/20	30/11/20	28/04/21	11/06/21
Benzene (µg/L)	**1300**	<1	<1	<1	<1	<1
Toluene (µg/L)	**-**	<2	<1	<1	<1	<1
Ethylbenzene (µg/L)	**-**	<2	<1	<1	<1	<1
Ortho-Xylene (µg/L)	**470**	<2	<1	<1	<1	<1
PFHxS (µg/L)	**-**	0.02	0.026	0.041	0.065	0.011
PFOS (µg/L)	**0.13**	0.03	0.054	0.062	0.065	<0.02
PFOA (µg/L)	**220**	<0.01	0.005[C]	0.014	<0.01	<0.01
Sum of PFHxS and PFOS	**-**	0.05	0.080	0.103	0.13	0.021[C]
Sum of PFAS (WA DER List)[B]	**-**	0.05	0.151[C]	0.196[C]	0.222[C]	0.086[C]
Indicator Variable	**DTV* (µg/L)**	**Baseline Site AQ11**	**Spring 2021 Site AQ12**		**Autumn 2022 Site AQ12**	
		April 2018	**21/9/21**	**8/11/21**	**5/05/22**	**31/05/22**
BTEXN (µg/L)						
Benzene (µg/L)	**1300**	<1	<1	<1	<1	<1
Toluene (µg/L)	**-**	<2	<1	<1	<1	<1
Ethylbenzene (µg/L)	**-**	<2	<1	<1	<1	<1
Ortho-Xylene (µg/L)	**470**	<2	<1	<1	<1	<1
PFHxS (µg/L)	**-**	0.02	0.037	<0.01	0.044	0.039
PFOS (µg/L)	**0.13**	0.03	0.032	0.021	0.047	0.054
PFOA (µg/L)	**220**	<0.01	0.013	<0.01	<0.01	<0.01
Sum of PFHxS and PFOS	**-**	0.05	0.069	0.026[C]	0.091	0.093
Sum of PFAS (WA DER List)[B]	**-**	0.05	0.169[C]	0.091[C]	0.166	0.176

*BTEXN: ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection); PFAS suite: DEE (2016) – Freshwater (95 % species protection – slightly to moderately disturbed ecosystems).

[B] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS.

[C] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01).

Table 6 (Cont'd).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Spring 2022 Site AQ12		Autumn 2023 Site AQ12	
		April 2018	30/10/22	30/11/22	18/05/2023	3/07/2023
Benzene (µg/L)	**1300**	<1	<1	<1	<1	<1
Toluene (µg/L)	**-**	<2	<1	<1	<1	<1
Ethylbenzene (µg/L)	**-**	<2	<1	<1	<1	<1
Ortho-Xylene (µg/L)	**470**	<2	<1	<1	<1	<1
PFHxS (µg/L)	**-**	0.02	0.031	0.026	0.028	0.020
PFOS (µg/L)	**0.13**	0.03	0.030	0.044	0.040	0.024
PFOA (µg/L)	**220**	<0.01	<0.01	<0.01	<0.01	<0.01
Sum of PFHxS and PFOS	**-**	0.05	0.061	0.070	0.068	0.044
Sum of PFAS (WA DER List)[B]	**-**	0.05	0.126[C]	0.135[C]	0.145	0.122
Indicator Variable	**DTV* (µg/L)**	**Baseline Site AQ11**	**Spring 2023 Site AQ12**		**Autumn 2024 Site AQ12**	
		April 2018	**20/09/23**	**15/11/23**	**8/5/24**	**28/5/24**
Benzene (µg/L)	**1300**	<1	<1	<1	<1	<1
Toluene (µg/L)	**-**	<2	<1	<1	<1	<1
Ethylbenzene (µg/L)	**-**	<2	<1	<1	<1	<1
Ortho-Xylene (µg/L)	**470**	<2	<1	<1	<1	<1
PFHxS (µg/L)	**-**	0.02	0.029	0.028	0.12	0.076
PFOS (µg/L)	**0.13**	0.03	0.031	0.032	0.094	0.061
PFOA (µg/L)	**220**	<0.01	<0.01	<0.01	<0.01	<0.01
Sum of PFHxS and PFOS	**-**	0.05	0.060	0.060	0.214	0.137
Sum of PFAS (WA DER List)[B]	**-**	0.05	0.154[C]	0.136[C]	0.309	0.217

*BTEXN: ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection); PFAS suite: DEE (2016) – Freshwater (95 % species protection – slightly to moderately disturbed ecosystems).
[B] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS.
[C] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01).

Table 6 (Cont'd).

Indicator Variable	DTV* (µg/L)	Baseline Site AQ11	Spring 2024 Site AQ12			
		April 2018	24/09/24	19/11/24		
Benzene (µg/L)	**1300**	<1	<1	<1		
Toluene (µg/L)	**-**	<2	<1	<1		
Ethylbenzene (µg/L)	**-**	<2	<1	<1		
Ortho-Xylene (µg/L)	**470**	<2	<1	<1		
PFHxS (µg/L)	**-**	0.02	0.17	0.033		
PFOS (µg/L)	**0.13**	0.03	0.093	0.039		
PFOA (µg/L)	**220**	<0.01	0.015	<0.01		
Sum of PFHxS and PFOS	**-**	0.05	0.263	0.072		
Sum of PFAS (WA DER List)[B]	**-**	0.05	0.373[C]	0.153[C]		
Indicator Variable	**DTV* (µg/L)**	**Baseline Site AQ11**				
		April 2018				
Benzene (µg/L)	**1300**	<1				
Toluene (µg/L)	**-**	<2				
Ethylbenzene (µg/L)	**-**	<2				
Ortho-Xylene (µg/L)	**470**	<2				
PFHxS (µg/L)	**-**	0.02				
PFOS (µg/L)	**0.13**	0.03				
PFOA (µg/L)	**220**	<0.01				
Sum of PFHxS and PFOS	**-**	0.05				
Sum of PFAS (WA DER List)[B]	**-**	0.05				

*BTEXN: ANZECC/ARMCANZ (2000) – slightly disturbed systems (90% species protection); PFAS suite: DEE (2016) – Freshwater (95 % species protection – slightly to moderately disturbed ecosystems).

[B] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS.

[C] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01).

3.2.2 Sediment Characteristics

Sediment samples were collected at Site AQ1, AQ4, AQ14 between autumn 2018 (baseline) and spring 2024 (during construction) (Table 7&8).

Results indicated that:

- Concentrations of lead measured at Site AQ1 (Survey 1: 100 mg/kg; Survey 2: 53 mg/kg) exceeded the guideline value (50 mg/L) on both sampling occasions within spring 2024. The majority (i.e. 17 of 19 times) of measurements of lead at AQ1 (range = 21 to 130 mg/kg) exceeded the threshold limit (50 mg/kg) detailed in the Interim Sediment Quality Guidelines (ISQG) (ANZECC/ARMCANZ 2000), including at the time of the baseline (91 mg/kg) survey (discussed further in Section 5.1);
- Nickel measured in sediments at Site AQ1 marginally exceeded the upper ANZECC/ARMCANZ (2000) guideline on one of two sampling occasions in spring 2022 (25 mg/kg), spring 2023 (26 mg/kg), autumn 2024 (27 mg/kg) and spring 2024 (24 mg/kg);
- Concentrations of lead (56 mg/kg), nickel (23 mg/kg) and zinc (220 mg/kg) measured at AQ4 marginally exceeded the ANZECC/ARMCANZ (2000) guideline levels during Survey 1 in autumn 2022 (Table 7), but not during spring 2024;
- Concentrations of measured at Site AQ14 have consistently been within the Baseline values;
- Concentrations of mercury measured at AQ1 exceeded the recommended trigger level during the autumn 2022 (Survey 1: <0.2 mg/kg; Survey 2: 0.29 mg/kg) but not subsequently, including during spring 2024 (Table 7);
- A spike in barium was detected at Site AQ14 in autumn 2019 (Survey 1: 902 mg/kg) but not subsequently. There are no guideline criteria for barium in sediments or water (ANZECC/ARMCANZ 2000);
- PFOS has consistently been detected at the sites sampled (range = <0.002 to 0.044 mg/kg) but concentrations continued to be below the recommended guideline value for Urban Residential/Public Open Spaces (32 mg/kg) as well as National Parks/Areas with High Ecological Values (6.6 mg/L);

- PFAS (range = <0.001 to 0.0483 mg/kg) measured at each site continues to be similar to baseline values and below the recommended guideline value for Urban Residential/Public Open Spaces (29 mg/kg) and National Parks/Areas with High Ecological Values (1.0 mg/L) (Tables 7&8).

Table 7. Mean (± SE) sediment metal results (mg/L) for surveys done between autumn 2018 (*n* = 1) and spring 2024 (*n* = 2).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Autumn 2019			Spring 2019		
		AQ1	AQ4	AQ14	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	26,800	24,300 (700)	2,295 (365)	-	-	-
Antimony	-	-	-	-	<0.5	<0.5 (0)	<0.5 (0)	-	-	-
Arsenic	**20**	<5	<5	<5	4	6 (0.9)	1 (0.2)	3.90 (0.6)	2.75 (0.5)	2.65 (0.3)
Barium	-	110	60	<10	100	66 (4.5)	455 (447)	135 (15)	76.5 (7.5)	29.5 (1.5)
Beryllium	-	<1	1	<1	0.96	1.2 (0.0)	<0.5 (0)	1.20 (0.1)	1.01 (0.1)	<0.5 (0.00)
Boron	-	<50	<50	<50	2.9	0.8 (0.3)	<1 (0)	<1.0 (0.0)	<1.0 (0.0)	<1.0 (0.0)
Cadmium	**1.5**	<1	<1	<1	<0.5	<0.5 (0)	<0.5 (0)	0.43[A] (0.2)	<0.5 (0.0)	<0.5 (0.0)
Chromium	**80**	23	21	3	21	23 (2.0)	3 (0.4)	21.0 (2.0)	13.5 (0.5)	6.3 (0.7)
Cobalt	-	8	6	<2	9	8 (1.9)	1 (0.1)	-	-	-
Copper	**65**	31	12	<5	28	11 (2.1)	2 (0.3)	30.0 (5.0)	6.1 (1.7)	9.0 (1.0)
Lead	**50**	**91**	44	<5	**72**	35 (0.0)	4 (0.2)	**78.0** (32.0)	21.5 (0.5)	12.0 (1.0)
Manganese	-	45	69	16	32	80 (2.0)	7 (0.8)	85.0 (55.0)	50.0 (15.0)	32.5 (12.5)
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2	<0.2 (0)	<0.2 (0)	<0.2 (0.0)	<0.2 (0.0)	<0.2 (0.0)
Molybdenum		-	-	-	2.2	1.0 (0.4)	<0.5 (0)	-	-	-
Nickel	**21**	14	9	<2	16	9 (0.0)	1 (0.0)	20.5 (0.5)	10.6 (1.4)	3.85 (0.2)
Selenium Total	-	<5	<5	<5	1	1 (0.0)	<0.5 (0)	2.65 (1.4)	1.59 (0.9)	0.63[A] (0.4)
Strontium	-	-	-	-	23	17 (4.5)	1 (0.1)	-	-	-
Vanadium	-	48	54	10	36	60 (9.5)	9 (0.9)	-	-	-
Zinc	**200**	93	96	17	100	64 (4.0)	14 (1.5)	119 (61.5)	29 (17.5)	74 (17.0)

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000)**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01)

NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Autumn 2020			Spring 2020		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-
Arsenic	**20**	<5	<5	<5	1.90 (0.2)	3.4 (0.4)	5.1 (3.1)	1.90 (0.4)	3.4 (1.2)	2.4 (0.3)
Barium	-	110	60	<10	83 (15)	63.5 (3.5)	41.3 (31.7)	87.0 (33.0)	69.5 (9.5)	37.5 (9.5)
Beryllium	-	<1	1	<1	0.72 (0.1)	0.98 (0.0)	0.5 (0.3)	0.71 (0.2)	0.79 (0.1)	<0.5 (0.0)
Boron	-	<50	<50	<50	0.85 (0.4)	0.5 (0.0)	0.5 (0.0)	1.95 (0.4)	1.25 (0.2)	0.75
Cadmium	**1.5**	<1	<1	<1	0.25 (0.0)	0.25 (0.0)	0.3 (0.0)	<0.05 (0.0)	<0.5 (0.0)	1.0[B] (0.5)
Chromium	**80**	23	21	3	14.5 (0.5)	18.5 (0.5)	12.9 (8.2)	13.5 (3.5)	13.0 (0.0)	6.2 (0.3)
Cobalt	-	8	6	<2	-	-	-	-	-	-
Copper	**65**	31	12	<5	16.5 (0.5)	11.0 (2.0)	16.7 (12.3)	16.5 (6.5)	7.9 (0.2)	7.2 (1.2)
Lead	**50**	**91**	44	<5	**71** (5.0)	33.5 (3.5)	23.5 (15.6)	**53.5** (10.5)	26.0 (1.0)	11.5 (0.5)
Manganese	-	45	69	16	38.5 (0.5)	66.5 (10.5)	49.5 (38.5)	56.5 (16.5)	52.5 (4.5)	31.0 (3.0)
Mercury	**0.15**	<0.1	<0.1	<0.1	0.10 (0.0)	0.10 (0.0)	0.1 (0.0)	<0.2 (0.0)	<0.2 (0.0)	<0.2 (0.0)
Molybdenum		-	-	-	-	-	-	-	-	-
Nickel	**21**	14	9	<2	10.7 (1.3)	8.65 (0.5)	5.4 (3.3)	11.5 (2.6)	6.5 (0.5)	2.8 (0.6)
Selenium Total	-	<5	<5	<5	0.70 (0.0)	0.44 (0.2)	0.6 (0.4)	0.63[B] (0.4)	0.40[B] (0.2)	<0.5 (0.0)
Strontium	-	-	-	-	-	-	-	-	-	-
Vanadium	-	48	54	10	25 (1.0)	41 (2.0)	36.0 (21)	23 (5.0)	32 (5.5)	19.0 (1.0)
Zinc	**200**	93	96	17	78 (6.0)	144 (46.5)	111.0 (79)	86 (24)	58 (6.0)	45.5 (19.5)

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)

NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Autumn 2021			Spring 2021		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-
Arsenic	**20**	<5	<5	<5	3.65 (1.3)	6.10 (0.0)	4.30 (0.8)	14.55 (9.5)	3.5 (2.6)	2.85 (0.7)
Barium	-	110	60	<10	116.5(23.5)	99.5 (10.5)	68.0 (5.0)	74.5 (18.5)	48.0 (41.0)	84.5 (11.5)
Beryllium	-	<1	1	<1	1.20 (0.2)	0.87 (0.1)	0.50[A] (0.2)	0.81 (0.2)	0.38 (0.4)	0.44[A] (0.4)
Boron	-	<50	<50	<50	2.00 (0.9)	1.75[A] (1.3)	1.40[A] (0.9)	0.80[A] (0.3)	<1 (0.0)	0.95[A] (0.5)
Cadmium	**1.5**	<1	<1	<1	0.41[A] (0.2)	<0.5 (0.0)	<0.5 (0.0)	<0.5 (0.0)	<0.5 (0.0)	<0.5 (0.0)
Chromium	**80**	23	21	3	24 (7.0)	24.5 (1.5)	13.0 (2.0)	17.5 (0.5)	12.7 (10.3)	12.0 (1.0)
Cobalt	-	8	6	<2	-	-	-	-	-	-
Copper	**65**	31	12	<5	23 (8.0)	13.5 (1.5)	12.8 (3.3)	13.0 (2.0)	6.55 (5.5)	12.3 (2.8)
Lead	**50**	**91**	44	<5	**80** (50)	31.5 (2.5)	27.5 (7.5)	25.5 (4.5)	16.2 (12.9)	27.0 (7.0)
Manganese	-	45	69	16	28 (8)	150 (40)	46 (5)	95 (75)	57.1 (53)	27.5 (13.5)
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2 (0.0)	<0.2 (0.0)	<0.2 (0.0)	<0.2 (0.0)	<0.2 (0.0)	<0.2 (0.0)
Molybdenum		-	-	-	-	-	-	-	-	-
Nickel	**21**	14	9	<2	17.5 (3.5)	9.75 (2.3)	5.85 (1.4)	10.5 (3.6)	4.1 (3.4)	7.3 (2.8)
Selenium Total	-	<5	<5	<5	1.20 (0.00)	0.88 (0.00)	0.41 (0.2)	0.88 (0.3)	0.44 [A] (0.4)	1.18 [A] (0.9)
Strontium	-	-	-	-	-	-	-	-	-	-
Vanadium	-	48	54	10	10 (13)	56 (2.0)	31 (3.0)	34 (7.0)	32 (22.4)	26 (2.0)
Zinc	**200**	93	96	17	92 (68)	77 (14.0)	94.5 (35.5)	46 (22.0)	35 (28.2)	43 (16.0)

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)

NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Autumn 2022 (5/5/22)			Autumn 2022 (31/5/22)		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-
Arsenic	**20**	<5	<5	<5	4.3	10	6	2.9	3.6	4.6
Barium	-	110	60	<10	140	150	61	87	71	52
Beryllium	-	<1	1	<1	1.2	1.7	0.61	0.84	0.83	<0.5
Boron	-	<50	<50	<50	3.7	5	1.8	2	1.8	1
Cadmium	**1.5**	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	**80**	23	21	3	23	49	11	17	20	9.9
Cobalt	-	8	6	<2	-	-	-	-	-	-
Copper	**65**	31	12	<5	24	32	14	19	14	13
Lead	**50**	**91**	44	<5	**54**	**56**	30	**55**	29	17
Manganese	-	45	69	16	28	320	66	25	110	41
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	**0.29**	<0.2	<0.2
Molybdenum		-	-	-	-	-	-	-	-	-
Nickel	**21**	14	9	<2	17	**23**	5.1	13	8.8	4.2
Selenium Total	-	<5	<5	<5	3.4	3	1.3	1.1	0.68	0.57
Strontium	-	-	-	-	-	-	-	-	-	-
Vanadium	-	48	54	10	37	99	31	35	46	33
Zinc	**200**	93	96	17	48	**220**	73	76	96	56

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

A For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)

NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Spring 2022 (10/10/22)			Spring 2022 (30/11/22)		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-
Arsenic	**20**	<5	<5	<5	1.9	3.6	9.8	6.1	4.1	2.1
Barium	-	110	60	<10	100	80	61	110	61	71
Beryllium	-	<1	1	<1	0.86	1	1.2	1.1	1.2	0.65
Boron	-	<50	<50	<50	4.4	2.6	4.2	1.7	<1	<1
Cadmium	**1.5**	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	**80**	23	21	3	19	24	22	56	14	7.3
Cobalt	-	8	6	<2	-	-	-	-	-	-
Copper	**65**	31	12	<5	20	15	25	36	6.7	5.4
Lead	**50**	**91**	44	<5	**79**	32	44	**62**	23	12
Manganese	-	45	69	16	57	130	62	53	78	74
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Molybdenum		-	-	-	-	-	-	-	-	-
Nickel	**21**	14	9	<2	14	11	9.9	**25**	6.3	3.4
Selenium Total	-	<5	<5	<5	0.62	0.61	1.1	1	0.54	<0.5
Strontium	-	-	-	-	-	-	-	-	-	-
Vanadium	-	48	54	10	24	48	67	35	40	21
Zinc	**200**	93	96	17	93	110	160	84	45	23

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)
NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Autumn 2023 (18/05/23)			Autumn 2023 (3/07/23)		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	26700	24500	20600	-	-	-
Antimony	-	-	-	-	<0.5	<0.5	<0.5	-	-	-
Arsenic	**20**	<5	<5	<5	2.8	3.1	4.6	2.9	5.1	4.2
Barium	-	110	60	<10	88	70	92	100	42	54
Beryllium	-	<1	1	<1	0.91	0.81	0.99	0.9	0.59	0.63
Boron	-	<50	<50	<50	4.5	2.2	3	2.6	<1	<1
Cadmium	**1.5**	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	**80**	23	21	3	19	20	19	15	18	15
Cobalt	-	8	6	<2	7.4	7.7	6.5	-	-	-
Copper	**65**	31	12	<5	22	12	18	17	9.6	16
Lead	**50**	**91**	44	<5	**120**	25	36	37	19	32
Manganese	-	45	69	16	38	91	130	23	90	44
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Molybdenum		-	-	-	1.8	0.86	0.66	-	-	-
Nickel	**21**	14	9	<2	14	9.9	8.3	12	5.5	6.7
Selenium Total	-	<5	<5	<5	1.3	0.79	1.1	1.6	0.53	0.68
Strontium	-	-	-	-	28	19	9.5	-	-	-
Vanadium	-	48	54	10	33	39	43	26	43	34
Zinc	**200**	93	96	17	100	97	77	48	54	72

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)
NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Spring 2023 (20/09/23)			Spring 2023 (15/11/23)		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-
Arsenic	**20**	<5	<5	<5	8	3.8	2.3	3.7	3.7	4.3
Barium	-	110	60	<10	140	48	42	150	79	78
Beryllium	-	<1	1	<1	1.5	0.63	<0.5	1.3	1.2	1.3
Boron	-	<50	<50	<50	6.4	<1	<1	3.7	4.2	1.2
Cadmium	**1.5**	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	**80**	23	21	3	30	14	6.8	31	22	12
Cobalt	-	8	6	<2	-	-	-	-	-	-
Copper	**65**	31	12	<5	**78**	8.7	4.5	24	19	10
Lead	**50**	**91**	44	<5	**94**	20	13	**87**	28	17
Manganese	-	45	69	16	95	54	42	31	130	55
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Molybdenum		-	-	-	-	-	-	-	-	-
Nickel	**21**	14	9	<2	**26**	5.4	2.6	20	11	8.2
Selenium Total	-	<5	<5	<5	2.1	0.89	0.61	0.91	0.65	<0.5
Strontium	-	-	-	-	-	-	-	-	-	-
Vanadium	-	48	54	10	51	33	20	46	40	31
Zinc	**200**	93	96	17	**230**	52	24	150	120	60

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)
NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Autumn 2024 (5/05/24)			Autumn 2024 (28/05/24)		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-
Arsenic	**20**	<5	<5	<5	5.2	1.3	1.5	3.7	3.6	5.3
Barium	-	110	60	<10	150	51	14	130	99	63
Beryllium	-	<1	1	<1	1.4	0.97	<0.5	1.1	1.5	0.94
Boron	-	<50	<50	<50	4.6	1.1	1.2	<1	<1	<1
Cadmium	**1.5**	<1	<1	<1	0.52	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	**80**	23	21	3	31	10	4.7	25	20	18
Cobalt	-	8	6	<2	-	-	-	-	-	-
Copper	**65**	31	12	<5	52	4.3	5.2	30	10	19
Lead	**50**	**91**	44	<5	**100**	16	7.1	**73**	32	38
Manganese	-	45	69	16	63	37	27	48	110	55
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Molybdenum		-	-	-	-	-	-	-	-	-
Nickel	**21**	14	9	<2	**27**	4.8	2.1	20	9.8	8.7
Selenium Total	-	<5	<5	<5	1.1	<0.5	<0.5	1.1	0.64	0.71
Strontium	-	-	-	-	-	-	-	-	-	-
Vanadium	-	48	54	10	49	20	12	39	42	43
Zinc	**200**	93	96	17	**200**	35	44	130	73	110

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)

NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 7 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Spring 2024 (24/09/24)			Spring 2024 (19/11/24)		
		AQ1	AQ4	AQ1	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
Aluminium	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-
Arsenic	**20**	<5	<5	<5	5	11	2.2	4.6	1.1	4.7
Barium	-	110	60	<10	150	110	23	97	31	75
Beryllium	-	<1	1	<1	1.5	4.1	<0.5	0.85	<0.5	0.73
Boron	-	<50	<50	<50	6	1.7	<1	6	<1	<1
Cadmium	**1.5**	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	**80**	23	21	3	32	32	6.5	16	8.1	17
Cobalt	-	8	6	<2	-	-	-	-	-	-
Copper	**65**	31	12	<5	33	5.8	5.4	56	4.9	11
Lead	**50**	**91**	44	<5	**100**	38	9.8	**53**	18	28
Manganese	-	45	69	16	46	110	32	67	51	68
Mercury	**0.15**	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Molybdenum		-	-	-	-	-	-	-	-	-
Nickel	**21**	14	9	<2	**24**	12	2.3	19	3.9	6.6
Selenium Total	-	<5	<5	<5	1.3	1.9	<0.5	0.87	<0.5	0.75
Strontium	-	-	-	-	-	-	-	-	-	-
Vanadium	-	48	54	10	46	80	18	34	16	47
Zinc	**200**	93	96	17	150	47	29	**230**	38	73

***Interim Sediment Quality Guideline – Low (Trigger value) (ANZECC/ARMCANZ 2000**

[A] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (eg. <0.02 taken as 0.01)
NB Aluminium, Antimony, Molybdenum, Strontium and Vanadium were not tested for by the Spring 2019 surveys because they were not required by the BMS (cf Biosis, 2018)

Table 8. Mean (± SE) sediment results for perfluoronated compounds between autumn 2018 (*n* = 1) and spring 2024 (*n* = 2).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Spring 2018			Autumn 2019		
		AQ1	AQ4	AQ14	AQ1	AQ4	AQ14	AQ1[C]	AQ4	AQ14
Perfluoronated compound (mg/kg)										
PFHxS	-	0.0036	0.0007	<0.0002	0.0023 (0.00)	<0.001 (0.00)	<0.001 (0.00)	0.0037	<0.001 (0.00)	<0.001 (0.00)
PFOS	32	0.0444	0.0061	0.0005	0.0310 (0.01)	0.0049 (0.00)	<0.002 (0.00)	0.0220	0.0085 (0.01)	<0.002 (0.00)
PFOA	29	-	-	-	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001	<0.001 (0.00)	<0.001 (0.00)
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005	0.0333 (0.01)	0.0055 [B] (0.00)	0.002 [B] (0.00)	0.0257	0.0090 [B] (0.01)	0.0015 [B] (0.00)
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005	0.0369 [B] (0.01)	0.0096 [B] (0.00)	0.0058 [B] (0.00)	0.0329	0.0150 [B] (0.01)	0.0075 [B] (0.00)
Indicator Variable	**Trigger Value***	**Baseline (Autumn 2018)**			**Spring 2019**			**Autumn 2020**		
		AQ1	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**
Perfluoronated compound (mg/kg)										
PFHxS	-	0.0036	0.0007	<0.0002	0.0016 (0.00)	<0.001 (0.00)	<0.001 (0.00)	0.0005 (0.00)	0.0005 (0.00)	0.0005 (0.00)
PFOS	32	0.0444	0.0061	0.0005	0.0075 (0.01)	0.0062 (0.00)	0.0028 (0.00)	0.0115 (0.00)	0.0015 (0.00)	0.0052 (0.00)
PFOA	29	-	-	-	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005	0.0231 (0.08)	0.0067 [B] (0.00)	0.0033[B] (0.00)	0.0120 (0.00)	0.0020 (0.00)	0.0057 (0.00)
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005	0.0281 [B] (0.08)	0.0117 [B] (0.00	0.0083 [B] (0.00)	0.0170 (0.00)	0.0070 (0.00)	0.0107 (0.00)

*DEE (2016) - Urban residential/public open spaces

[A] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS

[B] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01), the Sum of PFHxS and PFOS and the Sum of PFAS.

[C] Only one survey was undertaken at Site AQ1 in autumn 2019.

Table 8 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Spring 2020			Autumn 2021		
		AQ1	AQ4	AQ14	AQ1	AQ4	AQ14	AQ1[C]	AQ4	AQ14
Perfluoronated compound (mg/kg)										
PFHxS	-	0.0036	0.0007	<0.0002	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001[B] (0.00)	<0.001 (0.00)	<0.001 (0.00)
PFOS	32	0.0444	0.0061	0.0005	0.0070 (0.00)	0.0022[B] (0.00)	<0.002 (0.00)	0.016 (0.004)	0.006 (0.002)	0.004 (0.003)
PFOA	29	-	-	-	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005	0.0075[B] (0.00)	0.0032[B] (0.00)	0.0015[B] (0.00)	0.0164[B] (0.003)	0.0069[B] (0.002)	0.0042[B] (0.003)
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005	0.0125[B] (0.00)	0.0082[B] (0.00)	0.0065[B] (0.00)	0.021[B] (0.003)	0.0119[B] (0.002)	0.0090[B] (0.003)
Indicator Variable	**Trigger Value***	**Baseline (Autumn 2018)**			**Spring 2021**			**Autumn 2022**		
		AQ1	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**
PFHxS	-	0.0036	0.0007	<0.0002	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	0.0015 (0.0010)	<0.001 (0.00)	<0.001 (0.00)
PFOS	32	0.0444	0.0061	0.0005	0.0090 (0.00)	0.0030[B] (0.00)	0.009[B] (0.01)	0.0265 (0.0075)	0.0056 (0.0014)	0.0038 (0.0033)
PFOA	29	-	-	-	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005	0.0075[B] (0.00)	0.0032[B] (0.00)	0.0015[B] (0.00)	0.0280 (0.01)	0.0056 (0.00)	0.0036 (0.0036)
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005	0.0168[B] (0.01)	0.0089[B] (0.00)	0.0148[B] (0.01)	0.034[B] (0.0075)	0.0111[B] (0.0014)	0.0096[B] (0.0031)

*DEE (2016) - Urban residential/public open spaces

[A] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS

[B] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01), the Sum of PFHxS and PFOS and the Sum of PFAS.

[C] Only one survey was undertaken at Site AQ1 in autumn 2019.

Table 8 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Spring 2022			Autumn 2023		
		AQ1	AQ4	AQ14	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
PFHxS	-	0.0036	0.0007	<0.0002	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)
PFOS	32	0.0444	0.0061	0.0005	0.0134 (0.01)	0.0008[B] (0.00)	<0.003 (0.00)	0.017[B] (0.00)	0.002[B] (0.00)	0.007[B] (0.00)
PFOA	29	-	-	-	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005	0.0139[B] (0.01)	0.0013[B] (0.00)	0.0038[B] (0.00)	0.018[B] (0.01)	0.001[B] (0.00)	0.004[B] (0.00)
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005	0.0035[B] (0.00)	0.0046[B] (0.00)	0.0091[B] (0.00)	0.023[B] (0.00)	0.0075[B] (0.001)	0.013[B] (0.004)
Indicator Variable	**Trigger Value***	**Baseline (Autumn 2018)**			**Spring 2023**			**Autumn 2024**		
		AQ1	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**
PFHxS	-	0.0036	0.0007	<0.0002	<0.005 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.005 (0.00)	<0.001 (0.00)	<0.001 (0.00)
PFOS	32	0.0444	0.0061	0.0005	0.009[B] (0.01)	0.0021[B] (0.01)	0.0085[B] (0.01)	0.023[B] (0.01)	0.0022[B] (0.01)	0.0031[B] (0.01)
PFOA	29	-	-	-	<0.005 (0.00)	<0.001 (0.00)	<0.001 (0.00)	<0.005 (0.00)	<0.001 (0.00)	<0.001 (0.00)
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005	0.0198[B] (0.00)	0.0034[B] (0.00)	0.0098[B] (0.00)	0.0340[B] (0.00)	0.0030[B] (0.00)	0.0043[B] (0.00)
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005	0.0242 (0.01)	0.0076[B] (0.00)	0.014[B] (0.01)	0.0387 (0.01)	0.0077[B] (0.00)	0.0089[B] (0.00)

*DEE (2016) - Urban residential/public open spaces

[A] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS

[B] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01), the Sum of PFHxS and PFOS and the Sum of PFAS.

Table 8 (Cont'd).

Indicator Variable	Trigger Value*	Baseline (Autumn 2018)			Spring 2024					
		AQ1	AQ4	AQ14	AQ1	AQ4	AQ14	AQ1	AQ4	AQ14
PFHxS	-	0.0036	0.0007	<0.0002	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)			
PFOS	32	0.0444	0.0061	0.0005	0.0193 (0.01)	0.0032[B] (0.00)	<0.002 (0.00)			
PFOA	29	-	-	-	<0.001 (0.00)	<0.001 (0.00)	<0.001 (0.00)			
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005	0.0102[B] (0.01)	0.0048[B] (0.00)	0.0023[B] (0.00)			
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005	0.0217[B] (0.01)	0.0074[B] (0.00)	0.0065[B] (0.00)			
Indicator Variable	**Trigger Value***	**Baseline (Autumn 2018)**								
		AQ1	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**	**AQ1**	**AQ4**	**AQ14**
PFHxS	-	0.0036	0.0007	<0.0002						
PFOS	32	0.0444	0.0061	0.0005						
PFOA	29	-	-	-						
Sum of PFHxS and PFOS	-	0.0480	0.0068	0.0005						
Sum of PFAS (WA DER List) [A,B]	-	0.0483	0.0068	0.0005						

*DEE (2016) - Urban residential/public open spaces

[A] = PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTS and 8:2 FTS

[B] For any site, where a value has been recorded as less than the detection limit, it was assigned a value of half the detection limit in order to calculate the mean (e.g. <0.02 taken as 0.01), the Sum of PFHxS and PFOS and the Sum of PFAS.

3.3 Aquatic Macroinvertebrates

A total of 14 taxon were identified from edge habitat samples collected at Site AQ12 in Spring 2024 (Survey 1: 9 taxa; Survey 2: 12 taxa) (Table 11, Appendix 3). Seven taxa, Acarifomes (Water mites), Chironominae (True flies), Tanypodinae (True flies), Ceratopogonidae (Biting midges), Leptoceridae (Caddis flies), Libellulidae (Dragonflies) and Physidae (Freshwater snails), were collected on both sampling occasions (Appendix 3).

Site AQ12 obtained an OE50 score of 0.40 for Survey 1 and 0.50 for Survey 2 during Spring 2024 (Table 11, Figure 3), indicating that the macroinvertebrate assemblage at Site AQ12 was severely impaired (Band C) relative to reference sites selected by the AUSRIVAS model. The most recent OE50 scores were within the range of scores obtained since the baseline survey (Figure 3).

Similar to the findings of the previous surveys, taxon with > 0.80 probability of occurrence but not collected at the Anzac Creek site were the mayfly family, Leptophlebiidae, the aquatic bug family, Veliidae, at the time of Survey 2, and the beetle family, Hydrophilidae.

SIGNAL2 scores of 3.94 and 3.71 were obtained for both surveys (Table 4). The absence of mayflies was likely to have contributed to the lower score (Table 4, Figure 4). In summary, SIGNAL 2 scores obtained for Site AQ12 have changed little over time and indicate that the macroinvertebrate assemblage at AQ12 has commonly been dominated by pollution-tolerant taxa since the commencement of sampling in autumn 2018 (Table 11, Figure 4).

Table 9. Total number of taxa, AUSRIVAS & SIGNAL 2 outputs for Site AQ12 (*n* = 1).

Survey	No Taxa	SIGNAL-2	OE50	Band
Autumn 2018	13	4.00	0.49	B
Spring 2018 – Survey 1	9	3.25	0.39	C
Spring 2018 – Survey 2	5	3.07	0.10	D
Autumn 2019 – Survey 1	10	2.69	0.41	C
Autumn 2019 – Survey 2	8	3.41	0.20	C
Spring 2019 – Survey 1	11	2.09	0.38	C
Spring 2019 – Survey 2	11	2.18	0.19	D
Autumn 2020 – Survey 1	19	3.00	0.68	B
Autumn 2020 – Survey 2	13	3.33	0.49	B
Spring 2020 – Survey 1	10	3.10	0.40	C
Spring 2020 – Survey 2	13	3.33	0.40	C
Autumn 2021 – Survey 1	13	3.38	0.49	B
Autumn 2021 – Survey 2	12	3.64	0.41	C
Spring 2021 – Survey 1	10	2.41	0.30	C
Spring 2021 – Survey 2	6	3.00	0.30	C
Autumn 2022 – Survey 1	13	3.86	0.49	B
Autumn 2022 – Survey 2	7	4.58	0.31	C
Spring 2022 – Survey 1	12	3.25	0.30	C
Spring 2022 – Survey 2	9	4.74	0.40	C
Autumn 2023 – Survey 1	7	0.30	0.29	C
Autumn 2023 – Survey 2	8	0.30	0.29	C
Spring 2023 – Survey 1	12	3.82	0.40	C
Spring 2023 – Survey 2	9	4.00	0.50	C
Autumn 2024 – Survey 1	11	3.19	0.41	C
Autumn 2024 – Survey 2	8	4.00	0.29	C
Spring 2024 – Survey 1	9	3.94	0.40	C
Spring 2024 – Survey 2	12	3.71	0.50	C

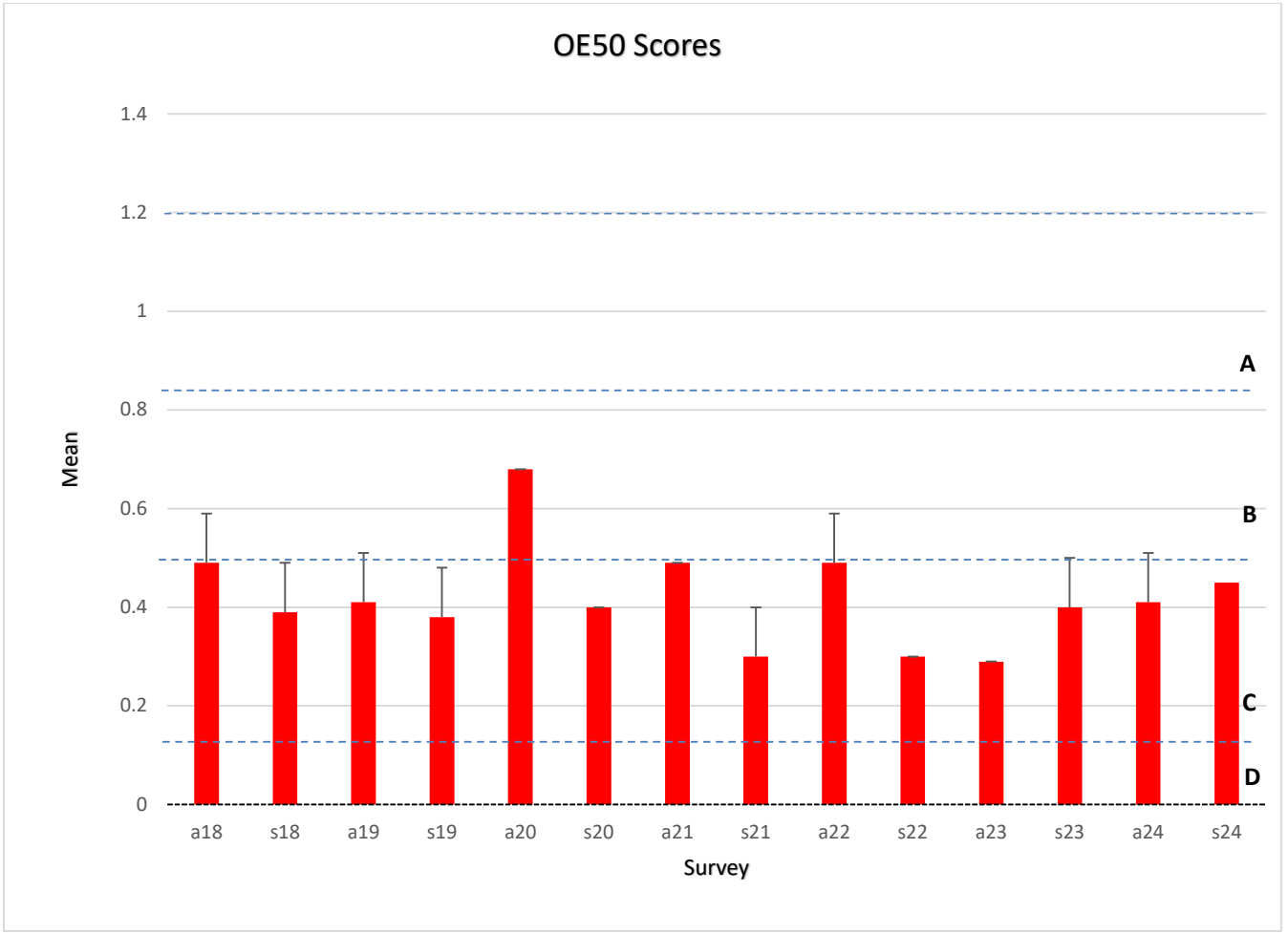

Figure 3. Mean (±SE) OE50 Taxa Scores and their respective Band Scores (B-D) for AUSRIVAS samples collected at Site AQ12 since autumn 2018. NB Note that the bands displayed are relevant to autumn edge habitat, these being slightly different to spring.

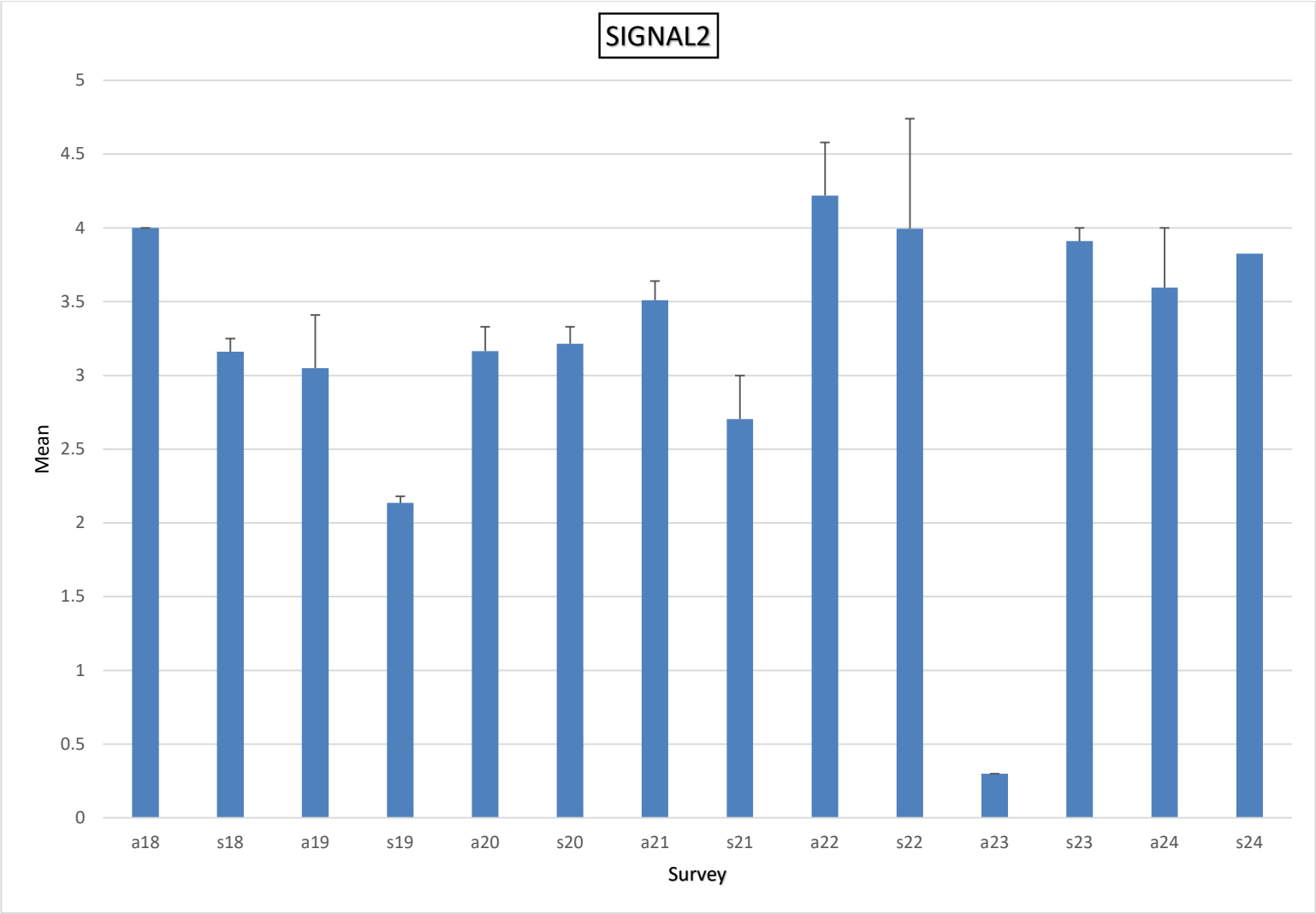

Figure 4. Mean (±) SIGNAL 2 results for Site AQ12 sampled in Anzac Creek since autumn 2018.

3.4 Fish

Four species of fish were collected while electro-fishing at Site AQ12 in spring 2024, including 3 individuals of Striped gudgeon (*Gobiomorphus australis*), one Long-finned eel (*Anguilla reinhardtii*) (20-30cm in length), a Firetail gudgeon (*Hypseleotris* cf *galii*) and numerous Gambusia (*Gambusia holbrooki*) (Table 10). A further species, Australian smelt (*Retropinna semoni*), was collected (1 individual) in net samples while collecting aquatic macroinvertebrates.

In total, ten species of fish, including three introduced species, have been collected since sampling commenced in autumn 2018 (Table 10). All the species caught were common within NSW (McDowall, 1996; DPI 2006; Howell and Creese, 2010). No threatened species of fish listed under the *NSW Fisheries Management Act, 1994* or the *Environment Protection and Biodiversity Conservation Act, 1999* were recorded.

Plate 13: Juvenile Long-finned eel collected at Site AQ12 (spring 2024).

Table 10. Fish collected at Site AQ12 between autumn 2018 and spring 2024[#].

Species	Common Name	A-18^	S-18	A-19	S-19	S-20	A-21	S-21	A-22	S-22	A-23	A-24	S-24
Anguilla reinhardtii	Long-finned eel	2	3	2	-	4	1	2	1	1	-	-	1
Anguilla australis	Short-finned eel	-	13	-	9	13	2	4	2	4	1	2	-
Galaxias maculatus	Common galaxias	-	-	-	-	-	-	-	8	-	-	1	1
Gobiomorphus australis	Striped gudgeon	28	8	3	2	-	-	-	2	2	3	1	3
Hypseleotris compressa	Empire gudgeon	13	-	-	-	-	-	-	-	-	1	-	-
Hypseleotris cf *galii*	Firetail gudgeon	-	-	-	1	1	-	-	-	-	-	-	1
Tandanus tandanus	Eel tailed catfish	-	-	-	-	-	-	-	-	-	1	-	-
*Carassius auratus**	Goldfish	-	2	-	-	-	1	-	-	1	-	-	-
*Gambusia holbrooki**	Gambusia	328	100's	10's	10's	100's	100's	100's	10's	100's	100's	-	80
*Misgurnus anguillicaudatus**	Oriental weatherloach	-	-	-	1	-	-	-	2	1	1	1	-
Retropinna semoni	Australian smelt	-	-	--		-	-	-	-	-	-	-	1
Unidentified sp.	-	-	-	-	-	-	-	1	-	-	-	-	-

^Biosis, 2018

*Introduced species

[#]Fish were unable to be sampled at Site AQ12 within the autumn 2020 survey period (due to instrument malfunction) or during autumn 2023 (due to the presence of extensive mats of green macro-algae).

3.5 Limitations

- Only one Baseline survey was able to be sampled in autumn 2018, due to the May 2018 bushfire (Biosis, 2018);
- Due to restricted access through the construction worksite, it was not possible to access Site AQ1 on 30 May 2019 to undertake the 2019 autumn survey 2. Whilst the collection of replicate samples at each site provides important measures of variability in habitat characteristics and concentrations of toxicants, the results from Survey 1 and subsequent surveys were within the range of results collected in the Baseline survey. Therefore, it is considered that the missing sample did not detract from being able to interpret the findings of the 2019 autumn sampling event, and that the intent and outcomes of the MPES2 monitoring survey were achieved;
- Water quality measurements collected during the biological sampling only provide a snapshot of quality at the time of sampling under the prevailing flow conditions;
- In the absence of external reference sites (i.e. similar sites but in systems not subject to the Project activities), it is not possible to account for changes in the variables examined that may occur naturally at a broader regional scale.

5.0 DISCUSSION

Stage 2 of the MPE Project involves the construction and operation of warehousing and distribution facilities on the MPE site and upgrades to approximately 2.1 kilometres of Moorebank Avenue. Warehouses 1, 3, 4, 5, 6, 7a and 7b are now operational. The next warehouse to be constructed is WH2, which is currently anticipated to occur in Q4 2025. During construction of WH2, water will be managed is accordance with the approved CEMP and water is discharged via the sediment (SED) Basins and into Anzac Creek (via DP5 and DP7).

5.1 Aquatic Habitat and Hydrology

At the time of the second spring 2024 survey, recent rainfall had replenished aquatic habitat at the sites sampled although there was little flow observed at the upstream sites (i.e. Sites AQ1-AQ8). Extensive cover of vegetation within the riparian zone contributes stability to the edges of the creek channel, although an area of active erosion has been apparent at the downstream end of the refuge pool (Site AQ12) since autumn 2020. The presence of a dense stand of Typha may have contributed to bank overflow in this area, by acting as a barrier to flow.

The popular aquarium plant, *Egeria densa* (Egeria), first observed within the large refuge pool in spring 2020, has commonly been observed subsequently, including at the time of the autumn 2024 surveys. Infestations of Egeria have been shown to displace native species of other submerged plants (e.g. Roberts et al., 1999), and have been observed in the Georges River near its confluence with Anzac Creek.

The noxious plant, Alligator Weed, continues to be widespread at the most upstream site (Site AQ1). Due to its highly invasive nature, Alligator weed is considered one of the greatest threats to waterways, wetlands, floodplains and irrigation systems in Australia (van Oosterhout, 2007; DPI, 2019).

Also notable at Site AQ1 was the presence of the introduced aquatic weed, Ludwigia (*Ludwigia peruviana*), within the creek channel. Found mostly in creeks and wetland areas, Ludwigia is a fast-growing invasive aquatic plant that can form dense colonies in slow-moving and static waterways (Sainty and Jacobs, 2003). An upright perennial shrub, it can grow to 3 m tall. Its presence can change water flows and increase the risk of flooding,

outcompete native plants and reduce food and shelter for fish and other native aquatic animals (Sainty and Jacobs, 2003).

Concentrations of lead measured in sediments at Site AQ1 (Survey 1: 100 mg/kg; Survey 2: 53 mg/kg) exceeded the guideline value (50 mg/L) on both sampling occasions within spring 2024. The majority (i.e. 17 of 19 times) of measurements of lead at AQ1 (range = 21 to 130 mg/kg) have exceeded the threshold limit detailed in the Interim Sediment Quality Guidelines (ISQG) (ANZECC/ARMCANZ 2000), including at the time of the baseline (91 mg/kg) survey. Nickel and zinc have also marginally exceeded the upper ANZECC/ARMCANZ (2000) guidelines, including on one of the two sampling occasions during spring 2024. Site AQ1 is situated upstream of potential inputs from the Project and therefore no additional testing of heavy metals at Site AQ1 should be considered necessary.

Importantly for this study, all toxicants, including total petroleum hydrocarbons and poly-fluoroalkyl substances (like PFAS and PFOS), that were monitored in sediments at the sites downstream of inputs from the MPES2 Project site (i.e., at Sites AQ4 and AQ14) in the spring of 2024, remained within the proper guideline levels.

5.2 Water Quality

Reduced dissolved oxygen levels, elevated nitrogen, aluminium, and copper measured in surface water in the large refuge pool (Site AQ12), including prior to commencement of the Project, reflect historic and current activities (ALS, 2011; Biosis, 2018). Concentrations of total petroleum hydrocarbons and poly-fluoroalkyl substances measured during spring 2024 remain similar to baseline values and within the recommended Australian-derived guidelines for water. Additional degradation of water quality does not appear to have occurred since the Project related construction work began.

5.3 Biological Monitoring

The macroinvertebrate assemblage supported by the refuge pool appears to experience some degree of environmental stress. This is evident in the OE50 Taxa Scores and Bands, which have generally been indicative of an assemblage that is less diverse compared to reference sites selected by the AUSRIVAS model throughout the survey period.

Low values of the SIGNAL 2 score and the number of macroinvertebrate types (only 12 taxa) were also indicative of a site suffering from one or more forms of anthropogenic disturbance (see Chessman, 2003a&b).

Lower than expected macroinvertebrate indices were not unexpected given long-term (decades) exposure to multiple stressors (e.g., reduced dissolved oxygen levels, elevated levels of nitrogen, and excessive aquatic plant growth) that can adversely affect the condition of aquatic habitat. The introduced fish, Gambusia (*Gambusia holbrooki*), has also consistently been observed within the refuge pool. Predation by Gambusia is listed as a Key Threatening Process by the NSW *Biodiversity Conservation Act 2016*, because of known effects on native frogs, freshwater fishes and aquatic macroinvertebrates.

Nevertheless, some pollution sensitive aquatic macroinvertebrates (including caddis fly and dragonfly larvae) and native species of fish continue to be collected, indicating that the creek provides important habitat for aquatic species. Of the species collected, all are common within NSW (McDowall, 1996; DPI 2006; Howell and Creese, 2010).

6.0 CONCLUSION & RECOMMENDATIONS

Examination of the results from the spring 2024 monitoring event found no evidence of changes in the indicator variables (bed and bank stability, surface water and sediment quality, assemblages of aquatic macroinvertebrates and fish) that could be attributed to the Project works. Thus, in accordance with the Biodiversity Monitoring Strategy, no adaptive management contingency measures were triggered.

Recommendations include:

- Sampling of the stream health monitoring programme to be repeated in autumn 2025;
- Land managers focus on containment and on-going suppression of Alligator Weed and Ludwigia within Anzac Creek and the riparian zone, particularly at Site AQ1, and the popular aquarium plant, *Egeria densa* (Egeria), commonly observed within the refuge pool.

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APPENDICES

Appendix 1 - GPS positions (UTMs) for stream monitoring sites (spring 2024).

Site Code	Easting	Northing
AQ1	308116	6240233
AQ4	308557	6240282
AQ8	309216	6240802
AQ12	309377	6241575
AQ13	309369	6241782
AQ14	309365	6241863

Datum: WGS 84, Zone 56H

Appendix 2 – Visual Assessment Scores

Appendix 2a – Ephemeral stream assessment results

	Autumn 2018		Spring 2018		Autumn 2019	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	88	Very Stable	75	Stable	80	Stable
AQ4	88	Very Stable	75	Stable	78	Stable
AQ8	91	Very Stable	93	Very Stable	93	Very Stable
	Spring 2019		**Autumn 2020**		**Spring 2020**	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	88	Very Stable	90	Very Stable	90	Very Stable
AQ4	80	Stable	88	Very Stable	89	Very Stable
AQ8	92	Very Stable	93	Very Stable	93	Very Stable
	Autumn 2021		**Spring 2021**		**Autumn 2022**	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	80	Very Stable	90	Very Stable	92	Very Stable
AQ4	89	Very Stable	89	Very Stable	90	Very Stable
AQ8	93	Very Stable	93	Very Stable	93	Very Stable
	Spring 2022		**Autumn 2023**		**Spring 2023**	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	92	Very Stable	88	Very Stable	88	Very Stable
AQ4	92	Very Stable	93	Very Stable	93	Very Stable
AQ8	94	Very Stable	94	Very Stable	94	Very Stable
	Autumn 2024		**Spring 2024**			
Site	**Score (%)**	**Category**	**Score (%)**	**Category**		
AQ1	94	Very Stable	92	Very Stable		
AQ4	94	Very Stable	92	Very Stable		
AQ8	94	Very Stable	94	Very Stable		

Appendix 2b – HABSCORE assessment results

	Autumn 2018		Spring 2018		Autumn 2019	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	27	Marginal	29	Marginal	32	Marginal
AQ4	28	Marginal	25	Marginal	25	Marginal
AQ8	41	Marginal	38	Marginal	38	Marginal
AQ12	55	Suboptimal	51	Suboptimal	53	Suboptimal
AQ13	21	Poor	23	Poor	21	Poor
AQ14	22	Poor	23	Poor	22	Poor
	Spring 2019		**Autumn 2020**		**Spring 2020**	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	30	Marginal	32	Marginal	27	Marginal
AQ4	26	Marginal	29	Marginal	28	Marginal
AQ8	41	Marginal	41	Marginal	41	Marginal
AQ12	51	Suboptimal	50	Suboptimal	53	Suboptimal
AQ13	19	Poor	21	Poor	22	Poor
AQ14	21	Poor	22	Poor	23	Poor
	Autumn 2021		**Spring 2021**		**Autumn 2022**	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	29	Marginal	31	Marginal	31	Marginal
AQ4	36	Marginal	38	Marginal	40	Marginal
AQ8	41	Marginal	41	Marginal	41	Marginal
AQ12	55	Suboptimal	55	Suboptimal	50	Suboptimal
AQ13	23	Poor	23	Poor	25	Poor
AQ14	24	Poor	24	Poor	25	Poor
	Spring 2022		**Autumn 2023**		**Spring 2023**	
Site	**Score (%)**	**Category**	**Score (%)**	**Category**	**Score (%)**	**Category**
AQ1	31	Marginal	32	Marginal	27	Marginal
AQ4	39	Marginal	40	Marginal	29	Marginal
AQ8	41	Marginal	41	Marginal	38	Marginal
AQ12	53	Suboptimal	53	Suboptimal	50	Suboptimal
AQ13	21	Poor	25	Poor	25	Poor
AQ14	25	Poor	25	Poor	25	Poor

Appendix 2b – HABSCORE assessment results

	Autumn 2024		Spring 2024			
Site	**Score (%)**	**Category**	**Score (%)**	**Category**		
AQ1	31	Marginal	27	Marginal		
AQ4	40	Marginal	40	Marginal		
AQ8	41	Marginal	41	Marginal		
AQ12	50	Suboptimal	53	Suboptimal		
AQ13	30	Marginal	21	Poor		
AQ14	32	Marginal	25	Poor		

Appendix 3 - Macroinvertebrate taxa collected at Site AQ12 in spring 2024 using the NSW AUSRIVAS protocol. Mosquito fish were also collected in the net samples**.**

Taxa	Survey 1 (24 September 2024)	Survey 2 (19 November 2024)
Acariformes	6	20
Belastomatidae	0	1
Ceratopogonidae	5	13
Chironomidae - Chironominae	25	20
Chironomidae - Tanypodinae	1	2
Coenagrionidae	2	0
Hydroptilidae	3	0
Leptoceridae	1	1
Libellulidae	1	3
Lumbriculidae	0	3
Physidae	1	1
Planorbiidae	0	1
Pleidae	0	2
Veliidae	0	2
Number of Taxa	**9**	**12**
Australian smelt	1	