Water and sediment quality in the Bull Creek catchment and City of Melville lakes 2017

Prepared by the South East Regional Centre for Urban Landcare for the City of Melville

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This assessment of surface water and sediment quality within the Melville Bull Creek catchment was undertaken in 2017 as part of an annual monitoring partnership program between the City of Melville, SERCUL and Department of Water and Environment Regulation. Initiated in 2007, the purpose of this monitoring program is to determine the water and sediment quality in the City of Melville (western) side of the Bull Creek catchment to guide management responses within the catchment.

This assessment is based on four sampling events of surface water and one sampling event of sediment collected in 2017. This report also compares the 2017 sample data with datasets from the previous ten years of monitoring (2007 - 2016) where spatial or temporal patterns have been observed.

Water and sediment results recorded in samples collected in 2017 were generally similar to results recorded in previous years. The following key water and sediment quality issues have been identified in the catchment over the eleven years of monitoring:

- Bull Creek main drain:
    - Total nitrogen concentrations exceeding the ANZECC trigger value for lowland rivers have consistently been recorded in some Bull Creek main drain sites, including the site closest to the drain outfall (PSDTBCMD);
        - A significant proportion of this nitrogen enters the drain in the form of ammonia nitrogen between the convergence of the two main upstream branches of the drain and Brockman Park;
    - High phosphorus concentrations exceeding the ANZECC trigger value for lowland rivers have often been recorded at John Creaney Park lake;
    - Oxygen saturations have consistently been below the ANZECC acceptable range for lowland rivers;
    - Sediment samples collected from John Creaney Park lake have recorded lead concentrations exceeding the ANZECC low trigger value in four out of the last five years;
    - Concentrations of iron and aluminium (total and soluble) exceeding ANZECC trigger values are consistently recorded at all Bull Creek main drain sites;
    - Concentrations of total zinc exceeding ANZECC trigger values have been regularly recorded at John Creaney Park inlet and downstream Elizabeth Manion Park (since monitoring at these sites began in 2014);
    - Concentrations of total copper exceeding ANZECC trigger values have often been recorded at downstream Elizabeth Manion Park (since monitoring at these sites began in 2014);
- Brentwood drain:
    - Water quality is generally better at Brentwood drain sites than Bull Creek main drain sites, with total nitrogen, total phosphorus and most metals generally below relevant ANZECC trigger values, although total oxidised nitrogen regularly exceeds the guideline value;
    - A pattern of generally declining concentrations of total nitrogen (and ammonia nitrogen), total and soluble iron and total aluminium has been noted at the most downstream Brentwood drain site (at Bateman Park) over the eleven years of monitoring;
    - Oxygen saturations have consistently been below the ANZECC acceptable range for lowland rivers;
    - Concentrations of iron and aluminium exceeding ANZECC trigger values are consistently recorded at all Brentwood drain sites;
- Melville Lakes:

- High total nitrogen (and ammonia) concentrations have been recorded on almost all sampling occasions at Booragoon Lake and Blue Gum Lake;
- Since 2013 at Quenda Lake, total nitrogen (although still usually below the trigger value) and total aluminium concentrations have increased and pH values have been somewhat lower;
- pH values at Marmion Reserve have often been high, particularly in spring months;
- Particularly low pH values (significantly less than the acceptable range for wetlands) have consistently been recorded at Booragoon Lake outlet and Blue Gum Lake outlet (and to a lesser degree Piney Lakes outlet);
- Regular exceedances of the trigger value for soluble zinc have been recorded at Frederick Baldwin Lake, partially as a result of the soft water at this site;
- Booragoon Lake and Blue Gum Lake, although only sometimes recording exceedances of total and soluble copper, lead and zinc, have sporadically recorded very high concentrations of these metals;
- In Booragoon Lake sediment samples, lead concentrations exceeding the trigger value have often been recorded, and arsenic, copper, mercury and nickel exceeding trigger values have been recorded on at least one sampling occasions within the last five years;
- Concentrations of total and soluble iron and aluminium exceeding ANZECC trigger values are consistently recorded at most Melville Lakes sites, and total and soluble iron concentrations at Booragoon Lake and Blue Gum Lake are particularly high;
- Total oxygen saturations at Quenda Lake, Frederick Baldwin, Blue Gum Lake appear to be have been declining over the eleven years of monitoring.

Based on the above findings, it is considered that Bull Creek main drain, Booragoon Lake and Blue Gum Lake have the poorest water quality in the catchment and therefore management responses should be focussed on improvement of these sites.

It is recommended that the monitoring program be continued in 2018 to detect any changes in water quality and to evaluate the impacts of changes to the catchment (such as the Brentwood Living Stream project and the ongoing works in the Bull Creek Reserves and the lakes). Further recommendations are focussed on suggested structural and non-structural controls to improve water quality and continued implementation of existing City of Melville management plans and restoration projects.

1. Introduction

1.1 City of Melville

The City of Melville is located 8km from the central business district of Perth and has an area of 52.72 km^2 with 18.1 km of foreshore. The City encompasses 18 suburbs connected by over 1,200 km of local, arterial and major roads. With a population of approximately 103,767 people within 40,546 dwellings, the City of Melville is the third largest local government in the metropolitan region (City of Melville 2014a). The City residents enjoy 210 parks and reserves comprising 600 hectares of public open space and 300ha of bushland. In the City, there are approximately 67 drainage sumps and over 300 km of stormwater drainage pipes (City of Melville 2010).

1.2 Melville Bull Creek catchment

The Bull Creek Catchment, as described in the Swan River Trust's Local Water Quality Improvement Plan – Bull Creek Catchment (2012), contains the sub-catchments of Bull Creek itself and six other adjacent drainage catchments that have outfalls to the Canning River. The entire Bull Creek Catchment covers an area of approximately 43.5 square kilometres. It includes areas within the cities of Melville and Canning in Perth's southern and south-eastern suburbs Willagee, Kardinya, Winthrop, Murdoch, Leeming, Bull Creek, Rossmoyne, Willetton, Riverton, Shelley and Parkwood. Most of the Bull Creek Catchment has been cleared for urban residential development, with some recreational areas and a light industrial area in Willetton. To accommodate this development, the drainage network within the Bull Creek Catchment is highly modified and is largely piped, however some natural wetlands remain. There is over 10km of foreshore within the Bull Creek catchment, some of which is in relatively natural condition (Swan River Trust 2012). This water quality assessment concerns the western part of the Bull Creek catchment within the City of Melville, which includes Bull Creek main drain and Brentwood drain as well as the chain of lakes to the west of Bull Creek (Booragoon Lake, Blue Gum Lake, Piney Lakes, Quenda Wetland, Frederick Baldwin Lake and Marmion Lake), hereafter referred to as the "Melville Bull Creek catchment".

Bull Creek main drain winds its way through a series of parks and urban land in the lower catchment, receiving stormwater from local drains, before discharging directly into Bull Creek and the Canning River (SRT 2012). Bull Creek main drain has good flow all throughout the year, even in summer, suggesting it is also strongly influenced by groundwater (Foulsham et al 2009).

The Brentwood drain also flows permanently due to groundwater interception, and receives additional water when flood control pumps at Frederick Baldwin Lake and Kingston Place in Kardinya are in operation. Frederick Baldwin Lake and Kingston Place receive stormwater and groundwater from the suburbs of Kardinya and Murdoch (City of Melville 2004b). The Brentwood main drain also receives water from local drains and converges with the Mandala Crescent Branch Drain (also known as the RAAF drain) at the Brentwood Living Stream site before flowing through Bateman Park and discharging into the Canning River. The Brentwood Living Stream project, driven by a partnership of several agencies (including Department of Biodiversity, Conservation and Attractions (DBCA) Rivers and Estuaries Division, City of Melville, SERCUL, Water Corporation and Main Roads) was launched in 2012 to mitigate some of the water quality issues identified in Brentwood drain at Bateman Park. The project involved the reconstruction of the water course where the Brentwood and Mandala Crescent drains converge (upstream of Bateman Park) using urban water sensitive nutrient/non-nutrient stripping designs.

Booragoon Lake, Blue Gum Lake outlet and Piney Lakes Reserve represent the northern extent of the Beeliar Wetland chain, a system consisting of inter-dunal depressions between the Spearwood and Bassendean dune systems which include a series of lakes running parallel with the coast (Natural Area Consulting 2012a 2012b and 2016). The chain of wetlands holds significance for the local aboriginal people as they were important camping and ceremonial areas; as well as providing an abundant source of food, offering fish, water fowl, shell fish, vegetable roots and bulbs (City of Melville n.d.). These wetlands are a surface expression of the underlying Jandakot Groundwater Mound aquifer (Natural Area Consulting 2012a).

Booragoon Lake Reserve is located approximately 10.5km south of Perth CBD in the suburb of Booragoon, bounded by Leach Highway, Aldridge Road and Lang Street, and occupies an area of approximately 13.5 ha. The reserve is comprised of wetland areas, upland remnant vegetation and parkland cleared spaces (Natural Area Consulting 2012). In the 1970s and 80s the Council drew water from a subterranean bore in the Alfred Cove area and pumped it into Blue Gum and Booragoon Lakes during summer to maintain the water level (City of Melville 2004a). However this practice no longer occurs and the Lake now has a water regime typical of Swan Coastal Plain wetlands, with water levels fluctuating in response to rainfall and groundwater level. Stormwater also enters the Lake from the surrounding urban catchment via five drains (including one drain collecting water from Leach Highway) and one drainage basin (Natural Area Consulting 2012a).

Blue Gum Lake Reserve is a wetland reserve located approximately 9.5km south of Perth Central Business District (Perth CBD) in the suburb of Mount Pleasant, and occupies an area of approximately 11.09 ha. The reserve is bounded by Canning Avenue, Moolyeen Road and Rountree Road and is comprised of wetland areas, upland remnant vegetation and parkland cleared spaces. The Reserve is comprised of four main areas: two wetland basins with an artificial island located between them, two areas of upland Banksia woodland community, a transitional zone characterised by Melaleuca and *Eucalyptus rudis* woodlands, and parkland cleared areas with an over storey of predominantly non-native eucalyptus. In addition to being a surface expression of the groundwater, Blue Gum Lake also receives water from stormwater inflow from seven drains collecting water from the surrounding urban catchment, two of which have defective basins at their outlet (Natural Area Consulting 2012b). Historically Blue Gum Lake would respond to fluctuations of the water table relating to seasonality and climatic variations but following the development of the area the lake has experienced significant changes to its natural cycle (Natural Area Consulting 2012b).

Piney Lakes Reserve is a bushland and wetland remnant area surrounded by urban development in the suburb of Winthrop in the City of Melville. The Reserve is bounded by Leach Highway to the north and Murdoch Drive to the east and encompasses approximately 67 ha (50ha of bushland and wetland environments and about 17ha of developed parklands to the south and west) (Natural Area Consulting 2016a). Piney Lakes includes two conservation category groundwater dependent wetlands: an eastern and a western wetland (DBCA 2017). The western wetland is sampled for the purposes of this assessment. The western wetland used to contain water permanently but in recent years has often been found to be dry (Natural Area Consulting 2016a).

Quenda Wetland is a unique small reserve of a high conservation value located at the corner of Murdoch Drive and South Street in the suburb of Murdoch. The wetland was originally seasonal, drying out in the summer months; however it has been artificially deepened to accommodate stormwater flows from surrounding development (Natural Area Consulting 2016b). A number of stormwater drains enter the lake, including a large drain collecting water from Murdoch St John of God Hospital carparks and roads to the south east of the lake (Natural Area Consulting 2016b).

Marmion Lake is located in the surburb of Myaree. In 2012 the Lake was found to be infested with a pest eel-tailed catfish species (*Tandanus tandanus*) and the aquatic weed *Salvinia molesta* (City of Melville 2016). In an effort to control these species the lake was drained in 2014 and the species successfully eradicated (Clayton 2015). Revegetation and removal of old vegetation has been occurring immediately surrounding the lake since this time (City of Melville 2016).

1.3 Background of the monitoring program

The City of Melville has been sampling the lakes and Bull Creek drains twice a year since 1996. In 2007 a partnership between the City, SERCUL and the Department of Water (now Department of Water and Environment Regulation or DWER) was established in order to standardise all water quality monitoring data collection, management and storage methods. The City has been utilising this data to develop some management programs within the city. The sites and parameters monitored have been modified in response to changes in budget and requirements since the program's introduction in 2007 (see **Appendix B**).

In 2006 the Australian Government's Coastal Catchments Initiative identified the Swan Canning river system as a coastal 'hot spot' and funding was provided to the Swan River Trust (now DBCA Rivers and Estuaries Division) to coordinate a Water Quality Improvement Plan for the region. The Swan River Trust developed the Local Water Quality Improvement Plan (WQIP) for the Bull Creek Catchment which was released on November 2012. The Bull Creek Catchment WQIP aims to reduce nutrient loads entering the Canning River through nutrient intervention and changed management practices. By using a treatment train approach, a combined set of management actions are applied along the nutrient pathways to meet water quality targets in the catchment (SRT 2012). The water quality monitoring partnership program between the City, SERCUL and DWER forms part of the "Prevention" approach.

Several changes were made to the program in 2017:

- Metals arsenic, cadmium, cobalt, manganese, mercury, molybdenum, nickel and selenium are no longer analysed at sites 15 and 16. Total concentrations of these metals had been analysed at these sites since they were introduced into the program in 2014 until 2016 as a screening exercise, and as exceedances of trigger values for these relatively uncommon contaminants were not recorded at these sites it is considered unlikely that they will do so in the future.
- For the remaining metals analysed at sites 15 and 16 (aluminium, chromium, copper, iron, lead and zinc), as is done at all other sites, total concentrations were analysed in July and soluble concentrations on all sampling occasions, which was not done previously. As soluble metals are generally more bioavailable than particulate metals, this allowed toxicity of these metals to be more accurately assessed.
- The Brockman Park inlet (ROSSTAFE) site within and previously monitored on behalf of the City of Canning, for which results are usually included in this assessment, was not monitored this year.

1.4 Purpose of the sampling

The purpose of this sampling program is to:

- ✓ Assess current water and sediment quality in the Melville Bull Creek Catchment;
- ✓ Identify patterns in water and sediment quality over time in the Catchment;
- ✓ Identify any pollutant hotspots in the Catchment; and
- ✓ Make recommendations for improvement of water and sediment quality in the Catchment.

This water quality monitoring program also contributes valid data to the DWER Water Information (WIN) database, which is utilised in the management of the State's water resources.

2. Methodology

Sampling was conducted in accordance with the Sampling and Analysis Plan (SAP) prepared by SERCUL (2017).

2.1 Site locations

14 sites from the Melville Bull Creek catchment were sampled to represent the water quality in different portions of Bull Creek and the Melville lakes, whilst taking into account accessibility and historical sampling sites.

Table 2.1-1 provides a detailed description and GPS coordinates of each of the sample sites. A map showing the location of the sites is provided in **Figure 2.1-1**.

Table 2.1-1: List and description of sampling sites

Site No.	WIR site ref.	Drain section/component	Sampling point Location	Easting	Northing
PSDTBCMD (MELDR-01)	6162178	Bull Creek Park Main Drain	Culvert under Leach Hwy	392965.3	6453785.6
MELDR-02	6162370	Brockman Park	Where piped drain opens	393466.5	6453208.5
MELDR-05	6162373	John Creaney Park outlet	Compensation Basin Outlet	392359	6452734.7
MELDR-06	6161691	Bateman Park	Downstream of the confluence of the 2 drains	392269.8	6453880.2
MELDR-07	6162375	Booragoon Lake	In the lake at the end of walkway	390734.68	6454164.09
MELDR-08	6162376	Piney Lakes	At the lake outlet	390151.59	6453473.10
MELDR-09	6140831	Quenda Lake	At the lake outlet	390749.20	6451597.51
MELDR-10	6162377	Frederick Baldwin	At the lake outlet	387989.87	6452295.91
MELDR-11	6162378	Marmion Reserve	At the lake outlet	387774.89	6454629.75
MELDR-12	6162379	Blue Gum Lake	At the lake outlet	391282.81	6454886.75
MELDR-13	6165324	Brentwood drain	Pulo Rd & Leach highway, 10m walking from Pulo Rd. Site moved at beginning of 2015-16 sampling due to construction works reshaping the drain.	392126.59	6453865.28
MELDR-14	6165325	RAAF drain	10 m down from pipe under Leach highway	392195	6453841
MELDR-15	6165331	John Creaney Park inlet	Approx. 5m upstream of the main inlet into John Creaney Park, access via Water Corp drain man hole (lid lifting and bucket and rope required)	392256.48	6452699.35
MELDR-16	6165332	Closed pipe Downstream Elizabeth Manion Park	On Nicholls Cres close to Hurley Way, in front of pathway, access via Water Corp man hole (lid lifting and bucket and rope required)	393327.76	6452478.47

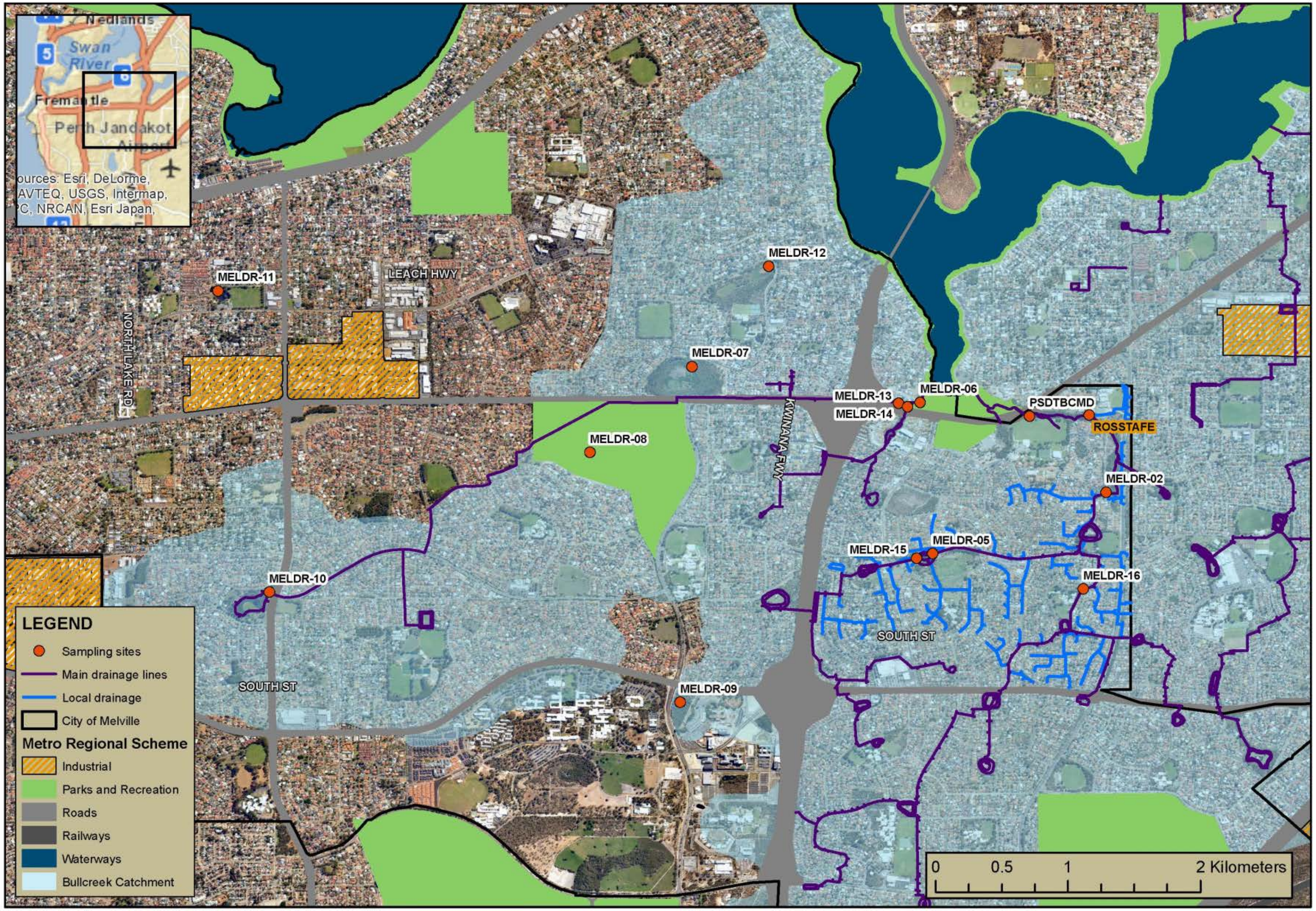

Figure 2.1-1: Sampling sites within the Melville Bull Creek catchment in 2017.

2.2 Sampling schedule and procedures

Sampling was conducted from the 14 Melville sites on the following dates: 19th July, 22th August, 19th September, and 11th October 2017. All sites were sampled on all sampling occasions except for site 7 (Booragoon Lake outlet) which was unable to be sampled in July as the only accessible water near the outlet was sequestered from the lake water by a large mat of macroalgae. Sampling procedure was in accordance with the SAP (SERCUL 2017). Temperature and rainfall data for the duration of the sampling is detailed in **Appendix A.**

Field observation forms were filled out for all samples and all of them were transported under "chain of custody" to the laboratory and analysed in accordance with the laboratory methods. All water and sediment samples collected were analysed by the National Measurement Institute (NMI), a laboratory accredited by the National Association of Testing Authorities (NATA), and also to CSIRO for particle size analysis.

2.3 Parameters measured

Water at each of the 14 sites was measured in situ for physical properties (dissolved oxygen, pH, electrical conductivity and temperature) and samples were collected and analysed for a range of contaminants likely to be present in urban and industrial catchments.

Water samples at all Melville Bull Creek sites were analysed for:

- Nutrients - total phosphorus (TP), total nitrogen (TN), total oxidised nitrogen (NO_x-N), total organic nitrogen (TON), dissolved organic nitrogen (DON), soluble reactive phosphorus (SRP) and nitrogen as ammonia/ammonium (NH_3-N/NH^{4+}-N) at all sites on all four sampling occasions.
- Total metals - aluminium (Al), chromium (Cr), copper (Cu), iron (Fe), lead (Pb) and zinc (Zn) tested at all sites on one sampling occasion for surveillance,
- Total mercury (Hg) tested at 3 sites (13, 14 and 6) on all four sampling occasions.
- Soluble metals - aluminium (Al), chromium (Cr), copper (Cu), iron (Fe), lead (Pb) and zinc (Zn) tested at all sites on all four sampling occasions.
- Soluble metals - mercury (Hg) at 3 sites (13, 14 and 6) on all four sampling occasions; and
- Total suspended solids and total water hardness at all sites on all four sampling occasions.

Sediment samples at the west side of the catchment were collected from 12 sites (sites PSDTBCMD, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14) for the analysis of:

- Total metals/metalloids (Al, As, Cr, Cu, Fe, Hg, Ni, Pb, Se and Zn), and
- Moisture
- Particle size analysis

Sediment samples were not collected from sites 15 and 16 (John Creaney Park inlet and Downstream Elizabeth Manion Park) as both sites are closed pipes.

2.4 Analysis methodology

All water and sediment samples collected were analysed by Chemcentre, which is a National Association of Testing Authorities (NATA) accredited laboratory.

Laboratory results were reported as per the limits of reporting (being the minimum detection level) for each parameter listed in **Table 2.4-1.**

Table 2.4-1: Analysis method and limit of reporting (LOR) for water and sediment samples

Measured parameter	LOR
WATER	
Total phosphorus	0.005 mg/L
Total nitrogen	0.025 mg/L
Total organic nitrogen	0.025 mg/L
Soluble reactive phosphorus	0.005 mg/L
Total oxidised nitrogen	0.01 mg/L
Nitrogen as ammonia	0.01 mg/L
Dissolved organic nitrogen	0.025 mg/L
Total Suspended Solids	1 mg/L
Total water hardness	1 mg/L
Aluminium – total and soluble	0.005 mg/L
Arsenic – total	0.001 mg/L
Cadmium - total	0.0001 mg/L
Cobalt - total	0.001 mg/L
Chromium - total and soluble	0.0001 mg/L
Copper - total and soluble	0.0001 mg/L
Iron – total and soluble	0.005 mg/L
Lead - total and soluble	0.0001 mg/L
Manganese - total	0.001 mg/L
Mercury – total and soluble	0.0001 mg/L
Molybdenum - total	0.001 mg/L
Nickel - total	0.001 mg/L
Selenium - total	0.001 mg/L
Zinc - total and soluble	0.001 mg/L
SEDIMENT	
Moisture	0.1 g/100g
Aluminium – total	1.0 mg/Kg
Arsenic – total	0.1 mg/Kg
Chromium - total	0.05 mg/Kg
Copper - total	0.5 mg/Kg
Iron - total	1.0 mg/Kg
Lead - total	0.5 mg/Kg
Mercury	0.02 mg/kg
Nickel - total	0.1 mg/Kg
Selenium	0.5 mg/kg
Zinc - total	0.25 mg/Kg

Sediment samples were also analysed by CSIRO laboratory for the particle size distribution. Particles were grouped into the following size classes according to the Wentworth scale (Wentworth 1922) using wet sieving followed by laser diffraction (Mudroch et al. 1997):

Class	Size
Clay	<4 µm
Silt	4-62 µm
Fine sand	62-250 µm
Medium sand	250-500 µm
Coarse sand	500-2,000 µm
Gravel	>2,000 µm

3. Guidelines

To provide a frame of reference as to the state of water and sediment quality in the Melville Bull Creek catchment, laboratory results have been compared to trigger levels from the ANZECC and ARMCANZ (2000) *Australian and New Zealand Guideline for Fresh and Marine Water Quality* (hereafter referred to as the "ANZECC guidelines"). Exceedance of a trigger value from the ANZECC guidelines indicates that there is the potential for an impact to occur and should therefore trigger a management response (ANZECC & ARMCANZ 2000). The rationale for the trigger values used in the ANZECC guidelines is provided in chapter 8 of the guidelines. **Table A-1, Table A-2 and Table A-3, Appendix A** show the ANZECC trigger values used to compare the results of the analysed parameters.

ANZECC and ARMCANZ (2000) have devised trigger values that should not be exceeded for physical and chemical stressors of different ecosystem types. The results of some sites (15, 5, 16, 2, ROSSTAFE, PSDTBMCD, 13, 14 and 6) were compared to the 'lowland rivers' trigger values and others (7, 8, 9, 10, 11 and 12) to 'wetlands' ecosystem trigger values. These are considered to be most applicable for the drains and lakes respectively. ANZECC and ARMCANZ do not provide a trigger value for total suspended solids, however DWER (DoW n.d.) use an interim assessment value of 6 mg/L, which has been used for comparison purposes in this assessment. To better graph the site results in accordance with their referenced trigger values they have been ordered with the 'lowland rivers' sites to the left and the 'wetlands' sites to the right. The 'lowland rivers' sites have been separated into the two main drainage lines (Bull Creek Main Drain and Brentwood Main Drain) and arranged from the top of the catchment to the bottom (entrance to the Canning River) creating a more visual display of the individual segments allowing for better interpretation of flow and spatial patterns and understanding the aquatic conditions upstream and downstream.

ANZECC and ARMCANZ (2000) have also developed "high reliability" trigger values for toxicants in fresh waters where sufficient "No Observed Effect Concentration" (NOEC) data is available and is published in chapter 3 of the guidelines. Several trigger values have been derived for each metal depending on the proportion of species for which protection is sought: 99%, 95%, 90% or 80%. Urban and industrial catchments tend to be highly modified and are often artificial ecosystems, where the risk of toxicant contamination is high and current environmental value is low. On that basis, the ANZECC trigger values for 80% protection of freshwater biota would be applicable to the waterbodies/tributaries within the City of Melville. However, the Bull Creek flows to the Canning River, where environmental values are high and for this reason, the toxicant results, metals and metalloid concentrations of the surface water of the Melville Bull Creek catchments were compared to the trigger values for 95% protection levels (where available), applicable to high conservation value and slightly to moderately disturbed ecosystems. For the metals cobalt and molybdenum, "high reliability" values are not available and therefore ANZECC and ARMCANZ recommend the use of "low reliability" trigger values calculated by different means. For chromium (III), the "high reliability" trigger value is considered too high and therefore the use of an interim value for freshwater protection is recommended. For iron, ANZECC and ARMCANZ (2000) suggest the use of an interim value based upon the current Canadian guideline level (CCREM 1991). The ANZECC trigger values for protection of biota for chromium (III), copper, lead and zinc are hardness dependent, and as such specific trigger values for each sample have been calculated (see relevant tables in **Appendix D** for the details and calculations).

The system being monitored is largely a piped system that ultimately discharges into the Canning River. Much of the monitoring captures data from water running directly off roads and residential areas with no treatment prior to entering the lakes and drains. From a human-use perspective, Bull Creek is not a source of drinking water but may be accessed by the public at several points, on public and privately owned land. Therefore it is reasonable to compare the toxicant results to the National Health and Medical Research Council's (NHMRC) *Guidelines for Managing Risks in Recreational Water* (2008). Trigger values for pH and dissolved oxygen are specified in these guidelines. For toxicant parameters (i.e. metals and ammonia), these guidelines recommend that recreational trigger values be calculated by multiplying the relevant trigger values in the NHMRC (2016) *Australian Drinking Water Guidelines* 6: 2011 (ADWG) by ten. An exceedance of the referenced trigger level does not indicate that 'standards' are not being met, but is an indication that further consideration should be given to the situation.

The revision to the ANZECC (2000) guidelines for sediment (Simpson et al 2013) provides both low and high trigger values for metals in sediment in chapter 3 (2000). Where concentrations are between the low and high values background concentrations should be investigated. If the results exceed the high guidelines or are above the background concentrations a further assessment for the bioavailability of the metal is required.

4. Field observations

The following relevant observations were recorded at Melville Bull Creek catchment sites on at least one sampling occasion in the 2017 sampling period:

- Iron staining, iron floc or iron reducing bacteria noted at sites 15, 5, 16, 2, 13, 6, 7, 8 and 11;
- Turbid or cloudy water at sites 15 and 6;
- Organic debris on the water surface at sites 15, 5, 16, 10, 11 and 12;
- Anoxic smell at sites 5 and 2;
- Tannin staining at sites 15, 5, PSDTBCMD, 13, 14, 7, 8, 9 and 12;
- Aquatic weeds at site 10 (*Bacopa*) and 12 (duckweed);
- Filamentous algae in water or on substrate at sites 5, 13, 7, 10 and 11;
- Green water (indicative of phytoplankton) at sites 13, 14, 6, 10 and 11;
- Lower than usual water level at site 9;
- Higher than usual water level at sites 7, 8 and 12.

5. Physicochemical Properties

Refer to **Tables D-1 to D-6 in Appendix D** for all physicochemical parameter data (pH, dissolved oxygen, electrical conductivity, total suspended solids and temperature) collected in the 2017 water quality sampling of the Melville Bull Creek catchments. **Table E-1, Appendix E** outlines the factors that influence changes in these physicochemical parameters and the impacts that changes to these parameters can have to aquatic ecosystems.

5.1 pH

pH is a measure of the acidity or alkalinity of a water body. pH is measured on a logarithmic scale, and as such a pH of 5 is ten times more acidic than a pH of 6 and a pH of 9 is ten times more alkaline than a pH of 8. A pH value of less than 6.5 is considered acidic, between 6.5 and 8.0 is considered neutral and higher than 8.0 is considered high by DWER (DoW n.d.).

pH levels in the surface water of the Melville Bull Creek catchment varied between sites. When compared against the appropriate lowland rivers (6.5 – 8) or wetlands (7 – 8.5) acceptable range, just less than half of the samples (26 out of 55) at eight out of the 15 sites (15, 5, 2, 7, 8, 9, 10 and 12) recorded pH values below the acceptable ranges on at least one occasion and four samples from site 11 exceeded the acceptable range (**Figure 5.1-1** and **Table D-1, Appendix D**). Furthermore, 15 samples recorded pH below the acceptable range for recreational use (6.5 – 8.5), and four samples above the acceptable range. The highest pH of 9.82 was recorded in August at site 11 (Marmion Reserve) and the lowest of 5.61 in July at site 7 (Piney Lakes outlet).

Figure 5.1-1: pH of the surface water of Melville Bull Creek catchment sites in 2017

Table 5-1 presents the recorded pH throughout the eleven-year monitoring period. Brockman Park, Booragoon Lake outlet, Piney Lakes outlet and Blue Gum Lake outlet (sites 2, 7, 8 and 12) have generally (more than 60% of the time) recorded pH below the acceptable range for lowland rivers or wetlands, and Quenda Lake Outlet (site 9) has generally recorded pH above the acceptable range for wetlands. John Creaney Park sites (15 and 5) and Frederick Baldwin Lake have often recorded results below the relevant acceptable range.

On the Bull Creek main drain, pH values are generally more acidic at John Creaney Park (site 5) than at downstream Elizabeth Manion Park (site 16), suggesting that the low pH values recorded at Brockman Park may be attributed to contributions from the western branch feeding into the Bull Creek main drain. However, pH levels are generally within acceptable limits further downstream at the Bull Creek main drain site closest to the river (PSDTBCMD).

Particularly low pH has often been recorded at Booragoon Lake (site 7) and Blue Gum Lake (site 12) in previous years (generally in the winter sampling months), however in 2017 pH values at these sites were only slightly below the acceptable range for wetlands.

5.2 Dissolved oxygen

Dissolved oxygen saturations in the surface water of the Melville Bull Creek catchments were generally below the acceptable ranges for lowland rivers (80-120%) or wetlands (90-120%) as applicable, with almost all samples (54 out of 55) recording DO% saturations below the acceptable ranges, and also below the recreational use guideline (>80%) (**Figure 5.2-1** and **Table D-2, Appendix D**). Only site 14 (RAAF drain) recorded a saturation within the acceptable range (the highest recorded saturation) of 81.1% in September. Booragoon Lake Outlet (site 7) recorded the lowest saturation in the catchment of 1.2% in October.

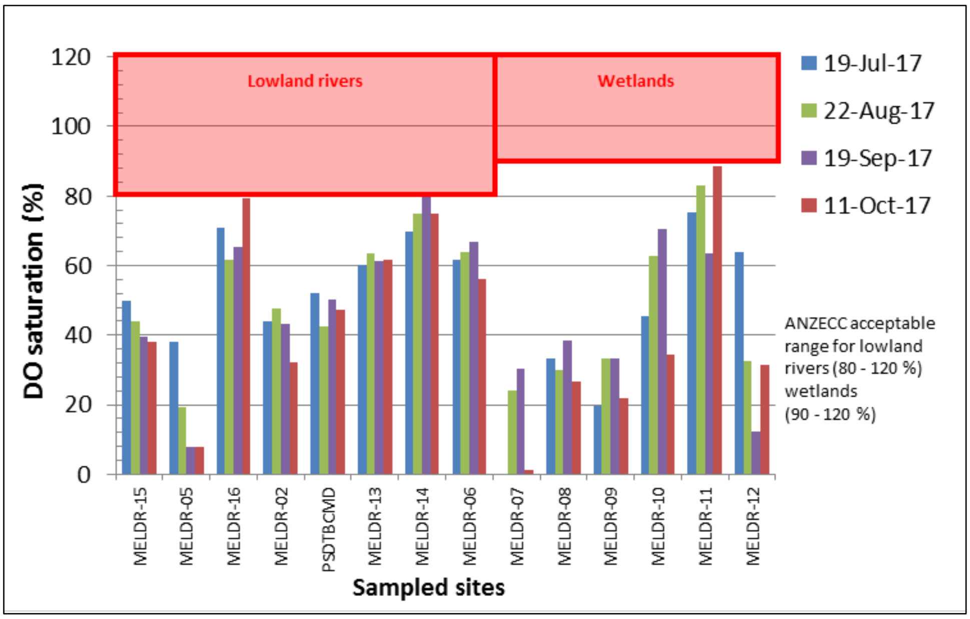

Figure 5.2-1: Dissolved oxygen (DO %) saturations of the surface water of the Melville Bull Creek catchment sites in 2017

When considering the dissolved oxygen concentrations in mg/L, from a total of 55 samples, 23 recorded very low concentrations (<4 mg/L), 17 recorded low concentrations (4.0 to 6.0 mg/L), 13 recorded moderately oxygenated concentrations (6.0 to 8.0 mg/L) and two samples recorded well oxygenated concentrations (8.0 to 10.0 mg/L) (**Figure 5.2-2** and **Table D-3, Appendix D)**.

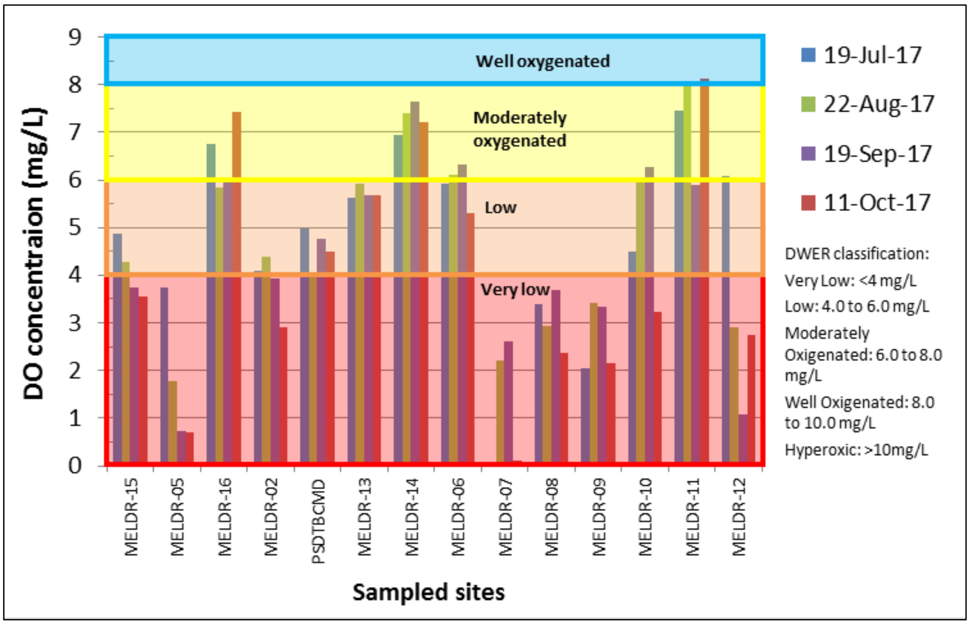

Figure 5.2-2: Dissolved oxygen concentrations (mg/L) of the surface water of the Melville Bull Creek catchments in 2017

Table 5-1 displays the dissolved oxygen saturations (%) and dissolved oxygen concentrations (mg/L) recorded over the eleven year monitoring period, with most concentrations having very low to moderate dissolved oxygen concentrations. It is evident that DO saturations have generally been outside the acceptable range for lowland rivers and wetlands, with the majority of saturations below the lower acceptable limit.

DO saturations have generally been slightly lower at site 13 (Brentwood drain) than at site 14 (RAAF drain), with saturations at downstream site 6 (Bateman Park) similar to those at site 13. DO saturations are generally significantly lower at the outlet of John Creaney Park (site 5) than the inlet (site 15) and also lower than at the other branch of the Bull Creek main drain at site 16 (downstream Elizabeth Manion Park). DO saturations at site 2 (Brockman Park) are between those at sites 5 and 16, with DO usually slightly higher at the most downstream Bull Creek main drain site (PSDTBCMD).

There also appears to have been a decreasing trend in dissolved oxygen at several of the lakes over the eleven year monitoring period: Quenda Lake (site 9: $p<0.05$, Kendall's tau=-0.563), Frederick Baldwin (site 10: $p<0.05$, Kendall's tau=-0.588) and Blue Gum Lake (site 12: $p<0.05$, Kendall's tau=-0.477) (calculated using the seasonal Mann-Kendall test available on the XLSTAT statistics package). Dissolved oxygen can fluctuate according to large range of factors, many of which are natural and out of human control (e.g. time of day, depth of waterbody, algal or plant growth, water temperature and mixing from rain or wind: see **Table E-1, Appendix E** for more details). However given the long period of monitoring at these sites showing a consistent decrease in dissolved oxygen, the decline in oxygen is of concern. It should be noted that Quenda Lake has recorded generally higher nitrogen concentrations and lower oxygen saturations since 2013 and Blue Gum Lake has recorded generally higher nitrogen and phosphorus concentrations and lower oxygen saturations since 2012 than in previous years (see **Section 6.1**), suggesting a possible link between eutrophication and low dissolved oxygen saturations at these sites.

5.3 Electrical conductivity

Electrical conductivity (EC) is the ability of water or soil to conduct an electric current. It is commonly used as a measure of salinity or total dissolved salts as solutions with high salt concentrations conduct electricity better than pure water. EC is increased when the total concentration of inorganic ions (particularly sodium, chlorides, carbonates, magnesium, calcium, potassium and sulfates) is increased.

Electrical conductivity in the surface water of the Melville Bull Creek catchments was varied. Six samples from sites 10 and 11 (Frederick Baldwin and Marmion reserve) recorded concentrations below the acceptable range for wetlands (0.3-1.5mS/cm) and 32 samples from all drain sites and site 7 (Booragoon Lake) recorded concentrations above the acceptable range for lowland rivers (0.12-0.3 mS/cm) or wetlands respectively (**Figure 5.3-1** and **Table D-4, Appendix D)**.. The lowest EC reading (0.129 mS/cm) was recorded at site 11 in August and the highest of 1.858 mS/cm recorded at site 5 (John Creaney Park) in August. Sites 5, 2, PSDTBCMD, 13, 14 and 6 recorded high electrical conductivity values on all four occasions and site 11 recorded low values on all sampling occasions.

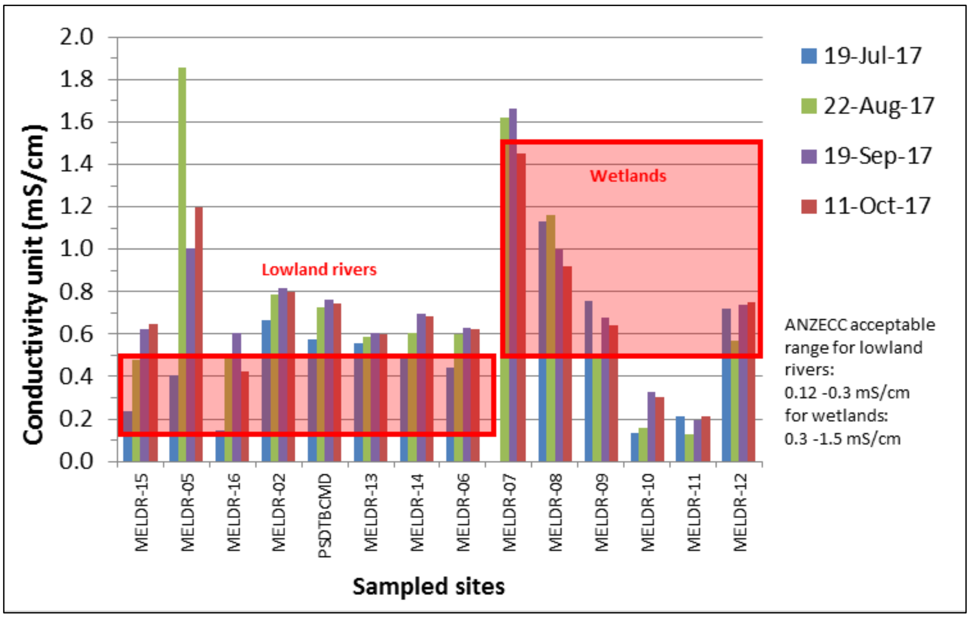

Figure 5.3-1: Electrical conductivity (mS/cm) of the surface water in Melville Bull Creek catchment sites in 2017

Table 5-1 presents the recorded EC throughout the eleven-year monitoring period. All drain sites (15, 5, 16, 2, PSDTBCMD, 13, 14 and 6) as well site Booragoon Lake (site 7) have generally recorded EC higher than the applicable acceptable range and Marmion Reserve (site 11) has generally and Frederick Baldwin (site 10) has often recorded EC levels lower than the acceptable range. Although electrical conductivity levels recorded in the Melville Bull Creek catchment are often above ANZECC acceptable ranges, they do not appear to be changing substantially over time and therefore any biota living in these lakes and drainage lines is likely to be adapted to these levels.

5.4 Total suspended solids

Total Suspended Solids (TSS) in a waterbody is a measure of the concentration of suspended materials in the water that can be removed by filtration. TSS can include a wide variety of material, most often comprising soil particles and organic material (e.g. algae, microorganisms, decaying plant and animal matter).

A value equal to half the limit of reporting was substituted for occasions where concentrations were recorded as 'below the laboratory limit of reporting', which is a standard technique to allow these 'unknown' values to be represented graphically and to differentiate them from those samples that recorded concentrations equal to the limit of reporting.

Total suspended solids concentrations were generally low across the catchment. Approximately one third of the samples (19 out of 55) recorded concentrations equal to or above the interim guideline at sites 15, 5, 16, 13, 6, 7, 8 and 12 (John Creaney Park inlet, John Creaney Park, Downstream Elizabeth Manion Park, Brentwood Drain, Bateman Park, Booragoon lake outlet, Piney Lakes outlet and Blue Gum Lake outlet respectively) on some sampling occasions (**Figure 5.4-1, Table D-5, Appendix D**). The highest concentration of 58 mg/L was recorded at site 16 (Blue Gum Lake outlet) in September. Six samples recorded concentrations below the limit of reporting of 1.0 mg/L.

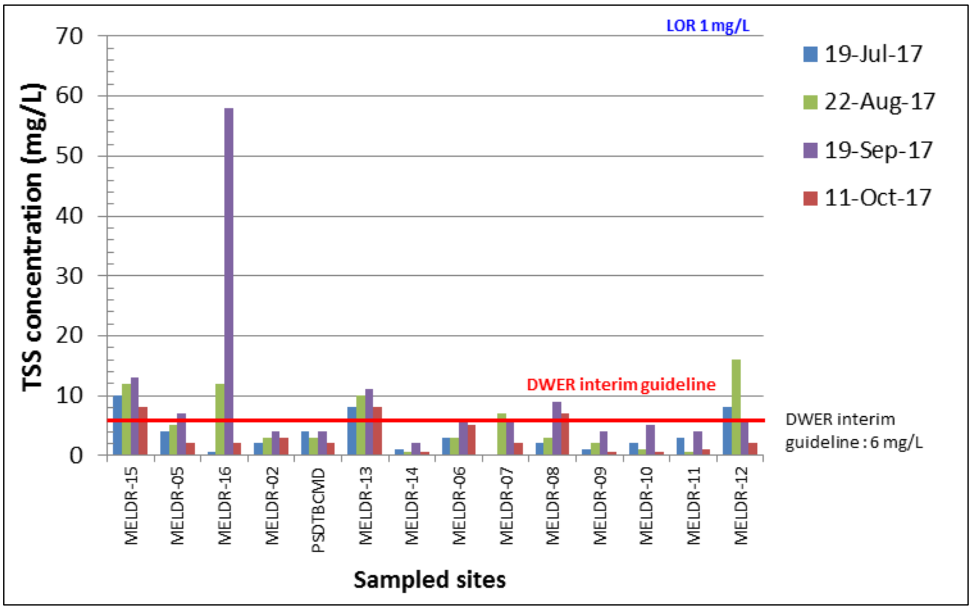

Figure 5.4-1: Total suspended solids (mg/L) of the surface water in Melville Bull Creek catchment sites in 2017

Table 5-1 shows the TSS concentrations recorded since 2007 over the ten-year monitoring period. Sites 15, 16, 13, 6 and 7 (John Creaney Park inlet, downstream Elizabeth Manion Park, Brentwood Drain, Bateman Park and Booragoon Lake outlet) have generally recorded concentrations above the interim guideline and Blue Gum Lake (site 12) has often recorded exceedances.

When comparing results between sites 13 and 14 (Brentwood Drain and RAAF Drain respectively), total suspended solids concentrations are usually lower at site 14 than at site 13, with TSS at site 6 often somewhere in between the two sites, suggesting the clearer water at site 14 may be diluting the more turbid water at site 13.

5.5 Temperature

It should be noted that water temperature will often increase throughout the day, and hence sampling time can partially influence recorded water temperature. During the 2017 monitoring period, sampling was conducted at varying times between 8 am and 4 pm.

Temperatures in the surface waters of the Melville Bull Creek catchments ranged from 14.0°C in July at Quenda Lake outlet (site 8) to 22.5°C in September at Booragoon Lake outlet (site 7) (**Figure 5.5-1** and **Table D-6, Appendix D**). Temperatures at all sites were considered to lie within a normal seasonal range.

Figure 5.5-1: Temperature of the surface water in Melville Bull Creek catchment sites in 2017

Table 5-1: Records of physicochemical parameters (pH, Dissolved oxygen (DO) saturation (%), DO concentration (mg/L), Conductivity (mS/cm) and temperature (°C) in the Melville Bull Creek catchments 2007 – 2017

pH Max 10.02 Min 3.24

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
	LOWLAND RIVERS (ANZECC acceptable range 6.5 - 8.0)																																											
MELDR-15																														6.16	6.11	6.21	6.41	6.24	6.76	6.68	6.61	6.56	6.46	6.54	6.85	6.58	6.4	6.49
MELDR-05	6.74	6.65			6.45	7.18	7.35		6.65	6.85			6.93	6.91	7.1	7.31	7.22	6.33	6.29	6.45	6.23	6.62	6.52	6.67	6.51	6.57	6.96	7.1	6.13	6.25	6.17	6.43	6.33	6.15	6.55	6.55	6.24	6.33	6.4	6.22	6.53	6.46	6.32	6.39
MELDR-16																														6.29	6.24	6.56	6.44	7.1	6.48	6.9	6.61	6.61	6.74		7.15	6.83	6.93	7.02
MELDR-02	6.07	6.21	6.44	6.23	6.14	6.94	6.34	6.39	6.29	6.54	6.36		6.24	6.34	6.28	6.37	6.31	6.45	6.18	6.28	6.22	6.18	6.33	6.38	6.27	6.32	6.54	6.71	6.1	6.21	6.17	6.22	6.11	6.04	6.16	6.16	6.26	6.22	6.16	6.23	6.24	6.24	6.21	6.25
PSDTBCMD	6.89	6.88	6.47	7.3	6.82	7.46	7.47	7.2	7.07	7.24	7.23		6.92	7.29	7.51	7.49	6.73	7.36	6.58	7.27	6.81	6.74	7.25	7.07	6.62	7.27	6.6	6.8	6.61	6.73	6.67	6.76	6.66	6.51	6.68	6.66	6.77	6.73	6.77	6.8	6.68	6.84	6.78	6.74
MELDR-13																											6.67	6.72	6.59	6.69	6.66	6.74	6.5	6.31	6.57	6.41	6.77	6.67	6.81	6.69	6.61	6.75	6.64	6.71
MELDR-14																											6.29	6.33	6.99	7.14	7.11	7.12	7.01	6.8	6.89	6.86	7.04	7.03	7.06	7.09	7.11	7.24	7.15	7.18
MELDR-06	6.17	6.51	7.6	6.35	6.35	7.27	6.58	6.68	6.74	6.52	6.67		6.98	6.94	7.26	6.87	7.15	7.01	6.46	7.07	6.88	6.89	7.08	7.12	6.71	7.06	6.12	6.25	6.82	6.8	6.78	6.87	6.83	6.74	6.74	6.56	7.25	7.13	7.48	6.91	6.79	7.18	6.82	6.98
Site	WETLANDS (ANZECC acceptable range 7.0 - 8.5)																																											
MELDR-07	3.26	4.69			5.71	7.17	7.19		3.94	6.77			6.23	6.55	6.88	5.6		5.45	6.29	6.78			3.91	3.94		3.74	6.38	6.68	4.5	6.26	6.76	6.83	3.34	3.24	6.19	6.58	4.35	3.55	3.83	6.55		6.79	6.85	6.67
MELDR-08	4.3	5.03			5.67	7.33			5.87										4.19	4.73		4.99	5.62	5.68	5.02	5.37	7.25	7.26	5.23	5.34	5.43	5.4	5.45	5.31	6.55	6.49	5.48	5.54	5.57	6.33	5.61	5.9	6.18	6.06
MELDR-09	7.08	7.37			7.11	7.69	7.52	7.51	7.04	7.14	6.96		7.5	7.53	7.26		5.14	6.91	6.07	6.83	7.08	6.74	7.21	7.03	6.92	6.6	8.04	9.29	6.02	6.31	6.26	6.85	6.41	6.27	6.92	6.8	6.37	6.38	5.66	6.73	6.39	6.37	6.72	6.76
MELDR-10	7.21	8.4			9.3	8.16	7.1	7.07	9.01	9.39	6.88		7.55	7.51	7.32	7.55	6.96	7.95	6.99	7.62	7.31	7.4	8.42	7.1	7.14	7.31	5.62	5.72	6.98	7.37	7.61	6.73	6.77	6.94	6.63	8.31	6.8	7.01	6.9	6.56	6.95	7.19	7.37	6.96
MELDR-11	7.56	8.31			8.38	8.17	9.08	8.16	8.67	9.3	9.7	9.21	7.34	7.52	7.87	9.08	7.22	7.8	7.51	7.59	7.64	7.65	8.24	8.42	7.43	7.64	6.26	6.82	7.32	7.09	7.81	8.3	8.08	7.9	9.92	9.99	7.4	7.46	7.96	10.02	9.12	9.82	9.51	9.21
MELDR-12	4.31	7.5			7.05	7.92	8.49		6.74	9.3	7.96		7.17	7.61	9.44	8.57	3.41	3.5	6.47	7.08	3.99	4.03	5.16	6.97	4.12	6.6	6.79	7.04	6.39	6.58	6.9	7	6.48	6.43	6.95	6.97	3.74	4.57	5.91	6.98	6.8	6.6	6.79	6.92

SITES RECORDING pH ALWAYS/GENERALLY OUTSIDE ACCEPTABLE RANGE
SITES RECORDING 40-60% of pH values ABOVE ACCEPTABLE RANGE
SITES RECORDING pH ALWAYS/GENERALLY WITHIN ACCEPTABLE RANGE

Record BELOW acceptable range | Record WITHIN acceptable range
Record ABOVE acceptable range | NO sample taken

DO saturation % Max 206.5 Min 0.3

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
	LOWLAND RIVERS (ANZECC acceptable range 80-120%)																																											
MELDR-15																														41.1	39.3	47.7	56.9	53	48.4	56	45.8	44.1	43.7	42.9	49.7	44	39.7	37.9
MELDR-05	13.1	21.9			29.9	8.8	2.7		42.8	65.4			74.3	26.2	14.6	12.7	60.2	11.4	76.3	7.7	9.4	60.9	2.3	21.1	27.8	22.5	88.9	71.7	31.6	8.1	12.6	18.2	13.1	0.3	0.6	1.6	10.1	12	45.4	12.9	37.9	19.3	7.8	7.7
MELDR-16																														79.4	97.9	82	65.1	71.1	63.7	70.2	68.1	80.8	87.1		71	61.7	65.2	79.5
MELDR-02	51.8	53.7	46.7	44.5	53.1	50.1	46.9	44.9	53.4	49.7	41.5		54.8	47.2	40.2	41.1	46.1	48.2	49.7	44.1	45.6	47.1	43.2	41.1	45.1	45.9	70.5	72.9	52.3	40.8	46	37	41.7	37.5	32.4	35.1	42	45.8	50.9	43.5	44.1	47.7	43.1	32
PSDTBCMD	65.5	70.7	83.7	66.1	66.6	61.2	68.3	62.7	61.8	67.2	69.5		65.3	57.9	55	51.6	62.2	59.1	54.3	57.7	48.3	56.8	51.7	48.6	57.2	55.1	75.7	73.2	63.7	53.6	53.6	52.5	56.4	53.7	45.9	51.5	50	56.9	64.4	55.1	52.2	42.6	50.1	47.1
MELDR-13																											51.2	47.8	78.1	65.4	69.3	71.8	55.1	63.1	65.5	47.6	58.7	64.2	57.3	68.5	60.1	63.5	61.1	61.5
MELDR-14																											8.7	13.3	88.4	77.7	82	80	91.6	75.7	50.7	69.5	78.5	85	87.5	82.4	69.9	75	81.1	75
MELDR-06	76.4	84.3	63.2	76.5	76.4	82.9	86.5	80.7	76.4	84.7	84.8		75.7	74.9	72.3	79.8	74.5	75.7	80.2	80.5	56.9	76.8	74.8	83.1	59	73.4	41.3	40	72.4	71.9	73.1	75.8	77	54.2	66.2	49.4	57.3	54.9	57.9	58.8	61.5	63.9	66.9	56
Site	WETLANDS (ANZECC acceptable range 90-120%)																																											
MELDR-07	123.2	20.7			49.5	47.2	36.6		115.2	19			61.2	12.1	91.4	78.6		115.6	32.9	22.9			51.9	52.5		71.7	36.8	37.8	42.5	0.6	136.6	19.9	79.6	61.4	1.7	2.2	37.5	56.4	52.9	8.9		23.9	30.3	1.2
MELDR-08	122.8	37.5			65.9	43.4			66.1										54.1	49.8		41.5	39	88.7	20.1	27.1	72.9	63.9	32.7	40.1	25.5	38.9	54.8	46.1	55.5	73.4	37.8	38.3	37.4	62.2	33.4	29.8	38.3	26.8
MELDR-09	62.4	92.1			93.4	82.5	91	75.6	84.9	100.7	74.1		101.2	89.9	80.4		76.2	97.3	70	78.3	72.5	85	81.3	77.8	77.8	55	86.7	97.6	35	3	0.8	29.6	33.4	32.4	60.2	36.8	36.2	40	22.3	31.7	19.8	33.4	33.4	21.8
MELDR-10	59.2	113			143.8	81.9	125.6	41.8	116.5	156.1	37.5		82.8	67.5	23.7	45.8	57.3	63	57.3	82.4	55.2	71.2	84.6	27.9	52.1	72.6	32.9	30.2	54.2	61.3	70.2	59.6	32.2	52	3.7	69	28.1	47.9	73.2	2.5	45.3	62.6	70.5	34.4
MELDR-11	84.8	122.8			110.5	80	123.8		102	206.5	188.3	186.4	48.5	54.8	103.7	134.1	61	65	67.2	55	65.8	68	82	110.7	39.6	68.5	33.9	37.3	61.6	15	64.6	67.6	76.2	80.5	121	96.1	65.4	68.1	75.1	132.3	75.1	83.1	63.6	88.4
MELDR-12	121.9	79.7			48.8	88.8	123.4	83.5	41.2	134.2	88.4		90	95.6	160.4	125.5	107.1	78.6	17.7	47.7	107.3	118.4	95.2	81.1	8.8	17.9	26.3	15.3	21.1		30.3	21.7	31.2	41.7	48.8	35.3	90	33	14.2	36.1	63.9	32.5	12.3	31.4

SITES RECORDING DO SATURATIONS ALWAYS/GENERALLY OUTSIDE ACCEPTABLE RANGE
SITES RECORDING 40-60% of DO saturations ABOVE ACCEPTABLE RANGE
SITES RECORDING DO saturations ALWAYS/GENERALLY WITHIN ACCEPTABLE RANGE

Record BELOW acceptable range | Record WITHIN acceptable range
Record ABOVE acceptable range | NO sample taken

DO concentration (mg/L) Max 16.35 Min 0.03

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																														3.92	3.61	4.27	5.56	5.1	4.42	5.06	4.58	4.34	4.38	3.99	4.86	4.29	3.73	3.56
MELDR-05	1.4	2.03			2.9	0.8	0.24		4.11	5.42			7.35	2.6	1.33	1.16	6.15	1.11	7.28	0.69	1.01	6.23	0.22	1.96	2.7	2.1	8.26	6.33	3.01	0.77	1.15	1.64	1.33	0.03	0.05	0.14	1.07	1.22	4.61	1.23	3.74	1.78	0.74	0.71
MELDR-16																														7.52	9.06	7.39	6.05	6.58	5.78	6.36	6.39	7.67	8.57		6.75	5.83	6.01	7.44
MELDR-02	4.77	4.91	4.12	3.92	4.87	4.52	4.16	3.95	4.93	4.46	3.65		5.13	4.31	3.64	3.69	4.18	4.39	4.5	3.96	4.1	4.32	3.92	3.7	4.17	4.19	6.39	6.42	4.91	3.73	4.16	3.3	3.81	3.43	2.9	3.14	3.84	4.22	4.78	3.95	4.08	4.39	3.93	2.92
PSDTBCMD	6.59	6.66	7.32	6.14	6.44	5.79	6.33	5.84	5.96	6.04	6.37		6.32	5.7	5.23	4.88	6.06	5.68	5.12	5.31	4.85	5.59	5.02	4.6	5.45	5.11	6.89	6.49	6.04	5.1	4.96	4.89	5.54	5.32	4.22	4.76	5.01	5.58	6.4	5.28	4.97	4.07	4.76	4.5
MELDR-13																											4.74	4.38	7.5	6.1	6.28	6.41	5.27	5.98	5.75	4.15	5.65	6.1	5.49	6.29	5.63	5.93	5.69	5.68
MELDR-14																											0.79	1.18	8.5	7.45	7.52	7.28	9.33	7.62	4.57	6.21	8.18	8.71	8.83	7.78	6.94	7.39	7.65	7.22
MELDR-06	7.37	7.8	5.83	6.71	7.25	7.5	7.45	7.03	7.29	7.22	7.24		7.25	7.27	6.66	7.32	7.01	7.1	7.43	7.21	4.87	7.63	7.12	7.65	5.56	6.75	3.74	3.56	6.93	6.77	6.66	6.81	7.51	5.3	5.91	4.43	5.77	5.45	5.77	5.51	5.93	6.11	6.33	5.3
MELDR-07	12.03	1.84			4.67	3.65	2.78		11.16	1.53			5.72	1.17	7.83	6.36		11.24	3.02	2.02			5.08	4.84		6.58	3.36	3.29	4.13	0.05	11.53	1.64	8.25	6.06	0.15	0.19	4.15	5.89	5.29	0.77		2.22	2.61	0.12
MELDR-08	11.6	3.32			6.71	3.53			6.49										5.17	4.5		4.53	3.88	7.79	1.96	2.48	6.46	5.15	3.24	3.79	2.28	3.57	5.87	4.8	4.7	6.37	4.39	4.05	3.81	5.75	3.39	2.93	3.7	2.36
MELDR-09	6.78	8.34			9.41	7.18	7.38	6.83	8.27	8.3	6.21		10.3	9	7.4		8.04	9.85	6.75	7.04	8.31	9.21	7.98	7.12	7.88	5.17	7.77	7.99	3.45	0.29	0.07	2.66	3.52	3.35	5.14	3.2	3.98	4.23	2.27	3.04	2.04	3.43	3.33	2.16
MELDR-10	5.9	9.85			13.46	6.9	10.16	3.76	11.03	12.36	3.1		7.84	6.55	2.17	4.28	5.78	6.13	5.21	7.25	5.94	7.26	7.77	2.61	4.97	6.71	2.93	2.54	5.19	5.53	6.1	5.24	3.21	4.95	0.33	5.67	2.94	4.88	7.32	0.23	4.5	6.05	6.28	3.23
MELDR-11	8.66	10.9			10.59	6.85	9.89	7.24	9.8	16.35	14.53	13.81	4.66	5.18	8.99	11.39	6.16	6.38	6.19	5.01	7.03	6.96	7.57	9.82	3.76	6.35	3.1	2.98	5.91	1.41	5.68	5.78	7.58	7.7	9.76	7.75	6.81	6.94	7.43	11.51	7.46	8.03	5.9	8.14
MELDR-12	11.8	6.9			4.51	7.08	9.5		3.93	10.65	6.66		8.12	8.81	13.57	9.79	10.27	7.34	1.61	4.05	11.2	11.86	8.38	6.82	0.86	1.57	2.17	1.2	1.96		2.39	1.76	3.03	3.71	3.68	2.65	9.14	3.25	1.35	2.84	6.08	2.92	1.07	2.75

very low <4 | moderately oxygenated 6-8 | hyperoxic >10
low 4-6 | well oxygenated 8-10

Table 5 1 (continued) : Records of physicochemical parameters (pH, Dissolved oxygen (DO) saturation (%), DO concentration (mg/L), Conductivity (mS/cm) and temperature (°C) in the Melville Bull Creek catchments 2007 – 2017

Conductivity (mS/cm) Max 33.2 Min 0.037

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11
LOWLAND RIVERS (ANZECC acceptable range 0.12 - 0.3 mS/cm)																				
MELDR-15																				
MELDR-05	0.096	0.798			1.038	0.796	1.23		0.761	0.877			0.289	0.9	1.036	0.738	0.037	1.061	0.839	1.182
MELDR-16																				
MELDR-02	0.79	0.769	0.814	0.809	0.814	0.788	0.822	0.806	0.742	0.806	0.848		0.568	0.79	0.805	0.809	0.762	0.754	0.832	0.773
PSDTBCMD	0.746	0.709	0.736	0.776	0.706	0.725	0.754	0.665	0.693	0.737	0.763		0.415	0.72	0.738	0.726	0.687	0.712	0.758	0.694
MELDR-13																				
MELDR-14																				
MELDR-06	0.769	0.711	0.734	0.989	0.724	0.705	0.769	0.713	0.603	0.644	0.661		0.415	0.604	0.624	0.632	0.616	0.614	0.638	0.597
Site	WETLANDS (ANZECC acceptable range 0.3 - 1.5 mS/cm)																			
MELDR-07	3.83	1.92			1.890	1.920	2.820		1.93	2.41			2.65	2.51	3.4	4.76		2.62	2.65	2.32
MELDR-08	0.951	0.79			0.666	0.685			0.781										1.278	0.984
MELDR-09	0.926	0.821			0.841	1.010	1.280	1.472	0.814	1.09	1.415		0.717	0.748	0.889		0.922	0.827	0.853	0.919
MELDR-10	0.212	0.24			0.342	0.328	0.590	0.558	0.351	0.418	0.7		0.181	0.23	0.452	0.547	0.087	0.114	0.19	0.212
MELDR-11	0.318	0.517			0.432	0.421	0.502	0.736	0.258	0.417	0.705	0.988	0.297	0.35	0.483	0.409	0.204	0.234	0.289	0.204
MELDR-12	1.014	0.706			0.687	0.888	1.006		0.667	0.936	1.411		0.714	0.809	1.003	1.196	0.834	0.732	0.652	0.832

Site	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
LOWLAND RIVERS (ANZECC acceptable range 0.12 - 0.3 mS/cm)																								
MELDR-15										0.61	0.617	0.712	0.505	0.557	0.808	0.792	0.682	0.477	0.344	0.621	0.234	0.481	0.626	0.649
MELDR-05	0.768	0.124	1.211	1.026	0.437	0.608	0.679	0.729	0.49	0.879	0.803	1.316	0.822	0.916	1.475	1.05	0.472	0.651	0.371	0.81	0.403	1.858	1.006	1.196
MELDR-16										0.517	0.641	0.741	0.617	0.76	0.725	0.845	0.393	0.432	0.219		0.143	0.484	0.604	0.424
MELDR-02	0.832	0.689	0.842	0.82	0.701	0.767	0.608	0.655	0.504	0.836	0.831	0.878	0.836	0.854	0.864	0.86	0.8	0.794	0.656	0.828	0.666	0.785	0.814	0.801
PSDTBCMD	0.78	0.598	0.761	0.744	0.48	0.741	0.606	0.655	0.551	0.782	0.766	0.802	0.769	0.773	0.77	0.779	0.75	0.734	0.519	0.779	0.575	0.726	0.764	0.744
MELDR-13							0.753	0.79	0.19	0.623	0.619	0.635	0.597	0.429	0.627	0.695	0.463	0.511	0.587	0.619	0.555	0.587	0.606	0.6
MELDR-14							0.828	0.86	0.49	0.459	0.634	0.736	0.502	0.539	0.701	0.607	0.481	0.445	0.545	0.665	0.51	0.605	0.695	0.685
MELDR-06	33.2	0.45	0.675	0.658	0.597	0.644	1.18	0.856	0.256	0.53	0.533	0.572	0.517	0.611	0.641	0.635	0.589	0.561	0.56	0.646	0.439	0.602	0.631	0.624
Site	WETLANDS (ANZECC acceptable range 0.3 - 1.5 mS/cm)																							
MELDR-07			3.57	3.94		2.17	1.166	1.333	2.038	1.874	1.75	1.811	3.06	2.989	3.134	2.767	2.449	2.336	1.919	1.671		1.619	1.662	1.454
MELDR-08		1.038	1.164	1.026	1.504	1.358	0.282	0.458	0.984	1.012	0.967	0.863	1.105	1.089	0.815	0.972	1.141	1.329	1.198	0.833	1.13	1.162	0.996	0.921
MELDR-09	0.814	0.806	0.828	0.855	0.782	0.739	0.289	0.267	0.877	0.788	0.672	0.935	0.706	0.727	0.852	0.749	0.864	0.909	0.825	0.997	0.758	0.492	0.676	0.641
MELDR-10	0.168	0.113	0.156	0.316	0.138	0.092	0.982	0.98	0.158	0.213	0.318	0.499	0.132	0.164	0.494	0.256	0.093	0.15	0.173	0.425	0.132	0.16	0.326	0.305
MELDR-11	0.34	0.346	0.317	0.391	0.297	0.211	1.746	1.981	0.187	0.235	0.248	0.242	0.24	0.287	0.281	0.234	0.166	0.21	0.286	0.295	0.214	0.129	0.195	0.213
MELDR-12	1.385	1.177	0.812	1.021	0.574	0.542	0.609	0.887	0.531	0.652	0.643	0.974	0.921	1.09	1.399	1.27	0.747	0.874	0.721	0.88	0.721	0.571	0.737	0.749

SITES RECORDING EC LEVELS ALWAYS/GENERALLY OUTSIDE ACCEPTABLE RANGE
SITES RECORDING 40-60% of EC levels ABOVE ACCEPTABLE RANGE
SITES RECORDING EC levels ALWAYS/GENERALLY WITHIN ACCEPTABLE RANGE

Record BELOW acceptable range | Record WITHIN the acceptable range
Record ABOVE acceptable range | NO sample taken

Total Suspended Solids (mg/L) DoW interim guideline: 6 mg/L Max 184 Min <1 LOR 1 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11
MELDR-15																				
MELDR-05	11	2			6	10	12		7	4			8	7	12	6	8	10	11	<1
MELDR-16																				
MELDR-02	1	3	2	3	4	1	2	1	2	2	2	54	1	2	1	3	2	1	3	1
PSDTBCMD	4	3	29	4	7	1	5	12	6	2	2	7	8	3	4	2	2	<1	2	4
MELDR-13																				
MELDR-14																				
MELDR-06	51	56	4	44	35	27	24	14	13	8	11	8	14	9	13	10	12	13	15	9
MELDR-07	17	59			42	5	58		37	11			32	11	11	184		19	5	3
MELDR-08	7	27			23	5			2										<1	<1
MELDR-09	3	1			9	<1	2	3	1	5	<1		2	<1	1	1	3	3	<1	<1
MELDR-10	1	1			3	1	6	11	1	1	8		1	1	4	3	1	<1	<1	1
MELDR-11	7	3			5	2	3	12	2	2	14	15	1	3	3	50	2	<1	2	1
MELDR-12	27	2			4	1	6		2	<1	9		1	<1	<1	3	<1	1	21	4

Site	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15										13	4	3	12	13	10	8	1	8	2	1	10	12	13	8
MELDR-05	9	2	4	3	7	5	5	5	6	4	3	11	3	4	4	5	8	2	2	2	4	5	7	2
MELDR-16										18	10	9	8	13	20	14	13	2	1	1	<1	12	58	2
MELDR-02	3	1	1	<1	3	2	3	1	3	3	2	1	2	1	1	1	0.5	1	1	1	2	3	4	3
PSDTBCMD	4	3	5	5	12	4	6	5	15	5	4	3	2	2	2	1	1	3	3	5	4	3	4	2
MELDR-13							21	12	17	13	17	8	7	6	5	5	10	11	10	1	8	10	11	8
MELDR-14							<1	3	2	2	1	<1	<1	<1	1	1	0.5	1	2	4	1	<1	2	<1
MELDR-06	14	13	8	6	17	10	16	7	18	11	11	2	17	5	4	4	5	6	7	5	3	3	6	5
MELDR-07			10	2		8	29	2	7	7	17	2	<1	1	8	7	15	4	7	1		7	6	2
MELDR-08		1	1	3	3	<1	<1	1	<1	1	4	<1	<1	<1	2	3	<1	1	<1	1	2	3	9	7
MELDR-09	1	1	<1	<1	1	<1	2	1	<1	1	1	<1	1	2	1	1	<1	<1	<1	5	1	2	4	<1
MELDR-10	1	2	5	3	2	1	<1	<1	2	<1	<1	<1	2	1	2	1	<1	2	2	2	2	1	5	<1
MELDR-11	1	3	1	2	3	2	1	3	1	3	2	1	2	3	4	2	<1	1	1	4	3	<1	4	1
MELDR-12	15	57	63	24	6	15	22	20	11	8	24	23	3	5	17	3	62	10	16	4	8	16	6	2

SITES RECORDING TSS CONCENTRATIONS ALWAYS/GENERALLY ABOVE GUIDELINE
SITES RECORDING 40-60% of TSS concentrations ABOVE ACCEPTABLE RANGE
SITES RECORDING TSS concentrations ALWAYS/GENERALLY WITHIN ACCEPTABLE RANGE

Concentration ABOVE guideline | Concentration < LOR
Concentration BELOW guideline | NO sample taken

6. Nutrients

The nutrient forms analysed during the 2017 monitoring include total nitrogen, nitrogen in ammonia/ammonium, nitrate and nitrite (oxidised nitrogen), total and dissolved organic nitrogen, total phosphorus and soluble reactive phosphorus.

Nutrient concentration data for water samples of the Melville Bull Creek catchments are displayed in **Tables D-7 to D-13** in **Appendix D. Table E-1, Appendix E** outlines the sources of nitrogen and phosphorus nutrients and the impacts that changes in these nutrients can have to aquatic ecosystems.

6.1 Nitrogen

Nitrogen in waterways can exist in both inorganic forms, including oxidised nitrogen (encompassing nitrate (NO_3^-) and nitrite (NO_2^-)) and ammonia nitrogen (including both ammonium (NH_4^+) and ammonia (NH_3)), and dissolved and particulate organic forms. Nitrogen is converted between these forms, as well as nitrogen gas (N_2), via physical and biological processes known collectively as the nitrogen cycle. When plants and animals die or when animals excrete their wastes, organic nitrogen in the water is converted by bacteria to ammonium/ammonia (mineralisation), then to nitrite and nitrate (nitrification). Ammonium can be converted to ammonia gas (volatilisation) in alkaline conditions and nitrate can be converted to nitrogen gas (denitrification) in anoxic conditions, with the release of these gasses into the atmosphere resulting in a loss of nitrogen from the water. Nitrites, ammonia and ammonium ions are therefore considered intermediate forms of nitrogen in aquatic systems (Northern Territory Government 2003).

Graphs for total nitrogen (TN), total oxidised nitrogen (NOx-N), nitrogen as ammonia/ammonium (NH3/NH4+-N), total oxidised nitrogen (TON) concentrations and dissolved oxygen (DON) concentrations, as well as nitrogen speciation, in the Melville Bull Creek catchment in 2017 are displayed in **Figure 6.1-1** and tables containing concentrations of the above parameters from the 2007-2017 sampling period are displayed in **Table 6.1-1.** For all graphs, a value equal to half the limit of reporting was substituted for those occasions where concentrations were recorded as 'below the laboratory limit of reporting' which is a standard technique to allow these 'unknown' values to be represented graphically and to differentiate them from those samples that recorded concentrations equal to the limit of reporting.

Total nitrogen (TN) concentrations varied across the Melville Bull Creek catchments. 20 out of 55 recorded TN concentrations above the ANZECC trigger values for lowland rivers (1.2 mg/L) or wetlands (1.5 mg/L) (**Figure 6.1-1-A** and **Table D-7, Appendix D**). The highest concentrations were recorded at Booragoon Lake (site 7, 7.9 mg/L, 5.2 mg/L and 3.5 mg/L in August, September and October respectively) and Brockman Park (site 2, 5.1 mg/L, 5.2 mg/L, 5.7 mg/L and 5.8 mg/L in July, August, September and October respectively). Exceeding concentrations were recorded on all sampling occasions at sites 2, PSDTBCMD, 7 and 12 (Brockman Park and Bull Creek MD and Blue Gum Lake), and on at least one sampling occasion at sites 5, 16, 14, and 7 (John Creaney Park, downstream Elizabeth Manion Park, RAAF drain and Blue Gum Lake outlet). The lowest concentration of 0.22 mg/L was recorded at site 10 (Frederick Baldwin) in August.

Total oxidised nitrogen (NOx-N) concentrations above relevant ANZECC trigger values (lowland rivers: 0.15 mg/L, wetlands: 0.1 mg/L) were recorded at 22 of the 55 samples from seven sites (16 (downstream Elizabeth Manion Park), 2 (Brockman Park), PSDTBCMD (Bull Creek Main drain), 13 (Brentwood drain), 14 (RAAF drain), 6 (Bateman Park) and 7 (Booragoon Lake)) (**Figure 6.1-1-B** and **Table D-8, Appendix D**). The four highest concentrations in the catchment were all recorded at site PSDTBCMD: 2.2 mg/L (almost 15 times greater than the trigger value), 2.1 mg/L, 1.9 mg/L and 1.6 mg/L in in October, September, August and July respectively. Sites PSDTBCMD, 13 and 6 (Bull Creek Main Drain, Brentwood drain and Bateman Park) also recorded exceeding NOx-N concentrations at all sampling occasions when samples were collected. Twelve samples recorded concentrations below the limit of reporting of 0.01 mg/L.

Ammonia nitrogen (NH^{4+}/NH_3-N) concentrations exceeded relevant ANZECC trigger values (lowland rivers: 0.08 mg/L, wetlands:0.04 mg/L) in 30 samples from 9 sites (15 (John Creaney Park inlet), 5 (John Creaney Park), 2 (Brockman Park), PSDTBCMD (Bull Creek main drain), 13 (Brentwood drain), 6 (Bateman Park), 7 (Booragoon Lake), 10 (Frederick Baldwin) and 12 (Blue Gum Lake)) (**Figure 6.1-1-C** and **Table D-9, Appendix D**). Sites 2, PSDTBCMD, 13, 6 and 12 recorded NH4+/NH3-N concentrations exceeding the trigger value for lowland rivers and wetlands on all sampling occasions. Five samples also recorded NH^{4+}/NH_3-N concentrations exceeding adjusted ANZECC trigger values for 95% level of protection: all samples from at site 2 (Brockman Park) and the August sample from site 7 (**Figure 6.1-1-B**). No sample recorded a concentration exceeding the recreational trigger value (5 mg/L). The highest NH^{4+}/NH_3-N concentrations were recorded at site 2 (4.8 mg/L, 4.6 mg/L, 4.2 mg/L and 4.2 mg/L in September, October, July and August respectively) and site 7 (4.3 mg/L and 2.3 mg/L in August and September respectively). Samples from sites 8, 9, 10 and 11 (Piney Lakes outlet, Quenda Lake outlet, Frederick Baldwin and Marmion Reserve) recorded at least one concentration below the limit of reporting of 0.01 mg/L.

No trigger values exist for **total oxidised nitrogen** (TON) or **dissolved oxidised nitrogen** (DON). Site 7 (Booragoon Lake) recorded the highest concentrations of both TON (3.5 mg/L in August) and DON (2.5 mg/L in October) (**Figure 6.1-1-D** and **Figure 6.1-1-E**). Site 11 (Marmion Reserve) recorded the lowest TON concentration (0.19 mg/L in August) and site 16 (downstream Elizabeth Manion Park) recorded the lowest DON concentration (0.18 mg/L in July).

Organic nitrogen (and mainly dissolved organic nitrogen) comprised the majority of total nitrogen at most sites (**Figure 6.1-1-F).** However, inorganic forms of nitrogen comprised more than 50% of total nitrogen at several sites on average:

- Site 2 (Brockman Park): average 82% ammoniacal nitrogen and 3% oxidised nitrogen;
- PSDTBCMD (Bull Creek Main Drain): average 55% oxidised nitrogen and 18% ammoniacal nitrogen; and
- Site 13 (Brentwood Drain): average 33% oxidised nitrogen and 20% ammoniacal nitrogen.

Considering the two main drainage branches in the catchment that discharge into the Canning River, total nitrogen concentrations in the most downstream Bull Creek main drain site (PSDTBCMD) have consistently exceeded the ANZECC lowland rivers trigger value throughout the eleven year sampling period, whereas concentrations at the most downstream Brentwood drain site (Bateman Park) have almost always been below the trigger value (**Table 6.1-1**). The branches coming from John Creaney Park (site 5) and Elizabeth Manion Park (site 16) have often (since monitoring of these sites began in 2014) contributed exceeding concentrations of nitrogen to Bull Creek main drain, however the majority of nitrogen appears to enter the drain between the convergence of these two branches and Brockman Park (site 2), where concentrations are consistently very high. This nitrogen is generally predominantly in the form of ammonia/ammonium. As water flows from site 2 to the most downstream site PSDTBCMD, total nitrogen concentrations reduce by an average of approximately 50% with the remaining nitrogen predominantly in the form of oxidised nitrogen rather than ammonia nitrogen.

TN concentrations are also consistently high at Booragoon Lake (site 7) and Blue Gum Lake (site 12) (**Table 6.1-1**). This is usually predominantly in the form of organic nitrogen, although ammonia nitrogen often exceeds the wetlands trigger value at these sites and has on occasion exceeded the trigger value for protection of biota at Booragoon Lake. Total nitrogen and nitrogen as ammonia/ammonium concentrations are often greatest at these sites in spring months and often correspond with high organic nitrogen concentrations and high soluble reactive phosphorus concentrations (see **Section 6.2**). Total nitrogen concentrations have been somewhat higher at Blue Gum Lake and somewhat lower at Booragoon Lake since 2012.

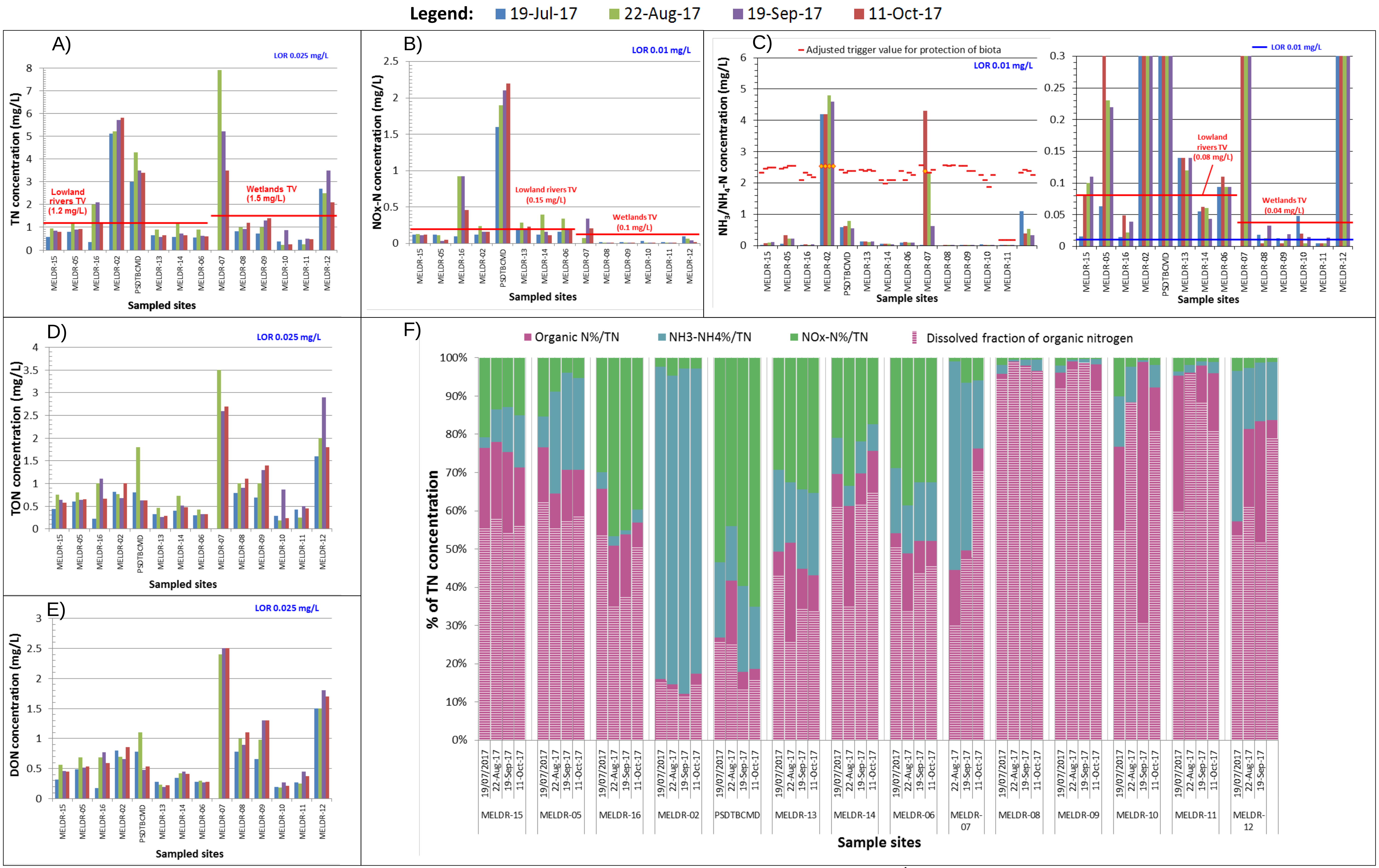

Figure 6.1-1: Graphs of A) Total nitrogen concentrations (mg/L); B) Total oxidised nitrogen (NOx-N) concentrations (mg/L); C) nitrogen as ammonia/ammonium (NH_3/NH^{4+}-N) concentrations (mg/L); D) Total oxidised nitrogen (TON) concentrations (mg/L); E) Dissolved oxygen (DON) concentrations (mg/L); and F) nitrogen speciation; in Melville Bull Creek catchment sites in 2017.

Table 6.1-1: Total nitrogen, total oxidised nitrogen (NOx-N), nitrogen as ammonia/ammonium (NH3/NH4+-N), total oxidised nitrogen (TON) concentrations and dissolved oxygen (DON) concentrations in the Melville Bull Creek catchment from 2007-2017

TN (mg/L) Max 20 Min 0.22 LOR 0.025 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
	LOWLAND RIVERS (ANZECC trigger value 1.2 mg/L)																																											
MELDR-15																														0.77	0.75	0.67	1	0.82	1	1.1	1.1	0.76	0.48	0.69	0.58	0.96	0.86	0.8
MELDR-05	0.89	1			1.5	1.9	2.4		1.3	1.1			1.4	1.3	2.1	2.5	0.45	1	1.4	1.4	1.5	0.27	1.3	1.4	0.87	0.94	0.83	1.1	0.91	1.1	0.88	1.4	1.3	1.3	1.6	1.6	0.91	0.87	0.32	0.82	0.79	1.2	0.9	0.92
MELDR-16																														0.7	0.63	0.81	0.82	11	1.4	2.9	0.64	0.37	0.37		0.34	2	2.1	1.2
MELDR-02	5.3	3.8	5.8	6.1	4.4	5.5	7.2	6.8	4.5	5.8	6.9	6.8	3.9	6	6.8	7.8	6.5	6	6.4	5.8	8.3	6.5	7.2	8.2	5.2	5	4.8	6.3	2.7	5.4	5.2	7	6.6	7	9.1	9.6	6.9	5.9	4.8	6.8	5.1	5.2	5.7	5.8
PSDTBCMD	2.7	2.4	0.63	3.5	2.6	2.9	4	2.9	2.8	3.1	3.8	4.1	1.7	3	3.9	3.9	3	3	3.1	3	4.4	2.9	4	4.4	2.1	3	3.3	3.7	2.6	3.3	3.2	4.2	3.8	3.8	4.5	4.5	3.5	3.2	2	3.5	3	4.3	3.5	3.4
MELDR-13																											0.64	0.6	0.47	0.66	0.62	0.53	0.51	0.51	0.55	0.52	0.69	0.63	0.66	0.67	0.65	0.9	0.58	0.64
MELDR-14																											0.75	0.69	0.71	0.96	0.73	0.59	0.49	0.49	0.59	0.59	0.68	0.63	0.62	0.55	0.58	1.2	0.73	0.64
MELDR-06	1	0.87	3.3	0.63	0.77	0.7	0.56	0.61	0.95	0.62	0.58	0.54	0.75	0.6	0.6	0.64	0.74	0.81	0.85	0.58	0.57	0.43	0.53	0.51	0.64	0.79	0.65	0.6	0.51	0.62	0.63	0.53	0.6	0.53	0.59	0.49	0.78	0.63	0.66	0.64	0.55	0.89	0.62	0.61
Site	WETLANDS (ANZECC trigger value 1.5 mg/L)																																											
MELDR-07	1.1	10			6.3	11	11		3	7.6			2.7	6.1	16	20		2.5	6.4	10			0.52	0.45		0.55	2.8	3.3	0.76	1.6	2.2	3.5	0.37	0.31	3.5	3	1.2	0.5	0.44	3		7.9	5.2	3.5
MELDR-08	1.1	1.7			2.3	0.62			0.78										0.61	0.65		0.62	0.76	0.62	1.6	1.4	0.79	0.71	1.2	0.95	1.3	0.78	0.73	0.58	0.66	0.65	0.76	0.85	1.1	0.83	0.82	1	0.92	1.2
MELDR-09	0.81	0.81			0.61	0.79	1.3	1.2	0.71	0.74	0.85		0.49	0.54	0.6	0.95	1.1	0.73	0.85	0.75	0.4	0.4	0.48	0.5	0.4	0.62	1.2	1.4	1.3	1.2	1.3	1.5	0.77	0.89	0.98	1	0.67	0.68	1	1.2	0.72	1	1.3	1.4
MELDR-10	0.67	0.31			0.37	0.46	1	1.3	0.32	0.55	1.1		0.33	0.29	0.65	0.77	0.38	0.28	0.46	0.34	0.32	0.41	0.32	0.52	0.3	0.25	0.29	0.44	0.67	0.34	0.32	0.56	0.24	0.33	0.63	0.49	0.31	0.27	0.28	0.48	0.37	0.22	0.88	0.26
MELDR-11	0.8	0.56			0.45	0.49	0.66	1.2	0.53	0.52	1.3	1.9	1	0.6	0.63	1.2	0.55	0.44	0.61	0.39	0.4	0.42	0.34	0.46	0.65	0.38	0.31	0.44	0.43	0.43	0.42	0.44	0.32	0.35	0.73	0.72	0.35	0.26	0.32	0.47	0.45	0.26	0.51	0.47
MELDR-12	2.6	2			1.3	1.4	1.7		1.4	1.2	2.4		1.3	1	1.2	1.7	0.78	0.22	1.2	3.3	3.9	7.1	3.7	3	1.5	2.3	2.6	3.2	2.2	2.1	2.4	5.4	3.9	3.5	2.4	3	0.86	0.63	2.2	2.6	2.7	2.5	3.5	2.1

SITES RECORDING TN CONCENTRATIONS ALWAYS/GENERALLY ABOVE ANZECC TRIGGER VALUE
SITES RECORDING 40-60% of TN concentrations ABOVE ACCEPTABLE RANGE
SITES RECORDING TN CONCENTRATIONS ALWAYS/GENERALLY BELOW ANZECC TRIGGER VALUE
Concentration ABOVE trigger value
Concentration BELOW trigger value
Concentration < LOR
NO sample taken

NOx (mg/L) Max 3.7 Min <0.01 LOR 0.01 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
	LOWLAND RIVERS (ANZECC trigger value 0.15 mg/L)																																											
MELDR-15																														0.071	0.1	0.1	0.22	0.14	0.17	0.15	0.37	0.21	0.14	0.13	0.12	0.13	0.11	0.12
MELDR-05	<0.01	0.075			0.056	0.019	<0.01		0.063	0.029			0.21	0.023	0.025	<0.01	0.05	0.073	0.029	0.068	<0.01	0.051	0.031	<0.01	0.099	0.12	0.074	0.051	0.079	0.057	0.077	0.019	0.062	0.015	0.005	0.01	0.036	0.082	0.059	0.038	0.12	0.11	0.035	0.049
MELDR-16																														0.17	0.16	0.14	0.2	0.67	0.8	1.7	0.15	0.16	0.15		0.1	0.92	0.92	0.46
MELDR-02	0.078	0.13	0.089	0.065	0.13	0.098	0.055	0.04	0.12	0.1	0.074	0.083	0.18	0.082	0.068	0.16	0.13	0.14	0.14	0.15	0.057	0.087	0.06	0.076	0.12	0.23	0.22	0.13	0.097	0.14	0.13	0.089	0.13	0.45	0.099	0.1	0.16	0.19	0.22	0.16	0.12	0.24	0.16	0.16
PSDTBCMD	1.9	1.2	0.078	2.3	1.2	1.6	2.2	2	1.5	2.3	3.2	3.7	0.95	2.3	2.8	2.7	1.8	1.8	2.2	1.9	2.5	1.6	2.1	2.4	1.2	2.1	1.8	2.8	1.1	1.9	2.1	2.8	2.5	2.3	3.4	3.7	2.4	2.1	1.3	2.6	1.6	1.9	2.1	2.2
MELDR-13																											0.2	0.19	0.12	0.22	0.19	0.16	0.13	0.11	0.089	0.11	0.3	0.32	0.34	0.26	0.19	0.29	0.2	0.23
MELDR-14																											0.23	0.077	0.23	0.43	0.21	0.06	0.12	0.071	0.038	0.029	0.31	0.25	0.24	0.066	0.12	0.4	0.16	0.11
MELDR-06	0.32	0.35	2.1	0.068	0.24	0.08	0.051	0.086	0.31	0.12	0.062	0.049	0.22	0.15	0.11	0.093	0.2	0.25	0.23	0.14	0.19	0.15	0.12	0.11	0.23	0.35	0.23	0.16	0.14	0.21	0.18	0.14	0.15	0.13	0.078	0.097	0.34	0.26	0.31	0.21	0.16	0.34	0.2	0.2
Site	WETLANDS (ANZECC trigger value 0.10 mg/L)																																											
MELDR-07	<0.01	0.018			0.022	0.51	0.3		0.015	0.15			<0.01	0.01	0.11	0.19		<0.01	<0.01	0.26			<0.01	<0.01		<0.01	<0.01	0.014	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.08	0.01	0.01	0.01	0.02	0.01		0.08	0.34	0.21
MELDR-08	<0.01	<0.01			<0.01	<0.01			<0.01										<0.01	<0.01		<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.011	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
MELDR-09	<0.01	0.011			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.014	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
MELDR-10	0.036	0.011			<0.01	0.018	0.026	0.43	0.01	<0.01	<0.01		0.016	<0.01	<0.01	0.019	0.037	<0.01	0.011	<0.01	0.018	0.11	<0.01	<0.01	0.021	<0.01	0.021	<0.01	0.036	0.014	<0.01	0.15	0.017	<0.01	<0.01	<0.01	0.022	0.019	0.018	0.005	0.037	0.005	0.005	0.005
MELDR-11	<0.01	<0.01			0.01	<0.01	<0.01	0.14	0.011	0.01	0.013	0.01	0.16	0.086	0.017	<0.01	0.034	0.034	<0.01	<0.01	<0.01	0.014	<0.01	<0.01	0.071	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	0.056	0.019	0.013	0.005	0.016	0.005	0.005	0.005
MELDR-12	<0.01	0.012			0.01	<0.01	<0.01		0.052	0.013	<0.01		<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.017	0.011	0.01	0.013	<0.01	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	0.11	0.20	0.01	0.14	0.01	0.01	0.03	0.01	0.10	0.07	0.05	0.02

SITES RECORDING TP CONCENTRATIONS ALWAYS/GENERALLY ABOVE ANZECC TRIGGER VALUE
SITES RECORDING 40-60% of TP concentrations ABOVE ACCEPTABLE RANGE
SITES RECORDING TP CONCENTRATIONS ALWAYS/GENERALLY BELOW ANZECC TRIGGER VALUE
Concentration ABOVE trigger value
Concentration BELOW trigger value
Concentration < LOR
NO sample taken

NH_3-N (mg/L) Max 14 Min <0.01 LOR 0.01 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
	LOWLAND RIVERS (ANZECC trigger value 0.08 mg/L)																																											
MELDR-15																														0.094	0.14	0.098	0.062	0.079	0.058	0.074	0.068	0.047	0.039	0.091	0.016	0.081	0.1	0.11
MELDR-05	0.014	0.24			0.53	0.73	0.049		0.2	0.076			0.15	0.44	0.1	1.3	0.01	0.086	0.052	0.044	0.45	0.044	0.31	0.43	0.15	0.19	0.14	0.25	0.27	0.45	0.28	0.13	0.51	0.52	0.32	0.1	0.4	0.22	0.048	0.16	0.063	0.33	0.23	0.22
MELDR-16																														0.037	0.035	0.093	0.057	9.7	0.073	0.41	0.061	0.014	0.043		0.015	0.049	0.022	0.039
MELDR-02	4.8	2.9	4.9	5.4	4	4.4	5.8	6.3	3.3	4.7	6.8	6.5	3.3	5.6	6.2	7	5.6	4.9	4.9	4.9	7.6	6	5.8	6.8	4	4	3.8	5.5	2	4.7	4.6	5.9	6.1	6.2	7.6	7.8	6.2	5.1	4	5.7	4.2	4.2	4.8	4.6
PSDTBCMD	0.5	0.39	0.27	0.1	1.2	0.47	0.7	0.12	0.25	0.13	0.21	0.039	0.27	0.48	0.54	0.26	0.3	0.53	0.43	0.39	1.6	0.85	1.3	1.3	0.35	0.46	0.54	0.75	0.88	0.72	0.55	1	0.63	0.76	0.37	0.34	0.6	0.55	0.23	0.48	0.59	0.62	0.79	0.55
MELDR-13																											0.12	0.15	0.075	0.16	0.14	0.19	0.16	0.16	0.14	0.15	0.16	0.15	0.13	0.16	0.14	0.14	0.12	0.14
MELDR-14																											0.023	0.045	0.047	0.066	0.066	0.098	0.05	0.05	0.047	0.041	0.059	0.035	0.019	0.043	0.055	0.062	0.061	0.044
MELDR-06	0.31	0.22	0.32	0.25	0.22	0.22	0.28	0.24	0.16	0.2	0.24	0.24	0.18	0.2	0.2	0.26	0.2	0.17	0.18	0.12	0.22	0.11	0.15	0.11	0.14	0.13	0.11	0.13	0.089	0.16	0.14	0.17	0.14	0.14	0.12	0.13	0.15	0.12	0.085	0.12	0.094	0.11	0.094	0.094
Site	WETLANDS (ANZECC trigger value 0.04 mg/L)																																											
MELDR-07	0.065	7.2			4.3	6.5	5		0.044	3.6			<0.01	3.4	12	14		<0.01	3.1	6.9			<0.01	0.022		<0.01	0.32	0.3	0.026	0.1	0.021	1.2	0.031	0.028	1.2	0.055	0.043	0.028	0.023	0.64		4.3	2.3	0.63
MELDR-08	<0.01	0.038			0.014	0.023			0.013										<0.01	0.016		<0.01	<0.01	0.013	0.027	0.013	0.016	0.026	0.025	0.028	0.025	0.017	0.028	0.023	0.02	0.025	0.028	0.023	0.011	0.022	0.018	<0.01	0.013	0.033
MELDR-09	0.017	0.015			0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	0.01	0.013	0.018	0.63	<0.01	0.076	0.046	<0.01	<0.01	<0.01	<0.01	<0.01	0.014	0.014	<0.01	<0.01	0.033	0.024	0.027	0.019	0.02	<0.01	<0.01	0.017	0.013	0.027	0.027	0.013	<0.01	0.012	0.019
MELDR-10	0.18	0.013			<0.01	<0.01	0.05	0.078	<0.01	0.017	0.36		0.041	0.013	0.21	0.26	0.05	<0.01	0.05	0.03	0.068	0.07	0.015	0.023	0.05	<0.01	<0.01	<0.01	0.034	0.033	0.017	0.059	0.031	0.021	0.018	0.035	0.055	0.04	<0.01	0.037	0.048	0.02	<0.01	0.015
MELDR-11	0.024	<0.01			<0.01	0.018	<0.01	0.017	<0.01	0.013	<0.01	0.011	0.54	0.15	0.026	<0.01	0.12	0.016	0.016	<0.01	0.015	<0.01	<0.01	<0.01	0.15	0.026	<0.01	<0.01	0.01	0.013	0.013	0.028	0.021	0.023	0.015	0.02	0.049	0.017	<0.01	0.01	0.005	0.005	<0.01	0.014
MELDR-12	0.37	0.31			0.087	0.089	<0.01		0.18	0.021	0.023		0.051	0.056	0.031	0.043	0.56	<0.01	<0.01	1.4	1.6	1	0.021	0.026	0.85	0.083	<0.01	0.027	0.027	0.043	0.07	0.034	2.1	1.4	0.021	0.9	0.028	0.05	0.11	0.34	1.1	0.39	0.53	0.33

Concentration ABOVE trigger value
Concentration BELOW trigger value
Concentration < LOR
NO sample taken
SITES RECORDING NH3-N CONCENTRATIONS ALWAYS/GENERALLY ABOVE ANZECC TRIGGER VALUE
SITES RECORDING NH3-N CONCENTRATIONS ALWAYS/GENERALLY BELOW ANZECC TRIGGER VALUE

DON (mg/L) Max 5.3 Min <0.01 LORs 0.01 & 0.025 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																														0.4	0.39	0.46	0.59	0.6	0.65	0.79	0.62	0.41	0.28	0.39	0.32	0.56	0.46	0.45
MELDR-05	<0.01	0.075			0.76	0.81	1.4		0.71	0.65			0.42	0.57	1.1	1	0.23	0.57	0.77	0.56	0.68	0.11	0.72	0.7	0.46	0.53	0.45	0.51	0.43	0.5	0.45	0.57	0.64	0.76	0.84	0.9	0.45	0.46	0.21	0.52	0.49	0.69	0.52	0.54
MELDR-16																														0.37	0.43	0.48	0.41	0.75	0.35	0.6	0.3	0.15	0.16		0.18	0.69	0.77	0.59
MELDR-02	0.078	0.13	0.089	0.065	0.25	1	1.1	0.3	1.1	0.93	0.44	0.23	<0.025	<0.025	<0.025	0.43	0.5	0.71	1.1	0.57	0.6	0.39	1.1	1.3	0.82	0.71	0.79	0.62	0.41	0.43	0.45	0.94	0.38	0.19	0.46	1.6	0.18	0.56	0.53	0.9	0.8	0.7	0.66	0.86
PSDTBCMD	1.9	1.2	0.078	2.3	0.083	0.74	0.92	0.76	0.99	0.57	0.34	0.36	0.32	0.19	0.45	0.89	0.68	0.74	0.41	0.61	0.34	0.48	0.59	0.76	0.5	0.53	0.76	0.099	0.39	0.57	0.57	0.26	0.53	0.7	0.64	0.35	0.43	0.43	0.43	0.39	0.78	1.1	0.48	0.54
MELDR-13																											0.23	0.22	0.2	0.27	0.22	0.16	0.21	0.24	0.31	0.25	0.18	0.13	0.18	0.19	0.28	0.23	0.2	0.22
MELDR-14																											0.43	0.56	0.35	0.43	0.43	0.39	0.29	0.37	0.49	0.46	0.28	0.22	0.34	0.42	0.35	0.42	0.45	0.41
MELDR-06	0.32	0.35	2.1	0.068	0.3	0.28	0.15	0.18	0.45	0.26	0.2	0.24	0.24	0.22	0.22	0.28	0.29	0.32	0.4	0.28	0.16	0.17	0.23	0.26	0.21	0.28	0.23	0.28	0.19	0.24	0.25	0.18	0.24	0.24	0.37	0.26	0.2	0.18	0.26	0.28	0.28	0.3	0.27	0.28
MELDR-07	<0.01	0.018			0.92	3.5	5.3		0.64	3.3			1.5	2.7	3.5	1.2		1.1	3.1	2.9			0.32	0.29		0.28	1.7	2.8	0.58	1	1.4	2.2	0.3	0.24	1.6	2.6	0.64	0.27	0.28	2		2.4	2.5	2.5
MELDR-08	<0.01	<0.01			0.64	0.5			0.69										0.6	0.6		0.54	0.72	0.57	1.5	1.2	0.76	0.63	1.1	0.88	1.3	0.69	0.65	0.56	0.48	0.55	0.73	0.82	0.99	0.77	0.78	1	0.9	1.1
MELDR-09	<0.01	0.011			0.54	0.66	0.92	1.1	0.69	0.66	0.74		0.44	0.5	0.55	0.89	0.38	0.43	0.7	0.68	0.39	0.35	0.44	0.48	0.35	0.54	1.1	1.3	1.2	1.1	1.1	1.4	0.71	0.84	0.71	0.91	0.58	0.65	0.99	1.2	0.66	0.98	1.3	1.3
MELDR-10	0.036	0.011			0.26	0.34	0.37	0.24	0.28	0.34	0.41		0.16	0.21	0.41	0.41	0.25	0.18	0.4	0.25	0.2	0.16	0.25	0.35	0.13	0.13	0.18	0.36	0.25	0.23	0.23	0.26	0.16	0.23	0.4	0.29	0.18	0.2	0.19	0.32	0.2	0.19	0.27	0.21
MELDR-11	<0.01	<0.01			0.3	0.38	0.52	0.62	0.37	0.4	0.76	0.94	0.22	0.27	0.43	0.67	0.3	0.28	0.44	0.32	0.24	0.23	0.25	0.35	0.22	0.24	0.23	0.37	0.26	0.23	0.26	0.34	0.17	0.27	0.49	0.57	0.21	0.2	0.26	0.41	0.27	0.25	0.45	0.38
MELDR-12	<0.01	0.012			1.1	1.2	1.2		1	1.1	1.4		0.82	0.89	1.1	1.4	0.18	0.13	0.92	1.9	1.2	0.69	0.75	2.1	0.35	1.4	1.9	1.9	1.6	1.6	1.6	1.5	1.4	1.5	1.6	1.9	0.29	0.29	1.6	2	1.5	1.5	1.8	1.7

NO sample taken
Highest concentration of the year
Lowest concentration of the year

TON Max 6 Min 0.15 LOR 0.025mg/L

Site	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15														0.61	0.51	0.47	0.73	0.61	0.81	0.89	0.63	0.5	0.3	0.46	0.44	0.75	0.64	0.57
MELDR-05	0.39	0.86	1.4	1.3	1	0.18	0.96	1	0.62	0.62	0.61	0.77	0.56	0.59	0.52	1.3	0.74	0.8	1.3	1.5	0.47	0.58	0.22	0.62	0.6	0.8	0.64	0.65
MELDR-16														0.49	0.44	0.58	0.56	0.85	0.51	0.86	0.42	0.2	0.17		0.22	1	1.1	0.66
MELDR-02	0.83	0.88	1.3	0.77	0.62	0.41	1.4	1.3	1	0.81	0.79	0.63	0.64	0.46	0.47	0.96	0.47	0.29	1.4	1.7	0.51	0.58	0.56	0.94	0.82	0.76	0.68	1
PSDTBCMD	0.98	0.76	0.48	0.77	0.35	0.48	0.6	0.79	0.6	0.53	1	0.15	0.65	0.66	0.6	0.33	0.61	0.72	0.75	0.38	0.56	0.58	0.47	0.44	0.8	1.8	0.63	0.63
MELDR-13											0.32	0.26	0.27	0.27	0.29	0.17	0.22	0.24	0.33	0.25	0.22	0.16	0.19	0.25	0.32	0.46	0.26	0.28
MELDR-14											0.5	0.57	0.43	0.46	0.46	0.44	0.32	0.37	0.51	0.52	0.32	0.35	0.37	0.44	0.4	0.73	0.51	0.48
MELDR-06	0.34	0.39	0.44	0.32	0.16	0.17	0.26	0.29	0.27	0.31	0.31	0.32	0.28	0.24	0.31	0.21	0.31	0.27	0.39	0.27	0.29	0.25	0.27	0.31	0.3	0.43	0.32	0.32
MELDR-07		2.5	3.3	3.2			0.51	0.42		0.55	2.5	3	0.73	1.4	2.2	2.4	0.33	0.28	2.3	2.9	1.1	0.47	0.4	2.3		3.5	2.6	2.7
MELDR-08			0.6	0.63		0.62	0.75	0.6	1.6	1.4	0.77	0.68	1.2	0.91	1.3	0.77	0.7	0.56	0.65	0.64	0.73	0.82	1.1	0.81	0.79	1	0.9	1.1
MELDR-09	0.42	0.72	0.77	0.7	0.39	0.39	0.47	0.48	0.4	0.61	1.1	1.4	1.3	1.1	1.3	1.4	0.75	0.87	0.97	1	0.65	0.66	1	1.2	0.69	1	1.3	1.4
MELDR-10	0.29	0.28	0.4	0.3	0.24	0.24	0.31	0.49	0.23	0.24	0.26	0.43	0.6	0.29	0.29	0.34	0.19	0.32	0.61	0.45	0.23	0.21	0.26	0.43	0.28	0.19	0.87	0.24
MELDR-11	0.4	0.39	0.59	0.39	0.38	0.41	0.33	0.45	0.43	0.35	0.31	0.43	0.42	0.41	0.4	0.41	0.29	0.33	0.72	0.7	0.24	0.23	0.31	0.46	0.43	0.25	0.5	0.45
MELDR-12	0.2	0.21	1.2	1.9	2.3	6	3.6	3	0.59	2.2	2.6	3.2	2.1	2.1	2.3	5.3	1.7	1.9	2.4	1.9	0.82	0.57	2.1	2.2	1.6	2	2.9	1.8

NO sample taken
Highest concentration of the year
Lowest concentration of the year

6.2 Phosphorus

Phosphorus in water can exists in both soluble and particulate forms. Soluble phosphorus is largely comprised of inorganic phosphate ions (PO_4^{3-}, also known as orthophosphate or soluble reactive phosphorus) but small amounts of condensed phosphate (polyphosphates and metaphosphates) and dissolved organic forms of phosphorus may be present. Particulate phosphorus is comprised of organic material (decaying plant and animal matter), phosphorus adsorbed to particulate material and phosphorus minerals (e.g. apatite).

Graphs for total phosphorus (TP) and soluble reactive phosphorus (SRP) in the Melville Bull Creek catchment in 2017 are displayed in **Figure 6.2-1** and tables containing concentrations of the above parameters from the 2007-2017 sampling period are displayed in **Table 6.2-1.**

Total phosphorus (TP) concentrations exceeded relevant ANZECC trigger values (lowland rivers: 0.065 mg/L, wetlands: 0.06 mg/L) in 14 out of 55 samples from six sites (15 (John Creaney Park inlet), 16 (downstream Elizabeth Manion Park), 7 (Booragoon Lake), 10 (Frederick Baldwin), 11 (Marmion reserve) and 12 (Blue Gum Lake)) (**Figure 6.2-1** and **Table D-12, Appendix D**). TP concentrations exceeded the wetlands trigger value on all sampling occasions at sites 7 and 12, and the highest concentrations by far were recorded at site 7 (4 mg/L, 3.6 mg/L and 1.6 mg/L in October, September and August respectively). The lowest concentration of 0.006 mg/L was recorded at both sites 9 (Quenda Lake Outlet) and 8 (Piney Lakes outlet).

Soluble reactive phosphorus (SRP) concentrations exceeded relevant ANZECC trigger values (lowland rivers: 0.04 mg/L, wetlands: 0.03 mg/L) in nine out of 55 samples from three sites (16 (downstream Elizabeth Manion Park), 7 (Booragoon Lake), and 12 (Blue Gum Lake)) (**Figure 6.2-1** and **Table D-12, Appendix D**). SRP concentrations exceeded the wetlands trigger value on all sampling occasions at sites 7 and 12, and the highest concentrations by far were recorded at site 7 (3.3 mg/L, 2.4 mg/L and 1.1mg/L in October, September and August respectively). 17 samples recorded a concentration below the limit of reporting (0.005 mg/L).

Table 6.2-1 shows the TP and SRP concentrations throughout the eleven-year sampling period. TP and SRP concentrations throughout the eleven-year sampling period in at drain sites have generally been below the lowland rivers trigger value. Although concentrations often exceed at site 5 (John Creaney Park) which may cause local problems in the lake (particularly as high nitrogen is also often recorded here), phosphorus levels are usually low in the most downstream site along the Bull Creek main drain (PSDTBCMD).

TP and SRP concentrations at Booragoon Lake (site 7) and Blue Gum Lake (site 12) are consistently high and often highest in October or November, with the highest TP concentrations often occurring concurrently with the highest ammonia concentrations (**Table 6.2-1**). TP and SRP concentrations since 2012 have been somewhat lower at Booragoon Lake (with the exception of particularly high results recorded in September and October 2017) and somewhat higher at Blue Gum Lake since 2012 as compared to previous years.

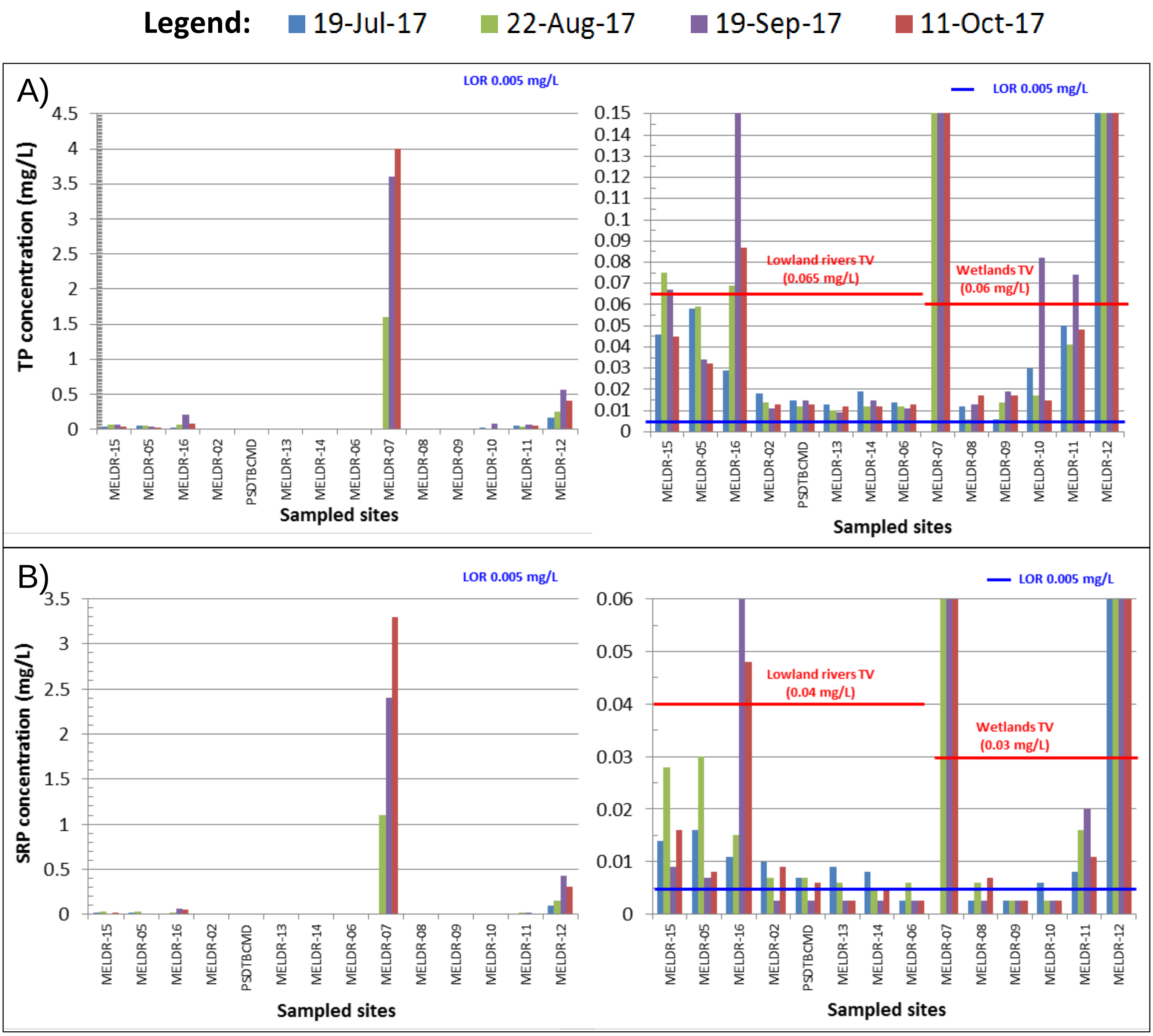

Figure 6.2-1: Graphs of A) Total phosphorus (TP) concentrations (mg/L); and B) soluble reactive phosphorus (SRP) concentrations (mg/L) in Melville Bull Creek catchment sites in 2017.

Table 6.2-1: Total phosphorus (TP) and soluble reactive phosphorus (SRP) concentrations (mg/L) in the Melville Bull Creek catchment from 2007-2017.

TP (mg/L) — Max 8.3 — Min <0.005 — LOR 0.005 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11
LOWLAND RIVERS (ANZECC trigger value 0.065 mg/L)																				
MELDR-15																				
MELDR-05	0.14	0.025			0.041	0.086	0.12		0.059	0.049			0.095	0.059	0.17	0.16	0.048	0.078	0.13	0.12
MELDR-16																				
MELDR-02	0.01	0.009	0.008	0.014	0.01	0.01	0.008	0.014	0.015	0.013	0.013	0.072	0.028	0.01	0.011	0.017	0.007	0.012	0.016	0.016
PSDTBCMD	0.017	0.012	0.008	0.016	0.019	0.015	0.014	0.022	0.02	0.016	0.014	0.022	0.039	0.014	0.02	0.015	0.011	0.013	0.018	0.018
MELDR-13																				
MELDR-14																				
MELDR-06	0.013	0.008	0.027	0.016	0.012	0.023	0.008	0.013	0.013	0.01	0.01	0.012	0.03	0.012	0.016	0.021	0.013	0.014	0.018	0.013
Site — WETLANDS (ANZECC trigger value 0.06 mg/L)																				
MELDR-07	0.12	3.2			1.3	2.6	8.3		0.66	3.2			1	1.5	0.95	3.9		0.81	1.2	2.9
MELDR-08	0.077	0.11			0.15	0.024			0.021										0.029	0.031
MELDR-09	0.02	0.018			0.014	0.014	0.017	0.02	0.012	0.012	0.013		0.012	0.015	0.02	0.028	0.025	0.03	0.025	0.017
MELDR-10	0.03	0.018			0.026	0.035	0.059	0.1	0.016	0.041	0.062		0.025	0.022	0.042	0.045	0.024	0.025	0.024	0.025
MELDR-11	0.036	0.032			0.03	0.039	0.042	0.077	0.033	0.038	0.11	0.16	0.042	0.034	0.049	0.089	0.039	0.033	0.044	0.027
MELDR-12	0.18	0.31			0.28	0.19	0.19		0.12	0.089	0.21		0.12	0.076	0.073	0.14	0.008	0.017	0.26	1.1

Site	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
LOWLAND RIVERS (ANZECC trigger value 0.065 mg/L)																								
MELDR-15										0.048	0.044	0.014	0.047	0.041	0.025	0.027	0.015	0.028	0.015	0.035	0.046	0.075	0.067	0.045
MELDR-05	0.1	0.032	0.052	0.064	0.073	0.071	0.042	0.034	0.083	0.052	0.05	0.088	0.043	0.051	0.076	0.069	0.098	0.036	0.022	0.035	0.058	0.059	0.034	0.032
MELDR-16										0.059	0.043	0.037	0.042	0.051	0.063	0.12	0.057	0.02	0.016		0.029	0.069	0.21	0.087
MELDR-02	<0.005	<0.005	<0.005	<0.005	0.023	0.018	0.03	0.012	0.051	0.019	0.019	0.011	0.006	0.008	<0.005	0.006	0.006	0.007	0.01	0.018	0.018	0.014	0.011	0.013
PSDTBCMD	0.013	0.006	0.012	0.011	0.029	0.016	0.034	0.017	0.024	0.02	0.014	0.012	0.011	0.008	0.008	0.008	0.009	0.01	0.012	0.009	0.015	0.012	0.015	0.013
MELDR-13							0.016	0.005	0.026	0.011	0.013	<0.005	0.011	0.008	0.005	0.008	0.009	0.006	0.007	0.008	0.013	0.01	0.009	0.012
MELDR-14							0.009	0.017	0.013	0.014	0.012	0.011	0.014	0.012	0.016	0.02	0.011	0.012	0.01	0.009	0.019	0.012	0.015	0.012
MELDR-06	<0.005	0.012	0.008	0.006	0.014	0.011	0.01	0.007	0.019	0.008	0.011	<0.005	0.016	0.006	0.006	0.009	0.01	0.009	0.011	0.01	0.014	0.012	0.011	0.013
Site — WETLANDS (ANZECC trigger value 0.06 mg/L)																								
MELDR-07			0.45	0.081		0.21	0.91	1.5	0.33	1.1	0.77	2.3	0.02	0.025	0.73	0.64	0.22	0.12	0.11	1.2		1.6	3.6	4
MELDR-08		0.034	0.034	0.025	0.12	0.069	0.013	0.016	0.016	0.014	0.015	0.01	0.01	0.008	0.01	0.017	0.019	0.013	0.015	0.015	0.012	0.006	0.013	0.017
MELDR-09	<0.005	<0.005	<0.005	<0.005	0.005	0.007	0.013	0.016	0.007	0.013	0.021	0.017	0.009	0.013	0.009	0.012	0.008	<0.005	0.01	0.009	0.006	0.014	0.019	0.017
MELDR-10	0.031	0.028	0.023	0.039	0.027	0.022	0.017	0.025	0.054	0.024	0.023	0.02	0.022	0.023	0.031	0.031	0.025	0.025	0.021	0.043	0.03	0.017	0.082	0.015
MELDR-11	0.035	0.03	0.027	0.029	0.066	0.025	0.024	0.033	0.039	0.04	0.04	0.03	0.027	0.025	0.048	0.094	0.026	0.019	0.021	0.054	0.05	0.041	0.074	0.048
MELDR-12	0.15	0.65	0.73	0.54	0.036	0.36	0.67	0.55	0.59	0.72	0.51	0.85	0.44	0.58	0.3	0.7	0.14	0.077	0.48	0.91	0.17	0.25	0.56	0.41

SITES RECORDING TP CONCENTRATIONS ALWAYS/GENERALLY ABOVE ANZECC TRIGGER VALUE
SITES RECORDING 40-60% of TP concentrations ABOVE ACCEPTABLE RANGE
SITES RECORDING TP CONCENTRATIONS ALWAYS/GENERALLY BELOW ANZECC TRIGGER VALUE
Concentration ABOVE trigger value
Concentration BELOW trigger value
Concentration < LOR
NO sample taken

SRP (mg/L) — Max 1.7 — Min <0.005 — LOR 0.005 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11
LOWLAND RIVERS (ANZECC trigger value 0.04 mg/L)																				
MELDR-15																				
MELDR-05	0.017	<0.005			<0.005	<0.005	<0.005		<0.005	<0.005			0.021	<0.005	<0.005	0.066	0.006	0.015	<0.005	0.01
MELDR-16																				
MELDR-02	0.009	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.012	<0.005	<0.005	0.008	<0.005	<0.005	<0.005	<0.005
PSDTBCMD	0.009	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	0.009	<0.005	0.009	<0.005	0.008	<0.005	<0.005	0.009	<0.005	<0.005	<0.005	0.005
MELDR-13																				
MELDR-14																				
MELDR-06	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	0.009	<0.005	<0.005	<0.005	<0.005
Site — WETLANDS (ANZECC trigger value 0.03 mg/L)																				
MELDR-07	0.015	0.048			0.13	1	1.2		<0.005	0.67			0.056	0.46	0.21	0.083		0.059	0.27	1.6
MELDR-08	0.008	<0.005			<0.005	<0.005			<0.005										<0.005	0.01
MELDR-09	0.007	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	0.006	<0.005	0.01	<0.005	<0.005	<0.005	0.014
MELDR-10	0.01	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	0.014
MELDR-11	0.007	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	<0.005	<0.005	0.01	0.009	0.005	<0.005	0.016
MELDR-12	0.008	0.16			0.18	0.078	0.048		0.064	0.021	0.022		0.042	0.033	0.018	0.081	<0.005	<0.005	0.077	0.73

Site	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
LOWLAND RIVERS (ANZECC trigger value 0.04 mg/L)																								
MELDR-15										0.011	0.016	0.012	0.011	0.013	<0.005	0.006	0.011	0.006	<0.005	0.011	0.014	0.028	0.009	0.016
MELDR-05	0.081	0.01	<0.005	<0.005	0.026	0.03	<0.005	<0.005	0.032	0.005	0.016	<0.005	0.019	0.009	<0.005	0.005	0.061	0.015	0.006	<0.005	0.016	0.03	0.007	0.008
MELDR-16										0.018	0.018	0.008	0.008	0.013	0.014	0.019	0.01	<0.005	<0.005		0.011	0.015	0.061	0.048
MELDR-02	<0.005	<0.005	<0.005	<0.005	0.01	0.007	0.014	<0.005	0.019	<0.005	0.006	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.01	0.007	<0.005	0.009
PSDTBCMD	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.006	<0.005	<0.005	<0.005	0.006	0.01	<0.005	<0.005	<0.005	0.007	0.007	<0.005	0.006
MELDR-13							<0.005	<0.005	<0.005	<0.005	<0.005	<0.007	<0.005	<0.005	<0.005	0.007	0.006	<0.005	<0.005	0.005	0.009	0.006	<0.005	<0.005
MELDR-14							<0.005	<0.005	<0.005	<0.005	<0.005	<0.008	0.005	<0.005	<0.005	0.008	0.006	<0.005	<0.005	<0.005	0.008	0.005	<0.005	0.005
MELDR-06	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.009	0.005	<0.005	<0.005	0.008	0.007	<0.005	<0.005	0.006	<0.005	0.006	<0.005	<0.005
Site — WETLANDS (ANZECC trigger value 0.03 mg/L)																								
MELDR-07			0.043	0.022		0.011	0.37	1.1	0.13	0.87	0.23	1.7	0.008	0.009	0.53	0.3	0.018	0.006	0.005	0.61		1.1	2.4	3.3
MELDR-08		0.007	0.008	<0.005	0.047	0.015	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	0.007	<0.005	<0.005	0.006	<0.005	0.006	<0.005	0.007
MELDR-09	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
MELDR-10	0.008	0.006	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005
MELDR-11	<0.005	<0.005	<0.005	<0.005	0.024	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.039	0.005	<0.005	<0.005	0.015	0.008	0.016	0.02	0.011
MELDR-12	<0.005	<0.005	<0.005	0.09	<0.005	0.073	0.3	0.12	0.22	0.45	0.17	0.23	0.32	0.4	0.025	0.56	0.006	<0.005	0.16	0.62	0.1	0.15	0.43	0.31

Concentration ABOVE trigger value
Concentration BELOW trigger value
Concentration < LOR
NO sample taken
SITES RECORDING SRP CONCENTRATIONS ALWAYS/GENERALLY ABOVE ANZECC TRIGGER VALUE
SITES RECORDING SRP CONCENTRATIONS ALWAYS/GENERALLY BELOW ANZECC TRIGGER VALUE

7. Metals and Hardness

Refer to **Tables D-14 to D-28 in Appendix D** for all metal and hardness concentration data collected in the Melville Bull Creek catchments for the 2017 water quality sampling program. **Table F-1, Appendix F** outlines potential sources of metals and hardness and the impacts of these parameters on aquatic ecosystems.

Total metal concentrations for aluminium, chromium, copper, iron, lead and zinc were tested for at all sites during the first sampling event (and at the second sampling event at site 7) for surveillance purposes. Soluble metal concentrations for aluminium, iron, chromium, copper, lead and zinc, as well as hardness concentrations, were tested at all sites on all sampling occasions. Total and soluble mercury was also tested at sites 6, 13 and 14 on all four sampling occasions.

For all graphs, a value equal to half the limit of reporting was substituted for those occasions where concentrations were recorded as 'below the laboratory limit of reporting' (<LOR) to allow these 'unknown' values to be represented graphically and to differentiate them from those samples that recorded concentrations equal to the limit of reporting.

7.1 Aluminium

Concentrations of **total aluminium** were high across the catchment, with 12 out of 14 sites recording exceedances the ANZECC trigger value for 95% level of protection of 0.055 mg/L (and therefore for samples with pH <6.5, the low reliability interim value for freshwater protection of 0.008 mg/L) (**Figure 7.1-1** and **Table D-14, Appendix D**). Similarly, 47 of 55 samples recorded **soluble aluminium** concentrations exceeding the ANZECC trigger value for 95% level of protection (and therefore for samples with pH <6.5, the low reliability interim value for freshwater protection of 0.008 mg/L) (**Figure 7.1-2** and **Table D-15, Appendix D**). The highest total aluminium concentration (0.55 mg/L) was recorded at site 13 (Brentwood drain) and the highest soluble aluminium concentration of 1 mg/L was recorded at site 9 (Quenda Lake Outlet) in August. The lowest concentrations of both total (0.029 mg/L) and soluble aluminium (0.015 mg/L) were recorded at site 10 (Frederick Baldwin) in July.

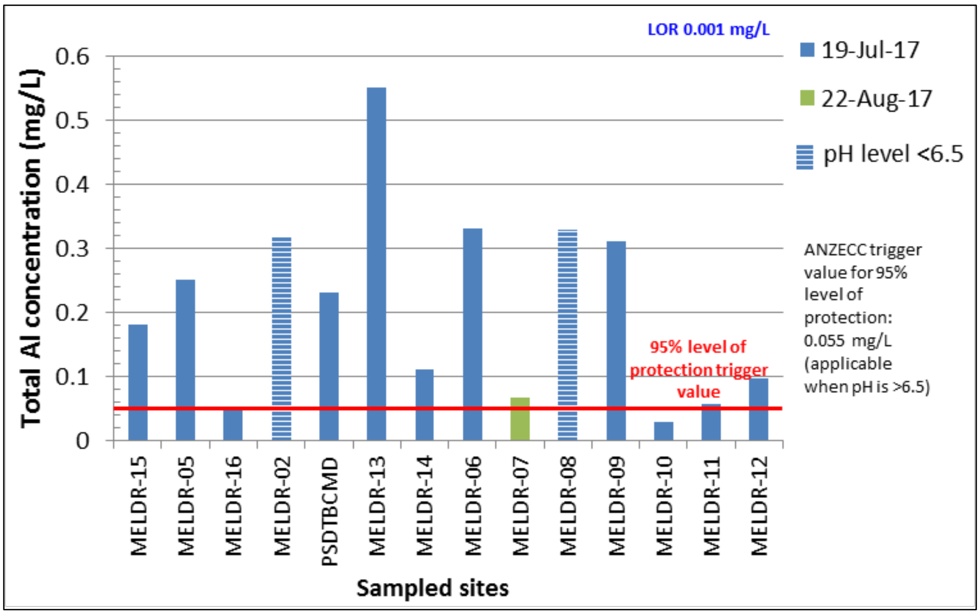

Figure 7.1-1: Total aluminium concentrations (mg/L) in the surface water of the Melville Bull Creek catchments in 2017

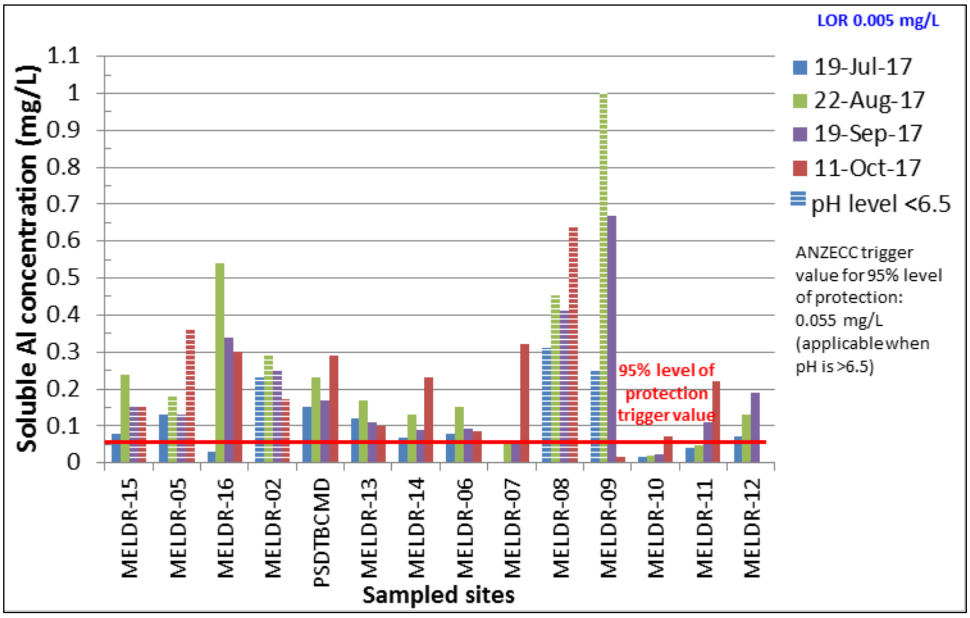

Figure 7.1-2: Soluble aluminium concentrations (mg/L) in the surface water of the Melville Bull Creek catchments in 2017

Table 7-1 shows total and soluble aluminium concentrations in the surface water of the Melville Bull Creek catchments recorded since this monitoring program began. Concentrations of both total and soluble aluminium exceeding the trigger values for protection of biota have generally been recorded at all sites except 10 (Frederick Baldwin) and 11 (Marmion Reserve). Total aluminium concentrations throughout the 11 year sampling period have generally been higher at site 2 (Brockman Park) than site 5 (John Creaney Park), which appears to be due to high inputs from the drainage branch containing site 16 (downstream Elizabeth Manion Park). Concentrations are then somewhat lower at the most downstream Bull Creek main drain site (PSDTBCMD). In the Brentwood drain, total aluminium concentrations coming from the Brentwood drain site before the living stream (site 13) are generally greater than those coming from the Mandala Crescent branch/RAAF drain (site 14), with concentrations at Bateman Park (site 6) similar to those from before the living stream.

7.2 Chromium

Total chromium and **soluble chromium** (which both include Cr^{3+} and Cr^{6+} chromium fractions) concentrations were below hardness adjusted trigger values (unmodified trigger value for chromium: 0.0033 mg/L) at all sites in 2017 (**Figure 7.2-1**, **Figure 7.2-2**, **Table D-16, Appendix D** and **Table D-17, Appendix D**). The highest total chromium concentration of 0.0019 mg/L was recorded at site 12 (Blue Gum Lake) and the highest soluble chromium concentration of 0.0038 mg/L was recorded at site 16 (Elizabeth Manion Park) in September. The lowest total chromium concentration of 0.0001 mg/L was recorded at sites 10 and 11, and two samples from site 10 recorded a soluble chromium concentration below the limit of reporting (0.0001 mg/L). No total or soluble chromium concentration exceeded recreational the guideline value for health (0.5 mg/L).

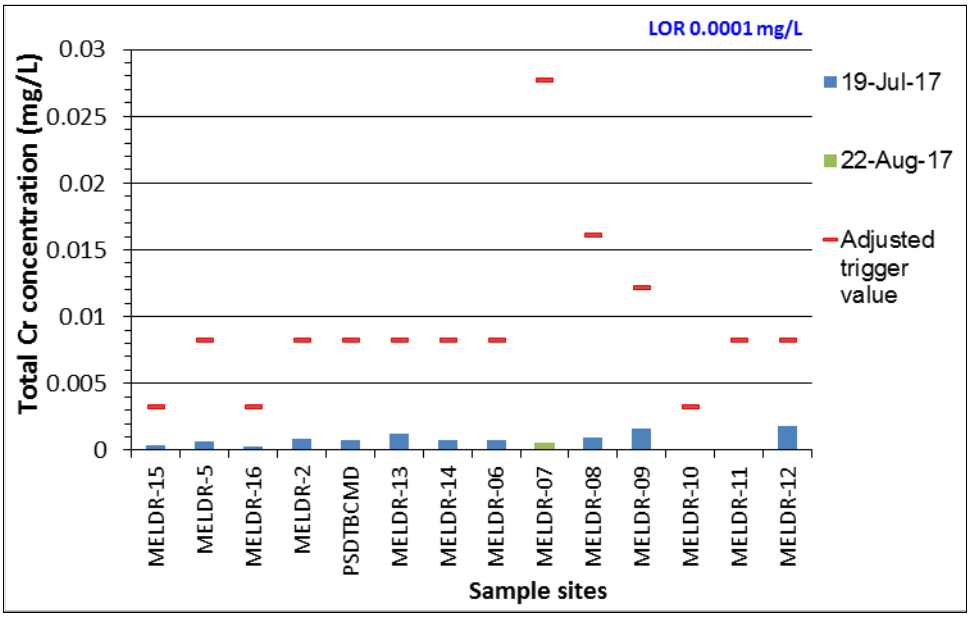

Figure 7.2-1: Total chromium concentrations (mg/L) in the surface waters of the Melville Bull Creek catchments in 2017

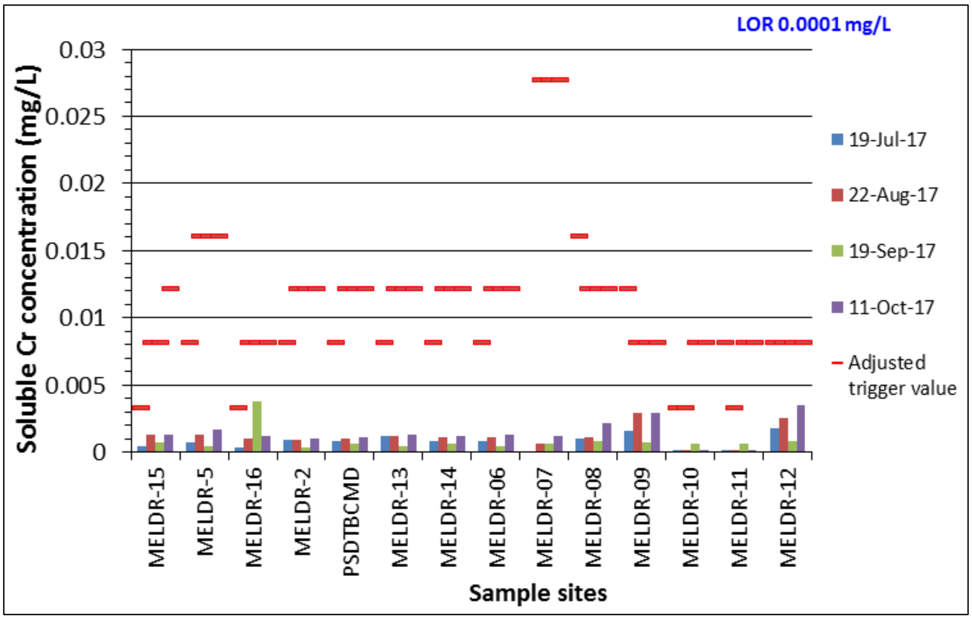

Figure 7.2-2: Soluble chromium concentrations (mg/L) in the surface water of the Melville Bull Creek catchments in 2017

Soluble chromium concentration have always been below adjusted ANZECC trigger values since sampling of this parameter began in 2009, and total chromium concentrations have only exceeded adjusted ANZECC trigger values in 2007 at Bateman Park (site 6) and Blue Gum Lake (site 12) and in 2008 at Bateman Park and Bull Creek main drain (PSDTBCMD) (**Table 7-1**).

7.3 Copper

Concentrations of **total copper** were variable across the catchment, with four out of 14 sites recording exceedances of hardness adjusted ANZECC trigger values for 95% level of protection (unmodified trigger value: 0.0014 mg/L) (**Figure 7.3-1** and **Table D-18, Appendix D**). Six of 55 samples recorded **soluble copper** concentrations exceeding the hardness adjusted ANZECC trigger values (**Figure 7.3-2** and **Table D-19, Appendix D**).The highest total copper concentration (0.0044 mg/L) was recorded at site 15 (John Creaney Park inlet) and the highest soluble copper concentration of 0.005 mg/L was recorded at site 16 (Elizabeth Manion Park) in August. The lowest concentration of total copper (0.0004 mg/L) was recorded at site 9 (Quebnda Lake outlet) and the lowest concentration of soluble copper (0.0002 mg/L) was recorded at site 13 (Brentwood drain) in October. No total or soluble copper concentration exceeded the recreational guidelines for aesthetic value (10 mg/L) or health value (20 mg/L).

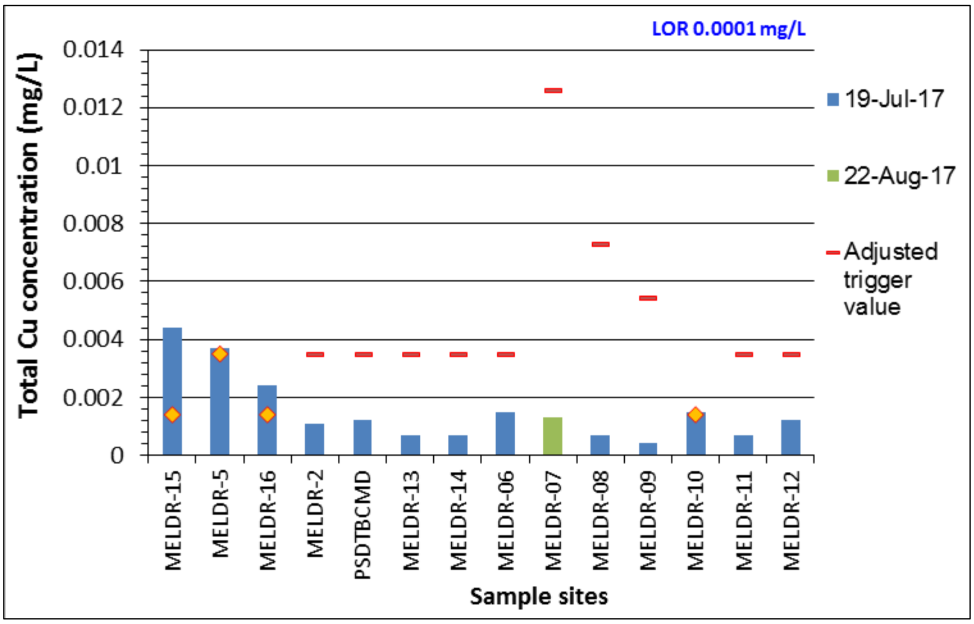

Figure 7.3-1: Total copper concentrations (mg/L) in the surface water of the Melville Bull Creek catchments in 2017

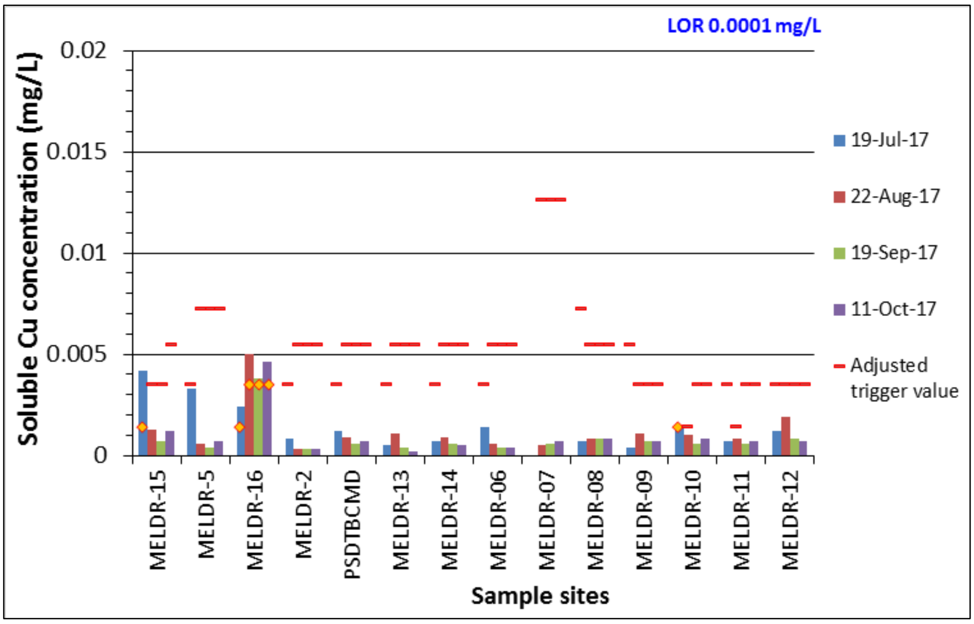

Figure 7.3-2: Soluble copper concentrations (mg/L) in the surface water of the Melville Bull Creek catchments in 2017

The often relatively high total copper concentrations recorded during the eleven year monitoring period in the two upstream branches of at Bull Creek main drain at sites 16 (downstream Elizabeth Manion Park) and 15 and 5 (John Creaney Park inlet and John Creaney Park) do not appear to be resulting in high concentrations at downstream sites 2 (Brockman Park) and PSDTBCMD (Bull Creek main drain) (**Table 7-1**). Although copper concentrations at site 10 (Frederick Baldwin) are similar to those recorded at other wetland sites, this site has recorded the greatest number of exceedances of total and soluble copper of any site, which is partially a consequence of the relatively soft water found at the site, Soluble and total copper exceedances have only been recorded sporadically at other sites over the eleven year sampling period.

7.4 Iron

Nine out of 14 sites recorded **total iron** concentrations exceeding the interim guideline value for iron (0.3 mg/L) (**Figure 7.4-1** and **Table D-20, Appendix D)** and 44 of 55 samples from all sites recorded **soluble iron** concentrations exceeding the interim guideline value for iron (**Figure 7.4-2** and **Table D-21, Appendix D**). The highest total iron (6.8 mg/L) and soluble iron (6 mg/L) concentrations were recorded at site 7 (Booragoon Lake) in August. The lowest total iron (0.053 mg/L) and soluble iron (0.039 mg/L) concentrations were recorded at site 16 (downstream Elizabeth Manion Park) in July. One total iron concentrations and six soluble iron concentrations also exceeded the recreational guideline for aesthetic value (3 mg/L).

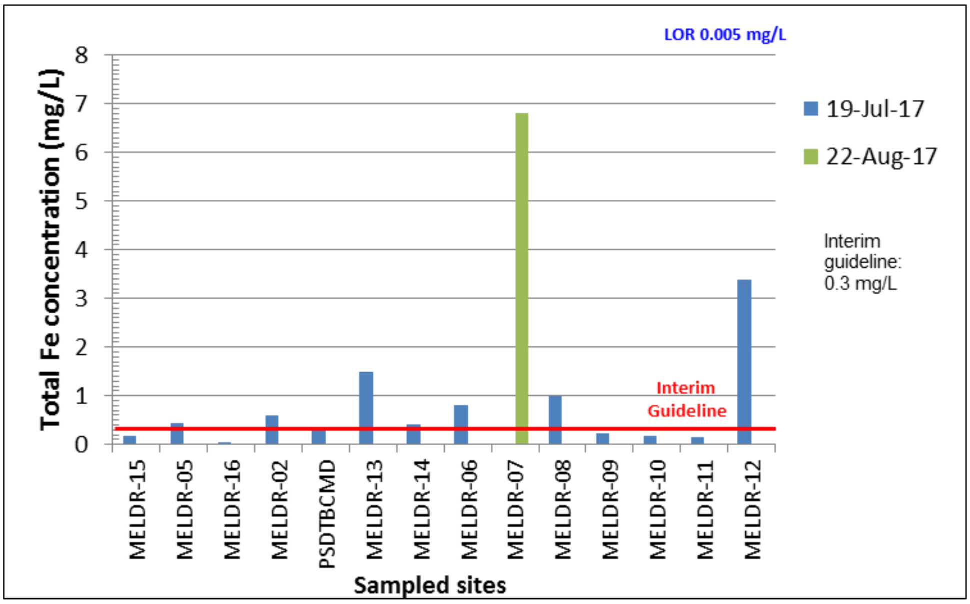

Figure 7.4-1: Total iron concentrations (mg/L) in the surface water of the Melville Bull Creek catchments in July 2017

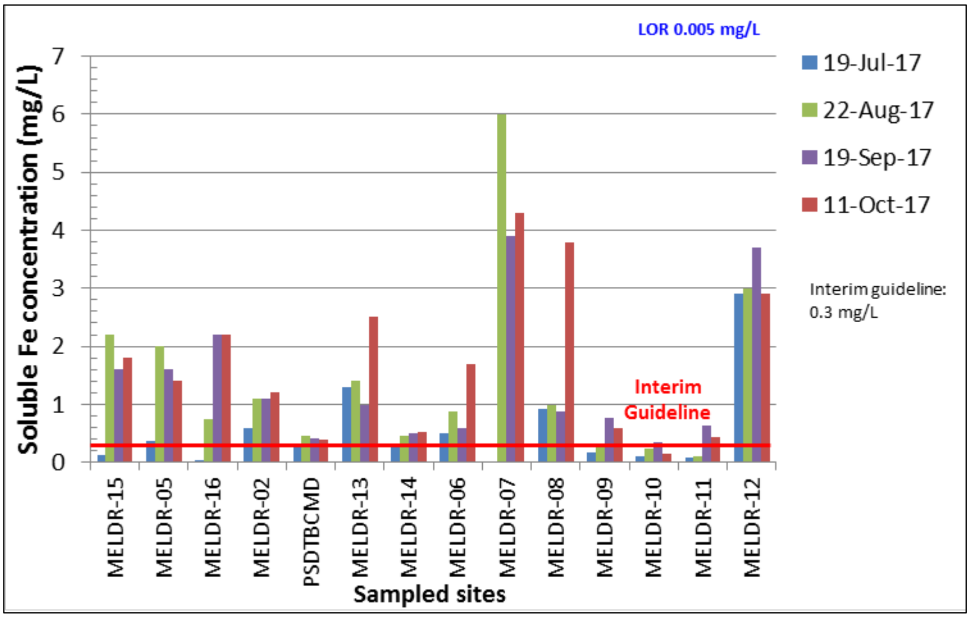

Figure 7.4-2: Soluble iron concentrations (mg/L) in the surface water of the Melville Bull Creek catchments in 2017

Table 7-1 shows that soluble iron concentrations recorded at Melville Bull Creek catchment sites have generally exceeded the interim guideline at most sites several except sites 10 and 11 since 2009. Total iron has also generally exceeded the interim guideline at all sites since 2007 except site 9 (Quenda Lake Outlet); however in recent years exceedances have been more common at this site.

Total iron concentrations appear to be variable but similarly high in the two upstream branches of the Bull Creek main drain at site 16 (downstream Elizabeth Manion Park) and 15 (John Creaney Park inlet), but lower at Brockman Park (site 2) and lower again at the most downstream Bull Creek main drain site (PSDTBCMD). The upstream portion of the Brentwood drain (site 13) appears to be contributing more iron than the Mandala Crescent Branch /RAAF drain (site 14) to the Brentwood drain outfall at Bateman Park (site 6). However total iron concentrations have been declining at site 6 over the eleven years of monitoring.

7.5 Lead

All samples recorded **total lead** and **soluble lead** concentrations below adjusted trigger values for lead (unadjusted trigger value:0.0034 mg/L) (**Figure 7.5-1** and **Table D-22, Appendix D** and **Figure 7.5-2** and **Table D-23, Appendix D**). The highest total (0.0073 mg/L) and soluble (0.0067 mg/L) lead concentrations were recorded at site 12 (Blue Gum Lake) in July. Concentrations below the limit of reporting (0.0001 mg/L) were recorded in one sample (site 11) for total lead and in five samples for soluble lead. All recorded total and soluble lead concentrations were below the recreational guideline for health value (0.1 mg/L).

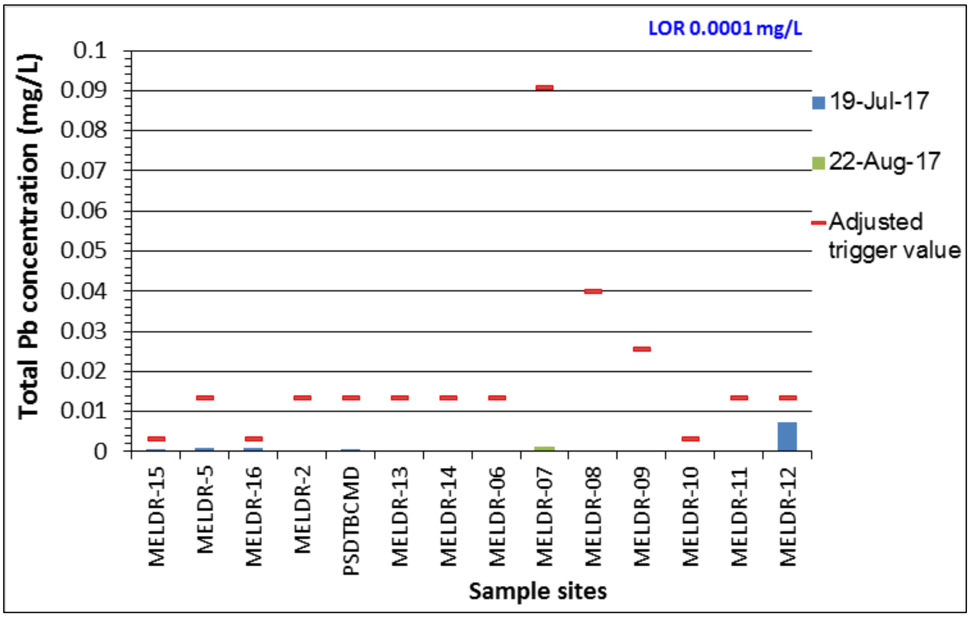

Figure 7.5-1: Total lead (Pb) concentrations (mg/L) in the surface water of the Melville Bull Creek catchment in 2017

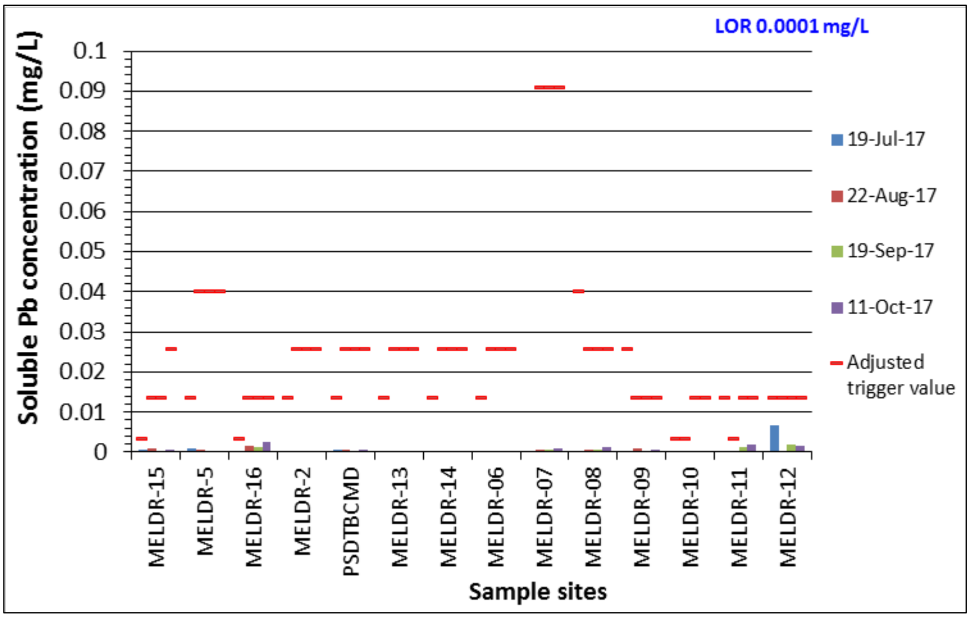

Figure 7.5-2: Soluble lead concentrations (mg/L) in the surface water of the Melville Bull Creek catchment in 2017

Concentrations of total lead exceeding the hardness modified trigger values have sporadically been recorded at sites 5, 10, 11 and 12 (John Creaney Park, Frederick Baldwin, Marmion Reserve and Blue Gum Lake outlet respectively) throughout the eleven year sampling period, and concentrations of soluble lead have only been recorded on three sampling events, at site 12 (Blue Gum Lake outlet) in July 2011 and July 2016 and at site 10 (Frederick Baldwin) in September 2012 (**Table 7-1**). The concentration recorded at site 12 in 2016 (0.095 mg/L) is the highest recorded over the ten years of monitoring.

7.6 Mercury

Total mercury and **soluble mercury** concentrations below the trigger values for protection of biota (0.0006 mg/L) and the recreational health value (0.01 mg/L) were recorded at all sites where these parameters were analysed: 13, 14 and 6 (Brentwood drain, RAAF drain and Bateman Park) (**Figure 7.6-1** and **Table D-24, Appendix D** and **Figure 7.6-2** and **Table D-25, Appendix D**). In July, sites 13 and 14 recorded concentrations of total and soluble mercury of 0.0002 mg/L, whereas concentrations of total and soluble mercury were below the limit of reporting (0.0001 mg/L) in all other samples.

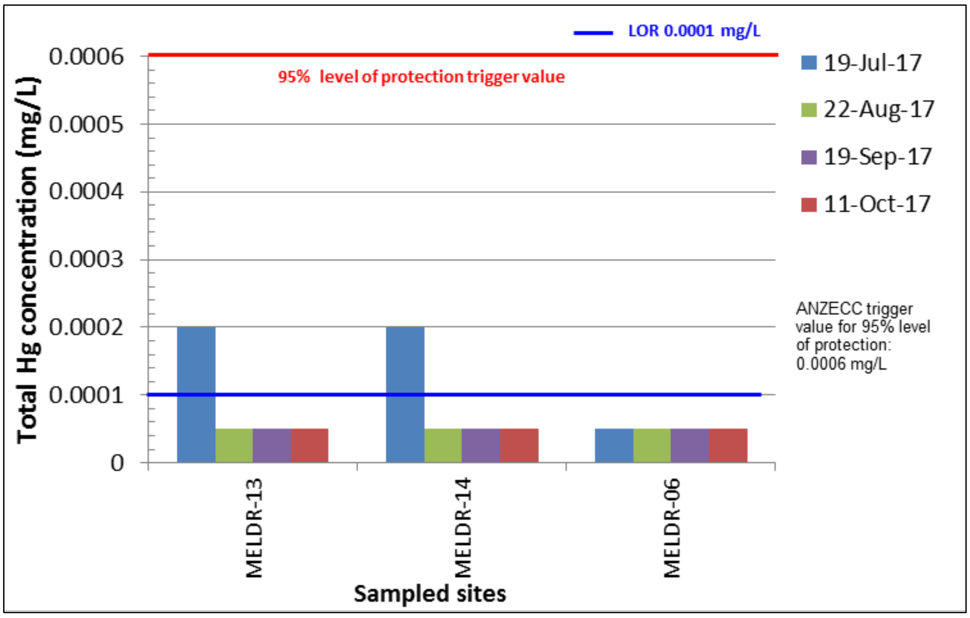

Figure 7.6-1: Total mercury (Hg) concentrations (mg/L) at sites 13, 14 and 6 in 2017

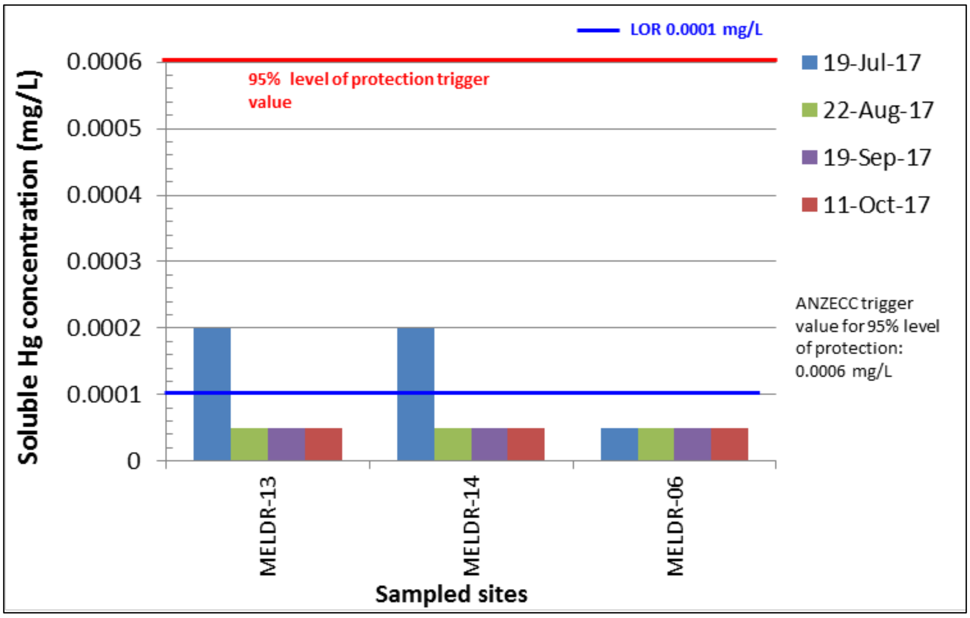

Figure 7.6-2: Soluble mercury (Hg) concentrations (mg/L) at sites 13, 14 and 6 in 2017

Total and soluble mercury concentrations recorded in sites 15, 16, 13, 14 and 6 (John Creaney Park inlet, downstream Elizabeth Manion Park, Brentwood drain, RAAF drain and Bateman Park) have always been below the trigger value for protection of biota on all occasions at which samples have been taken (**Table 7-1**).

7.7 Zinc

Concentrations of **total zinc** were variable across the catchment, with four out of 14 sites recording exceedances of hardness adjusted ANZECC trigger values for 95% level of protection (unmodified trigger value: 0.008 mg/L) (**Figure 7.3-1** and **Table D-26 Appendix D**). 12 of 55 samples recorded **soluble copper** concentrations exceeding the hardness adjusted ANZECC trigger values (**Figure 7.3-2** and **Table D-27, Appendix D**).The highest total zinc (0.14 mg/L) and soluble zinc (0.097 mg/L) concentrations were recorded at site 15 (John Creaney Park inlet) in July. The lowest concentrations of both total (less than the limit of reporting of 0.005 mg/L) and soluble (0.001 mg/L) zinc were recorded at site 11 (Marmion reserve) in July. No total or soluble copper concentration exceeded the recreational guidelines for aesthetic value (30 mg/L).

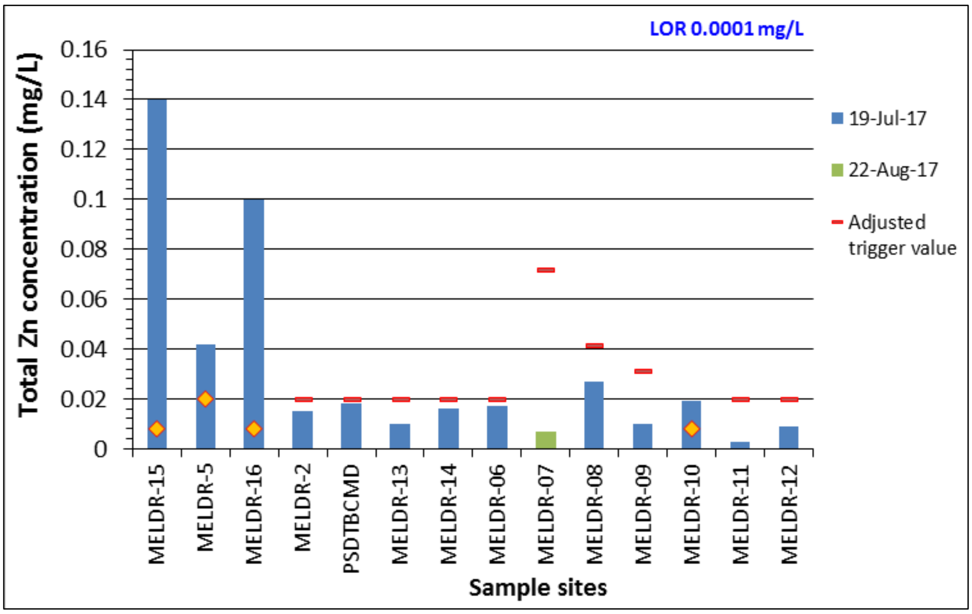

Figure 7.7-1: Total zinc (Zn) concentrations (mg/L) in the surface water of the Melville Bull Creek catchment in August 2017

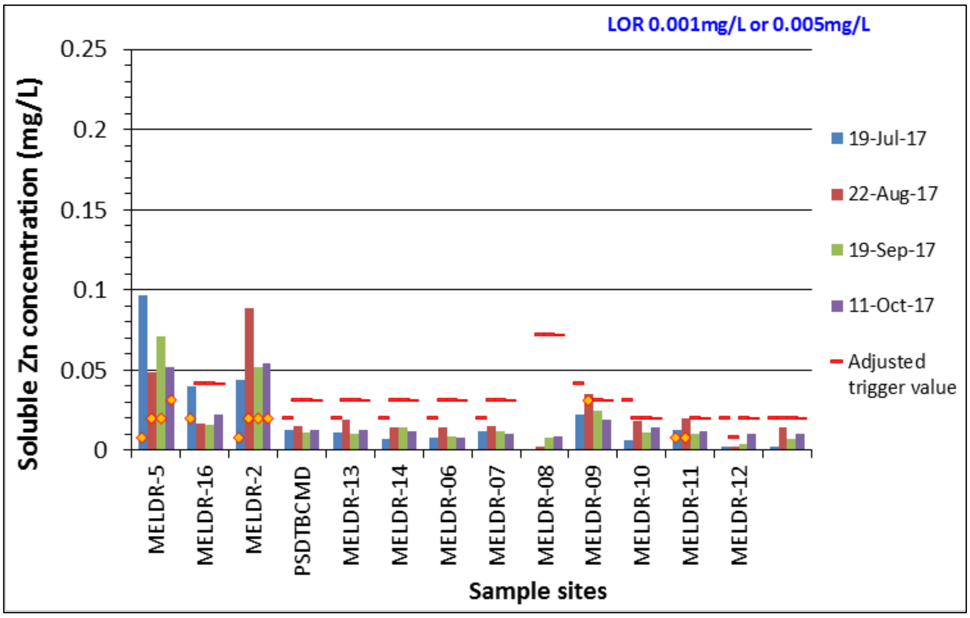

Figure 7.7-2: Soluble zinc concentrations (mg/L) in the surface water of the Melville Bull Creek catchment in 2017

At sites 15 (John Creaney Park inlet) and 16 (downstream Elizabeth Manion Park) on the upstream branches of the Bull Creek main drain, recorded concentrations of total zinc have regularly exceeded hardness modified trigger values since the introduction of these sites in 2014, and soluble zinc concentrations exceeded modified trigger values on every sampling occasion in 2017 (**Table 7-1**). Despite this, concentrations have not often exceeded further downstream at sites 2 (Brockman Park) and the most downstream site on the drain (PSDTBCMD). Site 10 (Frederick Baldwin) has regularly and site 8 (Piney Lakes outlet) has often recorded exceedances of soluble zinc since this parameter was first monitored at these sites from 2011 and 2015 respectively. All sites have recorded total and soluble zinc concentrations greater than hardness modified trigger values on at least one sampling occasion.

7.8 Hardness

Total hardness, expressed as calcium carbonate ($CaCO_3$), is the combined concentration of earth-alkali metals, predominantly magnesium (Mg^{2+}) and calcium (Ca^{2+}), and some strontium (Sr^{2+}) in the water. Other metal ions (such as aluminium, iron, zinc and manganese) also contribute to water hardness. The source of this hardness is limestone dissolved by water that is rich in carbon dioxide. Increasing calcium and magnesium in water (hardness) is frequently associated with increases in alkalinity (as calcium and/or magnesium carbonate), and thus, pH (ANZECC and ARMCANZ 2000).

The ANZECC guidelines (ANZECC and ARMCANZ 2000) classified the water hardness into five categories: soft (<59 mg/L), moderate (60 to 119 mg/L), hard (120 to 179 mg/L), very hard (180 to 240 mg/L) and extremely hard (>240 mg/L).

In 2017 water hardness in the surface water of the Melville Bull Creek catchments varied from a minimum of 24 mg/L recorded at site 16 (downstream Elizabeth Manion Park) in July to a maximum of 440 mg/L recorded at site 7 (Booragoon Lake) in August (**Figure 7.8-1** and **Table D-28:, Appendix D**). Five samples recorded soft water hardness (0 to 59 mg/L), 23 samples recorded moderate concentrations (60 to 119 mg/L), 20 samples recorded hard concentrations (120 to 179 mg/L), four samples recorded very hard concentrations (180 to 240 mg/L) and three samples recorded extremely hard concentrations (>240 mg/L).

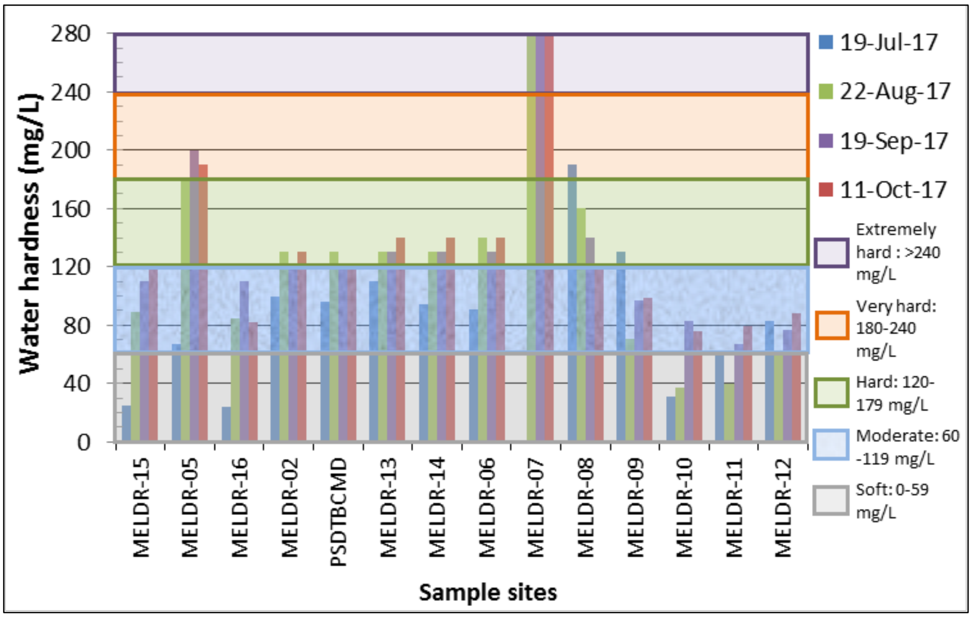

Figure 7.8-1: Water hardness concentrations (mg/L) in the Melville Bull Creek catchments in 2017

Table 7-1 shows the total water hardness concentrations in the surface of Melville Bull Creek catchments throughout the nine-year monitoring period. Most sites have usually recorded concentrations classified as moderate or hard and only sporadically recording concentrations classified as very hard or extremely hard; with the exception of site 5 (variable hardness, but generally becoming harder from winter to spring), site 7 (generally extremely hard) and site 10 (often soft).

Table 7-1: Records of metal (total and soluble aluminium (Al), total and soluble chromium (Cr), total and soluble copper (Cu), total and soluble iron (Fe), total and soluble lead (Pb), total and soluble zinc (Zn)) and hardness concentrations (mg/L) in the Melville Bull Creek catchments 2007 – 2017

Total Al (mg/L) ANZECC trigger value: 0.055 mg/L (Note: ANZECC trigger value applicable when pH>6.5) Max 3.9 Min 0.01 LOR 0.005 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17
MELDR-15																														0.047	0.31	0.21	0.53	0.48	0.23	0.6	0.42	0.19	0.22	0.21	0.18	
MELDR-05	0.065	0.24			0.18	0.13	0.084		0.22	0.095			0.19	0.14	0.12	0.14	0.14	0.31	0.38	0.21	0.16	0.16	0.15	0.1	0.23	0.23	0.18	0.16	0.21	0.2	0.22	0.14	0.22				0.16				0.25	
MELDR-16																														0.11	0.75	0.34	0.94	0.33	0.14	0.49	0.51	0.14	0.27		0.053	
MELDR-02	0.31	0.39	0.32	0.31	0.32	0.9	0.3	0.3	0.34	0.31	0.36	2.1	0.3	0.31	0.37	0.35	0.36	0.36	0.34	0.39	0.37	0.31	0.28	0.3	0.31	0.36	0.26	0.3	0.15	0.29	0.34	0.27	0.3				0.29				0.32	
PSDTBCMD	0.21	0.3	3.2	0.16	0.29	0.17	0.2	0.22	0.29	0.17	0.19	0.21	0.3	0.19	0.23	0.17	0.2	0.19	0.23	0.22	0.22	0.22	0.24	0.21	0.33	0.25	0.24	0.24	0.26	0.26	0.24	0.21	0.22				0.2				0.23	
MELDR-13																											1.1	0.76	0.43	0.83	0.79	0.48	0.48				0.54				0.55	
MELDR-14																											0.13	0.22	0.13	0.18	0.13	0.08	0.12				0.11				0.11	
MELDR-06	3.6	3.2	0.3	2.6	2.2	1.5	1.4	1.3	1.2	1.1	0.97	0.87	0.58	0.76	0.85	0.73	0.66	0.89	0.96	0.71	0.77	0.64	0.6	0.54	0.94	0.77	0.9	0.69	0.49	0.77	0.62	0.42	0.71				0.42				0.33	
MELDR-07	3.9	0.058			0.05	0.066	0.16		0.072	0.05			0.022	0.03	0.028	0.21		0.17	0.029	0.037			0.55	0.24		0.37	0.033	0.039	0.14	0.064	0.041	0.07	0.67				1					0.067
MELDR-08	0.3	0.29			0.3	0.13			0.25										0.37	0.24		0.2	0.2	0.14	0.35	0.35	0.29	0.25	0.37	0.37	0.57	0.3	0.37				0.29				0.33	
MELDR-09	0.058	0.17			0.28	0.052	0.1	0.11	0.27	0.086	0.043		0.054	0.05	0.052	0.037	0.72	0.2	0.19	0.18	0.05	0.049	0.11	0.041	0.083	0.37	0.46	0.4	0.87	0.51	0.6	0.35	0.38				0.39				0.31	
MELDR-10	0.079	0.065			0.053	0.029	0.031	0.056	0.055	0.051	0.053		0.048	0.06	0.097	0.072	0.084	0.035	0.041	0.044	0.039	0.17	0.079	0.053	0.049	0.032	0.035	0.032	0.045	0.036	0.03	0.018	0.03				0.03				0.029	
MELDR-11	0.067	0.032			0.041	0.035	0.053	0.16	0.056	0.044	0.11	0.089	0.038	0.04	0.052	0.36	0.04	0.044	0.051	0.041	0.018	0.043	0.04	0.049	0.034	0.034	0.022	0.12	0.01	0.019	0.028	0.026	0.03				0.03				0.057	
MELDR-12	0.22	0.062			0.058	0.039	0.036		0.059	0.035	0.2		0.052	0.06	0.062	0.16	1.8	0.61	0.074	0.11	0.32	0.18	0.052	0.038	0.12	0.072	0.097	0.083	0.054	0.12	0.16	0.15	0.12				0.9				0.096	

SITES RECORDING Al CONC. ALWAYS/GENERALLY ABOVE TRIGGER VALUE
SITES RECORDING Al CONC. ALWAYS/GENERALLY BELOW TRIGGER VALUE
Concentration ABOVE trigger value & pH > 6.5
Concentration ABOVE trigger value & pH <6.5
Concentration BELOW trigger value & pH < 6.5 (i.e. potential risk)
Concentration BELOW trigger value and pH > 6.5
NO pH reading
NO sample taken

Soluble Al (mg/L) ANZECC trigger value: 0.055 mg/L (Note: ANZECC trigger value applicable when pH>6.5 Max 1.8 Min <0.005 LOR 0.005 mg/L

Site	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																																	0.077	0.24	0.15	0.19
MELDR-05									0.037	0.14	0.16	0.12	0.11	0.057	0.13		0.073	0.15	0.18	0.09	0.15	0.14	0.2	0.096	0.18	0.13	0.073	0.067	0.12	0.13	0.06	0.11	0.13	0.18	0.13	0.15
MELDR-16																																	0.03	0.54	0.34	0.36
MELDR-02																									0.3	0.23	0.25	0.22	0.24	0.24	0.25	0.21	0.23	0.29	0.25	0.3
PSDTBCMD	0.16	0.87	0.085	0.071	0.098	0.13	0.12	0.11	0.15	0.16	0.15	0.15	0.13	0.14	0.13	0.12	0.09	0.16	0.15	0.12	0.13	0.14	0.17	0.12	0.15	0.12	0.11	0.087	0.14	0.15	0.18	0.12	0.15	0.23	0.17	0.17
MELDR-13																			0.12	0.093	0.057	0.1	0.12	0.097	0.14	0.11	0.31	0.081	0.12	0.11	0.14	0.19	0.12	0.17	0.11	0.29
MELDR-14																			0.094	0.079	0.095	0.09	0.099	0.054	0.082	0.061	0.068	0.039	0.059	0.065	0.078	0.059	0.068	0.13	0.09	0.1
MELDR-06	0.091	0.083	0.22	0.16	0.098	0.2	0.19	0.15	0.13	0.16	0.17	0.093	0.071	0.084	0.096	0.12	0.09	0.086	0.084	0.087	0.056	0.097	0.11	0.088	0.15	0.095	0.26	0.066	0.1	0.089	0.11	0.077	0.078	0.15	0.093	0.23
MELDR-07										0.15	0.016	0.023			0.56	0.23		0.37	0.022	0.039	0.14	0.056	0.032	0.082	0.61	0.4	0.067	0.011	0.89	0.78	0.32	0.047		0.053	0.058	0.084
MELDR-08																									0.36	0.24	0.16	0.16	0.24	0.36	0.46	0.29	0.31	0.45	0.41	0.32
MELDR-09																									0.38	0.28	0.11	0.12	0.32	0.35	0.99	0.38	0.25	1	0.67	0.64
MELDR-10									0.033	0.018	0.026	0.026	0.021	0.042	0.057	0.022	0.014	0.012	0.017	0.014	0.045	0.022	0.022	0.011	0.019	0.019	0.054	0.029	0.013	0.021	0.029	0.016	0.015	0.021	0.023	0.017
MELDR-11									0.013	0.018	0.012	0.022	<0.005	0.0067	0.014	0.016	0.005	0.006	0.009	0.044	0.01	0.01	0.011	0.02	0.011	0.013	0.05	0.062	0.012	0.018	0.026	0.043	0.039	0.049	0.11	0.072
MELDR-12									1.8	0.62	0.044	0.077	0.31	0.16	0.023	0.019	0.1	0.041	0.082	0.057	0.054	0.11	0.11	0.089	0.072	0.065	0.006	0.05	0.86	0.15	0.12	0.14	0.071	0.13	0.19	0.22

SITES RECORDING Al CONC. ALWAYS/GENERALLY ABOVE TRIGGER VALUE
SITES RECORDING Al CONC. ALWAYS/GENERALLY BELOW TRIGGER VALUE
Concentration ABOVE trigger value & pH > 6.5
Concentration ABOVE trigger value & pH <6.5
Concentration BELOW trigger value & pH < 6.5 (i.e. potential risk)
Concentration BELOW trigger value and pH > 6.5
NO pH reading
NO sample taken

Total Chromium (Cr) (mg/L) LOR 0.001 mg/L

Unmodified trigger value Cr III for 95% Level of Protection 0.0033 mg/L Max 0.006 Min <0.001

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17
MELDR-15																														<0.001	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.001	<0.001	0.002	0.0004	
MELDR-05	<0.001	0.002			0.002	0.002	0.0018		0.002	0.001			<0.001	0.002	0.002	<0.001	<0.001	0.001	0.0022	0.001	<0.001	<0.001	0.0014	0.0014	0.002	0.001	0.001	0.001	<0.001	0.002	0.001	0.002	0.002				0.001				0.0008	
MELDR-16																														<0.001	0.001	0.001	0.003	0.001	<0.001	0.002	0.001	<0.001	<0.001		0.0003	
MELDR-02	<0.001	0.001	<0.001	<0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.002	<0.001	0.001	0.001	<0.001	<0.001	<0.001	0.0014	0.001	<0.001	0.0016	0.0011	0.0012	<0.001	0.001	0.001	0.001	<0.001	0.002	0.001	0.002	0.002				0.001				0.0009	
PSDTBCMD	<0.001	0.001	0.004	<0.001	0.001	0.001	0.002	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	0.0014	0.001	<0.001	0.0013	0.0013	0.0013	0.002	0.001	0.001	0.001	0.001	<0.001	0.001	0.001	0.002				<0.001				0.0008	
MELDR-13																											0.004	0.002	0.003	0.003	0.003	0.002	0.002				0.002				0.0016	
MELDR-14																											0.001	0.002	0.001	0.002	0.001	0.001	0.001				<0.001				0.0008	
MELDR-06	0.006	0.005	<0.001	0.003	0.004	0.003	0.003	0.003	0.003	0.002	0.002	0.002	<0.001	0.002	0.003	0.001	<0.001	0.002	0.0028	0.002	0.0015	0.0027	0.002	0.002	0.003	0.002	0.003	0.002	0.003	0.003	0.002	0.002	0.003				0.002				0.0011	
MELDR-07	0.001	0.001			<0.001	0.001	0.002		<0.001	<0.001			<0.001	<0.001	<0.001	0.002		<0.001	<0.001	<0.001			<0.001	<0.001		<0.001	0.001	0.002	<0.001	<0.001	0.001	0.002	0.002				0.002					0.0006
MELDR-08	<0.001	0.002			0.002	0.001			<0.001										<0.001	<0.001		0.0011	<0.001	<0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002				<0.001				0.0009	
MELDR-09	<0.001	<0.001			0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.0011	<0.001	<0.001	<0.001	0.001	0.002	0.002	0.003	0.004	0.003	0.003	0.003				0.001				0.0016	
MELDR-10	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001				<0.001				0.0001	
MELDR-11	<0.001	0.002			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001				<0.001				0.0001	
MELDR-12	0.001	0.003			0.002	0.002	0.001		0.002	<0.001	0.001		0.002	0.002	0.002	<0.001	<0.001	<0.001	0.0019	0.004	<0.001	0.0011	<0.001	<0.001	<0.001	0.004	0.006	0.005	0.003	0.004	0.004	0.004	0.003				0.001				0.0019	

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE
SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE
Concentration ABOVE ADJUSTED trigger value
Concentration BELOW ADJUSTED trigger value
Concentration < LOR
NO sample taken

Soluble Chromium (Cr) (mg/L) LOR 0.001 mg/L

Unmodified trigger value Cr III for 95% Level of Protection 0.0033 mg/L Max 0.007 Min <0.001

Site	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																																	0.0004	0.0013	0.0007	0.0013
MELDR-05									<0.001	<0.001	0.0014	0.001	<0.001	<0.001	0.0012	0.0011	<0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	0.0007	0.0013	0.0004	0.0017
MELDR-16																																	0.0003	0.001	0.0038	0.0012
MELDR-02																									0.001	0.001	<0.001	0.007	<0.001	0.001	<0.001	<0.001	0.0009	0.0009	0.0003	0.001
PSDTBCMD	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.001	<0.001	0.0013	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	0.0015	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.0008	0.001	0.0006	0.0011
MELDR-13																			0.001	0.001	0.001	<0.001	<0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	<0.001	0.001	0.0012	0.0012	0.0004	0.0013
MELDR-14																			0.001	0.001	0.001	0.002	<0.001	0.001	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.0008	0.0011	0.0006	0.0012
MELDR-06	<0.001	<0.001	0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.0011	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.002	0.001	0.001	<0.001	<0.001	<0.001	0.0008	0.0011	0.0004	0.0013
MELDR-07										<0.001	<0.001	<0.001			<0.001	<0.001		<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.002	0.002	<0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001		0.0006	0.0006	0.0012
MELDR-08																									0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	0.0011	0.0008	0.0021
MELDR-09																									0.002	0.002	0.001	0.004	0.001	0.002	0.002	0.002	0.0016	0.0029	0.0007	0.0029
MELDR-10									<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.0001	0.00005	0.0006	0.00005
MELDR-11									<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0001	0.0001	0.0006	0.0001
MELDR-12									<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.004	0.004	0.003	0.004	0.003	0.003	0.002	0.003	<0.001	0.002	0.001	<0.001	<0.001	0.003	0.0018	0.0025	0.0008	0.0035

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE
SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE
Concentration ABOVE ADJUSTED trigger value
Concentration BELOW ADJUSTED trigger value
Highest concentration of the year
Concentration < LOR
NO sample taken

Table 7 1 (continued): Records of metal (total and soluble aluminium (Al), total and soluble chromium (Cr), total and soluble copper (Cu), total and soluble iron (Fe), total and soluble lead (Pb), total and soluble zinc (Zn)) and hardness concentrations (mg/L) in the Melville Bull Creek catchments 2007 – 2017

Total Copper (Cu) (mg/L) LOR 0.001 mg/L

Unmodified ANZECC trigger value for 95% Level of Protection 0.0014 mg/L Max 0.025 Min <0.001

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17
MELDR-15																														<0.001	<0.001	0.002	0.007	0.005	0.001	0.003	0.005	0.003	0.002	<0.001	0.0044	
MELDR-05	0.003	<0.001			<0.001	0.001	0.002		0.003	<0.001			0.008	0.002	0.002	0.002	0.004	0.002	0.0015	0.002	0.0031	0.0035	<0.001	0.0028	0.004	0.002	<0.001	0.001	0.002	0.002	0.001	0.001	0.003				0.002				0.0037	
MELDR-16																														<0.001	0.001	0.003	0.007	0.003	0.004	0.013	0.005	0.003	0.003		0.0024	
MELDR-02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0018	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001				<0.001				0.0011	
PSDTBCMD	<0.001	0.002	<0.001	0.001	0.001	0.002	0.001	0.002	0.002	0.001	<0.001	<0.001	0.004	0.001	0.001	0.001	0.0015	0.001	0.0011	0.001	<0.001	0.0021	0.001	0.001	0.003	0.002	0.001	0.001	0.002	0.002	0.002	0.001	0.001				0.001				0.0012	
MELDR-13																											0.001	<0.001	0.005	<0.001	<0.001	<0.001	0.001				<0.001				0.0007	
MELDR-14																											0.001	0.001	0.001	0.001	0.001	<0.001	<0.001				0.001				0.0007	
MELDR-06	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001	0.0025	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.005	<0.001	<0.001	<0.001	0.001				<0.001				0.0015	
MELDR-07	0.006	0.001			0.002	0.002	<0.001		<0.001	<0.001			<0.001	<0.001	<0.001	0.003		<0.001	0.0027	0.001			0.0034	0.0014		0.003	<0.001	0.001	<0.001	0.0015	0.002	0.002	0.025				0.013					0.0013
MELDR-08	0.003	0.001			0.001	<0.001			<0.001										0.0018	0.002		0.0015	<0.001	<0.001	0.001	<0.001	0.002	<0.001	<0.001	0.002	0.002	0.001	0.002				0.001				0.0007	
MELDR-09	<0.001	<0.001			<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.0011	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.002	0.001	<0.001	0.001				0.001				0.0004	
MELDR-10	0.001	0.001			0.001	0.001	<0.001	0.004	0.001	<0.001	<0.001		0.002	0.001	<0.001	0.001	0.003	0.002	0.001	0.002	0.0017	0.0045	0.0029	0.0024	0.001	0.002	<0.001	0.001	0.002	0.001	0.001	<0.001	0.002				0.002				0.0015	
MELDR-11	<0.001	<0.001			<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001				0.001				0.0007	
MELDR-12	0.002	<0.001			<0.001	<0.001	<0.001		<0.001	<0.001	<0.001		0.001	<0.001	<0.001	<0.001	0.01	0.004	<0.001	0.002	0.004	0.0032	0.0015	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001				0.007				0.0012	

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE
SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE
SITES RECORDING 40-60% OF CONCENTRATIONS ABOVE ADJUSTED TV

Concentration ABOVE ADJUSTED trigger value
Concentration BELOW ADJUSTED trigger value
Highest concentration of the year

Concentration < LOR
NO sample taken

Soluble Copper (Cu) (mg/L) LOR 0.001 mg/L

Unmodified ANZECC trigger value for 95% Level of Protection 0.0014 mg/L Max 0.021 Min <0.001

Site	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																																	0.0042	0.0013	0.0007	0.0012
MELDR-05									0.003	0.002	<0.001	0.002	0.002	0.0025	<0.001	0.0018	0.002	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	<0.001	0.0033	0.0006	0.0004	0.0007
MELDR-16																																	0.0024	0.005	0.0038	0.0046
MELDR-02																									<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0008	0.0003	0.0003	0.0003
PSDTBCMD	0.001	<0.001	<0.001	<0.001	0.003	0.001	0.001	0.002	0.0013	0.001	<0.001	0.001	<0.001	0.0018	0.001	0.001	0.001	<0.001	0.001	0.001	0.001	0.002	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.0005	0.001	0.001	<0.001	0.0012	0.0009	0.0006	0.0007
MELDR-13																			<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.0005	0.0011	0.0004	0.0002
MELDR-14																			0.001	0.001	0.001	0.001	<0.001	<0.000	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.0007	0.0009	0.0006	0.0005
MELDR-06	0.002	<0.001	0.002	<0.001	0.002	0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0014	0.0006	0.0004	0.0004
MELDR-07										<0.001	0.0022	0.001			0.0034	0.0014		<0.001	<0.001	<0.001	<0.001	0.0015	<0.001	0.002	0.021	0.009	<0.001	<0.001	0.013	0.009	0.002	<0.001		0.0005	0.0006	0.0007
MELDR-08																									0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.0007	0.0008	0.0008	0.0008
MELDR-09																									0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.0004	0.0011	0.0007	0.0007
MELDR-10									0.003	0.001	0.0013	0.002	0.0016	0.0033	0.0024	0.0012	0.001	<0.001	<0.001	<0.001	0.002	0.001	0.001	<0.001	0.002	0.001	0.001	0.001	<0.001	0.002	0.002	<0.001	0.0014	0.001	0.0006	0.0008
MELDR-11									<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	0.001	<0.001	0.002	0.001	<0.001	0.0007	0.0008	0.0006	0.0007
MELDR-12									0.011	0.004	<0.001	0.001	0.0023	0.0029	0.0015	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	0.002	0.001	<0.001	0.0012	0.0019	0.0008	0.0007

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE
SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE
SITES RECORDING 40-60% OF CONCENTRATIONS ABOVE ADJUSTED TV

Concentration ABOVE ADJUSTED trigger value
Concentration BELOW ADJUSTED trigger value
Highest concentration of the year

Concentration < LOR
NO sample taken

Total Fe (mg/L) Interim guideline 0.3 mg/L Max 19.0 Min 0.1 LOR 0.005 mg/L

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17
MELDR-15																														5.1	3.8	2.3	2.5	5.7	0.46	2.4	0.24	0.63	0.64	1.6	0.19	
MELDR-05	1.2	2.7			1.9	1.3	0.51		1.8	0.93			0.71	2.0	1.0	1.1	0.25	4.3	2.2	1.5	4.3	0.33	1.2	0.92	1.2	2.3	2.5	2.1	2.8	2.4	2.1	1.6	1.3				6.3				0.43	
MELDR-16																														6.5	7.5	3.3	1.4	1.5	0.68	2.7	1.1	0.33	0.55		0.053	
MELDR-02	1.1	2.0	1.2	1.1	1.6	1.2	1.2	1.2	1.4	1.2	1.5	15.0	1.1	1.3	1.1	1.3	1.2	1.5	1.4	1.4	1.9	1.2	1.0	1.2	1.3	1.5	1.7	1.4	1.5	1.7	1.6	1.3	1.1				1.5				0.59	
PSDTBCMD	0.76	1.0	13.0	0.68	1.6	0.6	0.88	0.97	0.79	0.64	0.85	0.88	1.2	0.68	0.78	0.58	0.58	0.82	0.88	0.65	0.9	0.59	0.78	0.75	1.2	0.9	1.2	1.1	1.1	1.2	0.8	0.86	0.53				0.54				0.34	
MELDR-13																											4.4	4.1	1.9	4.1	4.3	3.2	3.2				2.3				1.5	
MELDR-14																											0.9	1.5	0.6	0.9	0.9	0.86	0.56				0.45				0.42	
MELDR-06	16.0	12.0	1.4	12.0	8.3	6.6	7.0	6.4	4.3	4.9	6.2	5.6	2.8	4.5	4.5	5.1	4.1	4.6	4.6	3.4	7.0	3.7	4.0	3.1	4.7	3.9	3.8	3.4	2.2	3.6	3.3	2.8	2.7				2.1				0.81	
MELDR-07	3.9	15.0			9.5	7.3	16.0		5.4	6.9			4.8	6.3	4.5	19.0		3.3	4.5	3.3			5.4	1.3		4.7	5.8	2.8	2.0	5.9	5.0	2.8	6.9				5.2					6.8
MELDR-08	0.95	5.6			0.99	0.41			0.63										0.91	1.3		0.59	1.2	0.63	3.5	2.6	0.91	0.91	1.3	1.0	1.30	0.68	0.68				1.3				0.99	
MELDR-09	0.82	0.61			0.45	0.11	0.13	0.08	0.26	0.06	0.12		0.07	0.05	0.06	0.1	0.7	1.0	1.6	1.9	0.15	0.13	0.22	0.14	0.1	0.22	0.93	0.72	0.9	1.00	0.59	0.58	0.58				0.44				0.22	
MELDR-10	0.39	0.34			0.7	0.31	1.1	1.8	0.14	0.34	2.7		0.22	0.29	0.9	1.1	0.24	0.19	0.49	0.41	0.46	0.41	0.7	0.53	0.32	0.23	0.5	0.70	0.35	0.52	0.3	0.34	0.37				0.23				0.18	
MELDR-11	0.39	0.59			0.53	0.7	0.91	1.6	0.32	0.99	1.7	1.8	0.43	0.37	0.4	2.0	0.26	0.33	0.36	0.32	0.53	0.62	0.47	0.69	0.34	0.13	0.18	0.4	0.12	0.13	0.09	0.23	0.082				0.091				0.16	
MELDR-12	1.4	3.7			2.5	1.1	0.61		1.6	0.58	0.68		1.4	1.2	0.69	0.55	1.6	2.2	7.6	6.0	1.9	4.8	4.3	5.6	1.4	3.6	5.3	3.2	2.7	4.0	1.9	1.7	5.3				2.4				3.4	

SITES RECORDING Fe CONCENTRATIONS ALWAYS/GENERALLY ABOVE TRIGGER VALUE
SITES RECORDING 40-60% of Fe CONCENTRATIONS ABOVE TRIGGER VALUE
SITES RECORDING Fe CONCENTRATIONS ALWAYS/GENERALLY BELOW TRIGGER VALUE

Concentration ABOVE guideline
Highest concentration of the year
Concentration BELOW guideline

Concentration < LOR
NO sample taken

Soluble Fe (mg/L) Interim guideline 0.3 mg/L Max 6.00 Min 0.026 LOR 0.005 mg/L

Site	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																																	0.12	2.20	1.60	1.80
MELDR-05									0.1	2.9	1	0.73		0.22	0.77	0.57	0.66	1.6	1.2	0.64	2.7	1.2	1.8	0.7	1	0.96	0.44	0.35	6	1.40	0.34	1.10	0.36	2.00	1.60	1.40
MELDR-16																																	0.039	0.75	2.20	2.20
MELDR-02																									1	1.1	0.93	0.88	1	1.3	1.00	0.99	0.59	1.1	1.10	1.20
PSDTBCMD	0.35	0.25	0.24	0.2	0.3	0.29	0.25	0.25	0.35	0.48	0.36	0.3	0.34	0.27	0.31	0.32	0.24	0.42	0.5	0.37	0.3	0.46	0.37	0.33	0.26	0.34	0.34	0.14	0.30	0.34	0.32	0.33	0.25	0.46	0.42	0.40
MELDR-13																			2.7	2.3	0.6	2.0	1.7	1.1	1.7	1.3	2.6	0.87	1.9	2.3	1.7	1.30	1.3	1.4	1.0	2.50
MELDR-14																			0.68	0.56	0.4	0.6	0.57	0.5	0.42	0.55	0.77	0.39	0.30	0.40	0.26	0.36	0.28	0.46	0.49	0.53
MELDR-06	3.4	2.8	3.7	2.6	1.3	3.1	2.6	3.1	2.7	2.7	3.1	1.8	5.2	2.2	2.7	1.7	2.6	2.9	2.6	1.8	0.55	1.7	1.4	0.96	1.2	1.4	2	0.47	1.2	1.2	1	0.59	0.5	0.9	1	1.70
MELDR-07										0.99	1.3	1.1			3.9	1.2		4.1	2.5	2.2	1.7	5.6	2.3	2.1	5.7	2.4	2.3	1.7	3.9	3.7	2.7	3.0		6.0	3.9	4.3
MELDR-08																									0.66	0.44	0.49	0.59	1.10	1.40	1.20	0.81	0.91	0.99	0.88	3.80
MELDR-09																									0.41	0.45	0.37	0.3	0.38	0.36	0.34	0.5	0.18	0.29	0.76	0.6
MELDR-10									0.21	0.16	0.37	0.26	0.37	0.19	0.51	0.24	0.19	0.14	0.32	0.28	0.24	0.38	0.19	0.077	0.24	0.12	0.41	0.11	0.17	0.37	0.21	0.33	0.11	0.23	0.35	0.14
MELDR-11									0.19	0.2	0.081	0.081	0.21	0.11	0.085	0.11	0.16	0.05	0.066	0.14	0.12	0.037	0.026	0.096	0.04	0.03	0.19	0.22	0.06	0.11	0.18	0.48	0.078	0.10	0.63	0.44
MELDR-12									1.6	1.9	5.3	4.1	0.81	1.8	0.34	1.9	0.72	1.3	3.2	1.3	1.8	3.4	1.1	1.1	3.9	2.9	1.6	1.7	2.1	1.2	5.1	3.1	2.9	3.0	3.7	2.9

SITES RECORDING Fe CONCENTRATIONS ALWAYS/GENERALLY ABOVE GUIDELINE
SITES RECORDING Fe CONCENTRATIONS ALWAYS/GENERALLY BELOW GUIDELINE

Concentration ABOVE guideline
Highest concentration of the year
Concentration BELOW guideline

Concentration < LOR
NO sample taken

Table 7 1 (continued): Records of metal (total and soluble aluminium (Al), total and soluble chromium (Cr), total and soluble copper (Cu), total and soluble iron (Fe), total and soluble lead (Pb), total and soluble zinc (Zn)) and hardness concentrations (mg/L) in the Melville Bull Creek catchments 2007 – 2017

Total Lead (Pb) (mg/L) LOR 0.001 mg/L

Unmodified trigger value for 95% Level of Protection 0.0034 mg/L Max 0.095 Min <0.001

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17
MELDR-15																														<0.001	<0.001	<0.001	0.009	0.006	0.001	0.009	0.007	0.003	0.001	<0.001	0.0005	
MELDR-05	0.004	0.003			0.002	0.002	0.003		0.003	0.002			0.005	0.002	0.005	0.006	0.003	0.005	0.002	0.002	0.0068	0.0022	<0.001	<0.001	0.003	0.002	<0.001	0.001	0.002	0.001	<0.001	0.001	0.002				0.002				0.0011	
MELDR-16																														<0.001	0.002	<0.001	0.011	0.003	<0.001	0.01	0.01	<0.001	<0.001		0.0008	
MELDR-02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001				<0.001				0.0003	
PSDTBCMD	0.002	0.004	0.003	0.003	0.004	0.001	0.003	0.004	0.002	0.003	0.003	0.004	0.006	0.002	0.003	0.002	0.002	0.001	0.0022	0.002	0.0034	0.0028	0.0027	0.0029	0.006	0.003	0.004	0.004	0.007	<0.001	0.003	0.003	0.002				0.002				0.0006	
MELDR-13																											0.002	0.001	0.003	<0.001	0.001	<0.001	<0.001				<0.001				0.0001	
MELDR-14																											0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001				<0.001				0.0003	
MELDR-06	0.003	0.004	0.006	0.002	0.002	<0.001	0.001	0.001	0.002	0.002	0.001	<0.001	0.003	0.001	0.002	0.001	0.0015	0.001	0.0014	<0.001	0.0025	0.0028	0.0012	<0.001	0.002	0.001	0.002	0.001	0.003	<0.001	<0.001	<0.001	0.002				<0.001				0.0001	
MELDR-07	0.032	0.001			0.001	0.001	0.008		<0.001	0.002			0.002	<0.001	<0.001	0.012		0.002	<0.001	<0.001			0.004	0.003		0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005				0.002					0.0007
MELDR-08	0.002	0.003			0.002	<0.001			<0.001										0.0014	0.001		<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	0.001	0.002	<0.001	0.001				0.001				0.0004	
MELDR-09	<0.001	0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				<0.001				0.0002	
MELDR-10	0.002	0.003			0.002	<0.001	0.001	0.009	<0.001	0.001	0.003		0.002	0.002	0.005	<0.001	0.003	0.001	0.0024	0.002	0.0023	0.0039	0.006	0.0028	0.002	0.001	0.002	0.002	0.002	0.001	<0.001	<0.001	<0.001				0.001				0.0002	
MELDR-11	0.004	0.003			0.001	0.001	0.002	0.008	0.0013	0.002	0.005	0.003	0.001	0.002	0.003	0.014	0.002	0.002	0.0025	0.001	<0.001	0.0015	0.0021	0.0021	0.001	0.001	0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001				<0.001				0.00005	
MELDR-12	0.029	0.009			0.003	0.005	0.003		0.0056	0.005	0.019		0.011	0.01	0.011	0.014	0.065	0.026	0.0012	0.003	0.051	0.036	0.0065	0.008	0.019	0.003	0.001	<0.001	0.003	0.001	0.002	0.003	0.008				0.095				0.0073	

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE

Concentration ABOVE ADJUSTED trigger value

Concentration BELOW ADJUSTED trigger value

Concentration < LOR

NO sample taken

Soluble Lead (Pb) (mg/L) LOR 0.001 mg/L

Unmodified trigger value for 95% Level of Protection 0.0034 mg/L Max 0.092 Min <0.001

Site	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																																	0.0005	0.001	0.0003	0.0006
MELDR-05									<0.001	0.002	<0.001	<0.001	0.0015	0.0011	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001	0.001	0.0005	0.0002	0.0004
MELDR-16																																	0.0002	0.0017	0.0013	0.0025
MELDR-02	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0016	0.0011	0.001	<0.001	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0003	0.0003	0.0001	0.0002
PSDTBCMD																									0.002	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.0005	0.0007	0.0004	0.0007
MELDR-13																			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.00005	0.0001	0.00005	0.00005
MELDR-14																			<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0002	0.0003	0.0002	0.0003
MELDR-06	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0001	0.0002	0.00005	0.0001
MELDR-07										<0.001	<0.001	<0.001			0.004	0.003		0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.005	0.008	<0.001	0.002	0.006	0.003	<0.001		0.0007	0.0005	0.0009
MELDR-08																									0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.0004	0.0007	0.0006	0.0012
MELDR-09																									<0.001	<0.001	<0.001	0.001	<0.001	0.001	0.001	<0.001	0.0002	0.0011	0.0004	0.0006
MELDR-10									0.002	<0.001	0.0016	<0.001	0.002	0.0019	0.0038	<0.001	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.0002	0.0004	0.0002	0.0001
MELDR-11									<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.002	0.00005	0.0004	0.0013	0.0018
MELDR-12									0.066	0.024	<0.001	0.002	0.046	0.026	<0.001	0.0031	0.018	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	0.006	0.006	<0.001	0.006	0.092	0.011	0.006	0.002	0.0067	0.0061	0.0018	0.0017

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE

Concentration ABOVE ADJUSTED trigger value

Concentration BELOW ADJUSTED trigger value

Highest concentration of the year

Concentration < LOR

NO sample taken

Total Hg (mg/L) ANZECC trigger value: 0.0006 mg/L

Max <0.0001 Min <0.0001

Site	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001				
MELDR-16	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002					
MELDR-13	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
MELDR-14	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
MELDR-06	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Concentration ABOVE guideline

Highest concentration of the year

Concentration BELOW trigger value

Concentration <LOR

NO sample taken

Soluble Hg (mg/L) ANZECC trigger value: 0.0006 mg/L

Max <0.0001 Min <0.0001

Site	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001								
MELDR-16	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001								
MELDR-13	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
MELDR-14	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
MELDR-06	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Concentration ABOVE guideline

Highest concentration of the year

Concentration BELOW trigger value

Concentration <LOR

NO sample taken

Table 7 1 (continued): Records of metal (total and soluble aluminium (Al), total and soluble chromium (Cr), total and soluble copper (Cu), total and soluble iron (Fe), total and soluble lead (Pb), total and soluble zinc (Zn)) and hardness concentrations (mg/L) in the Melville Bull Creek catchments 2007 – 2017

Total Zinc (Zn) (mg/L) LOR 0.001 mg/L

Unmodified trigger value for 95% level of protection 0.008 mg/L — Max 1.2 — Min <0.001

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17
MELDR-15																														0.029	0.041	0.041	0.09	0.094	0.057	0.055	0.041	0.092	0.044	0.09	0.14	
MELDR-05	0.006	0.011			0.005	0.006	0.003		0.021	0.008			0.054	0.004	0.005	0.008	0.024	0.05	0.018	0.017	0.014	0.027	0.0084	0.012	0.03	0.03	0.028	0.014	0.031	0.021	0.018	0.007	0.023				0.016				0.042	
MELDR-16																														0.024	0.039	0.023	0.18	0.074	0.051	0.072	0.12	0.084	0.032		0.1	
MELDR-02	0.002	0.003	<0.001	<0.001	0.003	0.004	0.004	0.004	0.01	0.004	0.003	0.009	0.015	0.002	0.005	0.004	0.008	0.012	0.007	0.009	<0.001	0.011	0.0037	0.0019	0.021	0.019	0.03	0.035	0.021	0.012	0.01	0.005	0.009				0.005				0.015	
PSDTBCMD	0.006	0.007	0.011	0.012	0.006	0.009	0.005	0.009	0.015	0.008	0.002	0.005	0.02	0.006	0.008	0.006	0.017	0.014	0.011	0.01	0.0092	0.016	0.01	0.009	0.02	0.02	0.012	0.011	0.021	0.012	0.01	0.008	0.014				0.013				0.018	
MELDR-13																											0.019	0.008	0.033	0.011	0.012	0.008	0.01				0.007				0.01	
MELDR-14																											0.008	0.005	0.046	0.01	0.005	0.004	0.008				0.008				0.016	
MELDR-06	0.01	0.01	0.009	0.011	0.007	0.006	0.004	0.008	0.011	0.008	0.002	0.004	0.021	0.005	0.006	0.006	0.02	0.014	0.011	0.008	0.009	0.017	0.01	0.0053	0.02	0.01	0.015	0.0081	0.032	0.011	0.01	0.008	0.011				0.008				0.017	
MELDR-07	1.2	0.02			0.016	0.002	<0.001		0.058	0.002			0.009	0.002	<0.001	0.018		0.092	0.005	0.002			0.14	0.05		0.12	0.002	0.001	0.048	0.013	0.004	0.003	0.21				0.2					0.007
MELDR-08	0.13	0.026			0.024	0.009			0.031										0.07	0.026		0.05	0.011	0.0031	0.1	0.023	0.02	0.012	0.024	0.031	0.037	0.021	0.041				0.043				0.027	
MELDR-09	0.004	0.003			0.006	0.004	0.003	0.002	0.007	0.001	<0.001		<0.001	<0.001	0.002	0.002	0.22	0.091	0.033	0.01	0.014	0.014	0.012	0.0044	0.007	0.013	0.011	0.004	0.006	0.008	0.005	0.003	0.011				0.009				0.01	
MELDR-10	0.006	0.004			0.003	0.003	0.003	0.012	0.003	0.003	<0.001		0.004	0.002	0.004	0.007	0.02	0.041	0.009	0.007	0.011	0.023	0.014	0.0058	0.02	0.013	0.007	0.003	0.03	0.009	0.006	0.007	0.016				0.019				0.019	
MELDR-11	0.007	0.003			0.001	0.001	<0.001	0.008	0.0023	0.002	0.001	0.002	0.004	0.003	0.002	0.017	0.006	0.003	0.005	0.002	0.002	0.0058	0.0024	0.002	0.003	0.004	0.001	0.003	0.003	0.003	0.003	0.002	0.004				0.008				0.0025	
MELDR-12	0.19	0.001			0.001	0.002	<0.001		0.003	<0.001	0.004		0.003	0.002	0.003	0.002	0.65	0.22	0.013	0.003	0.16	0.11	0.016	<0.001	0.1	0.002	0.003	0.002	0.002	0.003	0.005	0.008	0.003				0.24				0.009	

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE
SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE
Concentration ABOVE ADJUSTED trigger value
Concentration BELOW ADJUSTED trigger value
Concentration < LOR
NO sample taken

Soluble Zinc (Zn) (mg/L) LOR 0.001 mg/L

Unmodified trigger value for 95% level of protection 0.008 mg/L — Max 0.58 — Min <0.001

Site	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																																	0.097	0.049	0.071	0.052
MELDR-05									0.025	0.05	0.016	0.026	0.0064	0.027	0.011	0.012	0.03	0.02	0.028	0.014	0.028	0.021	0.018	0.03	0.02	0.015	0.01	0.011	0.016	0.029	0.04	0.028	0.04	0.017	0.016	0.022
MELDR-16																																	0.044	0.089	0.052	0.054
MELDR-02	0.015	0.01	0.011	0.009	0.02	0.015	0.01	0.013	0.019	0.014	0.01	0.017	0.007	0.016	0.01	0.009	0.02	0.02	0.012	0.011	0.021	0.012	0.01	0.008	0.009	0.016	0.012	0.015	0.005	0.028	0.021	0.019	0.013	0.015	0.011	0.013
PSDTBCMD																									0.014	0.019	0.015	0.013	0.013	0.025	0.025	0.02	0.011	0.019	0.01	0.013
MELDR-13																			0.019	0.008	0.028	0.011	0.012	0.008	0.01	0.017	0.007	0.015	0.007	0.025	0.021	0.022	0.007	0.014	0.014	0.012
MELDR-14																			0.008	0.005	0.02	0.01	0.005	0.004	0.008	0.014	0.005	0.014	0.008	0.03	0.019	0.013	0.008	0.014	0.009	0.008
MELDR-06	0.015	0.015	0.015	0.012	0.02	0.016	0.018	0.02	0.02	0.014	0.013	0.022	0.009	0.017	0.01	0.0053	0.02	0.01	0.015	0.0081	0.032	0.011	0.01	0.008	0.011	0.015	0.006	0.014	0.008	0.066	0.022	0.015	0.012	0.015	0.012	0.01
MELDR-07										0.092	0.006	0.012			0.14	0.05		0.12	0.002	0.001	0.048	0.013	0.004	0.003	0.18	0.13	0.01	0.014	0.2	0.17	0.099	0.019		0.0025	0.008	0.009
MELDR-08																									0.038	0.029	0.023	0.021	0.043	0.042	0.038	0.034	0.022	0.035	0.025	0.019
MELDR-09																									0.011	0.015	0.012	0.011	0.009	0.026	0.019	0.018	0.006	0.018	0.011	0.014
MELDR-10									0.022	0.039	0.012	0.01	0.011	0.021	0.015	0.0055	0.02	0.013	0.007	0.003	0.03	0.009	0.006	0.007	0.016	0.02	0.006	0.008	0.019	0.026	0.021	0.021	0.013	0.02	0.01	0.012
MELDR-11									0.006	0.003	0.005	0.002	0.002	0.0055	0.0024	0.002	0.003	0.004	0.001	0.001	0.003	0.003	0.003	0.002	0.004	0.008	0.002	0.003	0.008	0.017	0.009	0.003	0.0025	0.0025	0.004	0.01
MELDR-12									0.58	0.0024	0.018	0.013	0.16	0.11	0.016	<0.001	0.1	0.002	0.003	0.002	0.002	0.003	0.005	0.008	0.003	0.011	0.018	0.009	0.24	0.11	0.029	0.013	0.0025	0.014	0.007	0.01

SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY ABOVE ADJUSTED TRIGGER VALUE
SITES RECORDING CONCENTRATIONS ALWAYS/GENERALLY BELOW ADJUSTED TRIGGER VALUE
SITES RECORDING 40-60% OF CONCENTRATIONS ABOVE ADJUSTED TV
Concentration ABOVE ADJUSTED trigger value
Concentration BELOW ADJUSTED trigger value
Highest concentration of the year
Concentration < LOR
NO sample taken

Total Water Hardness (mg/L) LOR 5 mg/L

Max 1,500 — Min 7

Site	Jul-07	Oct-07	Jan-08	Apr-08	Sep-08	Nov-08	Jan-09	Mar-09	Sep-09	Nov-09	Jan-10	Mar-10	Aug-10	Sep-10	Oct-10	Nov-10	Jul-11	Aug-11	Sep-11	Oct-11	Jul-12	Aug-12	Sep-12	Oct-12	Aug-13	Sep-13	Oct-13	Nov-13	Aug-14	Sep-14	Oct-14	Nov-14	Aug-15	Sep-15	Oct-15	Nov-15	Jul-16	Aug-16	Sep-16	Oct-16	Jul-17	Aug-17	Sep-17	Oct-17
MELDR-15																														110	130	140	100	100	150	150	130	98	65	99	25	89	110	120
MELDR-05	20	180			220	270	290		140	200			63	74	240	170	7	98	210	100	120	22	220	190	100	130	150	200	100	180	200	220	180	200	220	250	93	140	46	140	67	180	200	190
MELDR-16																														76	110	120	110	130	130	150	68	69	33		24	85	110	82
MELDR-02	120	130	130	130	130	1,100	120	130	120	120	120	140	92	130	130	75	120	120	140	120	120	100	130	120	110	130	130	150	94	130	180	150	120	130	110	130	120	130	100	110	100	130	120	130
PSDTBCMD	130	120	160	130	120	140	110	110	120	120	120	130	75	120	120	110	120	710	130	120	110	95	130	120	78	130	130	140	99	130	170	140	120	130	110	130	130	120	91	110	96	130	120	120
MELDR-13																											130	160	49	140	180	150	120	130	140	140	130	140	130	120	110	130	130	140
MELDR-14																											130	160	100	140	170	150	93	100	130	130	94	100	110	110	94	130	130	140
MELDR-06	170	160	110	200	150	190	150	150	130	140	140	160	87	130	130	140	130	140	130	130	170	100	150	150	130	150	140	160	65	140	180	150	120	130	140	140	130	130	120	120	91	140	130	140
MELDR-07	1,000	600			580	180	660		620	700			910	850	1,100	970		1,100	870	760			1,400	1,500		770	530	620	640	620	650	530	880	900	130	850	890	800	650	410		440	410	360
MELDR-08	170	110			80	82			110										220	150		150	170	150	230	200	140	140	150	140	180	130	140	140	100	130	270	220	200	140	190	160	140	120
MELDR-09	190	130			120	200	220	270	130	180	260		130	140	160	1,300	220	180	170	150	150	140	150	170	150	130	150	180	110	100	120	140	110	120	130	130	150	140	110	130	130	71	97	99
MELDR-10	70	69			80	120	120	150	76	70	130		56	71	130	160	29	29	51	53	41	20	38	99	32	24	67	130	35	71	110	140	36	39	85	64	20	32	37	71	31	37	83	76
MELDR-11	120	160			130	170	93	120	75	83	98	180	130	150	170	110	91	100	120	84	110	110	110	140	100	86	110	98	74	90	130	76	82	91	50	55	58	77	110	66	61	40	67	79
MELDR-12	230	98			100	160	130		92	110	210		98	110	120	140	210	140	100	110	280	210	110	130	150	73	75	120	73	78	110	120	94	110	810	150	180	130	95	91	83	62	77	88

NO sample taken
Soft 0-59 mg/L
Moderate 60-119
Hard 120-179
Very Hard 180-240
Extremely Hard > 240

8. Metals in sediment

A study of the Bull Creek sediments (Nice 2009) identified sediment concentrations in Bull Creek exceeding zinc, mercury, lead and selenium concentrations exceeding ANZECC guidelines for sediment (ANZECC & ARMCANZ 2000). Following this, an ecotoxicological investigation by Nice (2011) found that sediments collected in Bull Creek in the vicinity of the Bull Creek Main Drain and the Brentwood Main Drain were toxic to test organisms (mussels (*Mytils edulis planulatus*), copepods (*Gladioferans imparipes*), amphipods (*Grandidiella japonica)* and pink snapper (*Pagrus auratus*)). This investigation subsequently recommended investigation of disturbance in the Bull Creek catchment. This water and sediment quality assessment will help to determine the source of these metals in the catchment.

Refer to **Tables D-29 to D-38 in Appendix D** for all sediment metal concentration data collected in the Melville Bull Creek catchments in the 2016. **Table F-1, Appendix F** outlines potential sources of these metals.

For all graphs, a value equal to half the limit of reporting was substituted for those occasions where concentrations were recorded as ‘below the laboratory limit of reporting’ which is a standard technique to allow these ‘unknown’ values to be represented graphically and to differentiate them from concentrations equal to the limit of reporting.

8.1 Aluminium

No guideline currently exists for aluminium concentrations in sediment; therefore, it is difficult to gauge the severity of any potential impacts arising from the concentrations recorded in the sediment of the Bull Creek catchment. Sediment total aluminium concentrations in 2017 were varied across the catchment (**Figure 8.1-1** and **Table D-29, Appendix D**). The highest concentration of 5,290 mg/kg was recorded at site 7 (Booragoon Lake) followed by site 5 (John Creaney Park) which recorded 3,270 mg/kg. The lowest concentration of 383 mg/kg was recorded at site 8 (Piney Lakes outlet).

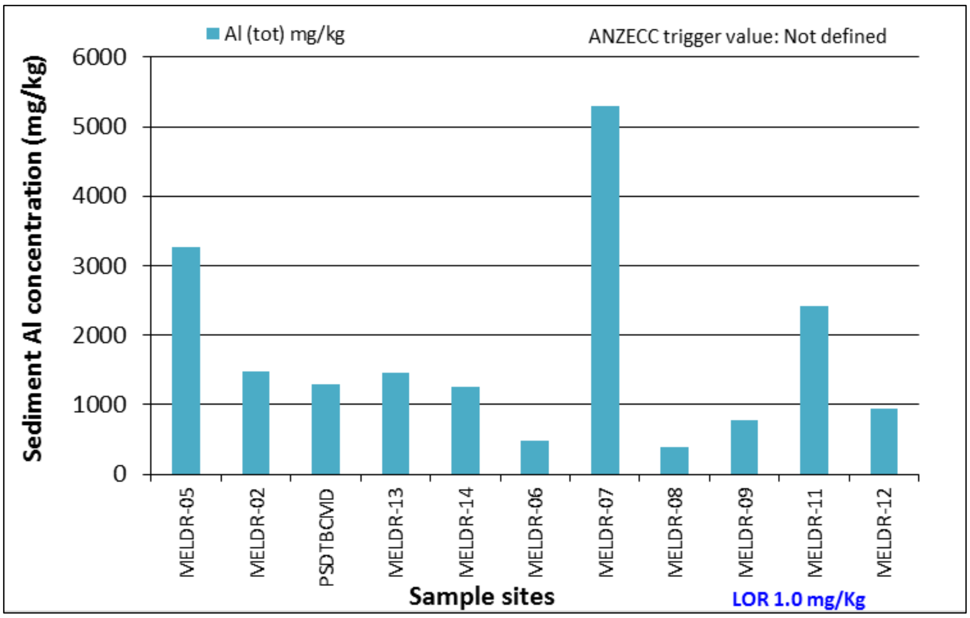

Figure 8.1-1: Sediment total aluminium concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Total aluminium concentrations have varied greatly in sediments of Melville Bull Creek catchment sites (over the last five years of monitoring, with no strong patterns evident (**Table 8.1-1**). It is notable that the very high result (30,000 mg/kg) recorded at site 13 (Brentwood drain) in 2016 is significantly higher than all other recorded concentrations, including those recorded in other years at site 13.

Table 8.1-1: Records of sediment total aluminium concentrations (mg/kg) in the Melville Bull Creek catchment 2013 - 2017

Aluminium (Al) (total sediment) (mg/kg) LOR 1.0 mg/Kg

ANZECC trigger value: ND

Max (red) 8,200 Min (blue) 360

Site name	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	2,300	1,300	630	5100	3270
MELDR-02	1,400	1,500	2,100	1200	1470
PSDTBCMD	500	1,300	8,200	8100	1300
MELDR-13	360	470	760	30000	1460
MELDR-14	560	460	470	1000	1260
MELDR-06	620	500	640	510	485
MELDR-07	6,500		2,300	7000	5290
MELDR-08	3,200	2,900	5,000	4600	383
MELDR-09	1,000	1,000	720	1100	774
MELDR-10	1,100	1,500	2,200	6500	
MELDR-11	1,100		2,900	1900	2420
MELDR-12	2,200	820	1,000	720	938

Highest concentration of the year

Lowest concentration of the year

8.2 Arsenic

Total arsenic concentrations in sediments in 2017 were all below the ANZECC low (20 mg/kg) and high (70 mg/kg) trigger values (**Figure 8.2-1** and **Table D-30, Appendix D**). The highest concentration of 4.9 mg/kg was recorded at site 7 (Booragoon Lake outlet). The lowest concentration of 0.1 mg/kg was recorded at sites 8 (Piney Lakes outlet) and 9 (Quenda Lake outlet).

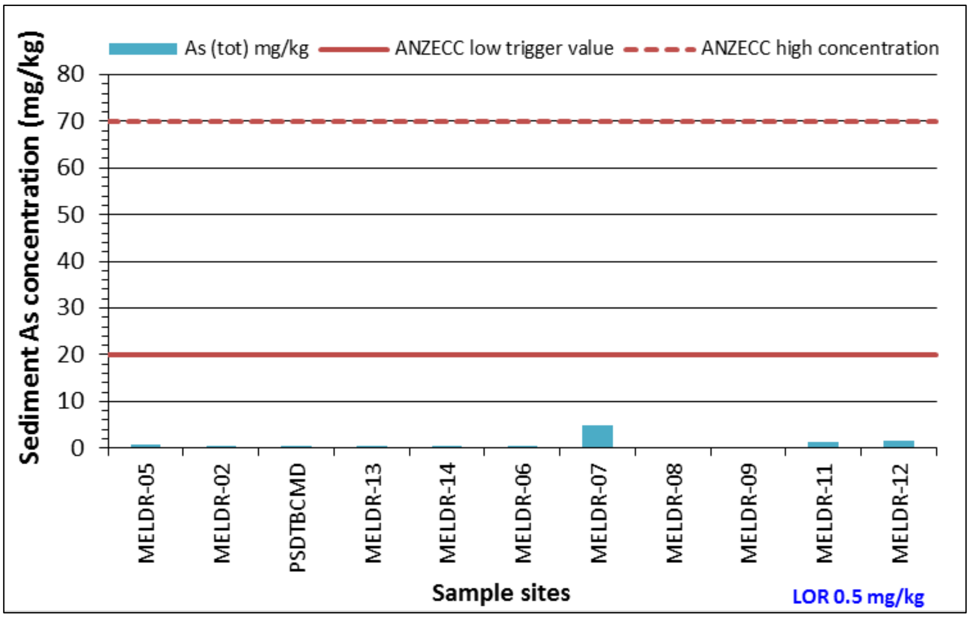

Figure 8.2-1: Sediment total arsenic concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Total arsenic concentrations in sediments at Melville Bull Creek catchment sites have been generally low in the previous five years of monitoring (**Table 8.2-1**). Site 7 (Booragoon Lake outlet) has recorded the highest concentrations in the catchment each year that sediment was collected from this site and has been the only site to record exceedances of the low trigger value (in 2015), however concentrations at this site were lower in 2016 and 2017 than in previous years.

Table 8.2-1: Records of sediment total arsenic concentrations (mg/kg) in the Melville Bull Creek catchment 2013 - 2017

Arsenic (As) (total sediment) (mg/kg) LORs 0.1 or 0.5 mg/kg

ANZECC low TV: 20 mg/kg, high TV: 70 mg/Kg

Max (red) 20 Min (blue) 0.1

Site name	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	0.8	<0.5	<0.5	1.9	0.8
MELDR-02	<0.5	<0.5	0.6	<0.5	0.4
PSDTBCMD	<0.5	0.8	2.6	4.1	0.6
MELDR-13	0.7	0.8	<0.5	0.7	0.6
MELDR-14	<0.5	<0.5	<0.5	0.6	0.6
MELDR-06	1.4	0.7	<0.5	<0.5	0.4
MELDR-07	18		20	7.1	4.9
MELDR-08	1.4	0.8	1.4	1.5	0.1
MELDR-09	<0.5	<0.5	<0.5	<0.5	0.1
MELDR-10	1.1	1.3	1.4	5.1	
MELDR-11	1		2.8	2.5	1.4
MELDR-12	1.4	<0.5	0.7	<0.5	1.7

Record >LOW Trigger Talue	Concentration < LOR
Record >HIGH Trigger Value	NO sample taken
Record <LOW Trigger Value	

8.3 Chromium

Total chromium (including Cr^{3+} and Cr^{6+} fractions) concentrations in sediments at all sites in the Melville Bull Creek catchments were below ANZECC low (80 mg/kg) and high (370 mg/kg) trigger values in 2017 (**Figure 8.3-1** and **Table D-31 Appendix D**). The highest concentration in the catchment of 26 mg/kg was recorded at site 13 (Brentwood drain) and the lowest concentration of 0.88 mg/kg was recorded at site 6 (Bateman Park).

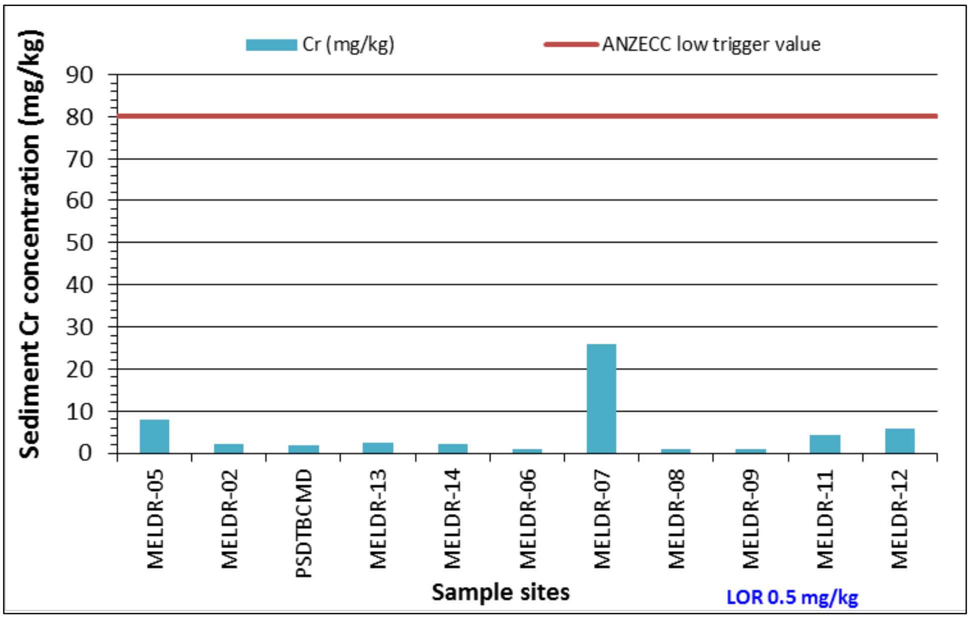

Figure 8.3-1: Sediment total chromium concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Total chromium concentrations in sediments at Melville Bull Creek catchment sites have been generally low in the previous five years of monitoring (**Table 8.3-1**). The concentration of 180 mg/kg recorded at site 13 (Brentwood drain) in 2016 is by far the highest concentration recorded in catchment over the five year period and has been the only sample to exceed the low trigger value.

Table 8.3-1: Records of sediment total chromium concentrations (mg/kg) in the Melville Bull Creek catchment 2013 - 2017

Chromium (Cr) (total sediment) (mg/kg)

LORs 0.05 or 0.5mg/kg

ANZECC lower TV: 80 mg/kg, higher TV: 370 mg/kg

Max (red) 72 Min (blue) 0.88

Site name	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	12	4.3	2	18	8
MELDR-02	3.3	3.4	4.2	11.0	2.2
PSDTBCMD	0.9	3.1	12	11	1.9
MELDR-13	1	1.5	1.7	180.0	2.4
MELDR-14	1.7	1.3	1.3	1.2	2.3
MELDR-06	2.1	2.5	1.6	1.2	0.88
MELDR-07	64		72	35	26
MELDR-08	9.4	6.5	12	10	1
MELDR-09	2.8	1.7	1.5	1.6	0.96
MELDR-10	3.6	3.9	4.6	23.0	
MELDR-11	4.4		5	3	4.2
MELDR-12	11	2.1	4.7	2.0	5.9

Record >LOW Trigger Talue	Concentration < LOR
Record >HIGH Trigger Value	NO sample taken
Record <LOW Trigger Value	

8.4 Copper

Total copper concentrations in sediments at all Melville Bull Creek catchment sites in 2017 were below ANZECC low (65 mg/kg) and high (270 mg/kg) trigger values (**Figure 8.3-1** and **Table D-32, Appendix D**). The highest concentration in the catchment (16 mg/kg) was recorded at site 5 and four sites recorded concentrations below the limit of reporting (0.5 mg/kg).

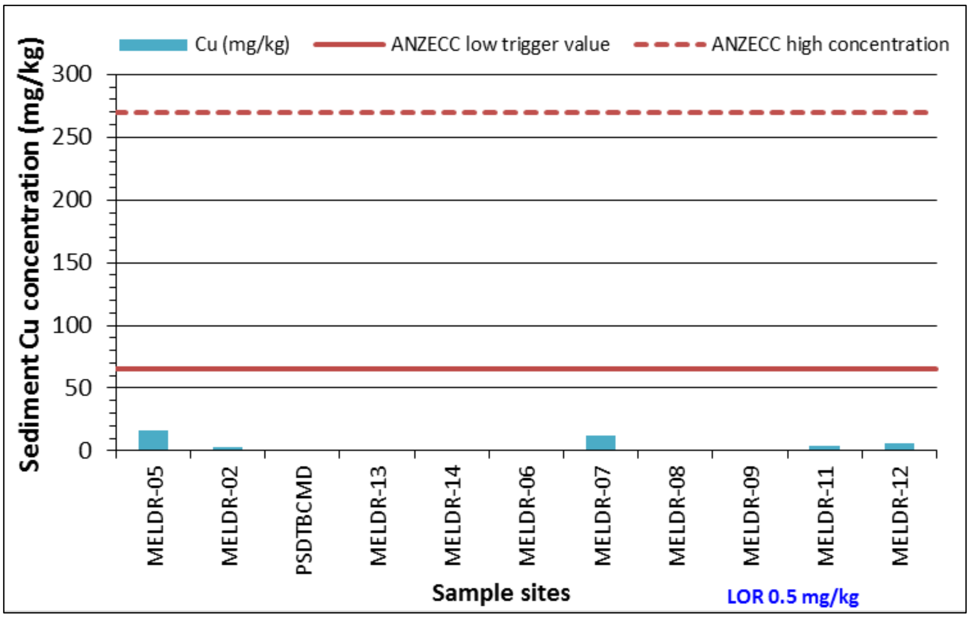

Figure 8.4-1: Sediment total copper concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Total copper concentrations in sediments at Melville Bull Creek catchment sites have been generally low in the previous five years of monitoring (**Table 8.4-1**). Only three samples (site 13 (Brentwood drain) in 2016, site 7 (Booragoon Lake) in 2015 and site 10 (Frederick Baldwin) in 2016) have recorded exceedances of the low trigger value in the five years of monitoring. Concentrations in these three samples were significantly higher than other concentrations recorded at these sites over the years.

Table 8.4-1: Records of sediment total copper concentrations (mg/kg) in the Melville Bull Creek catchment 2013 - 2017

Copper (Cu) (total sediment) (mg/kg)

All data in blue were <0.5 (LOR)

ANZECC lower TV: 65 mg/kg, higher TV: 270 mg/kg

Max (red) 250 Min (blue) <0.5

Site name	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	20	11	4.3	50.0	16.0
MELDR-02	7.9	3.6	7.0	16.0	3.3
PSDTBCMD	<0.5	4.2	1.3	2.4	0.8
MELDR-13	<0.5	0.7	<0.5	95.0	0.9
MELDR-14	<0.5	0.8	0.8	<0.5	<0.5
MELDR-06	0.9	2.1	0.5	<0.5	<0.5
MELDR-07	38		250.0	28.0	12.0
MELDR-08	13	10	16.0	14.0	<0.5
MELDR-09	<0.5	0.7	1.2	1.2	<0.5
MELDR-10	4.9	8	7.3	72.0	
MELDR-11	2.6		1.3	1.0	3.9
MELDR-12	11	3.2	4.2	1.2	6.0

Record >LOW Trigger Talue	Concentration < LOR
Record >HIGH Trigger Value	NO sample taken
Record <LOW Trigger Value	

8.5 Iron

No guideline currently exists for iron concentrations in sediment; therefore it is difficult to gauge the severity of any potential impact arising from the concentrations recorded in the sediment of the Melville Bull Creek catchment. In 2017 total iron concentrations in sediment were varied (**Figure 8.5-1** and **Table D-33, Appendix D**). The highest concentration of 8,200 mg/kg was recorded at site 7 (Booragoon Lake) and the lowest concentration of 180 mg/kg was at site 9 (Quenda Lake outlet).

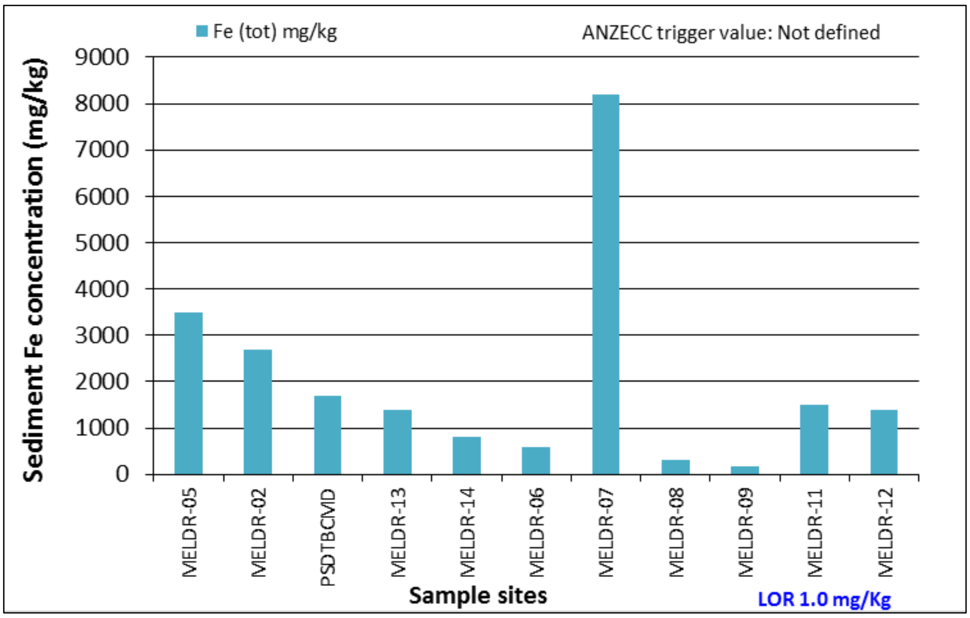

Figure 8.5-1: Sediment total iron concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Sediment total iron concentrations recorded in the last five years of monitoring of the Melville Bull Creek catchment have varied between sites (**Table 8.5-1**). Sites PSDTBCMD (the most downstream site in Bull Creek main drain) and site 7 (Booragoon Lake) have generally recorded the highest concentrations, although it is noted that concentrations at these sites in 2017 were lower (particularly so at PSDTBCMD) than in the previous years. Site 9 (Quenda Lake outlet) has always recorded the lowest concentrations.

Table 8.5-1: Records of sediment total iron concentrations (mg/kg) in the Melville Bull Creek catchment 2013 - 2017

Iron (Fe) (total sediment) (mg/kg) — LOR 1.0 mg/Kg

ANZECC trigger value: ND

Max (red) 56,000 — Min (blue) 85

Site name	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	6,200	3,400	1,700	7000	3500
MELDR-02	3,000	3,500	4,000	1400	2700
PSDTBCMD	810	3,700	56,000	57000	1700
MELDR-13	1,800	2,700	760	54000	1400
MELDR-14	650	560	620	1700	800
MELDR-06	3,400	2,500	1,200	730	590
MELDR-07	17,000		17,000	13000	8200
MELDR-08	2,100	1,500	2,100	1800	310
MELDR-09	85	170	350	180	180
MELDR-10	3,300	3,900	3,600	11000	
MELDR-11	1,100		3,000	1700	1500
MELDR-12	3,700	880	1,400	850	1400

Highest concentration of the year

Lowest concentration of the year

8.6 Lead

The ANZECC low and high trigger values for lead in sediment are 50 and 220 mg/kg respectively (ANZECC and ARMCANZ 2000). Lead concentrations in sediments of the Melville Bull Creek catchment in 2017 were varied: samples from two sites, 5 and 7 (John Creaney Park and Booragoon Lake outlet respectively), recorded concentrations exceeding the ANZECC low trigger value (50 mg/kg) of 52 mg/kg and 66 mg/kg respectively (**Figure 8.6-1** and **Table D-34, Appendix D**). No samples recorded exceedances of the high trigger value (220 mg/kg). The lowest concentration of 1.1 mg/kg was recorded at site 6 (Bateman Park).

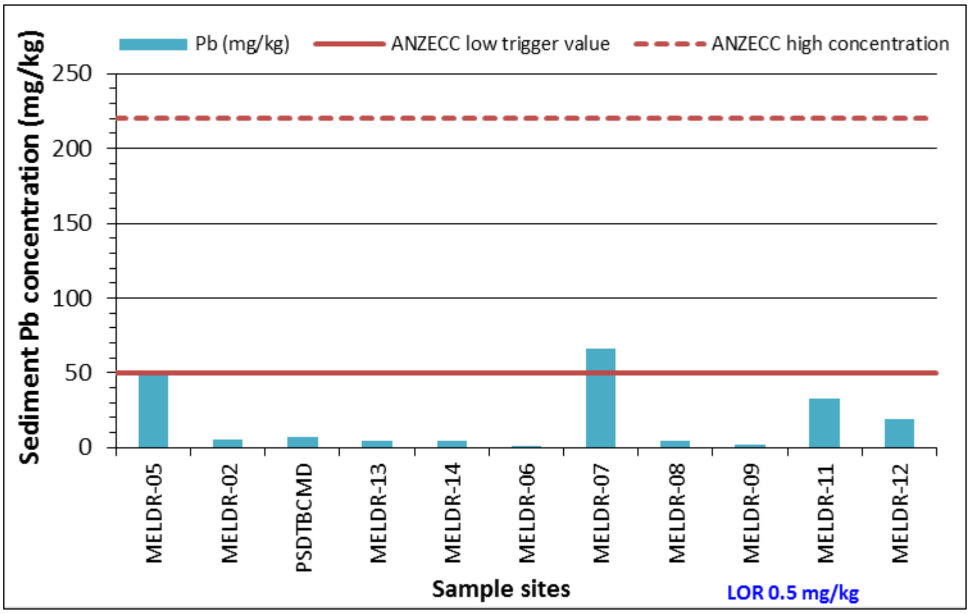

Figure 8.6-1: Sediment total lead concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Total lead concentrations in recorded in sediments have varied across the Melville Bull Creek catchment in the last five years of monitoring (**Table 8.6-1**). Concentrations exceeding the low trigger value have been recorded at six sites (5 (John Creaney Park), 13 (Brentwood drain), 7 (Booragoon Lake), 8 (Piney Lakes outlet), 10 (Frederick

Baldwin) and 12 (Blue Gum Lake) on at least one sampling occasion, and at Booragoon Lake on all sampling occasions.

Table 8.6-1: Records of sediment total lead concentrations (mg/kg) in the Melville Bull Creek catchment 2013 - 2017

Lead (Pb)(total sediment) (mg/kg)

LOR 0.05

ANZECC low TV: 50 mg/kg, high TV: 220 mg/kg

Max (red) 220 Min (blue) 1.7

Site number	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	220	80	14	130	52
MELDR-02	8.6	4.5	20	8.5	5.5
PSDTBCMD	4.2	29	9.6	14	6.8
MELDR-13	2.3	21	2.1	170	4.3
MELDR-14	7.4	8.3	9.2	3.5	4.5
MELDR-06	6.5	5.5	2.2	1.2	1.1
MELDR-07	120		50	56	66
MELDR-08	44	36	66	50	4.4
MELDR-09	1.7	2.9	7.7	3.5	1.8
MELDR-10	48	54	54	200	
MELDR-11	19		8.6	5.7	33
MELDR-12	150	12	59	15	19

Record >LOW Trigger Talue	Concentration < LOR
Record >HIGH Trigger Value	NO sample taken
Record <LOW Trigger Value	

8.7 Mercury

Total mercury concentrations in sediment were all below the ANZECC low (0.15 mg/kg) and high (1.0 mg/kg) trigger values at Melville Bull Creek catchment sites in 2017 (**Figure 8.7-1** and **Table D-35, Appendix D**). The only concentration greater than the limit of reporting (0.02 mg/kg) of 0.03 mg/kg was recorded at site 7 (Booragoon Lake).

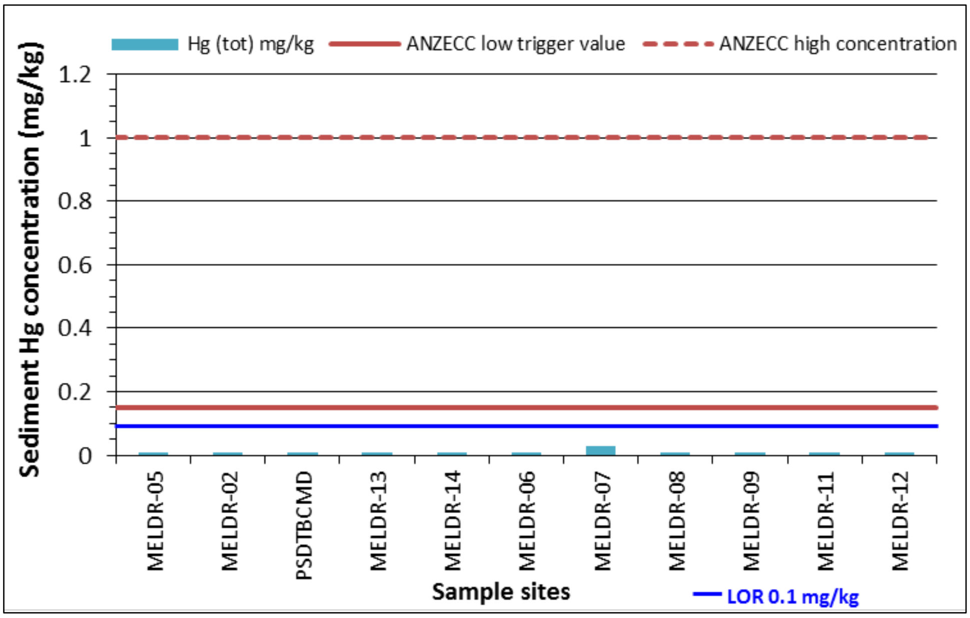

Figure 8.7-1: Sediment total mercury concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Concentrations of total mercury in sediments of the Melville Bull Creek catchment over the past five years of monitoring have generally been low (**Table 8.7-1**). The only exceedance of the ANZECC low trigger value in the past five years of monitoring has been at site 7 (Booragoon Lake) in 2017.

Table 8.7-1: Records of sediment total mercury concentrations (mg/kg) in the Melville Bull Creek catchment 2013 – 2017

Mercury (Hg) (total sediment) (mg/kg)

All data in blue w ere <0.02 or <0.1 (LORs)

ANZECC low TV: 0.15 mg/kg, high TV: 1.0 mg/kg

Max (red) 0.1 Min (blue) <0.1

Site name	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	<0.1	<0.1	<0.1	0.1	<0.02
MELDR-02	<0.1	<0.1	<0.1	<0.1	<0.02
PSDTBCMD	<0.1	<0.1	<0.1	0.1	<0.02
MELDR-13	<0.1	<0.1	<0.1	<0.1	<0.02
MELDR-14	<0.1	<0.1	<0.1	<0.1	<0.02
MELDR-06	<0.1	<0.1	<0.1	<0.1	<0.02
MELDR-07	<0.1		0.1	0.2	0.03
MELDR-08	<0.1	<0.1	0.1	0.1	<0.02
MELDR-09	<0.1	<0.1	<0.1	<0.1	<0.02
MELDR-10	<0.1	<0.1	<0.1	0.1	
MELDR-11	<0.1		<0.1	<0.1	<0.02
MELDR-12	<0.1	<0.1	<0.1	<0.1	<0.02

Record >LOW Trigger Talue	Concentration < LOR
Record >HIGH Trigger Value	NO sample taken
Record <LOW Trigger Value	

8.8 Nickel

Total nickel concentrations in sediment were all below the ANZECC low (21 mg/kg) and high (52 mg/kg) trigger values at Melville Bull Creek catchment sites in 2017 (**Figure 8.8-1** and **Table D-36, Appendix D**). The highest total nickel concentration of 4.2 mg/kg was recorded at site 7 (Booragoon Lake) and site 9 (Quenda Lake outlet) recorded a concentration less than the limit of reporting of 0.1 mg/kg.

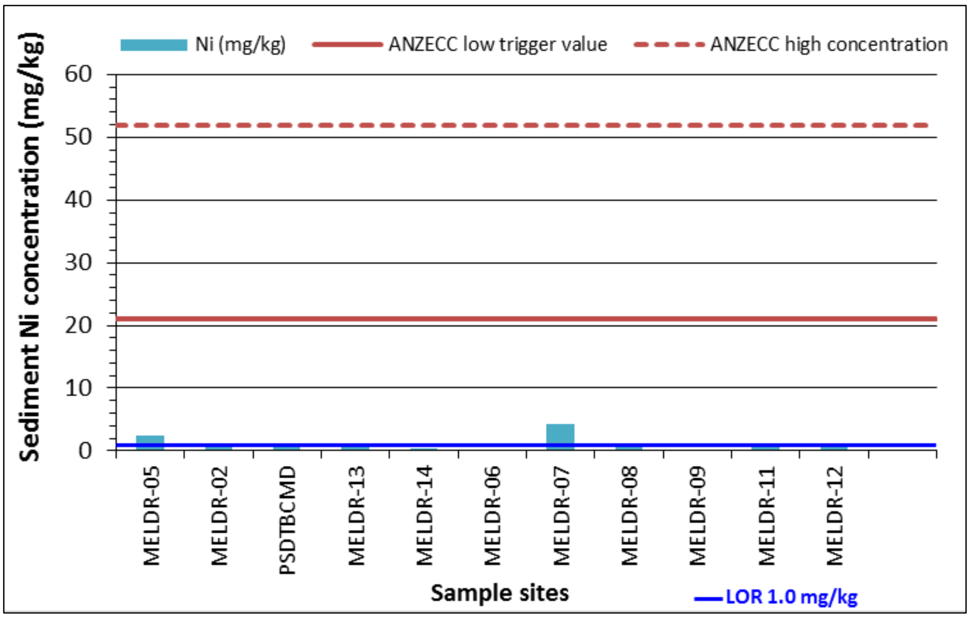

Figure 8.8-1: Sediment total nickel concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Concentrations of total mercury in sediments of the Melville Bull Creek catchment over the past five years of monitoring have generally been low (**Table 8.8-1**). The only exceedances of the ANZECC low trigger value in the past five years of monitoring has been at site 13 (Brentwood drain) in 2016 and at site 7 (Booragoon Lake) in 2015.

Table 8.8-1: Records of sediment total nickel concentrations (mg/kg) in the Melville Bull Creek catchment 2013 – 2017

Nickel (Ni) (total sediment) (mg/kg)

All data in blue were <0.1 or <1.0 (LORs)

ANZECC low TV:21 mg/kg, high TV: 52 mg/kg

Max (red) 31.0 Min (blue) <1.0

Site number	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	2.9	1.4	<1.0	5.5	2.4
MELDR-02	1.2	1.8	2.1	<1.0	0.7
PSDTBCMD	<1.0	1.3	1.8	1.6	0.5
MELDR-13	<1.0	<1.0	<1.0	21	1
MELDR-14	<1.0	<1.0	<1.0	<1.0	0.4
MELDR-06	<1.0	<1.0	<1.0	<1.0	0.2
MELDR-07	8.2		31	7.6	4.2
MELDR-08	4.8	2.7	5.5	5.1	0.5
MELDR-09	<1.0	<1.0	<1.0	<1.0	<0.1
MELDR-10	1.6	1.8	2.2	8.2	
MELDR-11	1.3		1.2	<1.0	1.2
MELDR-12	2.3	<1.0	<1.0	<1.0	0.8

Record >LOW Trigger Talue	Concentration < LOR
Record >HIGH Trigger Value	NO sample taken
Record <LOW Trigger Value	

8.9 Selenium

No guideline currently exists for selenium concentrations in sediment; therefore it is difficult to gauge the severity of any potential impact arising from the concentrations recorded in the sediment of the Melville Bull Creek catchment. Selenium concentrations in sediments in 2017 were all below the limit of reporting of 0.5 mg/kg except at sites 7 (Booragoon Lake outlet) which recorded a concentration of 1.3 mg/kg, 5 (John Creaney Park) which recorded a concentration of 0.14 mg/kg and 11 (Marmion Reserve) which recorded a concentration of 0.1 mg/kg (**Figure 8.9-1** and **Table D-37, Appendix D**).

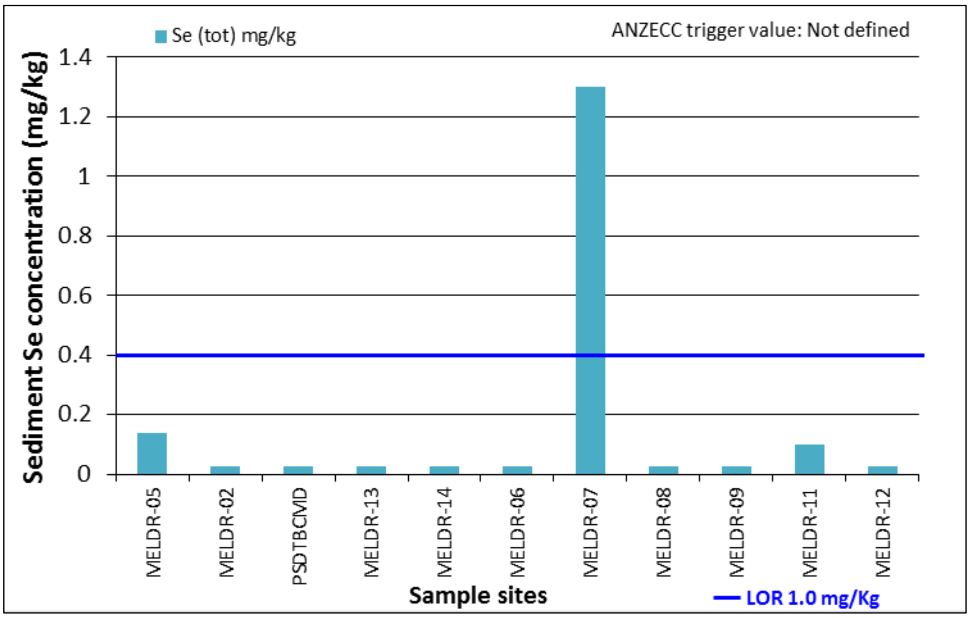

Figure 8.9-1: Sediment total selenium concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

Similar sediment total selenium concentrations have been recorded over the five years of monitoring of Melville Bull Creek catchment sites, with site 7 (Booragoon Lake outlet) generally the only site recording concentrations greater than 1 mg/kg (**Table 8.9-1**).

Table 8.9-1: Records of sediment total selenium concentrations (mg/kg) in the Melville Bull Creek catchment 2013 - 2017

Selenium (Se) (total sediment) (mg/kg)					
ANZECC trigger value: ND	All data in blue <0.05 or <1.0 mg/Kg (LORs)				
Max (red) 2.8	Min (blue) <0.05				
Site name	**Nov-13**	**Sep-14**	**Oct-15**	**Oct-16**	**Oct-17**
MELDR-05	<1.0	<1.0	<1.0	<1.0	0.14
MELDR-02	<1.0	<1.0	<1.0	<1.0	<0.05
PSDTBCMD	<1.0	<1.0	<1.0	1.1	<0.05
MELDR-13	<1.0	<1.0	<1.0	<1.0	<0.05
MELDR-14	<1.0	<1.0	<1.0	<1.0	<0.05
MELDR-06	<1.0	<1.0	<1.0	<1.0	<0.05
MELDR-07	2.8		1.3	2.9	1.3
MELDR-08	<1.0	<1.0	<1.0	<1.0	<0.05
MELDR-09	<1.0	<1.0	<1.0	<1.0	<0.05
MELDR-10	<1.0	<1.0	<1.0	<1.0	
MELDR-11	<1.0		<1.0	<1.0	0.1
MELDR-12	<1.0	<1.0	<1.0	<1.0	<0.05
Highest concentration of the year					
Lowest concentration of the year					

8.10 Zinc

Sediment total zinc concentrations in Melville Bull Creek catchment sites in 2017 were low, with all concentrations below ANZECC low (200 mg/kg) and high (410 mg/kg) trigger values (**Figure 8.10-1** and **Table D-38, Appendix D**). The highest concentration of 58 mg/kg was recorded at site 5 (John Creaney Park) and two samples (from sites 8 (Piney Lakes outlet) and 9 (Quenda Lake outlet)) recorded concentrations less than the limit of reporting of 0.25 mg/kg.

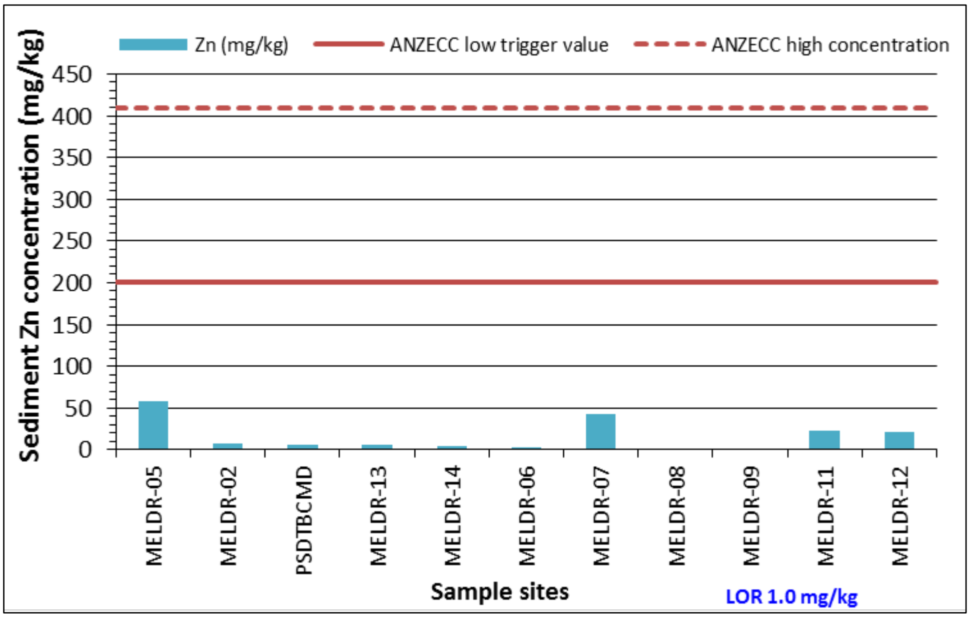

Figure 8.10-1: Sediment total zinc concentrations (mg/kg) in Melville Bull Creek catchment sites in 2017

During the five years of monitoring of Bull Creek catchment sites, only sites 13 and 10 (Brentwood drain and Frederick Baldwin respectively) have recorded zinc concentrations in exceedance of the low trigger value, recording anomalously high concentrations in 2016 (**Table 8.10-1**).

Table 8.10-1: Records of sediment total zinc concentrations (mg/kg) in the Melville Bull Creek catchments 2013 - 2017

Zinc (Zn) (total sediment) (mg/kg)

All data in blue <0.25 or <1.0 mg/Kg (LORs)

ANZECC low TV:200 mg/kg, high TV: 410 mg/kg

Max (red) 120 Min (blue) <1.0

Site number	Nov-13	Sep-14	Oct-15	Oct-16	Oct-17
MELDR-05	49	24	20	120	58
MELDR-02	26	15	49	19	7.2
PSDTBCMD	3.7	22	18	35	5.6
MELDR-13	13	27	6.8	390	5.7
MELDR-14	6.1	6.4	9.4	5.5	3.9
MELDR-06	14	22	4.4	4.2	3.1
MELDR-07	95		120	57	42
MELDR-08	34	25	39	49	<0.25
MELDR-09	1.0	<1.0	3.7	1.4	<0.25
MELDR-10	30	39	48	320	
MELDR-11	17		13	16	23
MELDR-12	37	9.9	13	5.6	21

Record >LOW Trigger Talue	Concentration < LOR
Record >HIGH Trigger Value	NO sample taken
Record <LOW Trigger Value	

8.11 Particle size analysis

Particle size distribution of sediment was grouped into the following size classes according to the Wentworth scale (Wentworth 1992):

- Clay <4 µm
- Silt 4-62 µm
- Fine sand 62-250 µm
- Medium sand 250-500 µm
- Coarse sand 500-2,000 µm
- Gravel >2,000 µm

The dominant sediment particle size fractions for seven of the 11 sites, sites 2, PSDTBCMD, 13, 14, 6, 11 and 12 (Brockman Park, Brentwood drain, RAAF drain, Bateman Park, Quenda Lake outlet, Marmion Reserve and Blue Gum lake outlet respectively), were medium sand and coarse sand (see **Table 8.1-1** and **Figure 8.11-1** for details). Sediment at sites 5 and 8 (John Creaney Park and Piney Lake outlet respectively) was comprised of coarse sand with some silt and medium sand, sediment at site 9 (Quenda Lake outlet) was comprised of medium sand with some fine sand, coarse sand and silt, and sediment at site 7 (Booragoon Lake outlet) was comprised of silt with some fine sand.

It should be noted that site 7, which had the finest sediment (53.34% silt, 16.17% fine sand and 9.16% clay) in 2017 also had the highest sediment aluminium, arsenic, chromium, iron, mercury, nickel and selenium concentrations, and recorded an exceedance of the trigger value for lead. This is likely to be because finer sediments are able to bind greater concentrations of trace metals due to their greater surface area to volume ratio (Parizanganeh 2008). Concentrations of these metals in water, other than for iron and aluminium, were below relevant trigger values and were similar to concentrations at other sites. This may indicate that the fine sediments are acting as a store for these metals rather than releasing them into the water column.

These results highlight the importance of including particle size analysis to gain a better understanding of the nature of the contamination and potentially help 'explain' the high concentrations of these metals both in water and in sediment.

Table 8.11-1: Particle size analysis results from Melville Bull Creek catchment sites in 2017

Site Name	Site Ref No.	Date Collected	Clay % (<4 µm)	Silt % (4-62 µm)	Fine sand % (62-250 µm)	Medium sand % (250-500 µm)	Coarse sand % (500-2,000 µm)	Gravel % (>2,000 µm)
JOHN CREANEY PARK	MELDR-05	11-Oct-17	4.19	**25.08**	9.14	20.48	**27.60**	13.50
BROCKMAN PARK	MELDR-02	11-Oct-17	0.00	0.00	3.09	**54.51**	**37.80**	4.60
BULL CREEK MD	PSDTBCMD	11-Oct-17	1.83	4.13	2.13	**61.12**	**30.20**	0.60
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.00	0.00	1.19	**53.41**	**44.00**	1.40
RAAF DRAIN	MELDR-14	11-Oct-17	0.00	0.00	7.39	**61.41**	**30.60**	0.60
BATEMAN PARK	MELDR-06	11-Oct-17	0.00	0.00	2.31	**53.29**	**44.30**	0.10
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	9.16	**53.34**	**16.17**	4.24	7.20	9.90
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	3.91	**19.77**	7.01	15.01	**53.60**	0.70
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	2.25	11.87	**15.68**	**55.01**	13.50	1.70
MARMION RESERVE	MELDR-11	11-Oct-17	1.92	11.97	7.50	**40.51**	**36.10**	2.00
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	1.82	11.68	8.47	**33.33**	**40.80**	3.90

Highest particle size %

Second highest particle size %

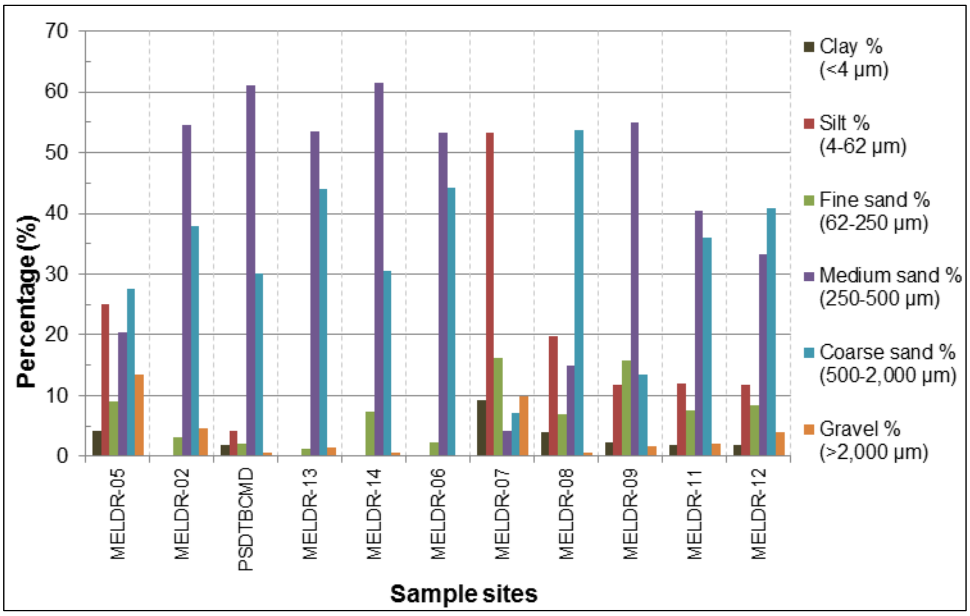

Figure 8.11-1: Particle size distribution (%) by site in sediment of the Melville Bull Creek catchments in 2017.

9. Summary of 2017 results

Figure 9-1, Figure 9-2, Figure 9-3 and **Figure 9-4** include catchment maps showing sites with water physicochemical properties, water nutrients, metals in water and metals in sediment respectively exceeding relevant trigger values/outside acceptable ranges. **Table 9-1, Table 9-2** and **Table 9-3** contain summaries of the physicochemical, nutrient and metal water quality data, and **Table 9-4** contains a summary of sediment metal concentrations, recorded in Melville Bull Creek catchment sites collected in 2017.

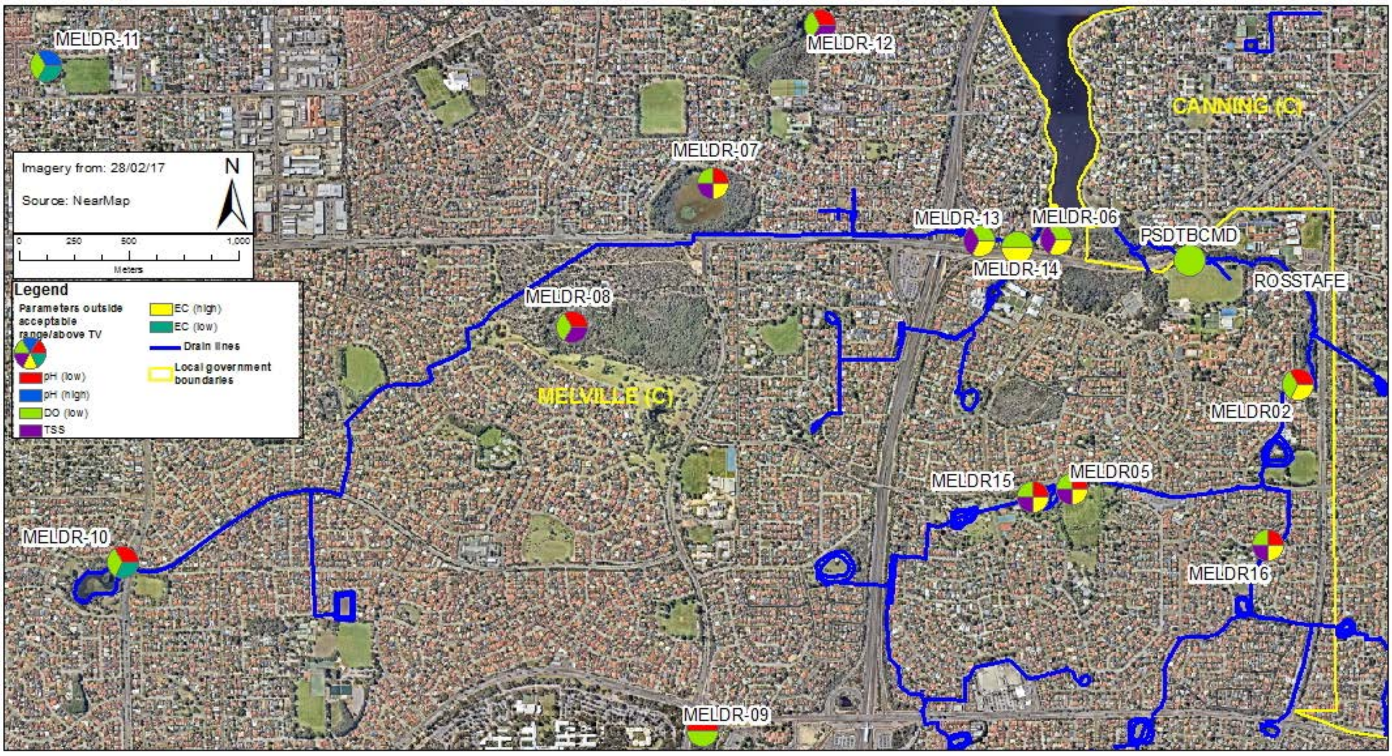

Figure 9-1: Site map showing sites with values outside of ANZECC acceptable ranges for lowland rivers (ANZECC and ARMCANZ 2000) for pH, dissolved oxygen % (DO) and electrical conductivity (EC) and exceeding the DWER interim value (DoW n.d.) for total suspended solids (TSS) in water at Melville Bull Creek catchment sites in 2017.

Table 9-1: Summary of physicochemical parameter values outside acceptable ranges/exceeding trigger values per site and physicochemical data overall in water at Melville Bull Creek catchment sites in 2017.

		Parameter	pH	Dissolved Oxygen (%)	Conductivity (uS/cm)	TSS | mg/L
		Acceptable range/trigger value	ANZECC acceptable range: lowland rivers: 6.5-8 wetlands: 7.0 - 8.5	ANZECC acceptable range: lowland rivers: 80 - 120 wetlands: 90 - 120	ANZECC acceptable range: lowland rivers: 6.5-8 wetlands: 7.0 - 8.5	DWER interim trigger value: 6
Site			Number outside range/above trigger value			
Drain sites	JOHN CREANEY PARK INLET	MELDR-15	2 (low)	4 (low)	3 (high)	4
	JOHN CREANEY PARK	MELDR-5	3 (low)	4 (low)	4 (high)	1
	DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	0	4 (low)	3 (high)	2
	BROCKMAN PARK	MELDR-2	4 (low)	4 (low)	4 (high)	0
	BULL CREEK MD	PSDTBCMD	0	4 (low)	4 (high)	0
	BRENTWOOD DRAIN	MELDR-13	0	4 (low)	4 (high)	4
	RAAF DRAIN	MELDR-14	0	3 (low)	4 (high)	0
	BATEMAN PARK	MELDR-06	0	4 (low)	4 (high)	1
Wetland sites	BOORAGOON LAKE OUTLET	MELDR-07	3 (low)	3 (low)	2 (high)	2
	PINEY LAKES OUTLET	MELDR-08	4 (low)	4 (low)	0	2
	QUENDA LAKE OUTLET	MELDR-09	4 (low)	4 (low)	0	0
	FREDERICK BALDWIN	MELDR-10	2 (low)	4 (low)	2 (low)	0
	MARMION RESERVE	MELDR-11	4 (high)	4 (low)	4 (low)	0
	BLUE GUM LAKE OUTLET	MELDR-12	4 (low)	4 (low)	0	3
		Total above acceptable range/trigger value	4	0	32	19
		Total below acceptable range	26	54	6	NA
		Total below LOR	NA	NA	NA	6
		Min (site)	5.61 (MELDR-08)	1.2 (MELDR-07)	0.129 (MELDR-11)	<1 (5 sites)
		Max (site)	9.81 (MELDR-11)	81.1 (MELDR-14)	1.858 (MELDR-05)	58 (MELDR-16)

Key	
	Exceedances recorded for this parameter on all sampling occasions when analysed
	Exceedances recorded for this parameter on at least one sampling occasion
	Exceedances not recorded for this parameter

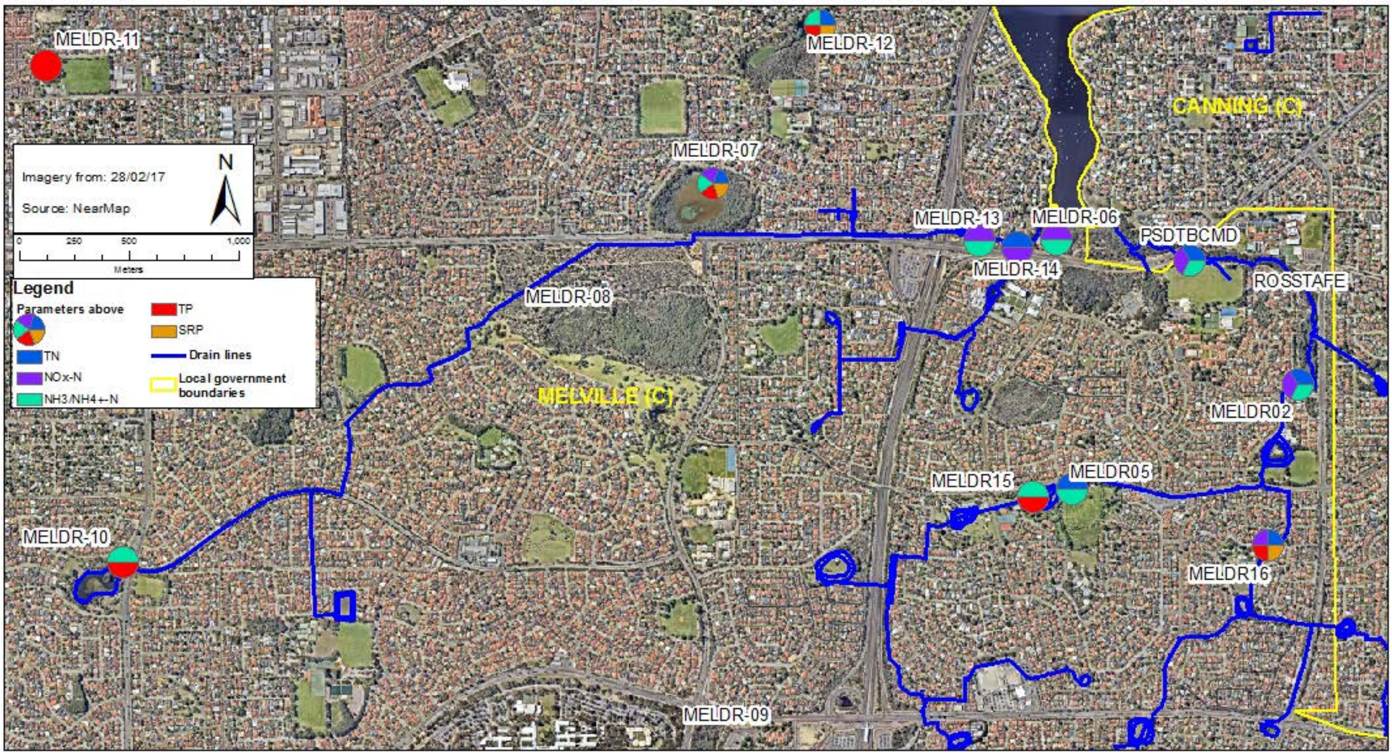

Figure 9-2: Site map showing sites with concentrations (mg/L) exceeding the ANZECC trigger value for lowland rivers or wetlands (ANZECC and ARMCANZ 2000) for total nitrogen (TN), total oxidised nitrogen (NOx-N), ammonia nitrogen (NH_3/NH^{4+}-N), total phosphorus (TP) and soluble reactive phosphorus (SRP) in water at Melville Bull Creek catchment sites in 2017.

Table 9-2: Summary of exceedances of trigger values for nutrients per site and nutrient data overall in water at Melville Bull Creek catchment sites in 2017.

		Parameter	Total Nitrogen (mg/L)	Total Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)		Dissolved Organic Nitrogen (mg/L)	Total Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)
		Trigger value	ANZECC stressor TVs: lowland rivers: 1.2 wetlands: 1.5	ANZECC stressor TVs: lowland rivers: 0.15 wetlands: 0.1	ANZECC stressor TVs: lowland rivers: 0.08 wetlands: 0.04	ANZECC TV for protection of biota (unadjusted) : 0.9	No TV	No TV	ANZECC stressor TVs: lowland rivers: 0.065 wetlands: 0.06	ANZECC stressor TVs: lowland rivers: 6.5-8 wetlands: 7.0 - 8.5
Site			Number of samples above trigger value							
Drain sites	JOHN CREANEY PARK INLET	MELDR-15	0	0	3	0			2	0
	JOHN CREANEY PARK	MELDR-5	1	0	3	0			0	0
	DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	3	3	0	0			3	2
	BROCKMAN PARK	MELDR-2	4	3	4	4			0	0
	BULL CREEK MD	PSDTBCMD	4	4	4	0			0	0
	BRENTWOOD DRAIN	MELDR-13	0	4	4	0			0	0
	RAAF DRAIN	MELDR-14	1	2	0	0			0	0
	BATEMAN PARK	MELDR-06	0	4	4	1			0	0
Wetland sites	BOORAGOON LAKE OUTLET	MELDR-07	3	2	3	0			3	3
	PINEY LAKES OUTLET	MELDR-08	0	0	0	0			0	0
	QUENDA LAKE OUTLET	MELDR-09	0	0	0	0			0	0
	FREDERICK BALDWIN	MELDR-10	0	0	1	0			1	0
	MARMION RESERVE	MELDR-11	0	0	0	0			1	0
	BLUE GUM LAKE OUTLET	MELDR-12	4	0	4	0			4	4
		Total above trigger value	20	22	30	5	NA	NA	14	9
		Total below LOR	0	12	6 (4 sites)		0	0	0	17
		Min (site)	0.22 (MELDR-10)	<0.01 (4 sites)	<0.01		0.18 (MELDR-16)	0.19 (MELDR-10)	0.006 (MELDR-08)	<0.005 (8 sites)
		Max (site)	7.9 (MELDR-07)	2.2 (PSDTBCMD)	4.8 (MELDR-02)		2.5 (MELDR-07)	3.5 (MELDR-07)	4 (MELDR-07)	3.3 (MELDR-07)

Key

Exceedances recorded for this parameter on all sampling occasions when analysed (red)	Exceedances not recorded for this parameter (green)
	No trigger value for this paramater (lilac)
Exceedances recorded for this parameter on at least one sampling occasion (yellow)	Parameter not analysed at this site (blue)

Figure 9-3: Site map showing sites with concentrations (mg/L) exceeding the ANZECC trigger value for protection of biota (ANZECC and ARMCANZ 2000) for total and soluble aluminium, copper, iron, and zinc in waters at Melville Bull Creek catchment sites in 2017.

Table 9-3: Summary of exceedances of metal trigger values per site and metals data overall in water at Melville Bull Creek catchment sites in 2017.

		Parameter	Aluminium (mg/L)		Chromium (mg/L)		Copper (mg/L)		Iron (mg/L)		Lead (mg/L)		Mercury (mg/L)		Zinc (mg/L)		Hardness (mg/L)
		Trigger value for protection of biota	0.055		0.0033 (unadjusted)		0.0014 (unadjusted)		0.3		0.0034 (unadjusted)		0.0006		0.008 (unadjusted)		No TV
			Total	Soluble	Total	Soluble	Total	Soluble	Total	Soluble	Total	Soluble	Total	Soluble	Total	Soluble	
Site			Number of samples above trigger value														
Drain sites	JOHN CREANEY PARK INLET	MELDR-15	1	4	0	0	1	1	0	3	0	0			1	4	
	JOHN CREANEY PARK	MELDR-5	1	4	0	0	1	0	1	4	0	0			1	1	
	DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	0	3	0	0	1	4	0	3	0	0			1	4	
	BROCKMAN PARK	MELDR-2	1	4	0	0	0	0	1	4	0	0			0	0	
	BULL CREEK MD	PSDTBCMD	1	4	0	0	0	0	1	3	0	0			0	0	
	BRENTWOOD DRAIN	MELDR-13	1	4	0	0	0	0	1	4	0	0	0	0	0	0	
	RAAF DRAIN	MELDR-14	1	4	0	0	0	0	1	3	0	0	0	0	0	0	
	BATEMAN PARK	MELDR-06	1	4	0	0	0	0	1	4	0	0	0	0	0	0	
Wetland sites	BOORAGOON LAKE OUTLET	MELDR-07	1	2	0	0	0	0	1	3	0	0			0	0	
	PINEY LAKES OUTLET	MELDR-08	1	4	0	0	0	0	1	4	0	0			0	1	
	QUENDA LAKE OUTLET	MELDR-09	1	4	0	0	0	0	0	2	0	0			0	0	
	FREDERICK BALDWIN	MELDR-10	0	0	0	0	1	1	0	1	0	0			1	2	
	MARMION RESERVE	MELDR-11	1	2	0	0	0	0	0	2	0	0			0	0	
	BLUE GUM LAKE OUTLET	MELDR-12	1	4	0	0	0	0	1	4	0	0			0	0	
		Total above trigger value	12	47	0	2	4	6	9	44	0	0	0	0	4	12	NA
		Total below LOR	0	0	0	0	0	0	0	0	1	5	10	10	1	2	0
		Min (site)	0.029 (MELDR10)	0.015 (MELDR10)	0.0001 (MELDR10 & MELDR11)	<0.0001 (MELDR10)	0.0004 (MELDR9)	0.0002 (MELDR13)	0.053 (MELDR16)	0.039 (MELDR16)	<0.0001 (MELDR10)	<0.0001 (3 sites)	<0.0001 (3 sites)	<0.0001 (3 sites)	<0.005 (MELDR11)	0.001 (MELDR11)	24 (MELDR16)
		Max (site)	0.55 (MELDR13)	1 (MELDR9)	0.0019 (MELDR12)	0.0038 (MELDR16)	0.0044 (MELDR15)	0.005 (MELDR16)	6.8 (MELDR12)	6 (MELDR7)	0.0073 (MELDR12)	0.0067 (MELDR12)	0.0002 (MELDR13 & MELDR14)	0.0002 (MELDR13 & MELDR14)	0.14 (MELDR15)	0.097 (MELDR15)	440 (MELDR7)

Key

Exceedances recorded for this parameter on all sampling occasions when analysed	Exceedances not recorded for this parameter
Exceedances recorded for this parameter on at least one sampling occasion	No trigger value for this paramater
	Parameter not analysed at this site

Figure 9-4: Site map showing sites with sediment lead concentrations (mg/kg) exceeding the low ANZECC trigger value (ANZECC and ARMCANZ 2000), sites not recording any exceedances of metals in sediments and sites where sediment samples were not collected at Melville Bull Creek catchment sites in 2017.

Table 9-4: Summary of exceedances of metal trigger values per site and metals data overall in sediment at Melville Bull Creek catchment sites in 2017.

		Parameter	Total Aluminium (mg/kg)	Total Arsenic (mg/kg)	Total Chromium (mg/kg)	Total Copper (mg/kg)	Total Iron (mg/kg)	Total Lead (mg/kg)	Total Mercury (mg/kg)	Total Nickel (mg/kg)	Total Selenium (mg/kg)	Total Zinc (mg/kg)
		Trigger value	No TV	Low TV: 20 High TV: 70	Low TV: 80 High TV: 370	Low TV: 65 High TV: 270	No TV	Low TV: 50 High TV: 220	Low TV: 0.15 High TV: 1	Low TV: 21 High TV: 52	No TV	Low TV: 200 High TV: 410
Site			Number of samples above low trigger value									
Drain sites	JOHN CREANEY PARK INLET	MELDR-15										
	JOHN CREANEY PARK	MELDR-5		0	0	0		1	0	0		0
	DOWNSTREAM ELIZABETH MANION PARK	MELDR-16										
	BROCKMAN PARK	MELDR-2		0	0	0		0	0	0		0
	BULL CREEK MD	PSDTBCMD		0	0	0		0	0	0		0
	BRENTWOOD DRAIN	MELDR-13		0	0	0		0	0	0		0
	RAAF DRAIN	MELDR-14		0	0	0		0	0	0		0
	BATEMAN PARK	MELDR-06		0	0	0		0	0	0		0
Wetland sites	BOORAGOON LAKE OUTLET	MELDR-07		0	0	0		1	0	0		0
	PINEY LAKES OUTLET	MELDR-08		0	0	0		0	0	0		0
	QUENDA LAKE OUTLET	MELDR-09		0	0	0		0	0	0		0
	FREDERICK BALDWIN	MELDR-10										
	MARMION RESERVE	MELDR-11		0	0	0		0	0	0		0
	BLUE GUM LAKE OUTLET	MELDR-12		0	0	0		0	0	0		0
		Total above trigger value	NA	0	0	0	NA	2	0	0	NA	0
		Total below LOR	0	0	0	4	0	0	10	1	8	2
		Min (site)	383 (MELDR8)	0.1 (MELDR8 & MELDR9)	0.88 (MELDR6)	<0.5 (4 sites)	180 (MELDR11)	1.1 (MELDR6)	<0.01 (10 sites)	<0.1 (MELDR9)	<0.5 (8 sites)	<0.25 (MELDR8 & MELDR9)
		Max (site)	5290 (MELDR7)	4.9 (MELDR7)	26 (MELDR7)	16 (MELDR5)	8200 (MELDR7)	66 (MELDR-07)	0.03 (MELDR7)	4.2 (MELDR7)	1.3 (MELDR7)	58 (MELDR5)

Key

- Exceedances recorded for this parameter on all sampling occasions when analysed (red)
- Exceedances not recorded for this parameter (green)
- No trigger value for this paramater (purple)
- Parameter not analysed at this site (blue)

10. Discussion

10.1 Comparison of 2017 data to previous data

Water and sediment results from samples collected in 2017 were generally similar to results recorded in previous years, with the following exceptions:

- Sites 7 (Booragoon Lake) and 12 (Blue Gum Lake), although still recording pH values lower than the ANZECC acceptable range, did not record particularly low pH values (i.e. less than 5) as they have done in previous years;
- Site 11 (Marmion Reserve) recorded high (>9) pH values on all sampling occasions in 2017, which has not occurred since 2010;
- At Booragoon Lake (site 7), total nitrogen concentrations recorded in August (7.9 mg/L) and September (5.2 mg/L), and total phosphorus concentrations recorded in September (3.6 mg/L) and October (4 mg/L) were significantly higher than those recorded at all sampling occasions at the site since 2011 and 2010 respectively;
- Sites 15 (John Creaney Park inlet) and 16 (downstream Elizabeth Manion Park) recorded higher total phosphorus concentrations than those previously recorded at all sampling occasions at these sites since monitoring of these sites began in 2014.
- The particularly high sediment metal concentrations recorded at site 13 (Brentwood drain) in 2016 were not recorded in 2017 and were also not recorded in 2013, 2014 or 2015, indicating that the sediment sample collected in 2016 was not representative of the typical sediment quality at the site.

10.2 Long term patterns

Monitoring of some sites in the Melville Bull Creek catchment has been occurring for over ten years, allowing long term patterns to be assessed. The following noteworthy long term patterns have been observed in the catchment:

- Dissolved oxygen saturations at site 9 (Quenda Lake outlet), 10 (Frederick Baldwin) and 12 (Blue Gum Lake) appear to be decreasing since monitoring began in 2007;
- Site 7 (Booragoon Lake), while still recording very high and variable concentrations of these parameters, has generally recorded lower concentrations of total nitrogen (and ammonia nitrogen) and total phosphorus since 2012 than in the years prior to this (since monitoring began in 2007);
- Site 12 (Blue Gum Lake), has generally recorded higher concentrations of total nitrogen (and ammonia), total phosphorus (and soluble reactive phosphorus) and total iron since 2012 than in the years prior to this (since monitoring began in 2007);
- Total nitrogen (and ammonia nitrogen), total iron and total aluminium concentrations have generally been declining at site 6 (Bateman Park) since monitoring of the parameters began in 2007;
- Site 9 (Quenda Lake outlet) has recorded generally higher total nitrogen (and ammonia nitrogen) and total aluminium concentrations since 2013.

10.3 Key Issues

Based on the below findings, it is considered that Bull Creek main drain, Booragoon Lake and Blue Gum Lake have the poorest water quality in the catchment and therefore management responses should be focussed on improvement of these sites.

10.3.1 Drainage branches

Bull Creek main drain

High total nitrogen concentrations, well in exceedance of the ANZECC trigger value for lowland rivers, have been recorded over the years at particular sites along the Bull Creek main drain since monitoring began in 2007. Total nitrogen is often high at sites along the two upstream branches of the Bull Creek main drain: at John Creaney Park (although not its inlet (site 15)) and at Elizabeth Manion Park. However a significant portion of nitrogen, predominantly as ammonia/ammonium, is being introduced to the drainage line between the convergence of these two branches and Brockman Park (site 2). This may be originating from groundwater, as high concentrations of ammonia have been recorded in the Jandakot Mound (Larsen et al 1998), and could possibly be even higher in this area as a result of the historical landfill at John Creaney Park (DWER 2017). As water flows from site 2 to the most downstream site PSDTBCMD, total nitrogen concentrations tend to reduce by an average of approximately 50%, perhaps due to uptake of nitrogen by macrophytes, loss to the environment as nitrogen gas or dilution from the drainage branch coming from Rossmoyne Senior High School (ROSSTAFE). The remaining nitrogen at PSDTBCMD is predominantly in the form of oxidised nitrogen rather than ammonia nitrogen, perhaps due to the slight oxygenation of the water occurring between these two sites. The exceeding total nitrogen concentrations consistently recorded at PSDTBCMD are of concern as this nitrogen would contribute to eutrophication of the Swan River. Furthermore, the ammonia concentrations in exceedance of the freshwater protection trigger value at Brockman Park are concerning as the portion of Bull Creek main drain downstream of Brockman Park is known to support a variety of native fauna species including frogs, fish and macroinvertebrates (City of Melville 2014b).

The often high phosphorus concentrations at John Creaney Park lake, while not resulting in high phosphorus concentrations in downstream Bull Creek main drain sites, could, in conjunction with high nitrogen concentrations, result in algal and nuisance macrophyte growth in the lake. Filamentous algae has often been observed at this lake over the years of sampling.

Sediment samples collected from John Creaney Park lake have recorded lead concentrations exceeding the ANZECC low trigger value in four out of the last five years. These high concentrations may be a legacy of previous contamination (possibly from the previous landfill at the site) persisting in the sediments due to their fine, organic nature, as lead is strongly bound by fine and organic particles (ANZECC and ARMCANZ 2000). Although lead concentrations in samples from this site have only once exceeded 95% freshwater protection hardness modified trigger values in the previous eleven years of monitoring (in 2007), under certain conditions (e.g. low pH) it could be released from the sediments and into the water column and have toxic effects on biota within the lake, as well as contributing to lead contamination in downstream Bull Creek main drain and the Canning River.

The high concentrations of iron and aluminium recorded at Bull Creek main drain sites are concerning as these metals can have negative effects on biota, however the concentrations recorded are similar to those recorded across all Swan and Canning River drainage catchments (Nice et al 2009). High concentrations of total zinc have been regularly recorded at John Creaney Park inlet and downstream Elizabeth Manion Park, and high total copper concentrations have often been recorded at downstream Elizabeth Manion Park since monitoring of these sites began in 2014. Soluble zinc and copper concentrations recorded at these sites in 2017 indicate a significant proportion of these total metals are likely to be soluble. Again however, concentrations of zinc and copper high exceedances of the trigger values for these metals is common across Swan and Canning River drainage catchments (Nice et al 2009), and concentrations have generally been acceptable at downstream sites.

Low oxygen saturations have been consistently recorded in Bull Creek main drain sites over the previous eleven years of sampling catchment. This is a common finding with heavily piped catchments and/or wetlands with excessively high organic loads (either from animal waste or vegetation decomposition), however this is still a concerning issue as low oxygen saturations can be directly harmful to biota, result in increased toxicity of some metals to biota, and result in phosphorus release from sediments and subsequent eutrophication. Dissolved oxygen saturations are particularly low at John Creaney Park, and much lower than at the inlet to the lake. When sampled, the lake at John Creaney Park always contains a large amount of leaf litter and organic debris, which may be contributing to high oxygen demand as this material decomposes. Groundwater, which is generally lower in oxygen than stormwater, may also be filling this lake.

Brentwood drain

Water quality has been comparatively good in recent years in the Brentwood and Mandala Crescent Branch drain sites (13, 14 and 6), with water at the most downstream site of the confluence of these drains at Bateman Park (site 6) showing a pattern of declining concentrations of total nitrogen (and ammonia nitrogen), total and soluble iron and total aluminium over the eleven years of monitoring. 2017 results at this site were comparable to those in 2016 - it is too early to determine whether the Brentwood Living Stream project has resulted in improvement of water quality at Bateman Park. However it should be noted that a preliminary macrophyte study conducted by North Metropolitan TAFE Diploma of Environmental Monitoring and Technology students and staff at Brentwood Living Stream recorded the presence of juvenile stoneflies (*Plecoptera*) and hydras (North Metropolitan TAFE 2017), species that are very sensitive to pollution and disturbance, indicating that the Living Stream is already providing a good macroinvertebrate habitat.

Although exceedances of total nitrogen are generally not recorded at these sites, the exceedances of total oxidised nitrogen (a form of nitrogen highly available for plant growth) generally recorded in these drains could result in algal or nuisance macrophyte growth in areas of the drains where water is still. The high concentrations of iron and aluminium recorded at these sites are also concerning as these metals can have negative effects on biota, however the concentrations recorded are representative of those recorded across all Swan and Canning River drainage catchments (Nice et al 2009).

10.3.2 Melville lakes

Sites 7 and 12 (Booragoon Lake and Blue Gum Lake) have usually recorded high total nitrogen (and ammonia) concentrations and almost always recorded high total phosphorus (and soluble reactive phosphorus) concentrations over the past eleven years of sampling. Often, these concentrations are higher in spring months than autumn months, which may be due to an accumulation of nutrients in the lakes over the rainy period or due to large waterbird populations in the lakes in spring. The combination of high soluble phosphorus and nitrogen is likely to be the cause of the algae often observed in these lakes. This is of concern as these lakes have high conservation value and algal blooms could negatively impact upon both the biota and aesthetic value of the lakes. Interestingly, nutrient concentrations have been generally lower at Lake Booragoon (with the exception of 2017 concentrations) since 2012 than the years prior to this, and conversely have been higher at Blue Gum Lake since 2012 than the years prior to this. The reasons for this are unknown and should be investigated.

The pH at site 11 (Marmion Reserve) has often been high in late spring and summer months in previous years, and was high at all sampling occasions in 2017. The combination of high pH and high dissolved oxygen saturation observed at this site may be due to the aeration fountain or to the photosynthesis of the algae (both macroalgae and phytoplankton) commonly observed at this site.

Although still usually below the trigger value, total nitrogen (largely total organic nitrogen) concentrations at site 9 (Quenda Lake) have been higher at the lake since 2013 than in the years prior to this. Total aluminium concentrations have also increased somewhat since this time, with concentrations often the highest of all the Melville Lakes, and pH values somewhat lower. It is possible that the lake be receiving more nutrient rich runoff as a result of the surrounding development in the previous five years (Fiona Stanley hospital and surrounding infrastructure). Natural Area Consulting (2016) noted that “Stormwater drainage from the hospital car park to the east is causing erosion of the Water Corporation sewerage line embankment, with dislodged soil being washed across the limestone path and into the wetland”, which may be resulting in these changes to water quality.

The decreasing dissolved oxygen saturations recorded at Melville Lakes sites over the eleven years of monitoring are concerning as this can be directly harmful to biota, result in increased toxicity of some metals to biota, and result in phosphorus release from sediments and subsequent eutrophication. The reasons for this decrease are unknown, but could be due to increases in biological oxygen demand at these sites over this time.

Values of pH recorded at Booragoon Lake outlet and Blue Gum Lake outlet (and to a lesser degree site 8 (Piney Lakes outlet)) have often been particularly low in the previous eleven years of monitoring (especially so in winter months), although were less so at Booragoon Lake and Blue Gum Lake in 2017. These low pH levels are of concern as low pH can increase the toxicity of some metals, and can also have a direct negative effect on biota. The cause of the low pH in these winter to early spring months may be due to oxidation of acid sulfate soils proven (Booragoon Lake (Oldweather 2012) or likely (Blue Gum Lake and Piney Lakes (Department of Environment Regulation 2016)) to be present at the lakes and acidification of the overlying lake waters due to generally lowered lake levels and seasonally fluctuating water levels. Lowered lake levels are likely to be as a result of both reduced stormwater flow and lower groundwater levels in the Jandakot Mound resulting from lower rainfall in recent years (Natural Area Consulting 2012a, 2012b). It is possible that the somewhat higher water levels observed at these lakes in winter and spring of 2017 may be resulting in less oxidation of acid sulfate soils and therefore less acidity entering the lake waters. Low pH can also be caused by the presence of high concentration of tannins in the water. Tannins are organic compounds derived from plant materials that give water a brown (often described as “tea coloured”) hue, and break down into humic and fulvic acids. The presence of excess plant material in the water is likely to result in the production of high concentrations of tannins. Tannin staining was noted in 2017 on various sampling occasions at sites 7, 8 and 12. Pine needles are known to be a rich source of acidic tannins (Northup et al 1995) and the pine trees adjacent to the wetland at Piney Lakes reserve may be partly responsible for the low pH values at this site.

Regular exceedances of soluble zinc have been recorded at site 10 (Frederick Baldwin Lake) as a result of the soft water at this site. Furthermore, Booragoon Lake and Blue Gum Lake, although only sometimes recording exceedances of total copper, lead and zinc, have sporadically recorded very high concentrations of these metals. Again, exceedances of trigger values for these metals are reasonably common across the Swan and Canning River drainage catchments (Nice et al 2009). However the low pH values found at Booragoon Lake and Blue Gum Lake are likely to increase the toxic effects of these metals to biota within these lakes; although dissolved organic material present at these sites (especially at Booragoon Lake and Blue Gum Lake) would bind a proportion of these metals and reduce their toxicity (ANZECC and ARMCANZ 2000). The very high hardness at Booragoon Lake is also likely to reduce the toxicity of these metals. Metal speciation testing could determine the proportion of labile (not complexed) metals complexed to organic material, and thus their actual potential for toxicity (CSIRO n.d.); however this speciation testing is relatively costly. Lead concentrations have always exceeded, and copper concentrations have once exceeded, the trigger value at Booragoon Lake and may be a source of these metals. High concentrations of arsenic, mercury and nickel have also been recorded in the comparatively fine-grained and organic sediments at Booragoon Lake over the last five years, however these metals are not currently analysed at this site so their effect on water concentrations cannot be determined.

The high concentrations of iron and aluminium recorded at many Melville lakes sites are concerning as these metals can have negative effects on biota, although the concentrations recorded at most Melville lakes sites are generally similar to those recorded across all Swan and Canning River drainage catchments (Nice et al 2009). Total iron concentrations at Booragoon Lake and Blue Gum Lake are particularly high however, which may be a result of acid sulfate soil oxidation (DER 2015), and thus may be more likely to result in damage to biota and/or unsightly iron flocs that compromise water clarity. It is noted that comparatively high concentrations of sediment aluminium and iron been recorded at Booragoon Lake within the previous five years.

11. Recommendations

11.1 Site specific recommendations

Bull Creek main drain (PSDTBCMD):

1.1 <u>Recommendations for site</u>

1.1.1 Continue to implement the current Bull Creek Reserves Strategic Management Plan: 2014-2019 (City of Melville 2014) to ensure that the restoration of the foreshore is congruent with the long term stability of the natural waterway's ecological and drainage functions.

1.1.2 Continue and extend the current floodplain restoration works throughout the Bull Creek reserve.

1.1.3 A macroinvertebrate assessment in the restored portion of Bull Creek main drain (starting at site 2 through to PSDTBCMD) is recommended to assess ecological health of the waterway and gauge the impact nitrogen as ammonia/ammonium contamination is having on the ecological health of the system. Annual assessments would allow the effect of changes to the Creek (i.e. water quality changes and habitat development as plants become established) on macroinvertebrates to be assessed. Further to macroinvertebrate surveys, mosquito dipping coupled with the water quality information should also be conducted as a comparable study on the overall health of the ecosystem.

1.1.4 Consider installing additional riffles along Bull Creek to improve dissolved oxygen levels. Hydrological studies would need to be conducted to inform riffle construction. Potential locations within the Creek at which these riffles could be installed (as shown in Figure XXX) include:

- At the beginning of the Bull Creek Reserve at Brockman Park: This location is considered ideal as it easily accessible to plant and is visible to the public;
- At the point in the creek in line with the end of the cul-de-sac Forster Court;
- Near the amphitheatre of Rossmoyne Senior High School.

Figure 11.1-1: Approximate potential location riffles could be installed in Bull Creek.

Brockman Park (MELDR-02):

1.2 Recommendations for site

1.2.1 Continue to implement the current Bull Creek Reserves Strategic Management Plan: 2014-2019 (City of Melville 2014b) to ensure that the restoration of the foreshore is congruent with the long term stability of the natural waterway's ecological and drainage functions.

1.2.2 Continue and extend the current floodplain restoration works throughout the Bull Creek reserve.

1.2.3 Further investigation to determine the source of the very high nitrogen as ammonia/ammonium concentrations at Brockman Park is highly recommended, as this ammonia/ammonium appears to be contributing a significant amount of the total nitrogen into Bull Creek. This could include the following:

- Review of detailed stormwater drainage maps in the area;
- Review of groundwater flow maps;
- Surface water quality sampling to include of the water body at Trevor Gribble Park;
- Groundwater monitoring upstream of Brockman Park.

1.2.4 Primary physical treatment is required prior to the Brockman Park stormwater pipe inlet to prevent gross pollutants, particulate matter and sediment entering Bull Creek Park waterway and its foreshore. Sediment deposition within the park has been observed by SERCUL staff on multiple occasions and a source investigation has been conducted by SERCUL and Water Corporation staff. Sediment was tracked as far upstream as Earnest Wild Park on the Water Corp main drain. Further investigation into the source is required to develop appropriate management actions.

1.2.5 The existing inlet structure requires regular maintenance to remove gross pollutants and sediment. Maintenance should be conducted once a year at minimum, preferably in autumn.

1.2.6 The implementation of an on-site and desktop drainage mapping investigation identified Trevor Gribble Park as a potential source for the sediment dumping occurring at Brockman Park, as it has a large sandy compensation basin directly connected to the main drainage line upstream. It is therefore recommended to stabilise the bare sand areas in this basin (see **Figure 11.1-2A**) by planting native groundcover revegetation. Furthermore, it is recommended to install a sediment and gross pollutant trapping structure underneath the outlet of the basin into the underlying piped drain to minimise soil/sand exposure and potential movement down the system in a storm event. This structure should be regularly cleaned. There was recently observed to be a large amount of leaf litter and sediment sitting on top of the grate (see **Figure 11.1-2B**).

Figure 11.1-2: A) Sandy area in Trevor Gribble Park compensation basin where planting is recommended; B) grate in Trevor Gribble Park compensation basin with leaf litter and sediment sitting on top.

John Creaney Park (inlet: MELDR-15, outlet: MELDR-05)

1.3 Recommendations for site

1.3.1 Major redesign and restoration of the lake at John Creaney Park is required to improve its water quality, as well as that of the downstream receiving environment (Bull Creek main drain and the Canning River). This restoration could include planting fringing vegetation, installation of a gross pollutant trapping system and dredging and disposing of any silty and/or possibly organic sediment at this site.

1.3.2 In previous years, significant amounts of lawn clippings were observed to be entering the water at John Creaney Park from adjacent park management. Restoration should include creating a buffer between lawn and wetland area to reduce organic load entering the basin.

1.3.3 Conduct groundwater sampling at John Creaney Park to determine whether contaminated groundwater from the previous landfill at the site is the source of the often high nutrients and poor sediment quality at the site.

1.3.4 Drain stencilling may be beneficial at sites along the drainage line such as Stocklands Shopping Centre and West Leeming Primary School to prevent discharge of contaminants into this drainage.

Downstream Elizabeth Manion Park (MELDR 16):

1.4 Recommendations:

1.4.1 Drain stencilling may be beneficial at sites along the drainage line such as Leeming Senior High School and Leeming Primary School to prevent discharge of contaminants into the drainage here;

1.4.2 The catchment for the branch of Bull Creek main drain containing site 16 is quite large, and encompasses several stormwater basins, Leeming Senior High School and a portion of drainage from Karel Ave. Sampling upstream of site 16 to determine the source of metal (copper and zinc) and nutrient (total nitrogen and phosphorus) contamination may be difficult (as two of the closest drainage basins upstream at Barracuda Park and William Hall Park were unable be sampled when attempted in 2007 due to lack of flow) but if after five years monitoring contamination at this site is found to be significant consider investigating suitable additional upstream sampling sites.

1.4.3 Consider “opening up” closed pipe systems beneath upstream stormwater compensating basins that are generally dry to incorporate some form of treatment to water passing through the site. This may be appropriate for the basin at William Hall Park, however the feasibility of this would require further investigation;

Bateman Park (MELDR-06), Brentwood drain (MELDR-13) and RAAF drain (site 14):

1.5 Recommendations for site:

1.5.1 Facilitate the maintenance of the Brentwood Living Stream restoration site: the rock riffles installed as part of the Brentwood Living stream project will trap sediment that will require routine removal by the Water Corporation as part of its ongoing maintenance plan agreement.

1.5.2 Following construction of the Brentwood drain, it is very important to continue monitoring this site for changes to the water quality to assess the impact/effectiveness of the restoration works. It may take several years before the Living Stream’s capacity to improve water quality reaches full effectiveness. Furthermore, Water Corporation and Main roads are in the planning stages for the reconstruction of the upstream Cloverleaf compensating basin (located at the off ramp of Leach Highway to Kwinana Freeway South bound) to mitigate the poor water quality issues from the freeway runoff and subsequently reduce negative impacts in the Brentwood drain downstream. Water quality monitoring results at site 13 will allow for the assessment of the impact of these works on the overall outcome of the Brentwood Living Stream project.

1.5.3 It may of benefit to consider providing education materials to the grounds staff at the RAAF nursing home facility to ensure optimal management of the lake there to reduce nitrogen entering this drainage line. This may result in decreased concentrations of total oxidised nitrogen and metals. This may include:

- Information about the implications of excess nutrients in waterways and how to reduce fertiliser application. SERCUL’s Phosphorus Awareness Project brochure may be a good starting point (http://sercul.org.au/docs/PAP.pdf).

- Information about the benefits of fringing vegetation around wetlands. Planting fringing vegetation (particularly sedges) around the lake within the facility may help to reduce nutrient and metal concentrations in lake water.

2. Booragoon Lake outlet (site 7)

2.1 <u>Recommendations:</u>

2.1.1 The restoration of the ecological function of the foreshore of Booragoon Lake needs to continue to ensure that the surface water entering via the foreshore is naturally treated prior to entering the lake. Continuing with the planting of large and medium trees as well as sedges within the foreshore are critical to both surface and groundwater treatment. Replacement of weeds with slower growing native species (such as *Baumea articulata*) will result in less organic waste production.

2.1.2 Continue the removal and control of invasive species, including grasses, that contribute to the large loads of organic material to the lake. A "grass reduction" program has been implemented to prevent grass (from the edge of the lake to the footpath) entering the lake, which should help to reduce nutrients entering the lake. However, it is important to ensure that where possible native species are planted shortly after control of large grassed areas to prevent erosion from occurring.

2.1.3 The City of Melville is currently in the process of revegetating one of the inlets on the western side of the lake in an effort to improve gross pollution management. It is recommended that other inlets to the lake are revegetated in a similar manner.

2.1.4 Investigate the suitability of planting vegetation within the remaining four drain outlets to the Lake as outlined in the *Booragoon Lake Reserve Strategic Management Plan* (Natural Area Consulting 2012a).

2.1.5 In future monitoring programs, analysed water samples for arsenic, mercury and nickel, as these exceedances of trigger values for these metals have been recorded in sediments collected from this site in previous years.

2.1.6 Ensure that excess sediment and litter is periodically removed from the drainage basin in the north-east corner of the Lake as necessary. This will decrease sediments (and associated nutrients and metals) entering the Lake body (DoE 2004).

2.1.7 Potential and existing acid sulfate soils have be shown to be present in Lake sediments in a preliminary acid sulfate soil investigation, and in combination with relatively low and fluctuating water levels are likely to be producing low pH levels in the lake (Oldweather 2012). It may be possible to neutralise acidity in the lake originating from oxidation of acid sulfate soils with materials such as aglime, sodium bicarbonate, hydrated lime or quicklime as described in Department of Environment Regulation (2015). This may need to be conducted on an ongoing basis (DER 2015). It is recommended that a more detailed assessment of the practicality and details of this recommendation be evaluated in liaison with DER. This may also reduce mobilisation of metals from sediment, resulting in lower water concentrations of soluble metals. However if pH levels in the lake remain similar to those recorded in 2017 this will not be necessary.

2.1.8 Considering the excessively high levels of total and soluble phosphorus it is recommended to investigate possible treatment methods for the control/removal of phosphorus in a wetland environment such as an application program for Phoslock.

2.1.9 Consider speciation testing for zinc and copper to determine the labile (and therefore bioavailable) proportion of these metal concentrations, as a proportion of the metals present may be complexed with dissolved organic material and therefore may not be toxic.

2.1.10 Macroinvertebrate sampling is recommended to provide an indication of eutrophic status and species richness in this lake of high conservation value.

3. Piney Lakes outlet (site 8):

3.1 <u>Recommendations for site:</u>

3.1.1 As low water levels have been observed at this lake in previous years (although not in 2017) consider monitoring of water levels throughout the year to allow for appropriate planning to occur.

3.1.2 It is recommended that a groundwater investigation be conducted to assess the cause(s) of the lowering of water levels at Piney Lakes. This could entail measuring groundwater levels on a seasonal basis at bores at existing or newly installed bores at and in the area surrounding Piney Lakes. Some groundwater abstraction does occur at Piney Lakes to facilitate landscaping of the surrounding parkland.

3.1.3 Further to the above, investigation into ecological water requirements (EWRs) for this EPP (WA 073) groundwater dependant wetland is required to determine the possible risk-of-impact of drawdown on the key elements of wetland ecosystem integrity (ecosystem processes, biodiversity, abundance and biomass of biota and quality of water and sediment) and allow for appropriate mitigation strategies to be devised.

3.1.4 Reducing the amount of grass and implementing hydrozoning of vegetation in parklands surrounding Piney Lakes will help to reduce groundwater abstraction. If local abstraction is the cause of low water levels then reducing abstraction may help to increase keep water levels at the Lakes.

4. Blue Gum Lake outlet (site 12):

4.1 <u>Recommendations for site:</u>

4.1.1 Continue with the current restoration works on the foreshore of the lake with native species particularly with native sedges and wetland plants.

4.1.2 Continue the removal and control of invasive species, including grasses, which contribute to the large loads of organic material to the lake. However, it is important to ensure that where possible native species are planted shortly after control of large grassed areas to prevent erosion from occurring.

4.1.3 Works are currently being undertaken at the receiving storm water basin to increase stormwater detention time and interaction with native vegetation.

4.1.4 A biofilter has been incorporated into the stormwater drain on Rountree Road, with planting scheduled to be undertaken in 2018.

4.1.5 Investigate the suitability of planting vegetation within the other drain outlets to the Lake as outlined in the *Bluegum Lake Reserve Strategic Management Plan* (Natural Area Consulting 2012b).

4.1.6 Reticulation and fertiliser application practices of upstream Karoonda Park should be reviewed to ensure that a minimum of nutrient enriched runoff is entering the lake from this park.

4.1.7 Considering the excessively high levels of total and soluble phosphorus it is recommended to investigate possible treatment methods for the control/removal of phosphorus in a wetland environment such as an application program for Phoslock.

4.1.8 Where this has not already been done, create a barrier between the foreshore and lawn verge to prevent encroachment of lawn grasses and weeds to facilitate a definite edge for more efficient park management.

4.1.9 The City of Melville has established an MOU with the tennis club in regards to fertiliser use and the storage of fertiliser within the tennis club precinct which involves regular inspections of the premises and annual meeting to discuss the progress and improvements. The City has established a good working relationship with the club and indicated this is an ongoing commitment to reduce the risk of impact to the Blue Gum Lake and its foreshore.

4.1.10 Following previous recommendations the City of Melville has provided guidelines in the form of letterbox drop educating residence about appropriate management of garden and lawn waste to reduce the weed and nutrient load impacting the Blue Gum Lake reserve and the resident macro-invertebrates and turtles. Drain stencilling (clean drains, river gains) and catchment education with school groups should be implemented when budget and time allows.

4.1.11 Given the particularly low pH of waters previously recorded at the site, consider conducting an acid sulfate soil investigation at the lake to determine the extent of acid sulfate soils and consider options for mitigation.

4.1.12 Consider speciation testing for aluminium, zinc and copper to determine the labile (and therefore bioavailable) proportion of these metal concentrations, as some of the metals present may be complexed with dissolved organic material.

4.1.13 Macroinvertebrate sampling is recommended to provide an indication of eutrophic status and species richness in this lake of high conservation value.

5. Quenda Lake outlet (site 9):

5.1 Recommendations for site:

5.1.1 Continued monitoringof this site is recommended to see the long term impact of the new drainage works from Main Roads, road construction and new building infrastructure upgrades in the surrounding areas.

5.1.2 Upgrades to the two stormwater inlets to the lake are scheduled to be undertaken in 2018 to allow for improved filtration of stormwater.

5.1.3 As recommended by Natural Area Consulting (2016b), it is recommended the City determine an appropriate management solution for the erosion caused by the stormwater entering the site from the hospital car park in liaison with stakeholders from St. Johns Hospital and the Water Corporation.

5.1.4 Continue implementing the other objectives included in the Quenda Wetland Reserve Strategic Management Plan (Natural Area Consulting 2016b).

6. Frederick Baldwin (site 10):

6.1 Recommendations for site:

6.1.1 Clear *Bacopa* and debris from the drainage inlet to the lake. This will improve lake hydrology as well as possibly reduce the oxygen demand created from this decaying organic material.

6.1.2 Investigate options for the improvement of hydraulic design within the lake.

6.1.3 A project is planned for 2018 to replace *Casuarina cunninghamiana* (Sydney she-oak) with local wetland tree species (*Melaleuca rhaphiophylla, Eucalyptus rudis*) in a staged fashion to reduce the weed seeding of downstream wetlands and waterways and increase nutrient uptake. Removing these trees will remove the needles which prevent the growth of understorey riparian vegetation.

6.1.4 Implement gradual foreshore revegetation program simultaneously with installation of bio-filtration sedge plantings to provide a buffer between the lawn recreational area and the lake foreshore. This will improve the aesthetics as well as improving the filtration of surface water entering the lake.

6.1.5 Signage is currently being developed at the lake to increase community awareness of where this lake's water comes from and where the lake water flows to encourage the community to consider responsible use of stormwater drainage.

6.1.6 Consider the placement of an aeration fountain to improve oxygen levels within the lake.

7. Marmion Reserve (site 11):

7.1 Recommendations:

7.1.1 It may be of benefit to consider providing educational materials to the grounds staff at the adjacent retirement villages on the west side of Marmion reserve to ensure gardening activities do not result in additional pollution to the lake. This may include information about the implications of nutrient pollution in waterways and how to optimally apply fertiliser to reduce nutrient pollution. SERCUL's Phosphorus Awareness Project brochure may be a good starting point (http://sercul.org.au/docs/PAP.pdf).

7.1.2 Continue to maintain the completed City of Melville foreshore restoration project. This project included the planting of island and large areas surrounding the lake with sedges and other dryland species and the removal of weeds.

7.1.3 It is understood that the City of Melville has removed collapsed and aging willows on the Lake island and from around the lake as well as older shrubs and weedy shrubs from around the lake and plans to replace this with native tree species. As willow trees are deciduous and known to produce large volumes of leaf litter (Latta 1974), this should provide a positive benefit to lake water quality by reducing the leaf litter entering the lake.

11.2 Catchment wide recommendations

1. Continue with the implementation of the Bull Creek Water Quality Improvement Plan (WQIP).
2. Continue monitoring the water and sediment quality at all sites in the catchment to generate more interpretable data about the condition of the catchment, to determine patterns and changes that may be happening over time and to detect anomalies in the concentrations of parameters that may occurring in response to events.
3. Low oxygen saturations within the wetlands, lakes and waterways of this catchment are common. This is a consistent finding with heavily piped catchments and/or wetlands with excessively high organic loads (either from animal waste or vegetation decomposition). It is recommended that wherever possible open water inlets and if possible outlets should flow over loosely arrange rocky substrate that provides some oxygenation during medium to high flow events. This, along with open water areas that allow wind driven oxygen transfer and appropriate wetland designs which allow for seasonal wetting/drying processes to assist microbial activity (breaking down organic matter) may provide a collective improvement in oxygenation over time.
4. It is recommended that audits of industrial premises such as those conducted as part of the Light Industry Program (LIP) are continued in the future. As part of the LIP program, a joint initiative between DWER, DBCA and local governments (including the City of Melville) conducted from 2015 to 2017, inspections of premises were conducted with the aim of reducing contaminants being released into groundwater and stormwater drainage. Funding for this program will continue until at least July 2018; however it is recommended that beyond this period trained City of Melville officers should continue to conduct light industry audits.
5. It is understood that City of Melville parks and gardens staff have undertaken SERCUL's Fertilise Wise training in the past (http://www.fertilisewise.com.au/docs/FWFertiliserTrainingAdvert.pdf). It is recommended that all parks and gardens staff who have not previously attended this training (or a similar course) should do so. The best management practices taught as part of this training should be implemented when managing parks, including optimal timing of fertiliser application and calculation of optimal rates of fertiliser application.
6. Five schools in the City of Melville have participated in SERCUL's Phosphorus Awareness Program in 2017, which involves education of both primary and high school students about how actions undertaken in the home and garden can impact the environment (https://www.sercul.org.au/for-educators/incursions-and-excursions/). It is recommended that other schools in the Melville Bull Creek catchment are encouraged to participate in this program.
7. Continue to educate residents about appropriate plant species, fertiliser and water use (Piney programs, brochures, mail outs and work with community groups);
8. As proposed in the WQIP for Bull Creek Catchment, review historical and current land use data, in particular contaminated and old tip sites, to identify potential sources of contaminants, prioritise areas requiring further investigation and identify management options;
9. As recommended in the Stormwater Management Manual for Western Australia (DoE 2004), coordinate road sweeping with maintenance activities (i.e. road or construction works) and specific events (i.e. storm events or public major events). Best results can be achieved by focusing on 'hot spots' rather than routinely sweeping all streets;
10. Continue to regularly remove accumulated pollutants (e.g. sediment and gross pollutants) from nodes in the stormwater network, such as pits and infiltration sumps;
11. Incorporate water sensitive urban design techniques into management practices when upgrading the catchment (e.g. permeable paving, bio-retention swales, pipe-less streets and rain gardens);
12. Continue to ensure the use of herbicides and insecticides on roadsides in undertaken as per manufacturer's recommendations, and ensure maintenance staff use appropriate handling and application procedures for these materials;
13. Continue to regularly conduct soil test and leaf tissue analysis on turf areas before applying fertilisers;
14. Continue to use native vegetation along roadsides, paths and in swales.
15. Continue to revegetate natural areas and remove weeds to increase biodiversity.
16. The following issues should be considered when formulating ASS environmental management strategies:
    a) The sensitivity and environmental values of the receiving environment. This includes the conservation, protected or other relevant status of the receiving environment (e.g. wetlands, Marine Parks, etc.).
    b) Whether groundwater and/or surface water are likely to be directly or indirectly affected.

c) The heterogeneity, geochemical and textural properties of soils on site.

d) The management and planning strategies of local government and/or state government.

17. The following examples of structural best management practices to be incorporated into management plans where appropriate:
    - Onsite detention;
    - Stormwater infiltration systems;
    - Buffer strips;
    - Pollutant traps;
    - Grass or reed swale drains;
    - Broken or flush kerbing;
    - Pervious paving materials;
    - Nutrient intervention installation
    - Native landscaping; and
    - Ponds and wetlands including implementation of living streams with the involvement of the community to provide multiple positive effects by increasing public awareness and further improving water quality.

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Appendix A ANZECC Trigger Values and Guidelines

Table A-1: Trigger values for physicochemical parameters and nutrients

Guideline	pH	DO % Sat	EC (mS/cm)	TSS (mg/L)	TN (mg/L)	NO_{x}-N (mg/L)	NH_3-N/NH_4-N (mg/L)	TP (mg/L)	SRP (mg/L)
Guideline values for recreational use (NHMRC 2008)	6.5-8.5	>80	-	-	-	30 (for NO_2^-) 500 (for NO_3^-) (health)	5 (aesthetic)	-	-
ANZECC Water Quality Trigger Values - lowland river (2000)	6.5-8.0	80-120	0.12-0.3	-	1.2	0.15	0.08	0.065	0.04
ANZECC Water Quality Trigger Values wetland (2000)	7-8.5	90-120 (>6mg/L)	0.3-1.5	-	1.5	0.10	0.04	0.06	0.03
ANZECC Water Quality Trigger Values - freshwater protection (2000)	-	-	-	-	-	-	0.9	-	-
DoW (n.d.) interim guideline	-	-	-	6	-	-	-	-	
Chemcentre Limit of Reporting	-	-	-	1	0.025	0.01	0.01	0.005	0.005

[1]Trigger value not adjusted for pH and temperature

Table A-2: Trigger values for metals in water

Guideline	Al (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Hardness (mg/L)
Recreational use guideline values (NHMRC 2008, NHMRC 2016)	-	0.5[5] (health)	-	10 (aesthetic) 20 (health)	3 (aesthetic)	0.1 (health)	0.01 (health)	30 (aesthetic)	-
ANZECC Water quality trigger value – Freshwater 95% (2000)	0.055[1]	0.0033[2,3]	0.0028[3]	0.0014[2]	0.3[4]	0.0034[2]	0.0006	0.008[2]	-
Chemcentre Limit of Reporting (required)	0.005	0.0001	0.001	0.0001	0.005	0.0001	0.0001	0.001	5

[1]Applicable only when pH>6.5, when pH<6.5 a low reliability interim value of 0.0008 mg/L is applicable
[2]Trigger values not adjusted for water hardness.
[3]Low reliability interim value
[4]Interim guideline
[5] Value for Cr^{6+} used

Table A-3: ANZECC trigger values for metals in sediment

Guideline	Al (mg/kg)	As (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Ni (mg/kg)	Se (mg/kg)	Zn (mg/kg)
ANZECC Low Trigger Value (2013)	N.D.	20	80	65	N.D.	0.15	50	21	N.D.	200
ANZECC High trigger value (2013)	N.D.	70	370	270	N.D.	1.0	220	52	N.D.	410
Chemcentre Limit of Reporting	10	0.2	0.05	0.1	5	0.02	0.5	1	0.05	0.25

Appendix B Changes to the monitoring program since 2007

In 2008 the following changes were made:

- Sites MELDR-03, MELDR-04 and MELDR-05 were dropped from the project as they were always dry in 2007 and are only overflow points from the drains rather than being representatives of the drainage network itself.
- The collection of organic carbon samples was discontinued due to insufficient funds.
- Analysis for polycyclic aromatic hydrocarbons, benzene, ethyl benzene, toluene and xylene (BTEX) and total petroleum hydrocarbons in water samples was discontinued from all sites, as they were rarely detected above laboratory limits of reporting in 2007 and due to reduced budget.
- Sampling frequency was altered from quarterly in 2007 to once every two months for 4 events in total in 2008. This is due to the very late start for the project in 2008 due to funding uncertainty.
- Sampling for sediment was discontinued as the City of Melville could not provide sufficient funds to continue this component of the sampling program.

The project started very late in 2008 (September) due to funding uncertainty from the major stakeholder and as a result all winter rains and flows have been missed for the 2008 sampling project. It is possible that this may have an effect on the water quality of the collected samples and the number of samples that can be collected.

In 2009 the following change was made:

- Soluble metals analysis (for soluble aluminium, chromium, copper, iron, lead and zinc) was added at two sites (MELDR-01 and MELDR -06) based on the recommendations from the previous year's results.

In 2010 the following change was made:

- Sampling frequency was altered from every two months to monthly during the winter for four events in total during 2010. This is due to the dry conditions at most of the sites throughout the year.

In 2011 the following changes were made:

- Sampling for metals that have recorded concentrations below the limit of report during the four-year sampling period was discontinued. Therefore, only eight total metals were included in the 2011 sampling program (aluminium, arsenic, chromium, copper, iron, nickel, lead and zinc) and cadmium and mercury were dropped. Surveillance monitoring of arsenic and nickel will be continued as these metals have consistently been detected above the LORs at some sites (particularly arsenic at Bateman Park, Booragoon lake, Frederick Baldwin, Marmion Reserve and Blue Gum Lake and nickel at John Creaney, Bateman Park and Booragoon Lake), despite having not been detected above trigger values.
- Considering the consistent, sometimes widespread, contamination of some metals in the catchment, soluble metals were included to provide data about the concentrations of these metals that may be available for biological uptake and therefore potentially impact on the biota. Soluble metals analysis for aluminium, chromium, copper, iron, lead and zinc was added at four more sites (MELDR-05, MELDR-10, MELDR-11 and MELDR-12). These four sites have consistently recorded concentrations above the trigger value.
- The City of Melville included soluble metals analysis for a fifth site; Booragoon Lake (MELDR-07) due to the works that the City has undertaken there.

There were additional changes to those included in the 2011 SAP due to some very low pH values (<4.5) recorded in Booragoon and Blue Gum Lakes and turtle deaths at Blue Gum lake.

- Addition of six new sites, one at Booragoon Lake (MELDR-BL1) and five at Blue Gum Lake (MELDR-BGL1, MELDR-BGL2, MELDR-BGL3, MELDR-BGL4 and MELDR-BGL5).
- Sampling for total acidity and total alkalinity in water at two existing sites (MELDR-07 and MELDR-12) and the new six sites (listed above).
- Sampling for titratable actual acidity (TAA) in sediment at these two lakes at two existing sites (MELDR-07 and MELDR-12) and the new six sites.

In 2012 the following change was made:

- Sampling at the six new sites (included in 2011) at Booragoon Lake (MELDR-BL1) and Blue Gum Lake (MELDR-BGL1, MELDR-BGL2, MELDR-BGL3, MELDR-BGL4 and MELDR-BGL5) was discontinued. However, if Blue Gum Lake pH falls rapidly again after a period of drying and rewetting, these sites would be sampled for the same parameters than in 2011.

In 2013 the following change were made:

- Due to proposed restoration works upstream Bateman Park site (site 6) two new sites were added upstream this site to collect baseline data from the two drains (Brentwood drain and RAAF drain) before they merge. These two new sites (sites 13 and 14) were sampled during October and November 2013 sampling events and were continued in the 2014 sampling monitoring program. These sites were sampled for the same parameters included at Bateman Park site (site 6).

In 2014 the following changes were made:

- Total metal analysis for mercury (Hg) (originally discontinued in 2011) was added to Bateman Park, Brentwood Drain and RAAF Drain (sites 6, 13 and 14) for suspicions of elevated levels where the proposed earth works may occur in the pending Brentwood MD restoration project. Earlier sediment testing conducted by SRT indicated Hg contamination at the site but subsequent testing was not consistent.
- In an effort to isolate the pollution source/s that were contributing with the poor water quality entering at Brockman Park site (site 2) two new sites were added to the last three sampling events. John Creaney Park inlet and Down Stream Elizabeth Manion Park (site 15 and 16) were tested for the same nutrients and physical parameters included in Brockman Park: dissolved oxygen, pH, temperature and electrical conductivity, total and soluble nutrients and total suspended solids. Additionally, these two sites were tested for the 14 total metals suite recommended by the Department of Water for new sites: aluminium, cadmium, arsenic, chromium, cobalt, copper, iron, mercury, nickel, lead, manganese, molybdenum, selenium, and zinc. Since soluble metals were not included in Brockman Park, they were also no included at the two new sites.
- The eastern side of the catchment (within the City of Canning) was monitored for the first time in 2014 including the Brockman Park inlet (ROSSTAFE) which enters the Bull Creek main drain downstream Brockman Park (site 2) and before Bull Creek MD (PSDTBCMD). The inclusion of the analysis of Brockman Park inlet in this report will provide insight into the relative contributions from the individual segments (Brockman Park in the City of Melville and Rossmoyne Drain in the City of Canning) and their impact downstream on Bull Creek MD (site1).

In 2015 the following changes were made:

- Total arsenic and total nickel in water were discontinued at the 12 original sites (1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14) as they have always recorded concentrations below the trigger values and on many occasions they have been equal to the limits of reporting at all sites. At the above mentioned 12 sites, six total metals (aluminium, chromium, copper, iron, lead and zinc) were included on one sampling occasion for surveillance, and six soluble metals (aluminium, chromium, copper, iron, lead and zinc) were included on all four sampling occasions.
- The addition of particle size analysis in sediment samples to enable better interpretation of metals concentrations in these samples. Particle size analysis was performed on the same sampling event when sediment samples were taken at 12 of the 15 sites included in the SAP.

Appendix C Temperature and rainfall data

The greatest flow in Bull Creek generally occurs as a result of winter rainfall between June and September. There is a delay between the onset of winter rain and the commencement of consistent flow in the catchment. Samples from the 14 Melville sites were collected during four sampling events (19th July, 22nd August, 19th September, and 11th October).

Rain fell on the July (11 mm), August (0.6 mm) and October (4.8 mm) sampling dates (**Figure C-1**). Rain also fell on the five days prior to each sampling events (July: 5.2 mm total, August: 14.8 mm total, September: 0.2 mm total, October: 2.4 mm total). There was an adequate amount of flow at the majority of the sites for sampling. The maximum air temperatures recorded for the four Melville sampling days were 19.1°C, 18.5°C, 22.1°C and 19.2°C respectively. These observations are based on a combination of both Mount Lawley and Perth Airport daily weather observations (Australian Government Bureau of Meteorology (BOM) 2017a).

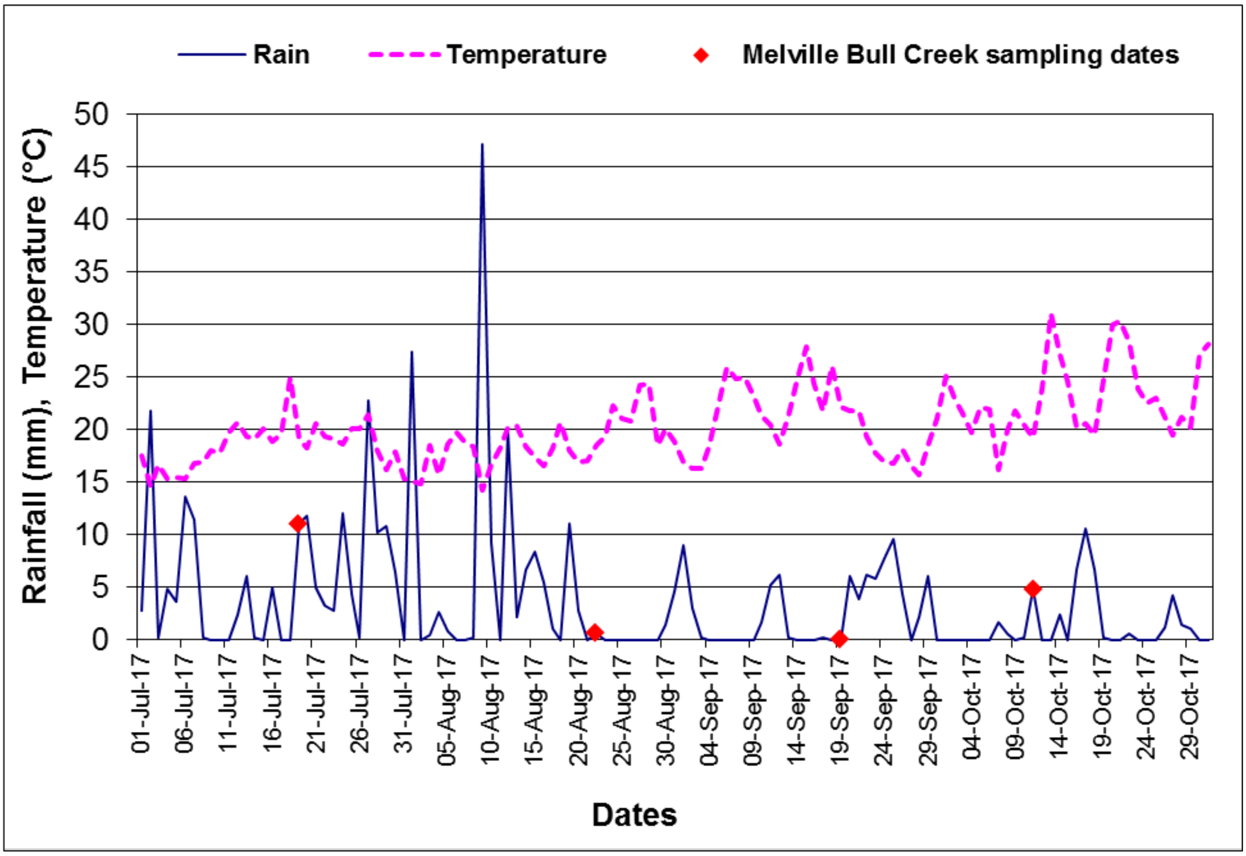

Figure C-1: Daily rainfall (mm) and temperature (°C) in Perth (a combination of observations from Mount Lawley and Perth Airport Metropolitan region) from July to October 2017

Source: Australian Government Bureau of Meteorology (BOM) 2017a

The Perth metro area had winter rainfall 60 mm below the long term average, but this was still the wettest winter in six years (BOM 2017b). June rainfall was less than half of the long-term average, but July and August rainfall was above average. In spring, Perth rainfall was below the long-term average (although still the wettest in three years), due to near average rainfall in September and October compensating for a dry November (BOM 2017c). Perth Metro average maximum and minimum temperatures were above average in both winter and spring in 2017, with the equal third-warmest mean maximum spring temperatures recorded in 2017 (BOM 2017b and 2017c).

Appendix D Water quality results tables

Physicochemical parameters in water

Table D-1: pH values in Melville Bull Creek catchment sites in 2017

pH Max (red) 9.82 Min (blue) 5.61

ANZECC trigger value for lowland rivers of SW Australia 6.5 - 8.0; for wetlands 7.0 - 8.5; for recreational value 6.5 - 8.5

Site Name	Site Number	Collect Date	pH (no units)	pH lower limit 6.5 Lowland Rivers/ 7 Wetlands	pH upper limit 8 Lowland Rivers/ 8.5 Wetlands	pH lower limit 6.5 Recreational	pH upper limit 8.5 Recreational
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	6.85	Acceptable	Acceptable	Acceptable	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	6.53	Acceptable	Acceptable	Acceptable	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	7.15	Acceptable	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	6.24	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	6.68	Acceptable	Acceptable	Acceptable	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	6.61	Acceptable	Acceptable	Acceptable	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	7.11	Acceptable	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	6.79	Acceptable	Acceptable	Acceptable	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	5.61	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	6.39	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	6.95	Does not meet guidelines	Acceptable	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	9.12	Acceptable	Does not meet guidelines	Acceptable	Does not meet guidelines
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	6.8	Does not meet guidelines	Acceptable	Acceptable	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	6.58	Acceptable	Acceptable	Acceptable	Acceptable
JOHN CREANEY PARK	MELDR-05	22-Aug-17	6.46	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	6.83	Acceptable	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	22-Aug-17	6.24	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	22-Aug-17	6.84	Acceptable	Acceptable	Acceptable	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	6.75	Acceptable	Acceptable	Acceptable	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	7.24	Acceptable	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	7.18	Acceptable	Acceptable	Acceptable	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	6.79	Does not meet guidelines	Acceptable	Acceptable	Acceptable
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	5.9	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	6.37	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	7.19	Acceptable	Acceptable	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	9.82	Acceptable	Does not meet guidelines	Acceptable	Does not meet guidelines
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	6.6	Does not meet guidelines	Acceptable	Acceptable	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	6.4	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Sep-17	6.32	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	6.93	Acceptable	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	19-Sep-17	6.21	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	19-Sep-17	6.78	Acceptable	Acceptable	Acceptable	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	6.64	Acceptable	Acceptable	Acceptable	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	7.15	Acceptable	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	6.82	Acceptable	Acceptable	Acceptable	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	6.85	Does not meet guidelines	Acceptable	Acceptable	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	6.18	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	6.72	Does not meet guidelines	Acceptable	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	7.37	Acceptable	Acceptable	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	9.51	Acceptable	Does not meet guidelines	Acceptable	Does not meet guidelines
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	6.79	Does not meet guidelines	Acceptable	Acceptable	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	6.49	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
JOHN CREANEY PARK	MELDR-05	11-Oct-17	6.39	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	7.02	Acceptable	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	6.25	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	6.74	Acceptable	Acceptable	Acceptable	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	6.71	Acceptable	Acceptable	Acceptable	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	7.18	Acceptable	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	6.98	Acceptable	Acceptable	Acceptable	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	6.67	Does not meet guidelines	Acceptable	Acceptable	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	6.06	Does not meet guidelines	Acceptable	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	6.76	Does not meet guidelines	Acceptable	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	6.96	Does not meet guidelines	Acceptable	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	9.21	Acceptable	Does not meet guidelines	Acceptable	Does not meet guidelines
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	6.92	Does not meet guidelines	Acceptable	Acceptable	Acceptable

Table D-2: Dissolved oxygen saturations in Melville Bull Creek catchment sites in 2017

Dissolved oxygen (DO%) Max (red) 88.4 Min (blue) 1.2

ANZECC acceptable range for lowland rivers: 80-120%, wetlands: 90-120%; NHMRC recreational value: >80%

Site Name	Site Number	Collect Date	DO (%)	DO lower limit 80/90 %	DO upper limit 120 %
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	49.7	Does not meet guidelines	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	37.9	Does not meet guidelines	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	71	Does not meet guidelines	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	44.1	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	52.2	Does not meet guidelines	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	60.1	Does not meet guidelines	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	69.9	Does not meet guidelines	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	61.5	Does not meet guidelines	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	33.4	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	19.8	Does not meet guidelines	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	45.3	Does not meet guidelines	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	75.1	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	63.9	Does not meet guidelines	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	44	Does not meet guidelines	Acceptable
JOHN CREANEY PARK	MELDR-05	22-Aug-17	19.3	Does not meet guidelines	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	61.7	Does not meet guidelines	Acceptable
BROCKMAN PARK	MELDR-02	22-Aug-17	47.7	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	22-Aug-17	42.6	Does not meet guidelines	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	63.5	Does not meet guidelines	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	75	Does not meet guidelines	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	63.9	Does not meet guidelines	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	23.9	Does not meet guidelines	Acceptable
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	29.8	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	33.4	Does not meet guidelines	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	62.6	Does not meet guidelines	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	83.1	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	32.5	Does not meet guidelines	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	39.7	Does not meet guidelines	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Sep-17	7.8	Does not meet guidelines	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	65.2	Does not meet guidelines	Acceptable
BROCKMAN PARK	MELDR-02	19-Sep-17	43.1	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	19-Sep-17	50.1	Does not meet guidelines	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	61.1	Does not meet guidelines	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	81.1	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	66.9	Does not meet guidelines	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	30.3	Does not meet guidelines	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	38.3	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	33.4	Does not meet guidelines	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	70.5	Does not meet guidelines	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	63.6	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	12.3	Does not meet guidelines	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	37.9	Does not meet guidelines	Acceptable
JOHN CREANEY PARK	MELDR-05	11-Oct-17	7.7	Does not meet guidelines	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	79.5	Does not meet guidelines	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	32	Does not meet guidelines	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	47.1	Does not meet guidelines	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	61.5	Does not meet guidelines	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	75	Does not meet guidelines	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	56	Does not meet guidelines	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	1.2	Does not meet guidelines	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	26.8	Does not meet guidelines	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	21.8	Does not meet guidelines	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	34.4	Does not meet guidelines	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	88.4	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	31.4	Does not meet guidelines	Acceptable

Table D-3: Dissolved oxygen concentration (mg/L) in Melville Bull Creek catchment sites in 2017

Dissolved oxygen (DO mg/L)

Max (red) 8.14 Min (blue) 0.12

Site Name	Site Number	Collect Date	O - DO (mg/L)
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	4.86
JOHN CREANEY PARK	MELDR-05	19-Jul-17	3.74
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	6.75
BROCKMAN PARK	MELDR-02	19-Jul-17	4.08
BULL CREEK MD	PSDTBCMD	19-Jul-17	4.97
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	5.63
RAAF DRAIN	MELDR-14	19-Jul-17	6.94
BATEMAN PARK	MELDR-06	19-Jul-17	5.93
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	3.39
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	2.04
FREDERICK BALDWIN	MELDR-10	19-Jul-17	4.5
MARMION RESERVE	MELDR-11	19-Jul-17	7.46
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	6.08
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	4.29
JOHN CREANEY PARK	MELDR-05	22-Aug-17	1.78
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	5.83
BROCKMAN PARK	MELDR-02	22-Aug-17	4.39
BULL CREEK MD	PSDTBCMD	22-Aug-17	4.07
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	5.93
RAAF DRAIN	MELDR-14	22-Aug-17	7.39
BATEMAN PARK	MELDR-06	22-Aug-17	6.11
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	2.22
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	2.93
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	3.43
FREDERICK BALDWIN	MELDR-10	22-Aug-17	6.05
MARMION RESERVE	MELDR-11	22-Aug-17	8.03
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	2.92
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	3.73
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.74
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	6.01
BROCKMAN PARK	MELDR-02	19-Sep-17	3.93
BULL CREEK MD	PSDTBCMD	19-Sep-17	4.76
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	5.69
RAAF DRAIN	MELDR-14	19-Sep-17	7.65
BATEMAN PARK	MELDR-06	19-Sep-17	6.33
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	2.61
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	3.7
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	3.33
FREDERICK BALDWIN	MELDR-10	19-Sep-17	6.28
MARMION RESERVE	MELDR-11	19-Sep-17	5.9
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	1.07
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	3.56
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.71
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	7.44
BROCKMAN PARK	MELDR-02	11-Oct-17	2.92
BULL CREEK MD	PSDTBCMD	11-Oct-17	4.5
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	5.68
RAAF DRAIN	MELDR-14	11-Oct-17	7.22
BATEMAN PARK	MELDR-06	11-Oct-17	5.3
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.12
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	2.36
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	2.16
FREDERICK BALDWIN	MELDR-10	11-Oct-17	3.23
MARMION RESERVE	MELDR-11	11-Oct-17	8.14
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	2.75

Table D-4: Electrical conductivity (mS/cm) in Melville Bull Creek catchment sites in 2017

Electrical Conductivity (EC) Max (red) 1.858 Min (blue) 0.129

ANZECC trigger value 0.12-0.3 mS/cm for lowland rivers; 0.3 - 1.5 mS/cm for wetlands

Site Name	Site Number	Collect Date	EC (mS/cm)	lower limit 0.12/0.3	upper limit 0.3/1.5
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.234	Acceptable	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.403	Acceptable	Does not meet guidelines
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.143	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.666	Acceptable	Does not meet guidelines
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.575	Acceptable	Does not meet guidelines
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.555	Acceptable	Does not meet guidelines
RAAF DRAIN	MELDR-14	19-Jul-17	0.51	Acceptable	Does not meet guidelines
BATEMAN PARK	MELDR-06	19-Jul-17	0.439	Acceptable	Does not meet guidelines
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	1.13	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.758	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.132	Does not meet guidelines	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.214	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.721	Acceptable	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.481	Acceptable	Does not meet guidelines
JOHN CREANEY PARK	MELDR-05	22-Aug-17	1.858	Acceptable	Does not meet guidelines
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.484	Acceptable	Does not meet guidelines
BROCKMAN PARK	MELDR-02	22-Aug-17	0.785	Acceptable	Does not meet guidelines
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.726	Acceptable	Does not meet guidelines
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.587	Acceptable	Does not meet guidelines
RAAF DRAIN	MELDR-14	22-Aug-17	0.605	Acceptable	Does not meet guidelines
BATEMAN PARK	MELDR-06	22-Aug-17	0.602	Acceptable	Does not meet guidelines
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	1.619	Acceptable	Does not meet guidelines
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	1.162	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.492	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.16	Does not meet guidelines	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.129	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.571	Acceptable	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.626	Acceptable	Does not meet guidelines
JOHN CREANEY PARK	MELDR-05	19-Sep-17	1.006	Acceptable	Does not meet guidelines
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.604	Acceptable	Does not meet guidelines
BROCKMAN PARK	MELDR-02	19-Sep-17	0.814	Acceptable	Does not meet guidelines
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.764	Acceptable	Does not meet guidelines
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.606	Acceptable	Does not meet guidelines
RAAF DRAIN	MELDR-14	19-Sep-17	0.695	Acceptable	Does not meet guidelines
BATEMAN PARK	MELDR-06	19-Sep-17	0.631	Acceptable	Does not meet guidelines
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	1.662	Acceptable	Does not meet guidelines
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.996	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.676	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.326	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	0.195	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.737	Acceptable	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.649	Acceptable	Does not meet guidelines
JOHN CREANEY PARK	MELDR-05	11-Oct-17	1.196	Acceptable	Does not meet guidelines
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.424	Acceptable	Does not meet guidelines
BROCKMAN PARK	MELDR-02	11-Oct-17	0.801	Acceptable	Does not meet guidelines
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.744	Acceptable	Does not meet guidelines
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.6	Acceptable	Does not meet guidelines
RAAF DRAIN	MELDR-14	11-Oct-17	0.685	Acceptable	Does not meet guidelines
BATEMAN PARK	MELDR-06	11-Oct-17	0.624	Acceptable	Does not meet guidelines
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	1.454	Acceptable	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.921	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.641	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.305	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.213	Does not meet guidelines	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.749	Acceptable	Acceptable

Table D-5: Total suspended solids (mg/L) in Melville Bull Creek catchment sites in 2017

Total Suspended Solids (TSS) — All data in blue were <1 (LOR)

DoW interim guideline 6 mg/L — Max (red) 58 — Min (blue) <1

Site Name	Site Number	Collect Date	TSS (mg/L)	DoW interim guideline
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	10	Does not meet guidelines
JOHN CREANEY PARK	MELDR-05	19-Jul-17	4	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.5	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	2	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	4	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	8	Does not meet guidelines
RAAF DRAIN	MELDR-14	19-Jul-17	1	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	3	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	2	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	1	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	2	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	3	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	8	Does not meet guidelines
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	12	Does not meet guidelines
JOHN CREANEY PARK	MELDR-05	22-Aug-17	5	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	12	Does not meet guidelines
BROCKMAN PARK	MELDR-02	22-Aug-17	3	Acceptable
BULL CREEK MD	PSDTBCMD	22-Aug-17	3	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	10	Does not meet guidelines
RAAF DRAIN	MELDR-14	22-Aug-17	0.5	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	3	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	7	Does not meet guidelines
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	3	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	2	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	1	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.5	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	16	Does not meet guidelines
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	13	Does not meet guidelines
JOHN CREANEY PARK	MELDR-05	19-Sep-17	7	Does not meet guidelines
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	58	Does not meet guidelines
BROCKMAN PARK	MELDR-02	19-Sep-17	4	Acceptable
BULL CREEK MD	PSDTBCMD	19-Sep-17	4	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	11	Does not meet guidelines
RAAF DRAIN	MELDR-14	19-Sep-17	2	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	6	Does not meet guidelines
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	6	Does not meet guidelines
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	9	Does not meet guidelines
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	4	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	5	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	4	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	6	Does not meet guidelines
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	8	Does not meet guidelines
JOHN CREANEY PARK	MELDR-05	11-Oct-17	2	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	2	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	3	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	2	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	8	Does not meet guidelines
RAAF DRAIN	MELDR-14	11-Oct-17	0.5	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	5	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	2	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	7	Does not meet guidelines
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.5	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.5	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	1	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	2	Acceptable

Table D-6: Water temperature (°C) in the Melville Bull Creek catchment sites in 2017

Temperature (°C)

Max (red) 22.5 Min (blue) 14

Site Name	Site Number	Collect Date	Temp (°C)
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	16.4
JOHN CREANEY PARK	MELDR-05	19-Jul-17	15.9
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	17.7
BROCKMAN PARK	MELDR-02	19-Jul-17	19.1
BULL CREEK MD	PSDTBCMD	19-Jul-17	17.7
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	18.4
RAAF DRAIN	MELDR-14	19-Jul-17	15.6
BATEMAN PARK	MELDR-06	19-Jul-17	17.1
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	14.5
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	14
FREDERICK BALDWIN	MELDR-10	19-Jul-17	15.7
MARMION RESERVE	MELDR-11	19-Jul-17	15.7
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	17.7
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	16.6
JOHN CREANEY PARK	MELDR-05	22-Aug-17	19.1
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	18
BROCKMAN PARK	MELDR-02	22-Aug-17	19.3
BULL CREEK MD	PSDTBCMD	22-Aug-17	17.4
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	18.6
RAAF DRAIN	MELDR-14	22-Aug-17	16
BATEMAN PARK	MELDR-06	22-Aug-17	17.4
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	18.7
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	16
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	14.2
FREDERICK BALDWIN	MELDR-10	22-Aug-17	17
MARMION RESERVE	MELDR-11	22-Aug-17	17
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	20.5
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	18.2
JOHN CREANEY PARK	MELDR-05	19-Sep-17	18.1
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	19.2
BROCKMAN PARK	MELDR-02	19-Sep-17	19.8
BULL CREEK MD	PSDTBCMD	19-Sep-17	17.6
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	18.7
RAAF DRAIN	MELDR-14	19-Sep-17	18.1
BATEMAN PARK	MELDR-06	19-Sep-17	17.9
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	22.5
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	16.9
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	15.5
FREDERICK BALDWIN	MELDR-10	19-Sep-17	21
MARMION RESERVE	MELDR-11	19-Sep-17	19
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	22.3
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	18.2
JOHN CREANEY PARK	MELDR-05	11-Oct-17	18.7
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	18.5
BROCKMAN PARK	MELDR-02	11-Oct-17	19.7
BULL CREEK MD	PSDTBCMD	11-Oct-17	17.4
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	19.1
RAAF DRAIN	MELDR-14	11-Oct-17	17.1
BATEMAN PARK	MELDR-06	11-Oct-17	18
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	17
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	21.5
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	15.6
FREDERICK BALDWIN	MELDR-10	11-Oct-17	18.4
MARMION RESERVE	MELDR-11	11-Oct-17	19.3
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	21.9

Nutrients in water

Table D-7: Total nitrogen concentrations (mg/L) in the Melville Bull Creek catchment sites in 2017

Total Nitrogen (TN) (mg/L) N (tot) {TN, pTN} (mg/L) LOR <0.025

ANZECC trigger value for lowland rivers (1.2 mg/L); for wetlands (1.5 mg/L)

Max (red) 7.9 Min (blue) 0.22

Site Name	Site Number	Collect Date	TN	Comparison to ANZECC trigger value
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.58	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.79	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.34	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	5.1	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Jul-17	3	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.65	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.58	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.55	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.82	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.72	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.37	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.45	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	2.7	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.96	Acceptable
JOHN CREANEY PARK	MELDR-05	22-Aug-17	1.2	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	2	Guideline exceeded
BROCKMAN PARK	MELDR-02	22-Aug-17	5.2	Guideline exceeded
BULL CREEK MD	PSDTBCMD	22-Aug-17	4.3	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.9	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	1.2	Guideline exceeded
BATEMAN PARK	MELDR-06	22-Aug-17	0.89	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	7.9	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	1	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	1	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.22	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.26	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	2.5	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.86	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.9	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	2.1	Guideline exceeded
BROCKMAN PARK	MELDR-02	19-Sep-17	5.7	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Sep-17	3.5	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.58	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	0.73	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	0.62	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	5.2	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.92	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	1.3	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.88	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	0.51	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	3.5	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.8	Acceptable
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.92	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	1.2	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	5.8	Guideline exceeded
BULL CREEK MD	PSDTBCMD	11-Oct-17	3.4	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.64	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.64	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.61	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	3.5	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	1.2	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	1.4	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.26	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.47	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	2.1	Guideline exceeded

Table D-8: Total oxidised nitrogen concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Total Oxidised Nitrogen (NOx) All data in blue were <0.01 (LOR)

ANZECC trigger value: 0.15 mg/L for lowland rivers; 0.10 mg/L for wetlands

All data in blue were <0.01 (LOR) Max (red) 2.2 Min (blue) <0.01

Site Name	Site Number	Collect Date	NOx	Comparison to ANZECC trigger value
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.12	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.12	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.1	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.12	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	1.6	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.19	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Jul-17	0.12	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.16	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.016	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.015	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.037	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.016	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.095	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.13	Acceptable
JOHN CREANEY PARK	MELDR-05	22-Aug-17	0.11	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.92	Guideline exceeded
BROCKMAN PARK	MELDR-02	22-Aug-17	0.24	Guideline exceeded
BULL CREEK MD	PSDTBCMD	22-Aug-17	1.9	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.29	Guideline exceeded
RAAF DRAIN	MELDR-14	22-Aug-17	0.4	Guideline exceeded
BATEMAN PARK	MELDR-06	22-Aug-17	0.34	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	0.077	Acceptable
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.005	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.005	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.005	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.005	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.065	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.11	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.035	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.92	Guideline exceeded
BROCKMAN PARK	MELDR-02	19-Sep-17	0.16	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Sep-17	2.1	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.2	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Sep-17	0.16	Guideline exceeded
BATEMAN PARK	MELDR-06	19-Sep-17	0.2	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	0.34	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.005	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.005	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.005	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	0.005	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.045	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.12	Acceptable
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.049	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.46	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	0.16	Guideline exceeded
BULL CREEK MD	PSDTBCMD	11-Oct-17	2.2	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.23	Guideline exceeded
RAAF DRAIN	MELDR-14	11-Oct-17	0.11	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.2	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.21	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.005	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.005	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.005	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.005	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.022	Acceptable

Table D-9: Nitrogen as ammonia/ammonium concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Nitrogen as ammonia/ammonium (sol mg/L) NH3-N/NH4-N (sol) (mg/L) All data in blue were <0.01 (LOR)

ANZECC trigger value for lowland rivers: 0.08 mg/L, wetlands: 0.04 mg/L; NHMRC guidleline for recreational value: 5 mg/L

Max (red) 4.80 Min (blue) <0.01

Site name	Site number	Date	NH3-N/NH4-N (sol) (mg/L)	pH	Adjusted ANZECC freshwater protection trigger value (mg/L)	Comparison to ANZECC freshwater protection trigger value	Comparison to ANZECC lowland rivers/wetlands trigger value	Comparison to NHMRC trigger value for recreation
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.016	6.85	2.33	Acceptable	Acceptable	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.063	6.53	2.46	Acceptable	Acceptable	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.015	7.15	2.09	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	4.2	6.24	2.54	Guideline exceeded	Guideline exceeded	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.59	6.68	2.43	Acceptable	Guideline exceeded	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.14	6.61	2.43	Acceptable	Guideline exceeded	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.055	7.11	2.09	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.094	6.79	2.38	Acceptable	Guideline exceeded	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.018	5.61	>2.57	Acceptable	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.013	6.39	2.54	Acceptable	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.048	6.95	2.26	Acceptable	Guideline exceeded	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.005	9.12	<0.18	Acceptable	Acceptable	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	1.1	6.8	2.33	Acceptable	Guideline exceeded	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.081	6.58	2.46	Acceptable	Guideline exceeded	Acceptable
JOHN CREANEY PARK	MELDR-05	22-Aug-17	0.33	6.46	2.49	Acceptable	Guideline exceeded	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.049	6.83	2.33	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	22-Aug-17	4.2	6.24	2.54	Guideline exceeded	Guideline exceeded	Acceptable
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.62	6.84	2.33	Acceptable	Guideline exceeded	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.14	6.75	2.38	Acceptable	Guideline exceeded	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	0.062	7.24	1.99	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	0.11	7.18	2.09	Acceptable	Guideline exceeded	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	4.3	6.79	2.38	Guideline exceeded	Guideline exceeded	Acceptable
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.005	5.9	>2.57	Acceptable	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.005	6.37	2.54	Acceptable	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.02	7.19	2.09	Acceptable	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.005	9.82	<0.18	Acceptable	Acceptable	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.39	6.6	2.43	Acceptable	Guideline exceeded	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.1	6.4	2.49	Acceptable	Guideline exceeded	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.23	6.32	2.54	Acceptable	Guideline exceeded	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.022	6.93	2.26	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	19-Sep-17	4.8	6.21	2.54	Guideline exceeded	Guideline exceeded	Acceptable
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.79	6.78	2.38	Acceptable	Guideline exceeded	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.12	6.64	2.43	Acceptable	Guideline exceeded	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	0.061	7.15	2.09	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	0.094	6.82	2.33	Acceptable	Guideline exceeded	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	2.3	6.85	2.33	Acceptable	Guideline exceeded	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.013	6.18	2.555	Acceptable	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.012	6.72	2.38	Acceptable	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.005	7.37	1.88	Acceptable	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	0.005	9.51	0.18	Acceptable	Acceptable	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.53	6.79	2.38	Acceptable	Guideline exceeded	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.11	6.49	2.49	Acceptable	Guideline exceeded	Acceptable
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.22	6.39	2.54	Acceptable	Guideline exceeded	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.039	7.02	2.18	Acceptable	Acceptable	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	4.6	6.25	2.54	Guideline exceeded	Guideline exceeded	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.55	6.74	2.38	Acceptable	Guideline exceeded	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.14	6.71	2.38	Acceptable	Guideline exceeded	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.044	7.18	2.09	Acceptable	Acceptable	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.094	6.98	2.26	Acceptable	Guideline exceeded	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.63	6.67	2.43	Acceptable	Guideline exceeded	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.033	6.06	2.57	Acceptable	Acceptable	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.019	6.76	2.38	Acceptable	Acceptable	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.015	6.96	2.26	Acceptable	Acceptable	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.014	9.21	0.18	Acceptable	Acceptable	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.33	6.92	2.26	Acceptable	Guideline exceeded	Acceptable

Table D-10: Total organic nitrogen concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Total Organic Nitrogen (TON) LOR <0.005

Max (red) 3.5 Min (blue) 0.19

Site Name	Site	Collect Date	TON
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.44
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.6
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.22
BROCKMAN PARK	MELDR-02	19-Jul-17	0.82
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.8
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.32
RAAF DRAIN	MELDR-14	19-Jul-17	0.4
BATEMAN PARK	MELDR-06	19-Jul-17	0.3
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.79
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.69
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.28
MARMION RESERVE	MELDR-11	19-Jul-17	0.43
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	1.6
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.75
JOHN CREANEY PARK	MELDR-05	22-Aug-17	0.8
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	1
BROCKMAN PARK	MELDR-02	22-Aug-17	0.76
BULL CREEK MD	PSDTBCMD	22-Aug-17	1.8
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.46
RAAF DRAIN	MELDR-14	22-Aug-17	0.73
BATEMAN PARK	MELDR-06	22-Aug-17	0.43
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	3.5
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	1
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	1
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.19
MARMION RESERVE	MELDR-11	22-Aug-17	0.25
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	2
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.64
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.64
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	1.1
BROCKMAN PARK	MELDR-02	19-Sep-17	0.68
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.63
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.26
RAAF DRAIN	MELDR-14	19-Sep-17	0.51
BATEMAN PARK	MELDR-06	19-Sep-17	0.32
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	2.6
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.9
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	1.3
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.87
MARMION RESERVE	MELDR-11	19-Sep-17	0.5
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	2.9
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.57
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.65
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.66
BROCKMAN PARK	MELDR-02	11-Oct-17	1
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.63
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.28
RAAF DRAIN	MELDR-14	11-Oct-17	0.48
BATEMAN PARK	MELDR-06	11-Oct-17	0.32
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	2.7
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	1.1
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	1.4
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.24
MARMION RESERVE	MELDR-11	11-Oct-17	0.45
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	1.8

Table D-11: Dissolved organic nitrogen concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Dissolved Organic Nitrogen (DON) (mg/L) All data in blue were <0.005 (LOR)

Max (red) 2.5 Min (blue) 0.18

Site Name	Site	Collect Date	DON
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.32
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.49
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.18
BROCKMAN PARK	MELDR-02	19-Jul-17	0.8
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.78
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.28
RAAF DRAIN	MELDR-14	19-Jul-17	0.35
BATEMAN PARK	MELDR-06	19-Jul-17	0.28
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.78
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.66
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.2
MARMION RESERVE	MELDR-11	19-Jul-17	0.27
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	1.5
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.56
JOHN CREANEY PARK	MELDR-05	22-Aug-17	0.69
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.69
BROCKMAN PARK	MELDR-02	22-Aug-17	0.7
BULL CREEK MD	PSDTBCMD	22-Aug-17	1.1
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.23
RAAF DRAIN	MELDR-14	22-Aug-17	0.42
BATEMAN PARK	MELDR-06	22-Aug-17	0.3
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	2.4
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	1
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.98
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.19
MARMION RESERVE	MELDR-11	22-Aug-17	0.25
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	1.5
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.46
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.52
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.77
BROCKMAN PARK	MELDR-02	19-Sep-17	0.66
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.48
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.2
RAAF DRAIN	MELDR-14	19-Sep-17	0.45
BATEMAN PARK	MELDR-06	19-Sep-17	0.27
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	2.5
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.9
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	1.3
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.27
MARMION RESERVE	MELDR-11	19-Sep-17	0.45
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	1.8
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.45
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.54
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.59
BROCKMAN PARK	MELDR-02	11-Oct-17	0.86
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.54
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.22
RAAF DRAIN	MELDR-14	11-Oct-17	0.41
BATEMAN PARK	MELDR-06	11-Oct-17	0.28
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	2.5
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	1.1
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	1.3
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.21
MARMION RESERVE	MELDR-11	11-Oct-17	0.38
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	1.7

Table D-12: Total phosphorus concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Total Phosphorus (TP) (mg/L) P (tot) {TP, pTP} (mg/L)

ANZECC trigger value: 0.065mg/L for lowland rivers; 0.06 mg/L for wetlands

All data in blue w ere <0.005 (LOR) Max (red) 4 Min (blue) 0.006

Site Name	Site Number	Collect Date	TP	Comparison to ANZECC trigger value
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.046	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.058	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.029	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.018	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.015	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.013	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.019	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.014	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.012	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.006	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.03	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.05	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.17	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.075	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	22-Aug-17	0.059	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.069	Guideline exceeded
BROCKMAN PARK	MELDR-02	22-Aug-17	0.014	Acceptable
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.012	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.01	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	0.012	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	0.012	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	1.6	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.006	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.014	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.017	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.041	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.25	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.067	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.034	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.21	Guideline exceeded
BROCKMAN PARK	MELDR-02	19-Sep-17	0.011	Acceptable
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.015	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.009	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	0.015	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	0.011	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	3.6	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.013	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.019	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.082	Guideline exceeded
MARMION RESERVE	MELDR-11	19-Sep-17	0.074	Guideline exceeded
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.56	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.045	Acceptable
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.032	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.087	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	0.013	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.013	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.012	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.012	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.013	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	4	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.017	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.017	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.015	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.048	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.41	Guideline exceeded

Table D-13: Soluble reactive phosphorus concentrations (mg/L) in the Melville Bull Creek catchment sites in 2017

Soluble Reactive Phosphorus (SRP) (mg/L) PO4-P (sol react) {SRP, FRP} (mg/L)

ANZECC trigger value: 0.04 mg/L for lowland rivers and 0.03 mg/L for wetlands

All data in blue were <0.005 (LOR) Max (red) 3.3 Min (blue) <0.005

Site Name	Site Number	Collect Date	SRP	Comparison to ANZECC trigger value
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.014	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.016	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.011	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.01	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.007	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.009	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.008	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.0025	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.0025	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.0025	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.006	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.008	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.1	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.028	Acceptable
JOHN CREANEY PARK	MELDR-05	22-Aug-17	0.03	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.015	Acceptable
BROCKMAN PARK	MELDR-02	22-Aug-17	0.007	Acceptable
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.007	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.006	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	0.005	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	0.006	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	1.1	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.006	Acceptable
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.0025	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.0025	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.016	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.15	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.009	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.007	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.061	Guideline exceeded
BROCKMAN PARK	MELDR-02	19-Sep-17	0.0025	Acceptable
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.0025	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.0025	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	0.0025	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	0.0025	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	2.4	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.0025	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.0025	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.0025	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	0.02	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.43	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.016	Acceptable
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.008	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.048	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	0.009	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.006	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.0025	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.005	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.0025	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	3.3	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.007	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.0025	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.0025	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.011	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.31	Guideline exceeded

Metals and hardness in water

Table D-14 : Total aluminium concentrations (mg/L) in water in Melville Bull Creek catchment sites in 2017

Total Aluminium (Al) (mg/L) LOR 0.005 mg/L

ANZECC trigger value: 0.055mg/L for 95% Level of protection

Max (red) 0.55 Min (blue) 0.029

Site Name	Site Number	Collect Date	Al (tot) (mg/L)	pH	Comparison to ANZECC trigger value 95% Level of Protection
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.18	6.85	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.25	6.53	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.053	7.15	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.32	6.24	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.23	6.68	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.55	6.61	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Jul-17	0.11	7.11	Guideline exceeded
BATEMAN PARK	MELDR-06	19-Jul-17	0.33	6.79	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.33	5.61	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.31	6.39	Guideline exceeded
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.029	6.95	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.057	9.12	Guideline exceeded
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.096	6.8	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	0.067	6.79	Guideline exceeded

Table D-15: Soluble aluminium concentrations (mg/L) in water in Melville Bull Creek catchment sites in 2017

Soluble Aluminium (Al) (mg/L) LOR 0.005 mg/L

ANZECC trigger value: 0.055mg/L for 95% Level of protection

Max (red) 1 Min (blue) 0.015

Site Name	Site Number	Collect Date	Al (sol) (mg/L)	pH	Comparison to ANZECC 95% trigger value
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.077	6.85	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.13	6.53	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.03	7.15	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.23	6.24	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.15	6.68	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.12	6.61	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Jul-17	0.068	7.11	Guideline exceeded
BATEMAN PARK	MELDR-06	19-Jul-17	0.078	6.79	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.31	5.61	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.25	6.39	Guideline exceeded
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.015	6.95	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.039	9.12	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.071	6.8	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.24	6.58	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	22-Aug-17	0.18	6.46	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.54	6.83	Guideline exceeded
BROCKMAN PARK	MELDR-02	22-Aug-17	0.29	6.24	Guideline exceeded
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.23	6.84	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.17	6.75	Guideline exceeded
RAAF DRAIN	MELDR-14	22-Aug-17	0.13	7.24	Guideline exceeded
BATEMAN PARK	MELDR-06	22-Aug-17	0.15	7.18	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	0.053	6.79	Acceptable
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.45	5.9	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	1	6.37	Guideline exceeded
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.021	7.19	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.049	9.82	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.13	6.6	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.15	6.4	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	19-Sep-17	0.13	6.32	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.34	6.93	Guideline exceeded
BROCKMAN PARK	MELDR-02	19-Sep-17	0.25	6.21	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.17	6.78	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.11	6.64	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Sep-17	0.09	7.15	Guideline exceeded
BATEMAN PARK	MELDR-06	19-Sep-17	0.093	6.82	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	0.058	6.85	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.41	6.18	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.67	6.72	Guideline exceeded
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.023	7.37	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	0.11	9.51	Guideline exceeded
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.19	6.79	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.19	6.49	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.15	6.39	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.36	7.02	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	0.3	6.25	Guideline exceeded
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.17	6.74	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.29	6.71	Guideline exceeded
RAAF DRAIN	MELDR-14	11-Oct-17	0.1	7.18	Guideline exceeded
BATEMAN PARK	MELDR-06	11-Oct-17	0.23	6.98	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.084	6.67	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.32	6.06	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.64	6.76	Guideline exceeded
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.017	6.96	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.072	9.21	Guideline exceeded
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.22	6.92	Guideline exceeded

Table D-16: Total chromium concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Chromium (Cr III) (total mg/L) Max (red) 0.0019 Min (blue) 0.0001 LOR = 0.0001

ANZECC unmodified trigger value for protection of biota: 0.0033 mg/L, NHMRC guideline for recreational use (health value): 0.5 mg/L

Site name	Site number	Date	Cr (tot) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value	Hardness range (mg/L)	Adjust factor	Unmodified ANZECC trigger value*
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.0004	25	1	0.0033	Acceptable	0-59	1	0.0033
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.0008	67	2.5	0.00825	Acceptable	60-119	2.5	
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.0003	24	1	0.0033	Acceptable	120-179	3.7	
BROCKMAN PARK	MELDR-2	19-Jul-17	0.0009	100	2.5	0.00825	Acceptable	180-240	4.9	
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.0008	96	2.5	0.00825	Acceptable			
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.0016	110	2.5	0.00825	Acceptable			
RAAF DRAIN	MELDR-14	19-Jul-17	0.0008	94	2.5	0.00825	Acceptable			
BATEMAN PARK	MELDR-06	19-Jul-17	0.0011	91	2.5	0.00825	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.0009	190	4.9	0.01617	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.0016	130	3.7	0.01221	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.0001	31	1	0.0033	Acceptable			
MARMION RESERVE	MELDR-11	19-Jul-17	0.0001	61	2.5	0.00825	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.0019	83	2.5	0.00825	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	22-Jun-17	0.0006	440	8.4	0.02772	Acceptable			

Table D-17: Soluble chromium concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Chromium (Cr III) (soluble mg/L) Max (red) 0.0038 Min (blue) <0.0001 All data in blue were <0.0001 mg/L (LOR)

ANZECC unmodified trigger value for protection of biota: 0.0033 mg/L, NHMRC guideline for recreational use (health value): 0.5 mg/L

Site name	Site number	Date	Cr (sol) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value	Hardness range (mg/L)	Adjust factor	Unmodified ANZECC trigger value*
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.0004	25	1	0.0033	Acceptable	0-59	1	0.0033
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.0007	67	2.5	0.00825	Acceptable	60-119	2.5	
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.0003	24	1	0.0033	Acceptable	120-179	3.7	
BROCKMAN PARK	MELDR-2	19-Jul-17	0.0009	100	2.5	0.00825	Acceptable	180-240	4.9	
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.0008	96	2.5	0.00825	Acceptable	>240	8.4	
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.0012	110	2.5	0.00825	Acceptable			
RAAF DRAIN	MELDR-14	19-Jul-17	0.0008	94	2.5	0.00825	Acceptable			
BATEMAN PARK	MELDR-06	19-Jul-17	0.0008	91	2.5	0.00825	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.001	190	4.9	0.01617	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.0016	130	3.7	0.01221	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.0001	31	1	0.0033	Acceptable			
MARMION RESERVE	MELDR-11	19-Jul-17	0.0001	61	2.5	0.00825	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.0018	83	2.5	0.00825	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.0013	89	2.5	0.00825	Acceptable			
JOHN CREANEY PARK	MELDR-5	22-Aug-17	0.0013	180	4.9	0.01617	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.001	85	2.5	0.00825	Acceptable			
BROCKMAN PARK	MELDR-2	22-Aug-17	0.0009	130	3.7	0.01221	Acceptable			
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.001	130	3.7	0.01221	Acceptable			
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.0012	130	3.7	0.01221	Acceptable			
RAAF DRAIN	MELDR-14	22-Aug-17	0.0011	130	3.7	0.01221	Acceptable			
BATEMAN PARK	MELDR-06	22-Aug-17	0.0011	140	3.7	0.01221	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	0.0006	440	8.4	0.02772	Acceptable			
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.0011	160	3.7	0.01221	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.0029	71	2.5	0.00825	Acceptable			
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.00005	37	1	0.0033	Acceptable			
MARMION RESERVE	MELDR-11	22-Aug-17	0.0001	40	1	0.0033	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.0025	62	2.5	0.00825	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.0007	110	2.5	0.00825	Acceptable			
JOHN CREANEY PARK	MELDR-5	19-Sep-17	0.0004	200	4.9	0.01617	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.0038	110	2.5	0.00825	Acceptable			
BROCKMAN PARK	MELDR-2	19-Sep-17	0.0003	120	3.7	0.01221	Acceptable			
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.0006	120	3.7	0.01221	Acceptable			
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.0004	130	3.7	0.01221	Acceptable			
RAAF DRAIN	MELDR-14	19-Sep-17	0.0006	130	3.7	0.01221	Acceptable			
BATEMAN PARK	MELDR-06	19-Sep-17	0.0004	130	3.7	0.01221	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	0.0006	410	8.4	0.02772	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.0008	140	3.7	0.01221	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.0007	97	2.5	0.00825	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.0006	83	2.5	0.00825	Acceptable			
MARMION RESERVE	MELDR-11	19-Sep-17	0.0006	67	2.5	0.00825	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.0008	77	2.5	0.00825	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.0013	120	3.7	0.01221	Acceptable			
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.0017	190	4.9	0.01617	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.0012	82	2.5	0.00825	Acceptable			
BROCKMAN PARK	MELDR-02	11-Oct-17	0.001	130	3.7	0.01221	Acceptable			
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.0011	120	3.7	0.01221	Acceptable			
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.0013	140	3.7	0.01221	Acceptable			
RAAF DRAIN	MELDR-14	11-Oct-17	0.0012	140	3.7	0.01221	Acceptable			
BATEMAN PARK	MELDR-06	11-Oct-17	0.0013	140	3.7	0.01221	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.0012	360	8.4	0.02772	Acceptable			
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.0021	120	3.7	0.01221	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.0029	99	2.5	0.00825	Acceptable			
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.00005	76	2.5	0.00825	Acceptable			
MARMION RESERVE	MELDR-11	11-Oct-17	0.0001	79	2.5	0.00825	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.0035	88	2.5	0.00825	Acceptable			

Table D-18: Total copper concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Copper (Cu) (total mg/L) Max (red) 0.0044 Min (blue) 0.0004 All data in blue were <0.0001 mg/L (LOR)

ANZECC unmodified freshwater 95% trigger value: 0.0014 mg/L, NHMRC guidelines for recreational use - aesthetic: 10 mg/L, health: 20mg/L

Site name	Site number	Date	Cu (tot) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value	Hardness range (mg/L)	Adjust factor	Unmodified ANZECC trigger value*
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.0044	25	1	0.0014	Guideline exceeded	0-59	1	0.0014
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.0037	67	2.5	0.0035	Guideline exceeded	60-119	2.5	
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.0024	24	1	0.0014	Guideline exceeded	120-179	3.9	
BROCKMAN PARK	MELDR-02	19-Jul-17	0.0011	100	2.5	0.0035	Acceptable	180-240	5.2	
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.0012	96	2.5	0.0035	Acceptable	>240	9	
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.0007	110	2.5	0.0035	Acceptable			
RAAF DRAIN	MELDR-14	19-Jul-17	0.0007	94	2.5	0.0035	Acceptable			
BATEMAN PARK	MELDR-06	19-Jul-17	0.0015	91	2.5	0.0035	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.0007	190	5.2	0.00728	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.0004	130	3.9	0.00546	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.0015	31	1	0.0014	Guideline exceeded			
MARMION RESERVE	MELDR-11	19-Jul-17	0.0007	61	2.5	0.0035	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.0012	83	2.5	0.0035	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	22-Jun-17	0.0013	440	9	0.0126	Acceptable			

Table D-19: Soluble copper concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Copper (Cu) (soluble mg/L) Max (red) 0.005 Min (blue) 0.0002 All data in blue were <0.0001 mg/L (LOR)

ANZECC unmodified freshwater 95% trigger value: 0.0014 mg/L, NHMRC guidelines for recreational use - aesthetic: 10 mg/L, health: 20mg/L

Site name	Site number	Date	Cu (sol) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value	Hardness range (mg/L)	Adjust factor	Unmodified ANZECC trigger value*
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.0042	25	1	0.0014	Guideline exceeded	0-59	1	0.0014
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.0033	67	2.5	0.0035	Acceptable	60-119	2.5	
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.0024	24	1	0.0014	Guideline exceeded	120-179	3.9	
BROCKMAN PARK	MELDR-2	19-Jul-17	0.0008	100	2.5	0.0035	Acceptable	180-240	5.2	
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.0012	96	2.5	0.0035	Acceptable	>240	9	
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.0005	110	2.5	0.0035	Acceptable			
RAAF DRAIN	MELDR-14	19-Jul-17	0.0007	94	2.5	0.0035	Acceptable			
BATEMAN PARK	MELDR-06	19-Jul-17	0.0014	91	2.5	0.0035	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.0007	190	5.2	0.00728	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.0004	130	3.9	0.00546	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.0014	31	1	0.0014	Guideline exceeded			
MARMION RESERVE	MELDR-11	19-Jul-17	0.0007	61	2.5	0.0035	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.0012	83	2.5	0.0035	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.0013	89	2.5	0.0035	Acceptable			
JOHN CREANEY PARK	MELDR-5	22-Aug-17	0.0006	180	5.2	0.00728	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.005	85	2.5	0.0035	Guideline exceeded			
BROCKMAN PARK	MELDR-2	22-Aug-17	0.0003	130	3.9	0.00546	Acceptable			
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.0009	130	3.9	0.00546	Acceptable			
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.0011	130	3.9	0.00546	Acceptable			
RAAF DRAIN	MELDR-14	22-Aug-17	0.0009	130	3.9	0.00546	Acceptable			
BATEMAN PARK	MELDR-06	22-Aug-17	0.0006	140	3.9	0.00546	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	0.0005	440	9	0.0126	Acceptable			
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.0008	160	3.9	0.00546	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.0011	71	2.5	0.0035	Acceptable			
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.001	37	1	0.0014	Acceptable			
MARMION RESERVE	MELDR-11	22-Aug-17	0.0008	40	1	0.0014	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.0019	62	2.5	0.0035	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.0007	110	2.5	0.0035	Acceptable			
JOHN CREANEY PARK	MELDR-5	19-Sep-17	0.0004	200	5.2	0.00728	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.0038	110	2.5	0.0035	Guideline exceeded			
BROCKMAN PARK	MELDR-2	19-Sep-17	0.0003	120	3.9	0.00546	Acceptable			
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.0006	120	3.9	0.00546	Acceptable			
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.0004	130	3.9	0.00546	Acceptable			
RAAF DRAIN	MELDR-14	19-Sep-17	0.0006	130	3.9	0.00546	Acceptable			
BATEMAN PARK	MELDR-06	19-Sep-17	0.0004	130	3.9	0.00546	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	0.0006	410	9	0.0126	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.0008	140	3.9	0.00546	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.0007	97	2.5	0.0035	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.0006	83	2.5	0.0035	Acceptable			
MARMION RESERVE	MELDR-11	19-Sep-17	0.0006	67	2.5	0.0035	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.0008	77	2.5	0.0035	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.0012	120	3.9	0.00546	Acceptable			
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.0007	190	5.2	0.00728	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.0046	82	2.5	0.0035	Guideline exceeded			
BROCKMAN PARK	MELDR-02	11-Oct-17	0.0003	130	3.9	0.00546	Acceptable			
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.0007	120	3.9	0.00546	Acceptable			
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.0002	140	3.9	0.00546	Acceptable			
RAAF DRAIN	MELDR-14	11-Oct-17	0.0005	140	3.9	0.00546	Acceptable			
BATEMAN PARK	MELDR-06	11-Oct-17	0.0004	140	3.9	0.00546	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.0007	360	9	0.0126	Acceptable			
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.0008	120	3.9	0.00546	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.0007	99	2.5	0.0035	Acceptable			
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.0008	76	2.5	0.0035	Acceptable			
MARMION RESERVE	MELDR-11	11-Oct-17	0.0007	79	2.5	0.0035	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.0007	88	2.5	0.0035	Acceptable			

Table D-20: Total iron concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Total Iron (Fe) (mg/L) LOR 0.005 mg/L

Interim guideline for biota protection: 0.3 mg/L, NHMRC guideline for recreation (aesthetic): 3 mg/L

Max (red) 3.4 Min (blue) 0.053

Site Name	Site Number	Collect Date	Fe (mg/L)	Comparison to interim guideline
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.19	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.43	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.053	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.59	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.34	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	1.5	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Jul-17	0.42	Guideline exceeded
BATEMAN PARK	MELDR-06	19-Jul-17	0.81	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.99	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.22	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.18	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.16	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	3.4	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	6.8	Guideline exceeded

Table D-21: Soluble iron concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Soluble Iron (Fe) (mg/L) LOR 0.005 mg/L

Interim guideline for biota protection: 0.3 mg/L, NHMRC guideline for recreation (aesthetic): 3 mg/L

Max (red) 6 Min (blue) 0.039

Site Name	Site Number	Collect Date	Fe (mg/L)	Comparison to interim guideline
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.12	Acceptable
JOHN CREANEY PARK	MELDR-05	19-Jul-17	0.36	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.039	Acceptable
BROCKMAN PARK	MELDR-02	19-Jul-17	0.59	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.25	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	1.3	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Jul-17	0.28	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.5	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.91	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.18	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.11	Acceptable
MARMION RESERVE	MELDR-11	19-Jul-17	0.078	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	2.9	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	2.2	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	22-Aug-17	2	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.75	Guideline exceeded
BROCKMAN PARK	MELDR-02	22-Aug-17	1.1	Guideline exceeded
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.46	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	1.4	Guideline exceeded
RAAF DRAIN	MELDR-14	22-Aug-17	0.46	Guideline exceeded
BATEMAN PARK	MELDR-06	22-Aug-17	0.88	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	6	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.99	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.29	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.23	Acceptable
MARMION RESERVE	MELDR-11	22-Aug-17	0.095	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	3	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	1.6	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	19-Sep-17	1.6	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	2.2	Guideline exceeded
BROCKMAN PARK	MELDR-02	19-Sep-17	1.1	Guideline exceeded
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.42	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.98	Guideline exceeded
RAAF DRAIN	MELDR-14	19-Sep-17	0.49	Guideline exceeded
BATEMAN PARK	MELDR-06	19-Sep-17	0.58	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	3.9	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.88	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.76	Guideline exceeded
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.35	Guideline exceeded
MARMION RESERVE	MELDR-11	19-Sep-17	0.63	Guideline exceeded
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	3.7	Guideline exceeded
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	1.8	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	11-Oct-17	1.4	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	2.2	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	1.2	Guideline exceeded
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.4	Guideline exceeded
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	2.5	Guideline exceeded
RAAF DRAIN	MELDR-14	11-Oct-17	0.53	Guideline exceeded
BATEMAN PARK	MELDR-06	11-Oct-17	1.7	Guideline exceeded
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	4.3	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	3.8	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.58	Guideline exceeded
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.14	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.44	Guideline exceeded
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	2.9	Guideline exceeded

Table D-22: Total lead concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Lead (Pb) (total mg/L) Max (red) 0.0073 Min (blue) <0.0001 All data in blue were <0.0001 mg/L (LOR)

ANZECC unmodified freshwater 95% trigger value: 0.0034 mg/L, NHMRC recreational guideline value (health value): 0.1 mg/L

Site name	Site number	Date	Pb (tot) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value	Hardness range (mg/L)	Adjust factor	Unmodified ANZECC trigger value*
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.0005	25	1	0.0034	Acceptable	0-59	1	0.0034
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.0011	67	4	0.0136	Acceptable	60-119	4	
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.0008	24	1	0.0034	Acceptable	120-179	7.6	
BROCKMAN PARK	MELDR-2	19-Jul-17	0.0003	100	4	0.0136	Acceptable	180-240	11.8	
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.0006	96	4	0.0136	Acceptable	>240	26.7	
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.0001	110	4	0.0136	Acceptable			
RAAF DRAIN	MELDR-14	19-Jul-17	0.0003	94	4	0.0136	Acceptable			
BATEMAN PARK	MELDR-06	19-Jul-17	0.0001	91	4	0.0136	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.0004	190	11.8	0.04012	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.0002	130	7.6	0.02584	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.0002	31	1	0.0034	Acceptable			
MARMION RESERVE	MELDR-11	19-Jul-17	0.00005	61	4	0.0136	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.0073	83	4	0.0136	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	22-Jun-17	0.0007	440	26.7	0.09078	Acceptable			

Table D-23: Soluble lead concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Lead (Pb) (soluble mg/L) Max (red) 0.0067 Min (blue) <0.0001 All data in blue were <0.0001 mg/L (LOR)

ANZECC unmodified freshwater 95% trigger value: 0.0034 mg/L, NHMRC recreational guideline value (health value): 0.1 mg/L

Site name	Site number	Date	Pb (sol) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value	Hardness range (mg/L)	Adjust factor	Unmodified ANZECC trigger value*
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.0005	25	1	0.0034	Acceptable	0-59	1	0.0034
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.001	67	4	0.0136	Acceptable	60-119	4	
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.0002	24	1	0.0034	Acceptable	120-179	7.6	
BROCKMAN PARK	MELDR-2	19-Jul-17	0.0003	100	4	0.0136	Acceptable	180-240	11.8	
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.0005	96	4	0.0136	Acceptable	>240	26.7	
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.00005	110	4	0.0136	Acceptable			
RAAF DRAIN	MELDR-14	19-Jul-17	0.0002	94	4	0.0136	Acceptable			
BATEMAN PARK	MELDR-06	19-Jul-17	0.0001	91	4	0.0136	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.0004	190	11.8	0.04012	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.0002	130	7.6	0.02584	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.0002	31	1	0.0034	Acceptable			
MARMION RESERVE	MELDR-11	19-Jul-17	0.00005	61	4	0.0136	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.0067	83	4	0.0136	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.001	89	4	0.0136	Acceptable			
JOHN CREANEY PARK	MELDR-5	22-Aug-17	0.0005	180	11.8	0.04012	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.0017	85	4	0.0136	Acceptable			
BROCKMAN PARK	MELDR-2	22-Aug-17	0.0003	130	7.6	0.02584	Acceptable			
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.0007	130	7.6	0.02584	Acceptable			
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.0001	130	7.6	0.02584	Acceptable			
RAAF DRAIN	MELDR-14	22-Aug-17	0.0003	130	7.6	0.02584	Acceptable			
BATEMAN PARK	MELDR-06	22-Aug-17	0.0002	140	7.6	0.02584	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	0.0007	440	26.7	0.09078	Acceptable			
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.0007	160	7.6	0.02584	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.0011	71	4	0.0136	Acceptable			
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.0004	37	1	0.0034	Acceptable			
MARMION RESERVE	MELDR-11	22-Aug-17	0.0004	40	1	0.0034	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.0061	62	4	0.0136	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.0003	110	4	0.0136	Acceptable			
JOHN CREANEY PARK	MELDR-5	19-Sep-17	0.0002	200	11.8	0.04012	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.0013	110	4	0.0136	Acceptable			
BROCKMAN PARK	MELDR-2	19-Sep-17	0.0001	120	7.6	0.02584	Acceptable			
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.0004	120	7.6	0.02584	Acceptable			
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.00005	130	7.6	0.02584	Acceptable			
RAAF DRAIN	MELDR-14	19-Sep-17	0.0002	130	7.6	0.02584	Acceptable			
BATEMAN PARK	MELDR-06	19-Sep-17	0.00005	130	7.6	0.02584	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	0.0005	410	26.7	0.09078	Acceptable			
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.0006	140	7.6	0.02584	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.0004	97	4	0.0136	Acceptable			
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.0002	83	4	0.0136	Acceptable			
MARMION RESERVE	MELDR-11	19-Sep-17	0.0013	67	4	0.0136	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.0018	77	4	0.0136	Acceptable			
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.0006	120	7.6	0.02584	Acceptable			
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.0004	190	11.8	0.04012	Acceptable			
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.0025	82	4	0.0136	Acceptable			
BROCKMAN PARK	MELDR-02	11-Oct-17	0.0002	130	7.6	0.02584	Acceptable			
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.0007	120	7.6	0.02584	Acceptable			
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.00005	140	7.6	0.02584	Acceptable			
RAAF DRAIN	MELDR-14	11-Oct-17	0.0003	140	7.6	0.02584	Acceptable			
BATEMAN PARK	MELDR-06	11-Oct-17	0.0001	140	7.6	0.02584	Acceptable			
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.0009	360	26.7	0.09078	Acceptable			
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.0012	120	7.6	0.02584	Acceptable			
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.0006	99	4	0.0136	Acceptable			
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.0001	76	4	0.0136	Acceptable			
MARMION RESERVE	MELDR-11	11-Oct-17	0.0018	79	4	0.0136	Acceptable			
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.0017	88	4	0.0136	Acceptable			

Table D-24: Total mercury concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Total Mercury (Hg) (mg/L) All data in blue were <0.0001 (LOR)

ANZECC trigger for 95% protection: 0.0006 mg/L, NHMRC guideline for recreation (health): 0.01 mg/L

Max 0.0002 Min (blue) <0.0001

Site Name	Site Number	Collect Date	Hg (mg/L)	Comparison to ANZECC trigger value 95% Level of Protection
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.0002	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.0002	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.00005	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.00005	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	0.00005	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	0.00005	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.00005	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	0.00005	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	0.00005	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.00005	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.00005	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.00005	Acceptable

Table D-25: Soluble mercury concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Soluble Mercury (Hg) (mg/L) All data in blue were <0.0001 (LOR)

ANZECC trigger for 95% protection: 0.0006 mg/L, NHMRC guideline for recreation (health): 0.01 mg/L

Max <0.0001 Min (blue) <0.0001

Site Name	Site Number	Collect Date	Hg (mg/L)	Comparison to ANZECC trigger value 95% Level of Protection
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.0002	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.0002	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.00005	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.00005	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	0.00005	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	0.00005	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.00005	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	0.00005	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	0.00005	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.00005	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.00005	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.00005	Acceptable

Table D-26: Total zinc concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Zinc (Zn) (total mg/L) Max (red) 0.14 Min (blue) <0.005 All data in blu

ANZECC freshwater 95% trigger value: 0.008 mg/L, NHMRC recreational use guidleine (aesthetic value): 30 mg/L

Site name	Site number	Date	Zn (tot) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.14	25	1	0.008	Guideline exceeded
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.042	67	2.5	0.02	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.1	24	1	0.008	Guideline exceeded
BROCKMAN PARK	MELDR-2	19-Jul-17	0.015	100	2.5	0.02	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.018	96	2.5	0.02	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.01	110	2.5	0.02	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.016	94	2.5	0.02	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.017	91	2.5	0.02	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.027	190	5.2	0.0416	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.01	130	3.9	0.0312	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.019	31	1	0.008	Guideline exceeded
MARMION RESERVE	MELDR-11	19-Jul-17	0.0025	61	2.5	0.02	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.009	83	2.5	0.02	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Jun-17	0.007	440	9	0.072	Acceptable

Hardness range (mg/L)	Adj fac
0-59	1
60-119	2
120-179	3
180-240	5
>240	9

Table D-27: Soluble zinc concentrations (mg/L) in Melville Bull Creek catchment sites in 2017

Zinc (Zn) (soluble mg/L) Max (red) 0.097 Min (blue) 0.001 LOR July=0.001 mg/L, LOR oth

ANZECC freshwater 95% trigger value: 0.008 mg/L, NHMRC recreational use guideline (aesthetic value): 30 mg/L

Site name	Site number	Date	Zn (sol) (mg/L)	Hardness (mg/)	Adjust factor	Adjusted trigger value	Comparison to ANZECC trigger ADJUSTED value
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	0.097	25	1	0.008	Guideline exceeded
JOHN CREANEY PARK	MELDR-5	19-Jul-17	0.04	67	2.5	0.02	Guideline exceeded
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	0.044	24	1	0.008	Guideline exceeded
BROCKMAN PARK	MELDR-2	19-Jul-17	0.013	100	2.5	0.02	Acceptable
BULL CREEK MD	PSDTBCMD	19-Jul-17	0.011	96	2.5	0.02	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	0.007	110	2.5	0.02	Acceptable
RAAF DRAIN	MELDR-14	19-Jul-17	0.008	94	2.5	0.02	Acceptable
BATEMAN PARK	MELDR-06	19-Jul-17	0.012	91	2.5	0.02	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	0.022	190	5.2	0.0416	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	0.006	130	3.9	0.0312	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Jul-17	0.013	31	1	0.008	Guideline exceeded
MARMION RESERVE	MELDR-11	19-Jul-17	0.001	61	2.5	0.02	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	0.003	83	2.5	0.02	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	0.049	89	2.5	0.02	Guideline exceeded
JOHN CREANEY PARK	MELDR-5	22-Aug-17	0.017	180	5.2	0.0416	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	0.089	85	2.5	0.02	Guideline exceeded
BROCKMAN PARK	MELDR-2	22-Aug-17	0.015	130	3.9	0.0312	Acceptable
BULL CREEK MD	PSDTBCMD	22-Aug-17	0.019	130	3.9	0.0312	Acceptable
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	0.014	130	3.9	0.0312	Acceptable
RAAF DRAIN	MELDR-14	22-Aug-17	0.014	130	3.9	0.0312	Acceptable
BATEMAN PARK	MELDR-06	22-Aug-17	0.015	140	3.9	0.0312	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	0.0025	440	9	0.072	Acceptable
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	0.035	160	3.9	0.0312	Guideline exceeded
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	0.018	71	2.5	0.02	Acceptable
FREDERICK BALDWIN	MELDR-10	22-Aug-17	0.02	37	1	0.008	Guideline exceeded
MARMION RESERVE	MELDR-11	22-Aug-17	0.0025	40	1	0.008	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	0.014	62	2.5	0.02	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	0.071	110	2.5	0.02	Guideline exceeded
JOHN CREANEY PARK	MELDR-5	19-Sep-17	0.016	200	5.2	0.0416	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	0.052	110	2.5	0.02	Guideline exceeded
BROCKMAN PARK	MELDR-2	19-Sep-17	0.011	120	3.9	0.0312	Acceptable
BULL CREEK MD	PSDTBCMD	19-Sep-17	0.01	120	3.9	0.0312	Acceptable
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	0.014	130	3.9	0.0312	Acceptable
RAAF DRAIN	MELDR-14	19-Sep-17	0.009	130	3.9	0.0312	Acceptable
BATEMAN PARK	MELDR-06	19-Sep-17	0.012	130	3.9	0.0312	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	0.008	410	9	0.072	Acceptable
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	0.025	140	3.9	0.0312	Acceptable
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	0.011	97	2.5	0.02	Acceptable
FREDERICK BALDWIN	MELDR-10	19-Sep-17	0.01	83	2.5	0.02	Acceptable
MARMION RESERVE	MELDR-11	19-Sep-17	0.004	67	2.5	0.02	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	0.007	77	2.5	0.02	Acceptable
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	0.052	120	3.9	0.0312	Guideline exceeded
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.022	190	5.2	0.0416	Acceptable
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	0.054	82	2.5	0.02	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	0.013	130	3.9	0.0312	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.013	120	3.9	0.0312	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.012	140	3.9	0.0312	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.008	140	3.9	0.0312	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.01	140	3.9	0.0312	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.009	360	9	0.072	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.019	120	3.9	0.0312	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.014	99	2.5	0.02	Acceptable
FREDERICK BALDWIN	MELDR-10	11-Oct-17	0.012	76	2.5	0.02	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.01	79	2.5	0.02	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.01	88	2.5	0.02	Acceptable

Hardness range (mg/L)	Adjust factor
0-59	1
60-119	2.5
120-179	3.9
180-240	5.2
>240	9

Table D-28: Water hardness (mg/L) in Melville Bull Creek catchment sites in 2017

Water Hardness (CaCO3) {Ca+Mg} (mg/L)

ANZECC trigger value for recreational value 500 mg/L

Max (red) 440 Min (blue) 24

Site Name	Site Number	Collect Date	Total Water Hardness
JOHN CREANEY PARK INLET	MELDR-15	19-Jul-17	25
JOHN CREANEY PARK	MELDR-05	19-Jul-17	67
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Jul-17	24
BROCKMAN PARK	MELDR-02	19-Jul-17	100
BULL CREEK MD	PSDTBCMD	19-Jul-17	96
BRENTWOOD DRAIN	MELDR-13	19-Jul-17	110
RAAF DRAIN	MELDR-14	19-Jul-17	94
BATEMAN PARK	MELDR-06	19-Jul-17	91
PINEY LAKES OUTLET	MELDR-08	19-Jul-17	190
QUENDA LAKE OUTLET	MELDR-09	19-Jul-17	130
FREDERICK BALDWIN	MELDR-10	19-Jul-17	31
MARMION RESERVE	MELDR-11	19-Jul-17	61
BLUE GUM LAKE OUTLET	MELDR-12	19-Jul-17	83
JOHN CREANEY PARK INLET	MELDR-15	22-Aug-17	89
JOHN CREANEY PARK	MELDR-05	22-Aug-17	180
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	22-Aug-17	85
BROCKMAN PARK	MELDR-02	22-Aug-17	130
BULL CREEK MD	PSDTBCMD	22-Aug-17	130
BRENTWOOD DRAIN	MELDR-13	22-Aug-17	130
RAAF DRAIN	MELDR-14	22-Aug-17	130
BATEMAN PARK	MELDR-06	22-Aug-17	140
BOORAGOON LAKE OUTLET	MELDR-07	22-Aug-17	440
PINEY LAKES OUTLET	MELDR-08	22-Aug-17	160
QUENDA LAKE OUTLET	MELDR-09	22-Aug-17	71
FREDERICK BALDWIN	MELDR-10	22-Aug-17	37
MARMION RESERVE	MELDR-11	22-Aug-17	40
BLUE GUM LAKE OUTLET	MELDR-12	22-Aug-17	62
JOHN CREANEY PARK INLET	MELDR-15	19-Sep-17	110
JOHN CREANEY PARK	MELDR-05	19-Sep-17	200
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	19-Sep-17	110
BROCKMAN PARK	MELDR-02	19-Sep-17	120
BULL CREEK MD	PSDTBCMD	19-Sep-17	120
BRENTWOOD DRAIN	MELDR-13	19-Sep-17	130
RAAF DRAIN	MELDR-14	19-Sep-17	130
BATEMAN PARK	MELDR-06	19-Sep-17	130
BOORAGOON LAKE OUTLET	MELDR-07	19-Sep-17	410
PINEY LAKES OUTLET	MELDR-08	19-Sep-17	140
QUENDA LAKE OUTLET	MELDR-09	19-Sep-17	97
FREDERICK BALDWIN	MELDR-10	19-Sep-17	83
MARMION RESERVE	MELDR-11	19-Sep-17	67
BLUE GUM LAKE OUTLET	MELDR-12	19-Sep-17	77
JOHN CREANEY PARK INLET	MELDR-15	11-Oct-17	120
JOHN CREANEY PARK	MELDR-05	11-Oct-17	190
DOWNSTREAM ELIZABETH MANION PARK	MELDR-16	11-Oct-17	82
BROCKMAN PARK	MELDR-02	11-Oct-17	130
BULL CREEK MD	PSDTBCMD	11-Oct-17	120
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	140
RAAF DRAIN	MELDR-14	11-Oct-17	140
BATEMAN PARK	MELDR-06	11-Oct-17	140
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	360
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	120
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	99
FREDERICK BALDWIN	MELDR-10	11-Oct-17	76
MARMION RESERVE	MELDR-11	11-Oct-17	79
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	88

Sediment metals

Table D-29: Total aluminium concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Aluminium (Al) (total) **(mg/kg)** LOR 1.0 mg/Kg

ANZECC trigger value: ND

Max (red) 5,290 Min (blue) 383

Site name	Site number	Date	Al (tot) mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	3270
BROCKMAN PARK	MELDR-02	11-Oct-17	1470
BULL CREEK MD	PSDTBCMD	11-Oct-17	1300
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	1460
RAAF DRAIN	MELDR-14	11-Oct-17	1260
BATEMAN PARK	MELDR-06	11-Oct-17	485
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	5290
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	383
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	774
MARMION RESERVE	MELDR-11	11-Oct-17	2420
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	938

Table D-30: Total arsenic concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Arsenic (As) (total sediment) (mg/kg) All data in blue were <0.1 (LOR)

ANZECC trigger value: low 20 mg/kg and high 70 mg/Kg

Max (red) 4.9 Min (blue) <0.1

Site name	Site number	Date	As (tot) mg/kg	Comparison to ANZECC lower trigger value 20 mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.8	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	0.4	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.6	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.6	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.6	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.4	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	4.9	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.1	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.1	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	1.4	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	1.7	Acceptable

Table D-31: Total chromium concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Chromium (Cr) (total) (mg/kg) LOR 0.05

ANZECC lower trigger value: 80 mg/kg and higher 370 mg/kg

Max (red) 26 Min (blue) 0.88

Site name	Site number	Date	Cr (mg/kg)	Comparison to ANZECC lower trigger value 80 mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	8	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	2.2	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	1.9	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	2.4	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	2.3	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.88	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	26	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	1	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.96	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	4.2	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	5.9	Acceptable

Table D-32: Total copper concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Copper (Cu) (total) (mg/kg) All data in blue were <0.5 (LOR)

ANZECC lower trigger value: 65 mg/kg & higher 270 mg/kg

Max (red) 16 Min (blue) <0.5

Site name	Site number	Date	Cu (mg/kg)	Comparison to ANZECC lower trigger value 65mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	16	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	3.3	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.8	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.9	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.25	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.25	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	12	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.25	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.25	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	3.9	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	6	Acceptable

Table D-33: Total iron concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Iron (Fe) (total) **(mg/kg)** LOR 1.0 mg/Kg

ANZECC trigger value: ND

Max (red) 8,200 Min (blue) 180

Site name	Site number	Date	Fe (tot) mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	3500
BROCKMAN PARK	MELDR-02	11-Oct-17	2700
BULL CREEK MD	PSDTBCMD	11-Oct-17	1700
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	1400
RAAF DRAIN	MELDR-14	11-Oct-17	800
BATEMAN PARK	MELDR-06	11-Oct-17	590
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	8200
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	310
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	180
MARMION RESERVE	MELDR-11	11-Oct-17	1500
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	1400

Table D-34: Total lead concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Lead (Pb) (total) (mg/kg) LOR 0.5

ANZECC lower trigger value: 50 mg/kg & higher 220 mg/kg

Max (red) 66 Min (blue) 1.1

Site name	Site number	Date	Pb (mg/kg)	Comparison to ANZECC lower trigger value 50 mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	52	Guideline exceeded
BROCKMAN PARK	MELDR-02	11-Oct-17	5.5	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	6.8	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	4.3	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	4.5	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	1.1	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	66	Guideline exceeded
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	4.4	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	1.8	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	33	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	19	Acceptable

Table D-35: Total mercury concentration (mg/kg) in sediment in the Melville Bull Creek catchment sites in 2017

Mercury (Hg) (total) (mg/kg) All data in blue were <0.02 (LOR)

ANZECC lower trigger value: 0.15 mg/kg and higher 1.0 mg/kg

Max (red) 0.03 Min (blue) <0.02

Site name	Site number	Date	Hg (tot) mg/kg	Comparison to ANZECC lower trigger value 0.15 mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.01	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	0.01	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.01	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.01	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.01	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.01	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	0.03	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.01	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.01	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	0.01	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.01	Acceptable

Table D-36: Total nickel concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Nickel (Ni) (total) (mg/kg) All data in blue w ere <0.1 mg/Kg(LOR)

ANZECC lower trigger value: 21 mg/kg & higher 52 mg/kg

Max (red) 4 Min (blue) <0.1

Site name	Site number	Date	Ni (mg/kg)	Comparison to ANZECC lower trigger value 21 mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	2.4	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	0.7	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.5	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	1	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	0.4	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	0.2	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	4.2	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.5	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.05	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	1.2	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.8	Acceptable

Table D-37: Total selenium concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Selenium (Se) (total) **(mg/kg)** LOR 0.5 mg/Kg

ANZECC trigger value: ND

Max (red) 1.3 Min (blue) <0.5

Site name	Site number	Date	Se (tot) mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	0.14
BROCKMAN PARK	MELDR-02	11-Oct-17	0.025
BULL CREEK MD	PSDTBCMD	11-Oct-17	0.025
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	0.025
RAAF DRAIN	MELDR-14	11-Oct-17	0.025
BATEMAN PARK	MELDR-06	11-Oct-17	0.025
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	1.3
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.025
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.025
MARMION RESERVE	MELDR-11	11-Oct-17	0.1
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	0.025

Table D-38: Total zinc concentration (mg/kg) in sediment in Melville Bull Creek catchment sites in 2017

Zinc (Zn) (total) (mg/kg) All data in blue w ere <0.25 (LOR)

ANZECC lower trigger value: 200 mg/kg & higher 410 mg/kg

Max (red) 58 Min (blue) <0.25

Site name	Site number	Date	Zn (mg/kg)	Comparison to ANZECC lower trigger value 200 mg/kg
JOHN CREANEY PARK	MELDR-05	11-Oct-17	58	Acceptable
BROCKMAN PARK	MELDR-02	11-Oct-17	7.2	Acceptable
BULL CREEK MD	PSDTBCMD	11-Oct-17	5.6	Acceptable
BRENTWOOD DRAIN	MELDR-13	11-Oct-17	5.7	Acceptable
RAAF DRAIN	MELDR-14	11-Oct-17	3.9	Acceptable
BATEMAN PARK	MELDR-06	11-Oct-17	3.1	Acceptable
BOORAGOON LAKE OUTLET	MELDR-07	11-Oct-17	42	Acceptable
PINEY LAKES OUTLET	MELDR-08	11-Oct-17	0.125	Acceptable
QUENDA LAKE OUTLET	MELDR-09	11-Oct-17	0.125	Acceptable
MARMION RESERVE	MELDR-11	11-Oct-17	23	Acceptable
BLUE GUM LAKE OUTLET	MELDR-12	11-Oct-17	21	Acceptable

Appendix E Potential effects of stressors on aquatic environments

In the context of water quality, stressors can be described as chemical compounds or indicators that are naturally occurring in waterways, for which values outside of certain ranges can have multiple negative effects. Stressors often reach undesirable levels in waterways as a result of human intervention. Stressors analysed in this monitoring program included physicochemical parameters (pH, dissolved oxygen, electrical conductivity, total suspended solids and temperature), nutrients (nitrogen and phosphorus in their various forms) and hardness. **Table E-1** describes the undesirable effects that these stressors can have on surface water bodies.

Table E-1: Effects of stressors on aquatic environments

Parameter	Factors/sources impacting stressor levels	Ecosystem impacts
pH	• **Natural** • Rainfall - (CO_2) in atmosphere decreases pH of precipitation • Algal or plant growth (photosynthesis increases pH, respiration decreases pH) o pH often higher during the day (more photosynthesis) and lower at night (more respiration) • Salinity • Underlying soil type (e.g. Bassendean sands – acidic, limestone – alkaline) • Influence of groundwater • Presence of acidic tannins from vegetation – decreases pH • **Anthropogenic** • Oxidation of acid sulfate soils due to manual disturbance or anthropogenic change in water levels – decreases pH • Acidic or alkaline discharges from industry • Acidic mining runoff or exposure of acidic rocks from mining • Acid rain resulting from certain industrial processes	• High or low pH can result in increased toxicity of certain metals (ANZECC and ARMCANZ 2000) • High – e.g. aluminium (pH>9) • Low –e.g. chromium (VI), nickel • High or low levels can be directly toxic to biota – different species tolerate different ranges • → changes can result in altered compositions and/or reduced biodiversity of plants and animals • Mosquitoes can tolerate low pH waters and can therefore become a nuisance in acidic wetlands where other macroinvertebrate predators may not survive • Alkaline conditions can result in conversion of ammonium (generally non-toxic) to ammonia (toxic) • Low pH can weaken shells and exoskeletons and kill macroinvertebrates

Table E-1 (continued): Effects of stressors on aquatic environments

Parameter	Factors/sources impacting stressor levels	Ecosystem impacts
Dissolved Oxygen (DO)	• **Natural** • Depth of waterbody (deeper waters more likely to have low oxygen levels) • Depth of measurement - surface waters often higher, bottom often lower o Stratification (e.g. different layers of salinity) can enhance this effect • Algal or plant growth (photosynthesis increases pH, respiration decreases pH) o DO often higher during the day (more photosynthesis) and lower at night (more respiration) • Decomposition of organic material – process consumes DO • Temperature • Rain and wind can introduce oxygen into water • Influence of groundwater • **Anthropogenic** • Microbial breakdown of excess organic material (e.g. from grass clippings, sewage, industrial wastes or as a result of eutrophication) – decreases DO • Oxidation of hydrocarbons, reduction of metals, microbial (bacterial and archaea) activity and nitrification – decreases DO. • Excess plant/macroalgal growth on the water surface from eutrophication can smother water – decreasing DO • Excess algal growth can also increase DO (high levels of photosynthesis) • Aeration through fountains and subsurface aeration - increases DO	• Low DO - directly toxic to biota • Especially fish and molluscs • High DO saturations can also be harmful • Oxygen bubbles can block blood vessels in fish resulting in death • Changes in DO result in altered redox conditions which can facilitate certain chemical reactions • Low DO results in phosphorus release from sediments – can lead to eutrophication (Correll 1998) • Low DO results in formation of reduced compounds, such as hydrogen sulphide, resulting in toxic effects on aquatic animals (Camargo & Alonso 2006) • Low DO can increase toxicity of certain metals (e.g. copper) and ammonia (ANZECC and ARMCANZ 2000) • Low DO levels also halt nitrogen loss from water by preventing nitrification of ammonia (Geoscience Australia 2015)

Table E-1 (continued): Effects of stressors on aquatic environments

Parameter	Factors/sources impacting stressor levels	Ecosystem impacts

Electrical Conductivity (EC)	• **Natural**
	  • Communication with the ocean will increase EC
	  • Proximity to ocean – fine sea spray or atmospheric salt can eventuate in waterbodies
	  • Depth of measurement - salt water heavier than freshwater so will sink
	    o Stratification (e.g. different layers of salinity) can enhance this effect
	  • Underlying geology
	  • Temperature
	  • Influence of groundwater
	  • Seasonal water level changes –increased rainfall and runoff can dilute water (decreasing EC) and evaporation concentrates ions (increasing EC)
	• **Anthropogenic**
	  • Discharges from industry
	    o E.g. sewage contamination can increase EC
	    o Oil spills can decrease EC
		• High or low levels can be directly toxic to biota – different species tolerate different ranges (Hart et al 1991)
		  • → changes can result in altered compositions and/or reduced biodiversity of plants and animals
		  • In this catchment water is naturally reasonably fresh, therefore high EC will result in loss of many endemic plant and animal species
		    o Particularly leeches, flatworms and macroinvertebrates without impermeable skeletons (pulmonate gastropods) (Dunlop et al 2005).

Total Suspended Solids (TSS)	• **Natural**
	  • Sources include soil particles and organic material (e.g. algae, microorganisms, decaying plant and animal matter)
	  • Windy conditions can result in increased resuspension of bottom sediments and introduction of soil particles
	  • Heavy rainfall will result in increased erosion of surrounding soils and increased introduction of particles through runoff
	• **Anthropogenic**
	  • Discharges from industry from runoff and dust
	  • Products of vehicle wear from road run-off
	  • Increased amounts of soil particulate material entering waterbodies as a result of construction and demolition operations.
		• Deposition of suspended solids can block pipes, change flow conditions in open channels (IEA 2006), alter streambed properties and aquatic habitat for fish, smother benthic organisms, and reduce the food supply and refuge for bottom feeding organisms, macrophytes, and benthic organisms (Chetia 2014)
		• High concentrations can reduce water clarity and light available to support photosynthesis → loss of submerged macrophytes (i.e. seagrasses)
		• High concentrations can impair the function of fish gills (ANZECC and ARMCANZ 2000)
		• Suspended solids can alter predator-prey relationships (e.g. could make it difficult for fish to see prey)
		• Suspended solids can also provide surface area for the sorption and transport of nutrients and other pollutants (e.g. metals and bacteria)
		  • → often used as an "indicator" of nutrients or other pollutants

Table E-1 (continued): Effects of stressors on aquatic environments

Parameter	Factors/sources impacting stressor levels	Ecosystem impacts

Temperature	• **Natural**
	  • Air temperature and sun exposure
	    o Therefore time of day
	  • Turbidity – increases temperature through scattering of solar radiation
	  • Waterbody depth and depth of measurement
	  • Vegetation - temperatures in unvegetated water bodies will vary more than those with vegetation due to greater exposure to weather conditions, but will generally be higher due to lack of shade
	• **Anthropogenic**
	  • Industrial discharges – can increase or decrease temperature
	  • Stormwater runoff from hot surfaces (e.g. roads and carparks) could increase the temperature of receiving water bodies
	  • Reservoirs could discharge cooler water to waterbodies.
		• Higher rates of plant and algae growth
		  • As soon as the temperature cools or other supporting processes cease, growth declines and biological decay commences → increased oxygen demand
		• Influences sediment redox reactions
		  • E.g. increased temperatures result in increased sediment phosphorus release (Lehtoranta 1995).
		• Increased temperatures increase metabolic rate of bacteria and therefore mineralisation of organic matter → release of bioavailable phosphorus and nitrogen species into the water (Lehtoranta 1995).
		• High temperatures reduce oxygen solubility
		• High temperatures increase solubility of salts
		• Many chemicals exhibit between a two and four fold increase or decrease in toxicity for each 10°C rise in temperature (ANZECC and ARMCANZ 2000).
		• Some organisms become more vulnerable to toxic wastes, parasites and diseases at low water temperatures
		• Increased metabolic rate of organisms with increasing temperature → increased oxygen demand (compounded by decreased oxygen solubility)
		• Different species tolerant to different ranges → changes can result in differing biotic communities
		  • Fish and macro-invertebrates are ectotherms as their body temperature is controlled by the temperature of the surrounding environment (Marsh et al 2005) – as such they particularly sensitive to temperature changes
		• Low temperatures - loss of spawning trigger for fish

Table E-1 (continued): Effects of stressors on aquatic environments

Parameter	Factors/sources impacting stressor levels	Ecosystem impacts

Nitrogen	• **Natural**
	  • Soil type – e.g. highly mineral soils will store less nitrogen available to be mobilised into the water
	  • Fringing and emergent vegetation type and volume
	  • Seasonal conditions
	  • Hydrology – loss of nitrogen as N_2 gas may occur more readily in certain wetland hydrology
	  • Sources include plant and animal decomposition, faecal material, lightning and volcanic activity
	• **Anthropogenic**
	  • Fertilisers
	  • Sewerage
	  • Feed lots
	  • Pet droppings
	  • Combustion of fossil fuels
	  • Plant debris (e.g. from glass clippings)
	  • Industrial and household cleaning products (e.g. runoff from car washing)
	  • Ammonia/ammonium specific:
	    o Industrial processes including the preparation of synthetic fibres (e.g. nylons), plastics and explosives, resins, human and veterinary medicines, fuel cells, rocket fuel, dyes, metal treating operations, refrigeration, and petroleum (DoE 2016).
	    o Proportion of ammonia/ammonium in water varies with pH & temperature (ammonium is predominant at pH 5 to 8) and as such levels can vary throughout the day
		• Some nitrogen is required for life - wetlands with very low concentrations of nitrogen and phosphorus will support little life (oligotrophic)
		• High concentrations (particularly of bioavailable forms) in conjunction with high phosphorus result in nuisance growth of aquatic plants/algae/cyanobacteria (blue green algae) known as eutrophication, which can have flow-on negative effects:
		  • Toxic effects of cyanobacterial toxins (particularly due to cyanobacteria in fresh and brackish waters) to humans, birds and aquatic biota
		  • Decreased dissolved oxygen from surface growth acting as physical barrier and decomposition of excessive growth → harm to fish, macroinvertebrates and desirable macrophyte species
		  • Decreased light available to desirable macrophyte species
		  • Reduction in recreational amenity (phytoplankton blooms and macrophytes in wetlands and lakes) from cyanobacterial toxins and odours produced from decomposing material
		  • Physical blocking of waterways
		  • Reduction in biodiversity or change in species composition
		    o E.g. mosquitoes (tolerant to poor water quality) can become predominant in eutrophic waterways
		• Nitrogenous fertilisers and car emissions can lead to acidification of waterbodies
		• High levels of ammonia are directly toxic to fish & aquatic organisms

Table E-1 (continued): Effects of stressors on aquatic environments

Parameter	Factors/sources impacting stressor levels	Ecosystem impacts

Phosphorus	• **Natural**
	  • Decomposition of organic matter
	  • Weathering of rocks
	• **Anthropogenic**
	  • Motor vehicle exhaust, fuels, lubricants, fertilisers, detergents, car wash products, eroded soils, and industrial wastes (IEA 2006)
	  • Runoff from impervious surfaces such as roads, parking lots and rooftops (especially in commercial, industrial and high-density residential areas) can potentially contribute a large portion of phosphorus to the water bodies as this water is not filtered (Department of Environment (Western Australia) 2004a)
		• Some phosphorus is required for life - wetlands with very low concentrations of phosphorus and nitrogen will support little life (oligotrophic)
		• Excessive concentrations (particularly bioavailable forms (i.e. SRP)) in conjunction with high nitrogen concentrations, can result in eutrophication (see ecosystem impacts of nitrogen for more information)

Hardness	• **Natural**
	  • Underlying geology – e.g. wetlands over limestone generally have hard water
	• **Anthropogenic**
	  • Discharges from operating and disused rock quarries
	  • Inorganic chemical industry
		• Generally, hard waters are more alkaline, and waters with greater hardness are generally less susceptible to acidification
		• Increasing water hardness and alkalinity specifically reduces the uptake and toxicity to freshwater organisms of several metals (such as cadmium, chromium III, copper, lead, nickel and zinc)

Appendix F Potential sources, factors affecting toxicity and impacts of metals found in urban stormwater

The metals analysed as part of this monitoring program can be derived from a wide variety of sources, some natural and some anthropogenic. Understanding the sources of these metals can provide potential avenues for investigation if high concentrations are detected. Furthermore, if high metal concentrations are encountered, other water quality indicators and local factors may provide an indication of the severity of the impact of these concentrations. The impact of hardness on concentrations is has been quantified for some metals (see tables in **Appendix D**), but also, for example, for metals that adsorb to suspended particles, the presence of these particles may reduce the bioavailability of some (but not all) of these metals to biota, thus effectively reducing their toxicity. As metals are generally more bioavailable in soluble form, factors that increase solubility will increase their toxicity. Different functional groups of biota may also differ in their sensitivity to metals. The main impact of metals to surface waters is generally toxicity to biota, but some metals (such as iron) can have other negative environmental impacts.

Table F-1 describes the potential sources, factors affecting impacts and toxic and other impacts of metals. Information regarding sources of metals is taken from The National Pollutant Inventory (Australian Government Department of Environment (DoE) 2016) and information regarding factors affecting toxicity and impacts to biota are derived from ANZECC and ARMCANZ (2000) unless otherwise stated.

Table F-1: Potential sources, factors affecting impacts and impacts of metals typically found in urban stormwater

METAL	SOURCES/USES	FACTORS AFFECTING IMPACTS	IMPACTS
Aluminium (Al)	• Natural leaching from soil and rock • Increased in soluble groundwater concentrations under acidic conditions, therefore strongly linked to the presence of Acid Sulfate Soils (ASS) (DER 2015b) • Anthropogenic sources include industrial discharges and corrosion of products containing aluminium • used in frames, door knobs, car bodies, plane parts, engines, cables, cans, solar mirrors & heat reflecting blankets (Lenntech n.d.-a)	• Toxicity to fish and invertebrates increased at pH<5.5 and >9, with a maximum toxicity around pH 5.0-5.2 • Toxicity reduced by complexing with humic (organic) substances • Toxicity reduced at high water hardness • Toxicity possibly increased with increased temperature	• Toxic to biota at high concentrations • Among aquatic plants, single celled plants most susceptible • Fish more susceptible than aquatic macroinvertebrates • Can affect the function of fish gills (Exley et al 1991)

Table F-1 (continued): Potential sources, factors affecting impacts and impacts of metals typically found in urban stormwater

METAL	SOURCES/USES	FACTORS AFFECTING IMPACTS	IMPACTS

Arsenic (As)	• Naturally present in the earth's crust
	• Can enter waterways through wind-blown dust and water run-off
	• Naturally released into the environment through weathering of rocks and volcanic activity
	• High arsenic concentrations in groundwater (and communicating surface waters) linked to the presence of Acid Sulfate Soils (ASS) (DER 2015b)
	• Mining and metal manufacturing main anthropogenic source of arsenic in Australia
	  • Other uses of arsenic in industry include manufacturing of food, paper products, glass products, petroleum and coal products and chemicals
	• Also released from combustion of fuels and other incineration activities
		• Several valencies exist in water – most common are As (III) and As (V)
		  • both bond with carbon to form numerous organo-arsenic compounds, some of which are very toxic (e.g. methylarsine)
		• Valency state main factor affecting toxicity – As (III) most toxic form
		• Toxicity of As (V) increases with increasing temperature
		• As (III) removed by sulfides, As (V) by clays
			• Toxic to biota
			• Can bio-accumulate in some animals
			• Phytoplankton is among the most sensitive organisms to both forms of arsenic
			• Higher trophic levels are less sensitive to arsenic because they generally accumulate the element from food rather than the water column.
			• Adult freshwater fish are generally less sensitive to arsenic

Chromium (Cr)	• Exists naturally in low concentrations (rocks, soil, plants, animals, volcanic dust, gasses) • Enters waterways through settling of atmospheric particles and rainfall and contaminated water and soil • Chromium in stormwater is mostly associated with suspended solids (IEA 2006) • Two forms: The trivalent form (Cr^{3+}) is mainly discharged from the metal industry where it is used for chrome plating, and the hexavalent form (Cr^{6+}) is mainly discharged from tanning & painting (IEA 2006) • Predominant form of chromium in the environment is Cr^{3+} • It is also used in industry to produce the following: electrical products, engine parts, fungicides, wood treatment products, ceramics, clay, paper, glass, porcelain, pharmaceuticals/medicines/medical treatment, steam & air conditioning supplies and cement products Other sources include combustion of fossil fuels, incineration of waste and sewerage sludge	• Toxicity of both forms decreases with increasing water hardness and/or alkalinity • Cr^{6+} toxicity increases in freshwater at lower pH • Cr^{6+} not affected by presence of suspended material, whereas Cr^{3+} is readily removed from the water column with both dissolved organic matter and suspended material • Toxicity decreases with increasing salinity and sulfate • More toxic at high temperatures	• Chromium VI is toxic to aquatic organisms, and a carcinogen for animals & humans • Cr^{3+} is far less toxic than Cr^{6+} • Chromium VI may bio-accumulate to some degree • Freshwater algae & invertebrates are more sensitive to Cr^{6+} than fish, with crustaceans particularly sensitive

Table F-1 (continued): Potential sources, factors affecting impacts and impacts of metals typically found in urban stormwater

METAL	SOURCES/USES	FACTORS AFFECTING IMPACTS	IMPACTS
Copper (Cu)	• Copper compounds naturally occur in rocks, soil, water, plants, animals and humans • Enters water from settling of atmospheric particles or dissolved in waters • Natural sources include decaying vegetation, forest fires and sea spray • Mining and metal manufacturing largest sources of copper emissions in Australia • Other industrial sources include electricity supply and manufacturing of chemicals, cement, lime, plaster and concrete products, transport equipment, petroleum, coal, beverages, paper products, glass products, motor vehicles and parts, wood products, ceramic products, food and beverage products, and textiles (DoE 2016) • Found to be related to the flow of vehicles and road network characteristics (Beasley & Kneale 2002). • Also possible release from solid and liquid fuel combustion, lawn mowing, leaching from antifouling paint on ships and boats	• Toxicity increases when hardness, alkalinity & dissolved oxygen decrease • Strongly attaches to organic matter and suspended material • Levels of dissolved organic matter in freshwaters usually remove copper toxicity (except in very soft waters) • Its toxicity in algae, invertebrates & fish generally increases as salinity decreases • Copper and lead toxicity appear to interact in synergism	• It is a micro-nutrient and essential to life at low concentrations, toxic at higher concentrations to freshwater fish, invertebrates and plants • Some species of algae particularly sensitive • Negatively affects fish and macro-invertebrates in various body systems across multiple life stages • Can bio-accumulate in aquatic organisms
Iron (Fe)	• Fourth most abundant metal in earth's crust • Naturally present in water in varying quantities depending upon local geology and other chemical factors • Insoluble ferric state (Fe^{3+}) usually more prevalent in surface waters (ANZECC and ARMCANZ 2000) • Soluble ferrous state (Fe^{2+}) present in reducing (anaerobic) waters and usually originates from groundwater (ANZECC and ARMCANZ 2000) • Manufacturing uses of iron compounds that may contribute anthropogenic iron pollution could include production of containers, cars, laundry machines, bridges, buildings, springs, pigments in glass, pharmaceutics, chemicals, iron fertilisers, pesticides, wood impregnation and photography (Lenntech n.d.-b)	• Solubility increases in acidic water • Solubility higher in anaerobic waters	• Essential for both plants and animals • Has been shown to be toxic to some macroinvertebrate species • In aerobic waters, ferric iron can form colloidal suspensions which can either form suspended flocs or settle and harden • may cause problems with turbidity, decreased light penetration and smothering of benthic organisms

Table F-1 (continued): Potential sources, factors affecting impacts and impacts of metals typically found in urban stormwater

Lead (Pb)	• Rare in nature, anthropogenic sources outweigh natural sources (ANZECC and ARMCANZ 2000) • Lead reaches aquatic environment through rainfall, lead dust , street runoff and industrial discharges (ANZECC and ARMCANZ 2000) • Also fires and fuel combustion • Lead used to be used in water pipes, stained glass windows, paint and fuel and as such these products may be partially responsible for the legacy of lead in waterways • Mining and metal manufacturing greatest industrial emitters • Also used in production of cement, plaster, concrete, iron, steel, petroleum, coal products, paper products, glass products, metal products, motor vehicles and parts, wood products, yarn and fabric	• Toxicity increases when water hardness decreases • Low solubility in water reduces toxicity • Strongly adsorbed by suspended clay, humic substances and other suspended material • Strongly complexed by dissolved organic material • Toxicity possibly increased at low pH	• Non-essential, highly poisonous element • Shown to affects chlorophyll synthesis in plants (e.g.Mesmar and Jaber 1991) • Can potentially bioaccumulate but not generally present in great enough concentrations that bioaccumulation has much effect
Mercury (Hg)	• Naturally occurring element found in rocks and ores • Can enter waterways from atmospheric particles settling or deposited by rain, or through emissions in water and soil • Natural sources of mercury in waterways include emissions from volcanoes and evaporation of water from soil • Largest source of mercury emissions in Australia from manufacturing, mining and alumina production of non-ferrous metals • Also can be released from burning of fossil fuels, precious metal mining, cement manufacturing, chemical manufacturing and sewerage • Landfills and disposal of batteries, thermometers and other mercury containing products can emit mercury to land, which can eventually end up in water	• Present as inorganic Hg (II) and organomercurial compounds (such as methyl mercury) - microorganisms can convert Hg (II) to methyl mercury • Increased toxicity with decreased hardness • Strongly adsorbed by particles, often associated with sediments • Strong affinity for chloride – toxicity of inorganic mercury reduced in saline waters	• Inorganic mercury relatively low toxicity and low ability to bioaccumulate • Methyl mercury particularly toxic - can be absorbed quickly • Can bioaccumulate in fish and their food chains • In mercury polluted areas, larger and older fish tend to have higher levels
Nickel (Ni)	• Exists naturally in soils and rocks often with arsenic, antimony and sulfur • Found at background concentrations in natural waters (ANZECC and ARMCANZ 2000) • Can enter waterways from settling of atmospheric particles or dissolved compounds in waters • Natural sources include weathering of rocks (ANZECC and ARMCANZ 2000) and volcanoes • Anthropogenic sources of atmospheric nickel include combustion of fossil fuels, mining and refining operations, steel production, nickel alloy production, electroplating, municipal waste incineration and nickel refineries • Can enter water in wastewater from municipal sewage treatment plants, stormwater runoff and from groundwater near landfill sites	• Toxicity increases with decreased hardness • Toxicity usually increases with decreased pH • Complexed by dissolved organic material • Less bioavailable when adsorbed to suspended material • Toxicity increases with decreasing salinity	• Essential to life • Moderately toxic to freshwater organisms • Reduces growth of freshwater algae at relatively low concentrations • Fish less sensitive to nickel, but it differs between species

Table F-1 (continued): Potential sources, factors affecting impacts and impacts of metals typically found in urban stormwater

METAL	SOURCES/USES	FACTORS AFFECTING TOXICTY AND IMPACTS	IMPACTS
Selenium (Se)	• Occurs naturally in the environment at varying concentrations, usually combined with other compounds (such as sulphide ores of other metals) • Commonly found in sedimentary rock formations • Can enter waterways from settling of atmospheric particles or dissolved compounds in waters • Exists in water as oxyions selenate (selenium (VI)) and selenite (selenium (IV)) • Natural sources in water include weathering of rocks • Released into the air and water from combustion of fossil fuels, smelting and refining of metals, glass and ceramics manufacturing and refuse incinerators • Can also enter waterways from anti dandruff shampoos and application as fungicides and insecticides	• Toxicity of selenate increases with decreasing sulfate and phosphate concentrations • Selenite uptake increases at low pH • Toxicity ameliorated by mercury and copper • Binding of selenium to particles does not reduce bioavailability	• Toxicity dependent on valency state – Se (IV) more toxic than Se (VI) • Selenites readily removed form water column, but selenates can bioaccumulate in aquatic ecosystems • Food chain uptake more significant than water uptake
Zinc (Zn)	• Exists naturally in rocks, soil, air, waters, plants and humans • Can enter waterways from settling of atmospheric particles or dissolved compounds in waters • Natural sources in water include weathering of rocks • Anthropogenic sources include mining, steel production, waste incineration, chemical waste dumps & landfills, sewage treatment plants, corrosion of galvanised structures, fertilisers and herbicides • Urban runoff also potential source from wear of car tyres or fuel combustion	• Toxicity increases with decreasing hardness and alkalinity • Levels of organic matter present in freshwater generally sufficient to remove zinc toxicity • pH determines stability of these compounds • Adsorbed by suspended material • Toxicity generally decreases with decreasing pH when pH <8 • Uptake and toxicity decrease with increasing salinity	• Essential for life • Labile Zn^{+2} most toxic form • Bioaccumulates in freshwater animal tissues but not a major problem