

# **Brockman River Catchment**

## ***Water Quality Monitoring Snapshot***

### ***August and October 2012***



***Plate 1:*** Spoonbill Lake, Brockman River catchment (2013).

**Prepared by the Ellen Brockman Integrated Catchment Group: March 2013**



**TRONOX**

This project is funded by Tronox on behalf of the Ellen Brockman Integrated Catchment Group.

Ellen Brockman Integrated Catchment Group

## **1. Acknowledgements**

This report was prepared for the Ellen Brockman Integrated Catchment Group by Natural Resource Management Officers Bonny Dunlop-Heague and Megan O'Grady and was funded by Tronox.

Water samples and monitoring data was collected by officers from the Ellen Brockman Integrated Catchment Group.

For further information contact the Ellen Brockman Integrated Catchment Group at the Chittering Landcare Centre.

Chittering Landcare Centre  
PO Box 62  
Muccea WA 6501  
Phone: (08) 9571 0300  
Fax: (08) 9571 4350  
Email: [chitteringlandcare@iinet.net.au](mailto:chitteringlandcare@iinet.net.au)

## **2. Executive Summary**

The assessment of water quality within the Brockman River catchment was undertaken in August and October 2012 in compliance with the sampling and analysis plan (EBICG, 2012). The objective of the snapshot was to collect annual data on the water quality within the catchment, to identify trends and priority sub-catchments for nutrient transport and salinity.

Monitoring stream salinity throughout a catchment enables the isolation of areas where the discharge of saline groundwater to streams is greatest. This is important as increasing salinity is the dominant threat to the Brockman catchment. The findings of this report will be used to make recommendations for degraded sites, to identify the major nutrient and salinity contributing subcatchments, to mitigate, improve or maintain water quality, and to prevent detrimental environmental effects downstream.

The Brockman River catchment receives less than 1000mm of rain per annum and much of the salt is stored in the soil profile. Extensive clearing of vegetation for agriculture has reduced evapotranspiration; increased recharge has resulted in rising groundwater levels, which mobilizes the stored salt. The salt laden groundwater then surfaces as hillside springs and valley floor seeps. Groundwater discharge causes soil salinity and contaminates previously potable water resources (Angell, 2000). Nutrients are not an issue in the Brockman catchment. The Brockman River is a contributor to the level of saline water entering the Upper Reaches of the Swan-Canning system and this could potentially alter and degrade ecological environments. Sediment and nutrients bound to particles are carried downstream and add to sediments in the Swan River. Under anoxic conditions these nutrients bound in the sediments are released, causing algal blooms and fish deaths.

It must be noted that this assessment is based on once-off grab sampling of water quality on two separate occasions in August and October 2012 to capture

winter and spring flow, from 26 selected sites within the Brockman River catchment (shown in Figure 5). Consequently, the results represent the condition of the water in the catchment at the time of sampling only. All 26 sites were tested for physical parameters (pH, conductivity, temperature and total suspended solids) and nutrients including total nitrogen, soluble organic nitrogen, nitrogen as ammonia, total oxidised nitrogen, total phosphorous and soluble reactive phosphorous. Seven out of the twenty-six sampling sites were strategically identified for the testing of heavy metals and water hardness.

In comparison to past water quality monitoring data collected by the Chittering Landcare Centre, pH values remain relatively stable at most sampling sites, and there is an overall trend of increasing salinity at most of the sampling sites since 1997. This is of great concern for the ecological health and function of the river and catchment. It is also of great concern to agriculture, industry and private landholders. If left unmanaged this could become a major issue for landholders in terms of agricultural production and water quality. Future monitoring will verify trends and patterns as more data is collected over a longer period of time. All data will be entered into the Department of Water's (DOW) Water Information Network (WIN) database.

### 3. **Key Findings**

- Higher than usual concentrations of Total Nitrogen were observed than in previous years, without the high rainfall events associated with the sampling occasions as could be expected. The fractions of nitrogen analysed in this report do not show a similar increased trend. Therefore it may be the undissolved organic fraction of the Nitrogen contributing to the increase. The following sites were identified through the 20120 snapshot as consistent contributors of nutrients to the Avon/Swan River and included Total Nitrogen, Total Oxidised Nitrogen and Filterable Organic Nitrogen which were recorded at these sites with concentrations above the ANZECC guidelines.

| <b>Sampling Site Name</b> | <b>Sampling Site Number</b> |
|---------------------------|-----------------------------|
| Kangaroo Creek Gully      | BRN6                        |
| Romany Creek              | BRN7                        |
| Wootra Brook              | BRN9                        |
| Flat Rocks Road           | BRN12                       |
| Keating Road              | BRN21                       |
| Udumung                   | BRN5                        |
| Bindoon River             | BRN10                       |
| Marbling                  | BRN23                       |
| Grey Rd                   | BRN27                       |
| Lake Chittering           | BRN15                       |
| Julimar Bridge            | BRN18                       |
| Yalliwirra                | BRN25                       |

- In 2012, Total Phosphorous concentrations were mostly within the guideline. However 11 sites recorded concentrations above the guideline all recorded on the October sampling occasion. Grey Rd (BRN27) recorded the highest concentration of 0.13mg/L, which is twice the ANZECC guideline.
- Water Hardness was 'extremely hard' at all sites sampled metals except Spoonbill Lake (BRN13) which was 'very hard' occasion.

- Metal concentrations in the surface waters of the Brockman River Catchment were generally below the Hardness-modified trigger value (HMTV) and ANZECC guidelines on most sampling occasions. However 6 of the 12 samples recorded concentrations above the ANZECC guideline for Aluminium, and most sites recorded concentrations higher than the indicative level for Iron.
- The Brockman River catchment recorded pH levels predominately within the ANZECC guidelines. Lake Chittering<sup>15</sup> recorded the highest of 9 occasions
- Water was more saline at the top of the catchment and became less saline as it flowed southwards towards the Avon River.

## Brockman River Catchment Water Quality Monitoring Snapshot August & October 2012

Table 1: Number of sites (out of a total of 26) equal to or exceeding the ANZECC water quality guidelines and trigger values. *Note: Heavy metals out of a total of eight sampling sites. Cadmium, chromium, copper, lead, nickel and zinc ANZECC water quality trigger values have been modified according to Water Hardness (Appendix D) and values must be equal to or exceed the Hardness-Modified Trigger Value to be over the Guideline.*

| Parameter                       | Number of Sampling Sites | Water Quality Trigger Value - Lowland Rivers |                           | TSS - DOW Interim Guideline |                           |
|---------------------------------|--------------------------|--|---------------------------|-----------------------------|---------------------------|
| <i>Physical</i>                 |                          | 526 <sup>th</sup> August                     | 722 <sup>nd</sup> October | 527 <sup>th</sup> August    | 722 <sup>nd</sup> October |
| pH                              | 26                       | 316  | 39                        |                             |                           |
| Conductivity                    | 26                       | 26   | 26                        |                             |                           |
| <i>Nutrients</i>                |                          |  |                           |                             |                           |
| Total Nitrogen                  | 26                       | 51   | 220                       |                             |                           |
| Total Oxidised Nitrogen         | 26                       | 159  | 33                        |                             |                           |
| Filterable Organic Nitrogen     | 26                       | 8  |                           |                             |                           |
| Nitrogen as Ammonia             | 26                       | 1  | 33                        |                             |                           |
| Total Phosphorous               | 26                       | 011  | 1                         |                             |                           |
| Filterable Reactive Phosphorous | 26                       | 00   | 00                        |                             |                           |
| Total Suspended Solids          | 26                       |  |                           | 43                          | 99                        |

| <i>Metal</i> | Number of Sampling Sites | Hardness Modified Trigger Value (400) | Hardness Modified Trigger Value (210) | ANZECC Trigger Value (mg/L) | 526 <sup>th</sup> August | 722 <sup>nd</sup> October |
|--------------|--------------------------|---------------------------------------|---------------------------------------|-----------------------------|--------------------------|---------------------------|
| Aluminium    | 7                        |                                       |                                       | 0.055                       | 40                       | 2                         |
| Arsenic      | 7                        |                                       |                                       | 0.024                       | 0                        | 0                         |
| Cadmium      | 7                        | 0.002mg/L                             | 0.0011mg/L                            | 0.0002                      | 1                        | 0                         |
| Chromium     | 7                        | 0.0084mg/L                            | 0.005mg/L                             | 0.001                       | 0                        | 0                         |
| Copper       | 7                        | 0.0126mg/L                            | 0.0072mg/L                            | 0.0014                      | 0                        | 0                         |
| Iron         | 7                        |                                       |                                       | 0.3                         | 5                        | 40                        |
| Nickel       | 7                        | 0.099mg/L                             | 0.057mg/L                             | 0.011                       | 0                        | 0                         |
| Mercury      | 7                        |                                       |                                       | 0.0006                      | 0                        | 0                         |
| Lead         | 7                        | 0.09mg/L                              | 0.04mg/L                              | 0.0034                      | 0                        | 0                         |
| Zinc         | 7                        | 0.072mg/L                             | 0.0416mg/L                            | 0.008                       | 0                        | 0                         |

**Key**

|    |  |
|----|--|
| 12 | Number of sites (out of a total of 26) equal to or exceeding guidelines or trigger value |
| 0  | All sites less than guideline or trigger value   |
| -  | No guideline or trigger value available  |
|    | Sample not analysed for parameter  |



## 4. Table of Contents

|  |           |
|--|-----------|
| <b>1. ACKNOWLEDGEMENTS.....</b>  | <b>2</b>  |
| <b>2. EXECUTIVE SUMMARY.....</b>   | <b>3</b>  |
| 3. KEY FINDINGS .....  | 5         |
| <i>Table 1: Number of sites (out of a total of 26) equal to or exceeding the ANZECC water quality guidelines and trigger values.....</i> | <i>7</i>  |
| <b>4. TABLE OF CONTENTS.....</b>   | <b>9</b>  |
| <b>4.1. LIST OF FIGURES .....</b>  | <b>11</b> |
| <b>5. BACKGROUND .....</b>   | <b>13</b> |
| <b>5.1. BROCKMAN RIVER CATCHMENT .....</b>   | <b>14</b> |
| 5.1.1. CLIMATE .....   | 17        |
| 5.1.2. GEOLOGY AND GEOMORPHOLOGY .....   | 20        |
| <i>The Darling Plateau.....</i>  | <i>20</i> |
| <i>The Dandaragan Plateau.....</i>   | <i>21</i> |
| 5.1.3. VEGETATION .....  | 21        |
| <i>Table 2: Spatial extent of remnant vegetation in the Brockman River catchment (WRC, 2002). .....</i>                                  | <i>22</i> |
| 5.1.4. LAND USE .....  | 22        |
| <b>6. METHODOLOGY .....</b>  | <b>24</b> |
| SITE SELECTION .....   | 24        |
| <i>Table 3: Location and description of selected sampling sites within the Brockman River catchment.....</i>                             | <i>25</i> |
| 6.1. WATER SAMPLING .....  | 27        |
| 6.2. WATER ANALYSIS.....   | 27        |
| <i>Table 4: Summary of chemical analysis techniques.....</i>   | <i>28</i> |
| <b>7. RESULTS AND DISCUSSION .....</b>   | <b>29</b> |
| 7.1. WATER QUALITY .....   | 30        |
| 7.1.1. Flow and Rainfall .....   | 30        |
| 7.2. PHYSICAL PROPERTIES .....   | 33        |
| 7.2.1. Temperature.....  | 33        |
| 7.2.2. pH .....  | 35        |
| 7.2.3. Electrical Conductivity.....  | 38        |
| 7.2.4. Total Suspended Solids.....   | 44        |
| 7.3. NUTRIENT CONCENTRATIONS IN WATER.....   | 48        |
| 7.3.1. Total Nitrogen.....   | 48        |
| 7.3.2. Ammonia as Nitrogen .....   | 52        |
| 7.3.3. Dissolved Organic Nitrogen .....  | 55        |
| 7.3.4. Total Oxidised Nitrogen .....   | 57        |
| 7.3.5. Total Phosphorous.....  | 61        |
| <i>Table 5. Number of sites (out of 26) equal to or exceeding the ANZECC Total Phosphorus guideline for lowland rivers.....</i>          | <i>61</i> |
| 7.3.6. Soluble Reactive Phosphorous.....   | 66        |
| 7.4. METALS IN SURFACE WATER .....   | 69        |
| 7.4.1. Hardness.....   | 70        |
| 7.4.2. Aluminium.....  | 74        |
| 7.4.2. Iron .....  | 76        |
| 7.4.3. Zinc.....   | 78        |
| 7.4.4. Copper.....   | 80        |

|   |            |
|---|------------|
| 7.4.5. Nickel.....  | 82         |
| 7.4.6. Other Metals.....  | 84         |
| <b>8. COMPARISON WITH PREVIOUS RESULTS.....</b>   | <b>85</b>  |
| <i>Table 6: Sub catchment salinity measurement based on six years of data between 2006 and 2012....</i>   | <i>86</i>  |
| <b>9. RECOMMENDATIONS.....</b>  | <b>88</b>  |
| <b>10. REFERENCES.....</b>  | <b>89</b>  |
| <b>APPENDIX A: WATER QUALITY RESULTS (RAW) .....</b>  | <b>95</b>  |
| NUTRIENTS.....  | 97         |
| HEAVY METALS .....  | 99         |
| <b>APPENDIX B – FRESHWATER TRIGGER VALUES AND GUIDELINES .....</b>  | <b>100</b> |
| TRIGGER VALUES AND GUIDELINES FOR TOXICANTS (HEAVY METALS) IN FRESHWATER .....  | 101        |
| TRIGGER VALUES AND GUIDELINES FOR TOXICANTS (HEAVY METALS) IN FRESHWATER .....  | 102        |
| <b>APPENDIX C – SALINITY MEASUREMENTS AND TOLERANCE LIMITS .....</b>  | <b>103</b> |
| <b>APPENDIX D - HARDNESS-MODIFIED TRIGGER VALUE CALCULATIONS BASED ON<br/>VARYING WATER HARDNESS (TABLE 3.4.4. ANZECC &amp; ARMCANZ, 2000).....</b> | <b>104</b> |
| <b>APPENDIX E - SAMPLING AND ANALYSIS PLAN.....</b>   | <b>105</b> |

## 4.1. List of Figures

|   |    |
|---|----|
| Figure 1: Catchments within the Swan-Canning Catchment (WRC, 2003).....   | 15 |
| Figure 2: Brockman River Catchment (WRC, 2003). ....  | 16 |
| Figure 3: Total monthly rainfall within the Brockman River catchment recorded at Bindoon Station (009112), and Wannamal Station (009040) in 2011 and 2012 (Bureau of Meteorology, 2013). ....   | 18 |
| Figure 4: Land use in the Brockman River Catchment.....   | 23 |
| Figure 5: Sampling site locations within the Brockman River Catchment. ....   | 26 |
| Figure 6: Water temperature of surface water within the Brockman River Catchment on the 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. ....   | 34 |
| Figure 7: pH of surface water within the Brockman River catchment on 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. ....  | 37 |
| Figure 8: Electrical conductivity within the main body of the Brockman River, recorded at sampling sites Grey Road (BRN27), Lake Road (BRN15), Julimar/Chittering Bridge (BRN18), Moondyne (BRN24) and Yalliwirra (BRN25) in 2012. .... | 40 |
| Figure 9: Conductivity in surface water within the Brockman River catchment on 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012.....   | 43 |
| Figure 10: Total Suspended Solids in surface water within the Brockman River catchment sampled 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. *blanks represent no sample taken or below limit of reporting.....            | 47 |
| Figure 11: Total Nitrogen in surface water within the Brockman River catchment sampled 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. *blanks represent no sample taken or below limit of reporting.....                    | 51 |
| Figure 12: Ammonia as NH <sub>4</sub> N concentrations in surface water within the Brockman River catchment on 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. *blanks represent no sample taken .....                       | 54 |
| Figure 13: Dissolved Organic Nitrogen concentrations in surface water within the Brockman River catchment on 26 <sup>th</sup> August 2010 *blanks represent no sample taken.....  | 56 |
| Figure 14: NO <sub>x</sub> -N (TON) concentrations in surface water within the Brockman River catchment in 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. *note blanks represent no sample taken.....                       | 60 |
| Figure 15: Total Phosphorous concentrations in surface water within the Brockman River catchment sampled on 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. *note blanks represent no sample taken.....                      | 65 |
| Figure 16: Filterable Reactive Phosphorous concentrations in surface water within the Brockman River catchment sampled on 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. *blanks represent no sample taken.....             | 68 |
| Figure 17: Water Hardness sampled from surface waters within the Brockman River catchment on 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012.....   | 72 |
| Figure 18: Aluminium concentrations in surface water within the Brockman River catchment on the 15 <sup>th</sup> August and the 22 <sup>nd</sup> of October 2012.....   | 75 |
| Figure 19: Iron concentrations in surface water within the Brockman River catchment on the 15 <sup>th</sup> of August and the 22 <sup>nd</sup> October 2012. ....   | 77 |

|  |    |
|--|----|
| Figure 20: Zinc concentrations in surface water within the Brockman River catchment on the 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. ....                                   | 79 |
| Figure 21: Copper concentrations in surface water within the Brockman River catchment on the 15 <sup>th</sup> August and the 22 <sup>nd</sup> October 2012. ....                             | 81 |
| Figure 22: Nickel concentrations in surface water within the Brockman River catchment on the 15 <sup>th</sup> August and 22 <sup>nd</sup> October 2012. *blanks represent not measured ..... | 83 |

## **5. Background**

The Brockman River catchment stretches across 1520 square kilometres and is the largest catchment of the lower Avon and upper Swan catchments. The Brockman River is approximately 90 kilometres in length and flows through the Chittering Valley along the Darling Scarp. The main issues within the catchment include a deteriorating natural resource base due to widespread clearing of native vegetation and an increased economic pressure on agricultural land to be more productive. This has resulted in increased salinity, water logging, erosion, pest plants and animals, and affected waterways due to increased sedimentation and reduced surface and ground water quality (WRC, 2003).

In 1996 discussions in Northam between the Water and Rivers Commission Regional Services, Western Australian state government and local governments in the catchment, documented their requirements for natural resource management. Together with the Shire of Chittering it was decided that the water quality of the Brockman River and its catchment was a priority and developed a successful funding application through the Natural Heritage Trust Fund to prepare an integrated natural resource management plan for the Brockman River catchment (WRC, 2003).

In 2012 the Ellen Brockman Integrated Catchment Group (EBICG) conducted an assessment of the Brockman River catchment surface water quality on 15<sup>th</sup> August and 22<sup>nd</sup> October. The objective of the snapshot was to build upon the existing years of data and establish baseline data on the water quality within the catchment. By monitoring stream salinity throughout a catchment, areas where the discharge of saline groundwater to streams is identified can then be targeted for remediation efforts. This sampling program and associated water quality results will be registered and entered into the Department of Water's (DoW) Water Information Network (WIN) database.

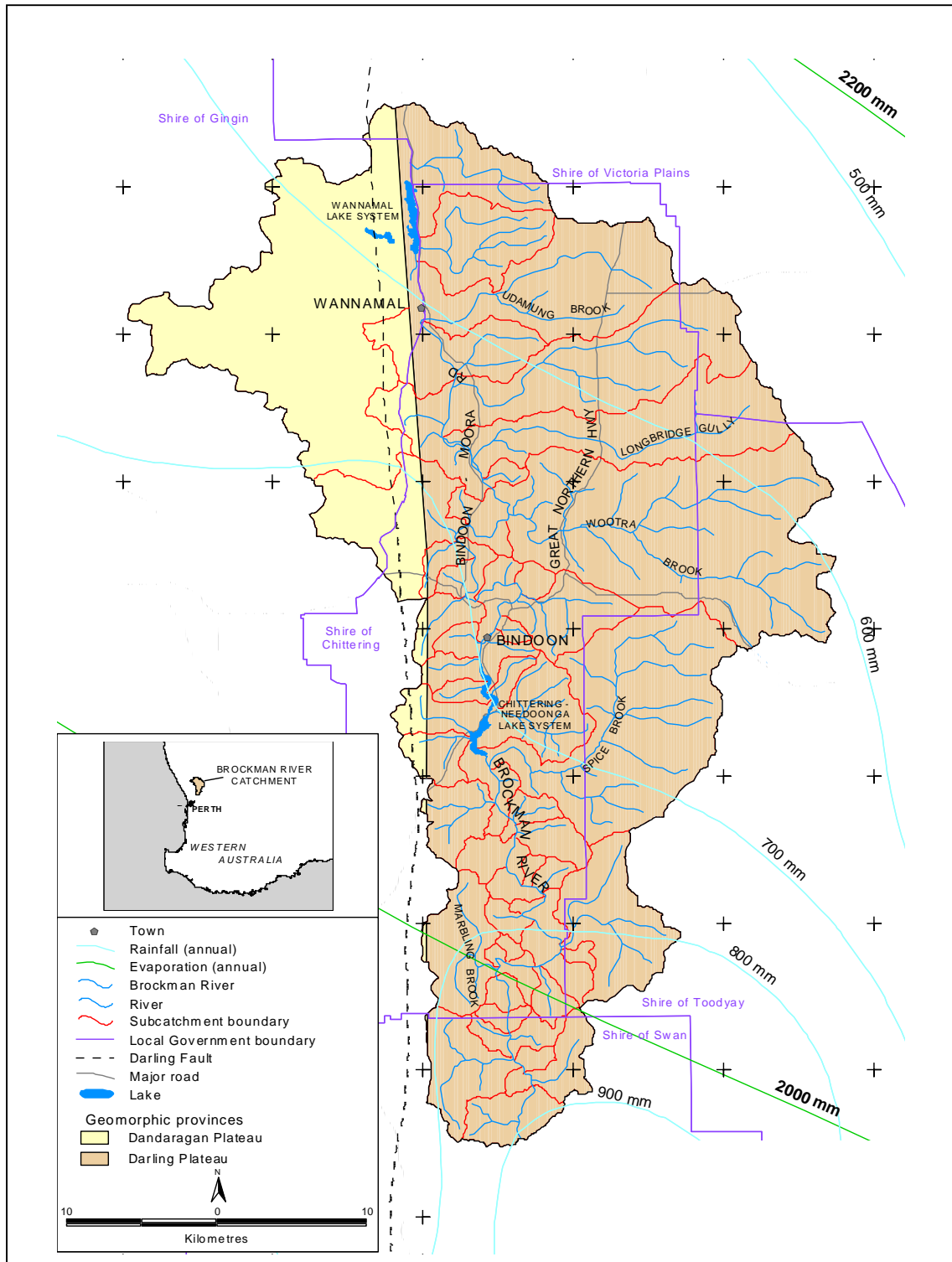
## **5.1. Brockman River Catchment**

The Brockman River catchment is located to the north-east of the Perth Metropolitan area in the south-west of Western Australia (Figure 1). The catchment covers an area inclusive of sixty-eight sub catchments, incorporating the townships of Bindoon and Wannamal (WRC, 2002). The largest part of the catchment lies within the Shire of Chittering, with the remainder within the shires of Victoria Plains, Toodyay, Gingin and the City of Swan (Figure 2). Other localities within the catchment include Mooliabeenie, Lower Chittering, Maryville Downs and South Chittering.

While the Brockman River flows into the lower Avon River and is thus, part of the Avon River catchment, its greatest impact is on the Swan River and is therefore considered part of the Swan River catchment. The Brockman River itself follows the Darling Scarp, flowing through the deeply incised Chittering valley to enter the Swan-Avon River 40kms upstream from Perth (WRC, 2002).

The natural resource base of the catchment is deteriorating because of the widespread clearing of native vegetation and the increased economic pressure on agricultural land to be more productive. These impacts have resulted in increased salinity, water logging, soil erosion via wind and water, sedimentation, eutrophication, overgrazing, weed invasion and pest animals within the catchment. These cumulative impacts have an offsite effect on the Brockman River and local wetland systems, and ultimately the Avon-Swan River.





**Figure 2:** Brockman River Catchment (WRC, 2003).



### **5.1.1.      *Climate***

The catchment experiences a typical Mediterranean climate of hot dry summers and cool wet winters. Average rainfall for the southern portion is 800mm/yr decreasing to less than 600mm/yr in the northern regions (Bureau of Meteorology, 1998). Rainfall in 2011 was significantly below the average annual rainfall for the region with a total of 450333.1mm received between January and December at Wannamal (Station 009040) and 394.2mm received at Bindoon (Station 009112) (Figure 3). This is significantly less than the rainfall received in 2011, which was slightly above the annual average. July and October were particularly dry months which have affected the water quality results, as they correspond with the sampling events. 'good' season due to the extended months of rainfall, the total annual rainfall was still below the average.

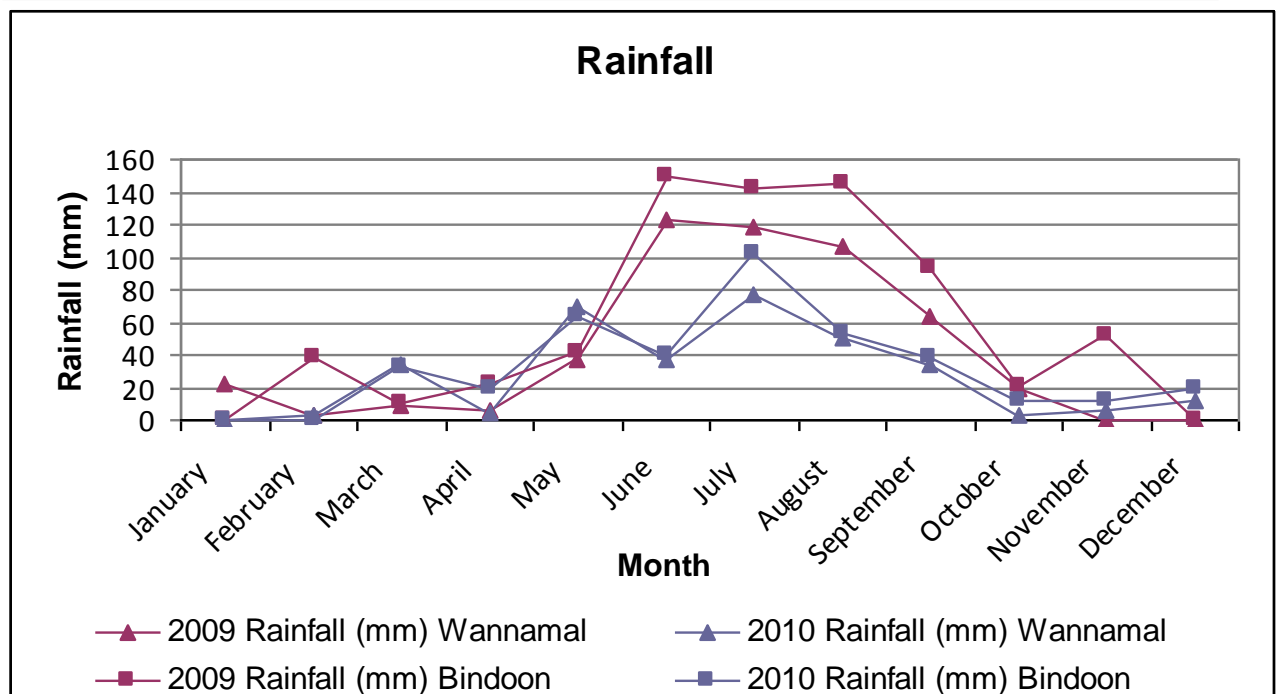
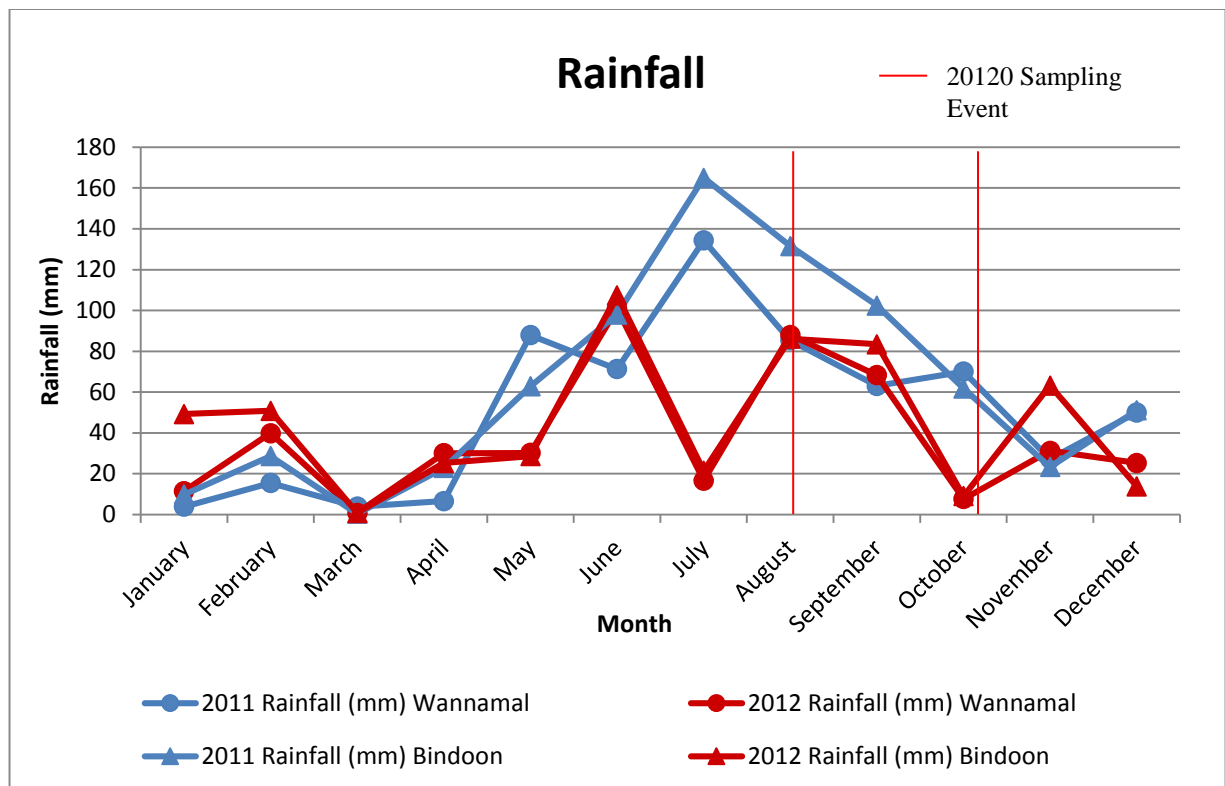


Figure 3: Total monthly rainfall within the Brockman River catchment recorded at Bindoon Station (009112), and Wannamal Station (009040) in 20109 and 20120 (Bureau of Meteorology, 20130).

Most water courses in the catchment flow during the winter months and have reduced or no flow during the summer months. Weather patterns typically have strong easterly to north-easterly winds in the morning and south-westerly in the afternoon during summer with thunderstorms and lightning common. During winter the winds come from the northwest to southwest (WRC, 2003).

### **5.1.2.        *Geology and Geomorphology***

The Darling Plateau, an ancient landmass worn down by erosion, underlies most of the eastern portion of the Brockman River catchment. To the west, the catchment extends over the Dandaragan Plateau. A major regional fault line, the Darling Fault, separates these two geomorphic regions (Figure 2).

#### **The Darling Plateau**

The Darling Plateau is made up of two major rock sequences. The first sequence is a 10km wide belt of crystalline rocks referred to as the Chittering Metamorphic belt. Intense erosion within the Chittering Metamorphic belt has produced a major north-south trending valley system in which the Brockman River flows south. The second sequence to the east is granitic rock covered with a lateritic cap referred to as the lateritic uplands (Wild and Low, 1978). Laterite is sometimes referred to as ironstone or coffee rock.

The deeply incised Chittering Valley is characterised by dissected, steep slopes and domed granite outcrops high in the landscape with variable and complex soils. Parent materials may be weathered or unweathered gneiss, granite or dolerite or may occur as colluvium. Colluvial lateritic material from the plateau surface may extend down slope. Yellow duplex and brown duplex and gradational earths are the most common soils. Generally, the yellower soils are associated with the granite, and the red and brown soils with dolerite dykes (King and Wells, 1990). Loamy soils, now extensively cleared for agriculture, are found on the lower valley slopes and floodplain.

The lateritic uplands are typified by undulating, dissected land surfaces with, pale orange lateritic soils and pea gravels. Red alluvial, clay soils characterise the valley floors while upland remnants of the plateau surface form higher land with sands and sandy gravels interspersed with laterite outcrops. Saline soils occur within the valley floors.

Most of the area outside reserves is cleared for agriculture with small pockets of native vegetation along fence lines and watercourses. Gully erosion is the predominant erosion hazard but landslips have occurred on the steeper slopes of the Chittering Valley.

#### The Dandaragan Plateau

The Dandaragan Plateau to the west of the Darling Fault is a wedge shaped erosion remnant of the Perth Basin with sediments covered by recent deposits of sand and laterite (Wild and Low, 1978). Sand plain features dominate the landscape with broad U-shaped valleys, sand-filled drainage lines and some breakaways. The soil pattern is closely related to topography (Churchward, 1980). Brown deep sands, yellow deep sands, pale deep sands, sandy gravels and shallow gravels are dominant, with red deep sandy duplex soils on the valley floors (Moore, 1998).

Soil landscapes are outlined in the Shire of Chittering Land Capability and Management Study prepared by Land Assessment Pty. Ltd. Part 1 – Working Paper and LandSmart™.

#### **5.1.3.       Vegetation**

Large areas of native vegetation remain in the eastern part of the catchment in the Avon Valley National Park, the proposed Julimar Conservation Park (currently State Forest) and in the Department of Defence Bindoon Training area. Other areas of native vegetation in the catchment are located within the ten CALM nature reserves and on some private property.

The greatest area of native vegetation occurs within the western forest/woodland and eastern heath regions while the central area consists of severely dissected remnants within an agricultural landscape. These areas have been heavily cleared and now the remaining remnants are generally small and dispersed.

Approximately 201 km<sup>2</sup> (13%) is reserved for conservation purposes with much of this conservation land being confined to the eastern Darling Scarp forests and north-western sand plain. The spatial extent of remnant vegetation in the Brockman River catchment is given in Table 2.

Table 2: Spatial extent of remnant vegetation in the Brockman River catchment (Connell, 2006).

|   |       |
|---|-------|
| Total area (km <sup>2</sup> )                       | 1,520 |
| Number of remnants                                  | 2,000 |
| Total Area Of Remnant Vegetation (km <sup>2</sup> ) | 770   |
| % Total Remnant Area                                | 51    |
| Remnant Vegetation Reserved (km <sup>2</sup> )      | 201   |
| % Original Area Reserved                            | 13    |
| % Remnant Area Reserved                             | 26    |

Source: Connell (2006).

#### **5.1.4. Land Use**

The economy of the Brockman River catchment and the livelihood of its residents are currently based on the natural resources of land and water. Animal products derived from pasture are the most extensive agricultural land use followed by broad scale crops and horticulture (Cook and Hatherly, 1997). The northern part of the catchment is mostly agricultural with cereal, beef, pigs, sheep and wool the major agricultural products with some horticultural products such as grapes and citrus. In the Chittering Valley, production is mostly beef, sheep, citrus and grapes (Figure 4). Expansion of horticulture and viticulture in the catchment is limited by the lack of suitable irrigation water.

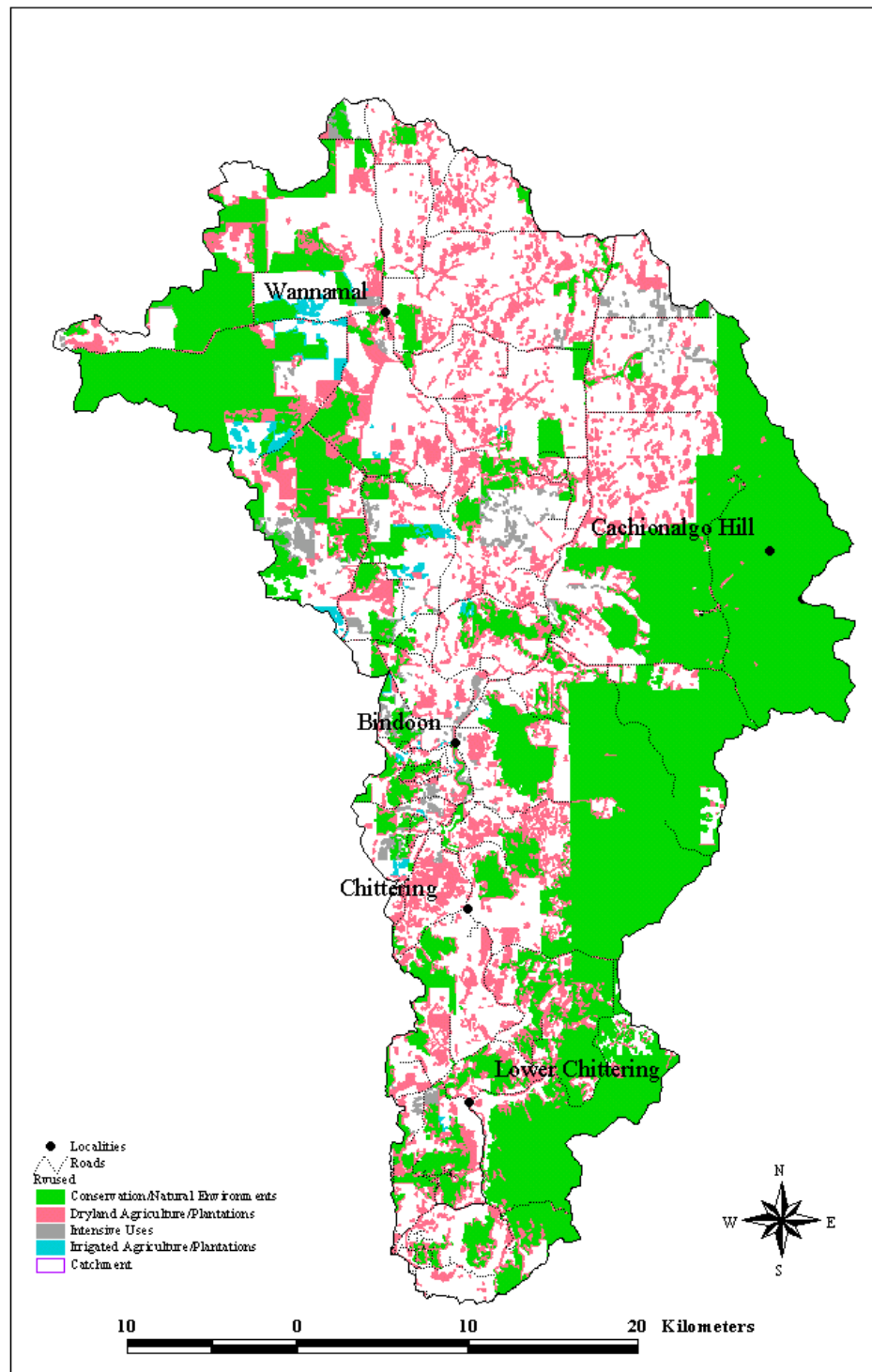


Figure 4: Land use in the Brockman River Catchment.

## **6. Methodology**

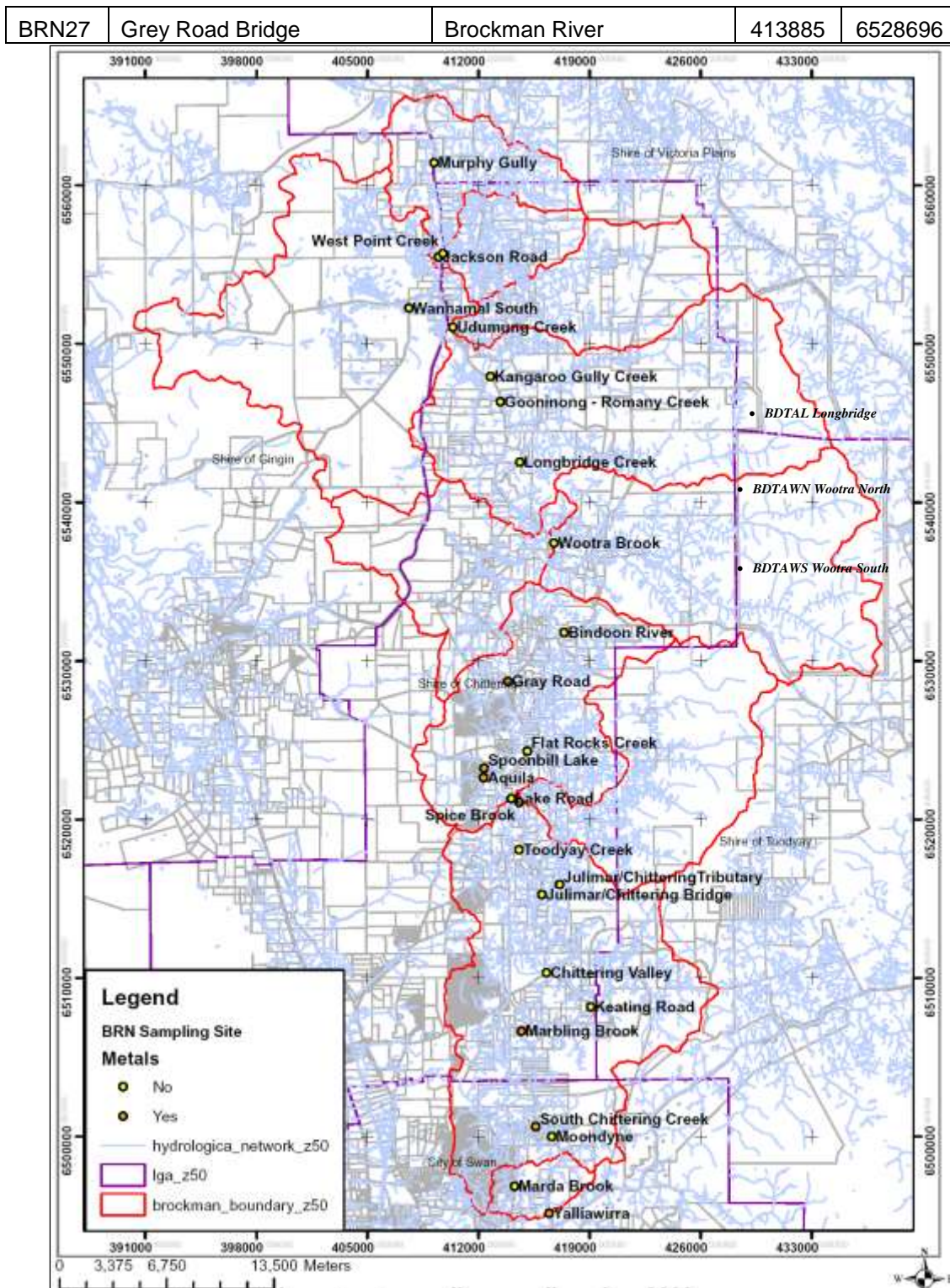
### ***Site Selection***

Water samples were taken from twenty-six sites within the Brockman River catchment (Figure 5). Crest Hill Road (BRN11) was removed from the sampling program in 2008 and replaced with Grey Road Bridge (BRN27)0. These sites were selected to be representative of sub-catchments carrying large volumes of water to the Brockman River, to determine their salinity, relative nutrient and metal contribution, and whether they were situated upstream or downstream of potentially high impact land uses or of likely contaminant sources. Table 3 lists the twenty-six sample sites by site number, site name and relative waterway component. Site location is also provided using street names, northings and eastings.



Table 3: Location and description of selected sampling sites within the Brockman River catchment.

| Site No. | Site name  | Description of waterway (inc. old site number)                 | Easting | Northing |
|----------|--|--|---------|----------|
| BRN1     | Murphy Gully Creek                               | BR22 - Bindoon Moora Rd  | 409205  | 6561412  |
| BRN2     | Jackson Road<br>(Wannamal Lake outlet)           | BR21 - Jackson Road  | 409457  | 6555480  |
| BRN3     | West Point Creek                                 | BR20 - West Point  | 409754  | 6555706  |
| BRN4     | Wannamal South                                   | Wannamal South Road  | 407596  | 6552244  |
| BRN5     | Udumung Creek                                    | BR18 - Hay Flat Road   | 410373  | 6551048  |
| BRN6     | Kangaroo Gully Creek                             | BR17A - Bindoon Moora Rd                                       | 412741  | 6547952  |
| BRN7     | Romany Creek                                     | BR17 - Waldeck West Road - Romany Creek                        | 413360  | 6546355  |
| BRN8     | Longbridge Creek                                 | BR16A - Ashman Rd to gate (2km) over fence & nth on fire break | 414649  | 6542478  |
| BRN9     | Wootra Brook                                     | BR15 - Owen's Road   | 416762  | 6537439  |
| BRN10    | Bindoon River                                    | BR15A - Great Northern Highway small bypass road bridge        | 417372  | 6531777  |
| BRN12    | Flat Rocks Creek                                 | Densley Road (off Flat Rocks)                                  | 415077  | 6524296  |
| BRN13    | Spoonbill Lake                                   | BR12 - spillway from Spoonbill Reserve                         | 412361  | 6523223  |
| BRN14    | Aquila, Hart Drive                               | BR12A - Flows through Aquila Reserve                           | 412306  | 6522632  |
| BRN15    | Lake Road<br>Brockman River                      | BR9 - Bridge on Lake Road below Lake Weir                      | 414090  | 6521308  |
| BRN16    | Spice Brook                                      | BR11A - off Lake Road across paddock to bridge                 | 414509  | 6521156  |
| BRN17    | Toodyay Creek<br>Toodyay Creek                   | 100m north of Blue Plains Road on Chittering Road              | 414561  | 6518111  |
| BRN18    | Julimar/Chittering Bridge<br>Brockman River      | BR5 - Julimar Rd/Chittering Rd intersection                    | 415996  | 6515275  |
| BRN19    | Julimar/Chittering Tributary<br>Julimar Rd Creek | BR8 - Julimar Rd (500m up from intersection Chittering Rd)     | 417103  | 6515877  |
| BRN20    | Chittering Valley                                | Cnr Chittering Valley and Chittering Road                      | 416288  | 6510308  |
| BRN21    | Keating Road                                     | BR4 - 500m east on Keating Road to gateway - Bitney Springs    | 419248  | 6508210  |
| BRN22    | South Chittering Creek                           | Chittering Road just north of Wilson Road                      | 415559  | 6500608  |
| BRN23    | Marbling Brook                                   | Bridge on Chittering Road                                      | 414704  | 6506641  |
| BRN24    | Moondyne<br>Brockman River                       | BR2 - from crossing  | 416623  | 6499996  |
| BRN25    | Yalliawirra<br>Brockman River                    | BR1 Gauging Station  | 416450  | 6495160  |
| BRN26    | Marda Brook                                      | Smith Road bridge/gate   | 414266  | 6496860  |



**Figure 5:** Sampling site locations within the Brockman River Catchment.

NB: Sampling Sites in *italics* are not part of the BROCKMANWQ program. These sites were part of the BDTA water quality monitoring program (CLG, 2010).

### **6.1. Water Sampling**

Sampling of the Brockman River was undertaken in 2012 on 526<sup>th</sup> August and 22<sup>nd</sup> October. The collection of the samples followed strict protocols to prevent contamination and ensure consistency in results. An outline of the sampling collection technique is included in the sampling and analysis plan for the Brockman River catchment (see appendix E).

Field observation forms were filled out for each water sample. All samples collected from the Brockman River catchment were transported to and analysed by the National Association of Testing Authorities (NATA) accredited MPL Laboratory.

### **6.2. Water Analysis**

Water at each of the sites was measured *in situ* for physical properties (pH, specific conductivity, salinity and temperature) using WTW pH and EC probes. Samples were collected and analysed for a range of contaminants likely to be present in semi-rural, agricultural catchments. They were then sent to MPL Laboratories to be analysed for nutrients including total nitrogen, total oxidised nitrogen, nitrogen as ammonia, total organic nitrogen, total phosphorous, filterable reactive phosphorous and total suspended solids.

Water samples from Spoonbill Lake (BRN 13), Aquila (BRN 14), Lake Rd (BRN 15), South Chittering Creek (BRN 22), Marbling Brook (BRN 23), Yalliarwarra (BRN 24) and Grey Rd (BRN 27) were also tested for heavy metals. These included cadmium, mercury, arsenic, copper, lead, zinc, aluminium, chromium, iron and nickel.

Table 4 summarizes the MPL laboratories analysis techniques used for physical parameters, nutrients and heavy metals.

Table 4: Summary of chemical analysis techniques.

| Parameters    | Limit of Reporting (LOR) | Variable Unit | Analysis Technique | Lab Reference-WILAB (based on APHA) |
|---------------|--------------------------|---------------|--------------------|-------------------------------------|
| Cond (Comp25) | 1                        | uS/cm         | direct read        | 5                                   |
| pH            | 0.05                     |               | direct read        | 5                                   |
| TSS           | 1                        | mg/L          | grav               | 5                                   |
| PO4-P         | 0.003                    | mg/L          | DA                 | 18                                  |
| NOx-N         | 0.005                    | mg/L          | DA                 | 18                                  |
| TP            | 0.01                     | mg/L          | DA                 | 18                                  |
| TN            | 0.05                     | mg/L          | DA                 | 18                                  |
| Na            | 1                        | mg/L          | ICP OES            | 17                                  |
| K             | 0.1                      | mg/L          | ICP OES            | 17                                  |
| Ca            | 0.1                      | mg/L          | ICP OES            | 17                                  |
| Mg            | 0.1                      | mg/L          | ICP OES            | 17                                  |
| Hard          | 1                        | mg/L          | ICP OES            | 17                                  |
| Al            | 0.005                    | mg/L          | ICP OES            | 17                                  |
| B             | 0.05                     | mg/L          | ICP OES            | 17                                  |
| Ba            | 0.001                    | mg/L          | ICP OES            | 17                                  |
| Be            | 0.0005                   | mg/L          | ICP OES            | 17                                  |
| Co            | 0.005                    | mg/L          | ICP OES            | 17                                  |
| Cr            | 0.001                    | mg/L          | ICP OES            | 17                                  |
| Cu            | 0.005                    | mg/L          | ICP OES            | 17                                  |
| Fe            | 0.01                     | mg/L          | ICP OES            | 17                                  |
| Mn            | 0.001                    | mg/L          | ICP OES            | 17                                  |
| Mo            | 0.005                    | mg/L          | ICP OES            | 17                                  |
| Ni            | 0.005                    | mg/L          | ICP OES            | 17                                  |
| Sn            | 0.05                     | mg/L          | ICP OES            | 17                                  |
| Sr            | 0.005                    | mg/L          | ICP OES            | 17                                  |
| Ti            | 0.01                     | mg/L          | ICP OES            | 17                                  |
| V             | 0.002                    | mg/L          | ICP OES            | 17                                  |
| Zn            | 0.005                    | mg/L          | ICP OES            | 17                                  |
| As            | 0.001                    | mg/L          | GFAAS              | 6                                   |
| Pb            | 0.001                    | mg/L          | GFAAS              | 6                                   |

## **7. Results and Discussion**

The National Water Quality Management Strategy provides guidance on both ecosystem and human health protection. Water quality guidelines are provided for a range of environmental values including aquatic ecosystems, primary industries, recreation and aesthetics, drinking water, industrial water, cultural issues, and monitoring and assessment (ANZECC & ARMCANZ, 2000). This report will compare sample concentration results with aquatic ecosystem trigger values for lowland river systems and, when necessary, livestock drinking water trigger values. This is in accordance with the trigger values suggested in the Brockman River Management Plan and the “Swan Canning Cleanup Program Action Plan”.

The Guidelines recognise three levels of protection for aquatic ecosystems; those with high conservation value, slightly to moderately disturbed ecosystems and highly disturbed ecosystems. To assess the level of toxicant contamination in aquatic ecosystems, trigger values were developed from data using toxicity testing on a range of test species. The trigger values (99%, 95%, 90% and 80%) approximately correspond to the levels of protection described above. This report will use the 95% protection level for aquatic ecosystems due to the high conservation value of the receiving environment of the Swan River.

It is important to note that an exceedence of the trigger value does not indicate that “standards” are not being met, but is rather an indication that further consideration should be given to the situation. An exceedence of the trigger value indicates that there is the potential for an impact to occur and should therefore trigger a management response such as further investigation or adaptation of the guidelines according to local conditions (ANZECC & ARMCANZ 2000). No ecosystem is pristine, so when using guidelines the realistic and achievable water quality of the Brockman River should be considered.

## **7.1.      *Water Quality***

### **7.1.1.      Flow and Rainfall**

The Brockman catchment makes up approximately 0.5% of the Avon catchment and discharges an average of 34 million cubic metres of water per year, which is roughly 5.5% of the Avon River annual flow (Land Assessment Pty. Ltd, 1999). In comparison to similar data from the Ellen Brook it can be noted that a significantly greater percentage of rainfall is retained and used within the Brockman River catchment.

The Brockman River flows south along the western edge of the Darling Plateau through a deeply incised valley to join the Avon River between the Walyunga and Avon Valley National Parks. The Wannamal Lake system to the north, and seasonal streams flowing from the east and west, drain directly into the Brockman River which meanders through three other wetland reserves including the Mogumber, Betts and Chittering Lakes Nature Reserves.

The Wannamal Lake system is listed as a culturally and ecologically significant wetland (Environment Australia, 2001). Analysis of water quality readings (J. Lane, CALM, pers. Comm.) since 1978 indicates that salinity in the lake is increasing. Observations made by long time residents of the area suggest that during the early 1950's the water was relatively fresh and that good clover pastures grew in nearby paddocks that are now bare salt scalds (Pers. Comm. D. Purser).

The township of Bindoon is situated on the Brockman River where it flows into Lake Needoonga, which is part of the Chittering Lake system and a wetland of National Significance (Environment Australia, 2001).

In the summer months water flow in the Brockman River is only from the southern end of the catchment. In 1975, CALM constructed a weir at the end of

the Chittering Lakes Nature Reserve to control the levels of Chittering and Needoonga Lakes. The gates in the weir regulate the flow of water and the depth of the lakes. The weir was installed after a drain was constructed that caused the lakebed to drain prematurely, impacting on the bird-breeding season.

The aim of the water management is to achieve a desirable water level in the lake throughout the year. The lake should be dry from mid-March to the opening rains and the more saline waters that accumulate during mid to late summer should not be released downstream in an uncontrolled manner (P. Dans, pers. Comm.). Thus, during the summer months, only the catchment south of the weir contributes to the water flow in the Brockman River.

The water levels in Lake Chittering are managed for:

- Wildlife management to sustain the lake vegetation survival and regeneration and the annual bird breeding season;
- The farming industry to avoid excessive flooding of adjoining agricultural land, and;
- The horticultural industry to avoid releasing excessively saline waters down the Brockman River that adversely impacts the opportunity for farmers to irrigate horticultural crops.

The Water and Rivers Commission has two monitoring stations along the Brockman River. The first monitoring station Tanamerah (S16006) is located a few kilometres upstream of the town of Bindoon at 413589E, 6531899N. This station records stage flow data for the Upper Catchment, which covers an area of approximately 96,000 hectares (Fulwood, 2001). The second monitoring station, Yalliwirra (S616019) is situated at the base of the Catchment at 416449E, 6495149N. It records stage flow data for the entire catchment, which covers an area of approximately 151,000 hectares.

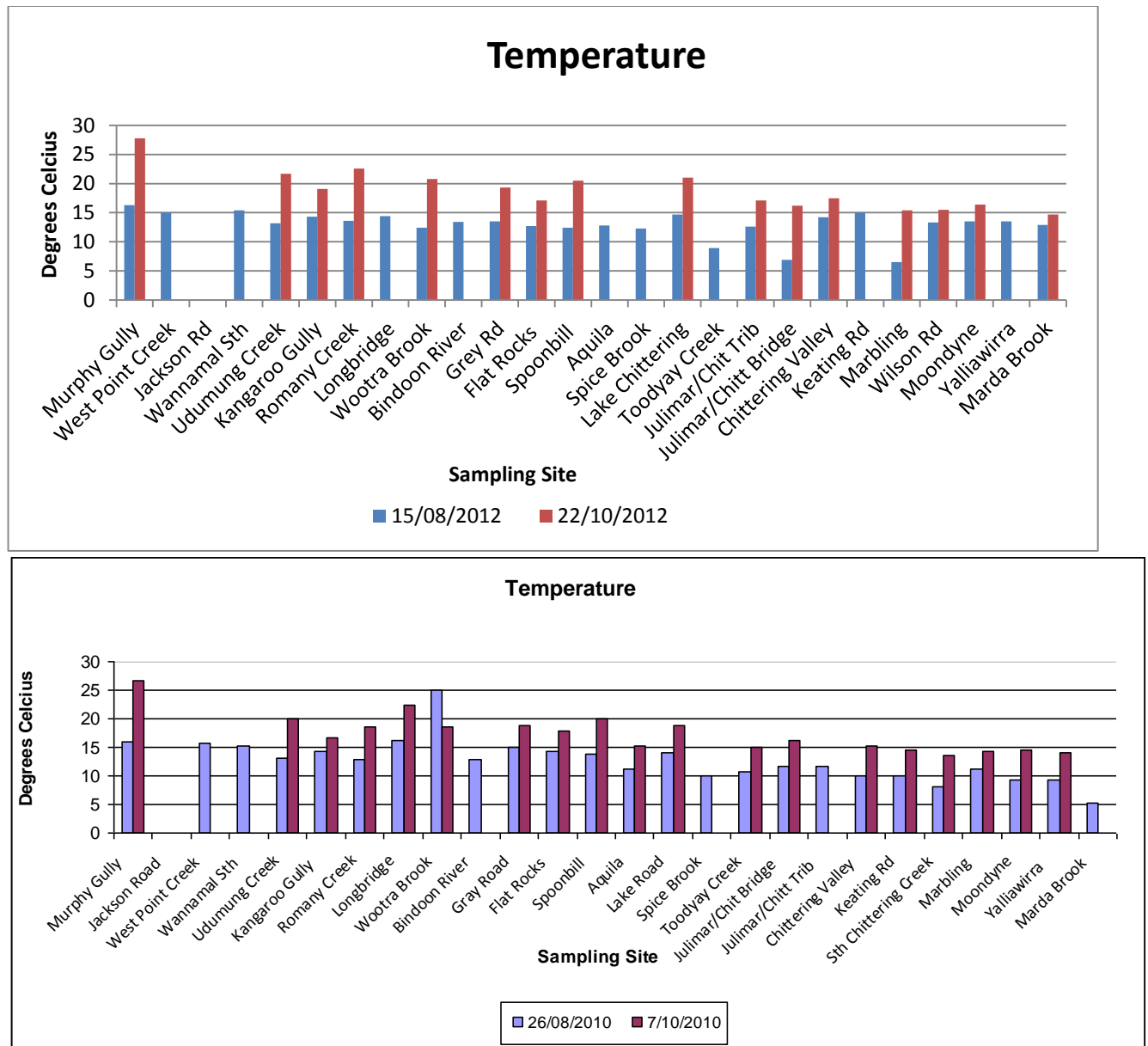
Spoonbill Lake is one of two remaining fresh to marginal waterways monitored in the Brockman River catchment for salinity. This puts significant importance and pressure on this resource as it continues to feed into the lakes of Chittering and supports downstream irrigation. It must be noted that water extraction has occurred within the Spoonbill subcatchment in recent years. This has resulted in dramatic fluctuations in Spoonbill Lake. Ongoing monitoring will be required to ensure that the existing ecosystem health and function of the reserve, subcatchment and Chittering Lakes is not negatively affected.



## **7.2.     *Physical Properties***

### **7.2.1.     Temperature**

Samples taken were from sites with flowing water at a depth ranging from 10-20cm below the surface and not in contact with the sediment at any time. August temperatures ranged between 6.5°C at Marbling (BRN23) and 16.3°C at Murphy Gully (BRN1). Water temperatures were generally warmer during the October sampling run, and ranged between 14.7°C at Marda Brook (BRN26) and 27.8°C at Murphy Gully (BRN1), (Figure 6).



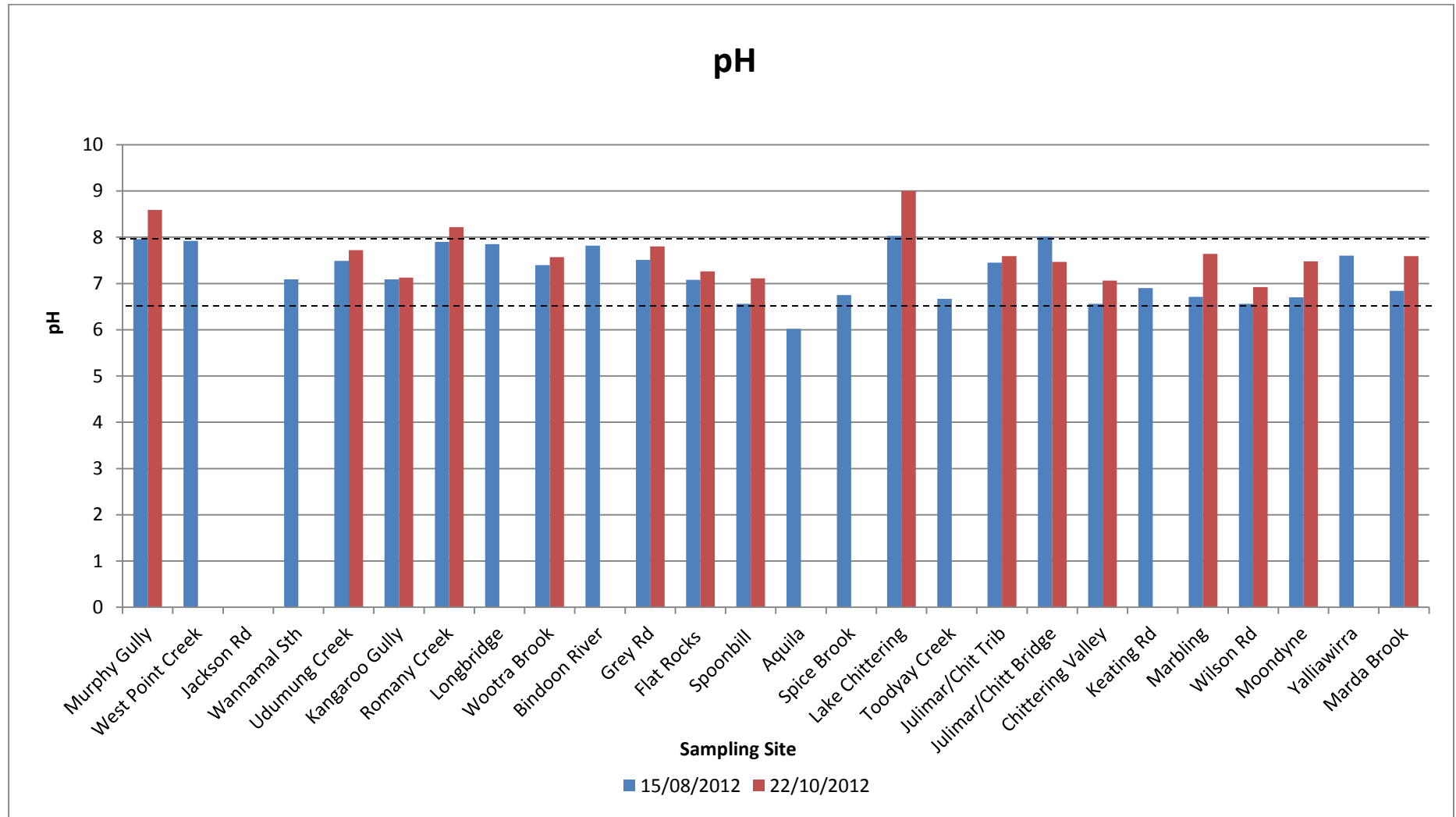
**Figure 6:** Water temperature of surface water within the Brockman River Catchment on the 526<sup>th</sup> August and 22<sup>nd</sup> October 20102.

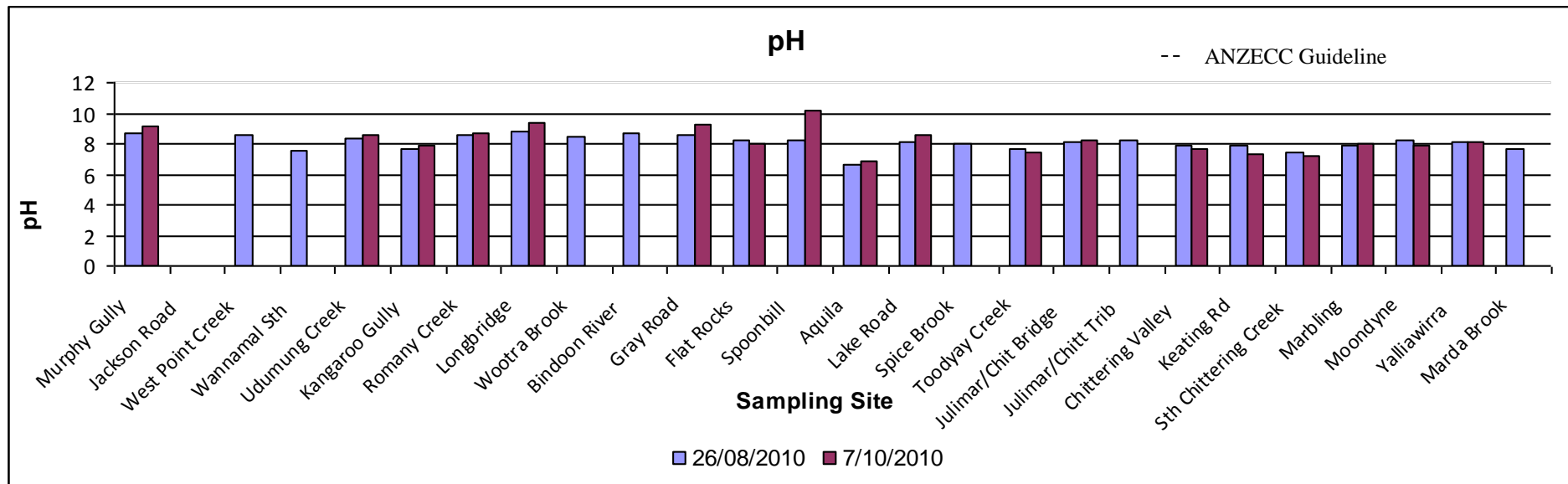
### 7.2.2. pH

pH is a measure of acidity and alkalinity. With a pH of 7.0 being neutral, a pH of less than 7 being acidic and a pH of greater than 7 being alkaline or basic. pH has an effect on chemical reactions and can alter other water quality parameters. The importance of pH on water quality lies mainly in its effect on other water quality parameters and on chemical reactions. For example, pH can affect the solubility and toxicity of a wide range of metallic contaminants (IEA 2003).

Since 2007 the Brockman River has recorded slightly alkaline pH, but the majority of sites fall within the ANZECC water quality guidelines of 6.5-8 for lowland rivers. In recent years there have been some outlier alkaline results. In 2010, Spoonbill recorded a pH value of 10.125 and in 2011 Lake Rd (BRN15) recorded a pH of 9.76. These results have not repeated at these sites since, but monitoring will continue. In 2012, three sites had slightly alkaline results with Lake Chittering (BRN15) recording the highest pH of 9.(Figure 7).

# Brockman River Catchment Water Quality Monitoring Snapshot August & October 2012





**Figure 7:** pH of surface water within the Brockman River catchment on 526<sup>th</sup> August and 22<sup>nd</sup> October 20102.

### 7.2.3. Electrical Conductivity

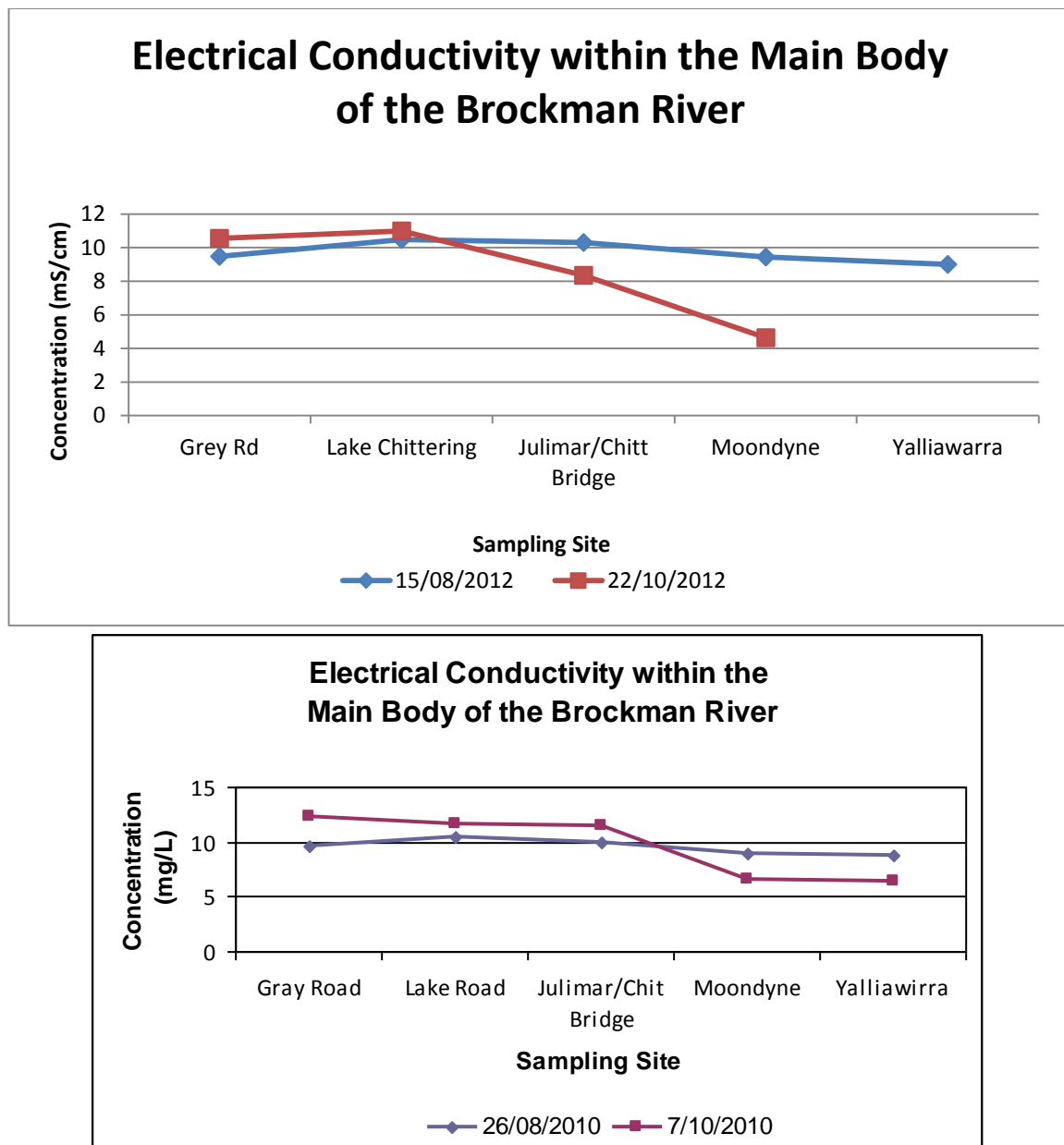
Electrical conductivity (EC) is the total concentration of inorganic ions (particularly sodium, chlorides, carbonates, magnesium, calcium, potassium and sulfates). Conductivity is often used as a measure of salinity. The conductivity level can directly affect the use of the water. For example, flora and fauna have varying tolerance levels to salinity. Therefore, this can have adverse effects on crops and stock as well.

Electrical conductivity ranged from 4.441.517mS/cm at Spoonbill (BRN13) to 29.325.7mS/cm at Murphy Gully (BRN2). All sites except Spoonbill (BRN13) and Marda Brook (BRN26) during the August sampling occasion consistently exceeded the ANZECC guidelines for freshwater lowland rivers of 0.12mS/cm to 0.3mS/cm (Figure 9). It should be noted that of the sites that exceeded the guidelines for ecosystem value, the majority of them were also within the brackish to saline levels<sup>11</sup> (occasionally Brackish water is between 3mS/cm and 9.1mS/cm, saline water is between 9.5mS/cm and 23mS/cm), anything above 1.6 is becoming brackish and would be detrimental for irrigation of stone fruit and citrus orchards. All sites sampled in October except Spoonbill (BRN13) and Marbling Brook (BRN23) also exceeded the ANZECC guidelines for freshwater lowland rivers (Figure 9).

and Spoonbill (BRN13) and Marda Brook (BRN26) recorded marginal levels of EC on both occasions in 2010. Wannamal South (BRN4), Bindoon River (BRN10), Aquila (BRN14), Spice Brook (BRN16), Toodyay Creek (BRN17), Chittering Valley (BRN20), Keating Rd (BRN21), Chittering Ck (BRN22), Moondyne (BRN24) and Yalliwirra (BRN25) recorded brackish levels during 2010. Murphy Gully (BRN1), West Point Creek (BRN3), uLongbridge (BRN8), Wootra Brook (BRN9), and Julimar Tributary (BRN19) Gray Rd (BRN27), Flat Rocks Rd (BRN12), Lake Rd (BRN15) and Julimar Bridge (BRN18) were identified as saline sampling sites. The Marbling Brook which is the last 'freshwater' perennial stream in the Brockman River catchment recorded marginal conductivity readings

in 2008 and 2009. In 2010 it was recorded as brackish, while in 2012 it gave marginal readings. The increasing conductivity levels in the Marbling Brook could be a direct result of the increased pressure on the aquatic ecosystem due to surrounding development and the number of bores drawing up water the M estate in Maryville. These results have caused landholders in the catchment to voice their concerns over the lack of good quality water required for new and expanding agricultural developments over the years (WRC, 2003). Ongoing monitoring is essential. MBrook thand. In 2012, the rainfall was again below average and this has showed in the EC level with a marginal reading.

It is also of great concern for the environmental value that nearly all sites consistently exceeded ANZECC water quality guidelines for lowland river systems, and were generally within the brackish to saline levels. The highest conductivity reading of 29.325.7mS/cm within the Brockman Catchment was recorded at Murphy Gully which is located at the northern most point of sampling along the Brockman River. Conductivity levels recorded at the sampling sites along the main body of the Brockman River were found to decrease from north to south (Figure 8). This pattern was also noted in the 2006, 2007, 2008 and 2009 *Water Quality Monitoring Snapshot of the Brockman River catchment* (EBICG, 2007, 2008, 2009 & 2010). Levels dropped to 4.4436mS/cm at Marda Brook (BRN26) during the October sampling occasion. This site is located just north of the confluence of the Brockman River and the Avon River. This concentration was above the guideline, brackish and as a result, unacceptable for the irrigation of stone fruit, citrus, peas, carrot, onion, grapes, lettuce and tomato. It is also unacceptable for human consumption or use in hot water systems (Appendix C).

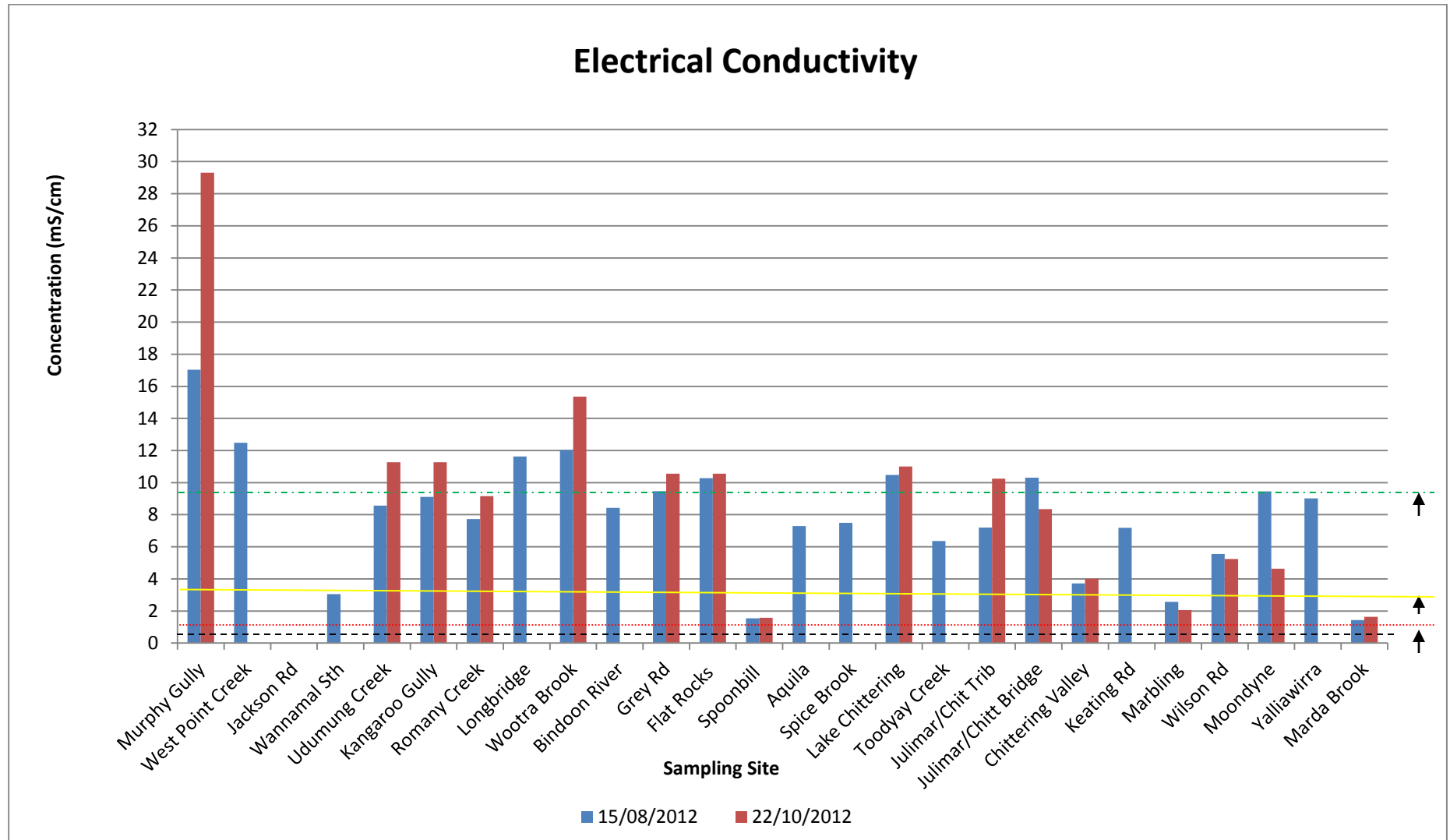


**Figure 8:** Electrical conductivity within the main body of the Brockman River, recorded at sampling sites Grey Road (BRN27), Lake Road (BRN15), Julimar/Chittering Bridge (BRN18), Moondyne (BRN24) and Yalliwarra (BRN25) in 20102.

The high level of vegetation clearing, primarily at the top of the catchment creates a weak correlation with increasing stream salinity, and a strong correlation with increasing groundwater salinity (Fulwood, 2001). This shows that the higher conductivity levels coming down the catchment and tributaries are diluted as they



flow through the Brockman River catchment and into the Avon River. This trend was also described in the *Salinity Survey in the Shire of Chittering* (Angell, 2000). Additionally, Angell (2000) found that a considerable portion of stream flow is contributed to the Brockman from saline groundwater sources. Base flow maintains stream flow throughout the year however, if extremely saline, base flow can have devastating effects on the river particularly during low rainfall seasons (approximately 200mm below average). This results in lower surface water inputs and low dilution rates. With exception to rainfall, salinity within the catchment has increased over a period of time (Fulwood, 2001).



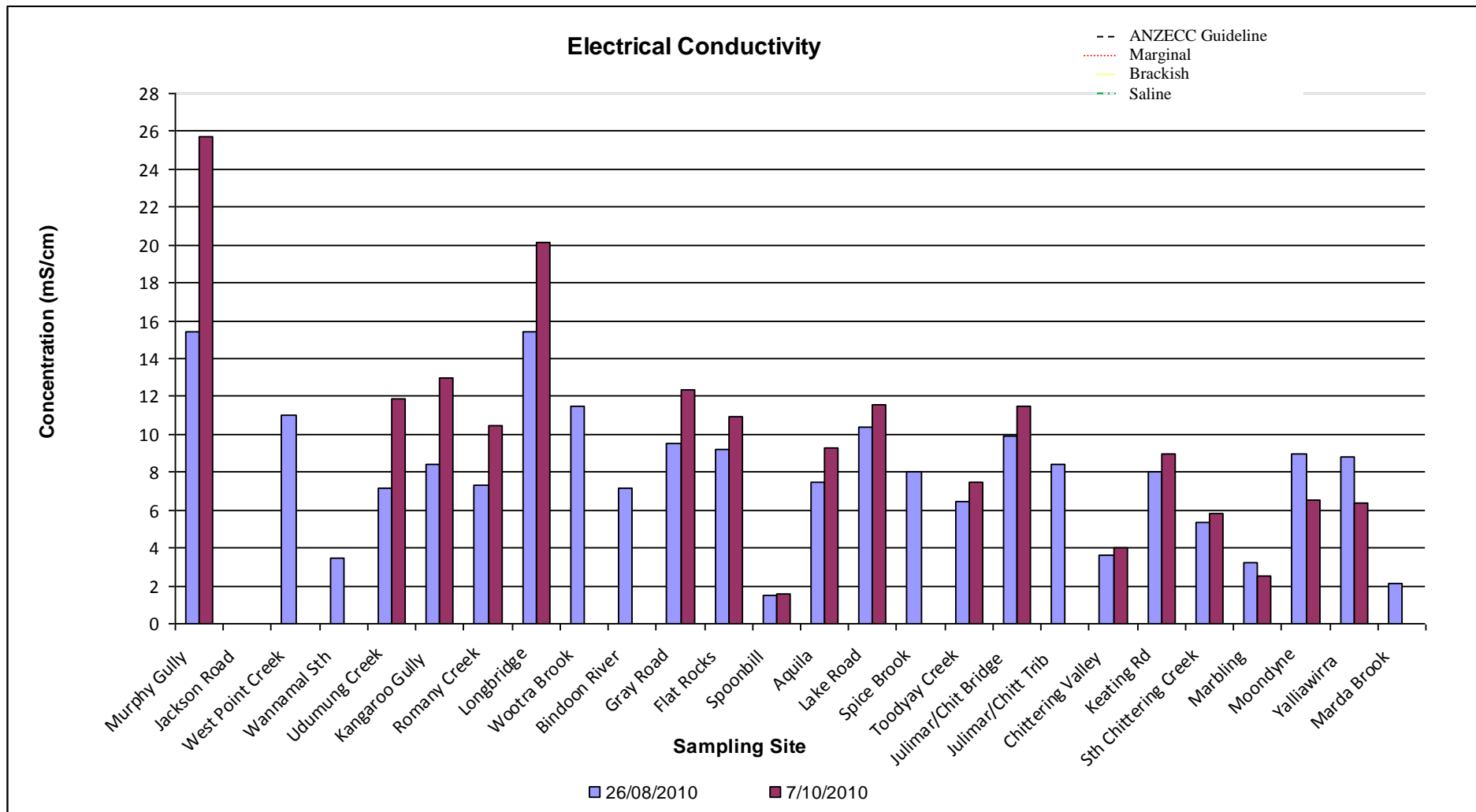


Figure 9: Conductivity in surface water within the Brockman River catchment on 526<sup>th</sup> August and 22<sup>nd</sup> October 20120.

#### 7.2.4. Total Suspended Solids

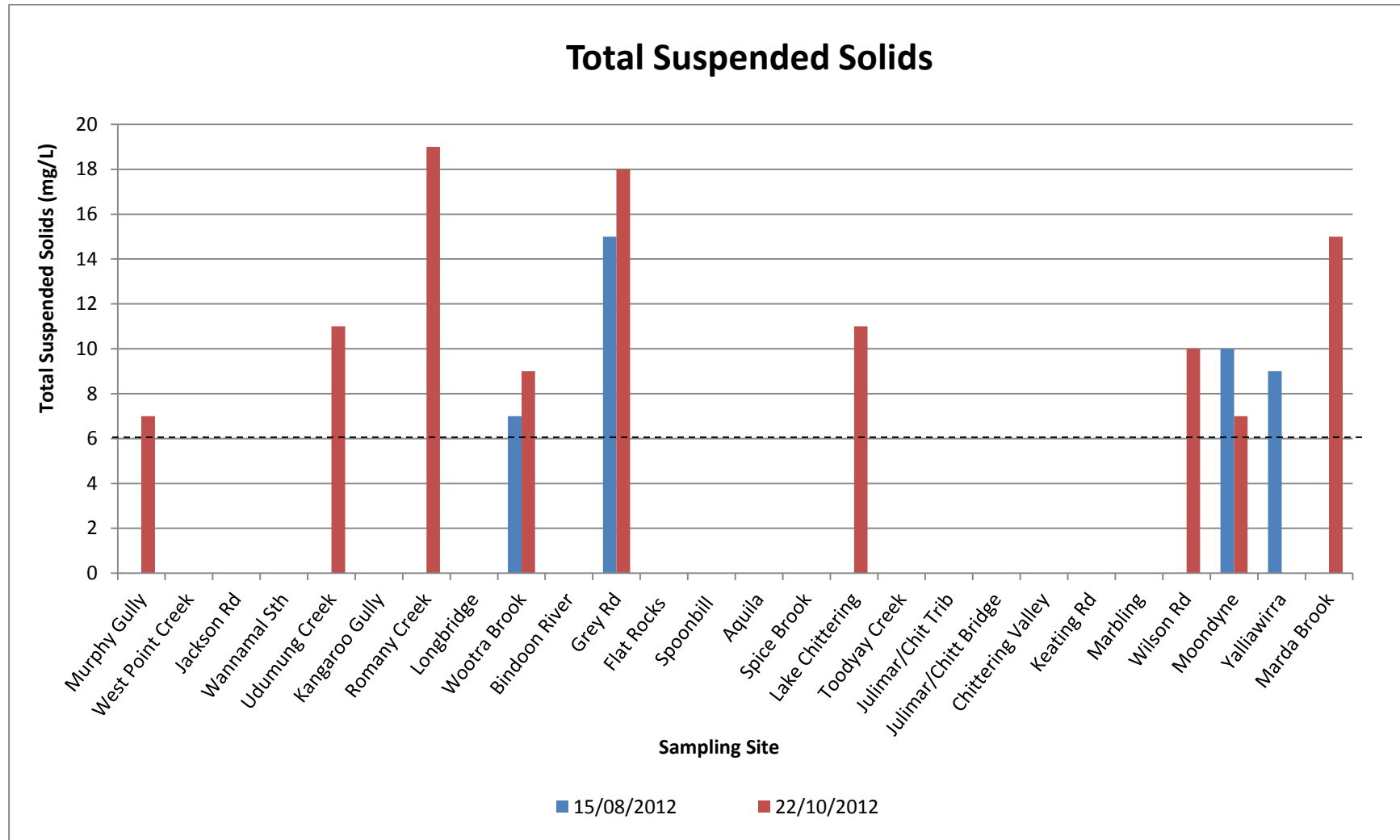
Total Suspended Solids (TSS) refers to naturally occurring suspended particles including; silt, phytoplankton and organic matter within a water body. Natural sources of TSS include water turbulence from storms, phytoplankton blooms and wind/wave action. However, TSS may also indicate detrimental environmental conditions such as erosion. This makes levels higher than normal in the water body and can result in increased deposition of material to the substrate that may smother faunal communities (McTaggart, 2002).

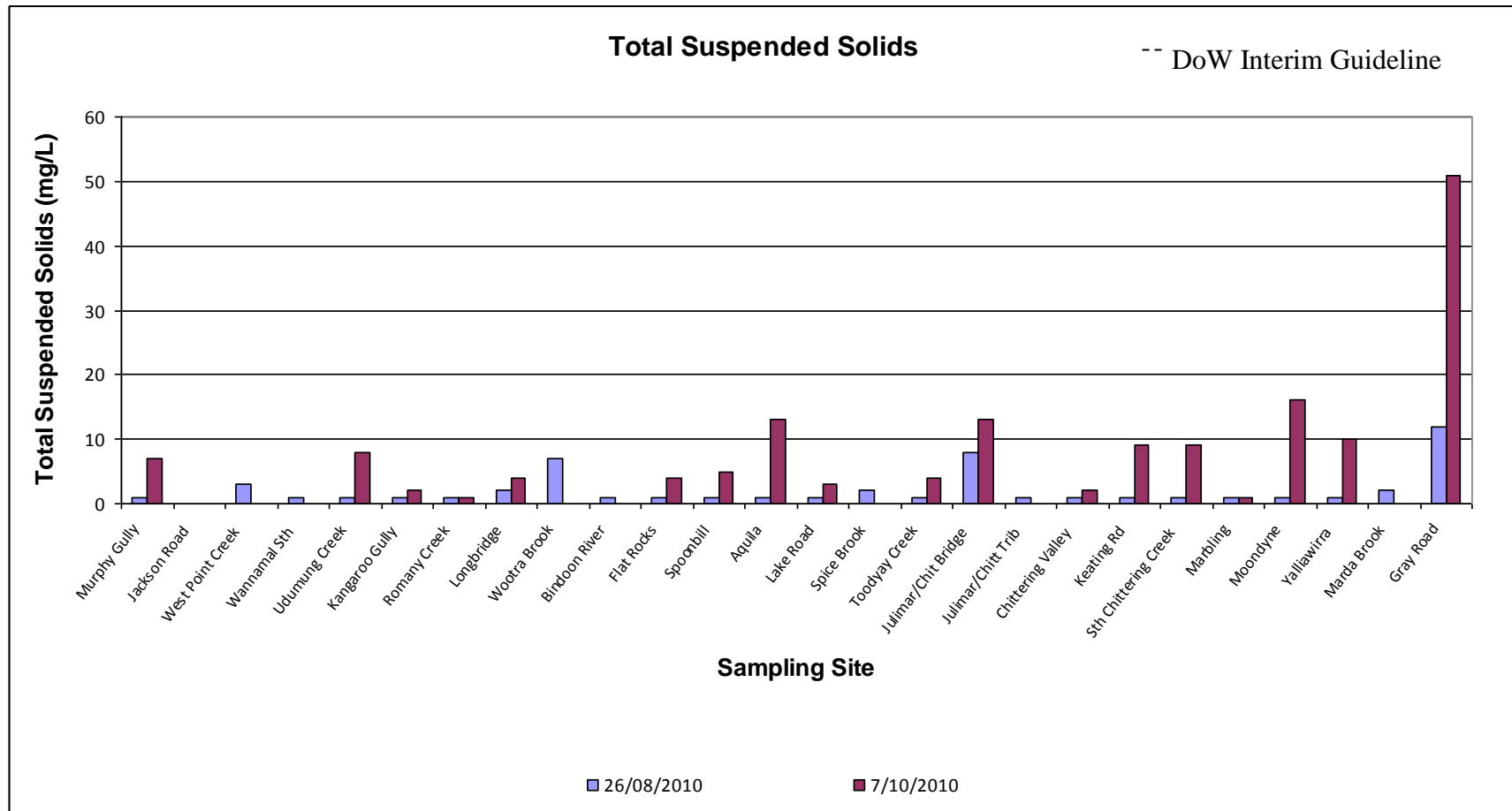
There are large variations in TSS throughout water bodies, therefore guidelines should be determined by including information on natural levels within the regional area of sampling. As no ANZECC guideline currently exists for TSS, this report will use the interim guideline of 6mg/L adopted by the Department of Water and originally developed by the Waters and Rivers commission for the Wilson Inlet report to community (October 2000). TSS in the Brockman catchment ranged between laboratory detection limits and 1951mg/L recorded at Romany Creek7Grey Road Bridgeindoon.

Julimar/Chittering Bridge (BRN18) and Grey Road Bridge (BRN27) exceeded the interim guideline of 6mg/L for TSS on both sampling occasions, with concentrations between 15 and 1851mg/L. Murphy Gully (BRN1), Udumung Creek (BRN5), Romany Creek (BRN7), Wootra Brook (BRN9), Lake Chittering (BRN15), Wilson Rd (BRN22), Moondyne (BRN24), Yalliarwarra (BRN25), and Marda Brook (BRN26) and Murphy Gully (BRN1) exceeded the interim guideline of 6mg/L for TSS on one of the sampling occasions with concentrations between 77 and 1916mg/L (Figure 10). The sites that exceeded the interim guideline are somewhat similar to previous years however the concentrations of the sites have reduced back down to typical levels from the higher than average levels in 2011 which were most likely due to higher levels of rainfall.

High TSS levels from contributing catchments are located across the catchment in areas of intensive stocking rates and grazing, high levels of cleared vegetation

and a lack of riparian vegetation. Stock have access to waterways in most of these areas causing increased erosion rates and sedimentation.





**Figure 10:** Total Suspended Solids in surface water within the Brockman River catchment sampled 526<sup>th</sup> August and 722<sup>nd</sup> October 20120. \*blanks represent no sample take

### **7.3.      *Nutrient concentrations in water***

Most nutrients present in the catchment are stored in the soils and are transported to the Brockman River via surface water (tributaries, drains and general run-off). The original sources of nutrients include; weathering, leaching from soils particularly in eroded areas, fertiliser run-off, detergents, sewerage, fixation by some plants, and decomposition of plant matter, animal wastes and other organic wastes (IEA 2003). Nitrogen and phosphorus are the two major essential elements to plants. Excessive amounts of nutrients in waterways can result in eutrophication with plant and algae growth, increases in nuisance insect numbers and unbalanced aquatic ecosystems. Nutrients include nitrogen in the form of ammonia, nitrate and nitrite, and phosphorus in the form of phosphate either dissolved (soluble reactive phosphate) or particulate (suspended).

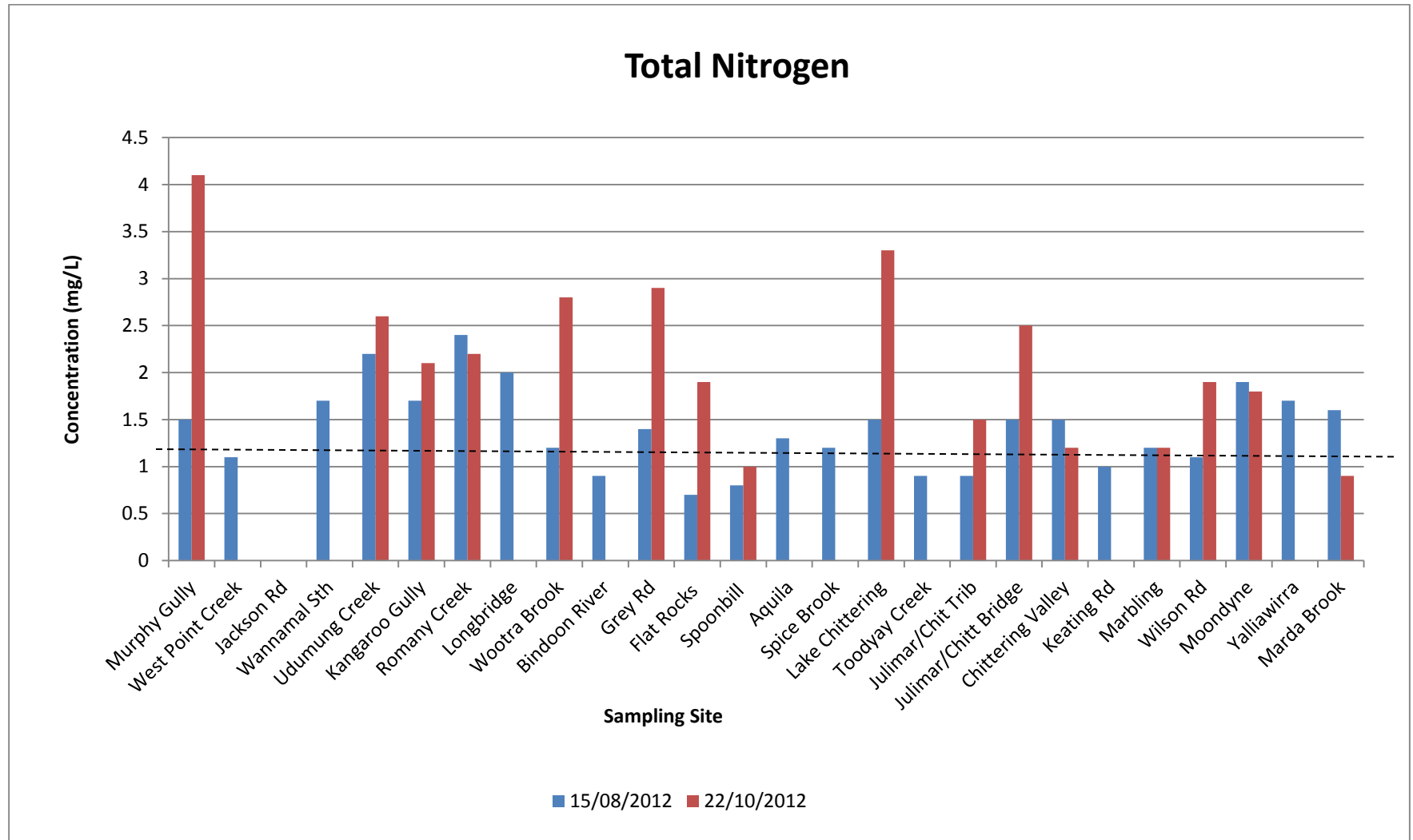
#### **7.3.1.      Total Nitrogen**

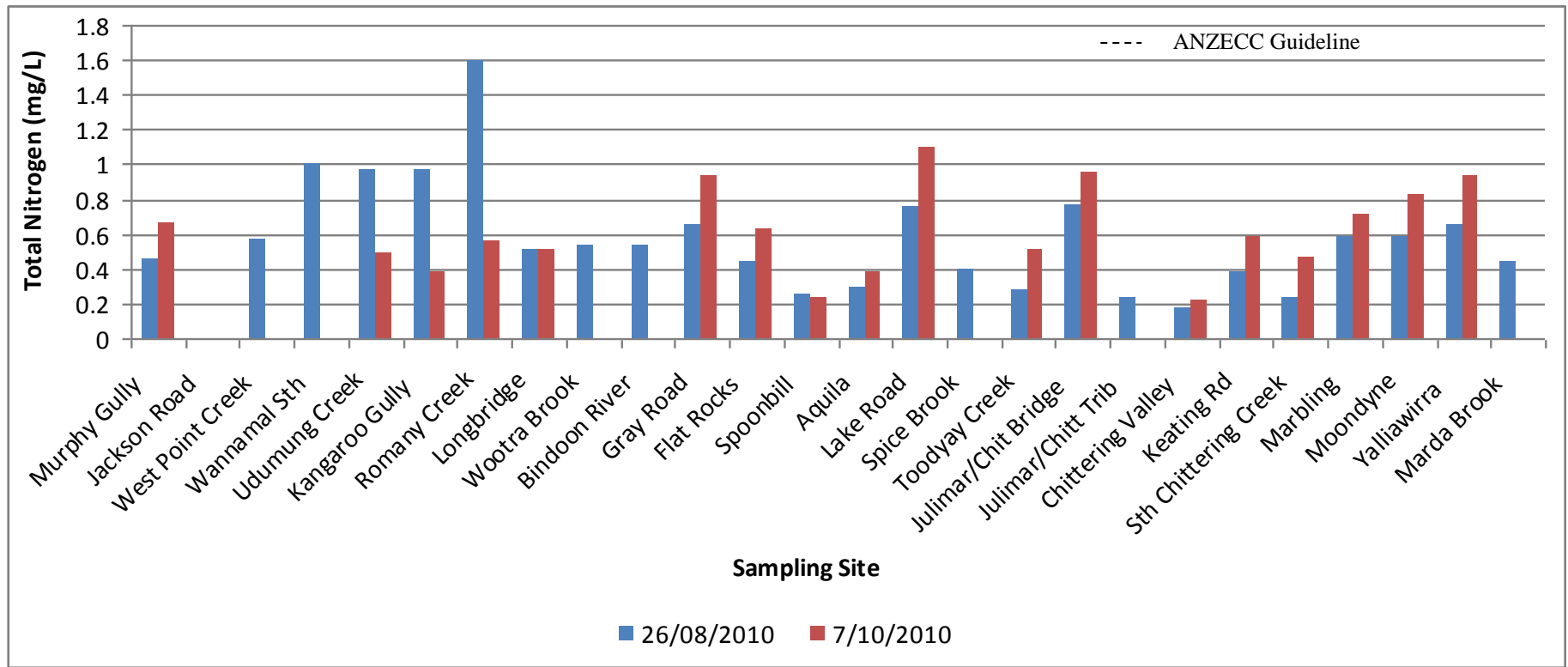
When plants or animals die they release nitrogen in the form of ammonium ( $\text{NH}_4$ ) that can then be oxidised by nitrifying bacteria to become nitrite and nitrate in a process known as nitrification. Total nitrogen (TN) refers to all forms of nitrogen present including organic (e.g. plant decay matter) and inorganic in the forms of ammonia, nitrate and nitrite (McTaggart 2002). Sources of nitrogen include fertilisers, industrial cleaning operations, feed lots, animal droppings, combustion of fossil fuels and plant debris.

Eleven of the twenty-six sites recorded a value at or below the ANZECC guideline of 1.2mg/L on the August sampling occasion. These sites were; West Point (BRN3), Wootra Brook (BRN9), Bindoon River (BRN9), Flat Rocks (BRN12), Spoonbill (BRN13), Spice Brook (BRN16), Toodyay Creek (BRN17), Julimar/Chittering Tributary (BRN19), Keating Rd (BRN21), Marbling (BRN22), and Wilson Rd (BRN22). Only four of the twenty-six sites recorded a value at or below the ANZECC guideline in the October sampling occasion. These were Spoonbill (BRN16), Chittering Valley (BRN20), Marbling Brook (BRN23) and Marda Brook (BRN26).



These results are higher than in previous years, but do not have a high rainfall event associated with the sampling occasions as could be expected. The fractions of Nitrogen analysed in this report (Total Oxidised Nitrogen, Dissolved Organic Nitrogen and Nitrogen as Ammonia) do not show a similar increased trend. Therefore it may be the undissolved organic fraction of the Nitrogen contributing to the increase. This could be due to the low flow at the time of sampling especially during the October sampling occasion. The erratic, atypical rainfall that was experienced during the 2012 season could have played a factor in the increase in TN concentrations as well. Continued monitoring is important to understand these processes.



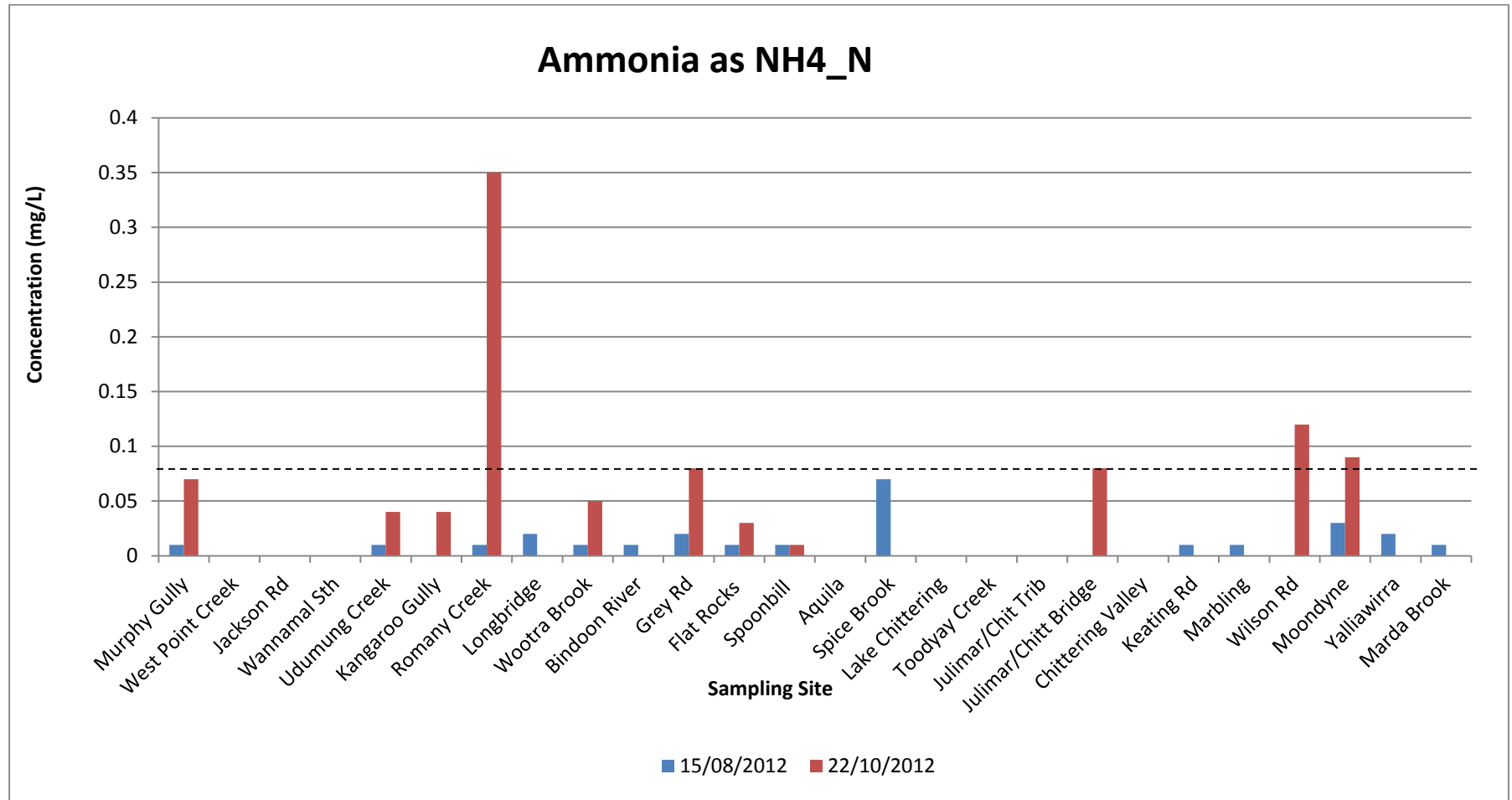


**Figure 11:** Total Nitrogen in surface water within the Brockman River catchment sampled 526<sup>th</sup> August and 22<sup>nd</sup> October 20102. \*blanks represent no sample taken

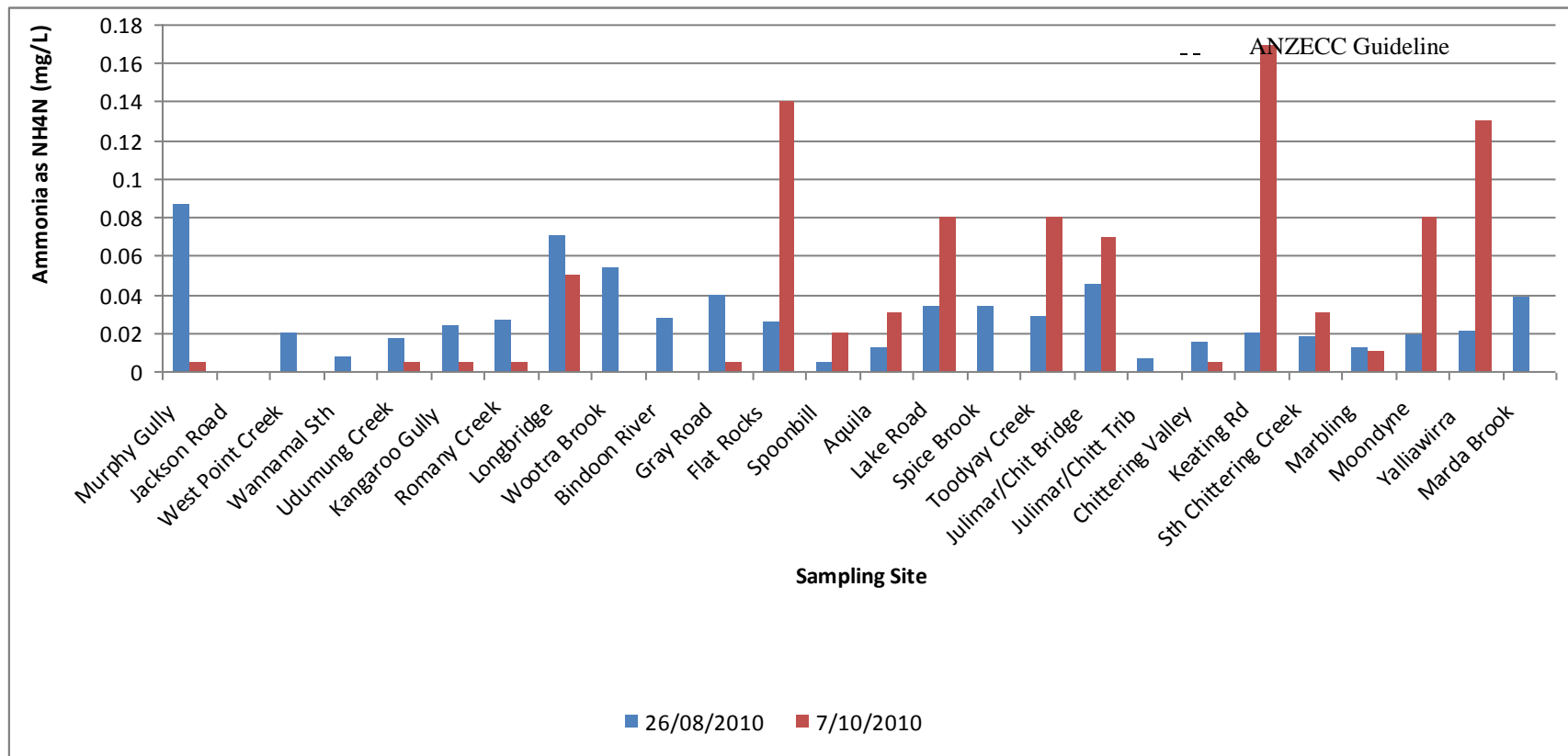
### 7.3.2. Ammonia as Nitrogen

All sites were within the ANZECC guideline of 0.08mg/L on the August sampling occasion, apart from three recordings; Romany Creek (BRN7), Wilson Rd (BRN22) and Moondyne (BRN24) except for Murphy Gully (BRN1). All sites were within the ANZECC Guideline of 0.08 on the October Sampling occasion except for Flat Rocks Rd (BRN12), Keating Road (BRN21) and Yalliwirra (BRN25), (Figure 12). Concentrations were generally higher on the October sampling occasion. This could be due to a rainfall event with increased runoff transporting nutrients directly into waterways, timing of fertiliser application and stock access to waterways.

Ammonia is used in fertilisers and cleaning agents. The majority of sampling sites are surrounded by agriculture including cattle grazing, pastures and cropping, stock yards, orchards and horticulture which are also sources of ammonia nitrogen.



# Brockman River Catchment Water Quality Monitoring Snapshot August & October 2012

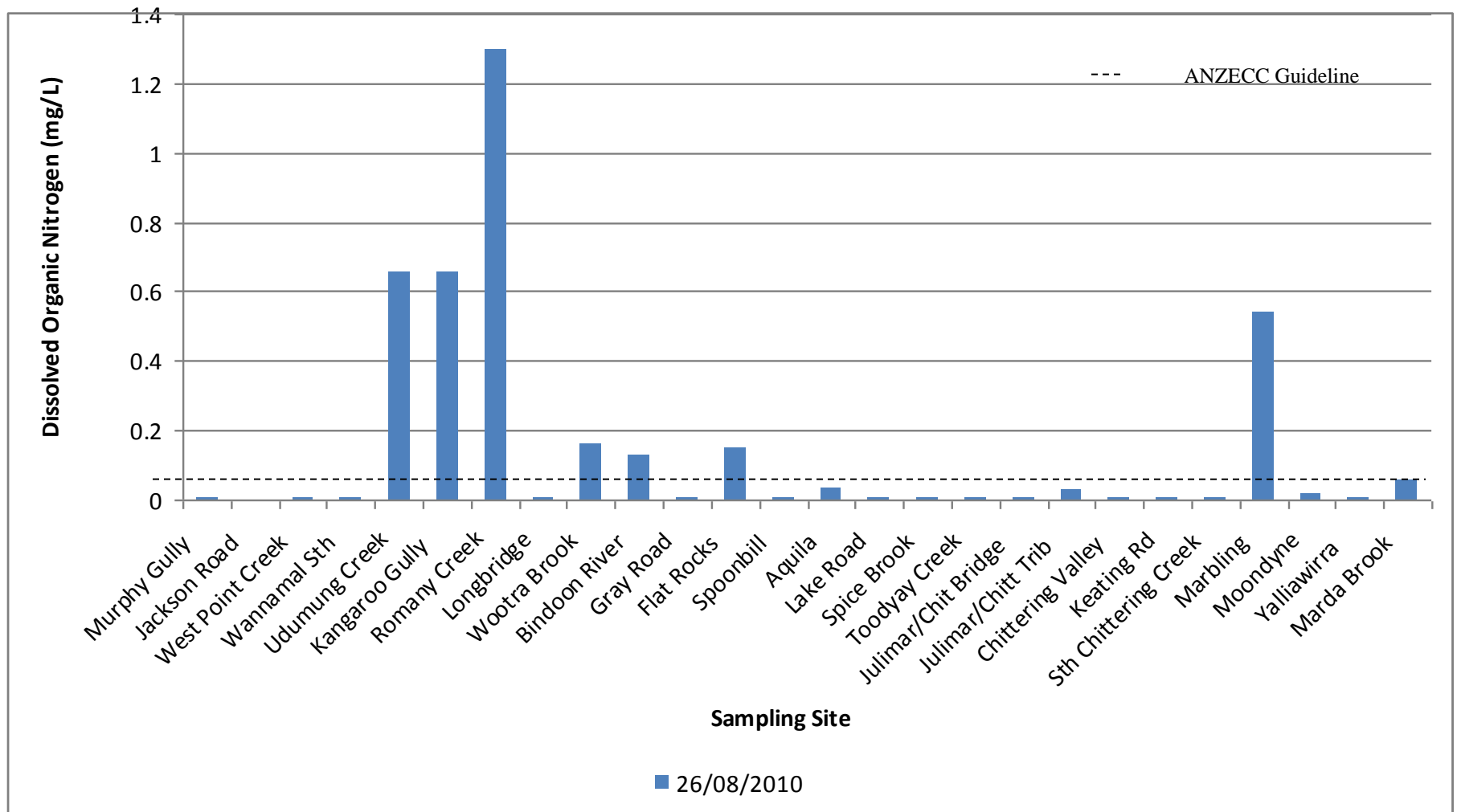


**Figure 12:** Ammonia as NH<sub>4</sub>N concentrations in surface water within the Brockman River catchment on 526<sup>th</sup> August and 722<sup>nd</sup> October 20102. \*blanks represent no sample taken

### 7.3.3. Dissolved Organic Nitrogen

Dissolved Organic Nitrogen (DON) is comprised of the organic forms of nitrogen including amino acids, proteins, urea and humic acid. Most sampling sites were within the ANZECC guideline of 0.04mg/L on the August Sampling occasion, except Udumung (BRN5), Kangaroo Gully (BRN7), Romany Creek (BRN6), Wootra Brook (BRN9), Bindoon River (BRN10), Flat Rocks Rd (BRN12), Marbling (BRN23) and Marda Brook (BRN26). Due to miscommunication with the laboratory the October sampling run was not measured for DON and therefore Figure 13 only illustrates the August Sampling occasion

It is important to mention that DON concentrations compared with total nitrogen, ammonia and total oxidised nitrogen concentrations showed that nitrogen exists primarily in its soluble form in the Brockman River catchment.



**Figure 13:** Dissolved Organic Nitrogen concentrations in surface water within the Brockman River catchment on 26<sup>th</sup> August 2010 \*blanks represent no sample taken.



#### 7.3.4. Total Oxidised Nitrogen

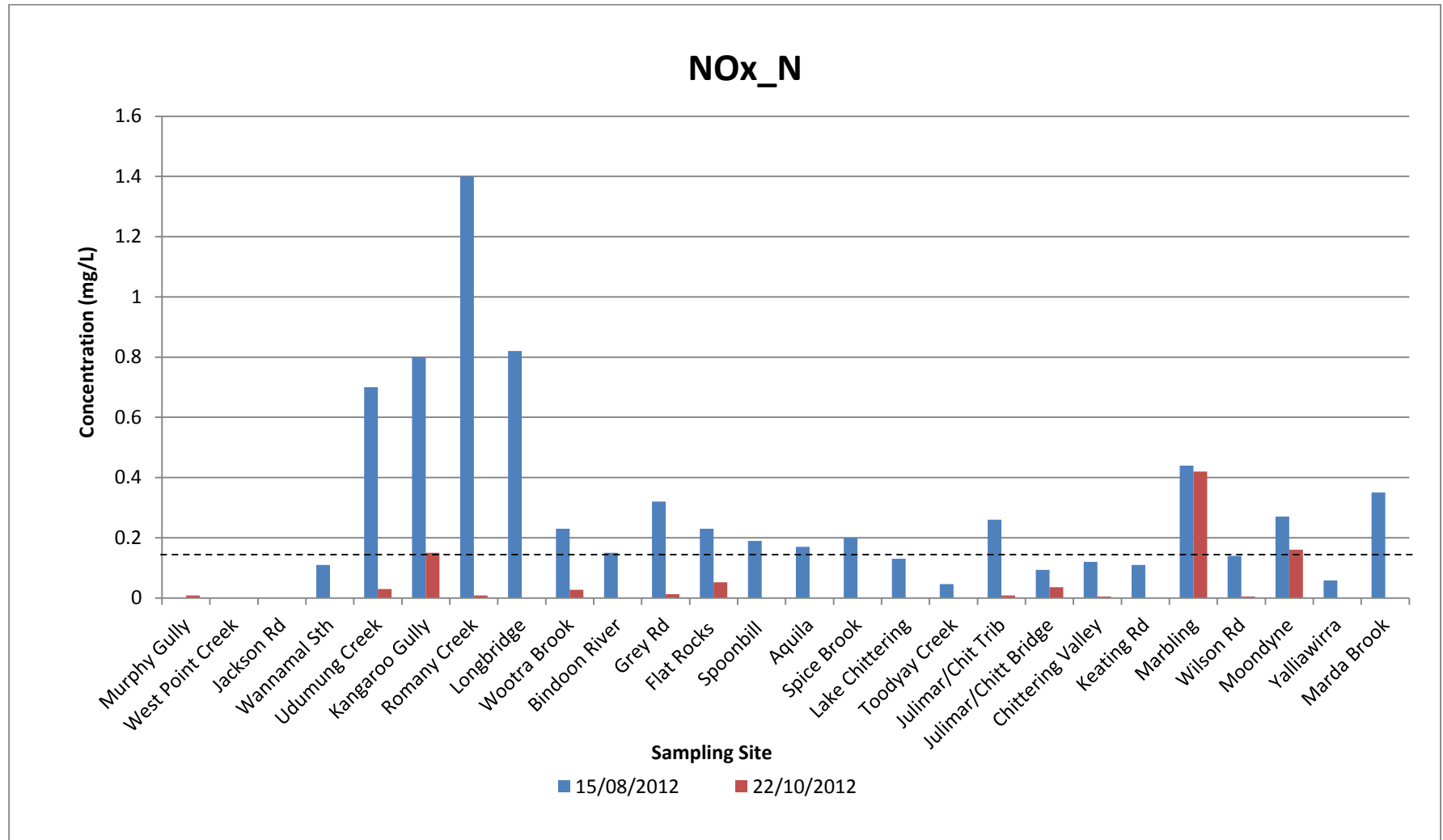
Total oxidised nitrogen is the sum of the oxidised forms of nitrogen, which includes nitrite and nitrate, and is often referred to as  $\text{NO}_x$ . Nitrite can be converted to nitrogen gas by denitrifying bacteria and ammonium ( $\text{NH}_4$ ) and in the form of nitrate; hence plants can easily absorb this form of nitrogen in a continuous cycle as it is readily soluble in water and is rapidly transported through the catchment via surface run-off, sub-surface and groundwater flows (Horwood, 1997).

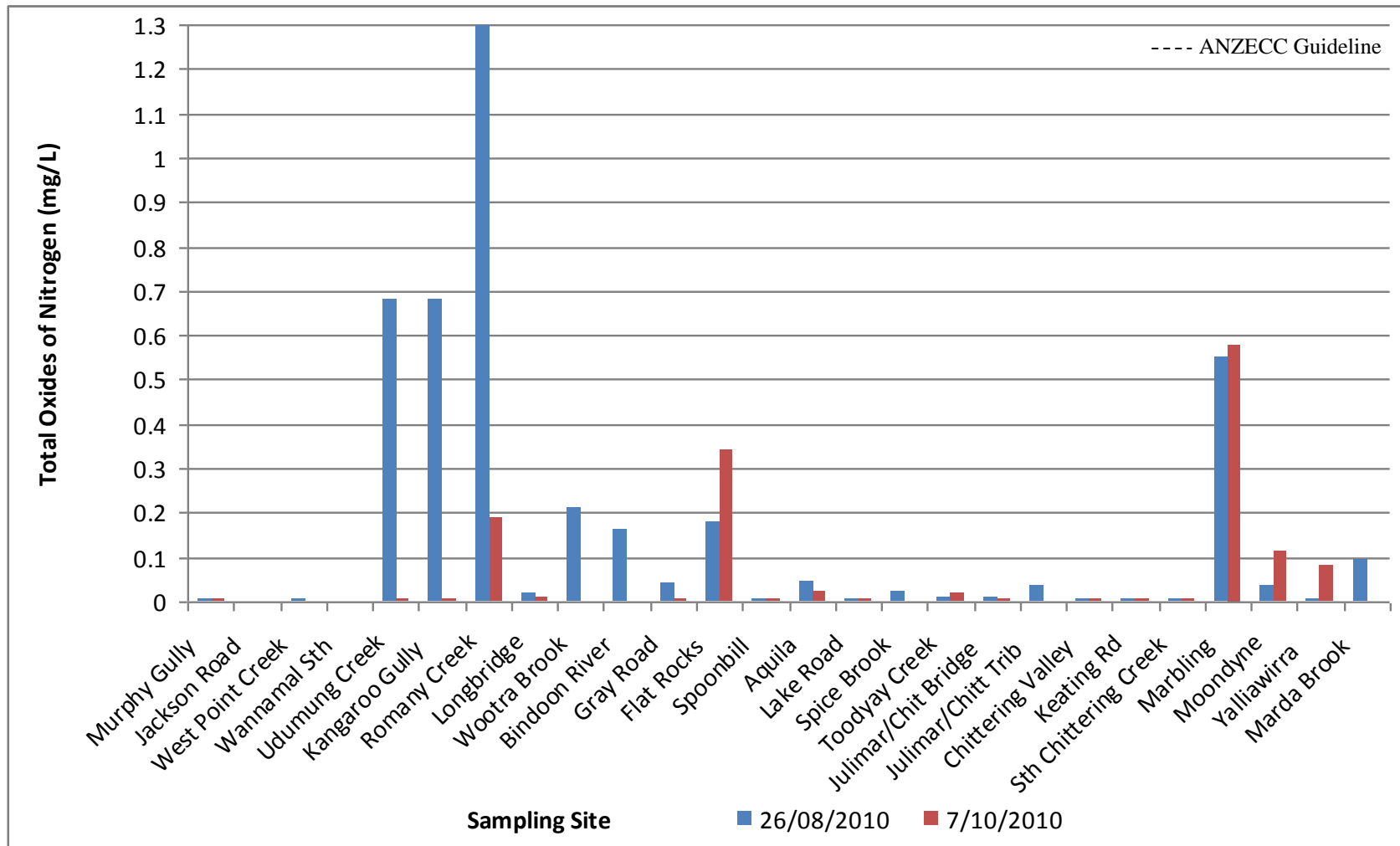
oRomany Creek (BRN7), Flat Rocks (BRN12) and Marbling Brook (BRN23) were above the ANZECC water quality guidelines of 0.15mg/L for lowland river systems and ecosystem health on both sampling occasions (Figure 14). Murphy Gully (BRN1, West Point (BRN3), Wannamal South (BRN4), Lake Chittering (BRN15), Toodyay Creek (BRN17), Julimar/Chittering Bridge (BRN18), Chittering Valley (BRN20), Keating (BRN21), Wilson (BRN22) and Yalliarwarra (BRN25) under on both occasions Udumung Creek (BRN5), Kangaroo Gully (BRN6), Wootra Brook (BRN9) and Bindoon River (BRN10), were above the ANZECC water quality guidelines of 0.15mg/L for lowland river systems and ecosystem health on (Figure 14). All other sites recorded concentrations below the guideline.

Romany Creek UdumungLongbridge (BRN8) and Marbling (BRN23) recorded a high TON concentration which is consistent with previous years. Romany Creek (BRN7) recorded the highest TON value of 1.4mg/L, over nine times greater than the guideline. This result is much higher in comparison with other sampling sites within the Brockman catchment and may be a result of site specific surface water runoff originating from the surrounding agricultural land.

It is interesting to note that TON concentrations have reduced back down to their typical values after significantly higher TON values in 2010. For example in 20,09

21 sites exceeded the ANZECC Guideline on one or more sampling occasions where as only 157 sites exceeded the ANZECC guideline on one or more sampling occasion<sup>2</sup>. This can most likely be accounted for the reduced rainfall received in 2012, where 2011 had a more average rainfall season. Cereal production, beef, pigs, and sheep may contribute to the higher concentrations of TON in the northern half of the catchment. In comparison, the primary production of the southern half of the catchment in the Chittering valley is vineyards and orchards. As a result the TON entering the river upstream from runoff carrying manure and organic matter is diluted as it flows through the catchment.





**Figure 14:** NOX\_N (TON) concentrations in surface water within the Brockman River catchment in 526<sup>th</sup> August and 722<sup>nd</sup> October 20102. \*note blanks represent no sample taken

### 7.3.5. Total Phosphorous

Total phosphorus (TP) is a measure of all phosphorus in the water including the available and unavailable (or potentially available) forms of phosphorus including orthophosphates (fertilisers), organic phosphate (plants & animals) and condensed phosphates (inorganic cleaning agents). Sources of phosphorus include fertilisers, plant debris, detergents, industrial wastes and lubricants (McTaggart 2002). Phosphorus is naturally occurring in the environment and is usually the limiting factor for aquatic plant growth as it is generally lower than nitrogen in most waterways. However, an increase in the total P level in freshwater bodies stimulates the production of *Chlorophyll a* in phytoplankton and results in an algal bloom (Russell, 2001).

As plants and animals excrete waste or die then decay, the organic phosphate sinks to the bottom of the waterway where bacteria convert it back to inorganic phosphate. Inorganic phosphate returns to the water column when sediments are disturbed, making it available again to plants which uptake it and it continues in the cycle. Inorganic phosphate is not as mobile as soluble forms of nutrients and tends to be absorbed by most soils and particulate material. This results in a steady accumulation of phosphorus slowly moving through the soil profile. Holding time of phosphorus in the catchment depends on the recharge rate to groundwater, rate of adsorption to soil particles and the extent of soil saturation (Gerritse, 1996).

Table 5. Number of sites (out of 26) equal to or exceeding the ANZECC Total Phosphorus guideline for lowland rivers.

| Year | Number of Sites |
|------|-----------------|
| 2006 | 0               |
| 2007 | 0               |
| 2008 | 7               |
| 2009 | 4               |

|      |    |
|------|----|
| 2010 | 11 |
| 2011 | 10 |
| 2012 | 11 |

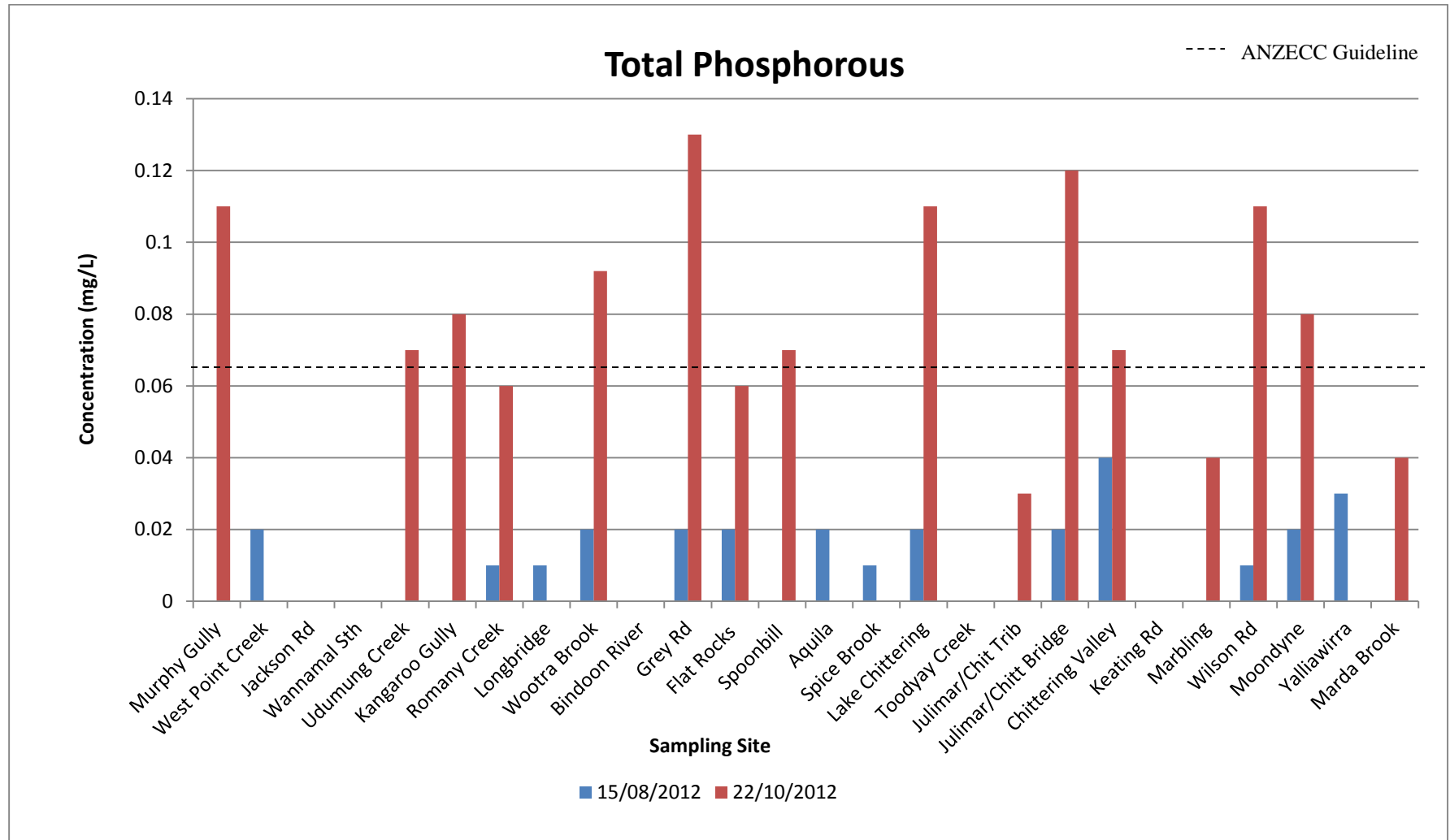
Phosphorus concentrations in the Brockman catchment have gradually increased since 2006, when there were no sites that recorded concentrations over the ANZECC guideline of 0.065mg/L for lowland river systems and ecosystem health. In 2012, eleven sites recorded concentrations above the guideline (Table 5). Wannamal South (BRN4) has recorded TP concentrations above the guideline in four of the last five years, and Julimar/Chittering Tributary (BRN19), Julimar/Chittering Bridge (BRN18) and Moondyne (BRN24) have recorded high concentrations three times in the last five years.

In 2012, the majority of sites were within the ANZECC guideline, yet Murphy Gully (BRN1), Udumung (BRN5), Kangaroo Gully (BRN6), Wootra Brook (BRN9), Grey Rd (BRN27), Spoonbill (BRN13), Lake Chittering (BRN15), Julimar/Chittering Bridge (BRN18), Chittering Valley (BRN20), Wilson Rd (BRN22) and Moondyne (BRN24) all exceeded the guideline. These high concentrations were all recorded in the October sampling occasion, with the highest value of 0.13mg/L at Gray Rd (BRN27), which is twice the ANZECC guideline.

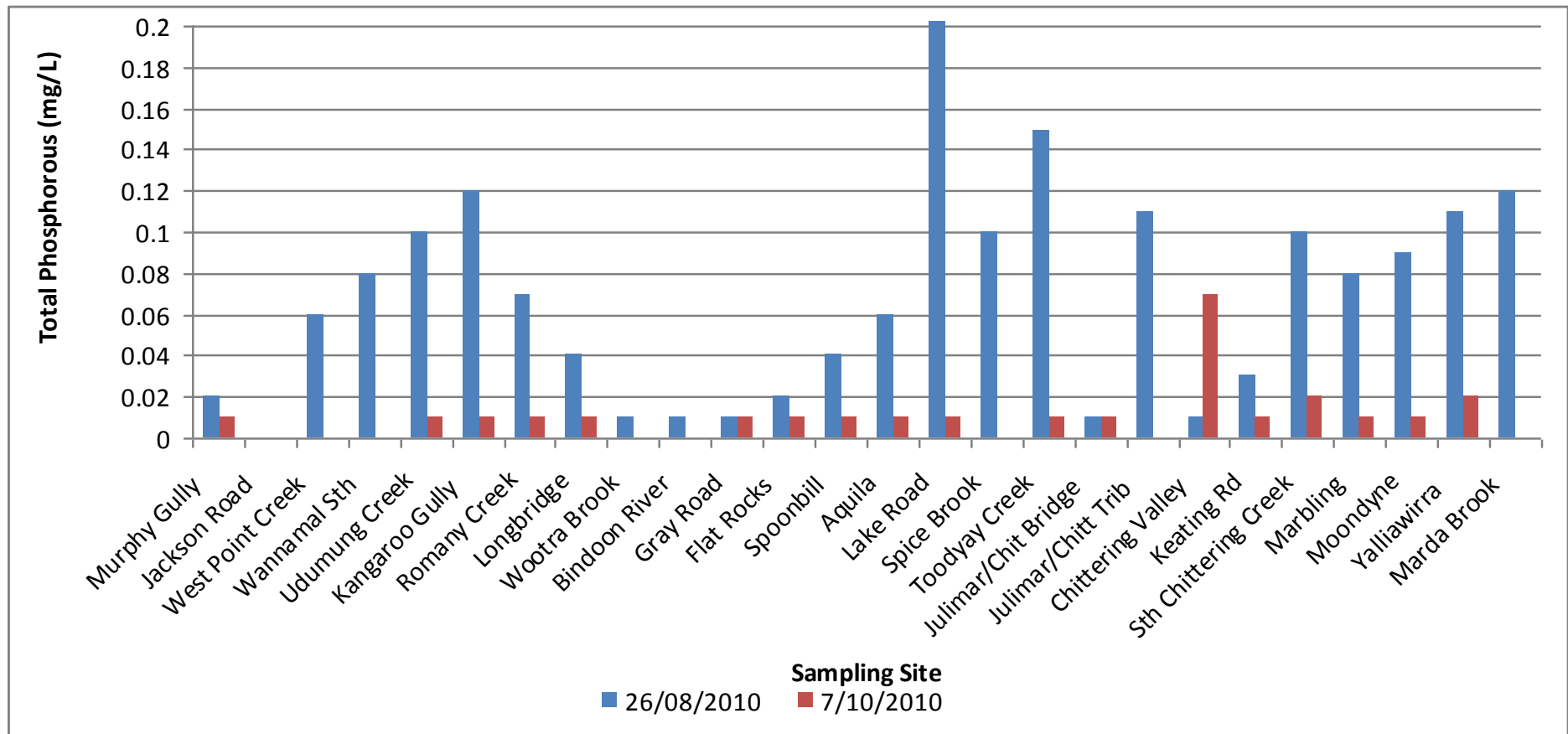
Duplex soils of sand over clay and loamy clays with high nutrient retention capabilities dominate on the Darling and Dandaragan Plateaus of the Brockman River catchment. These soils have a high nutrient retention capacity which reduces the level of nutrients entering the waterways other than through erosion and sedimentation (DEBCMP, 2001).

According to Russell (2001) it is storm events that trigger the hydrological pathways important for phosphorous loss. Export of phosphorus during peak flow times can get up to 20 times higher than pre-storm levels in stream flow from an agricultural catchment. Most of the phosphorus exported from an area during

these periods of heavy rainfall and storm activity are in particulate form as it is carried primarily in sediment and soil as a result of rill, gully and sheet erosion. Because of this total phosphorous concentrations are generally higher at the beginning of the rainfall season when the creeks and rivers are experiencing the “First flush”. However this theory does not explain the pattern observed in 2012, as there was a very dry spell leading up to the October sampling occasion. Continued long term monitoring is recommended to gain an understanding of phosphorous export from this catchment.





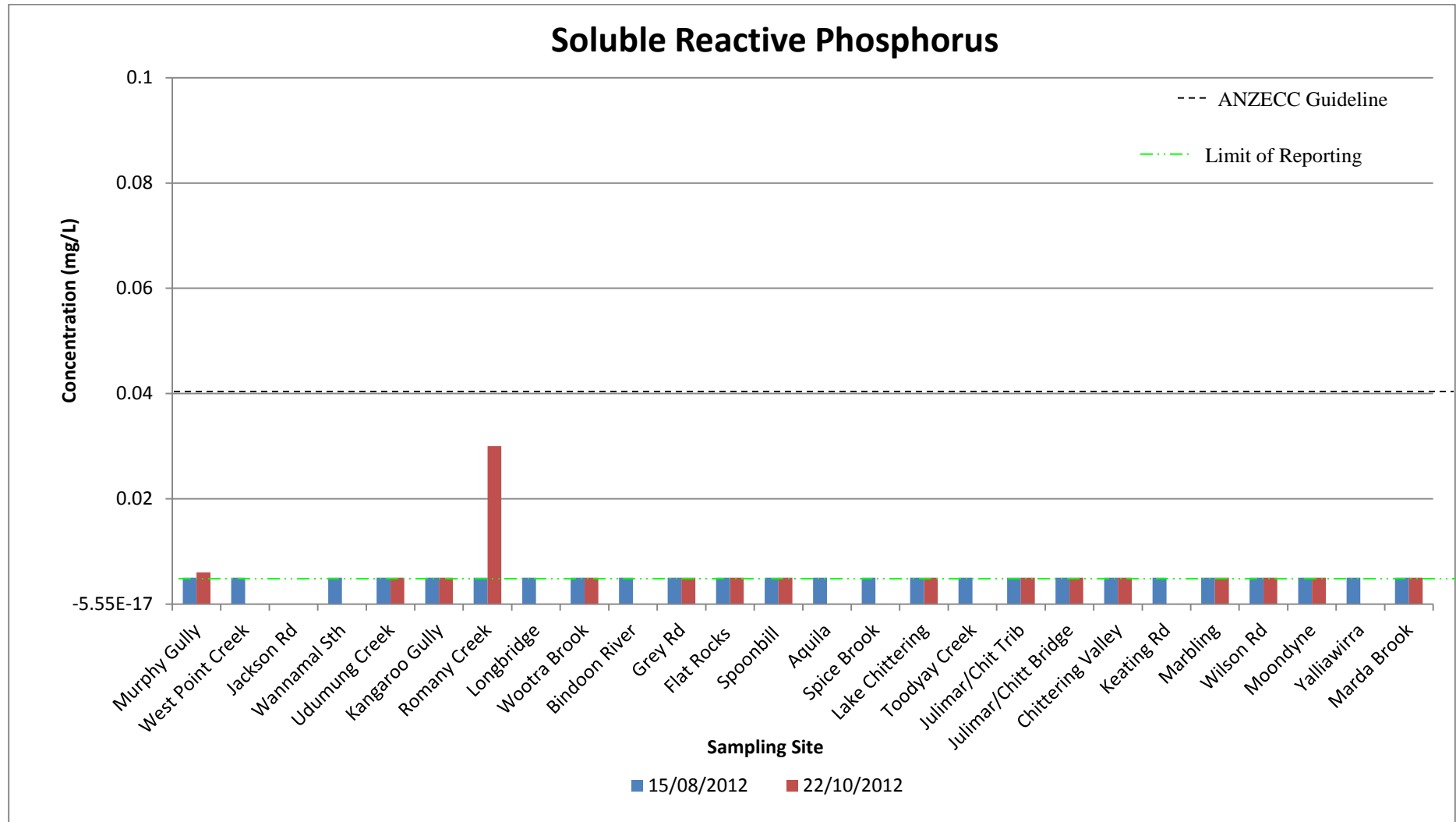


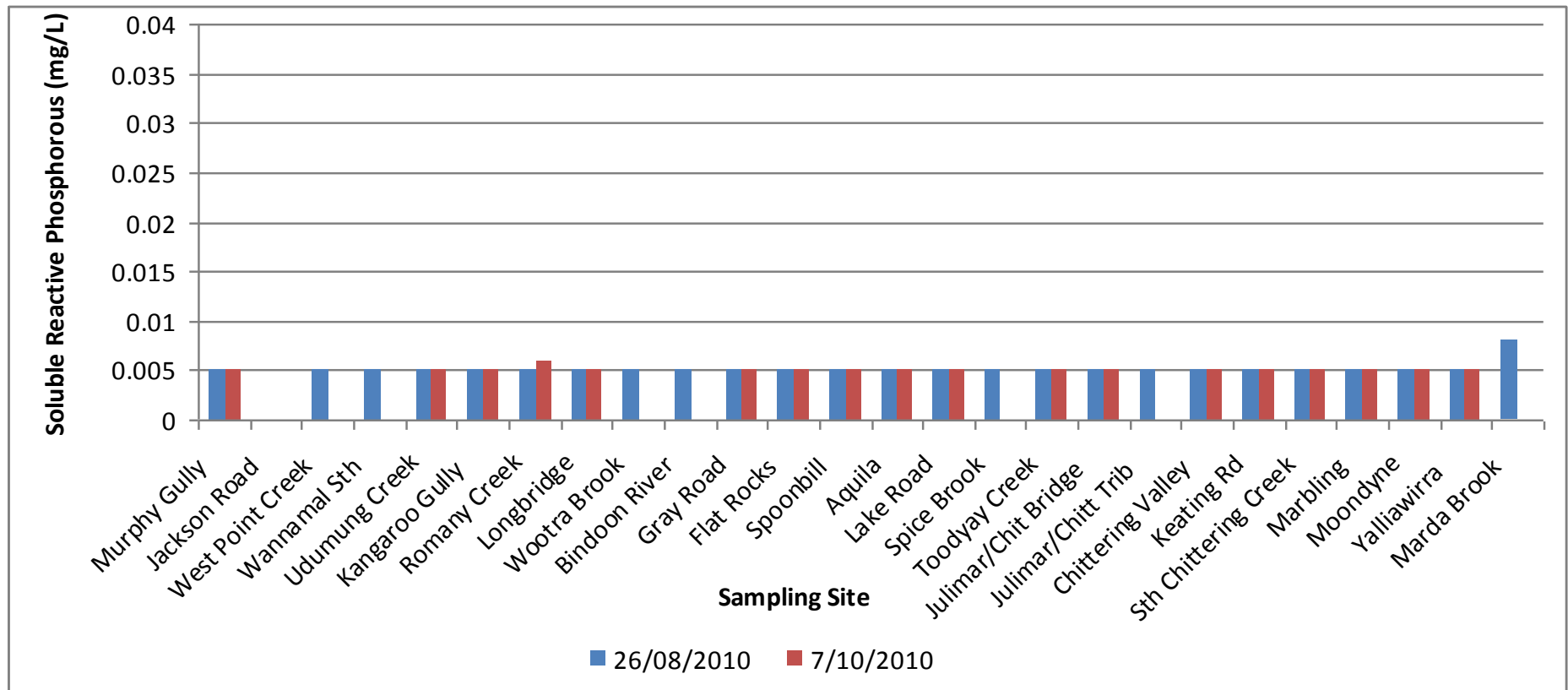
**Figure 15:** Total Phosphorous concentrations in surface water within the Brockman River catchment sampled on 5<sup>th</sup> August and 7<sup>th</sup> October 2012. \*note blanks represent no sample taken

#### 7.3.6. Filterable Reactive Phosphorous

Filterable reactive phosphorus (FRP) measures only the dissolved phosphorus in water and provides a measure of the immediately available phosphate in the system at the time of sampling; it is also referred to as  $\text{PO}_4$ . As this form of phosphorus is readily available it is more likely to stimulate algal blooms and this can lead to more decaying vegetation which alters river characteristics including elevated temperature, reduced oxygen and fish kills. This nutrient enrichment process is known as eutrophication (McTaggart, 2002).

SRP concentrations in surface water within the Brockman catchment were well below the ANZECC water quality guideline for lowland river systems value of 0.04mg/L and below the Limit of Reporting (LOR) at all sampling sites on both sampling occasions. Romany Creek (BRN7) was the only site to approach occasion, the rest were near or under the limit of reporting value except for Marda Brook (BRN26) with a value of 0.008 mg/L and Romany creek with a value of 0.006mg/L (LOR is 0.005mg/l) (Figure 16).





**Figure 16:** Filterable Reactive Phosphorous concentrations in surface water within the Brockman River catchment sampled on 526<sup>th</sup> August and 722<sup>nd</sup> October 2012. \*blanks represent no sample taken

#### **7.4.     *Metals in surface water***

Metals are usually found naturally in aquatic ecosystems; however, in excessive amounts they are associated with toxicity and pollution. They are derived from a variety of sources such as industrial waste, refuse leachate, corrosion of pipes and roofs (McTaggart, 2002). The most common sources of metal contaminants in the Brockman are pesticides and fertiliser application. Copper, zinc and cadmium in particular are often found in fertilisers. In the Brockman catchment most metals would enter the river via surface water run-off and groundwater contamination.

Aquatic organisms have varying tolerance levels to different metals. Metals that are essential for growth can become toxic to aquatic organisms at levels beyond their tolerance. This may only be slightly higher than normal concentrations. Metals may also accumulate in fatty tissues of animals and in the human body, so repeated exposure to heavy metals can cause levels to build up to a toxic level (IEA 2003). This is known as “bioaccumulation”.

Biomagnification can result in animals at the top end of the food chain accumulating a high concentration of heavy metals even if the organisms consumed at lower levels of the food chain have acceptable levels of heavy metals. Tolerance levels of aquatic organisms to heavy metals and ability to absorb those metals can be influenced by many factors including; interaction with other metals and formation of organic complexes (e.g. with organic carbon compounds), the chemical form of the metal, dissolved oxygen levels, salinity levels, temperature and the hardness of the water.

Metals were sampled for at seven strategically identified sites including Spoonbill 13 Spoonbill (BRN13), Aquila (BRN14), Lake Road (BRN15),

South Chittering Creek (BRN22), Marbling Brook (BRN23), Yalliwirra (BRN25) and Gray Road (BRN27) in August and October 2012.

In 2006 and 2007, heavy metal concentrations in the waters of the Brockman River catchment were well below the ANZECC guideline and Hardness-Modified Trigger Values apart from on one occasion. These heavy metals included aluminium, arsenic, iron, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc.

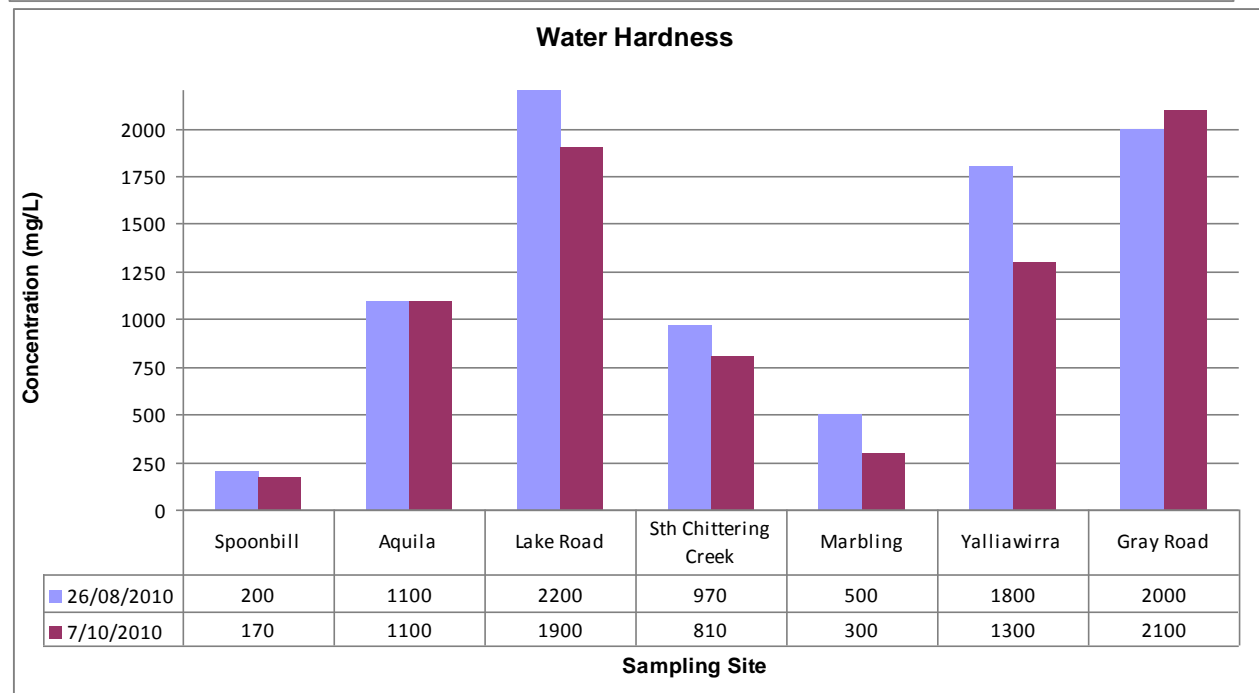
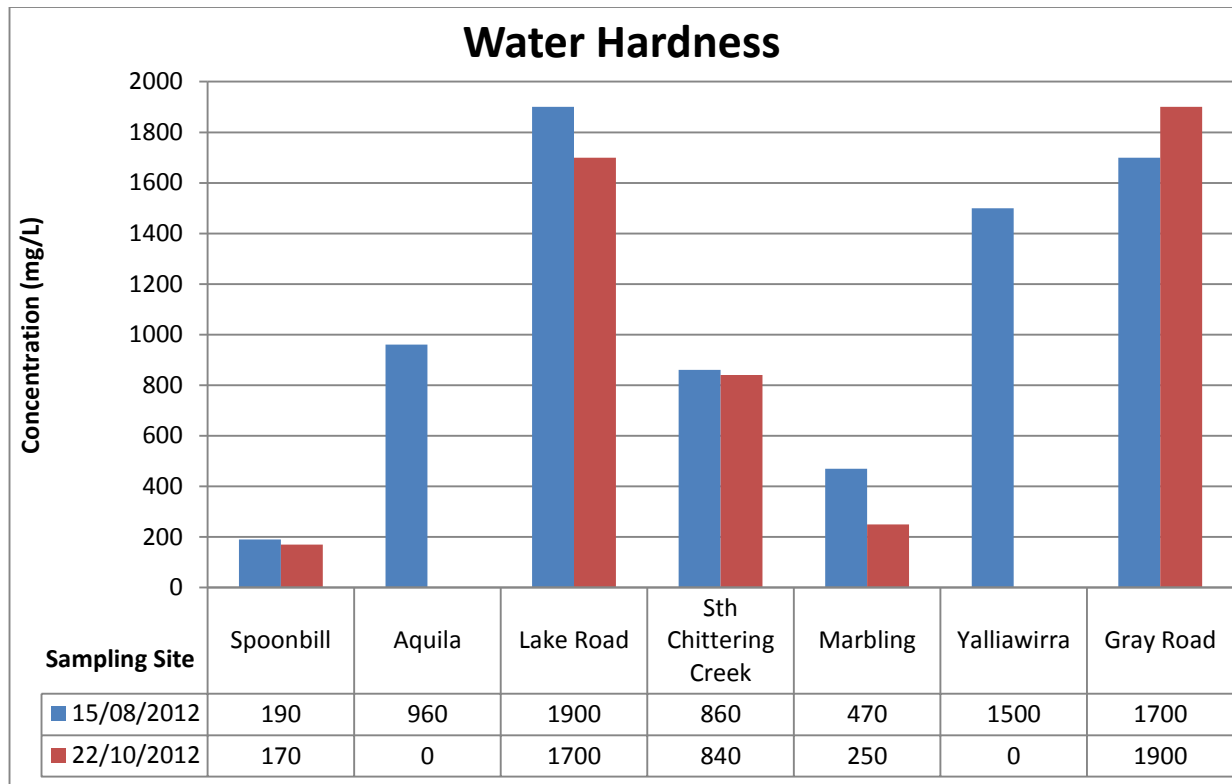
From 2008 to 2012, there have been many more results that are over the ANZECC guidelines for the various metals. Aluminium and Iron have recorded values above the guideline more so than the other metals. The elevated concentrations of these metals could be a result of surrounding land use and practices including fertiliser application, soil erosion carrying heavy metals to the waterways, groundwater contamination and sub-surface flow, and the natural occurrence of these trace elements in the soil. Water hardness affects the toxicity of the heavy metals in the environment. (Appendix A).

Sites which have been tested since 2006 include Udumung (BRN5), Spoonbill (BRN13), Aquila (BRN14), Lake Rd (BRN15), Julimar/Chittering Tributary (BRN19), Chittering Valley (BRN20), Keating Rd (BRN21), South Chittering Creek (BRN22), Marbling (BRN23), Moondyne (BRN24), Yalliwirra (BRN25), Marda Brook (BRN26), and Gray Rd (BRN27).

#### 7.4.1. Hardness

Total hardness, expressed as calcium carbonate ( $\text{CaCO}_3$ ), is the combined concentration of alkali-earth metals, predominantly magnesium ( $\text{Mg}^{2+}$ ) and calcium ( $\text{Ca}^{2+}$ ), and some strontium ( $\text{Sr}^{2+}$ ). The source of this hardness is possibly through the weathering of granite. Hardness levels range from <60mg/L (soft) to >400 mg/L (extremely hard).

Water hardness can have an ameliorating effect on the toxicity of some heavy metals including cadmium, copper, zinc, lead, nickel and chromium, as the calcium and carbonate ions compete directly for the same uptake pathways as these metals. Water samples with higher concentrations of water hardness need to have the trigger values for these metals adjusted by a hardness-dependent algorithm or the approximate factors applied to soft water trigger values of varying water hardness provided in ANZECC and ARMCANZ (2000), (Appendix D). Refer to Table 5 for the calculated Hardness-Modified Trigger Values (HMTV) for cadmium, copper, chromium, lead, nickel and zinc. Hardness ranged between 170170mg/L at Spoonbill LakeSpoonbill (BRN113) – very hard, and 92200mg/L at Lake Road (BRN15) and Gray Rd (BRN27) – extremely hard (Figure 17).



**Figure 17:** Water Hardness sampled from surface waters within the Brockman River catchment on 5<sup>th</sup> August and 722<sup>nd</sup> October 20102.

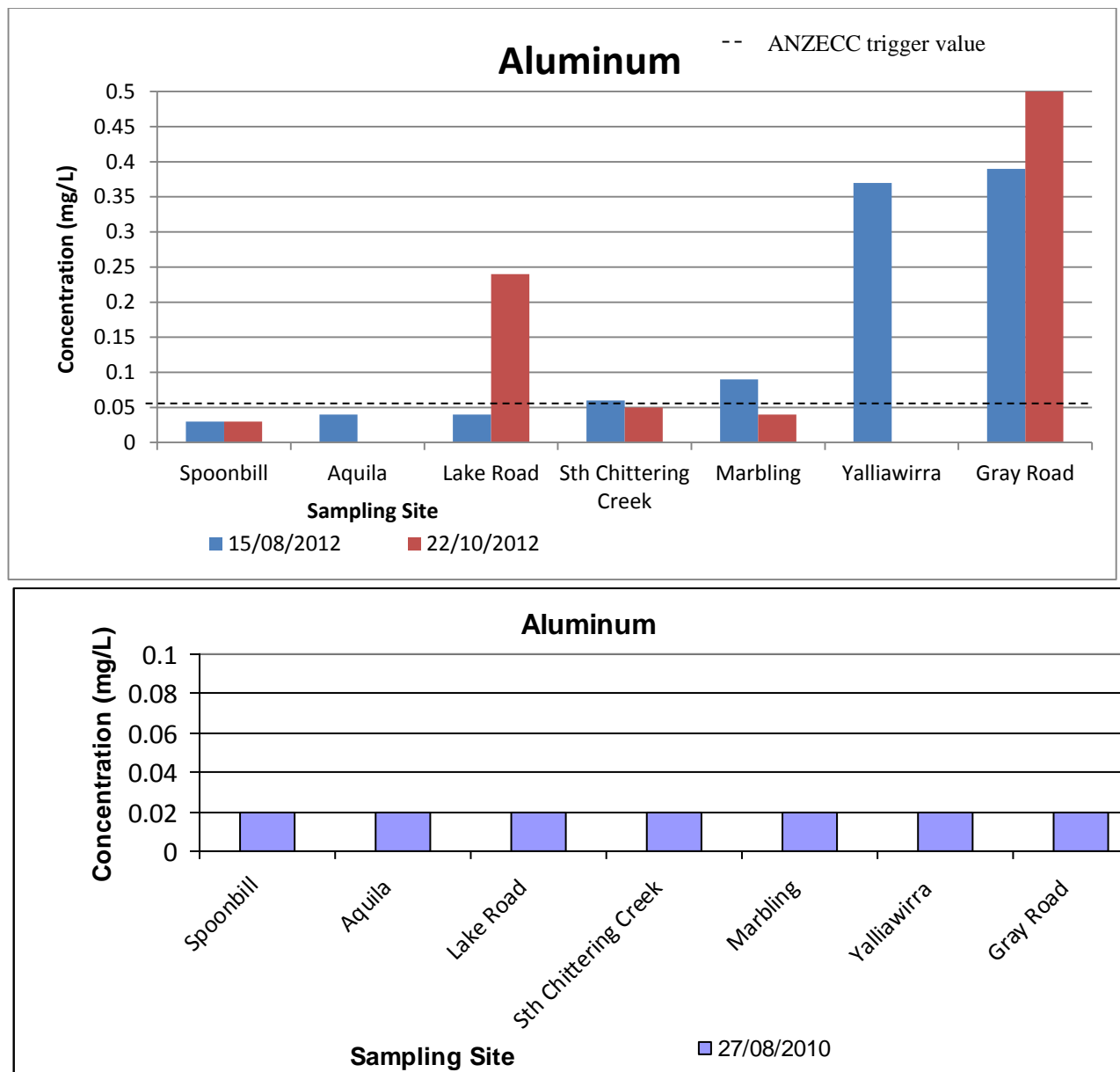
**Table 5:** Hardness-Modified Trigger Values (HMTV) for Cadmium, Copper, Chromium, Lead, Nickel and Zinc based on Figure 17 and Appendix D calculations.



| <b>Metal</b> | <b>ANZECC<br/>Trigger Value</b> | <b>HMTV for<br/>very hard<br/>water (180 –<br/>240).</b> | <b>HMTV for<br/>extremely<br/>hard water<br/>(250 -<br/>&gt;400mg/L)</b> |
|--------------|---------------------------------|--|--|
| Cadmium      | 0.0002                          | 0.0011   | 0.002  |
| Copper       | 0.0014                          | 0.0072   | 0.0126   |
| Chromium     | 0.001                           | 0.005  | 0.0084   |
| Nickel       | 0.011                           | 0.057  | 0.099  |
| Lead         | 0.0034                          | 0.04   | 0.09   |
| Zinc         | 0.008                           | 0.04   | 0.07   |

#### 7.4.2. 7.4.2 Aluminium

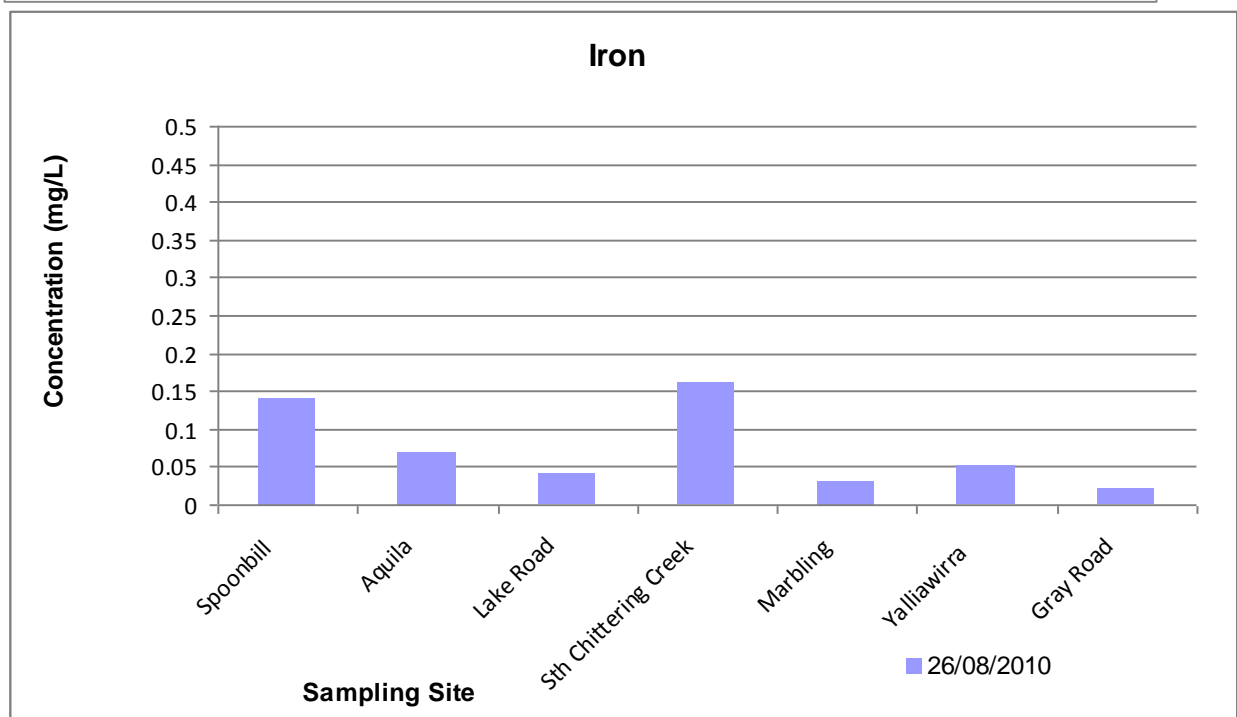
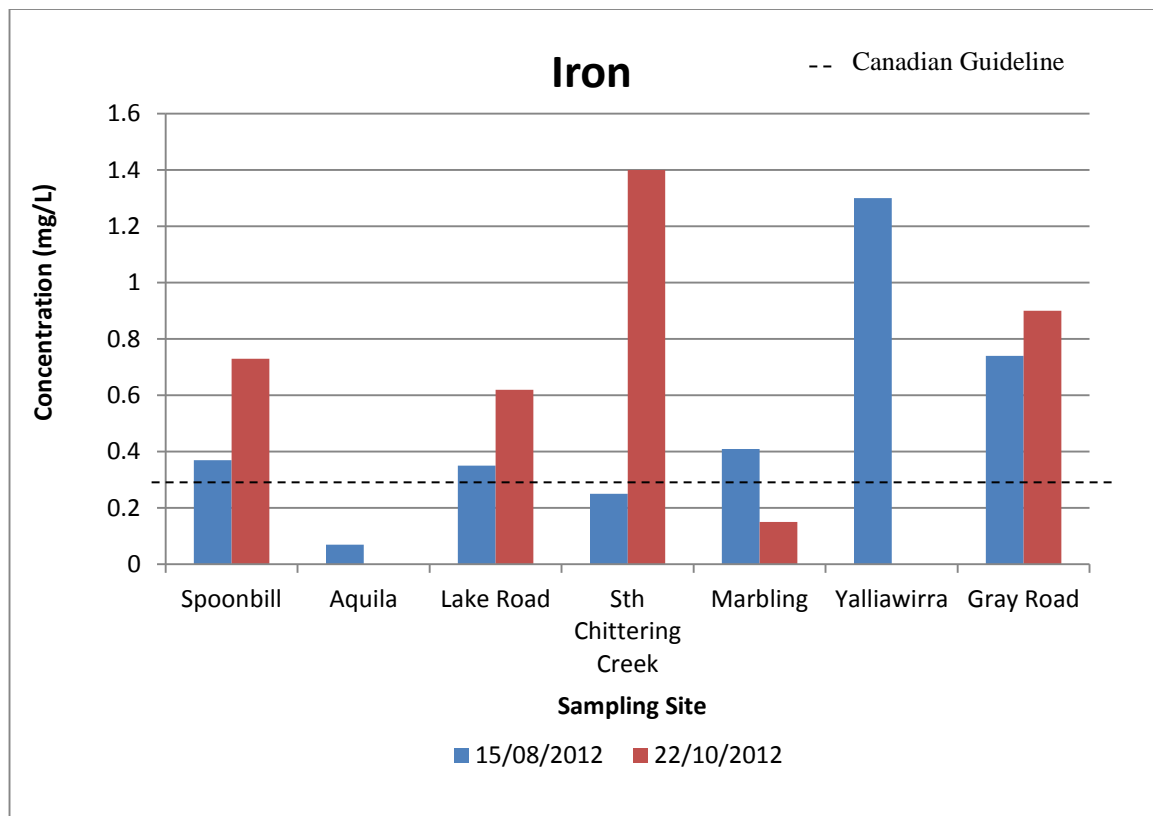
South Chittering Creek (BRN22), Marbling (BRN23), Yalliwarra (BRN25) and Gray Rd (BRN27) were above the ANZECC guideline of 0.055mg/L on the August sampling occasion (Figure 18). Lake Rd (BRN15) and Gray Rd (BRN27) exceeded the guideline on the October sampling occasion. In fact no site even reached the limit of reporting for Aluminium which is 0.02mg/L. occasion the samples were not analysed for aluminium due to a miscommunication with the laboratory.



**Figure 18:** Aluminium concentrations in surface water within the Brockman River catchment on the 526<sup>th</sup> August 22<sup>nd</sup> 22010.

#### 7.4.3. Iron

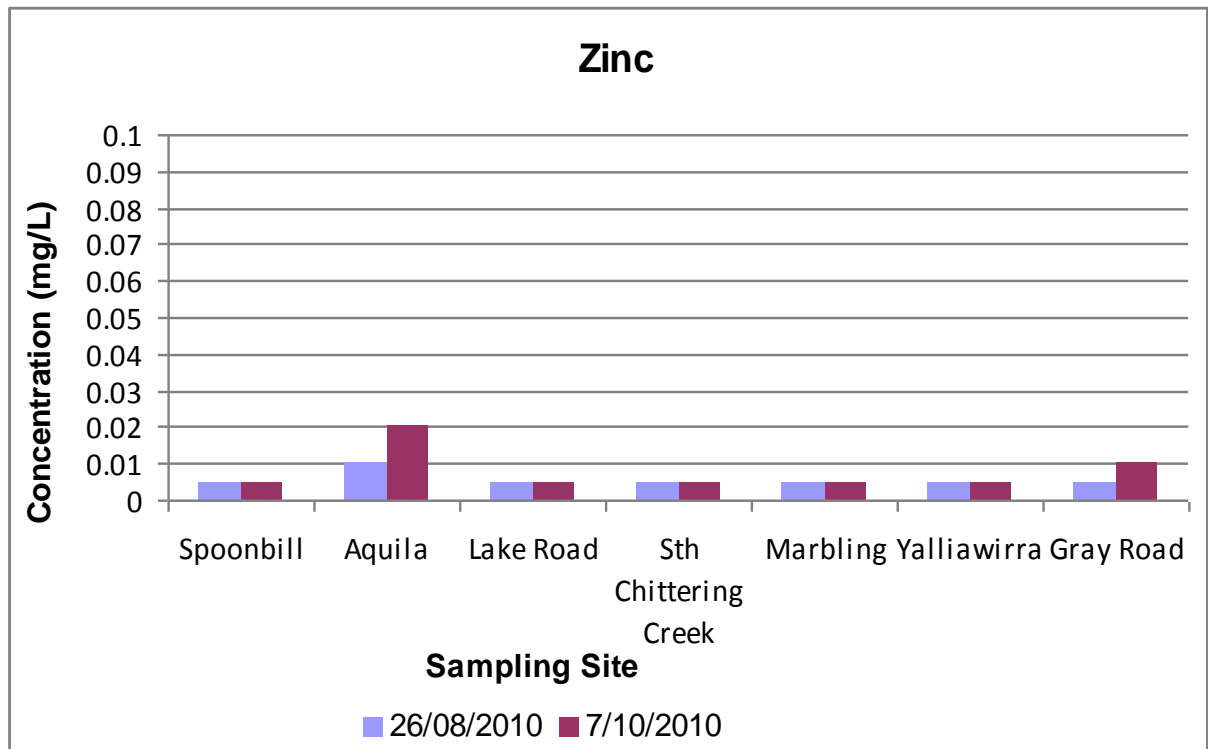
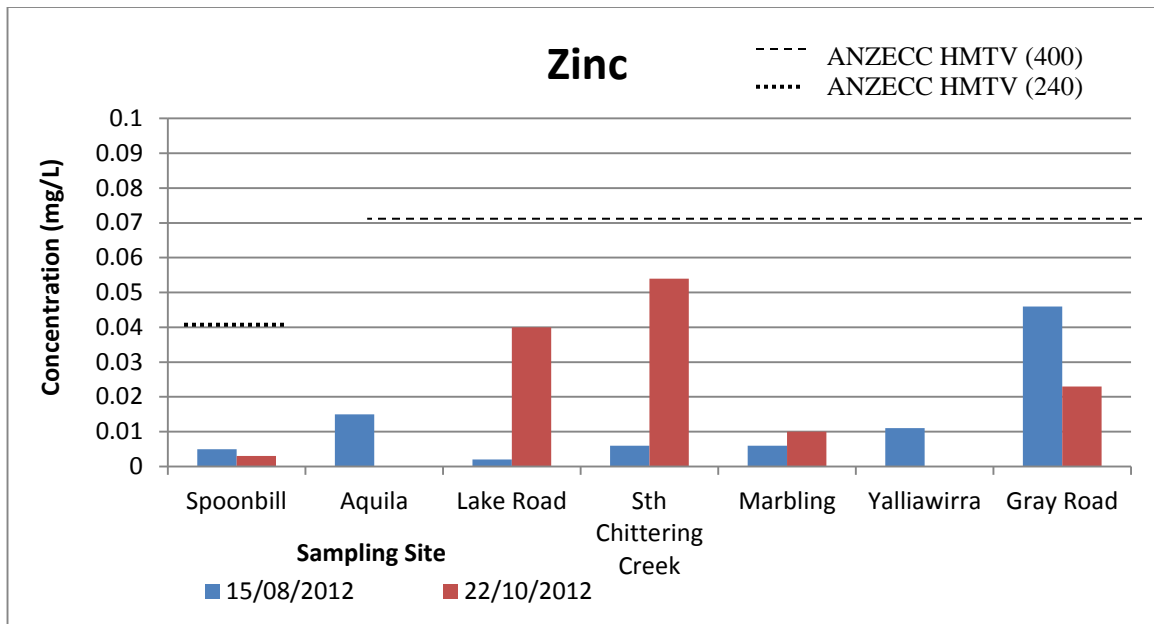
There is no ANZECC guideline trigger value or environmental concern level (ECLs) available for iron in fresh water as a result of insufficient data (ANZECC and ARMCANZ, 2000). Only Aquila (BRN14) and South Chittering Creek (BRN22) recorded iron concentrations below the current Canadian guideline of 0.3mg/L on the August sampling occasion (Figure 19). This guideline is advised by the ANZECC water quality guidelines to be used as an interim indicative working level for aquatic ecosystems and requires further monitoring. Marbling (BRN23) was the only site to record a Iron concentration below the guideline on the October occasion.



**Figure 19:** Iron concentrations in surface water within the Brockman River catchment on the 15<sup>th</sup> of August and the 22<sup>nd</sup> August 2012.

#### 7.4.4. Zinc

All sites were below the Hardness Modified Trigger Values (HMTV) of 0.07mg/L for sites with extreme water hardness: Aquila Reserve (BRN14); Lake Road (BRN15), South Chittering Creek (BRN22), Marbling Brook (BRN23), Yalliwirra (BRN25) and Grey Road Bridge (BRN27), and 0.04mg/L for Spoonbill (BRN1313) with very hard water, during both sampling occasion, (Figure 20).



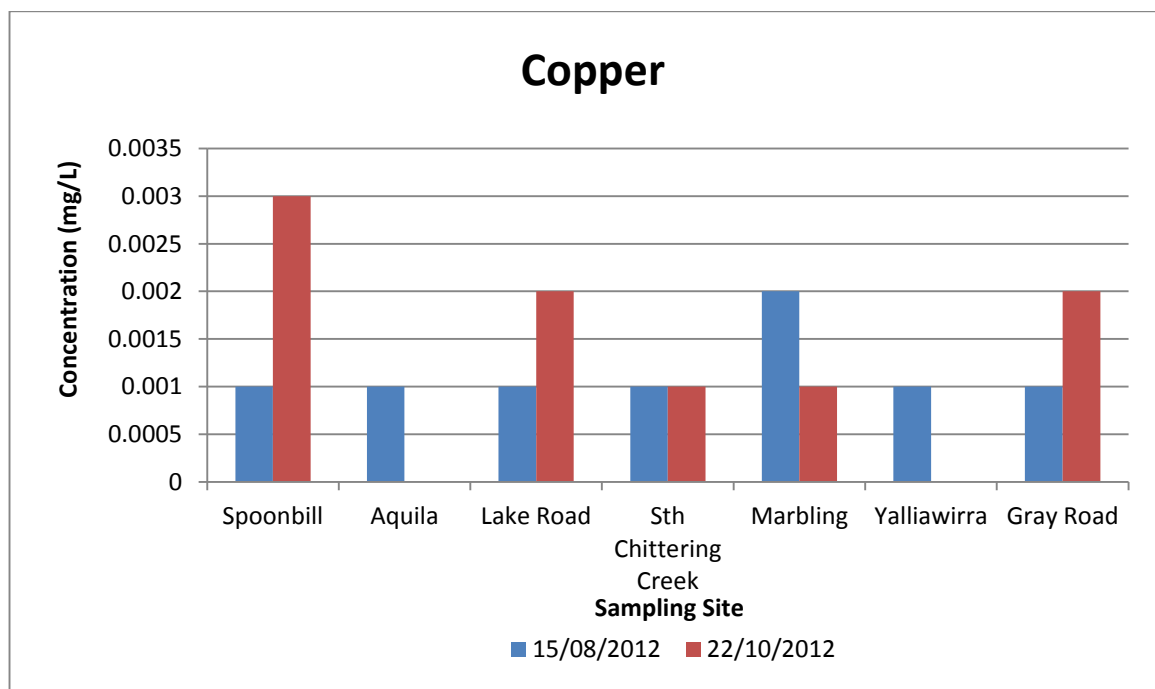
**Figure 20:** Zinc concentrations in surface water within the Brockman River catchment on the 526<sup>th</sup> August and 22<sup>nd</sup> October 20102.

#### 7.4.5. Copper

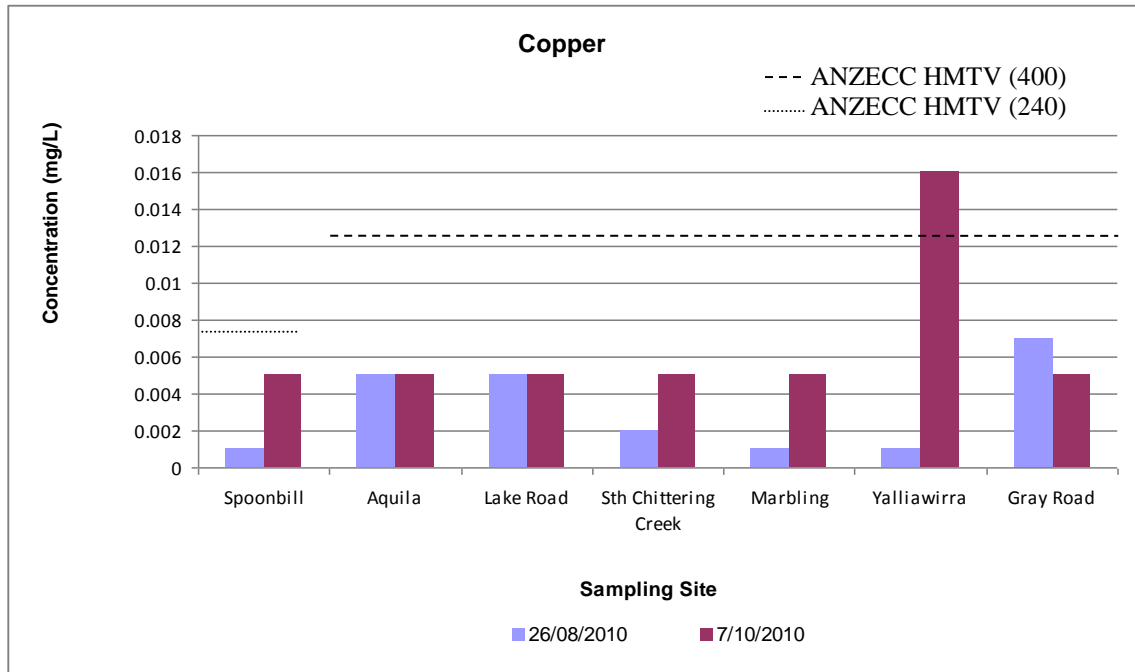
All sites were well below the hardness-modified trigger values (HMTV) of 0.0072mg/L for very hard water and 0.0126mg/L for extremely hard water most (0.001mg/L) , except Yalliwirra (BRN25) on the October sampling occasion with a concentration of 0.016mg/L, which exceeds the HMTV(Figure 21). Yalliwirra also exceeded the ANZECC trigger value of 0.0014mg/L for freshwater.

All sites are however well below the recommended ANZECC trigger values for livestock, which are 0.5mg/L for sheep, 1mg/L for cattle, and 5mg/L for pigs and poultry (low risk) in livestock drinking water on all sampling occasions.

Copper is used in building material, electrical and heat conductors, and in household products. It is also an essential trace element; however in sufficient amounts it can be toxic.





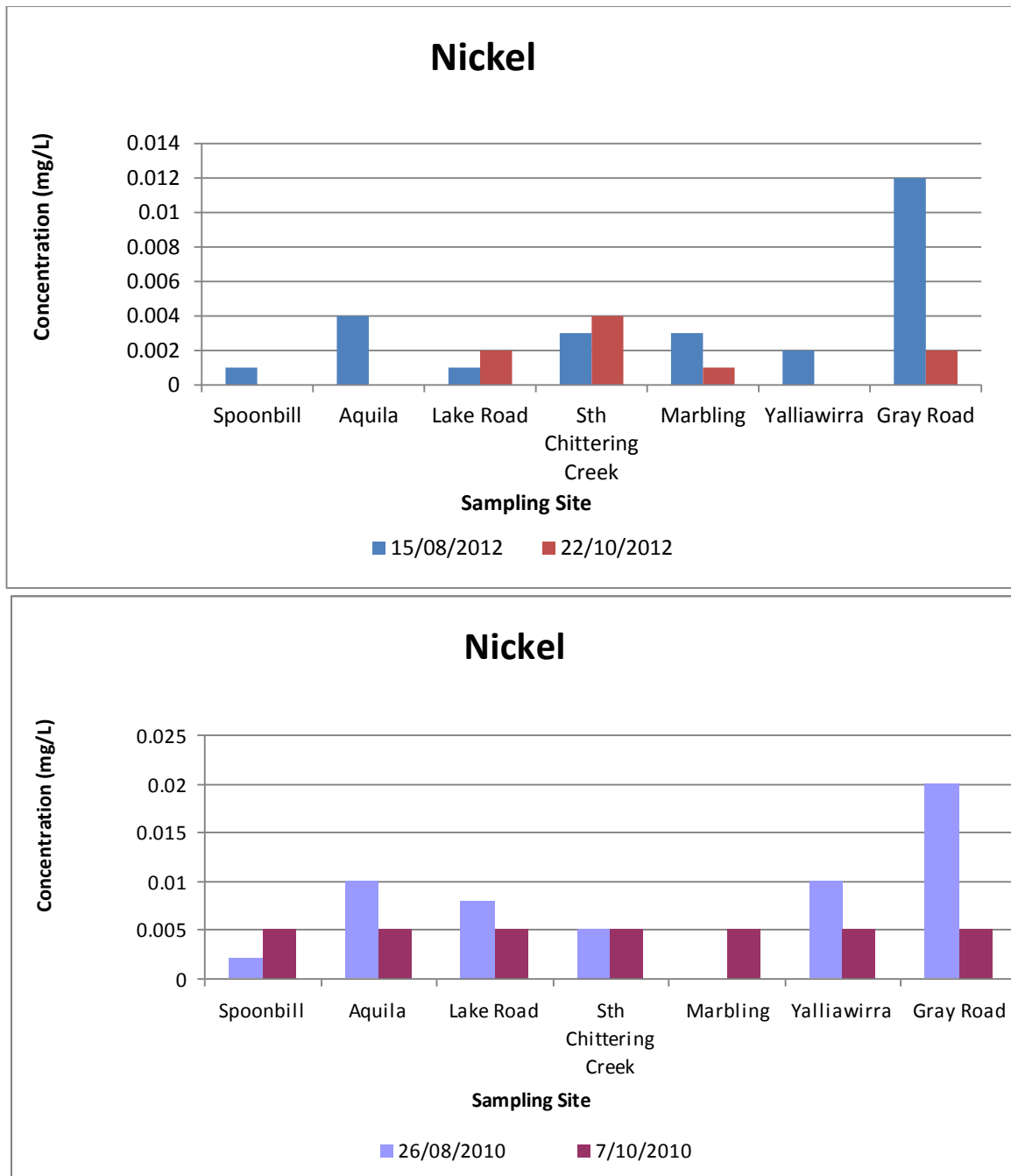


**Figure 21:** Copper concentrations in surface water within the Brockman River catchment on the 5<sup>th</sup> August and the 22<sup>nd</sup> October and 7<sup>th</sup> October 20102.

#### 7.4.6. Nickel

All sites were well below the hardness-modified trigger values (HMTV) of 0.057mg/L for very hard water and 0.099mg/L for extremely hard water. Grey Rd Bridge (BRN27) was above the ANZECC guideline of 0.011mg/L for fresh water in the south west of Western Australia on the August sampling occasions (Figure 21). It is important to note that nickel concentrations in livestock drinking water greater than 1mg/L may have adverse effects on animal health (ANZECC and ARMCANZ, 2000). The levels recorded in the Brockman are well below this guideline on all sampling occasions.

The concentration of nickel in natural waters is usually below 0.01 mg/L unless it has been contaminated by either corrosion of nickel plated plumbing, industrial waste or fallout from burning of fossil fuels.



**Figure 22:** Nickel concentrations in surface water within the Brockman River catchment on the 526<sup>th</sup> August and 22<sup>nd</sup> October 2012.

#### 7.4.7. Other Metals

Chromium (Cr), Arsenic (As), Lead (Pb) and Mercury (Hg) all recorded concentration levels below the relative limits of reporting (LOR) and ANZECC Trigger Values on both sampling occasions. However, cadmium (Cd) recorded a concentration of 0.0283mg/L at Grey Rd (BRN27) during the August sampling occasion. This is three times the ANZECC guideline and HMTV of 0.00842mg/L. This does not show up higher or lower in the river, so the source may come from a local drain. This will be continued to be monitored to identify whether this is a trend or a one off result.

## **8. Comparison with previous results**

The Brockman River Catchment Water Quality Monitoring Snapshot September 2006, was the first snapshot developed by EBICG for this catchment. Conductivity data of the sampling sites listed in Table 6 have been collected on a regular basis since 2006 by officers at the Chittering Landcare Centre. This data was collected using WTW EC meters and represents the water quality at the time of sampling only. This provides some certainty in comparing the data over the years of sampling. Table 6 provides the salinity (conductivity) of the subcatchments within the Brockman River catchment between 2006 and 2011.

Table 6: Sub catchment salinity measurement based on six years of data between 2006 and 20102.

| Site Name                          | Salinity Measurement       |
|------------------------------------|----------------------------|
| BRN1 Murphy Gully Road             | Saline                     |
| BRN2 Jackson Road                  | Brackish-Saline            |
| BRN3 West Point Creek              | Brackish-Saline            |
| BRN4 Wannamal South                | Brackish                   |
| BRN5 Udumung Creek                 | Brackish- Saline - Saline  |
| BRN6 Kangaroo Gully Creek          | - SalineSaline             |
| BRN7 Romany Creek                  | Brackish - Saline          |
| BRN8 Longbridge Creek              | Brackish - Saline          |
| BRN9 Wootra Brook                  | Brackish - Saline          |
| BRN10 Bindoon River                | Brackish                   |
| BRN11 Cresthill Road               | Brackish                   |
| BRN12 Flat Rocks Creek             | Brackish - Saline          |
| BRN13 Spoonbill Lake               | Marginal                   |
| BRN14 Aquila                       | Brackish                   |
| BRN15 Lake Road                    | Brackish - Saline          |
| BRN16 Spice Brook                  | Brackish                   |
| BRN17 Toodyay Creek                | Brackish                   |
| BRN18 Julimar/Chittering Bridge    | Brackish - Saline - Saline |
| BRN19 Julimar/Chittering Tributary | Brackish – Saline          |
| BRN20 Chittering Valley            | Marginal-Brackish          |
| BRN21 Keating Road                 | Brackish                   |
| BRN22 South Chittering Creek       | Marginal - Brackish        |
| BRN23 Marbling Brook               | Marginal-Brackish          |
| BRN24 Moondyne                     | Brackish                   |
| BRN25 Yalliwirra                   | Brackish                   |
| BRN26 Marda Brook                  | Marginal                   |
| BRN27 Grey Road Bridge             | Brackish- Saline           |

NB: The ANZECC guideline for conductivity in Lowland Rivers is 0.12mS/cm to 0.3mS/cm.

As stated in previous 'Water Quality Snapshots', there has been a steady increase in the salinisation of waterways within the Brockman River catchment over the past six years. Table 6 shows a direct relationship between salinity and location in the catchment where the sample has been taken. Northern sampling sites have been affected the most by salinity over the years and as the river flows southwards and receives more inflow from fresh tributaries, salinity appears to reduce (Table 6). However, without flow estimates load cannot be calculated so it is difficult to pinpoint areas of high salt input within the catchment and subsequent sites for remediation works (Angell, 2000). however further monitoring in 2011 will be crucial to confirm this increases are to do with dilution rather than an increase in salt in the catchment.

pH levels in the Brockman River catchment appear to remain relatively stable, although slightly alkaline, over the years of sampling.

Nutrient concentrations in the Brockman River catchment are generally not of concern; however concentrations of Total Nitrogen (TN), Total Oxidised Nitrogen ( $\text{NO}_x\text{-N/TON}$ ), Filterable Organic Nitrogen, Ammonia ( $\text{NH}_3\text{N}$ ), and Total Phosphorous (TP) have been recorded at various sites above the ANZECC guidelines on a number of sampling occasions. This should continue to be monitored to determine whether or not the Brockman River catchment is contributing significant levels of nutrients to the Avon/Swan River.

## 9. Recommendations

- Continue the sampling and analysis monitoring program within the Brockman River catchment and add new sampling sites where nutrient transport or salinity is expected to be significant, or to increase the number of sampling events as funding permits.
- Identify areas of future rehabilitation, revegetation and waterway protection based on the results of the sampling program.
- Identify subcatchments which contribute significant amounts of saline water, nutrients or metals to the Brockman River, determine possible causes and conduct remediation works.
- Subcatchments have been prioritised according to water quality, surrounding land use, and influence on their immediate environment. See table below. Sub catchment scale monitoring/progress reports will be conducted on one priority sub catchment per year, commencing with priority 1 (Spoonbill) and working towards priority 14 (Keating). It is the aim of these reports to compliment existing water quality monitoring snapshots; utilise monitoring data to determine existing trends over the years of sampling; to determine the impacts of on-ground works and monitor their success; and to provide detailed information on the priority subcatchments of the Brockman River catchment.

| Priority | Sub-catchment    |
|----------|------------------|
| 1        | Spoonbill        |
| 2        | Marbling         |
| 3        | Udumung          |
| 4        | West Point       |
| 5        | Flat Rocks       |
| 6        | Blue Plains      |
| 7        | Chittering Creek |
| 8        | Marda Brook      |
| 9        | Murphy Gully     |
| 10       | Romany Creek     |
| 11       | Kangaroo Gully   |
| 12       | Longbridge       |
| 13       | Wootra           |
| 14       | Keating          |



## 10. References

Allen, G.R. Midgley, S.H. & Allen, M. (2002) *Field guide to the freshwater fishes of Australia*. Western Australian Museum, Perth.

Angell, K. (1997). *Salinity survey in the Shire of Chittering*. Agriculture Western Australia.

ANZECC and ARMCANZ (2000). *National Water Quality Management Strategy: Australia and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

Australian Bureau of Statistics. (2001). *Shire of Chittering: a profile of the local government area*. Australian Bureau of Statistics, Western Australian Office. Commonwealth of Australia.

Aquatic Research Laboratory. (2005). *Ecological Water Requirements of the Marbling Brook – Intermediary Assessment*. School of Animal Biology, University of Western Australia, Perth, Western Australia.

Banfield, K. (2001). *Management Strategies for Nutrient and Sediment Loss in the Ellen Brook Catchment: With an Introduction to constructed wetlands*. Department of Agriculture. Western Australia.

Berowra Catchment Management Committee. (1997). *Berowra Creek Water Quality Management Strategy*. Department of Urban Affairs and Planning. New South Wales.

Booth, C.A. (1999). *Guide to good water*. Clean Up Australia Ltd. Glebe, New South Wales.

Bureau of Meteorology (2011) *Rainfall data*. [www.bom.gov.au](http://www.bom.gov.au) (accessed February 2011)

Buchanan, B. (1997). *Wannamal: a history*. Curtin University of Technology, Perth.

Buchanan, B. (2000). *Chittering: exploration to shire*. Curtin University of Technology, Perth.

Chittering Landcare Group. (2009). *Bindoon Defence Training Area: Water Quality Monitoring Snapshot; August and October 2009*. (unpublished).

Churchward, H.M. and McArthur, W.M. (1980) *Landforms and soil of the Darling system, Western Australia, Atlas of resources Darling system, Western Australia*. Department of Conservation and Environment, Perth.

Connell, S. (2006) *Remnant Vegetation Study of the Brockman River Catchment*. (unpublished)

Connell, S., & Ebert, M. (2001) *Vegetation in the Brockman River catchment*. (unpublished)

Conservation and Land Management. (1999). *Interim guidelines for nature reserves in the Shire of Chittering*. CALM, Mundaring.

Cook, D. & Hatherly, C. (1997). *Agriculture statistical overview 96/97 - Shire of Chittering*. Sustainable Rural Development Program. Agriculture Western Australia.

Coorong & Districts Local Action Plan Steering Committee. (1997). *Coorong and districts local action plan. Protecting agriculture and natural resources*. Coorong District Council. South Australia.

Department of Defence. (1998) *Environmental management plan: Bindoon training area*. Department of Defence Infrastructure division, Fremantle. Western Australia.

*Draft Ellen Brook Catchment Management Plan (DEBCMP)*. (2001). PPK Environment and Infrastructure (Australia) Pty Ltd.

Ellen Brook Integrated Catchment Group (EBICG) (2000). *Ellen Brook Catchment Management Plan*. Draft. PPK environment and Infrastructure (Aust) Pty Ltd. Perth.

Environment Australia (2001) *A directory of important wetlands in Australia. 3<sup>rd</sup> Edition*. Department of the Environment and Heritage, Canberra.

Environmental Protection Authority (2002). *Revised Environmental Quality Criteria Reference Document (Cockburn Sound) – a supporting document to the draft Environmental Protection (Cockburn Sound) Policy 2002*.

Environmental Protection Authority (2002). *Revised Draft Environmental Protection (Cockburn Sound) Policy 2002 – report to the minister for the environment as required under section 28 of the Environmental Protection Act, 1986*.

Evangelisti and Associates (1998). *Environmental input into Structure, land capability and catchment management within the Ellen Brook catchment and*

*surrounds. Shire of Chittering land capability and management study. Part 1: Working paper and Part 2: Study report..* Western Australian Planning Commission. Perth.

Frapple, P.A. (1975). *Land use and water quality survey of the Pacminex lease area.* Department of Agriculture, Western Australia.

Fulwood, Z. (2001) *The identification and amelioration of salinity in the Brockman River catchment.* Honours thesis, University of Western Australia.

Graham, D. (2001) *The Brockman River Valley - an area of abundance for at least 38,000 years.* Unpublished.

Hedde, E.M., Loneragan, O.W., & Havel, J.J. (1980) Vegetation complexes of the Darling system, Western Australia. In *Atlas of natural resources, Darling System, Western Australia.* Department of Conservation and Environment, Perth, Western Australia. pp 37-72.

Horwood, W. (1997). *Snapshot of Water Quality in Ellen Brook October 1996: Prepared for the Ellen Brook Integrated Catchment Group and Swan River Trust.* Swan River Trust. Western Australia.

IEA (Institute of Engineers Australia) (2003). *Australian Runoff Quality Guidelines (Draft).* Institute of Engineers Australia, Australia.

Kellogg, Brown & Root Pty Ltd (2003). *Water Study for the Shire of Chittering* Perth, Western Australia.

King, P.D. & Wells. M.R. (1990) *Darling Range rural land capability study.* Department of Agriculture, Perth, Western Australia

Lloyd, B. (2000). *Degradation in the Brockman River and Ellen Brook Catchments, Western Australia.* Department of Agriculture Western Australia. Perth.

Lovett, S. & Price, P. (Eds) (1999) *Riparian land management technical guidelines. Volume one: principals of sound management.* Land and Water Research Development Corporation (LWRRDC). Canberra.

Lovett, S. & Price, P. (Eds) (1999) *Riparian land management technical guidelines. Volume two: Legislation relating to riparian management.* Land and Water Research Development Corporation (LWRRDC). Canberra.

McTaggart A, 2002. *A Community Guideline to Surface Water Quality Investigations – Version 1.0.* Water and Rivers Commission Aquatic Science Branch.

Moore, G. (1998) *Natural Resources (Agriculture) – Situation statement for the Avon River Basin*. Agriculture Western Australia, on behalf of the Swan-Avon ICM and Central SRD program.

Morgan, D., Gill, H., & Potter, I. (1996) *The distribution of freshwater fish in the southwestern corner of Australia*. Report WRT4. Water and Rivers Commission. Perth.

Mount Lofty Ranges Interim Integrated Natural Resource Management Group. (2002). *Draft Integrated Natural Resource Management Plan for the Mount Lofty Ranges and Greater Adelaide Region*. Adelaide.

Meffe, G.K. & Carroll, C.R. (1994). *Principles of conservation biology*. Sinauer Associates. Sunderland, Massachusetts.

Oliver, K. (2001) *Shire of Chittering roadside vegetation management plan*. Honours Thesis, Curtin University of Technology.

Olsen, G. and Skitmore, E. (1991) *State of the rivers of the southwest drainage division*. Western Australian Water Resources Council.

Pen, L. J. (1999) *Managing our rivers. A guide to the nature and management of the streams of southwest Western Australia*. Water and Rivers Commission, Perth. Western Australia.

Pen, L.J. & Scott, M. (1999) *Foreshore condition assessment in farming areas of southwest Western Australia*. Report no. RR3. Water and Rivers Commission, Western Australia.

Porritt, S. (1974). *Land systems of the Brockman River catchment*. Department of Agriculture Western Australia.

Rutherford, I.D., Jerie, K. & Marsh, N. (2000). *A rehabilitation manual for Australian streams. Volume one*. Cooperative Research Centre for Catchment Hydrology. Department of Geography and Environmental Studies, University of Melbourne. Melbourne.

Rutherford, I.D., Jerie, K. & Marsh, N. (2000). *A rehabilitation manual for Australian streams. Volume two*. Cooperative Research Centre for Catchment Hydrology. Department of Geography and Environmental Studies, University of Melbourne. Melbourne.

Saunders, D.A. & Ingram, J.A. (1987) Factors affecting survival of breeding populations of Carnaby's cockatoo *Calyptorhynchus funereus latirostris* in remnants of native vegetation. In D.A. Saunders, G.W. Arnold, A.A. Burbridge

and A.J.M. Hopkins (Eds). *Nature conservation: the role of remnants of native vegetation*. Surrey Beatty and Sons, Sydney.

Shire of Chittering (2001) *Local planning strategy*. Bindoon, Western Australia.

Shire of Chittering (2001) *Town planning scheme number 6. District zoning scheme*. Bindoon, Western Australia.

Shire of Chittering (1999). *Planning strategy for the Shire of Chittering*. Bindoon, Western Australia.

Smith, G.T. (1987) The changing environment for birds in the southwest of Western Australia: some management implications. In D.A. Saunders, G.W. Arnold, A.A. Burbridge and A.J.M. Hopkins (Eds). *Nature conservation: the role of remnants of native vegetation*. Surrey Beatty and Sons, Sydney.

Storr, G.M., Smith, L.A., Johnstone, R.E. (1986) *Snakes of Western Australia*. Western Australian Museum, Perth.

Storr, G.M., Smith, L.A., Johnstone, R.E. (1990) *Lizards of Western Australia III: Geckos and Pygopods*. Western Australian Museum, Perth.

Swan Catchment Council (2002) *The Swan region- a natural resource management strategy*. Swan Catchment Council, Perth, Western Australia.

Swan River Trust. (1999). *Swan-Canning Cleanup Program. Action Plan*. Water and rivers Commission, Perth, Western Australia.

Tindale, N. (1974). *Aboriginal tribes of Australia*. University of California Press. Berkeley.

Water and Rivers Commission (2001) *Groundwater information and management options for the Brockman River catchment*. (unpubl.) Perth, Western Australia.

Waters and Rivers Commission (2000) Wilson Inlet report to the community. Summary of the Wilson Inlet catchment monitoring program. Waters and Rivers Commission and Wilson Inlet Management Authority, WA.

Water and Rivers Commission (2001) *Foreshore assessment of the Brockman River*. (unpubl.) Perth, Western Australia.

Water and Rivers Commission (1999) *A guide to the nature, protection, rehabilitation and long-term management of waterways in Western Australia*. Water and Rivers Commission River Restoration River Restoration Manual. Perth, Western Australia.

Water and Rivers Commission (2001) *Bremer River and Devil's Creek river action plan*. Water and Rivers Commission Management Series Report No. WRM 25. Perth, Western Australia.

Water and Rivers Commission (2000) *Water notes 1 to 29*. Water and Rivers Commission. Perth, Western Australia.

Water and Rivers Commission (2000) *Water facts 1 to 16*. Water and Rivers Commission. Perth, Western Australia.

Water and Rivers Commission (2003). *Natural Resource Management Plan for the Brockman River Catchment*. Water and Rivers Commission, Water Resource Management Series, No WRM 33.

Water Resources Directorate (1993) *Gingin groundwater area management plan*. Report No. WG160. Groundwater and Environment Branch. Water Authority of Western Australia. Perth.

Weaving, S. (1999). *Native vegetation handbook for the Shire of Toodyay*. Spatial Resource Information Group. Agriculture Western Australia and Greening Western Australia.

Western Australian Planning Commission (1999) *Draft Avon Arc sub-regional strategy. Urban services and infrastructure audit*. Perth. Western Australia.

Western Australian Planning Commission. (2000). *North-east Corridor extension Strategy*. Western Australian Planning Commission, Perth.

Wilde, S.A. & Low, G.H. (1978) *Geological survey of Western Australia, 1:250 000 geological series explanatory notes*. Perth, Western Australia.

## Appendix A: Water Quality Results (raw)

### Physical Parameters

| SITE NAME   | SITE  | DATE       | TEMP | pH           | CONDUCTIVITY    |
|---|-------|------------|------|--------------|-----------------|
| Measurement   |       |            | °C   |              | mS/cm           |
| <b>WQG (Aquatic Ecosystems; upland and <i>lowland rivers</i>)</b> |       |            |      | <b>6.5-8</b> | <b>0.12-0.3</b> |
| Murphy Gully Creek  | BRN1  | 15/08/2012 | 16.3 | 7.96         | 17.03           |
|   |       | 22/10/2012 | 27.8 | 8.59         | 29.3            |
| Jackson Road  | BRN2  | 15/08/2012 | NS-D | NS-D         | NS-D            |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| West Point Creek  | BRN3  | 15/08/2012 | 15   | 7.92         | 12.48           |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| Wannamal South  | BRN4  | 15/08/2012 | 15.4 | 7.09         | 3.05            |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| Udumung Creek   | BRN5  | 15/08/2012 | 13.2 | 7.49         | 8.57            |
|   |       | 22/10/2012 | 21.7 | 7.72         | 11.27           |
| Kangaroo Gully Creek  | BRN6  | 15/08/2012 | 14.3 | 7.09         | 9.11            |
|   |       | 22/10/2012 | 19.1 | 7.13         | 11.27           |
| Romany Creek  | BRN7  | 15/08/2012 | 13.6 | 7.9          | 7.73            |
|   |       | 22/10/2012 | 22.6 | 8.22         | 9.15            |
| Longbridge Creek  | BRN8  | 15/08/2012 | 14.4 | 7.85         | 11.63           |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| Wootra Brook  | BRN9  | 15/08/2012 | 12.4 | 7.4          | 12.03           |
|   |       | 22/10/2012 | 20.8 | 7.57         | 15.35           |
| Bindoon River   | BRN10 | 15/08/2012 | 13.4 | 7.82         | 8.43            |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| Cresthill Road  | BRN11 | 15/08/2012 |      |              |                 |
|   |       | 22/10/2012 |      |              |                 |
| Flat Rocks Creek  | BRN12 | 15/08/2012 | 12.7 | 7.08         | 10.27           |
|   |       | 22/10/2012 | 17.1 | 7.26         | 10.55           |
| Spoonbill Lake  | BRN13 | 15/08/2012 | 12.4 | 6.56         | 1.552           |
|   |       | 22/10/2012 | 20.5 | 7.11         | 1.576           |
| Aquila  | BRN14 | 15/08/2012 | 12.8 | 6.02         | 7.3             |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| Lake Road   | BRN15 | 15/08/2012 | 14.7 | 8.03         | 10.48           |
|   |       | 22/10/2012 | 21   | 9            | 11              |
| Spice Brook   | BRN16 | 15/08/2012 | 12.3 | 6.75         | 7.5             |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| Toodyay Creek   | BRN17 | 15/08/2012 | 8.9  | 6.67         | 6.36            |
|   |       | 22/10/2012 | NS-D | NS-D         | NS-D            |
| Julimar Bridge  | BRN18 | 15/08/2012 | 6.9  | 8.02         | 10.31           |

Brockman River Catchment Water Quality Monitoring Snapshot August & October 2012

|                        |       |            |      |      |       |
|------------------------|-------|------------|------|------|-------|
|                        |       | 22/10/2012 | 16.2 | 7.47 | 8.35  |
| Julimar Tributary      | BRN19 | 15/08/2012 | 12.6 | 7.45 | 7.2   |
|                        |       | 22/10/2012 | 17.1 | 7.59 | 10.25 |
| Chittering Valley      | BRN20 | 15/08/2012 | 14.2 | 6.56 | 3.72  |
|                        |       | 22/10/2012 | 17.5 | 7.06 | 4.02  |
| Keating Road           | BRN21 | 15/08/2012 | 15   | 6.9  | 7.18  |
|                        |       | 22/10/2012 | NS-D | NS-D | NS-D  |
| South Chittering Creek | BRN22 | 15/08/2012 | 13.3 | 6.56 | 5.56  |
|                        |       | 22/10/2012 | 15.5 | 6.92 | 5.25  |
| Marbling Brook         | BRN23 | 15/08/2012 | 6.5  | 6.71 | 2.57  |
|                        |       | 22/10/2012 | 15.4 | 7.64 | 2.06  |
| Moondyne               | BRN24 | 15/08/2012 | 13.5 | 6.7  | 9.45  |
|                        |       | 22/10/2012 | 16.4 | 7.48 | 4.63  |
| Yalliwirra             | BRN25 | 15/08/2012 | 13.5 | 7.6  | 9.01  |
|                        |       | 22/10/2012 | NS-D | NS-D | NS-D  |
| Marda Brook            | BRN26 | 15/08/2012 | 12.9 | 6.84 | 1.44  |
|                        |       | 22/10/2012 | 14.7 | 7.59 | 1.634 |
| Grey Road              | BRN27 | 15/08/2012 | 13.5 | 7.51 | 9.47  |
|                        |       | 22/10/2012 | 19.3 | 7.8  | 10.55 |



**Nutrients**

| SITE NAME  | SITE  | DATE       | TSS         | NOx_N        | Tot N       | Tot P        | NH4_N        | PO4_P        |
|--|-------|------------|-------------|--------------|-------------|--------------|--------------|--------------|
| <b>Measurement</b>   |       |            | <b>mg/L</b> | <b>mg/L</b>  | <b>mg/L</b> | <b>mg/L</b>  | <b>mg/L</b>  | <b>mg/L</b>  |
| <b>LOR</b>   |       |            | <b>1</b>    | <b>0.005</b> | <b>0.05</b> | <b>0.01</b>  | <b>0.005</b> | <b>0.005</b> |
| <b>WQG (Aquatic Ecosystems; upland and lowland rivers)</b> |       |            | <b>6</b>    |              | <b>1.2</b>  | <b>0.065</b> |              |              |
| Murphy Gully Creek   | BRN1  | 15/08/2012 | <5          | <0.005       | 1.5         | <0.01        | 0.01         | <0.005       |
|  |       | 22/10/2012 | 7           | 0.008        | 4.1         | 0.11         | 0.07         | 0.006        |
| Jackson Road   | BRN2  | 15/08/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| West Point Creek   | BRN3  | 15/08/2012 | <5          | <0.005       | 1.1         | 0.02         | <0.005       | <0.005       |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| Wannamal South   | BRN4  | 15/08/2012 | <5          | 0.11         | 1.7         | <0.01        | <0.005       | <0.005       |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| Udumung Creek  | BRN5  | 15/08/2012 | <5          | 0.7          | 2.2         | <0.01        | 0.01         | <0.005       |
|  |       | 22/10/2012 | 11          | 0.03         | 2.6         | 0.07         | 0.04         | <0.005       |
| Kangaroo Gully Creek                                       | BRN6  | 15/08/2012 | <5          | 0.8          | 1.7         | <0.01        | <0.005       | <0.005       |
|  |       | 22/10/2012 | <5          | 0.15         | 2.1         | 0.08         | 0.04         | <0.005       |
| Romany Creek   | BRN7  | 15/08/2012 | <5          | 1.4          | 2.4         | 0.01         | 0.01         | <0.005       |
|  |       | 22/10/2012 | 19          | 0.008        | 2.2         | 0.06         | 0.35         | 0.03         |
| Longbridge Creek   | BRN8  | 15/08/2012 | <5          | 0.82         | 2           | 0.01         | 0.02         | <0.005       |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| Wootra Brook   | BRN9  | 15/08/2012 | 7           | 0.23         | 1.2         | 0.02         | 0.01         | <0.005       |
|  |       | 22/10/2012 | 9           | 0.027        | 2.8         | 0.092        | 0.05         | <0.005       |
| Bindoon River  | BRN10 | 15/08/2012 | <5          | 0.15         | 0.9         | <0.01        | 0.01         | <0.005       |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| Cresthill Road   | BRN11 | 15/08/2012 |             |              |             |              |              |              |
|  |       | 22/10/2012 |             |              |             |              |              |              |
| Flat Rocks Creek   | BRN12 | 15/08/2012 | <5          | 0.23         | 0.7         | 0.02         | 0.01         | <0.005       |
|  |       | 22/10/2012 | <5          | 0.052        | 1.9         | 0.06         | 0.03         | <0.005       |
| Spoonbill Lake   | BRN13 | 15/08/2012 | <5          | 0.19         | 0.8         | <0.01        | 0.01         | <0.005       |
|  |       | 22/10/2012 | <5          | <0.005       | 1           | 0.07         | 0.01         | <0.005       |
| Aquila   | BRN14 | 15/08/2012 | <5          | 0.17         | 1.3         | 0.02         | <0.005       | <0.005       |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| Lake Road  | BRN15 | 15/08/2012 | <5          | 0.13         | 1.5         | 0.02         | <0.005       | <0.005       |
|  |       | 22/10/2012 | 11          | <0.005       | 3.3         | 0.11         | <0.005       | <0.005       |
| Spice Brook  | BRN16 | 15/08/2012 | <5          | 0.2          | 1.2         | 0.01         | 0.07         | <0.005       |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| Toodyay Creek  | BRN17 | 15/08/2012 | <5          | 0.046        | 0.9         | <0.01        | <0.005       | <0.005       |
|  |       | 22/10/2012 | NS-D        | NS-D         | NS-D        | NS-D         | NS-D         | NS-D         |
| Julimar Bridge   | BRN18 | 15/08/2012 | <5          | 0.093        | 1.5         | 0.02         | <0.005       | <0.005       |
|  |       | 22/10/2012 | <5          | 0.036        | 2.5         | 0.12         | 0.08         | <0.005       |
| Julimar Tributary  | BRN19 | 15/08/2012 | <5          | 0.26         | 0.9         | <0.01        | <0.005       | <0.005       |

Brockman River Catchment Water Quality Monitoring Snapshot August & October 2012

|                        |       |            |      |        |      |       |        |        |
|------------------------|-------|------------|------|--------|------|-------|--------|--------|
|                        |       | 22/10/2012 | <5   | 0.008  | 1.5  | 0.03  | <0.005 | <0.005 |
| Chittering Valley      | BRN20 | 15/08/2012 | <5   | 0.12   | 1.5  | 0.04  | <0.005 | <0.005 |
|                        |       | 22/10/2012 | <5   | 0.005  | 1.2  | 0.07  | <0.005 | <0.005 |
| Keating Road           | BRN21 | 15/08/2012 | <5   | 0.11   | 1    | <0.01 | 0.01   | <0.005 |
|                        |       | 22/10/2012 | NS-D | NS-D   | NS-D | NS-D  | NS-D   | NS-D   |
| South Chittering Creek | BRN22 | 15/08/2012 | <5   | 0.14   | 1.1  | 0.01  | <0.005 | <0.005 |
|                        |       | 22/10/2012 | 10   | 0.005  | 1.9  | 0.11  | 0.12   | <0.005 |
| Marbling Brook         | BRN23 | 15/08/2012 | <5   | 0.44   | 1.2  | <0.01 | 0.01   | <0.005 |
|                        |       | 22/10/2012 | <5   | 0.42   | 1.2  | 0.04  | <0.005 | <0.005 |
| Moondyne               | BRN24 | 15/08/2012 | 10   | 0.27   | 1.9  | 0.02  | 0.03   | <0.005 |
|                        |       | 22/10/2012 | 7    | 0.16   | 1.8  | 0.08  | 0.09   | <0.005 |
| Yalliwirra             | BRN25 | 15/08/2012 | 9    | 0.058  | 1.7  | 0.03  | 0.02   | <0.005 |
|                        |       | 22/10/2012 | NS-D | NS-D   | NS-D | NS-D  | NS-D   | NS-D   |
| Marda Brook            | BRN26 | 15/08/2012 | <5   | 0.35   | 1.6  | <0.01 | 0.01   | <0.005 |
|                        |       | 22/10/2012 | <5   | <0.005 | 0.9  | 0.04  | <0.005 | <0.005 |
| Grey Road              | BRN27 | 15/08/2012 | 15   | 0.32   | 1.4  | 0.02  | 0.02   | <0.005 |
|                        |       | 22/10/2012 | 18   | 0.013  | 2.9  | 0.13  | 0.08   | <0.005 |

# Brockman River Catchment Water Quality Monitoring Snapshot August & October 2012

## Heavy Metals

| SITE NAME              | SITE  | DATE       | Hardness | Al        | Cr         | Fe       | Ni         | Zn         | As         | Cd          | Cu          | Pb          | Hg          |
|------------------------|-------|------------|----------|-----------|------------|----------|------------|------------|------------|-------------|-------------|-------------|-------------|
| Measurement            |       |            | mg/L     | mg/L      | mg/L       | mg/L     | mg/L       | mg/L       | mg/L       | mg/L        | mg/L        | mg/L        | mg/L        |
| Limit of Reporting     |       |            |          | 0.005     | 0.001      | 0.01     | 0.005      | 0.005      | 0.001      | 0.0001      | 0.001       | 0.001       | 0.0001      |
| ANZECC                 |       |            |          | 0.055mg/L | 0.001 mg/L | 0.3 mg/L | 0.011 mg/L | 0.008 mg/L | 0.024 mg/L | 0.0002 mg/L | 0.0014 mg/L | 0.0034 mg/L | 0.0006 mg/L |
| Spoonbill Lake         | BRN13 | 15/08/2012 | 190      | 0.03      | <0.001     | 0.37     | 0.001      | 0.005      | <0.001     | <0.001      | <0.001      | <0.001      | <0.00005    |
|                        |       | 22/10/2012 | 170      | 0.03      | <0.001     | 0.73     | <0.001     | 0.003      | <0.001     | <0.001      | 0.003       | <0.001      | <0.00005    |
| Aquila                 | BRN14 | 15/08/2012 | 960      | 0.04      | <0.001     | 0.07     | 0.004      | 0.015      | <0.001     | <0.001      | <0.001      | <0.001      | <0.00005    |
|                        |       | 22/10/2012 | NS-D     | NS-D      | NS-D       | NS-D     | NS-D       | NS-D       | NS-D       | NS-D        | NS-D        | NS-D        | NS-D        |
| Lake Road              | BRN15 | 15/08/2012 | 1900     | 0.04      | <0.001     | 0.35     | 0.001      | 0.002      | <0.001     | <0.001      | <0.001      | <0.001      | <0.00005    |
|                        |       | 22/10/2012 | 1700     | 0.24      | <0.001     | 0.62     | 0.002      | 0.04       | <0.001     | <0.001      | 0.002       | <0.001      | <0.00005    |
| South Chittering Creek | BRN22 | 15/08/2012 | 860      | 0.06      | <0.001     | 0.25     | 0.003      | 0.006      | <0.001     | <0.001      | <0.001      | <0.001      | <0.00005    |
|                        |       | 22/10/2012 | 840      | 0.05      | <0.001     | 1.4      | 0.004      | 0.054      | <0.001     | <0.001      | 0.001       | 0.001       | <0.00005    |
| Marbling Brook         | BRN23 | 15/08/2012 | 470      | 0.09      | <0.001     | 0.41     | 0.003      | 0.006      | <0.001     | <0.001      | 0.002       | <0.001      | <0.00005    |
|                        |       | 22/10/2012 | 250      | 0.04      | <0.001     | 0.15     | 0.001      | 0.01       | <0.001     | <0.001      | <0.001      | <0.001      | <0.00005    |
| Yalliwirra             | BRN25 | 15/08/2012 | 1500     | 0.37      | 0.002      | 1.3      | 0.002      | 0.011      | <0.001     | <0.001      | 0.001       | <0.001      | <0.00005    |
|                        |       | 22/10/2012 | NS-D     | NS-D      | NS-D       | NS-D     | NS-D       | NS-D       | NS-D       | NS-D        | NS-D        | NS-D        | NS-D        |
| Grey Road              | BRN27 | 15/08/2012 | 1700     | 0.39      | 0.028      | 0.74     | 0.012      | 0.046      | <0.001     | <0.001      | <0.001      | <0.001      | <0.00005    |
|                        |       | 22/10/2012 | 1900     | 0.6       | 0.001      | 0.9      | 0.002      | 0.023      | <0.001     | <0.001      | 0.002       | <0.001      | <0.00005    |

\* Note: '<' represents a value below the limit of reporting.

## Appendix B – Freshwater Trigger Values and Guidelines

Trigger values and guidelines for nutrient concentrations and physical properties in lowland rivers and freshwater

| Guideline  | EC<br>mScm | D0 %<br>Sat        | pH      | Temp<br>°C | TN mg/L        | NO <sub>x</sub> N<br>mg/L | NH <sub>4</sub> N<br>mg/L | TP<br>mg/L | FRP<br>mg/L |
|--|------------|--------------------|---------|------------|----------------|---------------------------|---------------------------|------------|-------------|
| ANZECC Water Quality Guideline – Recreational (2000)       | -          | >80<br>(>6.5 mg/L) | 6.5-8.5 | -          | -              | 10                        | -                         | -          | -           |
| ANZECC Water Quality Trigger Values - lowland river (2000) | 0.12-0.3   | 80-120             | 6.5-8.0 | -          | 1.2            | 0.150                     | 0.08                      | 0.065      | 0.04        |
| ANZECC Water Quality Guidelines – Freshwater (1992)        | -          | >80-90<br>(>6mg/L) | 6.5-9.0 |            | <2<br>increase | 20-30                     | 0.01                      | 0.01-0.1   | -           |

# ***Trigger values and guidelines for toxicants (heavy metals) in freshwater***

\* Trigger values not corrected for hardness, ID = insufficient data to have ANZECC water quality guideline

| <b>Guideline</b>   | <b>As<br/>mg/L</b> | <b>Cr<br/>mg/L</b> | <b>Cu*<br/>mg/L</b> | <b>Fe<br/>mg/L</b> | <b>Mo<br/>mg/L</b> | <b>Mn<br/>mg/L</b> | <b>Ni*<br/>mg/L</b> |
|--|--------------------|--------------------|---------------------|--------------------|--------------------|--------------------|---------------------|
| ANZECC<br>Water Quality<br>Guidelines –<br>Recreational<br>(2000)        | 0.05               | 0.05               | 1                   | 0.3                | ID                 | 0.1                | 0.1                 |
| ANZECC<br>Water Quality<br>Trigger<br>Values<br>Freshwater<br>99% (2000) | 0.001              | 0.00001            | 0.001               | ID                 | ID                 | 1.2                | 0.008               |
| ANZECC<br>Water Quality<br>Trigger<br>Values<br>Freshwater<br>95% (2000) | 0.024              | 0.001              | 0.0014              | ID                 | ID                 | 1.9                | 0.011               |
| ANZECC<br>Water Quality<br>Trigger<br>Values<br>Freshwater<br>90% (2000) | 0.094              | 0.006              | 0.0018              | ID                 | ID                 | 2.5                | 0.013               |
| ANZECC<br>Water Quality<br>Trigger<br>Values<br>Freshwater<br>80% (2000) | 0.360              | 0.04               | 0.0025              | ID                 | ID                 | 3.6                | 0.017               |
| ANZECC<br>Water Quality<br>Guidelines –<br>Freshwater<br>(1992)          | 0.05               | 0.01               | 0.002-<br>0.005     | ID                 | ID                 | ID                 | 0.015-<br>0.15      |
| Limit<br>reporting   | 0.001              | 0.001              | 0.001               | 0.01               | 0.005              | 0.001              | 0.001               |

***Trigger values and guidelines for toxicants (heavy metals) in freshwater***

\* Trigger values not corrected for hardness, ID = insufficient data to have ANZECC water quality guideline

| <b>Guideline</b>  | <b>Pb* mg/L</b> | <b>Sn</b> | <b>Sr mg/L</b> | <b>Ti mg/L</b> | <b>V mg/L</b> | <b>Zn* mg/L</b> |
|---|-----------------|-----------|----------------|----------------|---------------|-----------------|
| ANZECC Water Quality Guidelines – Recreational (2000)     | 0.05            | ID        | ID             | ID             | ID            | 5               |
| ANZECC Water Quality Trigger Values Freshwater 99% (2000) | 0.001           | ID        | ID             | ID             | ID            | 0.0024          |
| ANZECC Water Quality Trigger Values Freshwater 95% (2000) | 0.0034          | ID        | ID             | ID             | ID            | 0.008           |
| ANZECC Water Quality Trigger Values Freshwater 90% (2000) | 0.0056          | ID        | ID             | ID             | ID            | 0.015           |
| ANZECC Water Quality Trigger Values Freshwater 80% (2000) | 0.0094          | ID        | ID             | ID             | ID            | 0.031           |
| ANZECC Water Quality Guidelines – Freshwater (1992)       | 0.001-0.005     | ID        | ID             | ID             | ID            | 0.005-0.05      |
| Limit of reporting  | 0.001           | 0.05      | 0.001          | 0.01           | 0.002         | 0.001           |

## Appendix C – Salinity measurements and tolerance limits

| Salt Measurement Conversions |      |          |       |        |                             |
|------------------------------|------|----------|-------|--------|-----------------------------|
| mS/cm                        | mS/m | ppm,mg/L | ppt   | gr/gal |                             |
| 0                            | 0    | 0        | 0     | 0      | ↑<br>distilled water        |
| 0.1                          | 10   | 55       | 0.06  | 4      |                             |
| 0.2                          | 20   | 110      | 0.11  | 8      |                             |
| 0.3                          | 30   | 165      | 0.17  | 12     |                             |
| 0.4                          | 40   | 220      | 0.22  | 15     |                             |
| 0.5                          | 50   | 275      | 0.28  | 19     | ↓<br><b>FRESH</b>           |
| 0.6                          | 60   | 330      | 0.33  | 23     |                             |
| 0.7                          | 70   | 385      | 0.39  | 27     |                             |
| 0.8                          | 80   | 440      | 0.44  | 31     |                             |
| 0.9                          | 90   | 495      | 0.50  | 35     |                             |
| 1.0                          | 100  | 550      | 0.55  | 39     | ↑                           |
| 1.5                          | 150  | 825      | 0.83  | 58     |                             |
| 2.0                          | 200  | 1100     | 1.10  | 77     |                             |
| 2.5                          | 250  | 1375     | 1.38  | 96     |                             |
| 2.7                          | 273  | 1500     | 1.50  | 105    |                             |
| 3.0                          | 300  | 1650     | 1.65  | 116    | ↓<br><b>MARGINAL</b>        |
| 3.5                          | 350  | 1925     | 1.93  | 135    |                             |
| 4.0                          | 400  | 2200     | 2.20  | 154    |                             |
| 4.5                          | 450  | 2475     | 2.48  | 173    |                             |
| 5.0                          | 500  | 2750     | 2.75  | 193    |                             |
| 5.5                          | 550  | 3025     | 3.03  | 212    | ↑                           |
| 6.0                          | 600  | 3300     | 3.30  | 231    |                             |
| 6.5                          | 650  | 3575     | 3.58  | 250    |                             |
| 7.0                          | 700  | 3850     | 3.85  | 270    |                             |
| 7.5                          | 750  | 4125     | 4.13  | 289    |                             |
| 8.0                          | 800  | 4400     | 4.40  | 308    | ↓<br><b>BRACKISH</b>        |
| 8.5                          | 850  | 4675     | 4.68  | 327    |                             |
| 9.0                          | 900  | 4950     | 4.95  | 347    |                             |
| 9.1                          | 910  | 5005     | 5.01  | 350    |                             |
| 9.5                          | 950  | 5225     | 5.23  | 366    |                             |
| 10.0                         | 1000 | 5500     | 5.50  | 385    | ↑                           |
| 10.5                         | 1050 | 5775     | 5.78  | 404    |                             |
| 11.0                         | 1100 | 6050     | 6.05  | 424    |                             |
| 11.5                         | 1150 | 6325     | 6.33  | 443    |                             |
| 12.0                         | 1200 | 6600     | 6.60  | 462    |                             |
| 12.5                         | 1250 | 6875     | 6.88  | 481    | ↓                           |
| 13.0                         | 1300 | 7150     | 7.15  | 501    |                             |
| 13.5                         | 1350 | 7425     | 7.43  | 520    |                             |
| 14.0                         | 1400 | 7700     | 7.70  | 539    |                             |
| 14.5                         | 1450 | 7975     | 7.98  | 558    |                             |
| 15.0                         | 1500 | 8250     | 8.25  | 578    | ↑<br><b>SALINE</b>          |
| 15.5                         | 1550 | 8525     | 8.53  | 597    |                             |
| 16.0                         | 1600 | 8800     | 8.80  | 616    |                             |
| 16.5                         | 1650 | 9075     | 9.08  | 635    |                             |
| 17.0                         | 1700 | 9350     | 9.35  | 655    |                             |
| 17.5                         | 1750 | 9625     | 9.63  | 674    | ↓                           |
| 18.0                         | 1800 | 9900     | 9.90  | 693    |                             |
| 18.5                         | 1850 | 10175    | 10.18 | 712    |                             |
| 19.0                         | 1900 | 10450    | 10.45 | 732    |                             |
| 19.5                         | 1950 | 10725    | 10.73 | 751    |                             |
| 20.0                         | 2000 | 11000    | 11.00 | 770    | ↑                           |
| 20.5                         | 2050 | 11275    | 11.28 | 789    |                             |
| 21                           | 2100 | 11550    | 11.55 | 809    |                             |
| 21.5                         | 2150 | 11825    | 11.83 | 828    |                             |
| 22                           | 2200 | 12100    | 12.10 | 847    |                             |
| 22.5                         | 2250 | 12375    | 12.38 | 866    | ↓                           |
| 23                           | 2300 | 12650    | 12.65 | 886    |                             |
| 23.5                         | 2350 | 12925    | 12.93 | 905    |                             |
| 24                           | 2400 | 13200    | 13.20 | 924    |                             |
| 24.5                         | 2450 | 13475    | 13.48 | 943    |                             |
| 25                           | 2500 | 13750    | 13.75 | 963    | ↓                           |
| 30                           | 3000 | 16500    | 16.50 | 1155   |                             |
| 53                           | 5300 | 29150    | 29.15 | 2041   |                             |
| 64                           | 6400 | 35200    | 35.20 | 2464   |                             |
| 11.97                        | 1197 | 6584     | 6.58  | 461    |                             |
|                              |      |          |       |        | ↑<br>sea water<br>sea water |

### Measurement Units

mS/cm = millisiemens per cm  
 mS/m = millisiemens per metre  
 ppm = parts per million  
 mg/L = milligrams per litre  
 gr/gal = grains per gallon

### Conversion Factors

mS/m x 100 = mS/cm  
 mS/m x 5.5 = mg/L  
 mS/m x 0.385 = gr/gallon  
 mS/m x 10 = EC uS/cm  
 gr/gal x 14.25 = mg/L

## Appendix D - Hardness-Modified Trigger Value calculations based on varying water hardness (Table 3.4.4. ANZECC & ARMCANZ, 2000).

| Hardness category (mg/L as CaCO <sub>3</sub> ) | Water Hardness (mg/L as CaCO <sub>3</sub> ) | Cd (mg/L) | Cr(III) (mg/L) | Cu (mg/L) | Pb (mg/L) | Ni (mg/L) | Zn (mg/L) |
|--|---|-----------|----------------|-----------|-----------|-----------|-----------|
| Soft (0-59)                                    | 30  | TV        | TV             | TV        | TV        | TV        | TV        |
| Moderate (60-119)                              | 90  | *2.7      | *2.5           | *2.5      | *4        | *2.5      | *2.5      |
| Hard (120-179)                                 | 150   | *4.2      | *3.7           | *3.9      | *7.6      | *3.9      | *3.9      |
| Very Hard (180-240)                            | 210   | *5.7      | *4.9           | *5.2      | *11.8     | *5.2      | *5.2      |
| Extremely Hard (>400)                          | 400   | *10       | *8.4           | *9        | *26.7     | *9        | *9        |



## **Appendix E - Sampling and Analysis Plan**

### *Brockman River Catchment Water Quality Monitoring Snapshot July and September 2012*



**Plate 1:** Spoonbill Lake, Brockman River (2008)

**Prepared by Ellen Brockman Integrated Catchment group: May 2011**



This project is co-funded by Tiwest and the Australian Government's initiative in Caring for our Country administered by Perth Region NRM.

## Table of Contents

|   |            |
|---|------------|
| <b>TABLE OF CONTENTS .....</b>  | <b>106</b> |
| LIST OF FIGURES .....   | 107        |
| <b>1. BACKGROUND .....</b>  | <b>108</b> |
| <b>2. CHANGES TO THE PROJECT .....</b>  | <b>112</b> |
| <b>3. SAMPLING SITE LOCATION .....</b>  | <b>114</b> |
| <b>4. SAMPLING FREQUENCY .....</b>  | <b>117</b> |
| <i>Table 1: Location and description of selected sampling sites within the Brockman River catchment. ....</i>                     | <i>116</i> |
| <b>5. MEASURED PARAMETERS .....</b>   | <b>119</b> |
| <b>6. QUALITY ASSURANCE AND QUALITY CONTROL .....</b>   | <b>119</b> |
| 6.1. BLANK SAMPLES .....  | 119        |
| 6.2. FIELD BLANKS (FB) .....  | 120        |
| 6.3. REPLICATES SAMPLES (RS) .....  | 120        |
| <b>7. STANDARD OPERATING PROCEDURES .....</b>   | <b>120</b> |
| 7.1. PHYSICAL PARAMETER SAMPLING (DoW, 2006A). ....   | 121        |
| 7.2. GRAB POLE SAMPLING (DoW, 2006A) .....  | 121        |
| 7.3. FILTERING A NUTRIENT SAMPLE .....  | 122        |
| 7.4. DOC/TOC SAMPLING .....   | 122        |
| <b>8. SAMPLING OPERATION REQUIREMENTS .....</b>   | <b>123</b> |
| <i>Table 2: Measurement parameters analysed at a given number of sites on two sampling runs. ....</i>                             | <i>123</i> |
| <b>9. SAMPLE BOTTLE REQUIREMENTS .....</b>  | <b>123</b> |
| <i>Table 3: Number of bottles required to sample for all identified measurement parameters, field blanks and replicates. ....</i> | <i>123</i> |
| <b>10. LABELLING .....</b>  | <b>124</b> |
| <b>11. PERSONAL SAFETY .....</b>  | <b>125</b> |
| <b>12. MPL LABORATORY .....</b>   | <b>125</b> |
| 13. ANALYTICAL METHODS AND LIMIT OF REPORTING (LOR) FOR MPL LABORATORY .....  | 126        |
| <i>Table 4: Analytical methods and limit of reporting (LOR) for MPL Laboratories .....</i>  | <i>126</i> |
| <b>14. SENDING SAMPLES TO THE LABORATORY .....</b>  | <b>127</b> |
| <b>15. MANAGEMENT AND REPORTING OF DATA .....</b>   | <b>127</b> |
| <b>16. COMPARISON OF RESULTS WITH GUIDELINES .....</b>  | <b>128</b> |
| <b>17. ROLES AND RESPONSIBILITIES .....</b>   | <b>128</b> |
| <b>18. COSTS OF THE BROCKMAN RIVER CATCHMENT SAMPLING PROGRAM .....</b>   | <b>130</b> |
| <i>Table 5: Costs of water quality sampling of the Brockman River catchment in 2009 with MPL on two sampling occasions. ....</i>  | <i>130</i> |
| <i>Table 6: Budget for the 2009 Brockman River catchment monitoring project. ....</i>   | <i>132</i> |
| <b>19. REFERENCES .....</b>   | <b>133</b> |
| APPENDIX A: ANALYSIS REQUIREMENTS .....   | 134        |
| APPENDIX B: EQUIPMENT LIST FOR COLLECTING WATER SAMPLES .....   | 135        |

**List of Figures**

Figure 1: Sub-catchments within the Swan-Canning Catchment (WRC, 2003)..... 109

Figure 2: Brockman River Catchment (WRC, 2003)..... 110

Figure 3: Proportion of Gross Value of Agricultural Production (GVAP) (Total \$23 million) by commodity: 1996/97. (Cook and Hatherly, 1997). ..... 111

Figure 4: Sampling site locations within the Brockman River Catchment. .... 118

Figure 5: Example of bottle label ..... 124

## 1. Background

The Brockman River catchment is located to the north-east of the Perth Metropolitan area in the south-west of Western Australia (Figure 23). The catchment covers an area inclusive of sixty-eight subcatchments, incorporating the townships of Bindoon and Wannamal (WRC, 2002). The greatest part of the catchment lies within the Shire of Chittering, with the remainder falling within the shires of Victoria Plains, Toodyay, Swan and Gingin (Figure 24). Other localities within the catchment include Mooliabeenie, Lower Chittering, Maryville Downs and South Chittering.

The catchment stretches across 1520 square kilometres and is the largest catchment of the lower Avon and upper Swan catchments. The Brockman River is approximately 90 kilometres in length and flows through the Chittering Valley along the Darling Scarp. The main issues within the catchment include a deteriorating natural resource base due to widespread clearing of native vegetation and an increased economic pressure on agricultural land to be more productive. The cumulative impacts of increasing salinity, waterlogging, soil erosion, sedimentation, eutrophication, overgrazing, weed invasion and pest animals have an offsite effect on the Brockman River, local wetland systems and ultimately the Avon-Swan River.

Monitoring involves observations and measurements that are analysed and reported for the purpose of providing information and knowledge about catchments and waterways (DoW, 2006). With support from Tiwest Joint Venture and the Department of Water (DoW), the Ellen Brockman Integrated Catchment Group commenced an annual sampling program focusing on nutrients, physical parameters and total suspended solids at 25 sites within the Brockman River catchment in 2006 and 2007. Water samples collected from seven of the twenty-five strategically selected sampling sites were also analysed for metals. Sampling was conducted twice (August & October). The 2011 sampling program will involve the sampling of twenty-six sites over two days on two occasions to capture the first consistent flow and the spring flow. Metals will be sampled for at seven of these sites. Additionally, the sampling of Gray Road (BRN27) will continue to replace Cresthill Road (BRN11) for the 2011 sampling program. This is to monitor the adjacent subdivision and townsite of Bindoon.

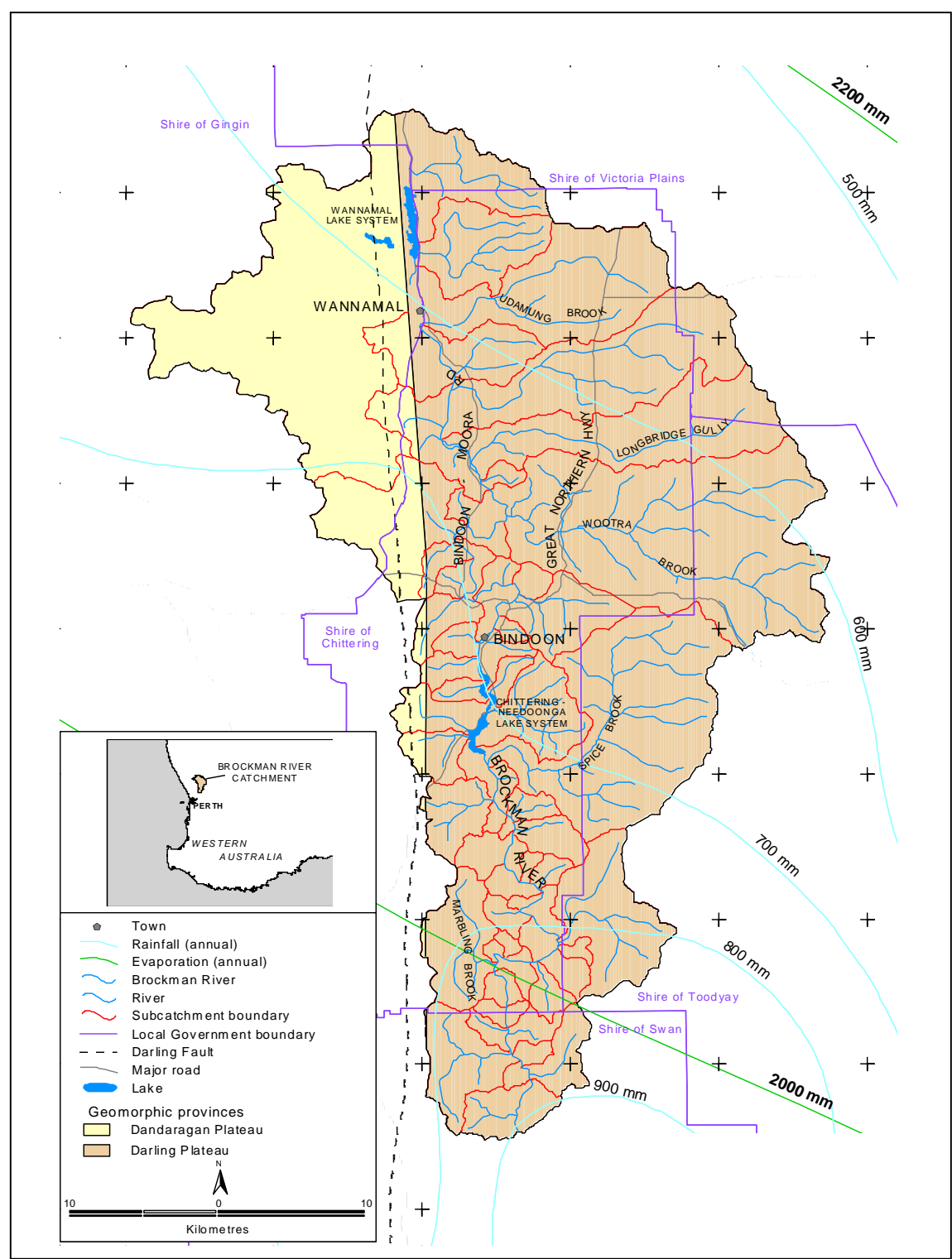
The aim of this sampling and analysis plan is to provide a report on the development of the Brockman River water quality monitoring program, to ensure that sampling is conducted

## Brockman River Catchment Sampling and Analysis Plan 2012

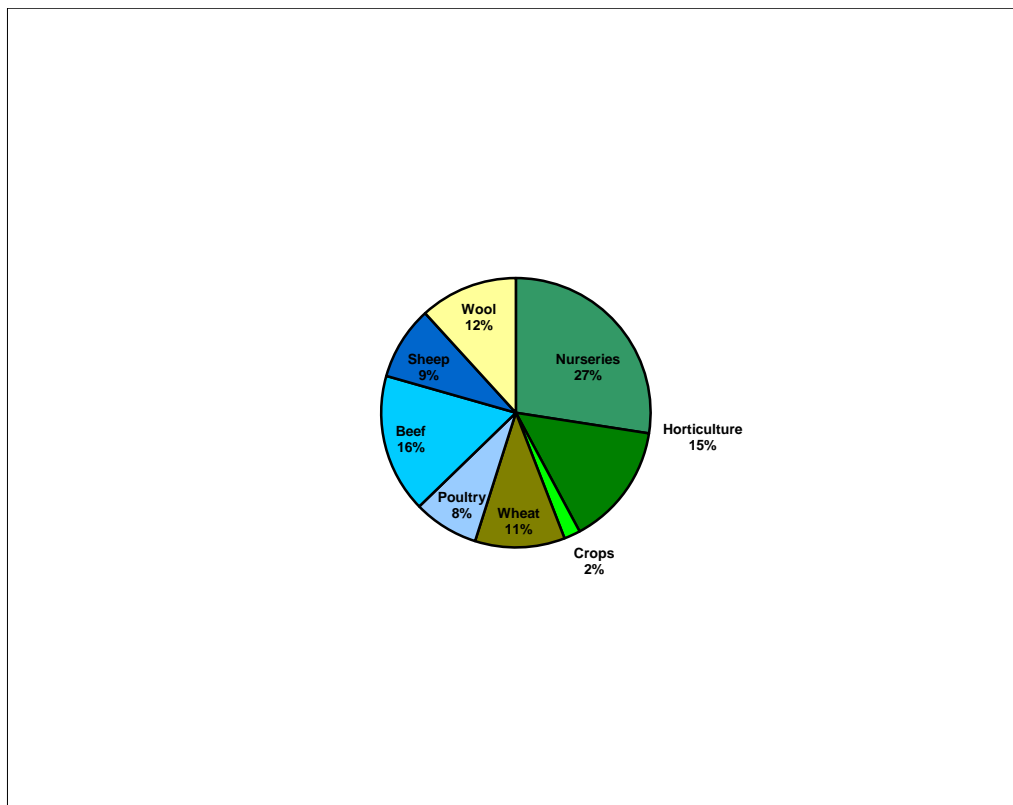
according to the relevant guidelines, ensuring that data standards are met and data quality continuity maintained (DoW, 2006). The aim of sampling from twenty-six strategically identified sites along the Brockman River is to monitor the priority sub-catchments. Priority sub-catchments are those that are contributing levels of nutrients and metals in concentrations above the ANZECC Water Quality Guidelines. The SAP and the sampling program will also help to establish baseline data for surface water quality within the catchment, and enable the identification of trends and emergent trends.



**Figure 23:** Sub-catchments within the Swan-Canning Catchment (WRC, 2003).



**Figure 24:** Brockman River Catchment (WRC, 2003).



**Figure 25:** Proportion of Gross Value of Agricultural Production (GVAP) (Total \$23 million) by commodity: 1996/97. (Cook and Hatherly, 1997).

## **2. Changes to the project**

This project commenced in 2006, please refer to the sampling and analysis plan (latest version/highest number) for details of the sampling for that year.

In 2007 the following changes were made to the project:

- Sampling frequency was increased from a one off event in 2006 to two events in 2007, one being conducted with the onset of winter rains and the second being undertaken during spring flows.
- Due to reduced budget DOW could not fund the analysis of samples at NMI laboratories; as a result EBICG sent the samples to MPL for analysis, through their funding arrangement with Tiwest.
- Site BRN 26 (Marda Brook) was added to the project, as it was considered a possible source of heavy metals and nutrients to the Brockman River. Analysis on water collected from that site was carried out for the following total heavy metals Ag, Al, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Sn, Sr, Ti, Tl, V, Zn, Hg, As, Pb, Sb, Se & Cr(VI) as well as total water hardness, total suspended solids, total phosphorous, total nitrogen, total oxidised nitrogen, soluble reactive phosphorous, dissolved organic nitrogen, and nitrogen as ammonia/ammonium.
- Samples were collected from a total of eight sites and analysed for total water hardness and for heavy metals (listed above) in 2007. Those sites were BRN 5, 19-23, 25 & 26 and 28.
- Water samples were also collected from the bottom of catchment site (BRN 25) for analysis for total and dissolved organic carbon.

In 2008 the following changes were made to the project:

- Site BRN 27 (Gray Road) was added to the project.
- Site BRN 11 (Bridge on Cresthill Road over the Brockman River) was removed from the project.



## Brockman River Catchment Sampling and Analysis Plan 2012

In 2009 the following changes were made to the project:

- Heavy metal concentrations were found to be insignificant at the sampling sites identified in 2007 and 2008, therefore, the following sampling sites have replaced previous years sampling sites;

| <b>2008 Sampling Sites for Heavy Metals</b> | <b>2009 Sampling Sites for Heavy Metals</b> |
|---|---|
| BRN 5 Udumung                               | BRN13 Spoonbill Lake                        |
| BRN19 Julimar Tributary                     | BRN14 Aquila, Hart Drive                    |
| BRN20 Chittering Valley                     | BRN15 Lake Road                             |
| BRN21 Keating Road                          | BRN22 South Chittering Creek                |
| BRN23 Marbling Brook                        | BRN23 Marbling Brook                        |
| BRN25 Yalliwirra                            | BRN25 Yalliwirra                            |
| BRN27 Gray Road Bridge                      | BRN27 Gray Road Bridge                      |
| BRN26 Marda Brook                           | Removed                                     |

In 2010 there were no changes made to the project

In 2011 the following changes were made to the project:

- Spoonbill Lake(BRN13) will not be analysed for metals as it has not recorded any significant metal concentrations.
- Udamung (BRN5) will be analysed for metals as it is located down stream of the WA Field and Game gun club and would like to discover if there is any contamination in the surface water.

In 2012 the following changes were made to the project:

- Spoonbill Lake(BRN13) will be analysed for metals as it is one of the last fresh water tributaries and it is imperative to ensure we monitor it for any decline.
- Udamung (BRN5) will not be analysed for metals as it is has not recorded any significant metal concentrations in 2011.
- Jackson Rd (BRN2) will be analysed for metals as there has been concerns about what metals are discharging from the Wannamal Lake system.

### **3. Sampling Site Location**

Water samples will be taken from twenty five sites within the Brockman River catchment (Figure 26). These sites have been selected to be representative of a particular part of the catchment; to determine their relative nutrient and metal contribution to the Brockman River; and whether they are situated upstream or downstream of potentially high impact land uses or of likely contaminant sources.

Table 7 lists the sampling sites by site number, site name and relative waterway component. Site location is also provided using street names, northings and eastings.

Table 7: Location and description of selected sampling sites within the Brockman River catchment.

| Site No. | Site name  | Description of waterway<br>(inc. old site number)                    | Easting | Northing |
|----------|--|--|---------|----------|
| BRN1     | Murphy Gully Creek                               | BR22 - Bindoon Moora Rd  | 409205  | 6561412  |
| BRN2     | Jackson Road<br>(Wannamal Lake outlet)           | BR21 - Jackson Road  | 409457  | 6555480  |
| BRN3     | West Point Creek                                 | BR20 - West Point  | 409754  | 6555706  |
| BRN4     | Wannamal South                                   | Wannamal South Road  | 407596  | 6552244  |
| BRN5     | Udumung Creek                                    | BR18 - Hay Flat Road   | 410373  | 6551048  |
| BRN6     | Kangaroo Gully Creek                             | BR17A - Bindoon Moora Rd   | 412741  | 6547952  |
| BRN7     | Gooninong<br>Romany Creek                        | BR17 - Waldeck West Road -<br>Romany Creek                           | 413360  | 6546355  |
| BRN8     | Longbridge Creek                                 | BR16A - Ashman Rd to gate<br>(2km) over fence & nth on fire<br>break | 414649  | 6542478  |
| BRN9     | Wootra Brook                                     | BR15 - Owen's Road   | 416762  | 6537439  |
| BRN10    | Bindoon River                                    | BR15A - Great Northern<br>Highway small bypass road<br>bridge        | 417372  | 6531777  |
| BRN12    | Flat Rocks Creek                                 | Densley Road (off Flat Rocks)  | 415077  | 6524296  |
| BRN13    | Spoonbill Lake                                   | BR12 - spillway from<br>Spoonbill Reserve                            | 412361  | 6523223  |
| BRN14    | Aquila, Hart Drive                               | BR12A - Flows through<br>Aquila Reserve                              | 412306  | 6522632  |
| BRN15    | Lake Road<br>Brockman River                      | BR9 - Bridge on Lake Road<br>below Lake Weir                         | 414090  | 6521308  |
| BRN16    | Spice Brook                                      | BR11A - off Lake Road across<br>paddock to bridge                    | 414509  | 6521156  |
| BRN17    | Toodyay Creek<br>Toodyay Creek                   | 100m north of Blue Plains<br>Road on Chittering Road                 | 414561  | 6518111  |
| BRN18    | Julimar/Chittering Bridge<br>Brockman River      | BR5 - Julimar Rd/Chittering<br>Rd intersection                       | 415996  | 6515275  |
| BRN19    | Julimar/Chittering Tributary<br>Julimar Rd Creek | BR8 - Julimar Rd (500m up<br>from intersection Chittering<br>Rd)     | 417103  | 6515877  |
| BRN20    | Chittering Valley                                | Cnr Chittering Valley and<br>Chittering Road                         | 416288  | 6510308  |
| BRN21    | Keating Road                                     | BR4 - 500m east on Keating<br>Road to gateway - Bitney<br>Springs    | 419248  | 6508210  |
| BRN22    | South Chittering Creek                           | Chittering Road just north of<br>Wilson Road                         | 415559  | 6500608  |
| BRN23    | Marbling Brook                                   | Bridge on Chittering Road  | 414704  | 6506641  |
| BRN24    | Moondyne<br>Brockman River                       | BR2 - from crossing  | 416623  | 6499996  |
| BRN25    | Yalliawirra<br>Brockman River                    | BR1 Gauging Station  | 416450  | 6495160  |
| BRN26    | Marda Brook                                      | Smith Road bridge/gate   | 414266  | 6496860  |
| BRN27    | Gray Road Bridge                                 | Brockman River   | 413885  | 6528696  |

#### **4. Sampling frequency**

Initial sampling will take place in winter (August). Timing will be dependent on consistent rainfall and flow. The second and final sampling occasion will be conducted during spring flow (October).

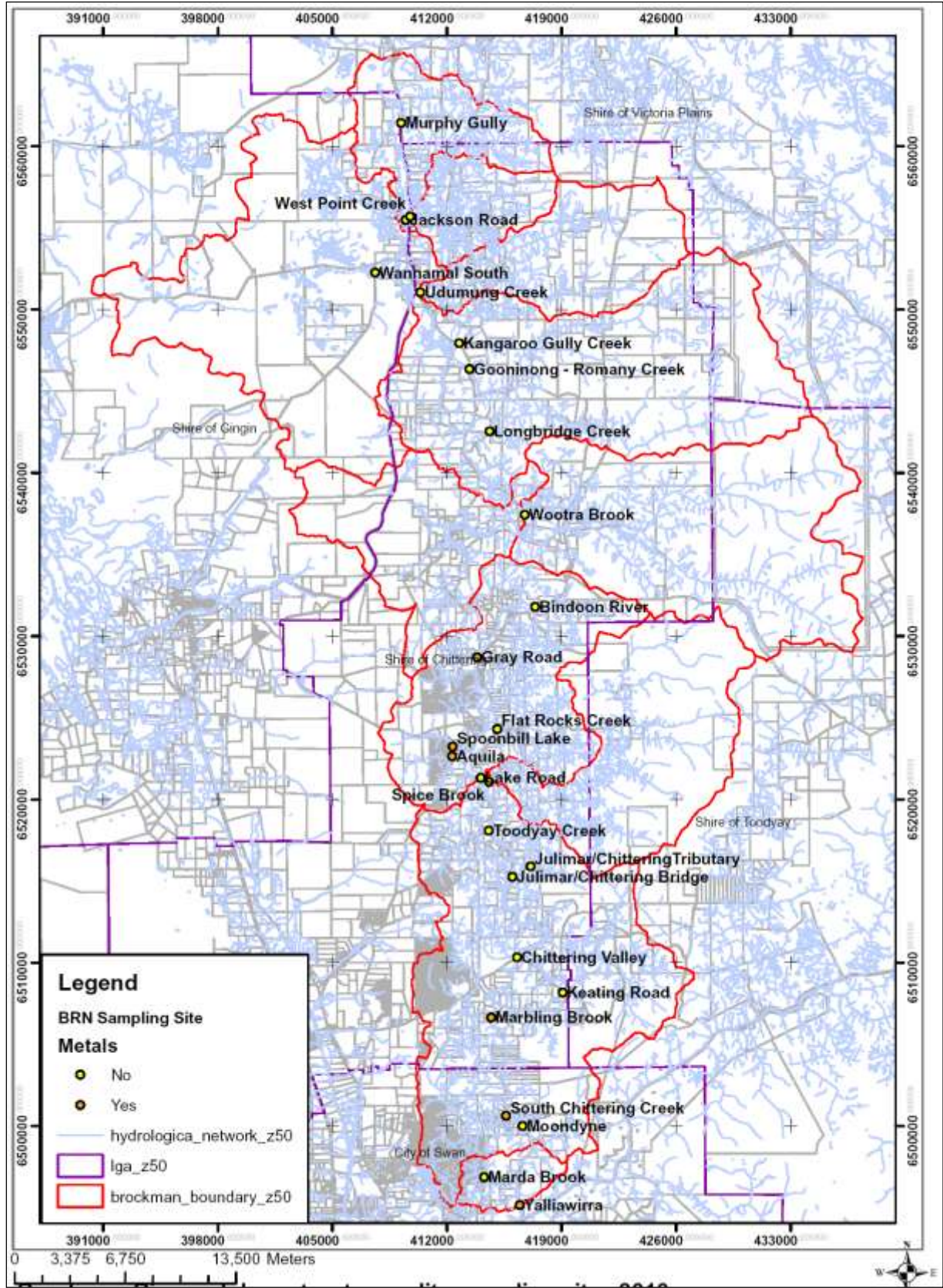


Figure 26: Sampling site locations within the Brockman River Catchment 2012

## **5. Measured parameters**

The twenty five selected sampling sites will be analysed in the field using pH and conductivity meters.

These sites will also be sampled for the analysis of nutrients including Total phosphorous (TP), Total nitrogen (TN), Total oxidised nitrogen (TON), Filterable reactive phosphorous (FRP), Dissolved organic nitrogen (DOrgN), and Nitrogen as ammonia (NH<sub>4</sub>-N), Dissolved organic carbon, Total organic carbon, Total suspended solids,

Total water hardness and total metals including iron, aluminium, copper, arsenic, lead, nickel, zinc, chromium, mercury and cadmium will be sampled for at Jackson Rd (BRN2), Spoonbill Lake (BRN13), Aquila (BRN14), Lake Road (BRN15), South Chittering Creek (BRN22), Marbling Brook (BRN23), Yalliwirra (BRN25) and Gray Road Bridge (BRN27). Refer to Appendix A for a tabular format of the selected parameters to be measured in surface waters within the Brockman River catchment.

## **6. Quality Assurance and Quality Control**

It is important to collect quality control samples as firm conclusions cannot be drawn from sampling data unless the quality of the data is known. The number and the types of quality control samples depend on the final use of the data, as well as the amount of time and money available for the monitoring program (DOW). This monitoring program will include one field blank and one replicate taken on one sampling occasion to ensure quality assurance and quality control of water quality data.

### ***6.1. Blank Samples***

Blanks are clean samples of deionised or distilled water, introduced at various stages of sampling. They are collected to detect and measure contamination in the sampling process as a result of ineffective field procedures, containers, equipment and transport. Often it is not possible to achieve absolutely no contamination, but rather only stable, minimal contamination levels. You need to set acceptable limits for these contamination levels, and when blanks are collected that fall outside this, you have a contamination issue that will require further investigation (DOW).

## **6.2. *Field Blanks (FB)***

Extra containers are taken to the site. Take a stock container of deionised/distilled water. On site, containers are opened and closed and the contents handled just as if these were normal samples being collected during transfer and storage, except they are filled with deionised/distilled water (leave or add appropriate preservative in the bottle if required—depending on which parameters the field blank is checking). These detect mainly contamination of sample during the collection procedure. Ideally at least one of these is collected per sampling team, per sampling trip, for all measured analytes (DOW).

## **6.3. *Replicates Samples (RS)***

Replicate samples are two or more samples collected from the same site and time, using exactly the same method. They can indicate the natural variations in the environment and variations caused by the field sampling method. It provides the experimental error and thus a measure of sampling accuracy. Two replicates will only indicate that variation exists (if there is any) but three replicates will enable some assessment of precision and bias (DOW).

# **7. Standard Operating Procedures**

To reduce contamination of samples with disturbed sediment, sampling is to begin at the most downstream site within the catchment and to be continued upstream. Physical parameters will be measured using WTW pH and EC probes while the water samples are collected. Calibration of the logger will need to occur prior to and at the end of the sampling with all calibration records kept in a logbook.

Grab surface water samples for chemical analysis of nutrients and heavy metals is collected just below the surface, avoiding any surface scums or debris (DoW, 2006a). Measuring of physical parameters, direct sampling and taking filtered samples are to be conducted using the ‘Guideline for Field Sampling for Surface Water Quality Monitoring Programs’, by the Water Science Branch, Department of Water (2006a).



### **7.1. *Physical Parameter Sampling (DoW, 2006a).***

- Lower the clean, maintained and calibrated data logger into the water body near or at the same site where the water samples were taken. Minimise disturbance to the sediment.
- Ensure that all probes are fully submerged. Ideally the probes should be approximately 10cm under the water surface and 10cm above the sediment.
- The probes should be kept in a gentle motion while taking care not to stir up the sediments.
- If the probe has a built in circulator ensure this is turned on.
- Allow sufficient time for the probe to stabilise, and then take the readings.
- Store the physical results electronically on the instrument's console, and on the Field Observation Form.

### **7.2. *Grab Pole Sampling (DoW, 2006a)***

- Ensure that labelling on the bottle to be filled is correct and that the sample number matches the number on the paperwork (Field Observation Form and Chain of Custody form).
- Check that the grab pole sampler is clean.
- Extend the pole sampler so that it will reach the point that you wish to sample.
- Lower the grab sampler into the water with the mouth of the bottle facing upstream into the flow of water to a depth of 15cm. Keep the bottle moving forwards, into the flow of water whilst it is filling (Standards Australia AS/NZS 566.6:1998 5.3.1).
- Allow to partially fill, take the bottle out of the water, swirl around and tip out the rinsate downstream of sampling site.
- Repeat two more times so that the grab pole sampler has been rinsed three times.
- Then, fill the grab sampler at a depth of 15cm, with the mouth of the bottle facing upstream, slowly moving the bottle forward, into the flow of water.
- Use this sample to rinse the labelled sample container three times. Cap, shake well, and pour the rinsate downstream of yourself.
- Remove the cap from the sample container only at the time of sampling and replace the cap immediately after collection of the sample.

- Fill the bottle to the shoulder.
- Metal samples do not require nitric acid in the sample bottles as the laboratory nitrifies the water sample in the lab.
- Do not touch the opening of the sample container with any part of the grab pole bottle or your hands as this can introduce contaminants.
- Cap and store the sample container in an ice-esky overnight. The samples will be delivered (chilled) to TiWest where a courier will pick them up and deliver them to MPL laboratory the following day.

### ***7.3. Filtering a Nutrient Sample***

Refer to DoW (2006a) for details on setting up a Filter Tower.

- Shake the sample gently before filtering.
- Pour a small amount of the sample into the top of the cleaned and assembled filter tower.
- Use the vacuum pump and the rubber bung.
- Swirl the filtered sample by carefully pouring it through both vacuum ports.
- Put the rubber bung back on and reattach the pump.
- Pour the required amount of sample plus a bit extra (for rinsing the sample container) into the top of the filter tower.
- Use the vacuum pump to filter the sample.
- Once the sample is filtered remove the vacuum from the collection chamber.
- Pour a small amount of the filtered sample into the pre-labelled sample container.
- Remove the cap from the sample container only at the time of sampling and replace the cap immediately after collection of the sample.
- Cap, swirl around the filtrate and discard.
- Repeat twice to ensure that the sample container is well rinsed.
- Fill the labelled sample container with the filtrate to the required level.
- Cap and store the sample container in an esky on ice-bricks.

### ***7.4. DOC/TOC Sampling***

- Rinse both DOC and TOC sample bottles three times prior to filling.
- When filling the bottles fill all the way to the top (i.e. leave no air bubble).
- As a standard use a filter tower to filter your sample.

## 8. Sampling operation requirements

| Sample Run | Field personnel | Number of sites                      | Measurement parameters  |
|------------|-----------------|--------------------------------------|---|
| 1          | Bonny Dunlop    | 25/25 (BRN 1 -26)                    | <u>Water</u><br>Nutrients, physical properties total suspended solids               |
|            | Megan O'Grady   | 1/25 (BRN 25)                        | TOC/DOC   |
|            |                 | 8/25 (BRN 2,13,14,15,22,23,25 & 27). | Metals and total water hardness (from TSS)  |
| 2          | Bonny Dunlop    | 25/25 (BRN 1 -26)                    | <u>Water</u><br>Nutrients, DOC, TOC, physical properties and total suspended solids |
|            | Megan Ogrady    | 1/25 (BRN 25)                        | TOC/DOC   |
|            |                 | 8/25 (BRN 2,13,14,15,22,23,25 & 27). | Metals and total water hardness (from TSS)<br><br>Field Blank and Replicate         |

Table 8: Measurement parameters analysed at a given number of sites on two sampling runs.

## 9. Sample bottle requirements

Table 9: Number of bottles required to sample for all identified measurement parameters, field blanks and replicates.

| Matrix | Parameters              | Bottle type | Sites | Sampling events | Samples/site | Duplicates | Field blanks | Total bottles |
|--------|-------------------------|-------------|-------|-----------------|--------------|------------|--------------|---------------|
| Water  | Total Nutrients and TSS | 500ml HDPE  | 25    | 2               | 1            | 1          | 1            | 52            |
| Water  | Dissolved Nutrients     | 500ml HDPE  | 26    | 2               | 1            | 1          | 1            | 52            |
| Water  | Metals                  | 500ml HDPE  | 8     | 2               | 1            | 1          | 1            | 16            |
| Water  | Total Water Hardness    | 500ml HDPE  | 8     | 2               | 1            | 1          | 1            | 16            |
| Water  | Total Organic Carbon    | 500ml HDPE  | 1     | 2               | 1            |            |              | 2             |
| Water  | Dissolved               | 500ml       | 1     |                 | 1            |            |              | 2             |

|       |                     |              |  |   |  |  |  |  |
|-------|---------------------|--------------|--|---|--|--|--|--|
|       | Organic Carbon      | HDPE         |  | 2 |  |  |  |  |
| Water | Physical parameters | N/A – insitu |  |   |  |  |  |  |

## 10. Labelling

The sample containers should be labelled with sequential sample registration number, the date of collection, the type of preservation (if any) and the client identification. Water samples are to be accompanied by field notes, field observation forms and chain of custody forms.

The sample bottle will be labelled prior to the time of sampling and collection in the field to ensure efficiency and organisation.

|                      |                            |
|----------------------|----------------------------|
| <b>Sample number</b> | <b>200638340</b>           |
| <b>Date</b>          | <b>22/08/2010</b>          |
| <b>Parameters</b>    | <b>Nutrients &amp; TSS</b> |
| <b>Agency</b>        | <b>EBICG/Tiwest</b>        |

**Figure 27:** Example of bottle label

## **11. Personal Safety**

A separate safety plan will be prepared and approved by representatives of the Department of Water and the Ellen Brockman Integrated Catchment Group prior to field sampling. Field sampling should not commence until the safety plan has been signed off by all parties involved in the sampling. The safety plan will indicate all areas of potential risk to personnel before, during and after the sampling, and develop specific strategies to minimise the risk.

## **12. MPL Laboratory**

MPL Laboratory is an accredited analytical laboratory which has been identified to analyse the water samples for the Brockman River catchment water quality monitoring program. Table 10 provides information on the analytical methods and limits of reporting, which are used by the laboratory. Following analysis MPL must produce a laboratory report which must provide details on the following in both electronic and final laboratory reports:

- Date and time of sample analysis
- Method code and description
- All laboratory Quality Control results including analyte recovery, accepted recovery range, lab blanks, lab duplicates, lab blank spike recovery, matrix spike recovery.

### ***13. Analytical Methods and Limit of Reporting (LOR) for MPL Laboratory***

Table 4 provides the MPL Laboratory method codes and limits of reporting (mg/L) for the measurement parameters selected for the Brockman River catchment sampling program. The measurement parameters cannot be detected below these limits provided.

Table 10: Analytical methods and limit of reporting (LOR) for MPL Laboratories

| Variable List | Limit of Reporting (LOR) | Variable Unit | Analysis Technique | Lab Reference- WILAB (based on APHA) |
|---------------|--------------------------|---------------|--------------------|--------------------------------------|
| Cond (Comp25) | 1                        | uS/cm         | direct read        | 5                                    |
| pH            | 0.05                     |               | direct read        | 5                                    |
| TSS           | 1                        | mg/L          | grav               | 5                                    |
| PO4-P         | 0.003                    | mg/L          | DA                 | 18                                   |
| NOx-N         | 0.005                    | mg/L          | DA                 | 18                                   |
| NH4-N         | 0.005                    | mg/L          | DA                 | 18                                   |
| DOrgN         | 0.05                     | mg/L          | Combustion         | 10                                   |
| TP            | 0.01                     | mg/L          | DA                 | 18                                   |
| TN            | 0.05                     | mg/L          | DA                 | 18                                   |
| Na            | 1                        | mg/L          | ICP OES            | 17                                   |
| K             | 0.1                      | mg/L          | ICP OES            | 17                                   |
| Ca            | 0.1                      | mg/L          | ICP OES            | 17                                   |
| Mg            | 0.1                      | mg/L          | ICP OES            | 17                                   |
| DOC           | 1.0                      | mg/L          | NIR                | 10                                   |
| TOC           | 1.0                      | mg/L          | ICP OES            | 18/5                                 |
| Hard          | 1                        | mg/L          | ICP OES            | 17                                   |
| Al            | 0.005                    | mg/L          | ICP OES            | 17                                   |
| Cd            | 0.001                    | mg/L          | ICP OES            | 17                                   |
| Cr            | 0.001                    | mg/L          | ICP OES            | 17                                   |
| Cu            | 0.005                    | mg/L          | ICP OES            | 17                                   |
| Fe            | 0.01                     | mg/L          | ICP OES            | 17                                   |
| Ni            | 0.005                    | mg/L          | ICP OES            | 17                                   |
| Zn            | 0.005                    | mg/L          | ICP OES            | 17                                   |
| Hg            | 0.0001                   | mg/L          | CV AAS             | 6                                    |
| As            | 0.001                    | mg/L          | GFAAS              | 6                                    |
| Pb            | 0.001                    | mg/L          | GFAAS              | 6                                    |

## **14. Sending samples to the laboratory**

Collected samples will be stored in an esky chilled to 4 °C with ice bricks out in the field and overnight, as the sampling will be conducted over 2 days. The samples will be delivered to Tiwest on the afternoon of the second day. A courier will pick the samples up the following day and deliver them (chilled) to MPL laboratory for analysis. A completed chain of custody (COC) must be included in the esky for the laboratory and a copy kept at the Chittering Landcare Centre. Turnaround time is 10 days from sample date to completion of analysis.

Once the samples are received the results will be emailed directly to the Chittering Landcare Centre and to 'data in' at Water Measurement and Information Branch, Department of Water.

## **15. Management and Reporting of data**

The sampling program and sampling sites will be registered with the Water Information Branch (WIN database managers) of the Department of Water. Water samples collected from the Brockman River catchment will be sent for analysis to MPL Laboratories, a laboratory accredited by the National Association of Testing Authorities (NATA). Analytical results will be returned to the Chittering Landcare Centre and to the Water Information Branch of the Department of Water to be entered onto their publicly accessible Water Information database (WIN). The water quality monitoring results will be collated, analysed and published as a Water Quality Snapshot Report for the Brockman River, where data will be compared to previous years sampling.

## **16. Comparison of Results with Guidelines**

Water quality results of the Brockman River catchment sampling and analysis program will be compared to the Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000). This guideline provides trigger values for both ecosystems and human health protection, as well as the following environmental values: aquatic ecosystems; primary industries; recreation and aesthetics; and drinking water. This snapshot will compare the results to the guideline trigger values for aquatic ecosystems and for livestock drinking water where appropriate.

The Guidelines recognise three levels of protection for aquatic ecosystems: areas which high conservation value, slightly to moderately disturbed ecosystems; and highly disturbed ecosystems. To assess the level of toxicant contamination in aquatic ecosystems, trigger values were developed from data using toxicity testing on a range of test species (ANZECC & ARMCANZ, 2000). The trigger values (99%, 95%, 90% and 80%) approximately correspond to the protection levels described above. Exceedance of the trigger value indicates that there is the *potential* for an impact to occur and should thus trigger a management response such as further investigation and possible remediation, or adaptation of the guidelines according to local conditions (ANZECC & ARMCANZ, 2000).

## **17. Roles and Responsibilities**

- Ellen Brockman Integrated Catchment Group (EBICG)/Chittering Landcare Centre will have overall responsibility for this project.
- The Water Science Branch of the Department of Water and Perth Region NRM are responsible for assisting with the preparation of the SAP, registering new sampling sites, providing advice regarding the sampling program and the preparation of the report of the results.
- Tiwest will be responsible for provision of sample bottles, delivery to laboratory and analysis costs of the samples.





## 18. Costs of the Brockman River catchment sampling program

Table 11: Costs of water quality sampling of the Brockman River catchment in 2012 with MPL on two sampling occasions.

| Parameter                   | Number of Sites | Number of Sampling Occasions | Cost of Analysis (\$) | Total Cost of Sampling (\$) |
|-----------------------------|-----------------|------------------------------|-----------------------|-----------------------------|
| <b>Nutrients</b>            | 26              | 2                            | <b>84.80</b>          |                             |
| <i>TSS</i>                  | 26              | 2                            | <i>9.90</i>           | <b>514.80</b>               |
| <i>TN</i>                   | 26              | 2                            | <i>14.40</i>          | <b>748.80</b>               |
| <i>TP</i>                   | 26              | 2                            | <i>14.40</i>          | <b>748.80</b>               |
| <i>Ammonia-N</i>            | 26              | 2                            | <i>9.90</i>           | <b>514.80</b>               |
| <i>Nox-N (Total Ox N)</i>   | 26              | 2                            | <i>9.90</i>           | <b>514.80</b>               |
| <i>SRP</i>                  | 26              | 2                            | <i>9.90</i>           | <b>514.80</b>               |
| <i>DOrganicN</i>            | 26              | 2                            | <i>16.4</i>           | <b>852.80</b>               |
| <i>TorganicN</i>            | 26              | 2                            | <i>0 (Calculated)</i> |                             |
| <b>Setup Cost</b>           |                 | 2                            | <b>12.45</b>          | <b>24.9</b>                 |
| <b>Metals</b>               | 7               | 2                            | <b>44.10</b>          |                             |
| <b>Setup Cost</b>           |                 | 2                            | <b>7.20</b>           | <b>14.40</b>                |
| <i>Al</i>                   | 7               | 2                            | <i>1.80</i>           | <b>25.20</b>                |
| <i>As</i>                   | 7               | 2                            | <i>6.75</i>           | <b>94.5</b>                 |
| <i>Cd</i>                   | 7               | 2                            | <i>6.75</i>           | <b>94.5</b>                 |
| <i>Cr</i>                   | 7               | 2                            | <i>1.80</i>           | <b>25.20</b>                |
| <i>Cu</i>                   | 7               | 2                            | <i>6.75</i>           | <b>94.5</b>                 |
| <i>Fe</i>                   | 7               | 2                            | <i>1.80</i>           | <b>25.20</b>                |
| <i>Hg</i>                   | 7               | 2                            | <i>9.90</i>           | <b>138.60</b>               |
| <i>Ni</i>                   | 7               | 2                            | <i>1.80</i>           | <b>25.20</b>                |
| <i>Pb</i>                   | 7               | 2                            | <i>6.75</i>           | <b>94.5</b>                 |
| <i>Zn</i>                   | 7               | 2                            | <i>1.80</i>           | <b>25.20</b>                |
| <b>Total Water Hardness</b> | 7               | 2                            | <b>1.80</b>           | <b>25.20</b>                |
| <b>DOC/TOC</b>              | 1               | 2                            | <b>38.70</b>          | <b>77.4</b>                 |
| <b>Blanks</b>               |                 | 1                            | <b>128.9</b>          | <b>128.9</b>                |
| <b>Replicates</b>           |                 | 1                            | <b>128.9</b>          | <b>128.9</b>                |
| <b>Batch Fee</b>            |                 | 2                            | <b>25.00</b>          | <b>50.00</b>                |
| <b>Total ex GST</b>         |                 |                              |                       | <b>\$4867.40</b>            |
| <b>GST</b>                  |                 |                              |                       | <b>\$486.74</b>             |

# Brockman River Catchment Sampling and Analysis Plan 2012

|                      |  |  |  |                  |
|----------------------|--|--|--|------------------|
| <b>Total Inc GST</b> |  |  |  | <b>\$5354.10</b> |
|----------------------|--|--|--|------------------|

*Please Note Analytical costs are based on 2010 prices for*

*MPL.*

Table 12: Budget for the 2012 Brockman River catchment monitoring project.

| Item  | Hours | People | Hourly Rate | Cost            |
|---|-------|--------|-------------|-----------------|
| <b>SALARY COSTS</b>   |       |        |             |                 |
| 1. Preparation of SAP   | 15    | 1      | \$33.89     | \$508.36        |
| 2. Sampling preparation   | 7.5   | 1      | \$33.89     | \$254.18        |
| 3. Sample collection  | 30    | 2      | \$33.89     | \$2033.40       |
| 4. Data management (site & program registration, data entry, verification/validation)                   | 7.5   | 2      | \$33.89     | \$508.36        |
| 5. Preparation/assistance with Report   | 37.5  | 2      | \$33.89     | \$2541.76       |
| 6. Travel costs/courier costs   | -     | -      | -           | \$600           |
| <b>CONSUMABLE COSTS</b>   |       |        |             |                 |
| 1. Analysis costs – Brockman River Monitoring Program 2012 (based on 2009 laboratory analytical prices) | -     | -      | -           | \$6123          |
| <b>TOTAL</b>  |       |        |             | <b>\$12,347</b> |

## 19. References

ANZECC and ARMCANZ (2000). *National Water Quality Management Strategy: Australia and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand

Banfield, K. (2001). *Management Strategies for Nutrient and Sediment Loss in the Ellen Brook Catchment: With an Introduction to constructed wetlands*. Department of Agriculture. Western Australia.

Department of Water. (2006). *Section 1: Water Quality Monitoring Program Design; A Guideline to the Development of Surface Water Quality Monitoring Programs*. Perth, Western Australia: Water Science Branch, Department of Water.

Department of Water. (2006a). *Section 2: Field Sampling Guidelines; A Guideline for Field Sampling for Surface Water Quality Monitoring Programs*. Perth, Western Australia: Water Science Branch, Department of Water.

Department of Water. (2006b). *Section 3: Technical Appendices; Standard Operating Procedures Water Sampling Methods and Analysis – Parameter Based*. Perth, Western Australia: Water Science Branch, Department of Water.

Horwood, W. (1997). *Snapshot of Water Quality in Ellen Brook October 1996: Prepared for the Ellen Brook Integrated Catchment Group and Swan River Trust*. Swan River Trust. Western Australia.

NHMRC & ARMCANZ (1996). *Australian Drinking Water Quality Guidelines*. National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand.

PPK Environment & Infrastructure (2000). *Ellen Brook Draft Catchment Management Plan* in association with Acacia Springs Environmental, Land Assessment, Hames Sharley, ERM Mitchell McCotter and V & C Semeniuk Research Group.

## Appendix A: Analysis Requirements

(To be attached to all COC forms)

Project: SG-C-BROCKMANWQ

COC numbers: \_\_\_\_\_

| Group    | Analytes  | Special instructions  |
|----------|---|---|
| <b>A</b> | Dissolved Nutrients:                            | To be reported at standard LORs   |
|          | Total Nitrogen                                  | 0.05mg/L  |
|          | Total oxidised nitrogen                         | 0.01 mg/L   |
|          | Nitrogen as ammonia                             | 0.01 mg/L   |
|          | Total Phosphorous                               | 0.01mg/L  |
|          | Total Filterable Phosphorous                    | 0.005mg/L   |
|          | Filterable reactive phosphorus                  | 0.005 mg/L  |
|          | Dissolved organic nitrogen                      | 0.025 mg/L  |
| <b>B</b> | Total Metals:                                   | To be reported at limits of reporting for analysis using ANZECC guideline trigger values: |
|          | Cd & Hg   | 0.1 µg/L (0.0001 mg/L)  |
|          | As, Cu, Pb & Zn                                 | 1.0 µg/L (0.001 mg/L)   |
|          | Al, Cr, Fe, & Ni                                | 5.0 µg/L (0.005 mg/L)   |
| <b>C</b> | Total Organic Carbon & Dissolved Organic Carbon | 1.0 mg/L (both)   |

**Please note:**

**Total water hardness (LOR of 1.0 mg/L) to be extracted from TSS bottle.**

***Appendix B: Equipment List for Collecting Water Samples***

- Twenty-six 500ml HDPE bottles. Two of the five sampling runs will require two extra for blanks and replicates. The metal sampling run will require an extra six bottles for Total Water Hardness.
- Calibrated Quanta probe for measurement of in-situ parameters, including the probe cover, protection cap and surveyor (provided by the Department of Water).
- Field filtering equipment – hand pump, filter tower, filter paper and tweezers.
- Deionised water for field blanks.
- Deionised water spray bottle for cleaning the filter tower.
- Tap water for filling the probe protection cap, and drinking water.
- Bucket for measurement probes/surveyor.
- Sampling and Analysis Plan (SAP)
- Safety Plan
- Chain of Custody (COC) forms
- Field Observation (FOF) forms
- Eskies with ice bricks.
- Masking tape
- Nitrile gloves, gumboots, waders, coveralls, safety glasses, sunscreen, hat, and other protective gear.
- Map of sites.
- GPS (if required)
- Permanent marker, pencil and pen

# **Safety Plan**

## **Brockman River Catchment Water Quality Monitoring Snapshot 2012**



**Plate 1:** Spoonbill Lake, Brockman River Catchment (2008)

**Prepared by Ellen Brockman Integrated Catchment group: June 2012**



This project is funded by Tiwest Joint Venture on behalf of the Ellen Brockman Integrated Catchment Group.



## Table of contents

|   |            |
|---|------------|
| <b>TABLE OF CONTENTS .....</b>  | <b>137</b> |
| <b>1. INTRODUCTION .....</b>  | <b>138</b> |
| <b>2. SITE ASSESSMENT .....</b>   | <b>139</b> |
| <b>3. SAMPLING SITE LOCATIONS .....</b>   | <b>140</b> |
| TABLE 1: LOCATION AND DESCRIPTION OF SAMPLING SITES IN THE BROCKMAN RIVER CATCHMENT. .... | 140        |
| <b>4. PERSONAL PROTECTION AND EQUIPMENT .....</b>   | <b>143</b> |
| <b>5. ACCESS TO MEDICAL HELP .....</b>  | <b>144</b> |
| <b>6. IMPORTANT CONTACT NUMBERS: .....</b>  | <b>144</b> |
| TABLE 2: EMERGENCY CONTACTS .....   | 144        |
| <b>7. HAZARD IDENTIFICATION .....</b>   | <b>146</b> |
| TABLE 3: RISK ASSESSMENT .....  | 146        |
| <b>8. EXPERIENCE OF SAMPLING PERSONNEL .....</b>  | <b>147</b> |

### List of Plates

|  |   |
|--|---|
| Plate 1: DoW Officer Dominic Heald sampling at Yalliwirra (2008) ..... | 1 |
|--|---|

### List of Figures

|  |     |
|--|-----|
| Figure 1: Location of sampling sites within the Brockman River Catchment. .... | 142 |
|--|-----|

## 1. Introduction

Collecting water, sediment and biota samples of unknown history potentially exposes sampling personnel to direct contact with material that may be hazardous to their health. The purpose of the safety plan is to provide personnel undertaking water quality sampling in the Brockman River catchment with safety and health requirements. The safety plan indicates all potential areas of risk to personnel before, during and after the sampling and recommends specific strategies to minimise this risk. Occupational health, safety and welfare in the workplace is a shared responsibility and the Chittering Landcare Centre relies on consultation, commitment and participation from all officers.

All employees have the responsibility for ensuring their own health, safety and welfare, reporting hazards in the work area and following established practices and procedures aimed at providing a safe and healthy work environment for all. This plan should be used in conjunction with the Chittering Landcare Centre's Occupational Health & Safety Policy, particularly the following protocol related to officers undertaking field work:

Before departing the office for field work, the worker must ensure that they:

- post their itinerary including specific details of times, location and contact mobile telephone on the staff notice board. If possible a contact landholder name and phone number should be provided.
- are suitably clothed with protective clothing and boots for the task.
- have all their safety equipment, adequate drinking water and first aid equipment in their vehicle.
- have their mobile phone with them and the battery is charged.
- have adequate fuel in their vehicle for the task.

The worker is to contact a staff member at the Chittering Landcare Centre no later than **1 hour** after their nominated time of return. The details of these checks are to be recorded next to the worker's name on the notice board.

If no contact has been made within one (1) hour of the lone worker's nominated time of return, Chittering Landcare Centre officers are instructed to attempt to make contact with the worker,

either by using the contact details posted on the notice board, or the designated mobile telephone.

If no response is received from the worker following attempts to make contact, inform the staff, Chittering Landcare Centre Manager or a senior officer from the Shire of Chittering (CEO, Deputy CEO or Shire Ranger) whose contact details are posted on the notice board. A search will then be initiated using the lone worker's stated itinerary.

## **2. Site assessment**

The purpose of the preliminary site assessment is to determine the best location to collect the sample. Site selection depends more on true representativeness of the area under investigation and any safety concerns associated with collecting the sampling. Site selection should not be determined primarily by ease of access although it is a factor contributing to site selection.

All sites involve foreshore environments and are accessed by road, and the issues involved for all sites are included in the "Hazard Identification" Table within this plan. Most sites are publicly accessible.

| Site No. | Site name                              | Description of waterway<br>(inc. old site number) | Easting | Northing |
|----------|--|---|---------|----------|
| BRN1     | Murphy Gully Creek                     | BR22 - Bindoon Moora Rd                           | 409205  | 6561412  |
| BRN2     | Jackson Road<br>(Wannamal Lake outlet) | BR21 - Jackson Road                               | 409457  | 6555480  |
| BRN3     | West Point Creek                       | BR20 - West Point                                 | 409754  | 6555706  |

### 3. Sampling site locations

*Table 13: Location and description of sampling sites in the Brockman River Catchment.*

*man River Catchment.*

## Brockman River Catchment Sampling and Analysis Plan 2012

|       |  |  |        |         |
|-------|--|--|--------|---------|
| BRN4  | Wannamal South                                   | Wannamal South Road  | 407596 | 6552244 |
| BRN5  | Udumung Creek                                    | BR18 - Hay Flat Road   | 410373 | 6551048 |
| BRN6  | Kangaroo Gully Creek                             | BR17A - Bindoon Moora Rd   | 412741 | 6547952 |
| BRN7  | Gooninong<br>Romany Creek                        | BR17 - Waldeck West Road -<br>Romany Creek                           | 413360 | 6546355 |
| BRN8  | Longbridge Creek                                 | BR16A - Ashman Rd to gate<br>(2km) over fence & nth on fire<br>break | 414649 | 6542478 |
| BRN9  | Wootra Brook                                     | BR15 - Owen's Road   | 416762 | 6537439 |
| BRN10 | Bindoon River                                    | BR15A - Great Northern<br>Highway small bypass road<br>bridge        | 417372 | 6531777 |
| BRN12 | Flat Rocks Creek                                 | Densley Road (off Flat Rocks)  | 415077 | 6524296 |
| BRN13 | Spoonbill Lake                                   | BR12 - spillway from<br>Spoonbill Reserve                            | 412361 | 6523223 |
| BRN14 | Aquila, Hart Drive                               | BR12A - Flows through<br>Aquila Reserve                              | 412306 | 6522632 |
| BRN15 | Lake Road<br>Brockman River                      | BR9 - Bridge on Lake Road<br>below Lake Weir                         | 414090 | 6521308 |
| BRN16 | Spice Brook                                      | BR11A - off Lake Road across<br>paddock to bridge                    | 414509 | 6521156 |
| BRN17 | Toodyay Creek<br>Toodyay Creek                   | 100m north of Blue Plains<br>Road on Chittering Road                 | 414561 | 6518111 |
| BRN18 | Julimar/Chittering Bridge<br>Brockman River      | BR5 - Julimar Rd/Chittering<br>Rd intersection                       | 415996 | 6515275 |
| BRN19 | Julimar/Chittering Tributary<br>Julimar Rd Creek | BR8 - Julimar Rd (500m up<br>from intersection Chittering<br>Rd)     | 417103 | 6515877 |
| BRN20 | Chittering Valley                                | Cnr Chittering Valley and<br>Chittering Road                         | 416288 | 6510308 |
| BRN21 | Keating Road                                     | BR4 - 500m east on Keating<br>Road to gateway - Bitney<br>Springs    | 419248 | 6508210 |
| BRN22 | South Chittering Creek                           | Chittering Road just north of<br>Wilson Road                         | 415559 | 6500608 |
| BRN23 | Marbling Brook                                   | Bridge on Chittering Road  | 414704 | 6506641 |
| BRN24 | Moondyne<br>Brockman River                       | BR2 - from crossing  | 416623 | 6499996 |
| BRN25 | Yalliawirra<br>Brockman River                    | BR1 Gauging Station  | 416450 | 6495160 |
| BRN26 | Marda Brook                                      | Smith Road bridge/gate   | 414266 | 6496860 |
| BRN27 | Grey Road Bridge                                 | Brockman River   | 413885 | 6528696 |

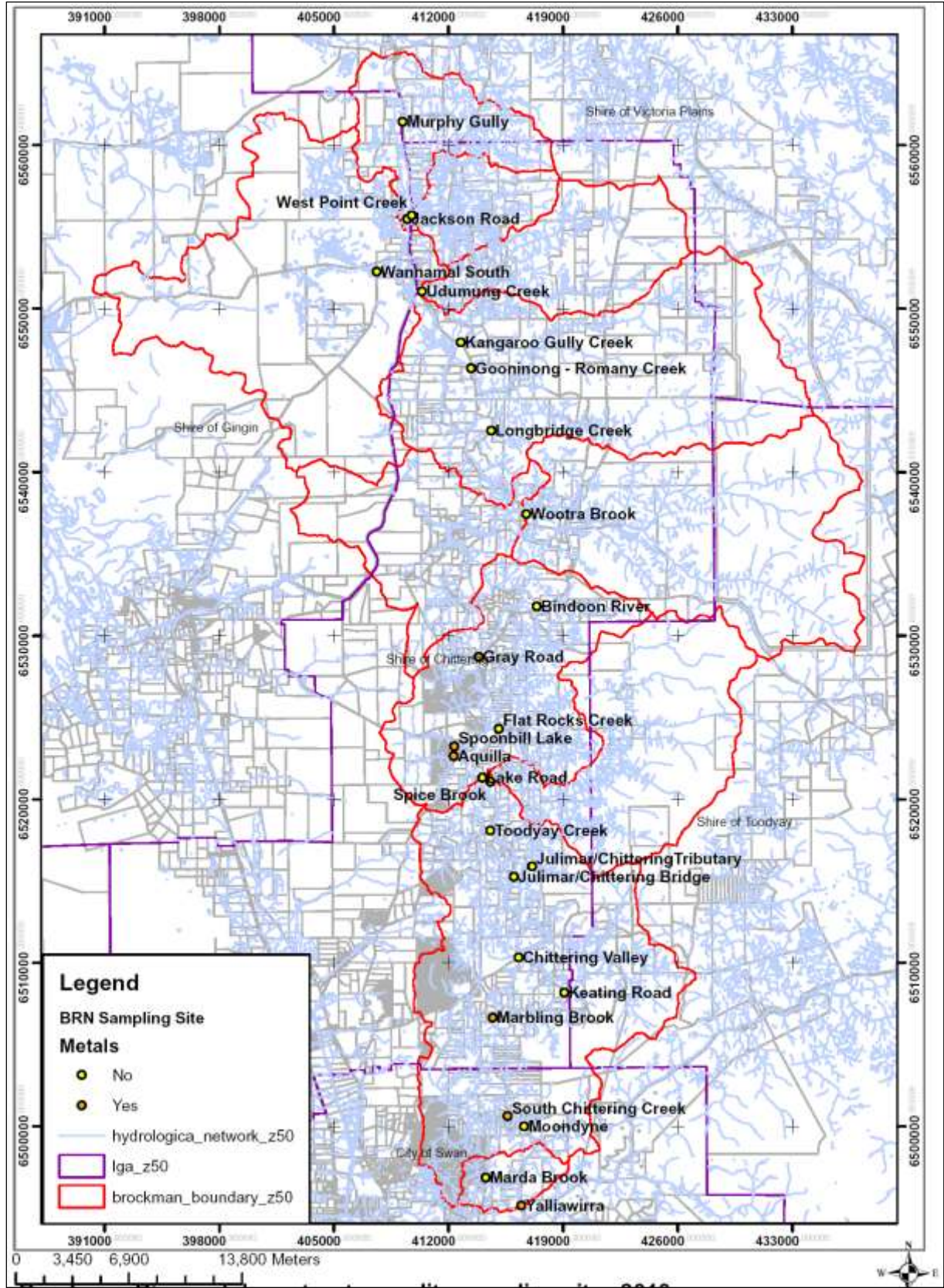


Figure 28: Location of sampling sites within the Brockman River Catchment in 2011

#### **4. Personal protection and equipment**

Officers involved in water sampling activities should heed the following to ensure that their personal safety outside of the office is made a priority.

- A mobile phone should be carried so that contact can be made with the office at specified times or for emergency.
- All work vehicles should be equipped with a first aid kit.
- All work vehicles should be equipped with a current fire extinguisher.
- All workers who work in isolated conditions in the field should have a current Senior First Aid certificate or first aid training to suit their particular needs.
- Workers driving four wheel drive vehicles should be trained in driving in such conditions.
- Personnel should wear thin nitrile gloves and eye protection whilst collecting water samples.
- If entering the water, waders or gum boots should be worn. The alternative to gum boots if not entering the water is steel capped, enclosed leather boots.
- Normal sun-protection should be adopted (hat, long sleeves and sunscreen) as the sampling is an outdoor activity. In the case of rain, a raincoat or weatherproof jacket should be worn.

Adequate water (at least 5 litres) should be carried on board the vehicle at all times and is located in the tray section of the ute. Drinking water regularly when out in the field is vital to prevent dehydration, particularly in warmer months.

## 5. Access to medical help

At least one of the sampling officers must have a current first aid certificate. The car used for sampling always has a first aid kit – it is located in the tray of the vehicle in a plastic box. At least one operational mobile phone will be with the officers at all times. If more than simple first aid treatment is required then the **emergency number 000** should be dialled and an ambulance ordered to escort the injured person to hospital. A map showing direction and routes to the nearest hospital must be provided to all personnel prior to departure in the field.

The nearest hospitals are:

1. **Swan District Hospital, Eveline Road, Middle Swan, 6056**  
**Tel: (08) 9347 5244**

To get to the Swan District Hospital, follow Great Northern Highway south, then right onto Eveline Road.

2. **Bindoon Medical Centre, Great Northern Highway, Bindoon WA 6502**  
**Tel: (08) 9576 1222**

To get to the Bindoon Medical Centre, follow Great Northern Highway to Bindoon.

## 6. Important Contact Numbers:

**Table 14: Emergency Contacts**

| Name/Service   | Contact phone | Mobile     |
|--|---------------|------------|
| <b>Chittering Landcare Centre</b> - Bonny Dunlop-Heague              | (08)95710300  | 0428434351 |
| <b>Chittering Landcare Centre</b> - Kay Reid                         | (08)95710400  | 0428528030 |
| <b>Chittering Landcare Centre</b> - Rosanna Hindmarsh (co-ordinator) | (08)95710400  | 0429887715 |
| <b>Chittering Landcare Centre</b> – Megan O’Grady                    | (08)95710200  | 0467243242 |
| <b>Chittering Landcare Centre</b> – Sue Pedrick                      | (08)95714351  | 0427203929 |
| <b>City of Swan</b> – Patrick Hedges (Ranger)                        | (08)92679267  | 0419192055 |
| <b>Fire Brigade</b> – Lower Chittering (Max Brown)                   | (08)95718149  | 0427089677 |
| <b>Fire Brigade</b> – Chittering (Dennis Badcock)                    | (08)95761536  | 0428947853 |
| <b>Medical Centre</b> - Bindoon                                      | (08)95761222  |            |
| <b>Police Midland</b>  | (08)92221111  |            |
| <b>Shire of Chitteriing</b> – Craig (Ranger)                         | (08)95760282  | 0427699700 |
| <b>Shire of Gingin</b> – Michael Pimm (Ranger)                       | (08)6551286   |            |
| <b>Perth Region NRM</b> – Administration                             | (08)93743333  |            |
| <b>Tiwest</b> – James Owen (Environmental                            | (08)95719246  | 0417174834 |



Brockman River Catchment Sampling and Analysis Plan 2012

|                           |              |  |
|---------------------------|--------------|--|
| Officer)                  |              |  |
| <b>Tiwest</b> – Reception | (08)95719333 |  |

## 7. Hazard identification

All personnel must be trained in identification of potential hazards at a sampling site. This involves listing potential dangers to sampling personnel when at the sampling site, such as collapse of stream bank, falling into the stream, and contact with water from the stream, exposure to heat, wind and rain.

All personnel must be briefed of potential hazards at sample sites. There is a potential for exposure to very acidic waters. Entry into the drains/waterways must be done wearing protective clothing unless pH has been determined to be within safe limits (pH 5.5-8).

**Table 15: Risk Assessment**

| Identified Risk  | Precautions  |
|--|--|
| Exposure to chemicals and handling of contaminated samples & sampling or entering potentially low pH waters. | Wear protective clothing at all times: field boots or gum boots, nitrile gloves (waders if expecting to go into water at above ankle level).   |
| Physical injury from falling (especially steep slopes with sandy banks)                                      | Inspect accessibility to site before transferring equipment from car. If site is too steep, unstable or otherwise dangerous do not sample.   |
| Insect, spider, rodent or snake bites.   | Inspect site prior to sampling, especially drain culvert openings and wear long pants and high boots for walking through long grass.   |
| Traffic on roads near sites  | Bright safety vest with reflective strip should be worn when working along road sides and care should be taken to watch out for traffic at all times. Hazard lights should be left on vehicle whilst sampling. |
| Manual handling of heavy equipment and eskies/samples  | Wear work boots and lift heavy objects ensuring no risk to back. If necessary, use two people to lift larger eskies.   |
| Sampling at sites where algal scums are present  | Always wear nitrile gloves when sampling and avoid contact with water. Take care when handling food after sampling.  |
| Sunburn, exposure (dehydration and heat stroke, exposure to cold).   | Apply sunscreen, wear hats, rain jackets, work pants, jumpers as appropriate. Take plenty of drinking water (labelled as drinking water and kept separate from sample bottles).                                |

## **8. Experience of sampling personnel**

Samples should only be collected by personnel who have received training from the Aquatic Science Branch of the Department of Water or a recognised authority.