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# Revision of the River Murray Water Quality Monitoring Program



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## Executive Summary

### Background

The physico-chemical monitoring component of the Water Quality Monitoring Program (WQMP) was designed by the Commission's intergovernmental Water Quality Committee and published in 1979. It was subsequently amended slightly in 1980 and 1983. The data was reviewed in 1988 and 1999 with further analysis of trends in 2002. In 2005 another review led to decreases or increases in the extent and frequency of analysis of various parameters, as well as a survey of heavy metals along the Murray.

Prior this revision the monitoring program measured a suite of water quality parameters at 36 sites along the Murray River and its major tributaries. In 2012 the Ministerial Council reduced the budget for monitoring to \$450,000 for the 2013–14 year, which essentially halved the capacity for the River Murray water quality sampling cost. At the same time, the budget for data analysis and program management was halved, necessitating cessation of various other functions such as coordinating event monitoring and assessing certain development proposals.

### Past revisions to the RMWQMP

Since commencement in 1978, a number of reviews of the RMWQMP and its datasets have been undertaken. These outlined methods and results, characterised the River Murray in terms of the attributes being monitored, presented trend analyses and made revisions to the sampling specifications. These revisions, together with continuous improvements by the contracting governments, captured efficiencies and successfully held the cost increases to a minimum level, with less than a 10% increase in total cost over the last ten years.

### New objectives

To achieve the statutory requirements within the reduced budget, the size of the sampling network and/or frequency must be reduced. Future activity must specifically focus on the core responsibilities of the Authority, having regard to Basin water quality obligations. The Authority's core responsibilities for River Murray water quality are defined in the Murray–Darling Basin Agreement under Schedule 1 and identified in the new objectives below (which are cross-referenced to the relevant Clauses):

- To establish, maintain and operate an effective and uniform system for measuring and monitoring water quality of the River Murray, its tributaries at or near their confluence, and stored water (Clause 45(c)).
- To provide data that assists the investigation of works or measures that could protect or improve the quality of river water (Clause 43(1)(b)).
- To provide data that allows assessment of the possible significant effect of any proposal on the water quality of the River Murray (Clause 49).
- To provide data that will assist the Authority to have regard to the improvement or maintenance of water quality when giving directions for the release of water from upper River Murray storages (Clause 98(4)(i)).

In relation to Objective 1, “effectiveness” of the RMWQMP has, in the past, been considered to be its degree of compliance with the guidelines of the National Water Quality Management Strategy. However, under the new budget only limited compliance is possible and the effectiveness of the RMWQMP would be better measured by its degree of support to the next

three objectives, which address core water quality responsibilities under the Murray–Darling Basin Agreement.

In relation to Objective 3, the assessment of the possible effect of proposals is based largely on comparative analyses of the loads of the proposed discharge relative to the background loads in the river – these background loads can only be calculated reliably with weekly data. For the stations situated within the main stem of the river the savings should be found by reducing the number of stations and parameters, rather than the frequency of sampling.

Since the establishment of the Basin Plan, the data also supports the assessment of the achievement of water quality objectives and targets.

### Measures to reduce cost

Given the significant budget cut, the Authority, based on a study undertaken by the Murray–Darling Freshwater Research Centre (MDFRC), and assessment by the intergovernmental Water Quality Advisory Panel, proposes to revise its current monitoring program by reducing some water quality parameters, the number of sites, and the frequency of sampling in the tributaries.

#### Reduce parameters sampled

The previous monitoring program under this review measured a suite of water quality parameters at 36 sites along the Murray River and its major tributaries (Figure 1). Basic water quality parameters (pH, turbidity, electrical conductivity [EC], colour and temperature) were measured at all sites on a weekly basis. Six additional parameters (oxides of nitrogen [NO<sub>x</sub>], total Kjeldahl nitrogen [TKN], total phosphorus [TP], filterable reactive phosphorus [FRP], silica and dissolved [soluble] organic carbon [DOC]) were measured weekly at 26 sites. Additional quarterly measurement of major ionic concentration (Sodium, Potassium, Calcium, Magnesium, Chloride, Sulphate and Bicarbonate) was carried out at six sites. The MDFRC review concluded a very high correlation between the overall EC of the samples and most ionic constituents measured at the various sampling sites. As a result, it appears the cessation of routine monitoring of sodium, potassium, calcium, magnesium, sulphate, chloride and bicarbonate could reduce the cost of chemical analyses in the program. Given the importance of bicarbonate (buffering) and sulphate (due to recent acid drainage issue from acid sulphate soil in lower part of Murray) the Authority proposes to keep these two parameters as a part of monthly monitoring program on all five locations.

The concentrations of 10 metals were measured at Morgan on an approximately monthly basis. The MDFRC review of the long-term data on these metals suggests there is little value in continuing this given the poor quality of the dataset and the lack of action regarding exceeding thresholds. They recommended suspending monthly sampling of metals and replacing with a well-designed sediment sampling program conducted every 3–5 years, using the URS (2007) results as a baseline for comparison. However, due to the severity of acid drainage discharge now being exported from the lower Murray irrigation area, South Australia has requested that the metal analysis at Morgan be shifted to Tailem Bend, with the addition of Arsenic to the suite of metals.

A recent Authority trend analysis of water quality parameters collected over the last 35 years (1978–2012), indicates general broad decreases in nutrients (TP, FRP, TKN, NO<sub>x</sub>) though NO<sub>x</sub> and TP show increases in the upper Murray (Jingellic to Bandiana). According to this report, the tributaries are clearly impacting on sampling sites downstream of their confluence with the Murray.

The report further emphasises the invaluable nature of the 35 year water quality data record and the importance of its continuation in the context of providing a risk management tool for potential changes caused by future climate and the Murray–Darling Basin Plan implementation.

### Reduce number of sites

Pursuant to Ministerial Council's decision of a reduced budget for water quality monitoring, the Authority engaged the MDFRC to investigate if the frequency of sampling, a reduction in the number of sites and/or a reduction in the number of constituents measured under the RMWQMP will result in an erosion of the Authority's ability to assess trends in key water quality parameters. The MDFRC report concluded that if the sampling program is being reduced, the number of sites rather than the frequency of sampling should be reduced. Further recommendations are to reduce some major ionic constituents such as sodium, potassium, calcium, magnesium, sulphate and chloride, and introduce sediment sampling at Morgan for heavy metal monitoring. MDFRC recommendations were consulted with the participating states through the Water Quality Advisory Panel (WQAP) members. For a new WQ monitoring program of the River Murray, the WQAP came up with a set of 28 sites (out of existing 36 sites) together with reduced sampling frequency for the tributaries with an aim to still deliver the obligation under Schedule 1 of the *Water Act 2007*.

### Reduce frequency

The WQAP members requested that the Authority consider reducing sampling frequencies for some sites where concentration is more important than load. For example, this would include tributaries that can be sampled monthly and still be adequately assessed against the water quality objectives. While the frequency for the tributary sampling frequency is proposed to be decreased to monthly, the main channel frequency shall be maintained at weekly in order to capture the data for calculating loads confidently. Weekly sampling in the main channel is considered essential to meeting the responsibilities of Clause 49 of Schedule 1 of the *Water Act 2007*. A list of class and frequency of analysis of the revised monitoring program is presented in Tables 1, followed by a list of 28 sites with water quality parameters and monitoring frequencies (Table 2). A detailed map showing the locations, parameters and classes of the revised water quality monitoring sites is given in Figure 2. Macroinvertebrate monitoring is expected to be carried out by a separate program, which is outside the scope of this revision.

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## 1. Introduction

As a requirement of the Murray–Darling Basin Agreement, the quality of water in the River Murray and its tributaries has been monitored routinely since 1978. Prior to this review, samples were collected at weekly or quarterly intervals from 36 sites along the River Murray and its tributaries and analysed for a range of attributes including physico-chemical and biological parameters. The statutory requirement in Clause 45 of the Agreement for maintaining an ‘effective and uniform system’ for monitoring enables the data to be used to address water quality-related responsibilities in Clause 43 (investigating works and measures), Clause 49 (assessing the impact of proposals) and Clause 98 (operating storages). This monitoring data provides the most significant and extensive long-term, continuous record of water quality in the River Murray. The program is periodically reviewed to update and improve its efficiency and effectiveness and was last revised in 2005 (Lawrence and Paterson, 2005). As a result of these reviews, the increase in the overall cost of collecting and analysing the samples has been limited to less than 10% over the last decade.

### 1.1. Drivers of the revision

On 29 June 2012 the Ministerial Council approved the undertaking of a review of arrangements for Murray- Darling Basin joint activities by a task force, to be overseen by the Basin Officials Committee (BOC). The outcome of this review was a reduced budget option totalling \$89.677M for 2013–14 (compared to the historic figure of \$119M), which was recommended by BOC to the Ministerial Council and considered out-of-session. In recommending the reduced budget option the River Murray water quality sampling, analysis and program management costs were halved, supplementary investigations were deleted and various other functions such as coordinating event monitoring and assessing certain development proposals were removed.

The Ministerial Council’s decision to reduce the sampling and analysis budget by half (from approximately \$900,000 to \$450,000) for sampling and analysing water quality along the Murray necessitates this revision of the existing sampling network and analytical protocol.

## 2. The River Murray water quality monitoring program

### 2.1. Origin

The Commission's statutory responsibilities in regard to water quality evolved in January 1973 when the South Australian Premier approached the then Prime Minister Whitlam expressing his anxiety about the maintenance of both water quality and quantity of water available in the River Murray. In March 1973 the Prime Minister invited the Premiers of the three states to discuss the River Murray, the existing powers of the River Murray Commission and the problems which had arisen with regard to ensuring water quality. This meeting resulted in a directive of the Prime Minister and State Premiers to investigate measures to protect and improve water quality in the River Murray. A River Murray working party was formed, comprising River Murray Commissioners of the day and reporting to a Ministerial Steering Committee. The Working Party convened sub-committees on water quality, irrigation practices, salinity and biological conservation. Their report<sup>1</sup> recommended broadening the functions of the Commission by amending the River Murray Waters Agreement. The three state Governments and the Commonwealth government accepted the recommendations of the working party report in October 1976 and authorised the Commission to operate on an interim basis within its proposed water quality functions, pending completion of legislative action to amend the River Murray Waters Agreement.

Accordingly, the Commission established a Water Quality Committee comprising experts nominated by the Commonwealth and the states of New South Wales, Victoria and South Australia, who in turn assigned a working group with the task of designing a monitoring program having due regard for the Commission's expanded responsibilities in the field of water quality. The location of sampling sites was based on pre-existing sites and gauging data, and the location of significant inflows and offtakes. The Water Quality Committee's report was published in 1979<sup>2</sup>. Sampling had commenced in accordance with their initial design in July 1978.

The amendments to the Agreement were subsequently finalised in 1982 with a major revision to the Agreement. The water quality responsibilities were strengthened through the late 1980s as the Agreement underwent revisions, until it was incorporated in Schedule 1 of the *Water Act 2007*.

### 2.2. The “construct” of water quality monitoring in the Agreement

The 1975 working party report was explicit in stating that to be effective in protecting and improving water quality, the following powers were required to monitor and investigate, to coordinate information, to set objectives and to make representations. These provisions exist in the current Agreement in Clauses 45 and 43, 47, 48 and Section 172(g) of the Water Act (see [Appendix A](#)). Making representations (as now provided for in Section 172(g)) was identified as having a correlative duty on the parties to provide information on proposals that may have a cumulative effect – hence Clause 49, which requires the parties to inform the Authority of proposals on the Murray. The proposing of quality standards that were applicable at a reach scale was seen as providing consistency between the state approaches to pollution control; and

<sup>1</sup> River Murray Working Party (1976) *River Murray Working Party Report to Steering Committee of Ministers October 1975*. Australian Government Publishing Service, Canberra.

<sup>2</sup> Water Quality Committee (1979) *River Murray Water Quality Monitoring Programme – Water Quality Committee Report to River Murray Commission*. River Murray Commission, Canberra.

being necessary in order to make recommendations to the parties on standards to be maintained, hence Clause 48, requiring the development of water quality objectives, now superseded by the Basin Plan's Target Values.

In addition the monitoring results were seen as informing operational responsibilities relating to water quality under the Agreement. For example, Clause 98(4) which allows the Authority to have regard to the improvement or maintenance of water quality in its operation of storages.

### 2.3. Description of the Program

The former River Murray Commission commenced the River Murray Water Quality Monitoring Program (RMWQMP) in July 1978 according to the design of its Water Quality Committee. The RMWQMP was designed according to the following stated functions:

- the provision of data which will enable the development and improvement of management plans for meeting water quality objectives in the River Murray
- the periodic reporting and assessment of water quality to determine trends
- the indication of changes in water quality brought about by control measures
- the requirement for additional investigation on control measures
- the characterisation of the effect of long term changes in land use and land management on water quality.

In its initial form, the RMWQMP had in its initial form a network of 32 stations located on the main stem of the River Murray and the lower end of its tributaries. A suite of up to 20 physico-chemical parameters were measured at varying frequencies according to the class of station. During 1980 the RMWQMP was expanded to include three more stations, as well as algal counts, macroinvertebrate sampling and heavy metal sampling at selected stations. During 1983 the frequency of nutrient measurements and the extent of major ion measurement were both increased. After 2005 a further station was added, major ion analyses were reduced and soluble organic carbon and colour measurements were increased. Figure 1 shows the location and class of each station and the parameters and frequencies sampled prior to the revision of the program.

This program prior to the revision also collected monitoring information on phytoplankton from 13 locations in the Murray. While revising the water quality monitoring program, one site (Barr Creek at Capels Flume/Crossing) under the phytoplankton monitoring sub-program were discontinued from Jan 2014 as it fell within the category of budget unviable sites. Remaining 12 monitoring sites in the revised program are given in [Table 2](#) and [Figure 2](#) respectively. Additionally, the MDBA monitors macro-invertebrates from eight locations in the Murray covering nearly 2,500 km of river length. Please note that only six sites from the macroinvertebrates program are shown in Figure 2. This long-term monitoring represents one of Australia's most extensive biological datasets and is used to determine the health of the Murray in response to changes in flow, water quality, river management and climate. Full description and review of the phytoplankton and macroinvertebrates monitoring programs are out of the scope of this revision.

Each station is monitored by one of the three states, with samples being analysed at their respective laboratories and final quality assured results made available to the MDBA approximately one month later. Of the thirty-six sites, New South Wales monitors seven, Victoria eighteen and South Australia the remaining eleven. [Appendix B](#) contains a state-by-state breakup of the monitoring activity.

Revision of the River Murray Water Quality Monitoring Program

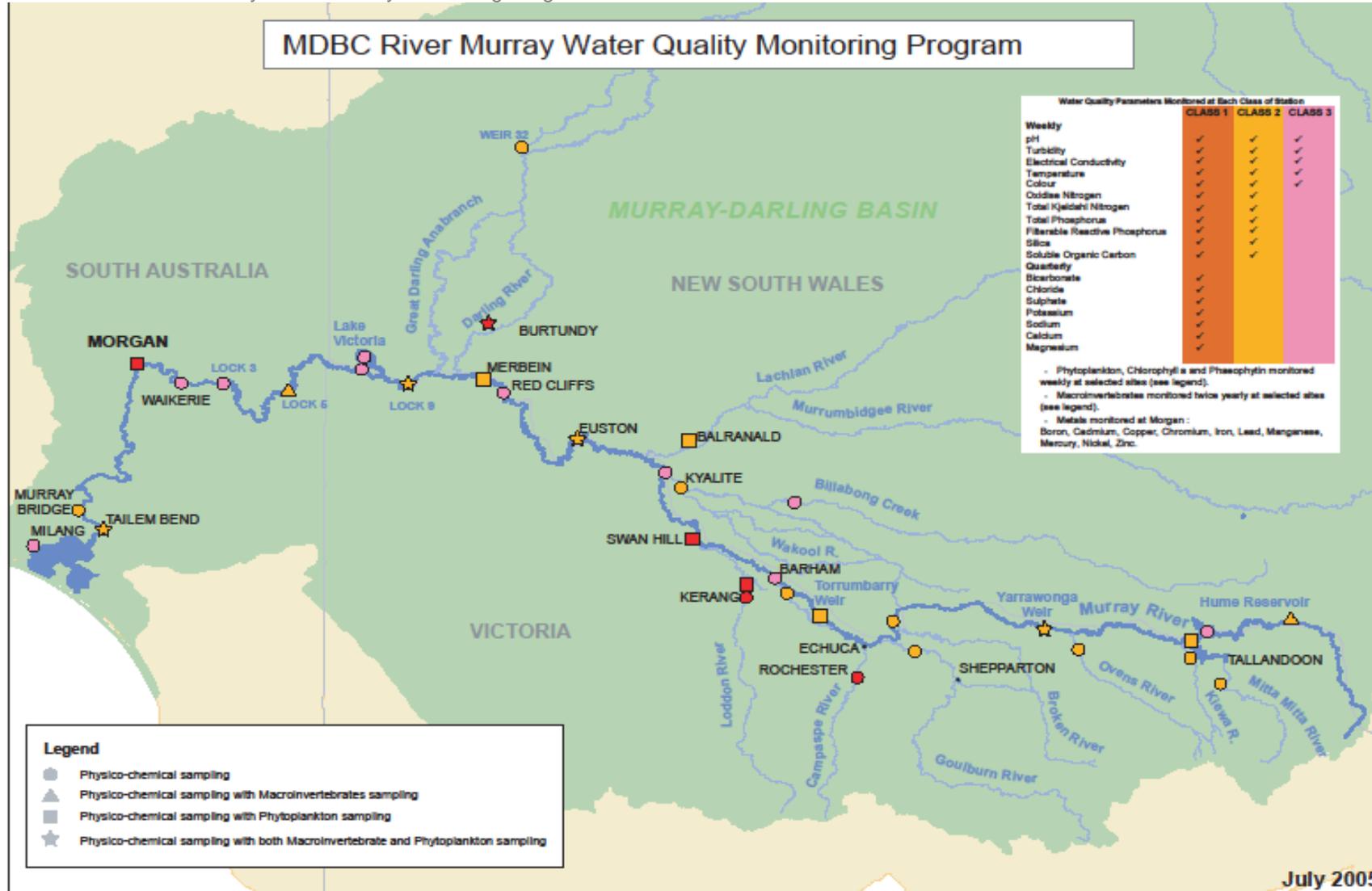


Figure 1. River Murray Water Quality Monitoring Program sites, parameters and frequencies prior to the revision (defunct w.e.f Dec 2013)

## 2.4. Review history

A review of the first eight years of the RMWQMP was published in 1988<sup>3</sup> together with the review of the first five years of phytoplankton<sup>4</sup>. Another parallel review of the first five years of macroinvertebrate data was published in 1989<sup>5</sup>. All three reviews outlined methods and results, characterised the River Murray in terms of the attributes being monitored, presented trend analyses and made recommendations for future monitoring. The reviews confirmed the need to continue the RMWQMP and resulted in a number of revisions to the sampling program. A number of supplementary investigations into water quality issues were also undertaken.

In line with the recommendations made in these early reviews, the former Murray–Darling Basin Commission (MDBC) conducted a second review of the RMWQMP in 1998 through a 3-stage process. This was: review, analysis and revision, which were undertaken over a six-year period as funds allowed.

The stage 1 report<sup>6</sup> was published in 1999 and provided a general description of the water quality variables monitored and the macroinvertebrate community. It identified the role of each variable as an indicator of water quality or ecological condition. This first stage also reviewed the broad relationships between the physico-chemical variables, phytoplankton, macro-invertebrates and stream-flow data.

The stage 2 report<sup>7</sup> was published in 2002 and provided specific analyses of temporal trends of key physico-chemical quality parameters and phytoplankton communities. It also described the relative impact of the tributaries on the water quality of the River Murray. The macroinvertebrate component of the RMWQMP was considered separately in this Stage 2 analysis via a discussion paper in 2000<sup>8</sup> which reviewed sampling methods and contained six recommendations for changing the program.

The stage 3 revision was completed and published in 2005<sup>9</sup>. It recommended changed objectives, decreases or increases in the extent and frequency of analysis of various parameters, and further investigation of the phytoplankton and macroinvertebrate datasets and the heavy metal sampling technique. The recommendations were adopted by the Commission and instituted as of 1 July 2005; and the further investigations have subsequently been completed.

In accordance with the Ministerial Council's decision of reducing budget the Authority engaged the MDFRC to investigate whether a reduction in the frequency of sampling, the number of sites and/or the number of constituents measured by the Murray–Darling Basin Authority under the

<sup>3</sup> Mackay, N, Hillman, T and Rolls, J (1988) Water Quality of the River Murray – Review of Monitoring 1978 to 1986. Water Quality Report No.1, Murray Darling Basin Commission, Canberra. 62pp.

<sup>4</sup> Sullivan, C, Saunders, J and Welsh, D (1988) Phytoplankton of the River Murray, 1980-1985. Water Quality Report No. 2, Murray Darling Basin Commission, Canberra. 61pp.

<sup>5</sup> Bennison, G L, Hillman, T J and Suter, P J (1989) Macroinvertebrates of the River Murray (Survey and Monitoring: 1980-1985). Water Quality Report No. 3, Murray Darling Basin Commission, Canberra. 77pp.

<sup>6</sup> AWT (1999) Water Quality Monitoring Program Review – Part 1 Data Summary and Recommendations. Report no. 98/169 AWT Melbourne.

<sup>7</sup> Water Ecoscience (2002) MDBC Water Quality Review Stage 2 – Data Analysis. Report No. 653. Water Ecoscience Melbourne

<sup>8</sup> AWT (2000) MDBC Biological Monitoring Review – Macroinvertebrate Sampling Discussion Paper. Report no. 498 AWT, Melbourne

<sup>9</sup> Lawrence, B and Paterson, L (2005) Review of the River Murray Water Quality Monitoring Program, MDBC, Canberra, 40pp.

RMWQMP will result in an erosion of our ability to assess trends in key water quality parameters. The MDFRC report<sup>10</sup> concluded that if the sampling program is being reduced, the number of sites rather than the frequency of sampling be targeted. Further recommendations are to reduce some major ionic constituent sampling and introduce sediment sampling for heavy metal monitoring. Based on the MDFRC recommendation and further consultation with senior staff, 28 sites are included as a minimum set for a revised program of River Murray water quality monitoring and for delivering the obligation under Schedule 1 of the *Water Act 2007*.

Recently Henderson et al. (2013)<sup>11</sup> undertook a trend analysis of water quality parameters collected over last 35 years (1978–2012) which indicates general broad decreases in nutrients (*TP, FRP, TKN, NOx*), though *NOx* and *TP* show increases in the upper Murray (Jingellic to Bandiana). According to this report, the tributaries are clearly playing an important role and have impact on sampling sites downstream of their confluence with the Murray. The report further emphasises the invaluable record of 35 years of water quality data; and the importance of its continuation in the context of providing a risk management tool for potential changes caused by future climate and the Murray–Darling Basin Plan’s implementation.

## 2.5. Other River Murray System monitoring data and its usage

Since the commencement of the RMWQMP in 1978 there has been significant development of monitoring programs throughout the Basin, supported both by individual state jurisdictions and through the former MDBC. Existing programs have also been modified over the period – including the RMWQMP (see section 2.3). Continuing attention has been given to avoid duplication. The following discussion summarises the types of data currently being collected, their purpose, and their contribution to the management of the River Murray System.

### 2.5.1. Water quality data

In addition to the RMWQMP’s suite of sites and parameters, there are other water quality parameters monitored at certain sites throughout the same geographic area for certain purposes. Such water quality sampling is undertaken by the relevant authority in each state, usually in a project based format, covering specific areas or specific attributes (such as algae). Within each of these projects is a network of linked activities and often the sampling undertaken for the RMWQMP parameters is included as one of these activities. A detailed description of each of these monitoring projects in each state was assembled as part of the 2005 review’s documentation of existing activity<sup>12</sup> and includes a tabulation of sites, parameters and frequencies.

Some of this data, such as turbidity levels and algal counts at some sites, is collected daily and/or is available over a shorter timeframe than that of the RMWQMP data; hence it is used for operational purposes at times.

<sup>10</sup> Baldwin DS, Whitworth KL and Pengelly J (2013). Investigating the influences of changes in the River Murray Water Quality Monitoring Program on future capacity to detect trends in water quality. Final Report prepared for the Murray Darling Basin Authority by The Murray Darling Freshwater Research Centre, May 2013, 21pp.

<sup>11</sup> Henderson, B., Liu Y, and Baldwin D (2013). Trends in physical and chemical aspects of water quality in the Murray Darling Basin 1978-2011. CSIRO Water for a Healthy Country Flagship, Australia. June 2013, 58pp.

<sup>12</sup> Paterson, L (2002) Current MDBC Water Quality Monitoring Programs. Draft document.

### 2.5.2. Water quantity data

The flow (and water usage data) collected by the MDBA and the state agencies is supplied to the MDBA on a daily basis for use in managing the River Murray System<sup>13</sup>. This data is known as operational data and is generally obtained by interrogating each flow site. The majority of sites used have a data logger or meter associated with the site, which allows for the collection of time series data. This is where any variation of flow during the day is accounted for and a total daily flow is determined (of hydrographically corrected data).

Flow, or data used to calculate flow, is measured either continuously or instantaneously at a network of gauging stations funded by the MDBA throughout the River Murray System.

The flow monitoring network is extensive and has been developed over a long period to meet the needs of conserving and regulating the water of the River Murray System and modelling its flow. Flow data is generally available and adequate to meet the needs of interpreting or calculating information from the RMWQMP. The flow data is the basis of the hydrological models of the River Murray System such as MSM and BIGMOD, which have been established into a modelling suite for running sequentially to address various issues at time steps of a month or a day. This modelling suite provides capability to simulate flows from 1891 to 2001 on a daily basis and salinities for the entire Murray and Lower Darling System for the Basin Salinity Management Strategy (having a benchmark period of 1975–2000). Flow and salinities can therefore be modelled on daily basis, while the resource assessment, water accounting, irrigation demand computation and policies relating to transfer of water between storages are carried out on a monthly time step<sup>14</sup>. In addition to the operational function, outputs from the River Murray models have underpinned all predictive assessments and policy advice made under the Living Murray Initiative, provided the basis for the Ministerial Council's decision to cap diversions and enabled the subsequent management of the Cap on diversions. They also support a host of ecological research projects and the analyses of flow scenarios in the scientific and community forums convened under the Living Murray Initiative.

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<sup>13</sup> Defined as the main course of the Murray, all its effluents and anabranches, its tributaries above Albury, the Darling below Menindee, the Commission dams and weirs and the Menindee Lakes storage.

<sup>14</sup> Close and Sharma, A. (2005). Hydrological Models used for water resource and salinity management in the River Murray system. In Proc. 28<sup>th</sup> International Hydrology and Water Resources Symposium, The Institution of Engineers, Australia, 10-14 November 2005, Wollongong, NSW

### 3. Recommendations

#### 3.1. New Objectives

The original objectives of the WQMP as published in 1979 were worded as functions and were the:

- provision of data which will enable the development and improvement of management plans for meeting water quality objectives in the River Murray
- periodic reporting and assessment of water quality to determine trends
- indication of changes in water quality brought about by control measures
- requirement for additional investigation on control measures
- characterisation of the effect of long term changes in land use and land management on water quality.

Those objectives were revised in 2005 to better reflect the nature of surveillance monitoring, update the terminology, accommodate contemporary management approaches and further evolve the approach of undertaking special studies to meet specific information and knowledge needs. The revised objectives are to:

- periodically report and assess water quality to understand variability and determine trends.
- provide data that will assist reporting against water quality objectives in the River Murray and will inform management of the River system.
- undertake additional investigations to characterise and understand the factors and processes affecting water quality and the river ecosystem, and inform management.

The Ministerial Council's approval of a reduced water quality sampling budget for 2013-14 necessitates a reduction of the scope of the current monitoring program that is significant enough to require an amended set of objectives that specifically focus on the core responsibilities of the Authority in regard to water quality. Those core responsibilities are defined in the Murray-Darling Basin Agreement and cross-references are included in the following proposed new objectives:

1. To effectively and uniformly measure and monitor water quality of the River Murray, its tributaries at or near their confluence, and stored water (Clause 45(c)).
2. To provide data that assists the investigation of works or measures that could protect or improve the quality of river water (Clause 43(1)(b)).
3. To provide data that allows assessment of the possible effect of proposals on the water quality of the River Murray (Clause 49).
4. To provide data that will assist the Authority to have regard to the improvement or maintenance of water quality when giving directions for the release of water from upper River Murray storages (Clause 98(4)(i)).

#### 3.2. Sites, parameters and frequency to be reduced

The physico-chemical monitoring component of the Water Quality Monitoring Program was designed by the Commission's intergovernmental Water Quality Committee and published in 1979. Later, it was slightly amended in 1980 and 1983 (see Section 2.3). The dataset was reviewed in 1988 and 1999 with further analysis of trends in 2002 (see Section 2.3). In 2005 a review by Lawrence and Paterson led to decreases or increases in the extent and frequency of analysis of various parameters, as well as a survey of heavy metals along the Murray.

The Ministerial Council's decision will result in an erosion of the Authority's ability to assess trends in key water quality parameters, and a reduction in the number of sampling.

### 3.2.1. Major ions

The previous monitoring program under this review measured a suite of water quality parameters at 36 sites along the Murray River and its major tributaries (Figure 1). Basic water quality parameters (pH, turbidity, electrical conductivity [EC]), colour and temperature) were measured at all sites on a weekly basis. Six additional parameters (oxides of nitrogen [NO<sub>x</sub>], total Kjeldahl nitrogen [TKN], total phosphorus [TP], filterable reactive phosphorus [frP], silica and dissolved organic carbon [DOC]) were measured weekly at 26 sites. Additional quarterly measurement of major ionic concentration (sodium, potassium, calcium, magnesium, chloride, Sulphate and Bicarbonate) was carried out at six sites. The MDFRC (2013) review concluded a very high correlation between most ionic constituents measured at the various sampling sites and the overall EC of the samples. As a result, it recommended ceasing routine monitoring of sodium, potassium, calcium, magnesium, sulphate, chloride and bicarbonate in order to substantially reduce the cost of chemical analyses in the program. Given the importance of bicarbonate (buffering) and sulphate (recent acid sulphate soil issue) the Authority proposes keeping them as a part of monthly monitoring program.

### 3.2.2. Heavy metals

The concentrations of ten heavy metals were measured at Morgan on an approximately monthly basis. The MDFRC (2013) review of the long-term data set suggests there is little value in this given the poor quality of the dataset and the lack of action regarding exceeding thresholds. It recommended suspending monthly sampling of metals and replacing with a well-designed sediment sampling program conducted every 3–5 years, using the URS (2007)<sup>15</sup> results as a baseline for comparison. However, due to the severity of acid drainage discharge now being exported from lower Murray irrigation area, South Australia has requested that the metal analysis at Morgan be shifted to Tailem Bend with the addition of arsenic to the suite of metals which the revised WQMP accommodates.

### 3.2.3. Sites and Frequency

Based on the MDFRC recommendation and further consultation with the WQAP, the revised program of monitoring retains 28 out of the existing 36 sites, which will be used to deliver the Water Act Schedule 1 obligation. The sampling frequency of all tributaries is proposed to be decreased to monthly (Table 1); however, the main river channel sampling frequency is kept at weekly interval to capture the required data in calculating loads. Also, weekly sampling of the main channel is considered essential to meeting obligations under Clause 49 of the *Water Act 2007*. Appendix C lists 28 sites with the classes describing parameters to be monitored and frequency of sampling. Tables 2 and Figure 2 give location details, parameters and classes of water quality monitoring sites for the revised program effective from December 2013. The macro-invertebrates monitoring is expected to be carried out through separate programs, which are outside the scope of this review.

<sup>15</sup> URS (2007). River Murray Heavy Metal Monitoring Pilot Study, February 2007, Final Report to Murray-Darling Basin Commission, URS Australia, NSW, 321 pp.

**Table 1: Class and frequency of analysis**

<b>CLASS 3</b> <b>(Weekly; M = Monthly)</b>	<b>CLASS 2 = Class 3 +</b> <b>(Weekly; M = Monthly)</b>	<b>CLASS 1 = Class 2 +</b> <b>(Monthly)</b>
pH	Oxidised Nitrogen	Bicarbonate
Turbidity	Total Kjeldahl Nitrogen	Sulphate
Electrical Conductivity	Total Phosphorus	
Temperature	Filterable Reactive Phosphorus	
Colour	Silica	
	Soluble Organic Carbon	

**Table 2: List of water quality monitoring sites for the revised water quality monitoring program 2013/14.**

Note: \$ denotes Boron, Chromium, Cadmium, Copper, Lead, Manganese, Zinc, Iron, Nickel, Mercury, Arsenic – Monthly; \* denotes Phytoplankton, Chlorophyll a (6002) & phaeophytin (6003) - weekly in the Murray River channel and monthly in the selected tributaries; # denotes Macro-invertebrates- Twice Yearly; D/S denotes downstream sampling; u/s denotes upstream sampling; M denotes monthly sampling.

<b>Location ID</b>	<b>Water quality monitoring site description</b>	<b>Class</b>	<b>State</b>
409025	River Murray D/S Yarrawonga Weir *#	2	NSW
410130	Murrumbidgee River at Balranald * M	2	NSW
414209	River Murray U/S Euston Weir *#	2	NSW
425007	Darling River at Burtundy *# M	1	NSW
409034	Wakool River at Kyalite M	2	NSW
414206	River Murray at Merbein *	2	NSW
401201A	River Murray at Jingellic #	2	VIC
401204A	Mitta Mitta River at Tallandoon	2	VIC
402205A	Kiewa River at Bandiana M	2	VIC
403241A	Ovens River at Peechelba M	2	VIC
405232	Goulburn River at McCoy Bridge M	2	VIC
406202	Campaspe River at Rochester M	1	VIC
404210	Broken Creek at Rices Weir M	2	VIC
407202	Loddon River at Kerang M	1	VIC
407209	Gunbower Creek at Koondrook M	2	VIC
409016	River Murray at Heywoods *	2	VIC
414204	Murray River at Redcliff	3	VIC
409204C	River Murray at Swan Hill *	1	VIC
409207B	River Murray d/s Torrumbarry Weir *	2	VIC
A4260200	River Murray d/s Rufus River Junction	3	SA
A4260501	River Murray at Lock 9 *# D/S	2	SA
A4260539	River Murray at Waikerie	3	SA
A4260512	River Murray at Lock 5 D/S	2	SA
A4260522	River Murray at Murray Bridge	2	SA
A4260524	Lake Alexandrina at Milang	3	SA
A4260551	River Murray at Tailem Bend *# \$	2	SA
A4260554	River Murray at Morgan *	1	SA
A4261034	Goolwa site *	3	SA



Figure 2: Revised Water Quality Monitoring Program sites, parameters and frequencies

### 3.3. Monitoring sites to be discontinued

For the revised water quality monitoring program the WQAP agreed to discontinue eight stations out of 36 existing WQMP sites (Table 3).

**Table 3. Monitoring sites to be discontinued.**

Location ID	Water quality monitoring site description	Class	Flow attribute	State
410134	Billabong Creek at Darlot	3	Flow Available	NSW
425012	Darling River d/s Weir 32 (Menindee)	2	Flow Available	NSW
A4260553	Lake Victoria (at outlet)	3	Level Only	SA
A4260516	River Murray at Lock 3 (D/S)	3	Flow data estimated	SA
407252A	Barr Creek at Capels Flume/Crossing *	1	Flow Available	VIC
409005A	River Murray at Barham	3	Flow Available	VIC
414200A	River Murray d/s Wakool Junction	3	Flow Available	VIC
401027	Lake Hume	3	Capacity & D/S Flow Available	VIC

### 3.4. Summary

The physico-chemical monitoring component of the Water Quality Monitoring Program (WQMP) was designed by the Commission's intergovernmental Water Quality Committee and published in 1979. It was subsequently amended slightly in 1980 and 1983. The data was reviewed in 1988 and 1999 with further analysis of trends in 2002. In 2005 another review led to decreases or increases in the extent and frequency of analysis of various parameters, as well as a survey of heavy metals along the Murray.

Prior this revision the monitoring program measured a suite of water quality parameters at 36 sites along the Murray River and its major tributaries. In 2012 the Ministerial Council reduced the budget for monitoring to \$450,000 for the 2013–14 year, which essentially halved the capacity for the River Murray water quality sampling cost. At the same time, the budget for data analysis and program management was halved, necessitating cessation of various other functions such as coordinating event monitoring and assessing certain development proposals.

Accordingly, the Authority engaged the MDFRC in 2012 to investigate if a reduction in the frequency of sampling, a reduction in the number of sites and/or a reduction in the number of constituents measured by the Murray–Darling Basin Authority under the River Murray WQMP will result in an erosion of the Authority's ability to assess trends in key water quality parameters.

This review captures the recommendations of the MDFRC investigation as well as the WQAP consultation and proposes a revised set of 28 out of the previous 36 sites as a revised set of sites for monitoring the River Murray water quality and phytoplankton (algae), and in delivering the obligation under the reduced budget situation. In addition, the frequency for the tributaries is revised to monthly; while the main stem sampling frequency shall be maintained as weekly to capture the data required for calculating loads confidently.

## 4. Appendices

### 4.1. Appendix A. Schedule 1 – The Murray- Darling Basin Agreement (*Water Act 2007*) (Extract relevant to WQMP)

#### **PART VII—INVESTIGATION, MEASUREMENT AND MONITORING**

##### 43. Investigations and Studies

- (1) The Authority may co-ordinate, carry out or cause to be carried out surveys, investigations and studies regarding the desirability and practicability of works or measures for the equitable, efficient and sustainable use of water and other natural resources of the Murray- Darling Basin, including but not limited to works or measures for:
  - (a) the conservation and regulation of river water;
  - (b) the protection and improvement of the quality of river water;
  - (c) the conservation, protection and management of aquatic and riverine environments; and
  - (d) the control and management of groundwater which may affect the quality or quantity of river water.
- (2) The Authority may, without further approval of any Contracting Government, carry out, or cause to be carried out surveys, investigations or studies pursuant to sub-clause (1) on or adjacent to:
  - (a) the upper River Murray; and
  - (b) the River Murray in South Australia.
- (3) Except as provided in sub-clause (2) or as authorised under the Water Act, the Authority must not carry out or cause to be carried out surveys, investigations or studies within the territory of any State without obtaining the consent of that State Contracting Government.

##### 44. Monitoring

The Authority, subject to clause 46, may establish, maintain and operate effective means for monitoring the quality, extent, diversity and representativeness of water and other natural resources of the Murray- Darling Basin, including but not limited to:

- (a) aquatic and riverine environments; and
- (b) the effect of groundwater on water and other natural resources

#### 45. Measurements of Water Quantity and Quality

The Authority must establish, maintain and operate an effective and uniform system:

- (a) for making and recording continuous measurements of -
  - (i) the flow of the River Murray, and tributaries of the River Murray within the boundaries of each State; and
  - (ii) the volume of stored water,  
  
at such locations as the Authority deems necessary to determine the volume of the intake from the several portions of the drainage area of the River Murray, the flow at selected locations along the River Murray and the losses from selected reaches of the River Murray, with their positions and modes of occurrence;
- (b) for making and recording continuous measurements of all diversions, whether natural or artificial, or partly natural and partly artificial, from the River Murray and its tributaries; and
- (c) for measuring and monitoring the quality of -
  - (i) River Murray water;
  - (ii) water in tributaries of the River Murray at such locations at or near the confluence of each of those tributaries with the River Murray as the Authority, after consultation with the appropriate authorities of each of the Contracting Governments, deems necessary; and
  - (iii) stored water.

#### 46. Need for Approval in Certain Cases

- (1) The Authority may, without further approval of any Contracting Government, establish, maintain and operate any system or means referred to in clauses 44 and 45 on or adjacent to:
  - (a) the upper River Murray; and
  - (b) the River Murray in South Australia.
- (2) Except as provided in sub-clause (1) or as authorised under the Water Act, the Authority must not establish, maintain or operate any system or means referred to in clauses 44 and 45 within the territory of any State without:
  - (a) informing the Committee of the proposed system or means; and
  - (b) obtaining the consent of that State Contracting Government.

#### 47. Power to Arrange Data in Lieu

Instead of establishing, maintaining or operating systems and means referred to in clauses 44 and 45, the Authority may:

- (a) adopt the results of any measurements or monitoring made by any Contracting Government; or
- (b) request a State Contracting Government to carry out any monitoring or measurement within its territory in such manner as the Authority considers necessary.

#### 48. Water Quality Objectives

- (1) The Authority must formulate water quality objectives for the River Murray and make recommendations with respect thereto to the Ministerial Council.
- (2) This clause ceases to have effect after the Basin Plan first takes effect.

#### 49. Authority to be Informed of New Proposals

- (1) Whenever a Contracting Government or a public authority is considering any proposal which may significantly affect the flow, use, control or quality of any water in the upper River Murray and in the River Murray in South Australia, that Contracting Government must, or must ensure that the public authority shall:
  - (a) inform the Authority of the proposal; and
  - (b) provide the Authority with all necessary information and data to permit it to assess the anticipated effect of the proposal on the flow, use, control or quality of the water.
- (2) The necessary information and data must be provided in sufficient time to allow the Authority:
  - (a) to assess the possible effect of the proposal on the flow, use, control or quality of that water; and
  - (b) to make representations thereon to that Contracting Government or public authority, before the Contracting Government or public authority decides if the proposal will proceed.
- (3) The Authority shall consult with each Contracting Government, and with any public authority responsible to a Contracting Government which that Contracting Government or the Authority considers is likely to consider a proposal of the type referred to in sub-clause (1), with a view to reaching agreement with that Contracting Government, or that public authority, as to:
  - (a) the types of proposals to which sub-clause (1) shall apply; and
  - (b) the criteria to be used in assessing those proposals to which sub-clause (1) applies.
- (4) Despite sub-clause (3), sub-clauses (1) and (2) apply to any proposal referred to in clause 23 of Schedule F.

## 4.2. Appendix B. State-by-state breakup of previous water quality monitoring program sites.

Table B1. State-by-state breakup of water quality monitoring program sites prior to the revision.

AWRC Number	Station	CLS	Code Name	Authority	River Distance (KM)	Lat	Long
414206	River Murray at Merbein *	2	MERBEIN	NSW	871	3410.0	14205.0
425007	Darling River at Burtundy *#	1	BURTUND	NSW	-	3345.0	14216.0
425012	Darling River d/s Weir 32 (Menindee)	2	WEIR32	NSW	-	3226.3	14222.8
414209	River Murray u/s Euston Weir *#	2	EUSTUS	NSW	1117	3435.0	14246.0
410130	Murrumbidgee River at Balranald *	2	BALRAN	NSW	1236	3440.2	14329.3
410134	Billabong Creek at Darlot (Windouran Weir)	3	DARLOT	NSW	-	3502.5	14411.8
409025	River Murray d/s Yarrawonga Weir *#	2	YARRADS	NSW	1992	3600.8	14559.7
414204	River Murray at Red Cliffs	3	REDCLIF	VIC	910	3418.0	14214.0
414200	River Murray d/s Wakool Junction	3	WAKJUNC	VIC	1282	3451.0	14320.5
409034	Wakool River at Kyalite	2	KYALITE	VIC	1284	3457.1	14328.8
409204	River Murray at Swan Hill *	1	SWANHIL	VIC	1402	3520.0	14334.0
407252	Barr Creek at Capels Flume (Crossing) *	1	CAPELSX	VIC	1405	3536.5	14257.0
407202	Loddon River at Kerang Weir	1	KERANGW	VIC	1405	3542.0	14355.0
409005	River Murray at Barham	3	BARHAM	VIC	1524	3537.9	14407.3
407209	Gunbower Creek at Koondrook	2	KOONDSP	VIC	1525	3539.5	14407.5
409207	River Murray d/s Torrumbarry Weir *	2	TORRDS	VIC	1638	3556.5	14427.5
406202	Campaspe River at Rochester	1	ROCHEST	VIC	1695	3621.0	14442.5
405232	Goulburn River at McCoys Bridge	2	MCCOYSB	VIC	1728	3611.0	14507.0
404210	Broken Creek at Rices Weir	2	RICESWR	VIC	1763	3558.0	14458.0
403241	Ovens River at Peechelba	2	PEECHEL	VIC	2029	3609.9	14614.3
409016	River Murray at Heywoods *	2	HEYWOOD	VIC	2223	3606.1	14701.5
402205	Kiewa River at Bandiana	2	BANDIAN	VIC	2209	3608.2	14657.1
409011	Lake Hume	3	HUMEUS	VIC	2225	3605.5	14703.5
401204	Mitta Mitta River at Tallandoon	2	TALLAND	VIC	2240	3624.5	14714.0
401201	River Murray at Jingellic #	2	JINGELL	VIC	2352	3556.0	14743.0
426524	Lake Alexandrina at Milang	3	MILANG	SA	25	3524.0	13859.0

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AWRC Number	Station	CLS	Code Name	Authority	River Distance (KM)	Lat	Long
426551	River Murray at Tailem Bend *#	2	TAILEMB	SA	88	3516.0	13927.0
426522	River Murray at Murray Bridge	2	MBRIDGE	SA	118	3506.0	13917.0
426554	River Murray at Morgan *	1	MORGAN	SA	315	3401.0	13941.0
426539	River Murray at Waikerie	3	WAIKERI	SA	383	3411.0	14059.0
426516	River Murray at Lock 3	3	LOCK3US	SA	431	3411.0	14021.0
426512	River Murray at Lock 5 #	2	LOCK5US	SA	562	3411.0	14046.0
426200	River Murray d/s Rufus River Junction	3	MRUFUSR	SA	695	3404.0	14114.5
426553	Lake Victoria	3	LVIC	SA	697	-	-
426501	River Murray at Lock 9 *#	2	LOCK9US	SA	765	3411.0	14136.0
4261034	Goolwa site *	2	Goolwa	SA	7	3550.0	13876.7

\* denotes Phytoplankton: Chlorophyll a and phaeophytin monitored weekly

# denotes Macroinvertebrates monitored twice yearly

NOTE: Metals monitored monthly at Morgan pending outcomes from an investigative study

**Table B2. Class and frequency of analysis of the water quality monitoring program prior to the revision.**

CLASS 3	CLASS 2 = CLASS 3+	CLASS 1 = CLASS 2+
Weekly	Weekly	Quarterly
pH	Oxidised Nitrogen	Bicarbonate
Turbidity	Total Kjeldahl Nitrogen	Sulphate
Electrical conductivity	Total Phosphorous	Chloride
Temperature	Filterable Reactive Phosphorous	Potassium
colour	Silica	Sodium
	Soluble Organic Carbon	Calcium
		Magnesium

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## 4.3. Appendix C. Revised Water Quality Monitoring Program (sites, classes, parameters and frequencies).

Table C1. Revised water quality monitoring program.

Station ID	Station	Class	Parameters	Flow attribute	State
409025	River Murray d/s Yarrowong Weir *#	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon  3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	NSW
410130	Murrumbidgee River at Balranald * M	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon  3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	NSW
414209	River Murray u/s Euston Weir *#	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon  3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	NSW
425007	Darling River at Burtundy *# M	1	1. Bicarbonate, Sulphate  2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon  3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	NSW
409034	Wakool River at Kyalite M	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon  3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Level only	NSW
414206	River Murray at Merbein *	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon  3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	No level or flow	NSW
401201A	River Murray at Jingellic #	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon	Flow available	VIC

## Revision of the River Murray Water Quality Monitoring Program

Station ID	Station	Class	Parameters	Flow attribute	State
			3. pH, Turbidity, Electrical Conductivity, Temperature, Colour		
401204A	Mitta Mitta River at Tallandoon	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
402205A	Kiewa River at Bandiana M	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
403241A	Ovens River at Peechelba M	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
404210	Broken Creek at Rices Weir M	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
407202	Loddon River at Kerang Weir	1	1. Bicarbonate, Sulphate, 2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
406202	Campaspe River at Rochester M	1	1. Bicarbonate, Sulphate 2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
407209	Gunbower Creek at Koondrook M	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon	Flow available	VIC

## Revision of the River Murray Water Quality Monitoring Program

Station ID	Station	Class	Parameters	Flow attribute	State
			3. pH, Turbidity, Electrical Conductivity, Temperature, Colour		
409016	River Murray at Heywoods *	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
409204C	River Murray at Swan Hill *	1	1. Bicarbonate, Sulphate 2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
405232	Goulburn River at McCoy Bridge M	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
409207B	River Murray d/s Torrumbarry Weir *	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
414204	Murray River at Red Cliff	3	3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	VIC
A4260200	River Murray d/s Rufus River Junction	3	3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow available	SA
A4260501	River Murray at Lock 9 *# D/S	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	Flow data estimated	SA
A4260512	River Murray at Lock 5 # D/S	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon	Flow data estimated	SA

## Revision of the River Murray Water Quality Monitoring Program

Station ID	Station	Class	Parameters	Flow attribute	State
			3. pH, Turbidity, Electrical Conductivity, Temperature, Colour		
A4260539	River Murray at Waikerie	3	3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	No level or flow	SA
A4260554	River Murray at Morgan *	1	1. Bicarbonate, Sulphate 2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	No flow. Level only	SA
A4260522	River Murray at Murray Bridge	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	No flow. Level only	SA
A4260551	River Murray at Taillem Bend *# \$	2	2. Oxidised Nitrogen, TKN, Total Phosphorus, FRP, Silica, Soluble Organic Carbon 3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	No flow or level	SA
A4260524	Lake Alexandrina at Milang	3	3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	No flow. Level only	SA
A4261034	Goolwa site *	3	3. pH, Turbidity, Electrical Conductivity, Temperature, Colour	No flow or level	SA

Total Number of Sites = 28, NSW = 6, Victoria = 13, SA = 9 (includes Goolwa site)

\$ denotes Boron, Chromium, Cadmium, Copper, Lead, Manganese, Zinc, Iron, Nickel, Mercury and Arsenic (Monthly)

\* denotes Phytoplankton, Chlorophyll a (6002) & phaeophytin (6003) weekly in the Murray River channel and monthly in the selected tributaries

# denotes Macro invertebrates twice yearly

M denotes monthly sampling instead of weekly sampling

D/S denotes downstream

U/S denotes upstream

**Table C2: Revised class and frequency of analysis**

<b>CLASS 3</b> <b>(Weekly; M = Monthly)</b>	<b>CLASS 2 = Class 3 +</b> <b>(Weekly; M = Monthly)</b>	<b>CLASS 1 = Class 2 +</b> <b>(Monthly)</b>
pH	Oxidised Nitrogen	Bicarbonate
Turbidity	Total Kjeldahl Nitrogen	Sulphate
Electrical Conductivity	Total Phosphorus	
Temperature	Filterable Reactive Phosphorus	
Colour	Silica	
	Soluble Organic Carbon	