

**Commonwealth Environmental Water Office**  
**Long Term Intervention Monitoring**  
**Basin Matter - Hydrology foundation report**

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# Final Report

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### Long Term Intervention Monitoring

### Basin Matter - Hydrology foundation report

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# Basin Matter - Hydrology foundation report

## Hydrology – flow regime

### 1 Why?

The flow regime is a Basin Matter under the Outcomes Framework that will be evaluated in its own right. The evaluation of the flow regime also underpins all of the other evaluations and forms the basis for the evaluation of outcomes for biodiversity, ecosystem function and resilience at the Basin scale.

### 2 What?

This component informs the evaluation of all other Basin Matters, and directly addresses the following short-term (one-year) and long-term (one-to-five-year) Basin-scale evaluation question:

- What did Commonwealth environmental water contribute to restoration of the hydrological regime?

The outputs of the Basin Evaluation of flow regime will comprise:

- A statistical report on flow components (cease-to-flow events; base flows; freshes; bank-full flows; and overbank flows) delivered over the duration of the LTIM Project compared with the flow regime under the case where no Commonwealth environmental water was delivered. This description will be provided at key hydrological sites, which are representative of the waterways targeted for Commonwealth environmental watering actions across the Basin. The report will be developed initially for the Selected Areas. It will be extended to other areas receiving Commonwealth environmental water in later years.
- An interpretation of this statistical report, which provides a valley-by-valley and whole-of-basin account of the Commonwealth environmental water's contribution towards achievement of the Basin Plan hydrological targets.
- Daily streamflow series at a set of representative hydrological sites for the actual and modelled without Commonwealth environmental water scenarios.

The Hydrological evaluation also underpins the evaluation of biodiversity, ecosystem function and resilience outcomes. This requires a three step process:

1. Identify flow outcomes to support evaluation of Commonwealth Environmental Water effects on flow regime (see above).
2. Identify resultant hydraulic outcomes to enable evaluation of whether environmental flow management achieved the expected hydraulic and connectivity outcomes.
3. The hydraulic outcomes are then used to evaluate the environmental outcomes and, over time, improve our understanding of environmental water requirements.

Scale is a critical issue for the evaluation process. From a temporal perspective, the evaluation starts with individual watering actions and then considers their influence on flow regimes over one to five year periods. As a consequence, the evaluation needs information on both individual watering actions and on the flow and hydraulic regime over the five year period. As such data describing the flow and hydraulic outcomes of each watering action and the regime in which it occurred will need to be generated.

From a spatial perspective, the evaluation starts with the scale of the watering action which may range from an individual site (wetland) in the case of pumped watering actions up to river valleys. The outcomes from these individual watering actions then need to be integrated to support an evaluation at the Basin scale over one to five years.

For the purposes of the Basin scale evaluation the resolution of the evaluation will be the Selected Area scale whilst acknowledging that some watering actions are at a finer scale. The Basin-scale evaluation will consider the role of smaller scale watering actions within the context of the selected area. For example if a wetland receives pumped water, the action will be evaluated from a Selected Area perspective, not the individual site.

### **3 How?**

This evaluation of the effect of CEWO water delivery on flow regime will be a collaborative undertaking by CEWO, MDBA and MDFRC. MDBA will be responsible for hydrological modelling, and in particular modelling streamflow discharge in the absence of CEWO water delivery and for the scenario where target Basin plan outcomes are achieved. The CEWO hydrology information officer will be responsible for coordinating the compilation of operational data to characterise CEWO environmental water deliver. MDFRC will be responsible for the analysis and interpretation of these data to evaluate basin-scale hydrological outcomes.

It is anticipated that the capacity to report on hydrological outcomes will evolve over the course of the project. Reporting will be constrained by the information that can be generated by the MDBA hydrological modelling team for this LTIM project.

#### **3.1 Sites**

The Basin-scale evaluation will be based on evaluation of flow outcomes at a suite of representative reaches. It will be important that the reaches have:

- recorded and modelled flow data
- some hydraulic modelling that will enable flow changes to be translated into hydraulic and lateral connectivity outcomes. Examples of the types of modelling would include inundation modelling, commence to flow/fill or channel morphology.

For the hydrological evaluation the 122 hydrological indicator sites used in developing the Basin Plan Ecological Sustainable Level of Take (MDBA, 2012). For the second step in which hydrological outcomes are converted into hydraulic outcomes the process will start with the 18 assets used in the development of the ESLT.

#### **3.2 Flow regime data collection and generation**

The environmental entitlement, allocation and volumes delivered in each valley by the CEWO will be compiled by the CEWO.

The flow actually achieved in the basin's mainstem rivers will be characterised using streamflow gauge measurements.

River models will be required to model the baseline and target flow regime respectively representing (i) streamflows in the absence of CEWO environmental water and (ii)

streamflows with full implementation of the Basin Plan. Discussions are underway with the MDBA to establish the scope of this task, methods and responsibilities. In the first instance, we expect MDBA will be able to provide BiGMod simulations for the baseline case (no CEWO Water delivery) for the Murray River subject to some limitations. Expansion of this to other rivers will require outputs from of state-owned models that are yet to be negotiated.

This evaluation requires the comparison of recorded streamflows with modelled flows (in the absence of CEWO water). This comparison will be heavily influenced by a number of assumptions that will need to be made and model errors. Procedures will be developed to evaluate these influences and adjust results where appropriate.

### **3.3 Hydraulic outcomes data generation**

Where possible, the flow data will then be linked to reach scale hydraulic indicators required to evaluate environmental outcomes, including water level (based on rating curves) and lateral connectivity which is a Basin Matter and needs to be reported on in its own right as part of the Hydrological evaluation (discussed below).

There are a range of additional metrics that would be useful in evaluating outcomes, however, the resources required to generate these data may not to be available over the life of the project. Discussions with other Basin Matter leaders regarding the hydraulic information needs are on-going.

### **3.4 Evaluation approach**

The evaluation will be based on the Basin Plan targets. Importantly, the assessment will examine the extent to which the CEWO has contributed to achieving the Basin Plan's target flow regime at the time-scale of 1–5 years. In concept, the evaluation will report progress along a scale starting at zero, where CEWO has made no contribution to the Basin Plan target (the baseline scenario) increasing to a maximum value where the CEWO water has been solely responsible for complete achievement of the Basin Plan hydrological targets (the target scenario).

This evaluation will report on environmental water entitlements, allocations, and delivery volumes referenced to the targets established in the Basin plan. It will also examine the environmental flow regime achieved in rivers across the basin. This will be informed by the environmental water demands used in establishing the ESLT in the Basin Plan (MDBA, 2012).

Changes in the frequency and average duration, magnitude and timing of events will be aggregated up to the valley and Basin scale to provide a spatially-integrated evaluation of the influence of Commonwealth environmental water on Basin flow regimes.

The baseline and target flow regimes will need to be defined prior to scenario modelling.

We expect reporting of hydrological outcomes from individual watering actions (i.e. at time-scales of less than one year) to be provided at the site-scale by the selected area providers.

### **3.5 Data provided for other Basin Matter teams**

As noted above, the hydrological evaluation underpins all of the other evaluations and forms the basis for the evaluation of outcomes for biodiversity, ecosystem function and resilience at the Basin scale. This will require the following data;

- 1) Supporting the evaluation at the seven Selected Areas will require daily streamflow series for three scenarios (actual flows, flows without CEWO environmental water,

and flows expected under full implementation of the Basin Plan). Using these daily flow series it will be possible to calculate specific flow metrics relating to flow components or specific flow events as required by other LTIM team members.

- 2) Supporting the evaluation at unmonitored areas will require daily streamflow series for three scenarios (actual flows, flows without CEWO environmental water, and flows expected under full implementation of the Basin Plan). Using these daily flow series it will be possible to calculate specific flow metrics relating to flow components or specific flow events as required. It is acknowledged that there may be some Areas where this is not feasible and in these instances, consideration will be given to using hydrological outcomes from an Area on the same river for which information is available (see point 3 below).
- 3) Supporting evaluation of environmental outcomes at the Basin scale will require daily streamflow series at for three scenarios (actual flows, flows without CEWO environmental water, and flows expected under full implementation of the Basin Plan) at representative sites across the Basin. The sites at which these data will be available, will be decided through the early stages of the project based on;
  - a. modelling capacity
  - b. The distribution of the Areas receiving Commonwealth Environmental Water.

Wherever possible the evaluation will use the 38 environmental indicator sites used in developing the Basin Plan Ecological Sustainable Level of Take where site-specific environmental demands were established.

Potential key metrics required by the Basin Matter Teams for river channels are summarised in Table X and for wetlands and floodplains are summarised in Table Y

**Table 1.** List of the hydrological metrics required by Basin Matters for evaluation of water actions within river channels

Metric	Basin Matters
Discharge	Metabolism
Type (recurrence interval)	Vegetation
Regime (Frequency, Time since last inundation)	Vegetation
Velocity	Metabolism
Timing	Fish, Vegetation
Depth (Height)	Fish, Vegetation
Rates of Rise and Fall	Vegetation



**Table 2.** List of the hydrological metrics required by Basin Matters for evaluation of water actions influencing wetlands and floodplains

Metric	Basin Matters
Discharge	Birds
Type (recurrence interval)	Birds, Vegetation
Regime (Frequency, Time since last inundation)	Birds, Vegetation
Velocity	
Timing	Birds, Vegetation

## 4 Risks

The risk to this component is that MDBA is not able to provide modelled streamflows under the baseline and target scenarios. The MDFRC will manage this risk by developing a transition strategy to gradually increase the hydrological information available to support the hydrological evaluation

A second risk is that the models required to convert hydrological information into hydraulic outcomes at the Area scale are not available or not fit for purpose. We will manage this risk through ongoing communication with Basin matter leaders to identify alternative evaluation strategies and ongoing communication with CEWO regarding risks, priorities and trade-offs.

A third risk is that the workload required to service both the Hydrological evaluation and Basin Matter evaluation exceeds the resources available. We will manage this risk through ongoing communication with CEWO regarding risks, priorities and trade-offs

This risk can be further broken down into two components;

- 1) The resources provided by CEWO are less than anticipated.
- 2) The scope of work is too large for the resources available.

# Hydrological connectivity

## 5 Why?

Hydrological connectivity contributes to the analysis of outcomes for biodiversity, ecosystem function and resilience at the Basin scale. It underpins evaluations related to floodplain vegetation and wetlands. Hydrological connectivity is also a Basin Matter under ecological function in the Outcomes Framework that will be evaluated as an indicator in its own right.

## 6 What?

This component informs the evaluation of all other Basin Matters and directly addresses the following short-term (one-year) and long-term (five-year) Basin-scale evaluation question:

- What did Commonwealth environmental water contribute to hydrological connectivity?

The outputs of Basin Evaluation of hydrology will comprise:

- an annual report on hydrological connectivity, which includes annual and cumulative (i.e. multi-year) statistics related to:
  - lateral connectivity at the Basin and valley scales
  - longitudinal connectivity in the southern and northern basins
- comparisons of statistics for the actual conditions and the modelled scenario without Commonwealth environmental water.
- Floodplain inundation extents, in areas where floodplain inundation models currently exist and utilising any additional floodplain inundation models that become available over the life of the project. If MDBA develops the capacity to map inundation extent, this information will underpin reporting on the extent of hydrological connectivity and support evaluation of wetland and floodplain Basin Matters.

## 7 How?

This evaluation of the effect of CEWO water delivery on Hydrological connectivity will be a collaborative undertaking by CEWO, MDBA and MDFRC. MDBA will be responsible for hydrological modelling, and in particular modelling streamflow discharge and floodplain inundation in the absence of CEWO water delivery and for the case where target Basin plan scenario. The CEWO hydrology information officer will be responsible for coordinating the compilation of operational data to characterise CEWO environmental water deliver. MDFRC will be responsible for the analysis and interpretation of these data to evaluate basin-scale hydrological outcomes.

### 7.1 Data collection

The data collected for the previous 'Flow Regime' component will also be used for the Hydrological connectivity component. In addition we will require information on floodplain and wetland water regimes. This will be modelled using inundation models available from the MDBA. Details of the suitable inundation models that are currently available are as follows.

- RiMFIM: Covers the River Murray from Hume dam to lower lakes. (2007 and updated in 2012 unpublished)

- RiMFIM\_Xtn: Covers the Edward Wakool River System, Lower Murrumbidgee River and the Lower Darling River
- MDBFim, covers the entire MDB at a course resolution.

In addition to these models, MDBA is expecting to extend model coverage in the northern basin during 2015, using the latest TVD method. This will include the entire Barwon–Darling and Condamine–Balonne as far upstream as St George. It is possible that inundation modelling will extend to other northern basin tributaries in the following years.

## 7.2 Evaluation approach

Longitudinal connectivity relates to the impacts of Commonwealth environmental water on sustaining flows downstream through the tributary valleys and the entire MDB river network to the lower Darling River and Lower Lakes. In the first instance, the hydrological analysis will be for particular valleys (starting with the Selected Areas) and longitudinal connectivity can be assessed in terms of the effect of Commonwealth environmental watering actions on flow components at the outlet of the valley.

Lateral connectivity relates to the exchange of water between river channels and floodplains or wetlands. Evaluation of lateral connectivity will rely on the available information and modelling capacity and is therefore expected to evolve as MDBA and State Agencies improve their capacity to predict the extent of inundation of wetland and floodplain systems. The development of reporting on lateral connectivity is expected to progress in three steps:

1. Identification of the ecosystems connected and the timing, type and duration of connection. This evaluation will be based on existing floodplain inundation models, analysis of Landsat imagery and information on commence to fill from MDBA and other sources.
2. Calculation of the area of inundation. This will be based on proposed MDBA modelling as it becomes available.
3. Calculation of the volume of water transferred from one ecosystem to another. Volume is routinely used as a hydrological indicator of connectivity but has relevance for only some elements of environmental connectivity. Initially, reporting on volumes may occur at sites where existing hydraulic models are available. Once MDBA develop their floodplain inundation models, volumes may be reported for other areas.

The changes in the frequency and average duration, extent and timing of connections will be aggregated up to the Basin scale to provide an evaluation of the influence of Commonwealth environmental water on hydrological connectivity.

## 7.3 Data provided for other Basin Matter teams

This component of the LTIM project will provide daily inundation extents for the major floodplains across the basin with and without CEWO environmental water. In some cases it will be possible to model a time-series of inundation extents for the duration of flood events. In other cases it will only be possible to model peak extents. Where water is pumped into wetlands, modelling will need to be undertaken for specific wetlands using site specific information as extensive inundation models do not have the capacity to model such actions. This information will support the same three needs as identified for the Hydrology – flow regime component, specifically:

- 1) Monitored Areas
- 2) Un-monitored Areas

### 3) Basin Scale

The specific Hydrological connectivity metrics that may be required for river channels (Table 3) and floodplains (Table 4) are listed in the tables below.

**Table 3.** List of the hydrological connectivity metrics required by Basin Matters for evaluation of water actions within river channels

Metric	Basin Matters
Inundation Extent	Fish, Metabolism, Ecosystem
Inundation Duration (shedding systems)	Fish,
Connection Duration	Fish

**Table 4.** List of the hydrological connectivity metrics required by Basin Matters for evaluation of water actions influencing wetlands and floodplains

Metric	Basin Matters
Depth (Height)	Birds, Vegetation
Inundation Extent	Birds, Ecosystem, Vegetation
Inundation Duration (shedding systems)	Birds, Vegetation
Connection Duration	Fish

## 8 Risks

The major risk to this component is that the MDBA is not able to provide model scenarios for streamflows or link these to modelled floodplain inundation.

A second risk is that the models required to convert hydrological information into hydraulic outcomes at the Area scale are not available or not fit for purpose.

A third risk is that the workload required to service both the Hydrological evaluation and Basin Matter evaluation exceeds the resources available. This risk can be further broken down into two components;

- 1) The resources provided by CEWO are less than anticipated.
- 2) The scope of work is too large for the resources available.

We will manage all these risks by through ongoing communication with Basin matter leaders to identify alternative evaluation strategies and ongoing communication with CEWO regarding risks, priorities and trade-offs.

## **References**

Murray-Darling Basin Authority (2012) Hydrologic modelling to inform the proposed Basin Plan - methods and results, MDBA publication no: 17/12, Murray-Darling Basin Authority, Canberra.