

---

**Commonwealth Environmental Water Office**  
**Long Term Intervention Monitoring**  
**Basin Matter - Hydrology foundation report –revision**  
**2019**

---

**Prepared by:** Mike Stewardson and Enzo Guarino

---

**Final Report- revision**  
**2019**

**La Trobe Publication 208/2018**



## **Basin-Matter— Basin Matter - Hydrology foundation report – revision 2019**

Report prepared for the Commonwealth Environmental Water Office by La Trobe University

For further information contact:

### **Nick Bond**

La Trobe University

PO Box 991

Wodonga VIC 3689

Ph: (02) 6024 9650

Email: [N.Bond@latrobe.edu.au](mailto:N.Bond@latrobe.edu.au)

Web: [www.latrobe.edu.au](http://www.latrobe.edu.au)

Enquiries: [cfe@latrobe.edu.au](mailto:cfe@latrobe.edu.au)

**Report Citation:** Stewardson, M and Guarino, E (2019) Long Term Intervention Monitoring Basin Matter – Hydrology diversity foundation report- revision 2019. Final Report prepared for the Commonwealth Environmental Water Office by La Trobe University, La Trobe publication 208/2018, 14pp.

This monitoring project was commissioned and funded by Commonwealth Environmental Water Office.

### Copyright

© Copyright Commonwealth of Australia, 2019



Long Term Intervention Monitoring Basin Matter – Hydrology diversity foundation report- revision 2019 (2019) is licensed by the Commonwealth of Australia for use under a Creative Commons By Attribution 3.0 Australia licence with the exception of the Coat of Arms of the Commonwealth of Australia, the logo of the agency responsible for publishing the report, content supplied by third parties, and any images depicting people. For licence conditions see: <http://creativecommons.org/licenses/by/3.0/au/>

This report should be attributed as Stewardson, M and Guarino, E (2019) Long Term Intervention Monitoring Basin Matter – Hydrology diversity foundation report- revision 2019. Final Report prepared for the Commonwealth Environmental Water Office by The Murray-Darling Freshwater Research Centre, La Trobe publication 208/2018, 14pp.

### Disclaimer

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government or the Minister for the Environment.

**While reasonable efforts have been made to ensure that the contents of this publication are factually correct, the Commonwealth does not accept responsibility for the accuracy or completeness of the contents and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication.**

**The material contained in this publication represents the opinion of the author(s) only. While every effort has been made to ensure that the information in this publication is accurate, the author(s) and La Trobe University do not accept any liability for any loss or damage howsoever arising whether in contract, tort or otherwise which may be incurred by any person as a result of any reliance or use of any statement in this publication. The author(s) and La Trobe University do not give any warranties in relation to the accuracy, completeness and up-to-date status of the information in this publication.**

Where legislation implies any condition or warranty which cannot be excluded restricted or modified, such condition or warranty shall be deemed to be included provided that the author's and La Trobe University's liability for a breach of such condition or warranty is, at the option of La Trobe University, limited to the supply of the services again or the cost of supplying the services again.

## Document history and status

Version	Date Issued	Reviewed by	Approved by	Revision type
Final	16/11/2018	Mike Stewardson	Nicole Thurgate	Internal
Final	23/05/2019	CEWO	Irene Wegener	External

## Distribution of copies

Version	Quantity	Issued to
Draft	1 x Word	CEWO
Final	1 x PDF 1 x Word	Irene Wegener

**Filename and path:** G:\SHE - Life Sciences\MDFRC\Projects\CEWO\CEWH Long Term Monitoring Project\499 LTIM Stage 2 - 2014-2019 Basin Evaluation\Basin Matter Evaluation\Basin Matters Foundation Report\updated reports\Hydrology Foundation Report 2019 revision

**Author(s):** Mike Stewardson and Enzo Guarino

**Author affiliation(s):** University of Melbourne and University of Canberra

**Project Manager:** Nicole Thurgate

**Client:** Commonwealth Environmental Water Office

**Project Title:** Basin-Matter— Hydrology foundation report- revision 2019

**Document Version:** Final revision

**Project Number:** M/BUS/499

**Contract Number:** PRN 1213-0427

# Contents

<b>Hydrology – flow regime</b> .....	<b>5</b>
<b>1 Why?</b> .....	<b>5</b>
<b>2 What?</b> .....	<b>5</b>
<b>3 How?</b> .....	<b>6</b>
3.1 Sites .....	6
3.2 Flow regime data collection and generation .....	6
3.3 Evaluation approach.....	6
3.4 Data provided for other Basin Matter teams .....	7
<b>4 Risks</b> .....	<b>8</b>
<b>Hydrological connectivity</b> .....	<b>9</b>
<b>5 Why?</b> .....	<b>9</b>
<b>6 What?</b> .....	<b>9</b>
<b>7 How?</b> .....	<b>9</b>
7.1 Data collection.....	9
7.2 Evaluation approach.....	10
7.3 Data provided for other Basin Matter teams .....	10
<b>8 Risks</b> .....	<b>11</b>
References.....	12

# 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 and freshes) 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. This information will be delivered in each of the five 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 in years 4 and 5.
- Daily streamflow series at a set of representative hydrological sites for the actual and modelled without Commonwealth environmental water scenarios will be reported on each year.

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 inundation regime over the five year period. As such data describing the flow and inundation 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

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 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 accounting data will be required to attribute the contribution of Commonwealth environmental water representing (i) actual streamflows and (ii) streamflows in the absence of CEWO environmental water. These streamflow data will be provided by the MDBA, State Agencies and other water authorities where access can be negotiated.

In some instances, 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 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.

### 3.4 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 two scenarios (actual flows, and flows without CEWO environmental water). 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 two scenarios (actual flows, and flows without CEWO environmental water). 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 two scenarios (actual flows, flows without CEWO environmental water) 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 1 and for wetlands and floodplains are summarised in Table 2

**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



**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
Regime (Frequency, Time since last inundation)	Birds, Vegetation
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 for tributaries of the Murray and Darling Rivers. 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 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 in year 4 and 5 (after sufficient data is collected)
  - longitudinal connectivity in the southern and northern basins
- 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. This can only be delivered if MDBA deliver this data and this has not happened to date. If this failure continues the hydrology team will collate inundation observations to address the contribution of CEWO water. This will be delivered annually as GIS data.

### 7 How?

This evaluation of the effect of CEWO water delivery on Hydrological connectivity will be a collaborative undertaking by CEWO, MDBA and MDFRC. In time MDBA may be able to provide 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 (this data is currently not available). 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

A map of maximum inundation extents will be compiled by combining data from several different sources. The highest quality data available are inundation extents mapped using Landsat and Sentinel satellite imagery using an inundation detection algorithm developed specifically for the MDB wetlands by NSW OEH. These data are a high quality, but their coverage is limited to the larger wetland systems in New South Wales. Some additional inundation mapping is possible using reports from visual surveys, aerial photography and hydrodynamic modelling. A national water mapping product (Water observations from Space - WOfS, provided by Geoscience Australia) is used to fill the

remaining data gaps. This national product allows a comprehensive basin-wide assessment but has some known limitations in its ability to detect inundation where it is obscured by emergent vegetation. Available observations of inundation will be accumulated to provide an inundation extent for the full year.

## 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 by:

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 (this work is being completed as part of the basin-scale ecosystem diversity project and will not be presented as part of the hydrology reporting).
2. Calculation of the area of inundation. This will be based on proposed MDBA modelling IF it becomes available.

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

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

Metric	Basin Matters
Inundation Extent	Birds, Ecosystem, Vegetation

## 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 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.