Methodology to calculate water use losses for environmental water delivery in South Australia

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Foreword

The Department for Environment and Water (DEW) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEW's strong partnerships with educational and research institutions, industries, government agencies, Natural Resources Management Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

John Schutz
CHIEF EXECUTIVE
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Contents

1 Introduction

This document provides the detail of the method used to calculate losses from environmental watering actions to inform the development of the application of losses of environmental water (DEW Environmental Flow Policy No. 10) and associated procedure.

It is difficult to determine losses due to flow enhancement and watering actions based on monitoring of discharge alone. For example, the change in measured volume downstream of a weir pool raising action over a period of time is not only influenced by the additional loss (seepage and evapotranspiration) due to the increase in inundated area from the environmental watering action, but also these losses from the reach that would have occurred without the action, as well as diversions from within the reach. Monitoring alone cannot separate these different effects, and as such this methodology is based on comparison of hydrological model runs.

2 Methodology

2.1 Hydrological Model

The SA River Murray Source model outlined in Beh et al. (2019) will be used to calculate losses due to environmental water actions for actions that this model has the functionality to represent. These actions, the relevant model nodes and data sources are outlined in more detail below.

This model is based on the Source Murray Model (SMM) developed and calibrated by Murray Darling Basin Authority (MDBA) documented in MDBA (2015). This model has been extended by Beh et al. (2019) to represent all of the weir pools in South Australia and the currently under construction Pike and Katarapko floodplain structures. The model also includes the more detailed representation of the Chowilla floodplain developed by the MDBA for water accounting purposes, not currently included in the SMM. The South Australian section of the Source model has been developed and calibrated from outputs of numerous runs of the existing detailed MIKE FLOOD hydrodynamic models, outlined in DHI (2014) and McCullough et al. (2017). Details of SA River Murray Source model refinements and calibration results are presented in Beh et al. (2019). The hydrological model will continue to be validated and updated as necessary as data is collected from additional operations into the future.

2.2 Modelling Approach

The SA River Murray Source model is capable of simulating the operation of the environmental regulators and associated works on floodplains, or the weir and locks within the river, and estimate the on-site water use by comparing the evaporation, seepage and water retention associated with operational scenarios against a model run without the watering action.

The model is run twice to determine post-event water use. The first model run represents actual conditions with the watering action. Recorded upstream flow (typically Flow to SA, depending on the action) is input to the model. Recorded water levels are used at relevant structures to represent the watering events, and observed climate data for rainfall and Morton's Lake evaporation (Morton, 1983) are applied. Once an acceptable representation of actual conditions is achieved based on comparison to downstream flow data and the expected operation, a second "no operation" run is simulated by creating water level, and if necessary, flow time series to represent the no operation case. The difference between these two model runs is then used to determine the water-use due to the watering action.

Water-use is estimated based on the difference between results of the two scenarios, i.e. the additional water-use associated with the proposed operation including increased evaporation and seepage due to increased inundation area and where appropriate retention of water on the floodplain during and following the operation. For each relevant node for a given site (outlined below), the following daily outputs are recorded:

- Rainfall volume
- Evaporation volume
- Seepage volume
- Storage Volume

The evaporation and seepage are summed, with rainfall subtracted, over the relevant period for the environmental watering action. The difference in storage volume between the end and start of the relevant period is used to determine any water retained within a node (e.g. trapped in a wetland on a floodplain). These volumes are summed for each node, and then across the relevant nodes to determine the loss over the duration of the environmental watering action. The difference in the loss, between the with and without action model runs, provides the estimate of the loss due to the environmental watering action.

The methodology outlined above describes the case for a post event water use calculation, when the observed water levels and climate data are available. Pre-event water use estimates, are calculated using the same method, but in the place of observed data planned operations, average climate and 'Annual Operating Plan Flow to SA' hydrographs are used.

Specific nodes used to calculate the loss for a given action and the input data used to configure the model are outlined in Table 1 to Table 10. Additional losses from increases in flow in the river due to environmental water delivery can be determined by combining the results across all the sites outlined below, if deemed necessary by the relevant policy and procedure. This analysis is considered further in the following section.

Table 1. Nodes used in the hydrological model to calculate the loss at Chowilla floodplain

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Chowilla Floodplain	Gum Flat 281	24004	-	-
Chowilla Floodplain	Lake Littra 280	24004	-	-
Chowilla Floodplain	Lake Limbra 282	24004	-	-
Chowilla Floodplain	Coombool Swamp 283	24004	-	-
Chowilla Floodplain	Werta Wert wetland 388	24004	-	-
Chowilla Floodplain	Chowilla Regulator 254	24004	A4261091	-
Chowilla Floodplain	Floodplain retention 389	24004	-	-
Chowilla Floodplain	Woolshed R256	24004	-	-
Chowilla Floodplain	Pipeclay Creek 150	-	-	Manual recordings during events.
Chowilla Floodplain	Slaney Creek 151	-	-	Manual recordings during events.
Weir pool 6	Lock 6	24004	A4260511	Flow to SA

Table 2. Nodes used in the hydrological model to calculate the loss at Pike floodplain

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Pike Floodplain	Pike inlet	-	-	Combined inflow at Deep Creek and Margret Dowling Creek
Pike Floodplain	Bank B offtake		-	-
Pike Floodplain	Mundic	24016	A4261244	-
Pike Floodplain	Upper Pike	24016	Recorded water level	-
Pike Floodplain	Lower Pike	24016	-	-
Weir pool 5	Lock 5	24016	A4260513	A4260511 + A4261091
Lake Merreti	Lake Merreti	24016	-	-
Lake Woolpolool	Lake Woolpolool	24016	-	-

Table 3. Nodes used in the hydrological model to calculate the loss at Katarapko floodplain

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Katarapko Floodplain	Katarapko inlet	-	-	Combined inflow
Katarapko Floodplain	Katarapko	24008	A4261225	-
Weir pool 4	Lock 4	24008	A4260514	A4260513
Gurra Gurra Lake	Gurra Gurra	24008	A4261170	A4260663
Berri Basin	Berri	24008	-	-

Table 4. Nodes used in the hydrological model to calculate the loss at Weir Pool 6

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Weir pool 6	Lock 6	24004	A4260510	A4261001

Table 5. Nodes used in the hydrological model to calculate the loss at Weir Pool 5

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Weir pool 5	Lock 5	24016	A4260512	A4260511 + A4261091
Lake Merreti	Lake Merreti	24016	-	-
Lake Woolpolool	Lake Woolpolool	24016	-	-

Table 6. Nodes used in the hydrological model to calculate the loss at Weir Pool 4

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Weir pool 4	Lock 4	24008	A4260514	A4260513
Gurra Gurra Lake	Gurra Gurra	24008	A4261170	A4260663
Berri Basin	Berri	24008	-	-

Table 7. Nodes used in the hydrological model to calculate the loss at Weir Pool 3

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Weir pool 3	Lock 3	24007	A4260516	A4260515
Lake Bonney	Lake Bonney	24007	-	-

Table 8. Nodes used in the hydrological model to calculate the loss at Weir Pool 2

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Weir pool 2	Lock 2	24012	A4260518	A4260517

Table 9. Nodes used in the hydrological model to calculate the loss at Weir Pool 1

Feature	Node Name	Climate Station	Downstream water level	Upstream flow
Weir pool 1	Lock 1	24578	A4260902	A4260519

Table 10. Nodes/Links used in the hydrological model to calculate the loss below lock 1

Feature	Node/Link Name	Climate Station	Downstream water level	Upstream flow
Lock1 to Swan Reach	R120	24564	-	A4260903
Swan Reach to Walker Flat	R121	24547	-	-
Walker Flat to Mannum	R122	24517	-	-
Lower Lakes	Lake Alexandrina	Average of stations; 23718 24518 24537 24539 24572 24576	Average of stations; A4260574 A4260575 A4260527 A4261133 A4260524	-
Lower Lakes	Lake Albert	Average of stations; 23718 24518 24537 24539 24572 24576	-	-

3 Assessing losses due to flow enhancement

An assessment of the increase in loss due to increases in flow at the SA Border has been undertaken to inform the Policy for Application of Losses to Environmental Water (DEW Environmental Flow Policy No. 10). The intention is to consider the case where environmental water is added to regulated flow conditions, when there is no unregulated flow to account for any additional losses due to the increased flow. It should be noted that this analysis only considers the additional losses due to the additional inundation due to the delivery of higher flow, no structures are operated in this analysis.

The methodology outlined above has been used for all the model nodes in South Australia. The average rainfall and evaporation for December was used, to represent relatively high loss rates (i.e. environmental water delivery may typically occur earlier in the year with lower net evaporation rates). Table 11 provides the additional loss per day expected after increasing the flow at the SA border from 5,000 ML/d (representative of regulated flow conditions) to higher flows that could be expected to be within the range that could be delivered using environmental water under regulated conditions (column 4). It can be seen that this additional loss is in the range of 1-2% of the enhanced flow rate.

While this is a small percentage of the total flow, the loss rate in column 4 of Table 11 is not immaterial. As such, it is recommended to determine losses due to flow enhancement on a case-by-case basis, which can be expected to be within the range presented in Table 11.

Table 11. Additional water use losses from increasing the flow at the SA border above 5,000 ML/d (regulated flow condition), based on average net evaporation in December.

SA Border flow (1)	Flow into Lower Lakes (2)	Loss within SA (Incl. diversions, etc.) (3)	Additional loss due to increase in flow (4)	Percentage of SA Border flow (5)
ML/day	ML/day	ML/day	ML/day	%
5000	2066	2934		
10,000	6902	3098	164	1.6%
20,000	16,839	3161	227	1.1%
30,000	26,698	3302	368	1.2%

4 References

Beh, E. Montazeri, M, Gibbs, M. (2019). *Refinements to the River Murray Source model in South Australia*. DEW Technical note 2019, Government of South Australia, Department for Environment and Water, Adelaide. In prep.

DHI (2014) *Lower Murray Hydrodynamic Model – Model development and calibration report*. Final Report to Department of Environment, Water and Natural Resources (DEWNR), Dec 2014

McCullough DP, Montazeri M & Esprey L (2017). *Refinement and calibration of Pike and Katarapko floodplain flexible mesh models*. DEWNR Technical note 2017/11, Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

MDBA (2015) *Source Model for the Murray and Lower Darling System*. Technical Report No. 2015/03, version 2, November 2016, Murray-Darling Basin Authority.

Morton, F. I. (1983) Operational estimates of areal evapotranspiration and their significance to the science and practice of hydrology, Journal of Hydrology, 66(1–4). pp 1-76.

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