THE BASIN PLAN IMPLEMENTATION

Namoi Water Resource Plan – Namoi Pre basin plan (PBP) scenario model – Namoi Regulated River System

Appendix B to Schedule F

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More information

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Glossary

Term	Definition
BDL	Baseline Diversion Limit under the Basin Plan
Cap	The Murray Darling Basin Ministerial Council Cap on Diversions
DPIW	NSW Department of Primary Industries, Water Division
EFRG	Environmental Flows Reference Group
EWA	Environmental Water Allowance
HEW	Held Environmental Water
IQQM	Integrated Quantity and Quality Model
LTAAEL	Long term Average Annual Extraction Limit
MDB	Murray Darling Basin
MDBA	Murray Darling Basin Authority
MDBC	Murray Darling Basin Commission
MDBSY Project	Murray Darling Basin Sustainable Yields Project
OFS	On farm storage
PBP	Pre-Basin Plan
SDL	Sustainable Diversion Limit
WA 2007	Commonwealth Water Act (2007)
WMA 2000	NSW Water Management Act (2000)
WRP	Water Resource Plan
WSP	Water Sharing Plan

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1 Introduction

The 2012 Basin Plan, established under the WA 2007, defines the maximum limit of consumptive diversions at valley as well as basin scale. WRPs are being developed for each valley to meet Basin Plan requirements. A significant element of the WRP is that the allowable long term average annual diversions have been set as the SDL. This SDL depends on an estimate of the BDL, which is the long term average annual diversion calculated over the period 1895-2009 that was allowable under state water planning law prior to when the Basin Plan was formulated. The SDL is the BDL minus a fixed recovery target.

These long term average annual diversions are estimated using computer models of the river system. These models estimate a range of water balance components such as streamflow and diversions based on climatically derived water availability, levels of water resource development, and water sharing policies.

An estimate of BDL by MDBA published in Schedule 3 of the 2012 Basin Plan has since been revised by NSW, with the changes principally based on improved ungauged inflow and transmission loss estimates using data collected during the millennium drought, and higher resolution of flow paths at some locations. These improvements are reported in a related technical note (DPI Water, 2017).

This revised BDL estimate has resulted in a commensurate revised SDL that the Namoi WRP needs to comply with. The Namoi WRP will be developed in the near future with the water sharing arrangements and rules informed by the results of a range of modelled scenarios. For these modelled scenarios to accurately estimate long term average annual diversions, the model needs to better reflect what is driving water use, based on conditions that exist in the valley now, rather than what existed in the valley over a decade ago as is modelled for the BDL. The current condition is better reflected in Pre Basin Plan scenario as introduced next.

1.1 The Pre-Basin Plan Scenario

The PBP scenario is the model configured with the development conditions and management arrangements that currently exist. This includes development conditions such as; public infrastructure, areas developed for irrigation, and the capacity of water users to extract and store water on farm, as well as management arrangements such as the distribution and usage patterns of entitlement holders, the crop area planting decisions of irrigation enterprises, and operation of storages to supply consumptive and environmental water.

The PBP scenario gives the best estimate of long term average water use under current conditions, and forms the baseline for water resource plan scenario development. There are many similarities with the BDL scenario. The similarity includes climatic inputs and the improvements of the physical processes from the revised BDL scenario model. However, the PBP scenario differs from the BDL scenario in its development conditions and management arrangements. The development conditions have evolved since the early 2000s. These includes different planted area, on-farm storages, crop types that are grown and the crop area planting decisions given available water resources.

The results from the PBP scenario will be used to establish what current long term average diversions are compared to SDL. The PBP will further be used to compare scenarios trialled as part of the WRP development process. These scenarios will typically focus on changing some of the water management arrangements to identify where productive and ecological outcomes can be improved, and to identify any trade-offs.

The PBP scenario can also make use of the information in a slightly longer climate data set. While the SDL must be calculated over the 1895-2009 climate period, other climate data, including the 7-year period since 2009 can also be used to identify improved outcomes and associated trade-offs.

This report describes the development of the PBP scenario.

1.2 Purpose of report

This report is intended primarily for Stakeholders Advisory Panel (SAP) as a record of the development conditions and management arrangements that will be a starting point for the preparation of WRP. The purpose of the report is to describe how the PBP Scenario was developed, and fully document what is included in this scenario.

The technical content of this report is kept to only that necessary to meet the intent. The general development and calibration of the model is described in the IQQM Cap Implementation Summary Report (Ribbons et al., 2005).

2 Model Development

2.1 WSP to BDL

The Namoi IQQM was initially developed in the mid-1990s. The capability of the Namoi IQQM to estimate annual and long term diversions was established by the independent review processes under Cap governance arrangements. The model was independently audited by Bewsher Consulting in 2005 for MDBC. The Auditor concluded the model to be sufficiently robust and unbiased, and it could be used to simulate long-term diversions. A further review of the model was undertaken as part of the MDB Sustainable Yields Project, and to establish its fitness-for-purpose for use for MDBA modelling for the Basin Plan (Podger et al., 2010). The calibration and set up of the audited model is described in the Namoi Valley IQQM Cap Implementation Summary Report (Ribbons et al., March 2005).

Namoi IQQM was used to develop the WSP of Namoi Regulated River Water Sources. The gazetted WSP quoted LTAAEL estimate of 238 GL/year. This estimate varied because of period of simulation and improvements of the model. MDBA made use of the 2006 version of Namoi IQQM for their BDL estimate published in the Basin Plan. The MDBA BDL simulated diversion over the period 1895 to 2009 was 245 GL/y.

The latest NSW BDL scenario model stemmed from continuous model improvement since 2006. The key updates from MDBA version to updated NSW BDL scenario model is listed below with details reported in Chowdhury and Jayawickrama (2017b).

- More consistent climate data source
- Improved ungauged flow and loss estimates due to longer calibration period.
- Higher resolution of flow path configuration
- Better reflection of Split Rock to Keepit transfer behaviour

The revised NSW BDL is 256 GL/y.

The PBP model setup is inclusive of all the above improvements.

2.2 BDL to PBP

The PBP scenario is intended to determine diversions based on conditions that currently exist. The major differences between BDL and PBP scenarios is the level of development that includes the maximum developed area, crop mix, crop planting decision, on farm storage and distribution of entitlements. The irrigation module was further calibrated to ensure that model was capable of replicating current volume of diversion hence representative of current level of development. The following sections discuss these updates.

2.2.1 Maximum Area

The area planted for irrigation in a year with high water availability is an indicator of the maximum irrigated area that would be grown by surface water sources in the Namoi Valley, and is used directly in the model. The maximum area in BDL was derived based on records from 1997 to 2002. Similar records were not subsequently collected, and instead this was estimated using remote sensing classification and field verification.

The key challenges of the remote sensing classification include differentiating between irrigated and dryland crops in wet periods, and differentiating crop types. Further independent work was needed to discriminate the source of water used (surface water or groundwater), location of regulated extraction and differentiating winter crop from fallow growth. This has been addressed in three stages.

1. Desktop definition of farm boundary polygons using Six Maps, a high resolution cadastral and imagery of NSW Spatial Services.
2. Field verification of polygons and classification into water source categories (surface water, ground water or both) based on advice from water users.
3. Analysis of imagery within the polygons post verification and classification. Summer area is computed using Landsat imagery of February 2012 and February 2013 (high water availability) and winter area uses MODIS imagery of 2010 to 2012 winters.

Accordingly PBP model uses maximum summer area of 38,540 ha representative of February 2012 crops and winter area of 10,330 ha representative of August 2010 crops.

2.2.2 Crop type

Namoi IQQM uses a fixed ratio of crops given a planted area in any year. The crops used are cotton, lucerne, summer cereal, summer pasture, winter pasture and wheat. The significance of the classification is limited to generating reasonable crop water demand. We analysed MODIS imagery from 2008 to 2016 within the validated polygons.

2.2.3 On farm storage and pump size

The volumetric capacity of on farm storages (OFS) contributes towards water use potential of the valley. Records of the OFS capacities from 1987-2006 were used to calibrate and configure models, showing gradual growth. No comparable data was collected after that, and so satellite imagery was used to produce a contemporary estimate.

Landsat imagery of storage surface area of January 2005 was compared with imagery of May 2012. The 2005 volume record is then modified based on the ratio of these areas. Accordingly PBP model uses an estimated capacity of 219,025 ML of on farm storage constituting an aggregate increase of 20% from BDL. Note that this overall increase is not uniformly distributed along the river. Pump capacity controls the rate at which water can be extracted, and is particularly important during supplementary events. Records kept in the DPIW licensing database show a capacity of 14,100 ML/d in the PBP scenario, 19% higher than the BDL scenario.

2.2.4 Water allocation to planted area

In a resource limited year the area planted for irrigation depends on the available water. The model considers the volume of farm storage, likely increase of AWD and expected rainfall while using an externally defined ML/ha planting rate. This relationship is described in a risk function in the model. This function was re-parameterised using observed September AWD, simulated farm storage volume, and summer planted area derived from MODIS imagery analysis. Based on an average of five resource limited years over the period 2008-2015, an average risk rate of 7.0 ML/ha (range 5.7-8.1 ML/ha) was calculated.

2.2.5 Entitlement distribution

The PBP model includes unit shares and distribution of General Security (GS), Supplementary (SA) and High Security (HS) entitlements stored in licensing database of the Department as of October 2012. This includes 6,098 ML of GS held environmental water (HEW) from October 2012. The PBP scenario model simulates environmental recovery as an irrigator.

2.2.6 Replication of current diversion

PBP model includes more up to date crop and farm infrastructure information from different sources as detailed from Section 2.2.1 to Section 2.2.5. This requires a recalibration of crop demand to diversions, including unmeasured parameters such as irrigation efficiency, runoff harvesting, and soil-capacity. The veracity of the method is tested by the PBP scenario model's ability to reproduce recent diversions from 2008-2016. Total diversions were reproduced to within 3% over this period, with satisfactory reproduction of temporal and spatial variability (Chowdhury, 2017).

2.2.6.1 Validation

Given the broad changes to the crop demands, and its significance to estimating current levels of diversions, the changes were validated by independent means.

A linear regression technique was applied with diversions estimated based on a combination of available storage in Split Rock Dam and Keepit Dam along with annual rainfall and potential evapotranspiration at Narrabri. The algorithm calibrated to the 1999-2007 period (within 0.1%), was used to estimate diversions over 2008-2015. The results indicated a 1% increase, which is within the uncertainty bounds of this method.

An alternate approach was also adopted to run BDL scenario model and PBP scenario model independently to simulate total diversions over the period 1999-2015, and for each run to report separately the percentage difference in average annual diversions for the first half (1999-2007) and second half (2008-2015) of this period. The results are reported in Table 1.

These results show that the BDL scenario model matches average diversions closely for the earlier period for when the development levels and risk function were more relevant, but significantly overestimated for the later period. Whereas the PBP configured scenario matched both periods to within 3%.

These results indicate that the BDL scenario is not appropriate for estimating diversions under current conditions in the Namoi Valley, and that the calibrated PBP scenario is more accurate for the purpose of estimating annual and long term average diversions.

Table 2-1. Annual diversion comparisons

Period	Observed (GL/y)	% difference scenario to observed	
		BDL	PBP
1999-2015	147.1	+5.0	+0.3
1999-2007	156.5	-0.8	-1.5

2008-2015	136.5	+12.5	+2.6

3 Results

The average annual usage for different components of the models is shown in Table 3-1. PBP simulates increase in supplementary take as a response to increase in OFS capacity and larger pumps (as discussed in Section 2.2.3) compared to BDL scenario. The decrease in general security take may be attributed to utilisation of more supplementary water and conservative planting area decision. There is an overall decrease in consumption per unit share of entitlement and a corresponding increase in river flow at Bugilbone.

Table 3-1. Key results of BDL and PBP simulation

Category	Scenario	
	BDL	PBP
Entitlements or Use Type	(long term average usage (GL/y) (1895-2009)	
General Security	191.4	142.8
Supplementary Access	44.3	59.5
Flood Plain Harvesting	18.6	17.5
Utilities, Domestic & Stock	1.4	3.4
GS Held Environmental Water[1]	n/a	8.2
Total usage	255.7	231.4
Flow at Bugilbone	524.3	538.3

[1] This is the current estimate based on Held Environmental Water licence as of March 2019, which is modelled as irrigator.

4 PBP model parameters

Table 4-1 contains all relevant configuration information for the PBP Scenario.

Table 4-1. Infrastructure and Development Parameters

Items	Description
General	
System File Name	NamoD093.SQQ
IQQM Version developed in	7.91.6
Available Simulation Period	30/09/1892-30/06/2016
Water Year	July to June
Valley Development Levels	
Maximum Crop area	February 2012, August 2010
Crop Mix	Average of 2008 to 2016
Licence Volume	As of October 2012
Crop Planting Decision	2008 to 2015
Catchment Information	
Headwater storages modelled	
Split Rock	
Inactive storage (GL)	3.2
Full supply volume (GL)	397.4
Keepit	
Inactive storage (GL)	6.6
Full supply volume (GL)	425.5
Entitlements	
General Security (shares)	
d/s Split Rock Dam	9,352
d/s Keepit Dam	
Consumptive	237,279
HEW NSW	0
HEW Commonwealth	6,098
d/s Keepit Dam Total	243,377
TOTAL VALLEY	252,729
High Security (shares)	
d/s Split Rock Dam	80
d/s Keepit Dam	3,904
TOTAL	3,984
Town Water Supply (shares)	2,421
Stock and domestic (shares)	2,160
Supplementary Access Cap (ML/y)	113,900
Irrigation development	
Maximum farm area (ha)	88,882
Maximum summer area (ha)	38,541
Maximum winter area (ha)	10,326
On-farm storage capacity (ML/d)	219,025

Items	Description
Installed pump capacity (ML/d)	14,065
On-farm storage operation	
Rainfall runoff harvesting	Yes
Airspace allowed	Yes
Accounting System Lower Namoi	
Type	Continuous
Debiting type	Water order
Maximum balance	200%
Maximum use of entitlement	125% subjected to a max of 300% in 3 consecutive years
Accounting System Upper Namoi (not modelled explicitly)	
Type	Annual, first priority
Debiting type	Water use
Uncontrolled flow	Use without debit when AWD < 60 %
Storage Operation	
Split Rock to Keepit transfers	Water can be transferred from Split Rock to Keepit when volume stored in Keepit is insufficient to meet projected downstream demands and when volume stored in Split Rock Dam above 38 GL. Releases made to a pattern.
In-stream requirements	
Average annual replenishment flow usages and maximum caps in brackets(ML/y)	
Pian Creek	2,000 (14,000)
Minimum flow requirements at various locations (ML/d)	
Manilla R d/s Split Rock	5 (Apr – Sep) and 6 (Oct – Mar)
Namoi R d/s Keepit	10
Namoi R @ Walgett	21 (Jun), 24 (Jul) and 17 (Aug)
Environmental Water	
Planned Environmental Water	
Surplus flow sharing	90:10 July to October (Environment: Irrigation) 50:50 the rest
Surplus flow threshold	Various, as of WSP c49(9) to (12), function (allocation, month)

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