Department of Science, Information Technology and Innovation

Nebine Creek

Nebine Creek Model Results to Support Basin Plan Requirements

Water Planning and Coastal Sciences

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Queensland Government

Prepared by

Queensland Hydrology
Water Planning and Coastal Sciences
Science Delivery Division
Department of Science, Information Technology and Innovation
PO Box 5078
Brisbane QLD 4001

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1 Introduction

The Nebine Model was developed by using IQQM Model as a platform. A detailed background to the data used, methodology, calibration and validation of the model development is documented in *Nebine Creek System IQQM Calibration – Nebine Ck., Wallam Ck. And Mungallala Ck. To the Culgoa River (DSITI, 2016).*

1.1 Current model

In preparing a water resource plan (WRP) and a resource operations plan (ROP) under the *Water Act 2000* (Qld), Queensland develops a hydrologic model to test management scenarios. The current plans, viz. the Water Resource (Warrego, Paroo, Bulloo and Nebine) Plan 2003 (current WRP) and the Warrego, Paroo, Bulloo and Nebine resource operations plan January 2006 (current ROP), uses the Integrated Quantity Quality Model (IQQM) for the catchment models.

The current ROP model for the Nebine Creek also forms the basis for the audited Cap model which supports Cap Reporting requirements under the Murray–Darling Basin Agreement and in the transition to the Basin Plan Section 71 reporting. Note that the current ROP and Cap models use different simulation periods but are otherwise the same.

1.2 Proposed Model

Queensland has developed a new model for the Nebine Creek as part of the review of the current WRP and ROP and for the proposed Water Resource Plan package being developed to comply with Basin Plan requirements. This new ROP model differs from the current model on the following points:

- Updated Methodology – Queensland has updated the model methodology based on the learnings from previous model builds to improve the robustness of the model. This update has come from model application, internal and external audits and developments external to technology. This is addressed in Appendix A. A key driver for this update was so that the model could be used to determine the sustainable diversion limit (SDL) and the baseline diversion limit (BDL) consistent with the Basin Plan requirements i.e. Chapter 10 and Position Statement 3 C Method for Determining Take.
- Better Data – With every review more data becomes available. This is particularly significant in the case of the Nebine where two new streamflow gauges at Wallam Ck. @ Cardiff and Nebine Ck. @ Roseleigh Crossing provided the capacity to better understand and simulate the flows in the stream. This is addressed in Appendix A.
- Overland Flow has been removed from the model as the information supporting this was poor. When reliable information becomes available as Overland Certification occurs in the catchment, it will be reflected in the model.

It needs to be noted that there have been no changes to water allocations between the current and new ROP models in either the flow management or threshold of access conditions.

1.3 Basin Plan Requirements

The Basin Plan prescribes requirements that Queensland needs to address to meet accreditation.

The key requirements that need to be addressed by the model are:

1. BDL — Baseline diversion limit of a SDL resource unit. The Baseline diversion limits are determined based on development conditions as specified in Schedule 3 of the Basin Plan. In general, the BDL is a sum of:
   - take from water courses
   - take from regulated river
   - take by floodplain harvesting
   - take by commercial plantation
   - take from basic rights

   The model provides a component of the take identified in Schedule 3 is the long-term annual average limit on the quantity of water that can be taken from the watercourse and from regulated rivers. The other forms of take are considered in the Water Accounting Methods Report (NRM, 2016).

2. SDL — Sustainable diversion limit of the Water Resource Plan area. The SDL is the long-term average sustainable diversion limit from a SDL resource unit as defined in Schedule 2 and 4 of the Basin Plan. Clause 10.10 of the Basin Plan specifies that the Water Resource Plan must set out the method for determining the maximum quantity of water that the plan permits to be taken for consumptive use during a water accounting period. This method may include the modelling. For the Nebine SDL resource unit, Queensland prepared the IQQM Model to meet this requirement. As there are no SDL adjustment measures proposed for the Nebine, the difference between BDL and SDL is achieved by Commonwealth water recovery. To simulate SDL in the model, the Commonwealth's water entitlements are treated as inactive (i.e. not used for consumptive take).

3. Annual Actual Take — Determination of annual actual take must be specified. As per clause 10.15 of the Basin Plan, the determination of the quantity of water, actually or estimated, taken for the consumptive use by each form of take from each SDL resource unit will be determined after the end of a water accounting period. The method used to estimate the quantities should be same as used to determine BDL and SDL.

4. Environmental Water — Determination of the environmental water requirements of environmental assets and ecosystem functions. Clause 8.51, sub-section (1) and (2) of the Basin Plan list a number of measures to determine the environmental water requirements of an environmental asset and states that a method to estimate them may include a conceptual model. The Nebine Creek has a relatively intact flow regime with only minor impacts. Existing environmental water recovered as part of the Water for the Future program will assist in further protecting the existing flow regime.

5. SDL Adjustment Proposals — Models are an important tool for evaluating the SDL adjustment proposals. Chapter 7 of the Basin Plan states that the Authority can propose adjustments to the surface water SDLs if certain additional changes in infrastructure are proposed through the implementation of 'supply measures' and 'efficiency measures'. Currently there are no SDL Adjustment Proposals in the Nebine. There may be a redistribution of the Northern Basin shared reduction under Chapter 7 of the Basin Plan, which could change the SDLs for each resource unit. However, this would be achieved by Commonwealth water recovery, which is reflected in the model.

Sections 10.22, 10.49 and 10.50 of the Basin Plan specify requirements that the WRP Package meet:

a) Section 10.22 states that a water resource plan must describe what was done to comply with the requirements mentioned in Part 4, Chapter 10 of the Basin Plan.

b) Section 10.49 states that:

- A water resource plan must be based on the best available information
- The water resource plan plan must identify and describe the significant sources of information on which the water resources plan is based.

c) Section 10.50 states that:
"A water resource plan must identify any significant method, model or tool that has been used to develop the water resource plan."

This report covers the requirements outlined above.

2 Nebine IQQM Model

The Nebine Model was developed by using the IQQM Model as a platform. A detailed background to the data used, methodology, calibration and validation of the model development is documented in *Nebine Creek System IQQM Calibration – Nebine Ck., Wallam Ck. And Mungallala Ck. To the Culgoa River (DSITI, 2016).*

3 Model Scenarios

In this section, the model scenarios are described. The details of the model scenarios are described in Table 1.

Table 1 Detail of the Model Scenarios

Case Number	Model Name	Description	Simulation Period
200A	Pre-development	A scenario with infrastructure and extractions for consumptive use removed from the model to simulate the predevelopment flows.	1889–2011
0902A	Current ROP	This model was developed to underpin the first generation Water Resource Plan and was later extended to cover the Basin Plan Period. Resource Operation Plan (2006).	1889–2009
1601A	New ROP	This model was developed to underpin the second generation Water Resource Plan representing all of the Water Allocations and licences in the basin. The model corresponds to the Resource Operation Plan (2016).	1889–2011
1601B	SDL	This model was developed at the request of the Murray–Darling Basin Authority. Queensland does not utilise this model for available water calculations.	1889–2011

All of the model scenarios cover a period greater than the Basin Plan (1895–2009) so they are able to fulfil the Plan’s requirements. All results in this report are provided for the Basin Plan period.

These scenarios were used to simulate the extractions (BDL) under the Resource Operation Plan for the Nebine Creek System.

The model simulated the:

- Water Allocations (including those held by the Commonwealth Environmental Water Holder (CEWH))
- Unallocated Water
- Water Licences

3.1 Reference Case (Case 200A)

A Pre-development case (case 200A) was simulated to describe the flow regime without any instream extraction across the river basin. The flows identified in this case were used as the baseline for evaluating how the various development scenarios affected streamflow.

3.2 New Resource Operation Plan (Case 1601A)

Details of the Resource Operation Plan IQQM are presented below.

3.2.1 Storage Details and Assumptions

No significant water infrastructure of note in the catchment.

3.2.2 Management System

The Nebine Creek is an unsupplemented system with no supplemented management of water.

3.2.3 High Priority Demand

There is no high priority demand supplied by the Nebine Creek.

3.2.4 Medium Priority Demand

There is no medium priority demand on the Nebine Creek.

3.2.5 Unsupplemented Licensed Data

This section presents the information used to model water use within the Basin.

Some licences have not been converted, and are still in the ROP model. These licences are described in Table 2. The crop model was not utilised in the new model as the hydrology availability and the conditions control the access.

Table 2 Resource Operation Plan Case 1601A –Licence Representation

Sub-Catchment	Licence Number	Pump Capacity (ML/day)	Nominal Volume	Start Threshold
Nebine E	43353Q	15.6	22	138 ML/d downstream of the point of take
Nebine C	43875Q	25.9	52.5	260 ML/d downstream of the point of take
Nebine B	17368E	Gravity diversion	-	0
	17850E	Gravity diversion	-	0

The water allocation were used in the model are presented in the Table 3. The water allocations were represented with no infrastructure limit and an annual volumetric limit.

Table 3 Unsupplemented Water Allocations in the Nebine Catchment

Water Allocation Number	Nominal Volume (ML)	Volumetric Limits (ML/year)	Max Rate for Taking Water (ML/day)	Flow Conditions	Special Conditions
	Nebine Zone C				
47	300	1,050	86.4	1500 ML/day passing the Booroorban to Bollon road	Nil
	Nebine Zone E				
46	90	250	25.9	1500 ML/day passing the offtake	Nil
48	1,490	1,750	100	Flows greater than 130 ML/day in Wallam Creek up to 1000 ML in a water year	Nil
48				Flows greater than 1000 ML/day in Wallam Creek up to 1750 ML in a water year	Nil
78	159	159	1	Nil	Nil
	Nebine Zone A				
85	1,000	5,920	332	1567 ML/day passing the offtake	Nil

4 Reconciliation with Murray–Darling Basin Plan Schedule 3

The Basin Plan places limits on water extractions within the SDL resource units. The model 1601A is proposed to estimate the available water, specifically the take from watercourses for water allocations and licences. This will support the Water Accounting Methods proposed in the Water Accounting Methods Report (NRM, 2016) for the other forms of take and classes of water access right. For the details on these proposed methods, see the report cited above.

The following section provides the comparison and a breakdown of the long term diversions between the model scenarios 0902A and 1601A, using the Basin Plan simulation period 1895–2009. Table 4 provides a comparison between the long term diversion of the water allocations in the model scenarios while Table 5 and Table 6 present the Baseline Diversion Limits for the current Resource Operation Plan (2006) and the new Resource Operation Plan (2016) model scenarios. The difference between the results of the two models is due to improvements in the model and data used, as discussed in Appendix A. Appendix B presents the modelled water balance for the scenario ROP 2016 (1601A).

Table 4 Long Term Diversions for the two respective Water Resource Plans (1895–2009)

Water Allocation Group	Water Allocation	Nominal Volume (ML)	Mean Annual Diversion (ML/yr) 0902A	Mean Annual Diversion (ML/yr) 1601A
WAG – A				
	Unallocated Water now 85	1,000	952	3,842
WAG – C				
	47	300	362	61
WAG – E				
	46	90	98	73
	48	1,490	1,445	1,127
	78	159	96	157

The following tables show the breakdown of diversions for the BDL and SDL within the Nebine System:

Table 5 Long Term Diversions from the Resource Operation Plan 2006 (1895–2009)

Water Product	Mean Annual Diversions (ML/annum)
Take from watercourse – Unsupplemented Water Allocations	1,515
Take from watercourse – License to take Water	1,066
Take from watercourse – Unallocated Water	990
Take from watercourse – Overland Flow	2,664
TOTAL	**6,235**

The Commonwealth held water was accounted for in the unallocated water at the time of the plan development. It was later gifted to the Commonwealth.

Table 6 Long Term Diversions from the Resource Operation Plan 2016 (1895–2009)

Water Product	Mean Annual Diversions (ML/annum)
Take from watercourse – Unsupplemented Water Allocations without flow conditions	157
Take from watercourse – Unsupplemented Water Allocations with flow conditions	5,103
Take from watercourse – Unallocated Water	100
Take from watercourse – Water License Volume limited	50
Take from watercourse – Water License Non-volume limited	4,297
TOTAL	**9,707**

5 Conclusion

The new model for the Nebine has benefited from additional information that has become available to update the legislative models that support the Queensland Water Resource Planning process and Murray–Darling Basin Plan requirements. The models have benefited from:

- new climatic and streamflow data
- updated methodology
- longer simulation period and better representation of climatic variability.

The Basin Plan has a simulation period from 1895 to 2009 which differs from both the current Resource Operation Plan (2006) and the new Resource Operation Plan (2016), causing some of the variation in the diversion figures between Basin Plan and State Plan. When a consistent period is applied, it is possible to compare take from watercourses by allocations and licences for the two plans, as shown in Table 7. CEWH entitlements are identified separately to assist with demonstrating how the SDL will be achieved through Commonwealth water recovery in the Nebine SDL resource unit. For estimates of the BDL and SDL, please refer to the Water Accounting Methods Report (NRM, 2016), as these estimates are comprehensive and include forms of take and classes of water access right not considered in the IQQM models.

Table 7 Long term mean annual diversions from watercourses under water allocations and licences: comparison of model 0902A and 1601A

Mean annual diversions (1895–2009)	ROP 2006 (0902A)	ROP 2016 (1601A)
Total	6.2 GL	9.7 GL
CEWH entitlements only	0.9 GL	3.8 GL
Total less CEWH entitlements	5.3 GL	5.9 GL

As can be seen in Table 7, the ROP 2016 (1601A) estimates of mean annual diversions are higher than the estimates provided by the ROP 2006 (0902A) model. The main difference between the two models is the new streamflow stations that provide information on the flows within the Nebine which was not available when the first model was developed. This has been detailed in Appendix A.

The new model demonstrates Queensland’s commitment to improve on the previous model’s robustness and defensibility. All future models will build on the new model and use the latest information, methodologies and technology available at the time when the next new model is developed.

6 References

Department of Natural Resources and Mines (2016), *Water Accounting Methods Paper for Warrego-Paroo-Nebine Water Resource Plan, State of Queensland, February 2016.*

Department of Science, Information Technology and Innovation (2016), *Nebine Creek System IQQM Calibration – Nebine Ck., Wallam Ck. And Mungallala Ck. To the Culgoa River.*

Appendix A – Methodology and Data Differences

Methodology and Data Differences 2003 to 2015

Variations in inflows and the model's physical components, such as loss and natural breakout representations, result from differences in the data and methodology used. The 2015 methods are different to those used in 2003. As a result it is extremely difficult to say exactly what causes variations between the models over short and long time periods.

Given the variations in methods it is more appropriate to work through the methodology used in the 2015 model. If the methodology is acceptable and has been applied correctly then the resultant model should be acceptable.

It should be noted that while in-bank flows are reasonably well defined, out of bank and high flow is not. This is due to the fact that on the flat landscape in extreme events water is likely to change its flow path. While this has been built into the model, it is likely that the behaviour in extreme events will differ to that in the model. This is true of both the 2003 and 2015 models.

Key variations between the 2003 and 2015 data and methods are outlined below. The following models are referred to:

- 2003 model – Basin plan model (This model was used to inform the development of the Murray–Darling Basin Plan).
- 2012 model – New WRP model (Initial model supplied to the MDBA to meet Basin Plan requirements of accreditation).
- 2015 model – Updated WRP model with changes made following the MDBA review. Only the Warrego was changed as a result of the review so for the Paroo and Nebine the 2012 and 2015 models are the same and are referred to here as the 2015 model.

Rainfall and Evaporation

Different rainfall and evaporation data were used. Since the 2003 models were calibrated, a number of issues have been identified with using grid data, especially for catchments where there is sub-optimum spatial and temporal station coverage, as is the case in these western rivers.

SILO patched point data, which is recorded station rainfall infilled with SILO data drill (grid) data at that location, was used in 2015 instead of mean reach rainfalls derived from the SILO data drill (grid) data. This change in climatic data has produced better response to flow events but the spatial and temporal patterns differ across the catchment between the two models.

In 2015, rainfall stations were chosen to give good spatial and temporal coverage in the reach. Various combinations of stations were considered during the Sacramento calibrations. Generally the 2015 reach mean rainfalls were higher.

In 2015, evaporation data were taken from the Warwick site, which is outside the catchment. The grid data in these catchments are extrapolated out from the Warwick station and very few others and it was felt it was better to use something that was based to some extent on real data. The evaporation at Warwick would be fairly similar to evaporation in these catchments and any errors are unlikely to have a large effect on the model.

Flow Data

Recorded flow data used to develop the 2003 and 2015 models has varied in a number of ways:

- Different and additional gauges used.
- Longer records with flows associated with more extreme weather conditions.
- Rating changes. This will change earlier flow records if the rating curves change.
- Data may have been extracted differently. Variations include use of different time offsets and different conversion calculations used to generate flow data from levels.

In the Nebine, in the 2003 model no flow data was available for model calibration. In the 2015 model data from two new gauges Wallam Ck. @ Cardiff and Nebine Ck. @ Roseleigh Crossing was used. This allowed the derivation and distribution of inflows and losses within the catchment to be significantly improved as in the 2003 study many assumptions on the catchment responses were based on the models developed for the surrounding catchments.

In the Paroo the main difference was just the extension of records with time.

In the Warrego, there were two key differences. Firstly, the Barringun flow data used in model calibration. There are records from two gauges at Barringun which do not overlap. The 2003 study used only 423003 (1968–81). The 2015 study only used 423004 (1993–date) in the residual calculations. In 2015, the earlier record could not be used to calculate the residual, as the return flow from Irrara Creek based on recorded data could only be generated from 1993. This was because this was the start of the recorded data used for the upstream reach model. This reach model was used to estimate the breakout flows. The full data set from the two gauges was used to review the accuracy of the 2015 validation model.

Secondly, data from three additional gauges, Cuttaburra Ck @ Turra, Ward River @ Binowee and Warrego River @ Wallen were used in the calibration. This allowed the inflow distribution within the catchment to be modelled better. The Turra station was especially useful as it allowed a much improved representation of what was occurring in the Cuttaburra system. Previously the lack of a gauge meant a lot of guess work occurred.

Use of all flow data where stations were still operational allowed for additional catchment responses to be captured in calibration using the longer data sets.

Residual Calculation Periods

The period’s residuals were calculated differently. In the 2015 model, it was decided to derive residuals using only recorded data at both the upstream and downstream gauges. Conversely, in 2003, residuals were calculated for the full length of the downstream gauge by using flow data from the upstream gauge from the full model to that upstream gauge. The 2003 full model used inflows (in all upstream reaches) that included residuals based on a combination of real and Sacramento data coming from upstream catchments and Sacramento data from the reach Sacramento models calibrated to these residuals.

The aim of working with recorded data only this time was to develop a cleaner model where the development of downstream residual inflows was not based on Sacramento data upstream, only recorded data.

Sacramento Calibrations

The 2015 Sacramento models are different to the 2003 ones. They use different catchment areas, rainfall, evaporation and flow data (residuals were developed on numerous different modelling assumptions and for different time periods and, in some cases, flow data were extracted differently).

In the Nebine in 2003 there was not enough flow data to calibrate an in catchment Sacramento model whereas the 2015 model is based on an in-catchment Sacramento calibration.

In the Warrego, Sacramento models were calibrated to residuals developed on numerous different modelling assumptions. This led to different time periods being used to the 2003 model, as shown in following figure. Different hydrological regimes were captured. Some calibrations were based on short periods of data but it was decided it was better to base the calibrations on recorded data rather than residuals derived using combinations of recorded and Sacramento data. In Sacramento calibrations, particular attention was made to ensure recessions were reproduced. Looking at the 2003 calibrations, this may not have been as much of a focus.

In the reaches above Wallen, the Sacramento calibrations were done manually in 2012 as reported in the 2012 report. Sacramento models in the Warrego reaches below Wallen were revisited after the initial MDBA review. A more recently developed and improved methodology was applied. This included using an assessment of trend in rainfall stations and flow/rainfall correlations to choose rainfall stations, and optimisation to derive the Sacramento parameter sets and rainfall station weightings.

Use of Historical Diversions in Residual Calculations

There are very few actual diversions and only recent departmental records of these. Trying to define and spread actual extractions in time and then add them back into the model for calibration would be very difficult and likely to cause errors in the low flows. In reality, there is little use of existing entitlements and limited meter records, so it was considered better to not include them in the estimation of inflows.

Effect of not including Non-Licensable Storages and Waterholes

Large waterholes occur naturally throughout the Western River System. In 2003, an attempt was made to quantify them using satellite imagery and local knowledge (primarily local knowledge) as stakeholders requested that they be represented in the model.

When the 2003 basic data were reviewed, it was decided the volume estimates were not reliable and waterholes would not be included in the model unless it could be seen in downstream flow comparisons for a reach that there was a real need for waterholes to improve the modelling of antecedent conditions or attenuation. If this occurred, they would be included in the model calibration where they were required, rather than as an addition after the calibration process.

Non-licensable storages include excavated tanks and gully dams that are used for stock watering, but are not required to have a licence and small waterholes along the waterways.

The total estimated volume of these was small. As indicated in the 2003 reports, 'These were assumed to have minimal effect on calibration results due to their size and date of construction relative to the calibration period. Thus, they were included in the model after calibration of the reach was completed.'

The storages were put on tributary branches and the additional inflows derived were to compensate for the inflow upstream of the storage that the storages captured. This basically produced a mass balance of what flowed downstream before the storage was added. The full utilisation of existing licences scenario only included extraction nodes below the additional inflow estimates so overall there was no impact on use estimates caused by adding them.

As with larger waterholes, the data on these storages obtained from regional staff within DNRM and local knowledge was limited. For the 2015 models, it was decided they were more likely to reduce the accuracy of the low flow calibration than to add any value, so they were not included.

Inflow Adjustments (using DMM)

In the Warrego, inflow adjustments (using the DMM program) was applied differently in the 2015 models to the 2003 models. In the 2015 models, Sacramento flows were not adjusted to flows at Barringun or Ford's Bridge using DMM, while in the 2003 model they were adjusted. This is a major difference in methodology. Not adjusting inflows means the contribution of the Sacramento inflows to the lower reaches is more apparent.

For the 1976 event in the 2003 study, the residual inflows upstream were tied to the recorded data at the Barringun gauge. In the 2015 model, upstream inflows below Wyandra were all Sacramento inflows, with no adjustments to the recorded data at Barringun. This led to an overestimation of the event at Barringun.

Similarly the 1990 event at Ford’s Bridge is overestimated due to Sacramento inflows in the lower reaches not being adjusted to the Ford’s Bridge flows.

It was decided that the model comparisons to recorded flows at both Barringun and Ford’s Bridge were acceptably accurate so adjusting the inflows to these gauges was not undertaken. This was also partially because adjusting the inflows up through the complicated breakouts in the lower reaches could have introduced errors into the model.

Flow Adjustment Explained

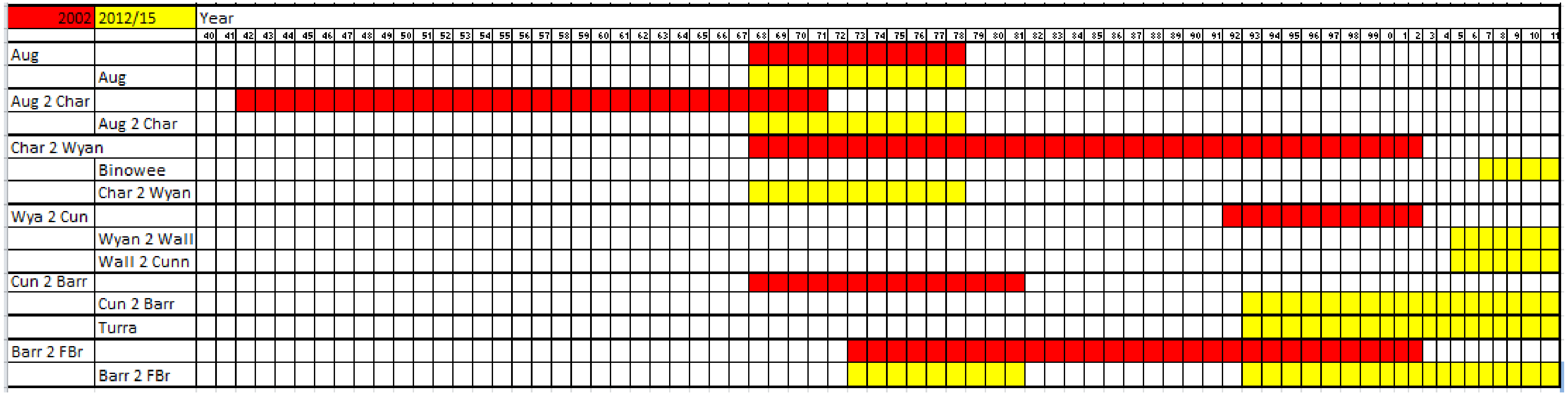
Once the full length inflow sequences for the whole model were included, further adjustments were made to the Sacramento parts of them to obtain a better match between the model and the long term recorded flow data in the catchment. The program DMM was used to make the adjustments.

DMM is an adjustment process applied across multiple reaches. It is used to adjust Sacramento data in multiple reaches upstream of a long term gauge, to bring the modelled and recorded flows into alignment. Recorded head water inflows and calculated residual inflows are not adjusted.

DMM first calculates the difference between modelled and recorded flows at the downstream gauge being adjusted to. The differences are caused by inaccuracies in Sacramento inflows due to things like inaccurate spatial and temporal rainfall and evaporation representation, and also by the averaging of lag and routing, and averaging of losses. DMM adjusts the Sacramento parts of the inflow sequences to get sequences which, when put with the calibrated model’s assumptions, will result in better alignment of the modelled and gauge flows at the long term gauge. It does multiple iterations to converge towards a best set of adjusted inflows and then the user decides which iteration’s inflows give the best result overall. A range of different methods are available to distribute the calculated difference upstream.

DMM can be applied to align the model to multiple long term gauges. In this case a DMM is done to the 1st gauge you want to DMM to then the inflow data adjusted to it is excluded from adjustments when the DMM to the 2nd gauge further downstream is done.

The final residual reach inflows are used in the model validation and model simulation runs.



Warrego Calculated Residual and Sacramento Model Calibration Period

Appendix B – Nebine Creek Water Balance - Scenario ROP 2016 (1601A)

	System Inflows ML				System Losses ML					Extractions ML			Storage ML		Error
Year	Tributary	Pumped	Effluent	Link	End sys	Effluent	Wetland	Link	Storage	Fixed Demands	HS Demands	GS Demands	Reservoir	Link	ML
1889	61,117	2,500	0	0	36,762	10,597	0	0	25	10,306	0	4,435	-1,488	-4	-0.001
1890	3,590,465	1,749	0	0	1,844,213	1,728,827	0	0	18	12,697	0	6,282	-8	-169	0.007
1891	1,906,649	1,251	0	0	743,063	1,152,170	0	0	17	8,626	0	4,698	511	163	0.069
1892	65,749	1,010	0	0	34,459	21,284	0	0	26	7,163	0	3,713	-9	-105	0.002
1893	16,021	415	0	0	10,547	2,549	0	0	28	1,005	0	3,154	730	115	0
1894	110,364	1,730	0	0	63,370	35,965	0	0	20	7,820	0	4,873	-15	-31	-0.002
1895	28,476	1,321	0	0	12,512	7,733	0	0	27	4,593	0	4,633	-324	26	0
1896	31,652	586	0	0	16,921	8,232	0	0	27	3,959	0	3,720	617	4	0
1897	14,349	403	0	0	6,078	2,384	0	0	32	2,296	0	3,767	-112	-83	0
1898	35,869	962	0	0	15,743	9,926	0	0	30	6,313	0	4,630	-60	-130	0
1899	13,127	246	0	0	5,997	2,332	0	0	30	1,849	0	3,534	179	190	0
1900	7,864	285	0	0	3,606	1,323	0	0	20	1,353	0	1,702	-150	4	0
1901	22,043	1,170	0	0	11,829	4,436	0	0	26	4,013	0	2,528	-402	20	0
1902	5,399	27	0	0	2,717	959	0	0	26	290	0	1,929	511	-16	0
1903	33,234	1,880	0	0	18,104	4,138	0	0	25	6,280	0	4,882	-857	-828	0
1904	35,726	480	0	0	20,669	6,217	0	0	29	4,997	0	5,716	624	796	0
1905	32,833	1,181	0	0	16,674	10,109	0	0	28	4,146	0	3,090	-10	43	0.001
1906	386,157	3,230	0	0	209,774	155,423	0	0	22	15,766	0	6,353	-1,484	-563	-0.001
1907	16,152	393	0	0	10,035	2,629	0	0	27	1,204	0	3,571	1,355	-433	0
1908	15,556	452	0	0	6,829	3,002	0	0	29	2,688	0	4,723	270	993	0
1909	46,229	1,176	0	0	11,414	4,807	0	0	27	5,885	0	4,815	-600	-19,857	0
1910	102,027	1,157	0	0	74,189	36,040	0	0	31	6,943	0	6,052	219	19,854	-0.004
1911	544,822	1,241	0	0	266,474	270,161	0	0	24	5,059	0	4,881	527	8	0.004

1912	68,695	2,363	0	0	41,733	15,087	0	0	35	10,663	0	2,037	-1,420	-83	-0.002
1913	74,894	1,300	0	0	44,592	22,296	0	0	22	3,066	0	5,900	198	-517	-0.001
1914	111,194	600	0	0	66,421	35,662	0	0	26	6,422	0	4,983	1,164	556	-0.008
1915	6,841	94	0	0	2,708	1,335	0	0	33	421	0	2,418	-22	2	0
1916	51,288	1,316	0	0	27,342	11,986	0	0	25	7,839	0	4,215	-1,142	-55	0
1917	609,286	1,349	0	0	239,782	359,579	0	0	23	4,853	0	6,370	409	-437	-0.044
1918	17,210	550	0	0	8,864	3,085	0	0	30	3,456	0	3,318	458	535	0
1919	19,187	664	0	0	10,445	5,428	0	0	31	2,045	0	2,234	334	-2	0
1920	296,974	3,487	0	0	163,383	113,102	0	0	26	15,315	0	6,822	-1,738	-75	0
1921	650,552	1,750	0	0	306,514	302,350	0	0	24	8,394	0	6,232	-13	-28,774	-0.014
1922	10,437	255	0	0	26,553	9,955	0	0	29	1,177	0	3,299	1,500	28,821	-0.001
1923	14,573	625	0	0	5,159	2,168	0	0	31	2,185	0	3,771	4	-1887	0
1924	104,924	2,494	0	0	71,914	24,371	0	0	26	6,415	0	5,863	-738	1,909	0
1925	13,149	0	0	0	6,913	2,404	0	0	32	1,680	0	3,100	990	-11	0
1926	68,853	1,766	0	0	26,217	27,983	0	0	27	9,396	0	6,434	-493	-69	-0.002
1927	70,652	1,729	0	0	28,334	28,029	0	0	26	7,850	0	3,568	-727	-3,847	0.001
1928	28,027	0	0	0	21,398	6,886	0	0	30	647	0	4,061	1,214	3,780	0
1929	28,765	1,014	0	0	19,295	6,156	0	0	30	2,269	0	2,127	6	93	-0.002
1930	23,008	1,429	0	0	10,432	4,721	0	0	27	4,784	0	3,971	-563	60	0
1931	144,410	2,247	0	0	64,278	54,569	0	0	20	11,614	0	4,949	-1,175	-10,052	-0.003
1932	9,555	0	0	0	13,746	3,821	0	0	32	198	0	3,528	1,735	10,035	0
1933	133,816	1,602	0	0	65,241	50,748	0	0	27	9,071	0	6,177	-1,350	-2,804	0.004
1934	19,365	338	0	0	13,056	3,742	0	0	29	2,074	0	4,635	1,026	2,809	0
1935	11,604	253	0	0	4,418	1,848	0	0	24	3,100	0	2,603	122	13	0
1936	20,541	824	0	0	8,919	3,514	0	0	28	3,478	0	5,312	120	-235	0
1937	148,204	1,671	0	0	79,120	58,657	0	0	26	7,182	0	5,046	146	10	-0.002
1938	16,640	466	0	0	6,236	3,298	0	0	31	3,892	0	3,820	-53	225	0
1939	36,829	1,321	0	0	14,853	9,415	0	0	26	8,155	0	5,164	-536	-2	0.001
1940	16,714	608	0	0	10,433	2,025	0	0	25	2,032	0	3,139	521	-189	0
1941	384,556	1,750	0	0	205,965	167,682	0	0	24	8,242	0	4,266	1	-128	-0.014
1942	153,626	1,716	0	0	51,275	70,853	0	0	27	9,428	0	4,929	-1,401	-17,428	-0.003

1943	31,549	177	0	0	31,529	14,232	0	0	32	1,244	0	3,683	1,246	17,747	0.001
1944	14,815	817	0	0	7,584	1,766	0	0	25	2,814	0	2,833	-612	0	0
1945	13,967	576	0	0	7,006	2,309	0	0	27	1,827	0	3,695	332	-10	0
1946	14,440	819	0	0	9,629	1,539	0	0	29	1,743	0	2,717	386	11	0
1947	161,729	1,715	0	0	91,863	57,727	0	0	26	8,119	0	5,700	-4	-4	0.001
1948	15,729	750	0	0	6,788	2,944	0	0	28	2,515	0	4,311	103	4	0
1949	122,698	1,858	0	0	61,345	46,420	0	0	28	9,137	0	6,675	-863	-88	0.002
1950	1,808,033	2,667	0	0	857,217	925,464	0	0	13	15,052	0	6,921	-927	-5,106	-0.091
1951	13,267	0	0	0	13,198	2,845	0	0	31	222	0	3,091	1,769	4,351	0.001
1952	27,740	1,186	0	0	11,569	4,745	0	0	24	7,054	0	5,738	-329	533	0
1953	49,263	1,719	0	0	32,081	8,243	0	0	26	5,840	0	5,153	52	310	0.001
1954	206,822	2,732	0	0	113,690	72,537	0	0	24	14,600	0	7,071	-1,245	-386	0
1955	301,385	391	0	0	141,958	154,092	0	0	21	1,849	0	5,624	1,386	384	0.007
1956	1,999,437	3,359	0	0	588,971	1,390,903	0	0	10	15,287	0	5,899	-1,641	-86	-0.055
1957	17,217	182	0	0	10,690	3,073	0	0	28	1,252	0	4,019	1,577	86	0
1958	25,259	742	0	0	9,867	5,550	0	0	30	4,970	0	5,473	149	-260	0
1959	147,556	1,746	0	0	89,950	51,447	0	0	28	4,268	0	3,875	12	255	-0.009
1960	14,560	165	0	0	6,965	2,480	0	0	31	1,112	0	4,148	8	2	0
1961	21,812	1,314	0	0	10,193	3,373	0	0	29	3,214	0	5,486	-800	-32	0
1962	32,866	193	0	0	16,700	9,039	0	0	28	2,535	0	4,068	801	-1,491	0
1963	652,998	2,225	0	0	322,405	315,392	0	0	19	11,265	0	7,199	-464	1,520	0.019
1964	18,474	801	0	0	9,156	3,506	0	0	30	2,923	0	3,808	162	-15	0
1965	27,114	951	0	0	12,228	7,700	0	0	31	4,874	0	1,896	-642	-694	0
1966	15,944	816	0	0	8,298	2,915	0	0	28	3,640	0	2,819	224	716	0
1967	40,344	234	0	0	18,964	13,438	0	0	26	4,405	0	4,456	725	-13	0
1968	93,149	1,342	0	0	43,489	39,298	0	0	27	7,975	0	3,464	-45	-193	0.001
1969	68,519	1,575	0	0	34,715	22,218	0	0	31	7,468	0	5,159	-674	171	0
1970	21,362	971	0	0	11,003	2,683	0	0	28	2,565	0	4,946	-190	-918	0
1971	106,781	1,191	0	0	26,219	21,903	0	0	23	5,215	0	5,136	36	-49,512	0.001
1972	11,200	791	0	0	38,137	17,781	0	0	34	4,943	0	2,227	669	50,461	0
1973	48,583	1,988	0	0	24,240	14,017	0	0	22	5,908	0	5,594	-784	-5	0

1974	349,881	750	0	0	146,527	196,536	0	0	22	3,973	0	4,512	984	-45	0.001
1975	185,240	1,598	0	0	18,268	13,571	0	0	26	7,325	0	6,632	-598	-140,418	-0.008
1976	1,517,550	1,152	0	0	516,124	1,134,905	0	0	22	4,982	0	3,589	601	140,318	-0.015
1977	125,977	1,750	0	0	88,675	29,269	0	0	27	5,326	0	4,601	18	153	-0.002
1978	44,008	1,616	0	0	18,032	7,143	0	0	25	10,831	0	6,061	-941	-2,592	0.001
1979	10,666	80	0	0	6,296	2,397	0	0	34	1,623	0	3,939	949	2,593	0
1980	13,103	510	0	0	5,736	2,237	0	0	32	2,044	0	3,237	-242	-85	0
1981	50,927	1,297	0	0	25,569	14,007	0	0	30	9,073	0	3,598	-8	61	0.001
1982	56,188	1,590	0	0	43,208	9,615	0	0	28	3,123	0	1,972	160	7	-0.001
1983	902,154	3,436	0	0	547,112	328,449	0	0	21	16,596	0	5,625	-1,689	-6,098	0.002
1984	230,998	1,300	0	0	159,277	66,792	0	0	25	7,531	0	5,254	476	6,104	-0.003
1985	31,147	1,200	0	0	17,627	4,836	0	0	27	5,267	0	4,639	85	-35	0
1986	17,153	729	0	0	9,283	2,526	0	0	32	2,430	0	4,131	476	45	0
1987	19,944	577	0	0	9,366	3,335	0	0	30	4,021	0	4,183	422	-8	0
1988	44,732	1,676	0	0	21,437	13,182	0	0	29	5,647	0	3,516	-597	-2,000	0.001
1989	246,723	812	0	0	99,113	138,446	0	0	26	7,833	0	4,735	615	2,004	-0.003
1990	1,207,355	1,538	0	0	493,304	705,958	0	0	22	6,412	0	3,436	237	3	0.011
1991	36,428	1,052	0	0	16,010	10,036	0	0	29	6,724	0	4,585	-89	-6	0
1992	9,099	58	0	0	4,306	1,715	0	0	32	796	0	2,437	132	-3	0
1993	16,986	586	0	0	8,415	2,684	0	0	30	2211	0	3,692	-546	4	0
1994	17,053	300	0	0	8,872	4,073	0	0	25	2,359	0	2,483	541	-84	0
1995	52,756	1,311	0	0	25,514	12,164	0	0	28	9,004	0	6,384	-911	-61	0
1996	34,009	953	0	0	19,400	6,834	0	0	29	4,419	0	4,874	443	150	0
1997	314,499	1,523	0	0	151,644	150,893	0	0	30	7,472	0	6,175	224	-33	-0.001
1998	93,691	2,054	0	0	51,452	26,877	0	0	28	10,913	0	5,458	-1,047	29	0.001
1999	121,938	677	0	0	62,636	48,360	0	0	19	3,316	0	6,798	1,061	-2,547	-0.003
2000	279,106	2,723	0	0	125,925	133,843	0	0	22	12866	0	6,540	-1,517	-1,116	0.001
2001	21,753	185	0	0	15,843	5,963	0	0	23	1,284	0	4,131	1,651	3,656	0
2002	28,086	1,028	0	0	17,326	5,919	0	0	22	3,336	0	2,719	193	15	0
2003	8,966	33	0	0	4,114	2,025	0	0	9	269	0	2,545	-33	-5	0
2004	141,356	2,961	0	0	78,756	45,574	0	0	17	10,022	0	6,669	-1,467	-1,811	-0.002

2005	14,319	308	0	0	11,382	2,242	0	0	34	1,645	0	2,248	1,109	1,815	0
2006	11,202	505	0	0	5,471	1,634	0	0	16	2,367	0	2,278	318	-258	0
2007	52,473	2,533	0	0	28,319	11,157	0	0	20	8,847	0	3,605	-1,763	-1,295	0.002
2008	73,481	318	0	0	46,576	22,957	0	0	18	1,385	0	4,930	1,432	635	-0.001
2009	33,431	950	0	0	13,604	5,094	0	0	10	3,565	0	4,213	50	-7,944	0
2010	1,358,489	2,497	0	0	613,787	732,712	0	0	13	14,501	0	7,334	-746	8,108	0.035
Average	**199,165**	**1,147**	**0**		**92,301**	**98,092**	**0**	**0**	**26**	**5,474**	**0**	**4,411**	**-948**	**-14**	**-0.116**