Paroo River

Paroo River Model Results to Support Basin Plan Requirements

Water Planning and Coastal Sciences

January 2016

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

Citation

DSITI, 2016. Paroo River - Paroo River Model Results to Support Basin Plan Requirements, Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane.

January 2016

Contents

List of tables

1 Introduction

The Paroo 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 *Paroo River Catchment IQQM Calibration – Generation 2 Headwaters t GS424201 Paroo River at Wanaaring (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 Paroo River 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 Paroo River 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 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 Paroo SDL resource unit, Queensland prepared the IQQM Model to meet this requirement. As there are no SDL adjustment measures proposed for the Paroo, 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. Paroo River 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 Paroo. 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 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 Paroo IQQM Model

The Paroo 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 *Paroo River Catchment IQQM Calibration – Generation 2 Headwaters t GS424201 Paroo River at Wanaaring (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
1601A	SDL	This model is the same as the model above as there is no water recovered in the Paroo Catchment. This would require updating if there was water recovered.	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 Paroo River System.

The model simulated the:

- Water Allocations
- 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 Paroo River 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 Paroo River.

3.2.4 Medium Priority Demand

There is no medium priority demand on the Paroo River.

3.2.5 Unsupplemented Licensed Data

This section presents the information used to model water use within the Basin. One licence has not been converted to a water allocation, and is still in the ROP model (Table 2). The details of the Water Allocations are presented in Table 3.

Table 2 Resource Operation Plan Case 1601A –Licence Representation

Sub-Catchment	Licence Number	Pump Capacity (ML/day)	Nominal Volume	Start Threshold
Paroo zone F (Quilberry Creek)	403149	Unknown	5	0

Table 3 Unsupplemented Water Allocations in the Paroo Catchment

Water Allocation Number	Nominal Volume (ML)	Volumetric Limits (ML/year)	Max Rate for Taking Water (ML/day)	Flow Conditions	Special Conditions
	Paroo Zone A				
30	20	40	2.2	Nil	Nil
31	30	30	4.32	Nil	Nil

4 Reconciliation with Murray–Darling Basin 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.

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				
	30	20	40	40
	31	30	30	30

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	70
Take from watercourse – License to take Water	19
Take from watercourse – Unallocated Water	100
TOTAL	**189**

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 – Water License Volume limited	5
Take from watercourse – Unsupplemented Water Allocations without flow conditions	70
Take from watercourse – Unallocated Water	100
TOTAL	**175**

5 Conclusion

The new model for the Paroo River 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 Paroo 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. Appendix B presents the modelled water balance for the scenario ROP 2016 (1601A).

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	0.2 GL	0.2 GL
CEWH entitlements only	0.0 GL	0.0 GL
Total less CEWH entitlements	0.2 GL	0.2 GL

As can be seen in Table 7, the ROP 2016 (1601A) estimates of mean annual diversions are the same as the estimates provided by the ROP 2006 (0902A) model.

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), *Paroo River Catchment IQQM Calibration – Generation 2 Headwaters t GS424201 Paroo River at Wanaaring*

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 Adjustment (using DMM)

In the Warrego, inflow adjustment (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

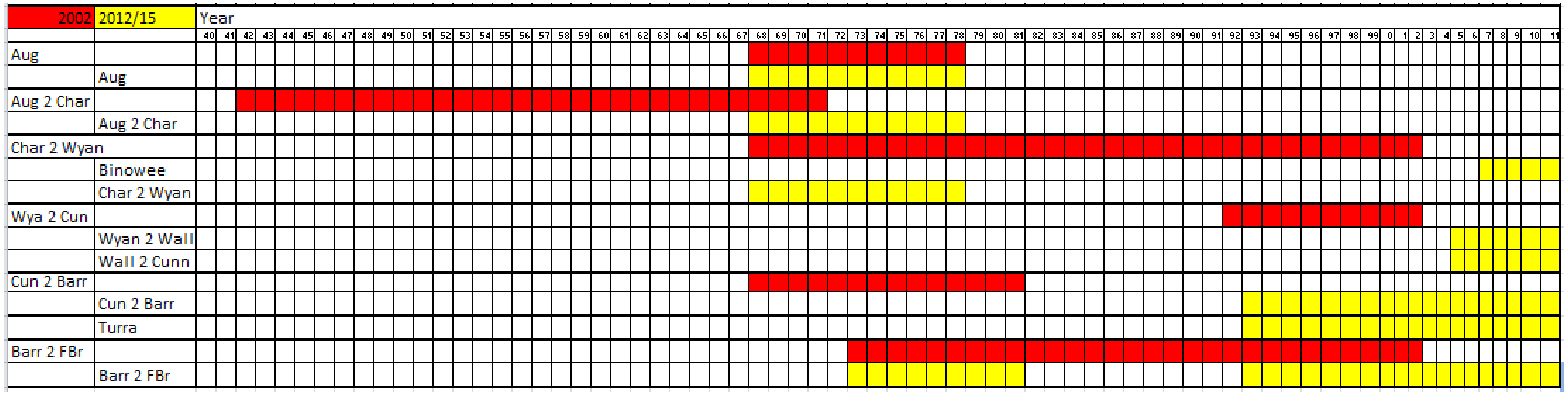
Once the full length inflow sequences for the whole model were included, further adjustments were made to the Sacramento parts of them to obtain a better match between the model and the long term recorded flow data in the catchment. The program DMM was used to make the adjustments.

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 – Paroo River 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	368,846	0	0	0	202,589	165,359	0	0	0	0	0	350	0	-549	0.002
1890	1,782,411	0	0	0	1,073,942	706,780	0	0	0	0	0	175	0	-1,514	-0.013
1891	2,577,783	0	0	0	1,591,476	988,113	0	0	0	0	0	175	0	1,981	0.009
1892	681,032	0	0	0	395,235	285,698	0	0	0	0	0	175	0	75	0.018
1893	116,609	0	0	0	58,918	57,267	0	0	0	0	0	175	0	-248	0
1894	1,120,003	0	0	0	665,095	449,904	0	0	0	0	0	175	0	-4,828	-0.003
1895	135,909	0	0	0	67,169	72,665	0	0	0	0	0	175	0	4,100	0.002
1896	911,795	0	0	0	565,677	346,655	0	0	0	0	0	175	0	712	-0.003
1897	548,779	0	0	0	319,925	226,842	0	0	0	0	0	175	0	-1,837	-0.017
1898	185,878	0	0	0	98,560	88,349	0	0	0	0	0	175	0	1,207	0.001
1899	57,453	0	0	0	26,044	32,132	0	0	0	0	0	175	0	898	-0.001
1900	31,722	0	0	0	11,670	18,861	0	0	0	0	0	175	0	-1,016	0
1901	107,777	0	0	0	52,784	55,818	0	0	0	0	0	175	0	1,000	0.002
1902	54,620	0	0	0	17,878	22,898	0	0	0	0	0	175	0	-13,669	0
1903	730,726	0	0	0	446,773	287,994	0	0	0	0	0	175	0	4,215	-0.016
1904	462,567	0	0	0	262,769	204,036	0	0	0	0	0	175	0	4,414	0.016
1905	67,979	0	0	0	31,211	41,193	0	0	0	0	0	175	0	4,599	-0.002
1906	1,843,954	0	0	0	1,126,133	714,144	0	0	0	0	0	175	0	-3,502	-0.026
1907	165,771	0	0	0	107,857	51,515	0	0	0	0	0	175	0	-6,224	0.001
1908	367,414	0	0	0	211,486	163,232	0	0	0	0	0	175	0	7,480	0.004
1909	459,196	0	0	0	258,257	190,772	0	0	0	0	0	175	0	-9,992	-0.02
1910	574,575	0	0	0	345,084	241,301	0	0	0	0	0	175	0	11,985	0.009
1911	569,187	0	0	0	347,143	222,047	0	0	0	0	0	175	0	178	-0.024

1912	265,054	0	0	0	151,436	112,505	0	0	0	0	0	175	0	-938	0.002
1913	486,138	0	0	0	283,561	201,255	0	0	0	0	0	175	0	-1,147	0.009
1914	703,673	0	0	0	430,793	269,339	0	0	0	0	0	175	0	-3,366	-0.017
1915	39,036	0	0	0	15,204	20,892	0	0	0	0	0	175	0	-2,766	0
1916	702,884	0	0	0	407,264	294,861	0	0	0	0	0	175	0	-584	0.008
1917	552,100	0	0	0	317,781	241,245	0	0	0	0	0	175	0	7,101	0
1918	203,827	0	0	0	110,822	94,404	0	0	0	0	0	175	0	1,575	-0.004
1919	70,671	0	0	0	32,883	38,148	0	0	0	0	0	175	0	535	0
1920	1,418,370	0	0	0	850,073	567,998	0	0	0	0	0	175	0	-124	0.045
1921	1,542,235	0	0	0	922,489	611,028	0	0	0	0	0	175	0	-8,543	-0.014
1922	42,251	0	0	0	15,108	21,121	0	0	0	0	0	175	0	-5,847	0
1923	207,453	0	0	0	66,906	67,140	0	0	0	0	0	175	0	-73,232	-0.007
1924	241,378	0	0	0	175,121	153,101	0	0	0	0	0	175	0	87,020	-0.001
1925	396,579	0	0	0	231,122	163,518	0	0	0	0	0	175	0	-1,764	-0.009
1926	859,699	0	0	0	523,511	338,059	0	0	0	0	0	175	0	2047	0.003
1927	182,364	0	0	0	51,406	49,549	0	0	0	0	0	175	0	-81,234	-0.005
1928	110,466	0	0	0	107,480	83,114	0	0	0	0	0	175	0	80,303	0.003
1929	114,120	0	0	0	63,806	51,436	0	0	0	0	0	175	0	1,297	-0.002
1930	477,183	0	0	0	269,520	206,311	0	0	0	0	0	175	0	-1,177	0.009
1931	1,091,585	0	0	0	642,596	440,504	0	0	0	0	0	175	0	-8,310	0.005
1932	100,494	0	0	0	56,320	53,684	0	0	0	0	0	175	0	9,685	-0.001
1933	682,361	0	0	0	399,036	280,635	0	0	0	0	0	175	0	-2,515	-0.01
1934	93,929	0	0	0	43,154	53,116	0	0	0	0	0	175	0	2,516	0
1935	158,173	0	0	0	85,409	72,151	0	0	0	0	0	175	0	-438	0.002
1936	812,376	0	0	0	490,545	318,004	0	0	0	0	0	175	0	-3,653	-0.013
1937	358,540	0	0	0	209,935	152,462	0	0	0	0	0	175	0	4,032	0.004
1938	170,379	0	0	0	94,704	75,535	0	0	0	0	0	175	0	35	0.002
1939	491,776	0	0	0	277,413	213,884	0	0	0	0	0	175	0	-303	0.012
1940	116,806	0	0	0	63,201	51,883	0	0	0	0	0	175	0	-1,548	0.001
1941	1,552,741	0	0	0	964,786	589,368	0	0	0	0	0	175	0	1,588	0.01
1942	1,406,425	0	0	0	705,876	638,960	0	0	0	0	0	175	0	-61,414	-0.007

1943	212,026	0	0	0	160,163	113,159	0	0	0	0	0	175	0	61,470	0
1944	56,927	0	0	0	24,364	32,358	0	0	0	0	0	175	0	-30	0
1945	61,796	0	0	0	26,438	35,299	0	0	0	0	0	175	0	115	0.001
1946	42,588	0	0	0	18,772	22,651	0	0	0	0	0	175	0	-990	0.001
1947	742,663	0	0	0	434,495	306,793	0	0	0	0	0	175	0	-1,200	-0.01
1948	293,968	0	0	0	157,956	127,224	0	0	0	0	0	175	0	-8,613	0.005
1949	1,721,693	0	0	0	1,058,830	673,510	0	0	0	0	0	175	0	10,822	-0.018
1950	2,156,382	0	0	0	1,298,656	855,823	0	0	0	0	0	175	0	-1,728	-0.022
1951	36,581	0	0	0	12,988	21,473	0	0	0	0	0	175	0	-1,946	0
1952	279,528	0	0	0	150,999	130,637	0	0	0	0	0	175	0	2,283	0.007
1953	224,332	0	0	0	123,685	101,991	0	0	0	0	0	175	0	1,519	0.004
1954	974,866	0	0	0	584,019	390,237	0	0	0	0	0	175	0	-435	-0.001
1955	703,292	0	0	0	423,199	280,328	0	0	0	0	0	175	0	410	0.029
1956	2,420,072	0	0	0	1,482,598	935,123	0	0	0	0	0	175	0	-2,176	0.007
1957	53,198	0	0	0	22,264	31,930	0	0	0	0	0	175	0	1,171	0
1958	136,340	0	0	0	72,047	63,769	0	0	0	0	0	175	0	-349	0.005
1959	118,915	0	0	0	62,040	57,332	0	0	0	0	0	175	0	632	-0.003
1960	123,616	0	0	0	63,616	59,744	0	0	0	0	0	175	0	-80	0.001
1961	248,191	0	0	0	142,761	105,556	0	0	0	0	0	175	0	301	0.008
1962	325,731	0	0	0	138,971	99,223	0	0	0	0	0	175	0	-87,362	-0.006
1963	805,724	0	0	0	535,797	357,522	0	0	0	0	0	175	0	87,770	0.006
1964	490,001	0	0	0	289,444	199,868	0	0	0	0	0	175	0	-514	0.011
1965	98,177	0	0	0	42,187	37,750	0	0	0	0	0	175	0	-18,066	0.001
1966	73,813	0	0	0	43,945	48,043	0	0	0	0	0	175	0	18,351	-0.001
1967	698,612	0	0	0	422,859	275,081	0	0	0	0	0	175	0	-497	0
1968	1,366,352	0	0	0	867,187	499,839	0	0	0	0	0	175	0	849	-0.033
1969	311,244	0	0	0	179,087	131,982	0	0	0	0	0	175	0	0	-0.002
1970	315,601	0	0	0	172,843	138,249	0	0	0	0	0	175	0	-4,334	0.003
1971	666,714	0	0	0	377,806	263,707	0	0	0	0	0	175	0	-25,026	-0.003
1972	463,679	0	0	0	296,218	195,417	0	0	0	0	0	175	0	28,132	0.012
1973	1,153,915	0	0	0	692,964	443,578	0	0	0	0	0	175	0	-17,199	-0.025

1974	1,623,550	0	0	0	1,018,790	623,010	0	0	0	0	0	175	0	18,425	-0.017
1975	266,687	0	0	0	95,769	84,121	0	0	0	0	0	175	0	-86,623	0.008
1976	2,438,387	0	0	0	1,364,417	1,154,478	0	0	0	0	0	148	0	80,656	-0.011
1977	161,305	0	0	0	79,579	87,490	0	0	0	0	0	202	0	5,966	-0.003
1978	150,626	0	0	0	66,709	81,995	0	0	0	0	0	175	0	-1,748	0.001
1979	52,989	0	0	0	29,901	24,663	0	0	0	0	0	175	0	1,750	0
1980	87,541	0	0	0	37,420	49,630	0	0	0	0	0	175	0	-315	-0.002
1981	397,114	0	0	0	218,280	178,972	0	0	0	0	0	175	0	313	-0.003
1982	57,829	0	0	0	25,529	32,298	0	0	0	0	0	6	0	4	-0.002
1983	1,611,022	0	0	0	1,018,902	572,557	0	0	0	0	0	344	0	-19,219	-0.001
1984	534,976	0	0	0	329,687	222,959	0	0	0	0	0	175	0	17,845	-0.022
1985	635,334	0	0	0	386,696	248,795	0	0	0	0	0	175	0	332	-0.001
1986	71,819	0	0	0	31,711	40,508	0	0	0	0	0	175	0	575	0
1987	495,985	0	0	0	274,251	215,041	0	0	0	0	0	175	0	-6,518	0.017
1988	732,535	0	0	0	440,805	294,965	0	0	0	0	0	175	0	3,410	0.007
1989	931,728	0	0	0	556,315	378,116	0	0	0	0	0	175	0	2,879	-0.006
1990	2,080,281	0	0	0	1,294,647	786,124	0	0	0	0	0	175	0	665	-0.052
1991	547,674	0	0	0	335,610	209,978	0	0	0	0	0	175	0	-1,911	-0.005
1992	375,595	0	0	0	138,634	130,164	0	0	0	0	0	175	0	-106,621	0.009
1993	193,616	0	0	0	166,817	130,210	0	0	0	0	0	175	0	103,587	0.004
1994	269,943	0	0	0	147,124	126,794	0	0	0	0	0	175	0	4,150	-0.007
1995	768,480	0	0	0	461,307	307,074	0	0	0	0	0	175	0	75	-0.008
1996	283,946	0	0	0	132,950	140,442	0	0	0	0	0	175	0	-10,379	0.001
1997	871,875	0	0	0	516,418	360,433	0	0	0	0	0	175	0	5,151	-0.014
1998	986,466	0	0	0	584,697	407,342	0	0	0	0	0	175	0	5,747	0.02
1999	320,893	0	0	0	131,104	130,826	0	0	0	0	0	175	0	-58,787	-0.005
2000	1,032,559	0	0	0	658,891	431,965	0	0	0	0	0	175	0	58,471	-0.013
2001	55,967	0	0	0	24,118	32,170	0	0	0	0	0	175	0	496	0.001
2002	130,064	0	0	0	69,308	59,931	0	0	0	0	0	175	0	-650	0.003
2003	81,136	0	0	0	38,882	42,500	0	0	0	0	0	175	0	421	0
2004	614,983	0	0	0	374,476	238,907	0	0	0	0	0	175	0	-1,426	0.01

2005	72,251	0	0	0	36,406	37,135	0	0	0	0	0	175	0	1,465	0
2006	89,004	0	0	0	38,704	48,676	0	0	0	0	0	175	0	-1,448	0.001
2007	1,106,517	0	0	0	498,892	359,881	0	0	0	0	0	175	0	-247,56,9	-0.021
2008	815,120	0	0	0	664,777	398,929	0	0	0	0	0	175	0	248,760	0.015
2009	251,393	0	0	0	110,095	93,927	0	0	0	0	0	175	0	-47,197	0.003
2010	2,348,310	0	0	0	1,419,112	966,982	0	0	0	0	0	175	0	37,960	0.051
Average	**576,817**	**0**	**0**		**339,896**	**236,744**	**0**	**0**	**0**	**0**	**0**	**176**	**0**	**-90**	**-0.098**