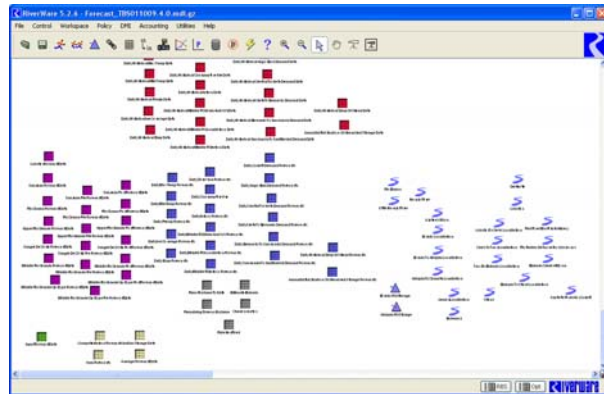
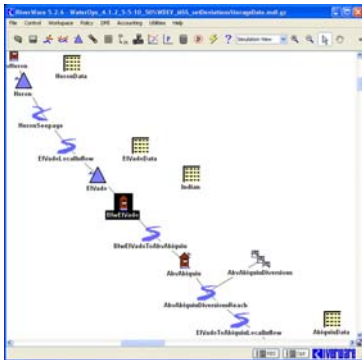


User Manual for Water Operations and Forecast Modules of URGWOM for Preparing Annual Operating Plans

Water Ops Model version 4.1.2



prepared by

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September 2010

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I. Introduction

The Water Operations module of the Upper Rio Grande Water Operations Model (URGWOM) was developed through an interagency effort and is used to complete daily timestep rulebased simulations for preparing Annual Operating Plans (AOPs) and other short-term forecasts of operations. The model was developed using the RiverWare software application developed by the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) at the University of Colorado at Boulder. Simulations are completed with the Water Operations Model through a current calendar year to forecast operations and resulting flows with consideration for the Natural Resources Conservation Service (NRCS) and National Weather Service (NWS) forecasted runoff volumes for different locations in the basin.

A separate Forecast Model is used as a pre-processor to produce forecasted inflows and other needed inputs. The Forecast Model is also set up in RiverWare but does not entail simulating any aspect of the physical system. The Forecast Model is actually a series of calculations completed as a pre-processor to develop needed inflow hydrographs for all the inflow nodes in URGWOM. Forecast period hydrographs are developed by comparing the NRCS/NWS forecast volumes against historical volumes for each forecast location and the historical year with the closest volume may be used to develop a forecasted hydrograph. Selected historical flows are proportionately adjusted such that the volume of the hydrograph matches the forecast volume. The same approach (without proportional adjustments) is also used for other needed input values. Flexibility is included that allows a model user to identify a preference for an early, average, or late runoff; specify another historical year; or utilize multiple historical years as an override to the determined historical year with the closest runoff volume.

Some needed inputs for the Water Operations Model such as initial conditions are obtained from the accounting module of URGWOM. Refer to Figure 1.1 for a schematic of the data transfers that occur between the different modules of URGWOM to complete AOP runs with the Water Operations Model. Data transfers are completed with the RiverWare data management interface (DMI) set up in the different modules of URGWOM and using files that have the format of the Corps of Engineers Hydrologic Engineering Center's Data Storage System (DSS).

Within the Water Operations Model, physical processes and operations of facilities in the Rio Grande Basin in New Mexico (Figure 1.2) from the Colorado state-line to El Paso, Texas (flood control operations only below Caballo Dam) are simulated at a daily timestep. Policy for setting dam releases along with diversions and other demands are represented in coded rules in an URGWOM ruleset. Various methods are included to represent processes such as floodwave travel times; reservoir evaporation and seepage; conveyance losses to deep percolation, evaporation, and transpiration; surface water-groundwater interaction; and irrigation return flows. Refer to the physical model documentation prepared by the URGWOM Technical Team (2005) for more details on methods and assumptions for representing the physical processes in the basin.

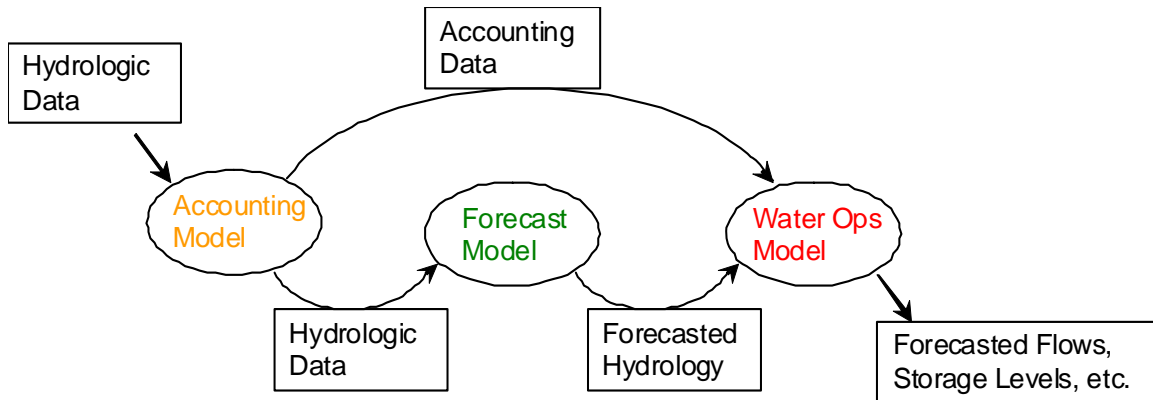


Figure 1.1. Schematic of Data Transfers between Modules of URGWOM for Completing AOP Runs with the Water Operations Model

Simulations include accounting to track storage and delivery of water allocated to specific users. Note that the primary difference between the planning and water operations modules of URGWOM is that accounts for all contractors for San Juan-Chama Project water are included in the Water Operations Model; whereas, numerous contractors are lumped into one Combined account in the Planning Model such that long-term model runs can be completed more efficiently.

This user manual provides background information on numerous aspects of policy and modeling assumptions represented in the current Water Operations Model. Setting up the Water Operations Model not only entails developing and setting up forecasted inflows but also identifying details of projected operations for an upcoming calendar year. As examples, past simulations have entailed setting up specific agreements for relinquished Compact credits and subsequent adjusted allocations for storage of Emergency Drought water at El Vado Reservoir, refining policy for Cochiti deviations implemented to provide recruitment or overbank flows, defining target flows for a year for Biological Opinion compliance, and setting the timing and magnitudes for Reclamation leases of San Juan-Chama Project water from contractors. All such aspects of operations are discussed in this user manual with details on the modeling assumptions and the location of key input parameters.

Instructions are presented in this user manual for exporting output from the Accounting Model and setting up and using the Forecast Model to obtain needed inputs for completing a Water Operations Model run to simulate operations and resulting flows and storage conditions through the end of a current calendar year. A list of numerous items to check in a Water Operations Model run is included with details on several user controls in the model that can be used to adjust releases for different purposes or the total release from each dam. Note that this document was prepared for the current version of the Water Operations Model noted on the title page.

This user manual is written for model users that have received RiverWare training and are able to navigate through RiverWare fairly efficiently. This user manual is not meant to serve as a manual for using the RiverWare software application.

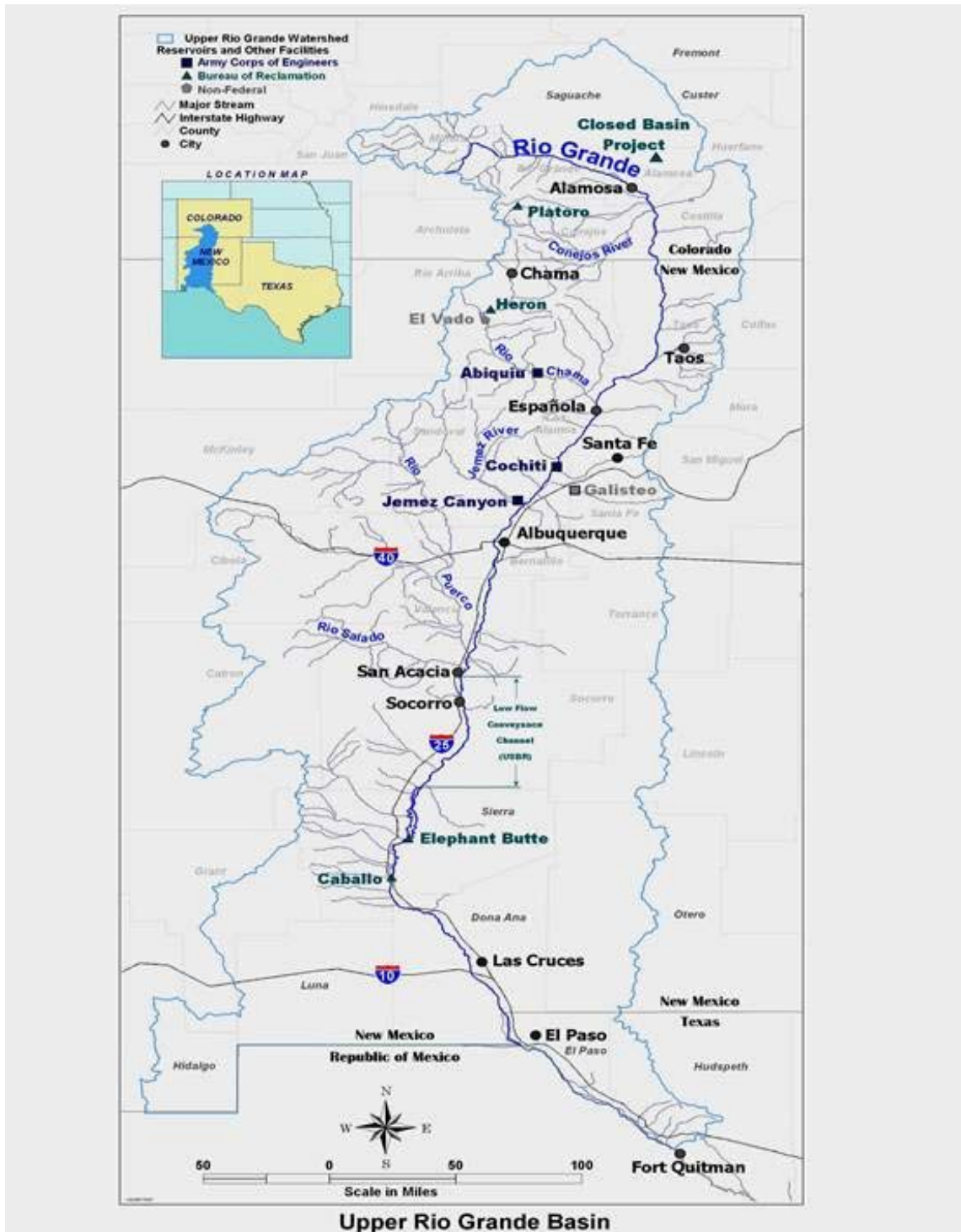


Figure 1.2. Rio Grande Basin Map

II. Modeling Assumptions

Several details and modeling assumptions need to be identified before setting up the Water Operations Model for preparing an AOP. URGWOM is set up to model standard operations for meeting demands and the storage of water allocated for different users. While these assumptions may likely all be appropriate for an upcoming year, details on the assumptions for the demands and standard policy for storage and releases at reservoirs in the system should be reviewed before completing a simulation. In addition, URGWOM is set up to simulate several previously implemented temporary water agreements and actions, and some of these actions, while temporary, may be implemented again for an upcoming year.

2.1. Demands

Modeling assumptions are presented about four primary demands in the basin: Middle Rio Grande Conservancy District (MRGCD) diversions, Albuquerque Bernalillo County Water Utility Authority (Albuquerque) surface water diversions, letter water deliveries for contractors for San Juan-Chama Project water to payback the river for depletions, and target flows as documented in the current Biological Opinion (Service, 2003). Notes about storage and deliveries of Prior and Paramount (P&P) water to the six Middle Valley pueblos are included with the discussion of MRGCD diversions.

2.1.1. MRGCD Diversions and Demand at Cochiti

Synthetic diversion schedules have been developed for each of the four main MRGCD diversions: Cochiti, Angostura, Isleta, and San Acacia. Separate schedules are input with DMIs for each of these diversions to series slots in the MiddleRioGrandeDiversionData data object. These values are set with rules, during simulation, for separate Diversion Requested series slots in the aggregate diversion site objects used for each of the four diversions. Two separate schedules are used for the Sili Canal and East Side Main canal at the Cochiti diversion, and two schedules are used for the Albuquerque Main Canal and Atrisco Feeder at the Angostura diversion. Five separate schedules are used for the Chical Lateral, Chical Acequia, Peralta Main Canal, Cacique Acequia, and Belen High Line Canal at the Isleta Diversion. Separate diversion schedules are included for the Low Flow Conveyance Channel and main canal at the San Acacia diversion; however, actual diversions from the river at the San Acacia diversion to the main canal are reduced based on the contribution from the Unit 7 drain. Diversions to the Low Flow Conveyance Channel would likely be set to zero for preparing an AOP unless some sort of test operation is planned or there is a significant change to operations. Note that the Low Flow Conveyance Channel still has flow during simulation due to gains from groundwater seepage.

Rio Grande water or San Juan-Chama Project water may be released from storage to provide flows for the diversions if needed. These releases are made to meet an identified total demand at Cochiti. Since some return flows to the river are available for diversion downstream, the total demand is less than the sum of the diversions. This demand curve (Figure 2.1) was calibrated based on historical demands and is input to the MRGCD series slot in the Middle Valley Demands data object. Note that actual historical releases from Cochiti Dam may exceed this demand curve in the model, even for recent years.

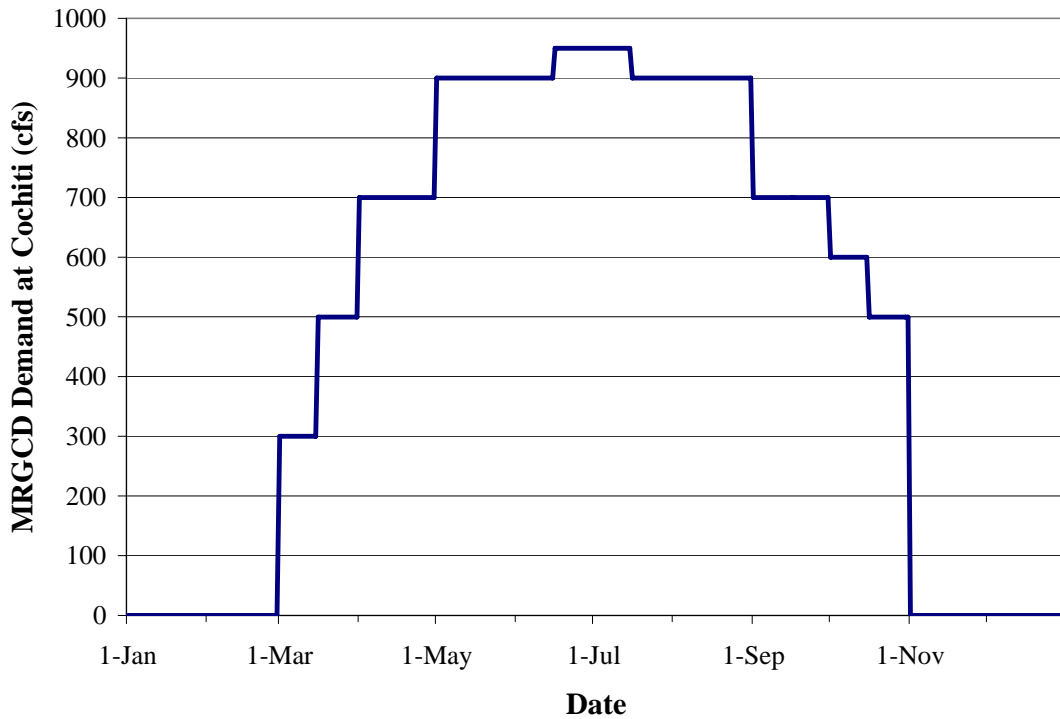


Figure 2.1. MRGCD Demand at Cochiti

2.1.1.1. Diversions for the Six Middle Valley Pueblos

Irrigated acreage for the six Middle Valley pueblos (Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta) is not represented separately from MRGCD land in URGWOM and diversions to the pueblos are included with MRGCD diversions; however, the storage and release of P&P water to assure the P&P demand is met is tracked separately in URGWOM. The methodology in URGWOM for computing a P&P storage requirement each year and the subsequent releases from P&P storage match the actual implemented approach and are tracked in the IndianStorage account on the El Vado level power reservoir object. Note that the storage requirement can be input if known for an upcoming year. Releases are made as needed if the natural flow would not meet the demand for the pueblos as input to the IndianDemand series slot in the MiddleValleyDemands data object. The MRGCD Demand curve actually represents the full demand at Cochiti for both MRGCD and the pueblos, and releases of native Rio Grande water or MRGCD San Juan-Chama Project water at El Vado Reservoir

designated to meet the full MRGCD demand curve are reduced to account for any releases of P&P water. All aspects of the approach for P&P storage and releases have undergone a thorough review, and any adjustments to parameters used to compute the storage requirement or releases should be completed through coordination with the URGWOM Technical Team and agency representatives.

2.1.1.2. Increased Angostura Diversions

When MRGCD is in a shortage situation, which is indicated when the MRGCD Demand at Cochiti cannot be met with available water in storage for MRGCD, diversions at Angostura are increased from the regular diversion requested values to the total canal capacity of 400 cfs. These increased diversions assure water is delivered to the pueblos and reflect adjustments in MRGCD operations during shortage situations such that the limited supply is used most efficiently. The capacity at Angostura is input as two separate values of 260 cfs and 140 cfs to the MaxCapacityAtAngosturaAlbMainCanal and MaxCapacityAtAngosturaAtriscoFeeder scalar slots, respectively, in the MiddleRioGrandeDiversionData data object. If this policy is implemented in a Water Operations Model run, this operation will likely result in simulated river drying below the Angostura diversion and will be of particular interest to various stakeholders and should be reviewed carefully against actual expected operations.

2.1.2. Albuquerque Surface Water Diversions

Albuquerque began surface water diversions in 2009, and URGWOM is currently set up to model full diversions with consideration for a preemptive cutoff to diversions before actual permit restrictions would result in curtailed diversions or during high flows. The preemptive cutoff represents the assumption that Albuquerque would switch to groundwater during low flows before curtailment per the permit or during high flows when it may be unsafe or impractical to operate the diversion dam or when flood control operations at Abiquiu or Cochiti might prevent Albuquerque from receiving a delivery of their allocated San Juan-Chama Project water. The high flow thresholds for a preemptive diversion cutoff are input as 1800 cfs out of Abiquiu or 4500 cfs out of Cochiti as input to the ThresholdHighAbiquiuOutflowForAlbPreemptiveCutoff and ThresholdHighFlowCochitiForAlbPreemptiveCutoff scalar slots in the MiddleValleyDemands data object. The threshold low flow for a preemptive cutoff is 200 cfs as input to the ThresholdCentralFlowForAlbPreemptiveCutoff and diversions will not restart until at least two weeks after any preemptive cutoff criterion is not satisfied and the flow at Central is greater than 250 cfs as input to the ThresholdCentralFlowForAlbRestart scalar slot.

The year 2009 is input to the AlbuquerqueStartYear table slot in the MiddleRioGrandeDiversionData data object as the year when diversions would begin. Full Albuquerque diversions may be set to 130 cfs where 65 cfs is provided by delivered San Juan Chama Project water, as input to the Albuquerque series slot in the

MiddleValleyDemands data object, and the other 65 cfs is native Rio Grande water that will be returned. Releases of Albuquerque's San Juan-Chama Project water are set to provide the 65 cfs with loss rates applied. The loss rate is based on the input San Juan-Chama loss rate from Abiquiu to Cochiti input to the Losses table slot in the SanJuanChamaRules data object and a monthly loss rate from Cochiti to the diversion as input to the CochitiToAlbuquerqueDiversionLosses periodic slot in that same data object. The input demand for the Albuquerque diversion should be checked against actual expected operations for an upcoming year and whether the full demand will be used and if any shutdown periods are planned.

2.1.3. Letter Water Deliveries

Contractors for San Juan-Chama Project water may cause depletions in the basin and then use allocated San Juan-Chama Project water to payback the river. These paybacks are set up as inputs in URGWOM based on an assumed future delivery schedule for the payback. Actual paybacks are determined by the Office of the State Engineer using the regional groundwater model, and the deliveries are requested as letters from the State to the Bureau of Reclamation (Reclamation), hence the name "letter water deliveries." Within URGWOM, the Exchanges Manager is used to establish a debt for contractors to deliver water to the location of the Otowi stream gage object in the model based on the input delivery schedule. The schedules include a portion of the delivery made during the irrigation season to contribute to the MRGCD demand and effectively payback MRGCD for depletions to the river and the remaining portion is delivered during the non-irrigation season to contribute to the Compact deliveries to Elephant Butte Reservoir and effectively payback the Compact for depletions. The distribution for the payback would theoretically match the timing for the depletion to the river.

If a contractor does not have water in storage at the time of a delivery request, the debt is maintained until the contractor has the water to make the payback, so actual releases from storage may not exactly match the input schedules. Annual volumes for Albuquerque deliveries include paybacks for the impact of past pumping and will vary from year to year depending on the overall status of that payback. Other contractors for San Juan-Chama Project water have smaller paybacks for their depletions in the basin. A list of potential assumed payback volumes is presented in Table 2.1, but these volumes should be checked against any available projected payback information from the Office of the State Engineer. Daily delivery volumes (acre-ft/day) are actually input to URGWOM by DMI to the DeliveryRequests data object where the timing for the payback for Nambe/PVID and Santa Fe is usually in November and/or December; whereas, the payback for other contractors is generally split between the irrigation season and November-December. **Note that letter water delivery schedules are input in the model in units of acre-ft/day as opposed to cfs.**

Table 2.1. Current Assumed Annual Letter Water Delivery Volumes for Contractors for SJC Water – Combined Account

Contractor	Annual Delivery (acre-ft)
Santa Fe	1000
Nambe/PVID	1000
Bernalillo	380
Espanola	200
Los Lunas	130
Belen	50
Taos	30
Jicarilla	0
Los Alamos/DOE	0
Red River	0
Twining	0
San Juan Pueblo	0
NMISC	0
Uncontracted	0
TOTAL	2790

2.1.4. Target Flows

The current model is set up to model releases of supplemental water for targets as documented in the Biological Opinion (Service, 2003). Supplemental water may consist of leased San Juan-Chama Project water or Emergency Drought water stored at El Vado Reservoir that is specifically designated for targets. More details on these two sources of supplemental water are presented in sections 2.3.1 and 2.3.2. Daily needed releases from Abiquiu Dam to meet targets at Central, Isleta, San Acacia, and San Marcial are computed in the model using hypothetical simulations, or separate side simulations in RiverWare to iterate and solve for the flow needed to meet the targets. The locations of these targets in the model match the following slots: Central.Gage Outflow, IsletaDiversionDam.Outflow, SanAcaciaFloodway.Gage Outflow, and SanMarcialFloodway.Gage Outflow. Targets are defined in the MinTargetFlows periodic slot in the MiddleValleyDemands data object where targets are a function of defined hydrologic conditions. (The last four columns with targets that are independent of a year classification are not currently used.)

A step down in targets following targets for the continuous flow requirement is included in the target table in the current model. This step down is needed to assure there is management for recession after the continuous flow requirement if the runoff ends before the continuous flow requirement. A separate step down in targets to manage recession after the runoff is triggered as part of discretionary operations as discussed in section 2.1.4.3.

2.1.4.1. Hydrology Year Type

The year classification for setting targets in the model is set based on a March through July forecasted flow volume at Otowi calculated with reference to input inflows. The year will be classified as dry, average, or wet based on the forecasted flow volume relative to threshold volumes computed as a percentage of the average flow. These percentages are input to the ForecastFactorsForHydYearType table slot in the MiddleValleyDemands data object, and the average March through July Otowi flow volume is input to the AverageOtowiForecast scalar slot in the Indian data object. The determined year classification on May 1st is maintained for the remainder of a calendar year. A year is classified as dry if stipulations of Article VII of the Compact are in effect, but since the year classification is set for the remainder of the year on May 1st, the year classification will not change if the Article VII status changes after May 1st. The year classification can also be set by the model user to utilize dry, average, or wet targets with input values of 1, 2, or 3 respectively.

2.1.4.2. Adjustment Factor

An adjustment factor can be included that will increase targets by a percentage (i.e. a target of 100 cfs will increase to 125 cfs with a 25% adjustment factor). A 25% adjustment factor is currently applied to targets because the model can set releases from Abiquiu to hit targets in the Middle Valley with much better precision than can be done in actual operations. Uncertainty about conveyance losses, MRGCD returns, local inflows, etc. combined with the travel time from Abiquiu to target locations and other physical operational constraints prevent actual releases from being adjusted with such precision, so an adjustment factor is applied to targets in the model such that modeled supplemental water releases more accurately reflect actual release volumes. Values for the adjustment factor are input to the MinTargetFlowsSafetyFactor periodic slot in the Middle Valley Demands data object. The value of 25% included in the current model was identified as an appropriate adjustment factor based on a comparison of historical supplemental water use from 2003 through 2006 and model results for supplemental water needed for a run using historical 2003 through 2006 hydrology.

2.1.4.3. Discretionary Operations

URGWOM is set up to simulate discretionary operations as part of the Biological Opinion which entail using supplemental water to manage recession after the runoff and control the rate of drying after river rewetting. This operation entails implementing a 30-day step down in targets at the end of the runoff and 7-day step down in targets thereafter following each river rewetting event. This aspect of operations can be turned off by setting the value in the TriggerImplementStepDownInTargets scalar slot to zero. The operation will be included as modeled policy if the input value in this scalar slot is 1.

Trigger flows for establishing if river rewetting has occurred are input to the RiverWetThresholds table slot in the MiddleValleyDemands data object where river wetting is defined by the threshold flows being exceeded at all three locations. River drying is then defined when the flow drops below one of the trigger flows in the RiverDryThresholds table slot. The step down target range for each location is established in the StepDownTargetRange table slot, and the duration and number of steps in a step down are defined in the DurationNumberStepsForStepDownInTargets table slot. Separate inputs for the duration and number of steps are established for the step down to manage recession after the runoff and the subsequent step downs in targets to control the rate of drying after each river rewetting event.

2.1.4.4. Shorted Diversions

If MRGCD is in a shortage situation and does not have the supply to meet their full demand, it is possible that full requested diversions would not be met. Requested diversions at MRGCD diversions may be shorted if MRGCD is in a shortage situation to prevent released supplemental water from being diverted that is specifically designated for targets. This adjustment is implemented in a simulation by completing additional side simulations in the model to iterate on what the diversions would be without supplemental water, and requested diversions at the main MRGCD diversions are reset from the full requested diversions to the determined shorted diversion. **This assumption is only applied if there are downstream targets.** If there are no downstream targets, it is assumed that any supplemental water still in the river is available for diversion. For example, if supplemental water is released to meet a target flow at Central, diversions may be shorted at Cochiti or Angostura if MRGCD would not have received their full requested diversion at those locations without supplemental water, but if there were no targets below Central, remaining supplemental water in the river may be diverted at the Isleta diversion during a shortage situation.

2.2. Reservoir Storage and Releases

Demands in the Middle Valley are met with specific sources of water. The MRGCD Demand at Cochiti is first met with natural flows including any letter water deliveries plus any releases of P&P water. Available native Rio Grande water in storage at El Vado is released from storage to augment flows if needed to meet the full demand at Cochiti. If no native Rio Grande water is available in storage, MRGCD San Juan-Chama Project water is released to meet the demand. (If no San Juan-Chama Project water allocated to MRGCD is available, MRGCD is in a shortage situation and requested diversions likely will not be fully met.)

Albuquerque's demand for surface water diversions and letter water deliveries is met by releasing Albuquerque's available San Juan-Chama Project water from storage at Abiquiu Reservoir. Letter water deliveries for other contractors are made from available storage for the contractor at Heron, El Vado, or Abiquiu Reservoir. Releases of

supplemental water as needed to meet targets are made from the Reclamation account at Abiquiu Reservoir where supplemental water may be available from leases for contractor's San Juan-Chama Project water or Emergency Drought water at El Vado that is passed through Reclamation's account at Abiquiu Reservoir in the model.

2.2.1. San Juan-Chama Project Water

Diversions from the San Juan basin through San Juan-Chama Project facilities to Heron Reservoir are computed with rules using input values for the flows in the San Juan tributaries and with consideration for diversion restrictions including an annual limit, ten-year diversion limit, and available space at Heron Reservoir. **Note that if Heron Reservoir is full during a simulation, diversions may be curtailed due to the lack of space and this would be of particular interest to stakeholders.** It is unlikely that the annual diversion limit or ten-year diversion limit would affect diversions.

San Juan-Chama Project water at Heron is first tracked in the model with the FederalSanJuan storage account on the Heron storage reservoir object. Water is allocated to contractors for San Juan-Chama Project water on January 1st of each calendar year based on the annual allocations input to the SanJuanContractorAllocations table slot (Figure 2.2) on the HeronData data object (Additional allocations are made on July 1st in the model with available water in the FederalSanJuan account if full allocations cannot be made on January 1st).

Figure 2.2. HeronData.SanJuanContractorAllocations Table Slot

2.2.1.1. Allocated Storage Space

Contractors have allocated storage space for San Juan-Chama Project water as input to the MaxAccountStorage periodic slots in the ElVadoData and AbiquiuData data objects (Figures 2.3 and 2.4). In the current model, MRGCD has all available storage space at El Vado Reservoir, but it could be assumed that MRGCD would allow other contractors to store water at El Vado as part of a planning study. The Water Operations Model is set up to allow several other contractors to store water at El Vado Reservoir. The limit for MRGCD storage of San Juan-Chama Project water is currently set to 183,000 acre-ft to approximately match the storage at the maximum El Vado pool elevation of 6901 ft.

Albuquerque has historically had the significant amount of allocated storage space at Abiquiu Reservoir, but with Albuquerque using more of their allocated San Juan-Chama Project water for surface water diversions to the new drinking water plant, assumptions for allocated storage space at Abiquiu should be reviewed. **Also note that allocated storage space is adjusted each year based on estimated sedimentation at Abiquiu Reservoir, so values likely will need to be updated in a model for a new year.** Storage is allowed at Abiquiu Reservoir up to a pool elevation of 6220 ft (Easement approvals from land owners are needed for storage above 6220 ft). In the current model,

the space is allocated to the Albuquerque, Santa Fe, Los Alamos, Espanola, Twining, and Reclamation storage accounts, with 2000 acre-ft also allocated for MRGCD, primarily to provide operational flexibility to MRGCD for moving water from El Vado Reservoir through Abiquiu Reservoir.

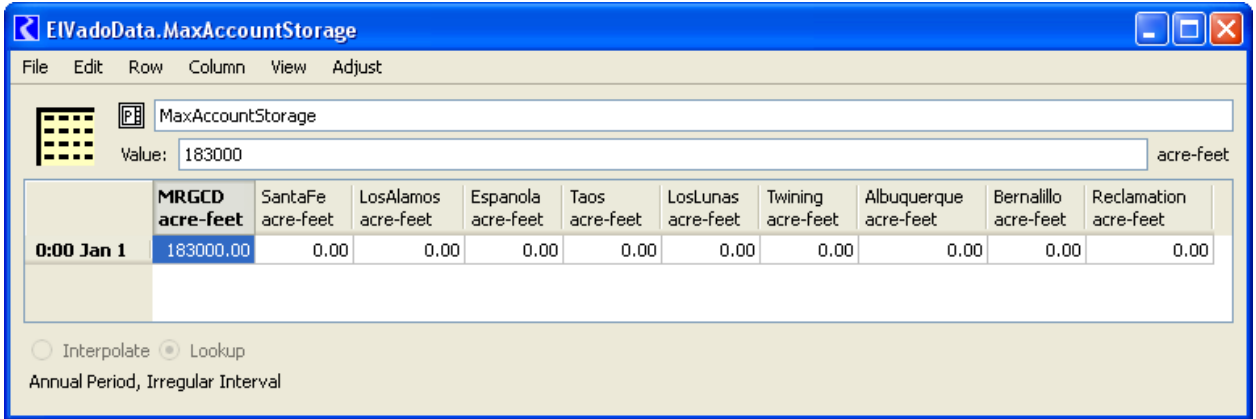


Figure 2.3. EIVadoData.MaxAccountStorage Period Slot

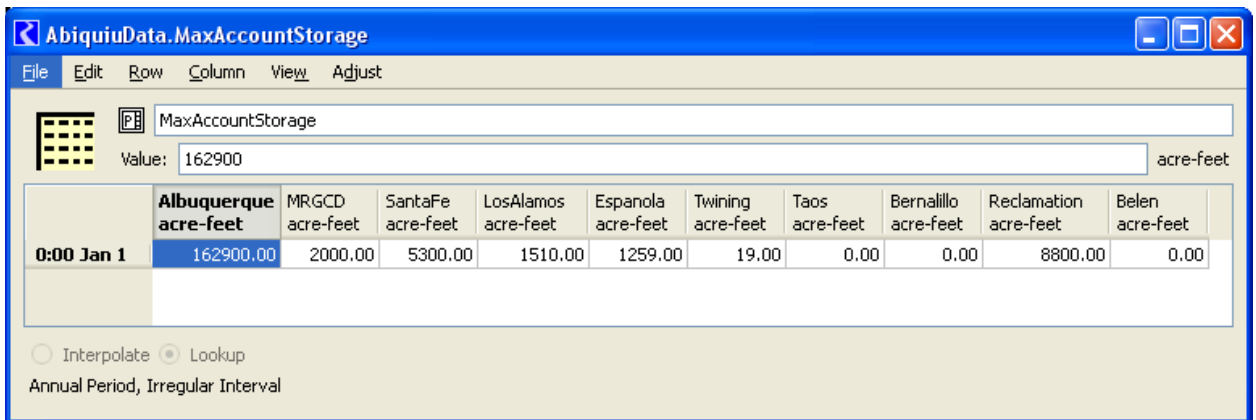


Figure 2.4. AbiquiuData.MaxAccountStorage Period Slot

2.2.1.2. Waivers

URGWOM is set up to allow contractors for San Juan-Chama Project water to retain current year allocated water, as discussed in section 2.2.1, that is still in storage at Heron Reservoir at the end of a calendar year, into the following year until an input waiver date. The current authorized waiver date of September 30th is input to the WaiverDate table slot in the HeronData data object in the current model. Coded policy entails releasing waiver water as possible during the following year, such that available downstream allocated storage space for the contractor is filled by the waiver date or all waiver water at Heron Reservoir is released by the waiver date. **Note that depending on the inputs for allowable cumulative account fill deliveries as discussed in section 2.2.1.3, some current year allocated water may also be delivered at the same time as waiver water to fill downstream allocated storage space.** Also, note that Reclamation is not currently set up to store leased water at Heron into the year following the year when the

water was originally allocated to the source contractors. The waiver option is turned on for a year during a simulation if the value in the annual HeronData.WaiverSwitch slot is set to 1.0. Waivers could be turned off by setting this switch to zero.

2.2.1.3. Deliveries to Allocated Storage Space

Allocated San Juan-Chama Project water for contractors as discussed in section 2.2.1 is periodically delivered to allocated storage space as discussed in section 2.2.1.1. Total delivery amounts from Heron to specifically fill allocated storage space for all contractors are input for set periods. Releases are made at an average rate to make the total release by the end of the period. The values for the total release amounts for set periods are input to the AccountFillMaxVolume periodic slot (Figure 2.5) in the HeronData data object and can be used to control the timing and amount of water that is moved from Heron to allocated storage space at El Vado and Abiquiu Reservoirs. Deliveries are made sequentially for individual contractors by setting the separate supplies that have a release type of AccountFill based on input priorities as set in the AccountReleasePriority periodic slot (Figure 2.6) in the HeronData data object. Note that waiver water, which is delivered gradually up to the waiver date, may be delivered at the same time which will impact the timing for when allocated storage space is filled.

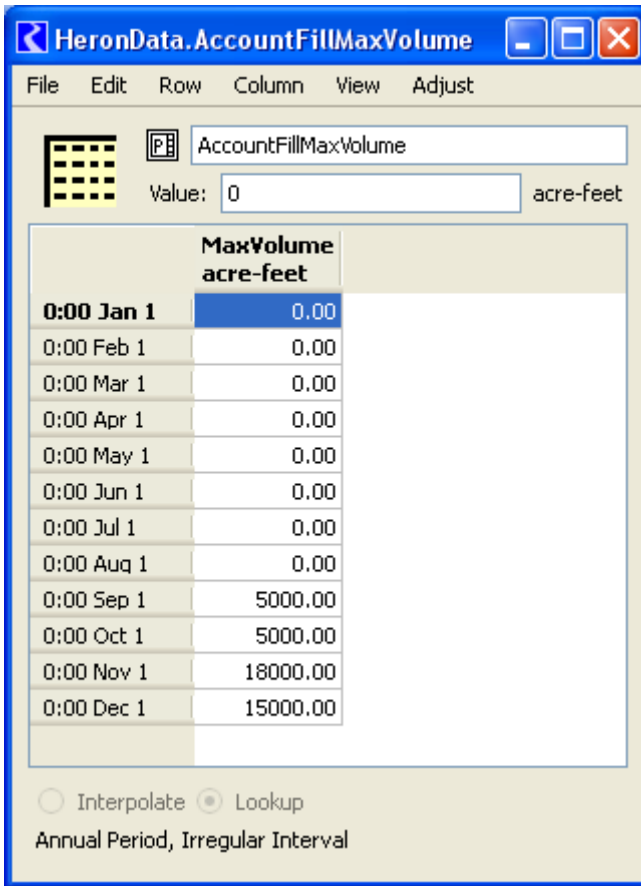


Figure 2.5. HeronData.AccountFillMaxVolume Periodic Slot

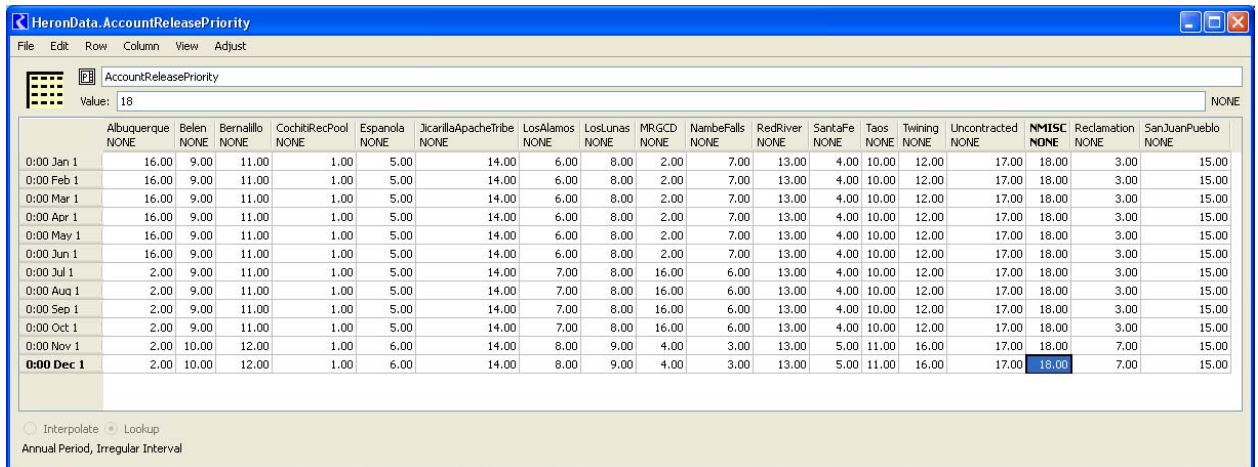


Figure 2.6. HeronData.AccountReleasePriority Periodic Slot

2.2.1.3.1. Cochiti Rec Pool

Releases of San Juan-Chama Project water for the Cochiti Recreation Pool are set in a similar manner to the AccountFill releases but are tracked separately in the model from the other AccountFill releases. Releases are made to fill the allocated rec pool space at Cochiti which is input as a storage value in the Permanent Sediment Content table slot in the Cochiti storage reservoir object. The current input value of 49,370 acre-ft provides the Cochiti rec pool surface area of 1200 acres based on the input elevation-area-capacity tables. With sediment accumulation at Cochiti Lake modeled during a simulation, the reservoir storage for maintaining the rec pool gradually increases during a simulation. Releases of San Juan-Chama Project water allocated for the Cochiti rec pool are made from Heron Reservoir to release set volumes over set periods as input to the HeronData.CochitiRecPoolMaxVolume periodic slot. Releases from Heron Reservoir are made at an average rate to release the input volume by the next date in the table. The timing for these deliveries may also be affected by the input priority for accounting supplies that have a release type of CochitiRecPool as set in the account release priority table as discussed further in section 2.2.1.3.2.

2.2.1.3.2. Priority Tables for Releases

Deliveries from Heron Reservoir to fill allocated storage space at downstream reservoirs (i.e. El Vado and Abiquiu Reservoirs) are made with accounts that have a release type of AccountFill and are made based on the priority for this release type in the ReleaseTypePriority periodic slot (Figure 2.7) in the HeronData data object. Accounts for other deliveries have different release types such as OtowiPaybacks for letter water deliveries as discussed in section 2.1.3. Initial demands for moving water are computed and then deliveries are made based on the input priorities. Assuming the initial computed release to meet different demands could be made and was not restricted to operational

constraints and accounts have water in storage to make the designated deliveries, all initial computed demands should be met. Deliveries from El Vado are set in a similar manner with reference to the corresponding periodic slots in the EIVadoData data object. **Values in these priority tables should only be adjusted through coordination with the URGWOM Tech Team.**

The screenshot shows a software window titled "HeronData.ReleaseTypePriority" with a menu bar (File, Edit, Row, Column, View, Adjust) and a toolbar. Below the toolbar is a search field containing "ReleaseTypePriority" and a "Value:" field set to "8". The main area contains a table with the following data:

	OtowiPaybacks NONE	Waiver NONE	AccountFill NONE	AccountDelivery NONE	AlbuquerquePaybacks NONE	ReleaseToMRGCD NONE	CochitiRecPool NONE	NMISC NONE	MRGCDPaybacks NONE	ElVadoDelivery NONE
0:00 Jan 1	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Feb 1	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Mar 1	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Apr 1	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Apr 30	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Jun 1	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Jul 15	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Aug 1	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Sep 1	5.00	7.00	8.00	9.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Oct 1	5.00	9.00	7.00	8.00	6.00	10.00	1.00	4.00	2.00	3.00
0:00 Nov 1	3.00	9.00	5.00	2.00	6.00	10.00	1.00	8.00	4.00	7.00
0:00 Dec 1	3.00	9.00	5.00	2.00	6.00	10.00	1.00	8.00	4.00	7.00

At the bottom of the window, there are radio buttons for "Interpolate" and "Lookup" (selected), and a label "Annual Period, Irregular Interval".

Figure 2.7. HeronData.ReleaseTypePriority Periodic Slot

In addition to the AccountFill releases, the current model is set up with specific accounts designated with a release type of AccountDelivery that will override original computed deliveries to assure MRGCD’s allocated storage space is filled. The URGWOM Tech Team is reviewing the current set up for setting accounts for moving water to fill allocated storage space to assure water is delivered at appropriate times and to also incorporate policy for using such deliveries to provide rafting releases below El Vado Dam. Accounts with a release type of ReleaseToMRGCD also work in a similar fashion to the AccountDelivery accounts in that the ReleaseToMRGCD accounts override initial estimates for deliveries to assure water is moved to MRGCD’s account. *The current model contains several accounting supplies with a release type of ReleaseToMRGCD that will move water from storage accounts for contractors for San Juan-Chama Project water to MRGCD’s account at El Vado Reservoir if this release type is set as higher priority, but this release type should be designated as lower priority unless such a transfer is desired.*

2.2.1.3.3. Input Maximum San Juan-Chama Project Outflows

A computed daily total need for San Juan-Chama Project water is determined for each reservoir during simulation based on separate computations for the demand for different water users, but this need can be restricted to not exceed an input maximum to the MaximumSJOutflow periodic slot in the data object corresponding with each reservoir. This allows the model user to effectively override how releases are computed in the rules

and restrict the outflow to a smaller release. Whether contractors get their demand for that day from the restricted release is a function of the inputs to the AccountReleasePriority and ReleaseTypePriority tables for the corresponding reservoir. Utilizing the MaximumSJOutflow slot along with inputs to the priority tables to control the model results requires an advanced understanding of the inner workings of the model, accounting, and rules, but this approach can be a very useful for achieving desired model results for deliveries.

2.2.1.4. Loans between Contractors

URGWOM is currently set up to allow Albuquerque to loan unused San Juan-Chama Project water to other contractors, but with the startup of surface water diversions, this policy, that had been modeled in the past, is likely no longer relevant for future AOPs. A minimum Albuquerque storage at Abiquiu Reservoir before water would be loaned is input to the AbiquiuData.MinPoolAlbuquerqueLoan table slot, but a high value (e.g. 200,000 acre-ft) would effectively prevent any loan from ever occurring because Albuquerque storage would never be so high (Total reservoir storage at the current maximum pool elevation of 6220 ft is 183,882 acre-ft.) If policy for Albuquerque to loan water to other contractors were to be simulated, the details of the policy would likely need to be reviewed against the current coded rules through coordination with the URGWOM Tech Team.

The Planning Model is also set up to model loans from MRGCD to either Reclamation or Albuquerque. Schedules for these loans are input to the ReclamationFromMRGCDLoan and AlbuquerqueFromMRGCDLoan series slots in the HeronData data object. Loans would be made, if MRGCD has the water in storage to loan, based on these input schedules and paid back to MRGCD when Reclamation or Albuquerque has available water for the payback. These loans would be tracked with the Exchanges Manager in RiverWare. This policy allows for specific agreements to be modeled, but if any future loans between these contractors were to be modeled, the details of the policy would likely need to be reviewed against the current coded policy through coordination with the URGWOM Tech Team. All values are set to zero for these series slots in the current database files.

2.2.2. Native Rio Grande Water

Native Rio Grande water is effectively bypassed at Heron Reservoir, but there is a restriction that the Heron pool elevation cannot change by more than one foot a day (Input to the HeronData.maxDeltaPoolElev table slot). Rio Grande water may be stored at El Vado as discussed further below, and native Rio Grande water may be stored at Abiquiu Reservoir and Cochiti Lake for flood control operations. Policy for making stepped releases at Abiquiu and Cochiti Dams is included in the URGWOM ruleset. Inflows are bypassed at Jemez Dam unless storage is needed for channel capacity restrictions through coordinated operations with Cochiti Dam.

2.2.2.1. Channel Capacities

Water may be stored at Abiquiu to assure the downstream channel capacities are not exceeded as input to the AbiquiuData.ChannelCapacities table slot. The capacity immediately below Abiquiu Dam is input as 1800 cfs, and the capacities at Chamita and Otowi are 3000 and 10,000 cfs, respectively. Channel capacities below Cochiti Dam are input to the CentralChannelCapacity and SanMarcialChannelCapacity periodic slots in the CochitiData data object. In the current model, the Central channel capacity is set to 7000 cfs and the San Marcial channel capacity is input as 5000 cfs. (A San Marcial channel capacity of 5000 cfs will prevent the Central channel capacity of 7000 cfs from being reached.) Different channel capacities for different periods within a calendar year could be established. A series slot called ChannelCapacityOpsFlag is set up in the CochitiData data object to indicate which channel capacity controlled with a value of 1 indicating the Central channel capacity controlled and a value of 2 indicating the San Marcial channel capacity controlled (a NaN value in this slot indicates that channel capacities did not control the release for that timestep). Channel capacities below Elephant Butte and Caballo Dams are input to the ChannelCapacities table slot in the ElephantButteData and CaballoData data objects. The channel capacity below Elephant Butte Dam is input as 5000 cfs, and the channel capacity below Caballo Dam is set to 3500 cfs with a capacity of 11,000 cfs at El Paso.

2.2.2.2. Carryover Storage

Water stored at Abiquiu and Cochiti Reservoirs during flood control operations will be subsequently released as possible, but any water still in storage after July 1st and after the flow at Otowi drops below 1500 cfs, as input to the MinLockinFlow table slot in the FloodCarryOverData data object, will be retained in storage if 212,000 acre-ft of space is available. Carryover storage will be released starting in January of the following year at a determined constant rate such that the water is evacuated by March 31st. Resulting storage of Rio Grande water at Abiquiu Reservoir and/or Cochiti Lake from a simulation for an upcoming year, including any potential carryover storage, should be checked as this operation would be of particular interest to stakeholders.

2.2.2.3. Article VII of the Compact

Inflows of native Rio Grande water at El Vado Reservoir will be stored if not needed to meet downstream demands and if the stipulations of Article VII of the Compact are not in effect. Article VII of the Compact (States of New Mexico, Colorado, and Texas, 1938) stipulates that water may not be stored in post-Compact Reservoirs if there is less than 400,000 acre-ft of usable project (usable) storage, where usable storage is calculated as the sum of storage at Elephant Butte Reservoir, not including any San Juan-Chama Project water or New Mexico credit water, plus storage at Caballo Reservoir. Usable storage is computed in the model and recorded to the CompactVIIUsableWater series slot in the RioGrandeCompact data object, and the resulting Article VII status is recorded to

the Article VII Switch series slot in that data object where a value of 1 indicates that Article VII is in effect and a value of 0 indicates that the provision is not in effect. Note that the usable storage adjusts immediately for any accounting transfer from the New Mexico Compact credit account to the Rio Grande account as a result of relinquished credits.

2.2.2.4. Storage at El Vado Reservoir

If the stipulations of Article VII of the Compact are in effect, inflows of native Rio Grande water at El Vado Reservoir will be bypassed after water has been stored to meet the computed P&P storage requirement as discussed in section 2.1.1.1 and water has been stored to fill any allocated space for Emergency Drought water as a result of relinquished Compact credits (Refer to section 2.3.2). Releases may include the release of P&P water as needed and any available native Rio Grande water to meet the MRGCD demand as needed.

If Article VII is not in effect, native Rio Grande water will be stored as not needed to meet the MRGCD demand to ultimately meet a target elevation by a target date as input to the TargetElevation periodic slot in the ElVadoData data object (Figure 2.8). During a calendar year, all available native Rio Grande inflows are stored *during the runoff*, prior to the May 25th input target elevation, until the storage reaches 65% of the storage corresponding with that target elevation where the 0.65 fraction is input to the FractionOfTargetElevToStartPercRGRel scalar slot in the ElVadoData data object. The current input value of 65% of target storage yields an elevation of 6878.35. This elevation is approximately at the crest of the spillway gates. A computed percentage of native Rio Grande inflows are bypassed thereafter such that the reservoir will reach the target fill date on May 25th based on forecasted inflows. This computed percentage is recorded to the ElVadoData.PercentRGRelease series slot in the ElVadoData data object.

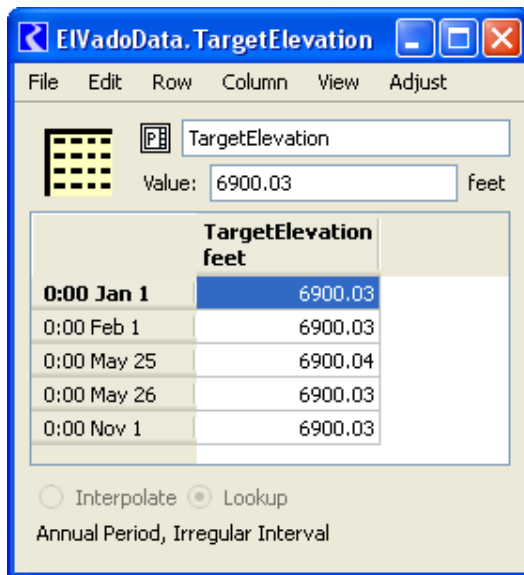


Figure 2.8. ElVadoData.TargetElevation Periodic Slot

After the reservoir has filled, water may be evacuated to target an end-of-irrigation season target elevation if Article VII is NOT in effect. This operation has historically entailed evacuating water as needed before the winter to prevent icing on the spillway gates but is not implemented if the pool elevation exceeds this winter target elevation and Article VII is in effect, with the assumption that all water in storage should be retained as possible if Article VII is in effect. Also, storage of San Juan-Chama project water is not evacuated even if the pool elevation exceeds this target winter pool elevation. Heaters have recently been installed to prevent icing on the gates so a lower end-of-irrigation season target pool elevation is not included in the current model, but a lower target elevation can be re-implemented if necessary.

2.2.2.4.1. Article VIII of the Compact

URGWOM is set up to model El Vado Dam releases that would be made based on a call by Texas per Article VIII of the Compact which essentially states that Texas may call for a release, starting in January, of water in storage from post-Compact reservoirs to the amount of an accrued Compact debt to bring the usable storage up to 600,000 acre-ft. A switch to identify whether this policy should be modeled is included as the TriggerImplementArticleVIIIOps scalar slot in the RioGrandeCompact data object. This policy will be modeled if a value of 1 is entered in this scalar slot but will not be included if the value is set to 0. **This aspect of policy would likely be turned off for a Water Operations Model run but is included in the ruleset for long-term studies completed with the Planning Model.**

The coded policy entails referencing a threshold debt for when a call would actually be made as input to the ThresholdCompactCreditToStartArticleVIIIOps scalar slot in the RioGrandeCompact data object which is set to -20,000 acre-ft in the current model based on the assumption that Texas would not actually make a call until the debt accrued to exceed 20,000 acre-ft. Releases are made in the model by establishing a new minimum release of Rio Grande water for an Article VIII release season as set in the ArticleVIIIReleaseSeason table slot in the RioGrandeCompact data object. Releases are set to a computed average rate to release a volume equal to the Compact debt over the Article VIII release season, but no release will be made if there is no RioGrande water in storage.

2.2.2.5. Releases from Elephant Butte and Caballo Dams

Releases from Elephant Butte Dam are set to provide an input full demand if the supply is available based on the storage at Elephant Butte and Caballo Reservoirs plus a forecasted Elephant Butte Reservoir inflow volume from the runoff. The full demand for a year is input to the AverageDemand periodic slot in the ElephantButteData data object. **This demand schedule for Water Operations Model simulations has historically been provided by Reclamation's El Paso office each year.** If the full demand cannot be

provided, a percentage of the demand that can be met is computed monthly based on the ratio of the available supply to the remaining demand for the year. This percentage is recorded monthly to the `DownstreamDemandPercentage` series slot in the `ElephantButteData` data object. The resulting daily demand from Elephant Butte Reservoir is recorded to the `DownstreamDemand` series slot in that data object. The demand from Caballo Reservoir is set with reference to the same computed `DownstreamDemandPercentage` value and a separate full demand schedule for Caballo Reservoir as input to the `AverageDemand` periodic slot in the `CaballoData` data object. Releases from Elephant Butte and Caballo Dams are set to the releases to provide the corresponding computed `DownstreamDemand` with consideration for flood control operations.

2.3. Water Agreements

Details about any potential temporary agreements for an upcoming year need to be identified before setting up a Water Operations Model run. URGWOM is set up to model some agreements that have been implemented historically including the following: Reclamation leases of San Juan-Chama Project water from contractors, relinquished Compact credits and storage of Emergency Drought water, Cochiti deviations to provide recruitment or overbank flows, and pumping from the Low Flow Conveyance Channel. URGWOM is also set up to model reregulation storage at Abiquiu Reservoir and alternate timing for letter water deliveries; however, these actions have not been implemented but only studied with URGWOM in the past.

2.3.1. Reclamation Leases

For this user manual, supplemental water is defined as water designated to be released to meet target flows in the Middle Valley. There are two sources for supplemental water: water may be leased by Reclamation from contractors for San Juan-Chama Project water or native Rio Grande water may be stored as Emergency Drought water at El Vado to be used for targets (Refer to section 2.3.2 for more details on Emergency Drought water). Leases of San Juan-Chama Project water by Reclamation from contractors are set up as transfers from account storage for the other contractors to Reclamation's account. Details for the magnitude and timing for Reclamation leases for an upcoming year need to be identified to set up the leases in the Water Operations Model runs.

These transfers are made based on inputs to series slots in each of the `HeronData`, `ElVadoData`, and `AbiquiuData` data objects that have names ending with "WaterLease" where the transfers occur at the reservoir corresponding with the data object from the source storage account to Reclamation's storage account exactly as input. If the source storage account does not have the available water needed for a daily transfer, the transfer is not made. (Series slots are also included in these data objects for a Combined account, but these additional slots are not used in the Water Operations Model. These slots must

be maintained in the Water Operations Model such that the single ruleset that is also used with the Water Operations Model will also work with the Planning Model.)

2.3.1.1. Threshold YTD Otowi Flow Volume for Conserving Lease Water

A test policy for conserving leased San Juan-Chama Project water during wet periods is currently established in URGWOM where lease water will not be used for targets after a threshold year-to-date Otowi flow volume has been reached. This threshold volume is input to the ThresholdOtowiVolumeHoldLeaseWater scalar slot (Figure 2.11) in the MiddleValleyDemands data object. A value of 1,000,000 acre-ft has been analyzed previously, but this policy should not be included in Water Operations Model runs unless such a policy is actually implemented. In the Water Operations Model, this policy is turned off by setting the value to 999,999,999 acre-ft, which would never be met.

This policy as coded only applies to leased water. Available Emergency Drought water would still be used to meet targets regardless of the year-to-date Otowi flow volume. Any actual alternative policies for conserving leased water could be implemented into the model but any new defined policy would need to be implemented into the model by the URGWOM Tech Team.

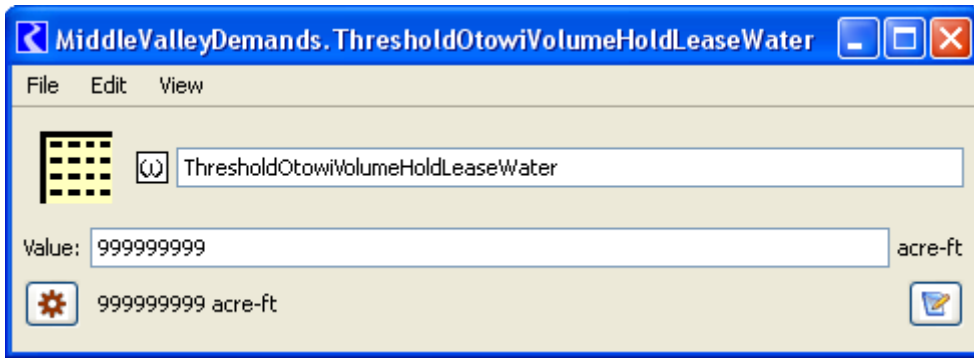


Figure 2.11. MiddleValleyDemands.ThresholdOtowiVolumeHoldLeaseWater Scalar Slot

2.3.2. Relinquished Credits and Emergency Drought Water

URGWOM is set up to model relinquished Compact credits and the subsequent storage of Emergency Drought water at El Vado Reservoir when stipulations of Article VII of the Compact are in effect (Refer to section 2.2.2.3 for more details on Article VII). This aspect of policy can be turned on or off by setting the value in the TriggerModelRelinquishedCredits scalar slot in the EIVadoData data object to 1 or 0, respectively. Policy is coded for computing relinquished credits and allocations for storage of Emergency Drought water, but for Water Operations Model runs, these details are likely known or can be estimated by the model user based on expected actual agreements for an upcoming year and would thus be input.

To input a relinquished credit, the date for the relinquishment is input to the DateOfRelinquishment column in the RelinquishedCreditsTriggers table slot (Figure 2.12) in the ElVadoData data object and the magnitude of the relinquishment would then be input for that input date in the RelinquishedNMCredits series slot. Note that usable storage for assessing Article VII status is updated immediately for the resulting accounting transfer from the New Mexico Compact credit account to the Rio Grande account at Elephant Butte Reservoir.

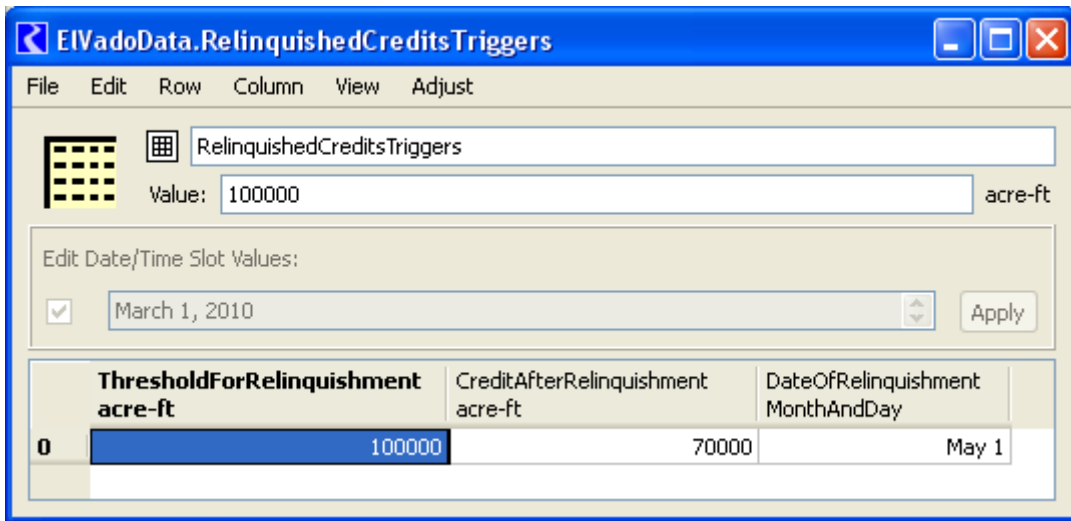


Figure 2.12. RelinquishedCreditTriggers Table Slot

Resulting allocations for storage of Emergency Drought water at El Vado Reservoir are distributed based on the proportions input to the second column in the RelinquishedNMCreditAllocations table slot (Figure 2.13). Any initial allocations for storage from past relinquished credits are input to the first column in this table. Allocations are tracked in the MRGCDDroughtAllocation, SupplementalESAAllocation, and MunicipalitiesAllocation series slots in the ElVadoData data object. Any water in storage for the corresponding account contributes to the allocation, so the initial allocations should be greater than or equal to any initial storage in these accounts on the ElVado reservoir object. When water is released, the allocation has been used and is reduced. Maximum annual releases for MRGCD or ESA could be input to the last two rows of the RelinquishedNMCreditAllocations table slot, but values of 99,999 acre-ft are currently input to effectively represent no annual release limit.

	Volume acre-feet	Proportion NONE
0: MRGCDDrought	9664.03	0.3333
1: SupplementalESA	0.00	0.3333
2: Municipalities	0.00	0.3333
3: MaxMRGCDDroughtAnnualRelease	99999.00	NaN
4: MaxSupplementalESAAnnualRelease	99999.00	NaN

Figure 2.13. EIVadoData.RelinquishedNMCreditAllocations Table Slot

Coded policy for computing a relinquishment will be used if no value is input to the RelinquishedNMCredits series slot for the input relinquishment date. The current assumption is that Compact credits will be relinquished on the input date for a relinquishment if the Compact credit exceeds the value (currently input as 100,000 acre-ft) in the ThresholdForRelinquishment column in the RelinquishedCreditsTriggers table slot (Figure 2.12) to reduce the credit to the value (currently input as 70,000 acre-ft) in the CreditAfterRelinquishment column in that same table slot.

2.3.2.1. Storage of Emergency Drought Water

Inflows of native Rio Grande water to El Vado Reservoir when Article VII is in effect are stored to separate accounts for Emergency Drought water *after* any storage requirement for P&P needs is met first. Storage accumulates in the Emergency Drought accounts with the actual inflow of native Rio Grande water. Available inflows of native Rio Grande water for Emergency Drought storage are split between the MRGCDDrought and SupplementalESA accounts based on the ratio of available allocation for the accounts. *An allocation for storage of Emergency Drought water for municipalities is tracked in URGWOM but water is not currently stored for use by municipalities since exact policy for how such water would be used by municipalities has not been defined.* If needed for an AOP run, storage of Emergency Drought water could potentially be modeled as reregulation storage at Abiquiu and/or Cochiti Reservoirs using the conservation accounts at these reservoirs, discussed further in Section 2.3.5.

2.3.2.2. Releases of Emergency Drought Water

Water for MRGCD is tracked in an MRGCDDrought account at El Vado reservoir and is used to meet the MRGCD demand when native Rio Grande water is no longer available

to meet the MRGCD demand at Cochiti but before any of MRGCD's San Juan-Chama Project water would be used. Emergency Drought water for meeting targets is tracked in the SupplementalESA account at El Vado Reservoir and is used to meet targets before leased San Juan-Chama Project water in the Reclamation account at Abiquiu is used. A specific season for using SupplementalESA water can be defined in the ESAReleaseDates table slot in the ElVadoData data object; however, the entire calendar year is designated in the current model. A maximum release of SupplementalESA water can also be defined in the MaxESARelease table slot in the ElVadoData data object, but this value is effectively not used in the current model as it is set to 9999 cfs.

Within URGWOM, releases from the SupplementalESA account are effectively bypassed through Reclamation's account in the model (Water is first released from the Reclamation account to meet targets and water in the SupplementalESA account is released to replenish the storage in the Reclamation account if SupplementalESA water is available). Modeling alternate assumptions about relinquished Compact credits and the use of Emergency Drought water would require model development that should be coordinated with the URGWOM Tech Team. To not simulate relinquished credits, all values in the RelinquishedNMCredits annual series slot (Figure 2.13) could be input as 0 and relinquished credits would not be computed in the model and no allocation be made with zero input for annual relinquished credits. If relinquished credits are not modeled, any Emergency Drought water in storage at the beginning of the run as an initial condition would still be used to meet targets.

2.3.3. Cochiti Deviations

Cochiti deviations are authorized through 2013 where the Corps may temporarily store native Rio Grande water to be released at the time of the peak and augment flows to provide recruitment flows in the Middle Valley (Corps, 2009). Specific criteria are coded for identifying whether the runoff is sufficient to enact Cochiti deviations to provide recruitment flows (or overbank flows) but the runoff is insufficient for providing the needed hydrograph by just bypassing inflows at Cochiti Lake. Operations entail providing overbank flows if conditions support providing the higher flows. One input to review is the year for suspending this aspect for operations as input to the table slot called LastYearCochitiDeviationsAuthorized in the MiddleValleyDemands data object (Refer to Figure 2.14 for a screen capture of this slot in the model). Cochiti deviations can easily be turned off for a model run by setting this value to a year prior to the run period. Current coded policy for deviations could be modeled for a period after 2013 by simply resetting this input to a later year.

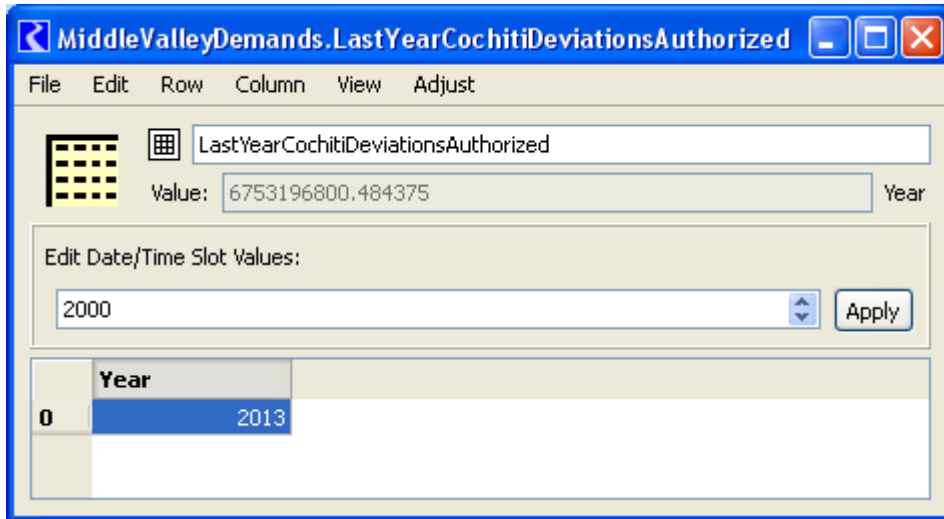


Figure 2.14. MiddleValleyDemands.LastYearCochitiDeviationsAuthorized Table Slot

Deviations will be implemented to provide *recruitment* flows if the March through July Otowi flow forecast is between 50% and 80% of average and the projected peak inflow to Cochiti Lake during the recruitment or overbank season is between 1800 and 5000 cfs or the March through July forecast is greater than 80% of average but the projected peak inflow is less than 3500 cfs. The recruitment or overbank season is defined by the dates input to the RecruitmentOrOverbankSeasonDates table slot in the MiddleValleyDemands data object, and the projected peak inflow to Cochiti is determined during a simulation. Deviations will be implemented to provide *overbank* flows if the Otowi forecast is between 80% and 120% of average and the projected peak inflow to Cochiti is between 3500 and 10,000 cfs or the Otowi forecast is between 50% and 80% of average but the project peak inflow is greater than 5000 cfs. These referenced fractions for the Otowi forecast as a percentage of average for identifying whether deviations should be implemented to provide recruitment or overbank flows are input to the EnvironmentalPercentages table slot in the MiddleValleyDemands data object. The average March through July Otowi flow volume is input to the AverageOtowiForecast scalar slot in the Indian data object (Note that this average Otowi flow volume is also referenced in a similar manner for evaluating whether the hydrology year type for setting target flows is dry, average, or wet as discussed in section 2.1.4.1). The threshold peak Cochiti inflow rates referenced when determining whether deviations should be implemented to provide recruitment or overbank flows are input to the EnvironmentalMinMaxPeakFlows table slot in the MiddleValleyDemands data object.

The date to start storage at Cochiti Lake for deviations can be input to the PresetDayForCochitiDeviationsStorage table slot. *The value in the companion UsePresetDayForCochitiDeviationsStorage scalar slot must be set to 1 if an input date for storage is to be used.* If this option is used when the storage actually begins prior to the simulation Start Timestep (i.e. storage began in April for a Water Operations Model run beginning May 1st), the Start Timestep should be input for the preset date to begin storage. If no preset date is input, the date to begin storage is set to 24 days before the projected date of the peak inflow to Cochiti Lake. The value for the number of days

before the peak to begin storage is input to the DaysOfCochitiDeviationsStorageBeforePeak scalar slot in the MiddleValleyDemands data object. The amount of conservation storage is set with reference to the Otowi forecast and a lookup against the values in the RGConservationSpaceTable table slot. The designated target amount of conservation storage can also be input to the December 31 slot in the ComputedRGConservationSpaceAvailable series slot as an override to the lookup table.

Target flows to provide recruitment or overbank flows are input as 30-day target hydrographs in the EnvironmentalTargets table slot in the MiddleValleyDemands data object. If deviations are implemented, targets at Central are reset such that day five in the appropriate target hydrograph matches the date of the projected peak inflow to Cochiti Lake.

Water in storage for Cochiti deviations will be evacuated by the end of a deviations period which lasts for 45 days as input to the DurationCochitiDeviationsPeriod scalar slot in the MiddleValleyDemands data object. Water will begin to be evacuated 15 days before the end of the Cochiti deviations period at a constant rate if that constant rate is greater than the flow needed to meet the target in the established recruitment or overbank target hydrograph. A value of 3000 acre-ft is input to the LowStorageToEndDeviationsTargets scalar slot to shift Central targets back to original targets if storage at Cochiti for deviations drops below this threshold. This adjustment is needed to prevent other sources for supplemental water (i.e. leased San Juan-Chama Project water or Emergency Drought water for ESA) from being used to meet the recruitment or overbank targets established specifically for Cochiti deviations. Any needed adjustments to the coded policy for Cochiti deviations would likely need to be implemented through coordination with the URGWOM Tech Team and the Corps.

2.3.4. Pumping from the Low Flow Conveyance Channel

URGWOM is set up to model pumping of flows from the Low Flow Conveyance Channel (LFCC) to the river to prevent river drying. Refer to Figure 2.15 for a picture of pumps used to pump from the LFCC. Diversions at the Neil Cupp site, North Boundary of the Bosque del Apache National Wildlife Refuge, and South Boundary are simulated (Pumping at the Fort Craig site was determined to be inconsequential to simulation results and is not included).

Water that seeps into the Low Flow Conveyance Channel is pumped to the river where pumping begins based on specific river flow triggers. Different triggers could be established as a function of the year classification for setting targets (section 2.1.4.1); although, the threshold low San Acacia flow triggers for initiating pumping at each site is the same in the current model regardless of the year type. The rate of pumping does vary based on year type. Values are input to the Dry, Normal, and Wet table slots (Figures 2.16 through 2.18) in the LFCCPumpingTriggers data object. Different values are set up for the winter of wet years as defined by dates input to the

WetSanMarcialWinterTargetSeasonDates table slot. After pumping has initiated at a site, pumping will continue for a minimum of one week and until the flow at San Acacia has exceeded 150 cfs as input to the SanAcaciaFlowTriggerForShutDown scalar slot in the LFCCPumpingTriggers data object. Pumping will cease for the year at each site after the dates for each site input to the DateToShutDownForYear table slot. It is assumed in the current model that pumps at the Neil Cupp site and North Boundary would not be used after June 30th, so for most of the simulation period for Water Operations Model runs, only operations for South Boundary pumps are included. **Note that the dates in the DateToShutDownForYear table slot could all be set to January 1st to not model any pumping from the Low Flow Conveyance Channel for a simulation.**



Figure 2.15. Low Flow Conveyance Channel Pumps

	NeilCupp cfs	NorthBoundary cfs	SouthBoundary cfs
0: SanAcaciaFlowTriqgerForStartUp	80	100	130
1: PumpingRate	40	30	40

Figure 2.16. LFCCPumpingTriggers.Dry Table Slot

LFCCPumpingTriggers.Normal

File Edit Row Column View Adjust

Normal

Value: 80 cfs

	NeilCupp cfs	NorthBoundary cfs	SouthBoundary cfs
0: SanAcaciaFlowTriqgerForStartUp	80	100	130
1: PumpingRate	20	20	30

Figure 2.17. LFCCPumpingTriggers.Normal Table Slot

LFCCPumpingTriggers.Wet

File Edit Row Column View Adjust

Wet

Value: 80 cfs

	NeilCupp cfs	NorthBoundary cfs	SouthBoundary cfs
0: SanAcaciaFlowTriqgerForStartUpWinter	80	100	130
1: WinterPumpingRate	40	30	50
2: SanAcaciaFlowTriqgerForStartUpSummer	80	100	130
3: SummerPumpingRate	20	20	20

Figure 2.18. LFCCPumpingTriggers.Wet Table Slot

2.3.5. Reregulation Storage

Reregulation storage (referred to as Conservation storage within the model) at Abiquiu is not currently authorized and likely would not be included for a Water Operations Model run unless such storage was actually implemented for an upcoming year. This aspect of policy is included in the ruleset for long-term studies completed with the Planning Model. Reregulation storage entails allowing storage at Abiquiu Reservoir above the current maximum easement pool elevation of 6220 ft as input to the SJCEasement column in the PoolLevels table slot in the AbiquiuData data object. If the total storage with reregulation storage was to be increased, this SJCEasement value should be adjusted accordingly (e.g. a value of 6277.18 would be input for a total storage of 500,000 acre-ft based on the elevation-capacity table). The value in the RGConservationSpaceAvailable

table slot would then also be adjusted from zero to the total allowable storage to be modeled (e.g. 500,000 acre-ft). No additional conservation storage is allowed after that storage level has been reached.

Resulting reregulation storage allows storage of native Rio Grande inflows not needed to meet the MRGCD demand and is tracked with the Rio Grande Conservation storage account on the Abiquiu level power reservoir object in URGWOM. Reregulation storage is then released as needed for targets and is used before water in the Reclamation account based on the input priorities in the AccountReleasePriority periodic slot in the AbiquiuData data object. Reregulation storage still in storage within the dates input to the RGConservationReleaseDays table slot is completely evacuated at a computed constant rate (Past studies have also included an alternate coded policy to only evacuate reregulation storage as needed to keep the Compact credit whole). Coded policy for reregulation storage at Abiquiu would likely need to be reviewed with the URGWOM Technical Team if such an operation were to be conducted and simulated with the Water Operations Model.

Reregulation storage at Cochiti Lake is currently simulated as part of Cochiti deviations and could also be set up for meeting target flows. The URGWOM Tech Team is working on setting up URGWOM to simulate potential reregulation storage at Jemez Reservoir but this capability has not yet been implemented into the current version of the model.

2.3.6. Alternate Timing for Letter Water Deliveries

A proposed action that has been analyzed with URGWOM entails modeling alternate schedules for letter water deliveries if specific conditions are satisfied for the portion of deliveries made to payback the Compact. The alternate delivery schedules have been studied to evaluate benefits of the alternate delivery timing on ESA considerations including augmenting flows needed for recruitment, targets and to prevent river drying, or to help manage recession after the runoff. Such an operation has not actually been implemented and likely would not be simulated in Water Operations Model runs. If such a policy was implemented and needed to be simulated with the Water Operations Model, the current coded policy would need to be reviewed against actual implemented policy changes. The standard letter water delivery schedule should be input to the Albuquerque series slot in the DeliveryRequests data object and any inputs to the AlbuquerqueScenario1 and AlbuquerqueScenario2 are inconsequential and can be neglected. Since the Water Operations Model includes delivery schedules for each individual contractor, the Combined series slot along with the CombinedScenario1 and CombinedScenario2 series can also be neglected. These series must however be included in the Water Operations Model such that the single ruleset also used with the Planning Model can be used with the Water Operations Model.

III. Inputs and Model Set Up

Needed inputs to complete simulations with the Water Operations Model include initial conditions and numerous series for an identified simulation period. These inputs are imported using the database data management interface (DMI) capability in RiverWare. Steps are presented below for exporting values from an up-to-date run with the Accounting Model and also setting up and running the Forecast Model to provide the needed series for a Water Operations Model run. The process for setting up the Water Operations Model and checking results is also presented. All the different steps for ultimately preparing an AOP run with the Water Operations Model are also presented separated by the different modules of URGWOM after an initial discussion of environment variables that need to be established on the model user's computer for running the RiverWare DMIs.

3.1. Environment Variables

Before work can begin to set up a Water Operations Model run, RiverWare environmental variables must be established on a computer for the DMIs to be invoked in the Accounting Model, Forecast Model, and Water Operations Model for identifying the location of database files. These variables should be checked on the computer being used. The paths are established by going to the Control Panel – Performance and Maintenance – System – Advanced tab – and clicking on the Environment Variable button. Three new environment variables may be needed for 1) URGWOMHistoricDSS (for the location of the DSS files with the historical data), 2) URGWOMWaterOpsDSS (for the location of DSS files for storing current condition information), and 3) URGWOMWaterOpsDSSForecastVarInput (for the location of DSS files with output from the Forecast model to be imported to the Water Operations Model). The path with the location of the corresponding database files on a computer being used should be input as the value for each variable. All the current database files for each location may need to be obtained from the Corps if the files are not already available on the system for your organization or agency.

3.2. Accounting Model

The separate Accounting Module of URGWOM as run by Reclamation each day provides key initial condition information for Water Operations Model runs and year-to-date information needed in the Forecast Model for correctly adjusting the forecasted runoff for the runoff volume so far for the year. Refer to the separate user manual for the Accounting Model for details on setting up and completing simulations with the Accounting Model (Boroughs, 2010). After an Accounting Model run has been completed with all needed data for the period through the identified Initial Timestep to be

used in a needed Water Operations Model run (or the date of the NRCS/NWS forecast), the following steps should be followed to export needed information:

1. Open the Accounting Model.
2. Invoke the OutputDataForWaterOpsAndForecast_DBDMI to export Rio Grande storage values and reach flows as needed in the Forecast model.
 - Other values needed for initial conditions in the Water Operation Model are also exported.
 - For completing a Water Operations Model run using a January 1 forecast, this output DMI needs to be invoked in the previous years Accounting Model to get needed December 31 initial conditions.
3. Exit the Accounting Model.

3.3. Forecast Model

The separate Forecast Module of URGWOM (URGWOM Technical Team, 2002) serves as a pre-processor for developing forecasted runoff hydrographs to input to the Water Operations Model. Hydrographs are developed for all the needed inflow series in URGWOM based on the NRCS/NWS runoff forecasts. Upstream inflows and local inflows are estimated for the calendar year and corresponding pan evaporation, evapotranspiration (ET), and precipitation values are determined. Demands and diversions can also be forecasted based on historical operations. The Forecast Model is set up in RiverWare but does not entail simulating any aspect of the physical system. The model is actually a series of calculations, and results are input to the Water Operations Model.

Three periods are defined in the Forecast Model: Pre-Forecast, Forecast, and Post-Forecast. The pre-forecast period is the period up to the month for the forecast and actual data are used for this period in a Water Operations Model run. The forecast period is the runoff period defined as the month of the forecast through July, and the post-forecast period represents the remainder of the calendar year after the runoff period (August through December).

Forecast period hydrographs are developed by comparing the NRCS/NWS forecast volumes against historical volumes for each forecast location, and the historical year with the closest volume is used to develop the forecasted hydrograph. Historical flows are proportionately adjusted such that the volume of the hydrograph matches the forecast volume. An average of multiple closest years can also be selected to develop a hydrograph shape that is based on an average of those years, and the model user can also specifically identify a preference for an early, average, or late runoff. A specific historical year can be selected as an override to the determined historical year with the closest runoff volume if the model user wants the hydrograph shape to match the pattern from a specific historical year.

Once the years have been selected for developing the flow inputs, the same years are used to set other inputs (e.g. evaporation, precipitation, etc.) without any adjustment to the

historical data. For example, if the year selected for setting inflows is 1995 (as determined by the closest year approach or any other user-defined approach), other inputs will be set to the corresponding historical value on that date without any adjustment (i.e. the forecasted evaporation for April 10th will match the value from April 10, 1995).

3.3.1. Update Data Objects with Historical Data

The Forecast Module of URGWOM contains historical data in data objects with names starting with DailyHistorical (Refer to Figure 3.1). Historical data in these data objects are scheduled to be updated each year to include data in the URGWOM database maintained in DSS files. URGWOM historical database updates and administration are not discussed in this user manual but any updates to the database over the past year would need to be imported into the new Forecast model. This update is completed by following these steps:

1. Adjust the Run Control to have an Initial Timestep of December 31, 1974 (Start Timestep of January 1, 1975) and a Finish Timestep that matches the last timestep with updates in the historical database DSS files.
2. Invoke the DMI group with all the input DMIs for importing historical data. In version 4.0 of the Forecast Model, the DBDMI_InputHistoricalAgAreasAndCURatesOpenWaterAndRiparian DMI group would be invoked which includes the DBDSS_InputHistoricalAgAreas, DBDSS_InputHistoricalAgCURates, and DBDSSInputReachOpenWaterEvapAndRiparianETRates DMIs. Also, the DBDSS_InputHistoricalData and DBDSSForecastInputGWHeadsAndStorages DMIs should be invoked.

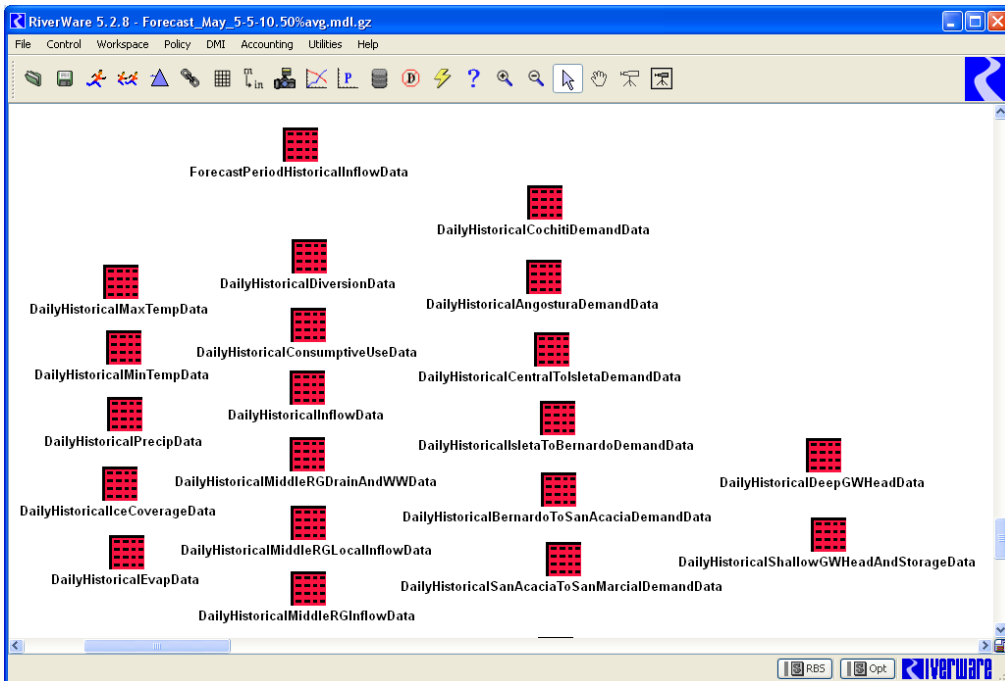


Figure 3.1. Data Objects with Historical Data in Forecast Model

3.3.2. Model Set Up

Several inputs to the Forecast model are hand-entered based on the forecast and user preferences for generating forecast hydrographs. The following steps should be followed to set up the Forecast Model.

1. Open the StartDay table slot in the green InputForecastData data object (Figure 3.2). Set the input to match the Forecast date as a Julian day (i.e. a value of 91 if the forecast date is April 1st and it is not a leap year).

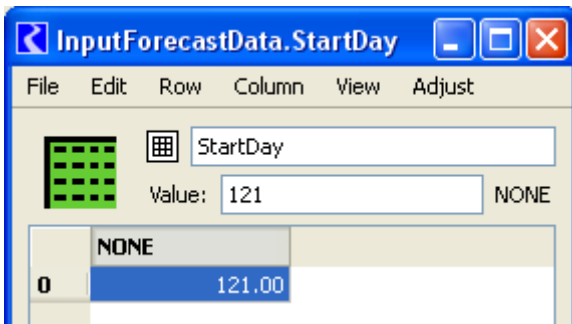


Figure 3.2. Start Day Table Slot in the InputForecastData Data Object

2. Adjust the Run Control to have an Initial Timestep of December 31 of the previous year (Start Timestep of January 1) and a Finish Timestep as the day prior to the forecast date.
3. Select all objects – except for the red historical data objects – and synchronize the objects with the run control by selecting Workspace – Objects – Synchronize Object and then
 - selecting Synchronize Selected Objects with Run Period and
 - check the box to Exclude Slots with Different Timestep from Run
 - then click on the Sync button.

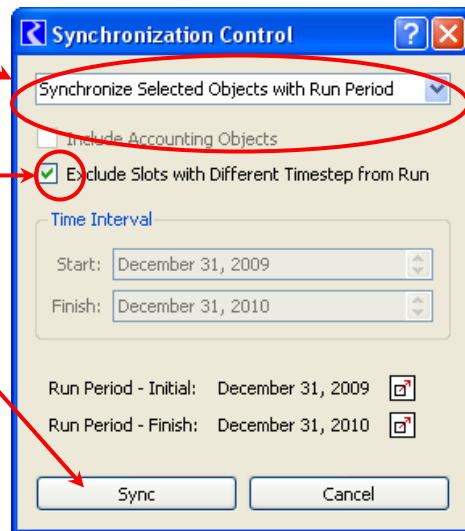


Figure 3.3. RiverWare Dialog to Synchronize Objects

4. Invoke the UpdatePointInflow and UpdateRGStorage DMIs to bring in needed information exported from the Accounting Model.
 - Check the imported values in the reach and reservoir objects.
5. Input forecasts to the Forecasts table slot based on the forecast information available at <http://www.wcc.nrcs.usda.gov/cgi-bin/bor.pl> for a selected exceedence level (i.e. 10%, 50%, 90%, etc.) for each forecast location.
 - Input NaNs for the forecast for later months if needed.
 - The Lobatos forecast should be obtained from the Colorado Division of Water Resources.
6. Input values in the EstimatedEndOfFebruaryAndJuly31RGStorage table slot.
7. Adjust values in the NumberOfYears table slot if needed.
 - Values may all already be set to 1, but if desired by the model user, data from more than one historical year may be averaged to develop a forecast series for the parameter noted by the row label and location listed as the column label. Data from the closest number of years will be used to develop the average series.
8. Adjust values in the NumberOfYearsPreForecast and NumberOfYearsPostForecast table slots in the same manner for identifying the number of closest years to use for developing forecast series for these separate periods.
9. Input values in the HydrologicTimingSwitch table slot if there is interest in forcing the model to produce a forecast with an early, average, or late runoff.
 - Specific years that have either an early, late, or average timing for the runoff are already input to the HydrologicTimingData table slot. Note that some alternative years with early, average, or late runoff are also already stored in this table in rows with label names that start with Other, so the input values in the Early, Average, and Late rows could be adjusted to these other values if desired. Trigger values of 1 should be input to the HydrologicTimingSwitch table slot if the corresponding input years should be used.
10. Input values in the PreForecastHydrologicCategorySwitch and PostForecastHydrologicCategorySwitch table slots if there is interest in forcing the model to use data from either a dry, average, or wet year for the corresponding forecast period.
 - Specific years that were dry, average, or wet are input to the PreForecastHydrologicCategoryData and PostForecastHydrologicCategoryData table slots for the regions identified by the column labels in each table. Trigger values of 1 should be input as switches if the corresponding input years should be used.
11. Input values in the UserInputSimilarYears, PreForecastUserInputSimilarYears, and PostForecastUserInputSimilarYears table slot if it is desired to use specific historical years for the corresponding forecast period and region identified by the column label in each table.
 - These inputs allow the model user to override a determined closest year with a specific historical year.
12. Set inputs to the ForecastRatio, PreForecastRatio, and PostForecastRatio table slots as needed.

- Inputs to these tables allow for the model user to directly input a fraction to increase the results for the corresponding forecast period and the region identified by the column label in each table.
13. Adjust the value in the BlendingRatio table slot if needed (ranging from 0 to 1).
- The forecast flows may be adjusted to prevent abrupt changes in the last observed flow from the pre-forecast period and the first flow for the forecast period. If the absolute value of the difference in the flows divided by the last pre-forecast flow exceeds the input value in the Blending Ratio slot, then the first three forecast flows are adjusted to provide a ramp up or ramp down over the first three days of the forecast period.
14. Values in the DistributionPercent table slot could be adjusted, but new analyses would need to be completed before changes are made to the established values.
- Since NRCS/NWS forecasts are provided for eleven locations, the forecast for local inflows must be split up to provide the input series for the separate local inflow nodes in URGWOM.
 - The determined local inflow between Lobatos and Otowi is distributed based on the input percentages for the four local inflow nodes in URGWOM (note that values in rows 3 through 6 of this table sum to 1.0).
 - The forecasted inflow at El Vado is distributed between Willow Creek and the local inflow at El Vado based on the percentage input for AzoteaWillow (6%) to the table for Willow Creek and 1 minus that percentage for the local inflow at El Vado (94%).
 - ElVadoToAbiquiuLocalInflow and AbiquiuToChamitaLocalInflow are assumed to equal the El Vado forecast multiplied by the corresponding input percentages.
15. No change to the values in the LittleNavajoRegressionCoeff table slot should be needed.
- These values were generated based on historical data for developing a forecast for the Little Navajo River as a function of the forecast for the Rio Blanco.
16. No change to the values in the AverageForecastPeriodLosses table slot should be needed.
- These values were developed to represent an estimated loss percentage for the designated reaches for then estimating the intervening flow between forecast points.

3.3.3. Model Run and Output DMIs

The Forecast Model is run in rulebased simulation with the Forecast Model ruleset. To complete a simulation, use the following steps:

1. Open and load the Forecast Model ruleset.
2. Adjust the Run Control in the model to have an Initial Timestep of December 31 of the previous year (Start Timestep of January 1) and a Finish Timestep as December 31 of the current year.
3. Run the model.

- The simulation may take a minute or two to complete.
- 4. Save the model with a name that designates the month of the forecast and forecast exceedence percentage.
- 5. Invoke the DBDSSForecastOutputToWaterOpsGWHeadsAndStorages and DBDSSOutputForecastDataForWaterOps database DMIs by invoking the DMI group named DBDSS_OutputForWaterOps.
- 6. Exit the Forecast Model.
- 7. Rename output DSS files to identify the month of the forecast and forecast exceedence percentage and move the DSS files to a location for this simulation based on your organization's or agency's protocol.

3.4. Water Operations Model

Steps for setting up an initial Water Operations Model for an upcoming year are presented below followed by the steps for setting up that model (or updating a previous model for the current year) with a new forecast. Details for completing a run are then presented with a list of numerous aspects to review and possible model adjustments that may need to be implemented before finalizing an AOP run.

3.4.1. Setting Up New Model for Current Year

After running the output DMI in the Accounting Model and subsequently setting up and running the Forecast model and running the output DMIs in the Forecast model, a Water Operations Model run can be set up. If a Water Operations Model has not been set up yet for the current year, the steps in this section should be followed:

1. Open the previous year Water Operations Model.
2. Invoke the DBDSSWaterOpsOutputForSucceedingWaterOpsModel output database DMI.
3. Load a Water Operations Model to be used for the current year.
4. Adjust the Run Control to have an Initial Timestep as the day prior to the forecast date (i.e. Start Timestep will match the forecast date) and a Finish Timestep as December 31 of the current year.
5. Synchronize the objects with the run control by 1) selecting Workspace – Objects – Synchronize Object, 2) checking the box noted Include Accounting Object, 3) checking the box noted Exclude Slots with Different Timestep from Run, and 4) clicking on the Sync button.
 - Set time series range for the Reservoir Summary table series slots in the El Vado and Abiquiu reservoir objects to January 1 through December 31.
 - The time series for the following four annual slots may need to be reset back to have an annual timestep: Indian.OtowiForecast, ElVadoData.RelinquishedNMCredits, SanJuanDiversions.AnnualDiversion, and HeronData.WaiverSwitch.

- This is done by selecting View – Time Series Range when the slot is opened and choosing Yearly for the timestep. The time series range for the SanJuanDiversions.AnnualDiversion slot should be reset for eleven years and extended 10-years before the initial timestep (e.g. if the Run Control is set to April 1, 2011 through December 31, 2011), the time series for the annual timestep SanJuanDiversions.AnnualDiversion slot should be set to 2001 C.E. to 2011 C.E. Ten initial values are needed for this slot for checking the diversions from the San Juan basin against the ten-year diversion limit for San Juan diversions. If waivers are to be modeled, the annual value for the waiver switch should be set 1.0. A value of 0 would indicate that waivers are not allowed.
6. Invoke the DBDSSWaterOpsInputDataFromPrecedingWaterOpsModel input database DMI.

3.4.2. Updating Model for Current Year

After a model has been set up for the current year, the following steps are followed to set up a simulation with the current forecast or updating the model with a new forecast:

1. Update the Run Control if needed to have an Initial Timestep as the day prior to the forecast date (i.e. Start Timestep will match the forecast date) and a Finish Timestep as December 31 of the current year.
 - Note that there may be a need to use a Start timestep that is a few days before the Forecast date such that the entire system is executing by the forecast date with consideration for lag times represented in the model.
2. If the model is being set up for a January 1 forecast, invoke the DBDSSWaterOpsInputAllDataJanuary DMI group. Otherwise, invoke the DBDSSWaterOpsInputAllDataPostJanuary group.
 - The latter group contains the DBDSSWaterOpsInputForecastData, DBDSSWaterOpsInputInitialData, DBDSS_WaterOpsInitializeShallowGroundwaterHeadAndStorage, and DBDSS_WaterOpsInputGroundwaterDeepHeads input database DMIs, and the first group is the same but includes the alternate DBDSSWaterOpsInput31DecInitialData DMI for the DBDSSWaterOpsInputInitialData DMI.
 - If synthetic diversion schedules should be used versus historical diversion data, invoke the DBDSSWaterOpsInputPlanningTimeseriesWAMMVData database DMI to override the historical values derived from the Forecast Model.
 - Review imported data to assure various inputs were imported completely and correct for any bad or missing inputs as needed.
 - Check the Albuquerque and MRGCD series for their demand in the MiddleValleyDemands data object.
 - Check the synthetic series for MRGCD diversions in the MiddleRioGrandeDiversionData data object.

- Check the letter water delivery schedules in the DeliveryRequests data object.
- 3. Input accounting supplies for San Juan-Chama Project water in transit as needed. This step may need to be completed through coordination with the lead model user for the Accounting Model.

Several model inputs should be checked and verified against anticipated operations for the upcoming year. The entire discussion in section II of this user manual should be reviewed, but a few specific items to check are noted below:

4. If a storage requirement for P&P needs has been determined for the upcoming year and is known based on information provided by Reclamation and BIA, input the storage requirement for the end-of-month date for each month of the simulation period in the IndianStorageReq series slot in the ElVadoData data object (i.e. input the values for April 30, May 31, June 30, etc.)
5. If a Relinquished Credit is anticipated and known based on information provided by ISC and Reclamation, set the date for the relinquishment in the RelinquishedCreditsTriggers table slot in the ElVadoData data object and set the relinquishment magnitude for that date in the RelinquishedNMCredits series slot.
 - Check the proportions in the RelinquishedNMCreditAllocations table slot for distributing the resulting allocations for storage of Emergency Drought water.
6. Check values in all the series slots that end with WaterLease in the HeronData, ElVadoData, and AbiquiuData data objects and verify the leases against actual Reclamation leases for the upcoming year.
 - Neglect the series for the Combined account.
7. Check input values in the AverageDemand periodic slots in the ElephantButteData and CaballoData data objects against expected demand for the upcoming year as provided by Reclamation's El Paso Area Office.
8. The following set parameters in the model should be reviewed. Refer to section II of this user manual for background information on all of these aspects of the model and operations. These parameters are not input with DMIs but should be reviewed:
 - Values in the CentralChannelCapacity and SanMarcialChannelCapacity periodic slots in the CochitiData data object.
 - Allocated storage space for contractor San Juan-Chama Project water as listed in the MaxAccountStorage periodic slots in the ElVadoData and AbiquiuData data objects.
 - The value in the WaiverDate table slot in the HeronData data object should be set to September 30th.
 - Values in the MinTargetFlows periodic slot (and MinTargetFlowsSafetyFactor periodic slot) in the MiddleValleyDemands data object.
 - The value in the TriggerImplementStepDownInTargets scalar slot in the MiddleValleyDemands data object should be 1 if the step downs should be modeled or 0 if not.

- The value for the ThresholdOtowiVolumeHoldLeaseWater in the MiddleValleyDemands data object should be 999999999.
- The value in the TriggerImplementArticleVIIIOps in the RioGrandeCompact data object should be set to 0.
- The value in the MinPoolAlbuquerqueLoan table slot should be set to 200,000 acre-ft such that Albuquerque loans are not actually modeled.
- The value in the RGConservationSpaceAvailable table slot in the AbiquiuData data object should most likely be set to zero unless Rio Grande water is allowed to be stored in Abiquiu Reservoir (e.g. from an agreement for storage of Emergency Drought water).

3.4.3. Completing a Run

The Water Operations Model is run as a rulebased simulation using the latest URGWOM ruleset. To complete a simulation, use the following steps:

1. Open and load the URGWOM ruleset.
2. Run the model. The simulation may take 20 or 30 minutes to complete.
3. Save the model with a name that designates the month of the forecast and forecast exceedence percentage referenced.
4. Review the Results.
 - a. Numerous plots have been created previously and saved in the Water Operations Model using the RiverWare Output Manager and can be generated again.
 - b. Check some results of particular interest including 1) the resulting hydrology year type for setting target flows per the BO, 2) whether Heron Reservoir filled and subsequently prevented full San Juan diversions, and 3) and whether carryover storage was locked in at Abiquiu and/or Cochiti Reservoir.
 - c. Check for specific results of significance including potentially increased Angostura diversions resulting from MRGCD shortage situation.
 - d. Verify accuracy of results for Cochiti deviations.
 - e. Review Albuquerque diversions and potential cutoff periods.
 - f. *If Article VII was not in effect*, check the results for filling at El Vado Reservoir.
 - Identify the potential need to adjust the timing as a percent of full storage (i.e. the value in the FractionOfTargetElevToStartPercRGRel scalar slot in the ElVadoData data object) to begin bypassing a percentage of Rio Grande inflow to hit the target fill elevation on the target fill date.
 - If needed, adjust the target elevations and corresponding dates in the TargetElevation periodic slot in the ElVadoData data object.
 - g. Check releases of San Juan-Chama Project water from Heron, El Vado, and Abiquiu Dams. Review potentially completing the following edits but any adjustments made as follows require a more advanced understanding of the

- inner workings of the model, ruleset, and accounting and should be completed through close coordination with the URGWOM Technical Team.
- Adjust input values for MaximumSJOutflow for each reservoir as needed.
 - Adjust input values AccountFillMaxVolume in the HeronData data object.
 - Adjust input values for the CochitiRecPoolMaxVolume periodic slots.
 - Adjust inputs to the AccountReleasePriority, ReleaseTypePriority, and ReservoirPriority tables in the data objects for each reservoir as needed.
- h. If needed because reservoir operations may be known in advance (i.e. a planned release schedule), total reservoir outflows can be input for select days of a simulation. These inputs are set to the TotalOutflow series slots in the data objects corresponding with each reservoir.
5. Revise inputs as needed based on the model review.
 6. Re-run the model.
 7. Save the new simulation.
 8. Repeat the review of results until a final simulation is completed.
 9. Save and Exit the Water Operations Model.
 10. Output may be exported to Excel for generating plots and graphs using all the plotting capabilities in Excel.

3.4.4. Errors

If a simulation aborts during a run, errors may need to be resolved through coordination with the URGWOM Tech Team. The model is set up to abort if a Rio Grande supply does not get set. This allows for the source of a problem to be identified by backtracking through the assignments made with the rules from the time the run aborted. Most abort errors are caused by missing inputs. Warnings may post noting that RiverWare could not converge on a solution within a set number of iterations. If these warnings are only posted for a few timesteps within a run, these warnings could probably be neglected.

The Run Analysis dialog in Windows is a very useful tool for identifying the source for any problems. The dispatch information for all the objects in the model can be sorted based on the “position” of the objects on the work space, and it is then possible to scroll from upstream objects to downstream objects to see the location where the dispatching could not continue at the first timestep the full system did not execute. The exact location of a potential missing input or other problem can often be identified using this approach.

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