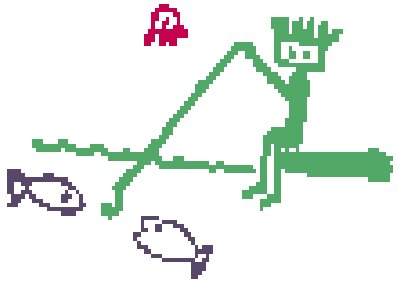
February 11, 2003

San Juan River Basin
Recovery Implementation Program
Hydrology Committee
October 29, 2002
Meeting Summary



Members/Alternates Present:	Representing:
Pat Page, Chairman	U.S. Bureau of Reclamation
Ray Alvarado	State of Colorado
Ron Bliesner	U.S. Bureau of Indian Affairs
Rick Cox	Water Development Interests
Mike Hamman	Jicarilla Apache Nation
Steve Harris	Water Development Interests
John Simons	U.S. Bureau of Reclamation
Bernadette Tsosie	Navajo Nation
Brian Westfall	U.S. Bureau of Indian Affairs
John Whipple	State of New Mexico
Others present:	**Representing:**
Dave Barr	S.J. Soil and Water Conservation District
Dan Crabtree	U.S. Bureau of Reclamation
Amy Cutler	U.S. Bureau of Reclamation
Dave Frick	Jicarilla Apache Nation
Dave King	U.S. Bureau of Reclamation
Bob Krakow	U.S. Bureau of Indian Affairs
John Leeper	Navajo Nation
Mike Roarke	U.S. Geological Survey
Ed Warner	U.S. Bureau of Reclamation
Marilyn Greenberg, Program Assistant	U.S. Fish and Wildlife Service
Shirley Mondy, Program Coordinator	U.S. Fish and Wildlife Service

Introductions and Review of Agenda Items

Pat Page welcomed the participants, who then introduced themselves. The draft agenda was approved.

Report from USGS on Results and Effectiveness of Additional Gage Readings

Mike Roarke from USGS explained that additional measurements of the gages were requested for the entire year, but were only taken during irrigation season due to a misunderstanding and

loss of staff. Due to the misunderstanding, USGS intends to do the additional measurements all year long this year at no additional cost to the Program. Mike stated that there were some items that would improve the work, if they could be funded.

The San Juan gage near Archuleta is an extremely stable gage. There is stable rock riffle and channel control in that area. The cable way is in a good location, making the measurements extremely stable there. The variation in the measurements is very small, which is an indication of a good control. Additional measurements will help to indicate variability over time.

The Farmington gage is fairly stable. There is riffle downstream of the gage. This gage should be stable like Archuleta, but it is not. There used to be a cable across the river, but the landowner asked them to remove it in the mid 90's and USGS had to start measuring off the bridge, which created big positive shifts. USGS can measure off the bridge and then go make a wading measurement, which can be more accurate even than a cable way. They have stopped measuring off the bridge, but that is the only way of measuring during high water. USGS has tried to contact the landowner to put the cable back in. They will try to contact a landowner a bit further down.

Ron Bliesner indicated that the high releases since 1991 have been developing the bar in the river near that gage. USGS can and will use a moving boat method with a tag line until they can get another cable line back in there. Email Mike Roarke [mroark@usgs.gov] if you would like to receive the data regarding these new measurements.

Mike Roarke questioned what the Hydrology Committee's main interest is. Ron Bliesner responded that target base flows and high spring releases are most important.

The Shiprock gage is a very problematic site. There has been considerable vandalism, and hydrographers have been shot at while in the stream. USGS had to move the gage site away from the cable way because of the vandalism. They are proposing to move this site upstream, but are having a difficult time getting landowners' permission to go on their property to make measurements. There is also quite a bit of debris buildup under the bridge, which may impact high water measurements.

The Four Corners gage had been moved because it was missing the main flow at the original location. It may be moved again to more accurately catch the main flow.

Summary:
San Juan River near Archuleta has stable control, no changes are needed

San Juan River at Farmington has fairly stable control. A method is needed to measure higher flows.

San Juan River at Shiprock has unstable control and problematic gage structure. A method is needed to measure high flows near the gage.

San Juan River at Four Corners has fairly stable control since the gage move, no changes are needed.

John Simons indicated that the real time record as well as the long term record is needed, in

order to respond quickly to flow changes. Mike Roarke responded that having the web page has increased the necessity for maintaining up-to-date data. USGS is looking at having people call in the readings and recording them (on the webpage) right away. Right now if people are out in the field for a week making measurements, and then in the office for the next week entering the data, then the data may be two weeks off. USGS is working on a pilot program to make the data more current.

John Whipple asked if Reclamation or USGS checked in with Utah regarding the Bluff gage to see if they were having similar problems to what was being experienced with the Shiprock gage. No discussions have taken place regarding the Bluff gage. All indications are that this gage is functioning properly, but it is probably worth checking with the USGS office in Utah.

Steve Harris asked Mike Roarke what he would do if he were selecting a combination of gages to correctly determine the flow in the habitat. Mike responded that he would probably use the one in Utah and in Farmington (if there were a way to measure the high flows). Those would be the best, most accurate gages.

Pat Page asked whether the Committee wanted to budget for gaging stations for this year. **The Committee agreed to fund the additional trips by the USGS (as was identified in the Hydrology Committee's FY2003 Scope of Work), and suggested that the USGS fund the necessary improvements (new cable way) at the Shiprock gage.** ***Pat Page will talk to BOR contract people to get a contract going for USGS for 2003. Ron Bliesner will talk with John Leeper to see if there is anything that can be done by Navajo Nation to assist USGS in obtaining access. Jerry Thomas at BIA in Shiprock manages those access contracts - he may also be able to help.***

Update on Temperature Modeling

Amy Cutler from the Salt Lake City Office of the Bureau of Reclamation discussed the reservoir modeling that she is working on. The two dimensional reservoir model CE-QUAL-W2 was built by the Army Corps of Engineers. This model requires daily and hourly time series input data. The available boundaries water quality data set (water temperature and total dissolved solids) were in monthly and quarterly grab samples. Therefore, daily time series were built using statistical regression techniques. The model period (1995 to 2000) selected was based on the hydrology and reservoir elevations that would represent a wide range of reservoir conditions. This selected period had some large missing data gaps that were filled using statistical and regression techniques.

To calibrate the temperature reservoir model, collected water temperature profiles and release temperatures from the reservoir for the model period were used to compare with the model output. The water temperature profiles that were available consisted of quarterly reservoir samples from four years: 1973, 1976, 1989, and 2000. Also available were monthly water temperature data from Archuleta. Amy does not have the Program data. ***Ron Bliesner will get the Program reservoir temperature profiles and release temperature data to Amy Cutler.***

Some of the expectations and concerns expressed by the Hydrology Committee were: January, April, August, and November data are represented on the calibration slide; March, May, July, and August data would be preferred to catch the transition phase. Can daily meteorological data at Navajo Dam be used rather than the Farmington hourly data? Amy will

look at the Navajo meteorological data to see if it helps with the reservoir model calibration.

The next steps are: finalize calibrations, send for peer review, run temperature control scenarios, and run the river model. The current proposal is a one-dimensional steady state river model (QUAL2E). The present geometry setup can go to two-dimensional in the future if needed. The intent of the model is to demonstrate the need for (or not) a temperature control device (TCD).

To email Amy with further questions or comments: acutler@uc.usbr.gov

Marilyn Greenberg will send a copy of this meeting summary to Amy Cutler, per her request.

Peer Review of Water and Temperature Modeling

[This discussion was limited to temperature modeling.]
What about Amy Cutler's temperature model? Is someone needed who can make sure that the model is applied appropriately after the model is developed? There is an existing subcontract for peer review by the model software creator and additional peer review may not be needed. If the consultant is going to review it, and the Hydrology Committee is reviewing it periodically, is peer review needed? This will be discussed further at the June Hydrology Committee meeting. ***Peer review discussion should be added to next summer's meeting agenda when Amy Cutler comes back to present progress and findings.*** **Since it is too late to peer review the approach of the temperature model, and peer review would only determine if it was done correctly, the Hydrology Committee decided that the Committee is sufficient as peer review for this model.**

Review and Approval of August 20, 2002, Draft Conference Call Summary

The meeting summary was approved.

Review of Action Item Log (attached to 8/20/2002 Draft Conference Call Summary)

There was discussion of the completion of a Hydrology Committee risk analysis on the impacts of implementation of the flow recommendations in this drought year. ***John Simons will prepare the risk analysis on the effects to the water supply (as presented at the September 24, 2002, Navajo Shortage Sharing Meeting). This information will be given to Bill Miller to give to the Biology Committee.***

Budget, Schedule, and Status Report

The percent complete table reflects the revised schedule and revised distribution of workload. Dave King did a lot of work that John Simons was going to do. New staff in Grand Junction (Eric Knight) was added and trained, and a lot of data had to be chased down. Dave King expects to finalize the model in late February or early March, then get documentation out for review, and the expected completion date is June 2003.

Table 2
The FY2003 budget for Model Development totals $96,720, which appears to be $42,000 over budget. In actuality, there is $18,000 that was not spent in 2002 that BOR expects to be able to carry over to 2003. $4,000 was used for an Animas La Plata Project (ALP) task that will be restored to the Program. $11,500 was spent on long-term tasks scheduled for later on in the

project, such as technical transfer, maintenance and operation of model. The remaining $8,000 budget overage is due to increased Denver Service Center costs. There is money available to cover this, so no additional money will be needed or requested, and money will not be taken from the model operation and maintenance budget. Eric Knight was added to the staff and his training has begun. His time will be charged to the $77,500 budgeted for 2003 Model Operation and Maintenance.

Budget and Status Report

Pat Page addressed the July 30, 2002 budget table and concerns that some areas may be over budget. Reclamation will get their new hydrologist involved and hopefully, this will serve to get the budget back on track. Some items are taking longer and costing more than originally planned, but Reclamation plans to get back on schedule. Pat Page will attend the Coordination Committee meeting to discuss the FY03 budget request. Committee members indicated that Pat Page was doing a good job and asked that he continue to stay on top of tracking the budget.

Baseline Depletions and Consultations (w/ Joy Nicholopoulos via conference phone)

The Hydrology Committee had questions about baseline depletions and consultation which Joy Nicholopoulos answered via conference call.

It is John Whipple's interpretation that the Hydrology Committee is supposed to review environmental baseline depletions and make recommendations for any changes that need to be made. There is a concern (particularly from Navajo Nation) that this is not the forum to review and evaluate baseline depletion amounts. If this Committee is reviewing baseline depletions that have resulted from Section 7 consultations, and determines that the depletion is incorrect, does consultation have to be reopened? Joy Nicholopoulos responded that the Service wants to use the SJRIP and it's committees to do adaptive management. Committees are best equipped to look at these things, and if we have to reevaluate under Section 7, so be it.

When asked about what to do with the small and intermediate level of depletions that don't show up in the model, Joy asked about adding an aggregate option on the model. We need other people's feedback on these. She suggested putting it in the model sort of as a reserve, as an added error cushion - depletions that may not be fully utilized at the moment, or even those that may never happen, or error items.

There were concerns that a consultation should be between the Service and the agency.

Joy Nicholopoulos responded that this discussion is a process discussion, not an outcome discussion. We cannot negotiate a consultation by Committee, but we are trying to come up with a process to handle these intermediate depletions to operate the model more accurately. Cleaning up our data is model management, even Program management. We need to know what the universe looks like out there in terms of double counted data, erroneous data, etc. Steve Harris commented that flow recommendations are just one component of this Program. There is nothing that says that flow recommendations are inviolate. What is the minimum size for which it is worthwhile to run the model? It is not that accurate that we can say when these things work, and when they don't work. There is enough slop in the model that small depletions may not show up in meeting the flow recommendations. If the model is triggered, then we have to go to another level of decision making.

The Service does intend to rely on the Hydrology Committee for review and guidance on depletion data. If people have heartburn with that then we need to rethink this process.

This may be another discussion with the Coordination Committee to clarify the intent of establishing the parameters of the Hydrology Committee. Joy Nicholopoulos added that everyone needs to understand what is behind every number and how we got to that number. It needs to be an open process, above board, and everyone can ask questions. The baseline is reviewed in each consultation, rather than just automatically given as a basis for each new consultation.

Joy also stated that there should be a summary of this discussion available at the next Coordination Committee meeting to clarify the intent when establishing the parameters of the Hydrology Committee. Her understanding was that the Service had the ability to go to the different Committees to ask for review and advice regarding different data. This advice would be reviewed, and have legal review, and then the Service may go back to the Committee to clarify what was intended. This is the most efficient and above board way to do business and make decisions.

Mike Hamman asked about whether the Service would come to the Hydrology Committee, in the event of a consultation. Joy Nicholopoulos responded that if the Service gets a consultation request and does not have the best available data, then they would go to the appropriate committee for technical information on specific areas prior to making a policy call. It is a negotiation between parties, it doesn't have to be concrete, and the Service wants to work with whomever possible to get the most accurate information. The more people involved the better, with the exception of proprietary information, which is why the Service would only provide a committee with the necessary information for technical feedback.

Discussion of Operating Criteria

Steve Harris explained his concern that the flow recommendations need to be met exactly as they are written. The Hydrology Committee needs to put together a list of changes needed in the model for the Coordination Committee. Look at the last 12 years to see how closely the flow recommendations have been met each year. Include where the Hydrology Committee thinks the flow recommendations need to be changed; or where they are not being met; or where operating criteria needs to be changed to better meet flow recommendations. The Hydrology Committee responsibility is to point out to people how we can better meet the Program goals where it is within our purview - as it is with the flow recommendations. The operating criteria needs to incorporate the flow recommendations exactly as written, as well as incorporate the flexibility to run the model with the two different gage interpretation methods that are being discussed at this time. ***Ron Bliesner will extract language out of the flow report to add a section on base flow into the 8/19/2002 operating criteria.***

[Please see Attachment A, pages 6 - 7: Draft Operating Criteria dated 8/19/02]

Item number 1 on page 7 is approved by the Hydrology Committee as part of the new operating rules because it may better meet the flow recommendations.

Number 2 is approved.

Number 3 will be analyzed and recommendations will be made.

Number 4 will need to be analyzed and recommendations made.

Number 5 fits within the present operation. This isn't even discussed in the flow recommendations - so it is just figuring out how to do it. It allows change midstream. Approved.

Number 6 will be analyzed and recommendations made.

Number 7 is not specifically addressed in flow recommendations. We have an opportunity to look at something that we haven't had a chance to look at before. This will be analyzed and recommendations made.

Number 8 will be done the way it has always been done.

Ron Bliesner will add a discussion of what the baseflow is and then send it out to the Hydrology Committee again as a draft - with the notes on what is approved and the conditions of approval.

Steve Harris asked if Ron Bliesner and Vince LaMarra would give the habitat mapping/ geomorphology presentation that they give to the Biology Committee to the Hydrology Committee. ***Ron Bliesner will notify the Hydrology Committee when this presentation will be given in the Biology subcommittee meeting.*** Steve Harris would also prefer a 15-20 minute presentation directly to the Hydrology Committee, for those who are unable to make it to the Biology Committee meeting.

Outstanding Data Needs to Complete Modeling Work

Return flow data is lacking. Need to develop daily return flow lagging coefficients for the daily decision model. Provisional data will be used until newer, better data becomes available.

Update on Long Range Plan

There will be a Coordination subcommittee conference call on the LRP on November 5, 2002 at 9 a.m. to discuss the plan. Pat Page will be on the call.

Navajo Reservoir Operations - Discussion of Latest Forecast and Review of 2002 Operations

On Thursday, October 31, 2002, the release out of Navajo Dam will be reduced to 350 cfs**.** With tributary inflows and the fact that irrigation diversions have been turned off for the winter, the target base flows will still be met at this reduced release.

Navajo Reservoir Operations - Discussion of Latest Forecast

John Simons went over the latest forecast for the basin, which shows that under the worse-case scenario, there will be shortages in 2003. Reclamation is still evaluating several operating alternatives to determine effects on users.

Discussion on Defining "Extreme Conditions" (per request from Coordination Committee)

The Coordination Committee has requested that the Hydrology Committee come up with some

criteria of what would trigger “extreme conditions” procedures. Then Reclamation would use that information to work with the Biology Committee and/or the Service to determine how to proceed.

At the Navajo Unit shortage sharing meeting on October 28, 2002, it was discussed that a shortage declaration would result in an equitable sharing of shortages, including the fish, down to some threshold level. Reclamation would have to go back to the Biology Committee to determine what that threshold would be. The Committee agreed to table this issue until the Shortage Sharing group comes up with a plan.

What the Coordination Committee wants to know is “are we in a condition that was not anticipated in the model?” The Program is looking to the Hydrology Committee to determine what constitutes an extreme condition so that everyone can be notified. Sharing shortages are not in the model. This is an adaptive management process, when do we need to deal with it? Right now, this is just planning. The concern is about having a process to know when we would be dealing with an extreme condition.

In the discussion of shortage sharing and determination of extreme conditions, Ron Bliesner expressed the opinion that the endangered fish had taken a shortage in the summer of 2002 because 500 cfs flows were not maintained throughout the critical habitat range. This position is based on the Biology Committee believing that the “two of four gages” in the Flow Recommendations meant the two gages with the lowest flow. Others expressed the position that there was no shortage to the fish because the Flow Recommendations state “any two of four gages” and that the 7-day average flow as measured by the two high flow gauges did not fall below 500 cfs. This position is based on the Flow Recommendations being silent on selection of the two gages based on high or low flow.

The Biology Committee considered the summer of 2003 as an extreme condition, indicated in a memo that in recognition of the drought conditions, the flow in the habitat range could be dropped to as low as 350 cfs for this summer drought period only if it was measured by the following method: “Use the lesser of the average of Bluff, Four Corners, and Shiprock and the average of Farmington, Shiprock, and Four Corners.” Further, the lower flow would allow measurement of habitat conditions below 500 cfs. There was concern by some that the three gage measurement criteria, though probably a better method to determine flow in the critical habitat, would require a change in the Flow Recommendations. This concern was believed to be a Coordination Committee issue.

Our response to the Coordination Committee concerning their request for the hydrology committee to define “extreme conditions” could be that there is a group that is analyzing shortage sharing criteria. The Hydrology Committee could agree to let the shortage sharing group work it through, and then look at what they come up with to determine if we need to clarify anything any further.

Pat Page stated that the Hydrology Committee will keep this on the radar screen. The Committee will come up with a response to the Coordination Committee during the February Hydrology Committee meeting. ***Defining triggers for extreme conditions - add to agenda for conference call in February.***

Set 2003 Meeting Dates

The Committee selected the following dates for conference calls:
Feb 11, 9 am – 12 noon
June 3rd, 9 am – 12 noon

The budget will need to be done in March or April; it is due by end of June.

The Committee selected the following dates for meetings:
Tuesday, April 1, 2003, 8:30am. If the model is going to be demonstrated, the meeting should be held in Durango.
August 5, 2003
October 14 2003

San Juan Basin Hydrology Model
Draft Operating Criteria - 8/19/2002

Background

This document specifies the operating criteria for the third generation San Juan Basin Hydrology Model (SJBHM). This model is used to support long-term operation and planning decisions in the San Juan River Basin. Primary uses of the model are to evaluate operating scenarios related to meeting San Juan River Basin Recovery Implementation Program (SJRIP) flow recommendations and to evaluate the impact of proposed projects. This document provides a brief overview of the flow recommendations, a brief overview of existing operating criteria, and an outline of potential operating criteria for the third generation model.

The SJRIP flow recommendations consist of two basic components: 1. baseflows to provide sufficient aquatic habitat for species recovery and 2. flushing flows to create and maintain habitat over time. The baseflow is a minimum flow that should be maintained in the San Juan River at reference stream gages within the critical habitat. The flushing flows are provided by making releases during spring runoff with specified hydrographs whose characteristics are dependent upon available flow. The flows at the reference gage (Four corners, NM) are statistically evaluated to determine if flow recommendations are being met. The flow recommendations for spring peak flows are determined to be met when the maximum return periods and recurrence frequencies for specified flows and durations over the period of hydrologic record are met. Tables 1 and 2 summarize the SJRIP flushing flow recommendations.

Table 1. Maximum Return Period Between Events

Flow Criteria & Min Duration	Max. Return Period - yrs
9700 cfs for 5-days	10
7760 cfs for 10-days	6
4850 cfs for 21-days	4
2450 cfs for 10-days	2

Table 2. Flow Duration Statistics

Duration	Threshold Discharge			
	>10,000	>8,000	>5,000	>2,500
	Average Frequency			
1 days	30.0%	40.0%	65.0%	90.0%
5 days	20.0%	35.0%	60.0%	82.0%
10 days	10.0%	33.0%	58.0%	80.0%
15 days	5.0%	30.0%	55.0%	70.0%
20 days		20.0%		65.0%
21 days			50.0%	
30 days		10.0%	40.0%	60.0%
40 days			30.0%	50.0%
50 days			20.0%	45.0%
60 days			15.0%	40.0%
80 days			5.0%	25.0%

The basic approach to meeting the recommended flows is to specify basic operating criteria for the hydrologic model and evaluate the output of the model to determine if the statistics are met.

First and Second Generation Operating Criteria

The first and second generation models used the following basic operating criteria:

1. Operate San Juan Chama by project operating criteria.
2. Operate Animas La Plata by project operating criteria.
3. Operate all other projects to emulate historical operations.
4. Operate Navajo Reservoir to meet historical operating criteria as well as meet flow recommendations.

Navajo Reservoir is the primary facility that is managed to meet flow recommendations. The second generation model enabled ALP to stop pumping in June when a flushing release has not occurred for the past two years and a larger release is not occurring this year. Some additional mitigation options were explored for ALP but both were found unusable. The complete set of operating constraints for Navajo Reservoir are:

1. Maximum release of 5000 cfs.
2. Minimum release of 250 cfs.
3. Minimum elevation of 5985 during the non-irrigation season.
4. Minimum elevation of 5990 during the irrigation season.
5. Provide NIIP demands.
6. Provide downstream demands.
7. Meet COE flood control restrictions.
8. Release surplus water not needed for other uses during runoff season.
9. Release surplus water to meet end of December target space after runoff season.
10. Meet flow recommendations baseflow specification.

A set of criteria were developed to make flushing releases based upon water supply and previous releases. This is referred to as the decision tree and is shown on Figure 1. The following definitions and conditions are used in the decision tree diagram:

1. available water – water that is not committed to other uses
2. spill – water in excess of storage capacity that must be released to prevent water flowing over the spillway
3. flow recommendation release hydrograph volumes – specified to provide the desired hydrographs for various levels of water supply
4. previous releases – influence the need to make a release in the current year.

The circled numbers shown at decision points correspond to path numbers that are used to track decisions. The flow recommendation release volumes consist of four basic hydrographs as specified in Table 1. During wet years, more water must be released from Navajo than the flushing release volume to prevent Navajo from spilling. The excess water (spill minus available water) is applied to the nose of the hydrograph while attempting to maintain the basic shape of the hydrograph.

Figure 1. First and Second Generation SJRIP Decision Tree

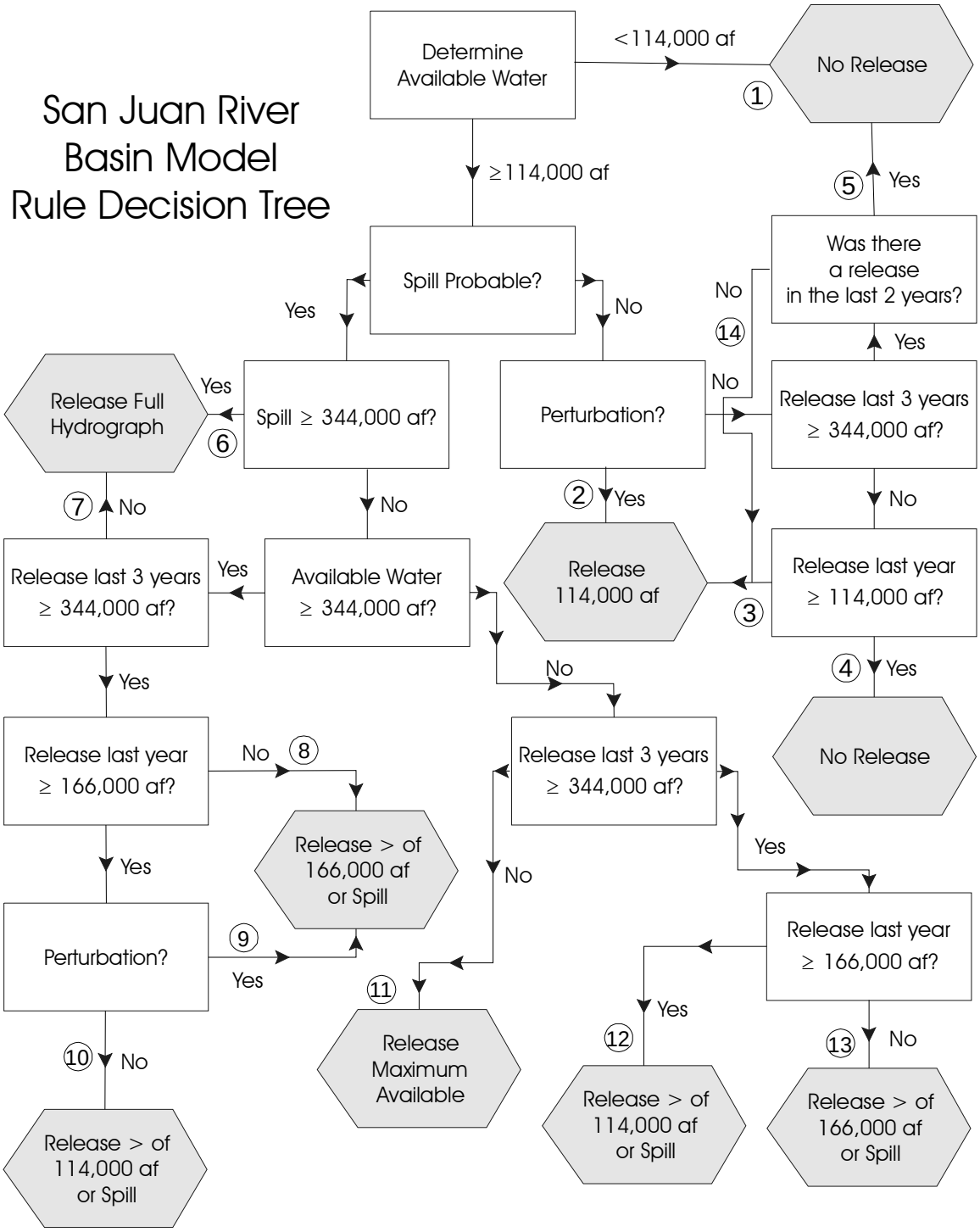


Table 1. Navajo Fish Release Hydrographs

344,000 ac-ft Hydrograph			236,000 ac-ft Hydrograph			166,000 ac-ft Hydrograph			114,000 ac-ft Hydrograph		
CFS	Days	Ac-ft	CFS	Days	Ac-ft	CFS	Days	Ac-ft	CFS	Days	Ac-ft
1,000	7	13,884	1,000	1	1,983	1,000	1	1,983	1,000	1	1,983
2,000	7	27,769	1,500	1	2,975	1,500	1	2,975	1,500	1	2,975
3,000	7	41,653	2,000	1	3,967	2,000	1	3,967	2,000	1	3,967
4,000	7	55,537	2,500	1	4,959	2,500	1	4,959	2,500	1	4,959
5,000	21	208,264	3,000	1	5,950	3,000	1	5,950	3,000	1	5,950
4,500	1	8,926	3,500	1	6,942	3,500	1	6,942	3,500	1	6,942
4,000	2	15,868	4,000	1	7,934	4,000	1	7,934	4,000	1	7,934
3,500	1	6,942	5,000	21	208,264	5,000	13	128,926	5,000	7	69,421
3,000	2	11,901	4,000	1	7,934	4,000	1	7,934	4,000	1	7,934
2,500	2	9,917	3,500	1	6,942	3,500	1	6,942	3,500	1	6,942
2,000	2	7,934	3,000	1	5,950	3,000	1	5,950	3,000	1	5,950
1,500	2	5,950	2,500	1	4,959	2,500	1	4,959	2,500	1	4,959
1,000	2	3,967	2,000	1	3,967	2,000	1	3,967	2,000	1	3,967
			1,500	1	2,975	1,500	1	2,975	1,500	1	2,975
			1,000	1	1,983	1,000	1	1,983	1,000	1	1,983
Total Release	63	418,512		35	277,686		27	198,347		21	138,843
Base Release*	600	74,975		600	41,653		600	32,132		600	24,992
Net Release		343,537			236,033			166,215			113,851
*600 cfs for 63 days			*600 cfs for 35 days			*600 cfs for 27 days			*600 cfs for 21 days		

Limitations of First and Second Generation Model

SJBHM is a RiverWare model that uses RiverWare engineering objects to simulate basin hydrography and facilities, RiverWare data objects to store decision data, and RiverWare Policy Language (RPL) to implement operating criteria using rules. The first and second generation versions of SJBHM were monthly time step models that simulated various daily processes. SJC, ALP, and the flushing release computations are all daily computations within the monthly model. Although daily computations can be done with RPL, engineering objects only fire at the model's time step. Therefore, disaggregation and aggregation issues existed. The most problematic was the flushing release criteria.

The specified flushing release was from Navajo Reservoir. The flow recommendation criteria are evaluated at the Four Corner's gage. Since the model was a monthly model and the flow recommendations are based on daily flow statistics, the daily downstream flow at Four Corner's had, to be estimated. This was accomplished by disaggregating the monthly model output into pseudo-daily values after the model had run to evaluate the results against the flow recommendations. Since the model does not know when certain flow conditions have been met, this information cannot be used for future decisions during the model run. The only historic decision information that was available to the model during the run was the type of previous year's release.

These models also had a computational inefficiency related to application of the excess water to the flushing release. Specifically, the set of possible hydrographs was recomputed every March and every April. These could be specified in a data object as a prescribed hydrograph for a given water supply. These would essentially be sub-paths of the existing paths.

Options Made Possible By Third Generation Daily Decision Model

The third generation SJBHM will be a daily model. This will give the modelers considerably more flexibility in applying the operating criteria in RPL. Furthermore, it will shift disaggregation issues from the model output to the model input, requiring that the disaggregation process be utilized only when there is a change in input data.. In addition, the ability to compute the flow recommendation performance statistics during a model run provides the ability to use these statistics to affect releases during a model run. How this might be accomplished remains to be decided and is the purpose of this document.

A daily model introduces input data issues as noted above. A daily model also affects operations other than the flow recommendation releases. For instance, the COE flood control criteria are based upon a forecast of daily flows. This requires that daily inflows to Navajo Reservoir be known. Forecasts are based upon monthly hydrology and demands and historical forecast error. Historical forecast error is based upon historical forecast unregulated inflow compared to actual historical unregulated inflow. With the daily model, two questions arise: Will monthly forecast be sufficient for a daily model? Should the option of using mid-month forecasts be explored?

The third generation model implementation also suggests a revisit of the criteria evaluation. For instance, only the San Juan Four Corners gage is presently used to compute performance statistics. Would it make sense to use a sampling of gages as is done in the actual operations? Can more creative use of the fall surplus water release be made? Can the final flushing release decision be delayed until mid-May?

Given the above background and historical information, the following operating criteria are proposed for the third generation model.

Third Generation Operating Criteria

The fundamental operating criteria for the third generation SJBHM will remain the same. However, the StateMod baseline model and the RiverWare monthly migration model will be doing some of the work. Emulation of historical operations should be considerably more sophisticated using this system. SJC will be operated in the migration model. The daily decision model will consist only of those nodes necessary to operate ALP and Navajo Reservoir. The monthly model will only have to be operated when hydrology is revised or when baseline depletions are revised. Disaggregated daily and some monthly data (forecasts) will be transported between the migration model and the daily decision model. (See ThirdGenModelAndDataDevSummary for additional information on the modeling system.)

ALP will be operated in the daily decision model. Its operation will remain the same but have to be reimplemented in RPL for the daily time step. Initially, the overall operating criteria for Navajo Reservoir will remain the same. The flushing release computations will be adjusted to take advantage of the daily time step and enhanced RiverWare features. It is also highly recommended that the daily COE flood control criteria be implemented. RPL code already exists to do this but daily inflows to Navajo would have to be developed.

Due to limited resources to implement the new model, it is highly recommended that the basic process of using a decision tree not be abandoned. This would also facilitate incremental implementation, debugging, and decision tracking. As the model is debugged, calibrated and verified, adjustments to the operating criteria can be made. Initially, the following adjustment to the release decisions are recommended:

1. In the first and second generation models, one of four discrete hydrographs are used if a flushing release is required and water is available in Navajo. These were shown in Table 1 and total 114000, 166000, 236000 and 344000 ac-ft above a 600 cfs baseflow. If a release of 114,001 ac-ft is called for, the model would release the second hydrograph of 166,000 ac-ft. This results in an over release of 52,000 ac-ft. In the third generation model, this problem will be eliminated, by releasing the actual volume that is required. In the example given, 114,001 ac-ft or a close approximation (see item 2 below) would be released instead of 166,000.

2. All release hydrograph possibilities will be prescribed by storage in data objects to reduce computations. The decision tree will determine the basic flushing release volume but a table will determine the actual shape of the hydrograph based upon excess water. This would be called a sub-path to the main decision path.

3. A better algorithm for timing releases will be investigated that includes an analysis of weather data to provide a simulation of forecasting the timing of the Animas runoff to better match the peak release with the peak runoff from the Animas. Presently, the release is centered on the same date each year.

4. The decision tree will be adjusted to incorporate evaluation of return period statistics during the model run. For instance, if the 9700 cfs for 5 days event has occurred within the required 10 years, the decision tree would not necessarily force a release. Conversely, if a condition that was required every 10 years had not occurred for 7 or 8 years, an attempt to conserve a release in a given year may be made to allow making a larger release in a subsequent year. The exact

nature of these rules must be developed based on trial and error operation, but the concept is to better target the desired results when determining the releases. Again, these would probably be sub-paths of the main decision path.

5. Presently, once a release begins, it cannot be adjusted. In years where the forecast runoff is not met, the model over-released. With the daily timestep, reservoir inflow will be checked against forecast, with the potential of shortening the duration of the peak when the inflow falls short.

6. Base releases will utilize a mix of down-stream gages and implement the present flow recommendations as written, utililizing a running mean.

7. With and integrated daily timestep model, it may be possible to include operation of Ridges Basin Reservoir in meeting flow recommendations. The possibility of joint operation of Navajo and Ridges Basin Reservoir will be explored.

8. The performance statistics will be evaluated using the same criteria as actual operations are using.

San Juan Basin Hydrology Model
Provisional Depletion Data
10/30/2002

The following is a summary of provisional depletion data that have been provided to Colorado for use in the third generation model.

Arizona and Utah

Historic

1929-1969 are same as second generation's 1970 values.
1970-1993 are same as second generation.
1994-2000 are same as second generation's 1993 values.

Baseline – same as second generation model which are essentially 1993 historic.
The Utah irrigation depletions, which average about 4000 acre-feet/year, were considered to be on-stream depletions in the second generation model. Utah non-irrigation depletions and all Arizona depletions were considered to be off-stream in the second generation model. These same assumptions were used in the provisional third generation data set and model set up.

New Mexico

Historic

1929-2000 irrigation depletions – Modified Blaney-Criddle depletions computed using provisional historic acreages and cropping patterns from NMISC, extended climate data developed by Keller-Bliesner Engineering, and climate station weighting developed by Reclamation. Hammond historic diversions were used from 1970-2000. NIIP historic data were used to estimate return flows which were provided to Colorado with NIIP historic diversions. All other diversions are estimated as a function of depletion and efficiency. Efficiencies were computed for Hammond and NIIP from available data. All other efficiencies were provided by NMISC.

1929-2000 non-irrigation depletions – Power plant diversions and depletions were provided by NMISC. All other non-irrigation diversions and depletions are based on second generation data which are essentially a blend of CU&L and Northwest Assessment data for the 1970-1993 period. Efficiencies were computed for the power plants from available data. All other efficiencies were provided by NMISC. These data were distributed from the second generation hydrologic unit totals to the third generation depletion nodes. The provisional non-irrigation, non-power plant data are:

1929-1969 are same as second generation's 1970 values.
1970-1993 are same as second generation.
1994-2000 are same as second generation's 1993 values.

Baseline

Non-irrigation depletions are essentially same as 1993 except for the power plants which are based upon water rights.

Irrigation depletions except for NIIP use 1965 acreage and cropping patterns which is consistent with second generation baseline. NIIP uses annual depletions provided by Keller-Bliesner Engineering that correspond to consulted depletion of 270,000 acre-feet/year.

New Mexico off-stream nodes are consistent with second generation.

Provisional Data Set
Response To NMISC
11/05/2002

We do not believe that the Hydrology Committee has made a decision regarding use of original Blaney-Criddle. Based upon 5/24/2002 recommendation of Steve Harris and 6/24/2002 committee meeting discussion, Reclamation added the ability to use either original or modified Blaney-Criddle as well as use user provided frost dates. The provisional data set was developed using typical Reclamation Consumptive Uses and Losses (CU&L) setup which is to use modified Blaney-Criddle and SCS effective precipitation method. The typical NMISC setup of Blaney-Criddle is to use original Blaney-Criddle and Reclamation effective precipitation method. Reclamation's Blaney-Criddle model now supports a variety of setups.

We emphasize that the provisional data set was put together so that the modelers can test the natural flow computation process, test the Data Management Interfaces (DMI's), and to proceed with development of models and rules. When revised data are provided by NMISC and other sources, these data will be incorporated into the data set and models. We anticipated that NMISC will provide historic and baseline irrigated acreage and cropping patterns and historic and baseline non-irrigation depletions. Reclamation is willing to use NMISC irrigation depletions if they include an estimate of headgate diversions.

Previous non-irrigation data were used to develop the provisional data set because we had no other data to work with. It was your suggestion that we distribute the second generation data to the third generation nodes to develop the provisional data set. Again, the only purpose of this data set is to allow the modelers to move ahead.

Because of the departure of Darrell Dyke from Reclamation, we do not know the full history of the second generation New Mexico non-irrigation data set. However, it is our belief that these data are basically Northwest Assessment data and CU&L data were only used to extend the data set to 1970 through 1993. Again, whatever data that NMISC provides will be used in the final model.

We used the power plant depletions and diversions that NMISC provided to estimated efficiencies for the power plants. We used Hammond recorded data for 1970-2000 to estimate Hammond efficiencies. NIIP efficiencies were estimated using recorded data by Keller-Bliesner Engineering. We used the non-irrigation and irrigation efficiencies that you verbally communicated to us for all other projects. Again, we will use whatever NMSIC provides for these projects in the final model.

SJRIP Hydrology Model Monthly Log

The following is a monthly log of work on third generation San Juan Recovery Implementation Program Hydrology Model and associated data development. Additional information are available from the SJRIP Hydrology Model web page at http://wcao.uc.usbr.gov/envprog/sjrip.

October, 2002

A daily natural flow model to support the daily decision model was built and partially populated. DMI control, mapping, and scripts were completed for this model. A ruleset to disaggregate extended monthly gage flows and historic depletions was developed. Daily flow fractions were developed for mainstem gages and tributaries. Model will compute daily gains for the mainstem gages that will be used by daily decision model. Static data DMI's were updated. Provisional New Mexico, Arizona, and Utah historic and baseline data sets were provided to CWCB in StateMod format.

September, 2002

Second generation documentation was completed except for some loose ends. Completed updating of historic gaged flows through water year 2000. Conducted technical transfer to new person with focus on support of long-term data maintenance. Improved DMI's, control files, map files, and run scripts to facilitate long-term data maintenance. Created initial documentation of data stores, scripts, control files, map files, and DMI's to facilitate long-term data maintenance. Adjusted schedule and budget to reflect actual FY2002 work, expenditures, and schedule. Worked on daily natural flows model, DMI's, and rulesets. Spreadsheet aggregation utilities were developed.

August, 2002

Preliminary power depletions and system efficiencies were obtained from NMISC. NIIP historic and baseline depletions were developed. Reclamation updated their historic streamflow data and Reclamation reservoir operations data. Reclamation operations data were provided to CWCB. Jicarilla hydrology node information (precipitation and area) was obtained. SJC data set was extended through 2000 and daily flow fractions for the tributaries were developed. An improved SJC configuration and ruleset was tested with the second generation and implemented in the migration model. Rules were tested to support migration of forecasts data from the migration model to the decision model. First draft of revised operating criteria for Navajo was formulated.

July, 2002

Discussions were held with NMISC regarding the mainstem configuration. The irrigation nodes are established but acreage adjustments remain. The non-irrigation configuration is nearing completion. NMISC needs to provide efficiencies, capacities, and non-irrigation depletions. The Jicarilla nodes were located and a hydrology node provided for their water. Daily depletion disaggregation fractions were obtained from the contractor and their usage was tested in RiverWare. A forthcoming version of RiverWare will compute diversion requests of user provided depletion requests. The ability to use user provided frost dates was added to Reclamation's Blaney-Criddle model. A data management interface (DMI) was developed for StateMod daily data to facilitate future data updating. DSS DMI's were also developed to facilitate data archiving.

June, 2002

The RiverWare model and SJRIPDB were modified for known configuration changes. New Mexico non-irrigation configuration remains. Return flow apportions were computed for the known configuration. The ET spreadsheets were adjusted and a New Mexico irrigation spreadsheet was prototyped. Additional climate data were obtained or developed including daily data for all of New Mexico. Disaggregation data and procedures were evolved. Options to implement the disaggregation data and procedures in the RiverWare models were scoped. Additional data management utilities were developed and long-term options to maintain and update data were investigated. Available historic USGS and reservoir operations data were obtained.

May, 2002

Daily climate data were obtained to support daily evapotranspiration estimates that will be used to facilitate disaggregation of irrigation depletions. Monthly climate data for the entire basin were updated through 2000 except for 3 stations that not yet available. Climate station weights were developed for the anticipated New Mexico irrigation depletion nodes. NMISC cropping patterns and acres were extended from 1929 through 2000 by depletion node in Blaney-Criddle format. The cropping patterns are being used for the daily evapotranspiration computations as well. The ability to optionally compute irrigation depletions using original Blaney-Criddle was added to the code and a comparison run was made. Work was done on other disaggregation data development as well. Hammond historic data were obtained and integrated with historic estimates. Considerable work was done on the StateMod and RiverWare models for the mainstem reconfiguration.

April, 2002

Additional adjustments were made to the modeling approach and associated documentation to address Hydrology Committee questions and to reflect

evolution of the model development. The RiverWare monthly model was modified to use diversion objects in lieu of water user objects for supplemental water cases. This allows easier recognition of them in the model, reduces the size of the model, and separates their management. The code that creates the model was migrated to RiverWare 4.0.4. Reclamation's Blaney-Criddle calculator was modified to compute original Blaney-Criddle and to use some of the data formats developed for SJRIP. Original Blaney-Criddle crop coefficients for New Mexico (which are seasonal) were obtained from the New Mexico State Engineer's Office.

March, 2002

An initial cut was made to map New Mexico's irrigation depletions to StateMod and RiverWare nodes.After adding expected non-irrigation nodes, an initial cut was made on return flow distribution.The configuration is being negotiated with NMISC.A discussion was held with CWCB regarding supplemental hydrology nodes (gains between gage nodes) on the main stem of the San Juan.The latest version of CWCB's San Juan StateMod model was obtained to use as a starting point for the main stem reconfiguration.The RiverWare model will be built consistent with the StateMod although some configuration issues remain in both Colorado and New Mexico.

February, 2002

The database and software that are being used to create the monthly model from the StateMod natural flow model was extended to support multiple versions of models. In addition, the ability to distinguish and create water objects by RiverWare depletion request types was provided. This will enable optional use of acres and rates verses user provided depletion requests. The lastest San Juan StateMod model was obtained to begin reconfiguration of the main stem San Juan nodes. Provisional acres and cropping patterns were obtained from New Mexico for computation of historic depletions. Initial work was begun on historic Arizona and Utah depletions including obtaining revised data from Utah. The flow recommendations performance spreadsheet was evolved in anticipation of daily model output. RPL (RiverWare Policy Language) functions were specified to compute the flow recommendation statistics within a model run so that they can be used to optimize releases. This implementation will be funded by research funds because it has application in other basins.

January, 2002

Technical work was limited due to other obligations but a few data management support items were completed that include development of DMI's to import into RiverWare and export data from RiverWare in a format that is consistent with the spreadsheets produced by a RiverWare data file (RDF). These DMI's will enable us to make model updates using output of previous runs. In addition, the ability to optionally include html targets to objects and slots was added to selected DMI's. These formats will be used to provide data access via the internet to

stakeholders. A spreadsheet and documentation were developed to facilitate computation of equivalent RiverWare depletion slots from equivalent StateMod data. Another spreadsheet was developed to convert and store the previous model's climate data in the new model's monthly format.

December, 2001

Technical work was limited due to vacation, other obligations, development of the budget, and preparation of contract specifications. However, a few small items were completed. An application was created to create and update a table of model runs that provides links to data and plots. These tables will be added to the web site when an appropriate data format is available. Technology were obtained from another project that has developed a way to create and post a set of plots to an Acrobat (pdf) file from a standard RiverWare output file (RiverWare Data File (RDF)). An inconsistency on use of the minimum pumping to ALP was corrected and posted to the web site rulesets. The process to create a RiverWare model from StateMod was evolved to be more usable as the respective models are reconfigured.

A cooperative agreement was prepared with Kellller-Bliesner to assist with work plan items 10, 16, 20, 23, and 24. Work under this cooperative agreement has not commenced

November, 2001

Technical work was limited due to vacation, other obligations, and development of the budget. However, a few small items were completed. A utility to convert StateMod area-capacity data to RiverWare format was developed and a DMI was created to import the area-capacity data into RiverWare. Documentation of static data DMI's was drafted and added to the web page. Some adjustments were made to the web pages for consistency and to prototype inclusion of data and plots from models. An outline of documentation needs was provided to CWCB. Configuration and data issues were discussed with NMISC. A disaggregation needs document was drafted and provided to Keller-Blisner for review and extension.

October, 2001

Minimal technical work was done due to vacation, other obligations, work station procurement, and development of the budget and contract specifications.

September, 2001

1. Task H – Completed testing of StateMod water right procedures. This required fixing of RiverWare bug that was discovered in late August.

2. Task L – Slightly revised web page and scoped means to link to model visualization pages. Improved SRJIP database software to facilitate posting of data to web site.
3. Task K – Prepared background material and met with Hydrology Committee subteam and full team.
4. Task A - Gage errors were analyzed and correction options were evaluated.

August, 2001

1. Task L – Official web page was posted and slightly revised.
2. Tasks H and J – Additional testing StateMod water right procedures was conducted.
3. Task C - New Mexico Interstate Streamflow Commission was asked for clarification on irrigated lands identified by their GIS coverage.
4. Task H - CADSWES completed incorporation of lagged return flows into decision functions. Reclamation verified that they worked properly.
5. Task K - Revised Plan Of Study to reflect actual progress made in FY2001 and expected rollover into FY2002.

July, 2001

1. Tasks G and J - We fine tuned the programmatic means of creating RiverWare model from a StateMod model. Although this process worked for the Gains model, initially RiverWare would not save the validation model. This problem has been corrected. The validation model with existing main stem configuration was programmatically created using spatial coordinates that were estimated from known latitudes and longitudes. This resulted in some portions of the model being extremely congested. The locations of objects is being adjusted to improve model navigation. The model will be recreated programmatically after the improved visualization and mainstem reconfiguration are completed.

2. Task L – Reclamation Salt Lake web master was contacted to obtain an official site for the hydrology model web page. A numeric site has been assigned but the official name awaits registration. Committee will be posted as soon as site is posted.

3. Tasks H and J – We scoped and tested implementation of StateMod water rights procedures in RiverWare. Testing to date has not included reservoirs because a few additional StateMod procedural questions remain to be resolved. A report of the implementation has been drafted and will be provided to the committee after testing is completed.

4. Tasks H and J – We had a meeting with CADSWES to discuss possibility of using RiverWare's accounting functionality to support water right rules

and areas for improved performance. This will consist of creating compiled versions of some of the RPL (RiverWare Policy Language) functions that were written to support water rights rules.

5. Tasks C and L – An automated means of creating a web page visualization of a RiverWare model has been developed (by another project and borrowed for our use). We will provide a link to the gains model when the official web site is posted. We will use this mechanism to provide access of model data to those committee members that do not have access to RiverWare.

June, 2001

1. Developed programmatic means of creating RiverWare model from StateMod model. This will facilitate updating of RiverWare model as reconfiouration changes are made to StateMod model. Using software tc create the RiverWare model also reduces the chances of making linking errors. We used this program to create first version of validation model.

2. Met with CWCB to clarify additional StateMod data and methods.

3. Created Piedra Validation model. We intend to use this model and a calibration model of same subbasin to verify DMI's, compare basic items to StateMod, and to prototype water rights emulation in RiverWare. After our meeting with CWCB, this model is matching nicely with StateMod to the extent that it has been checked.

4. Developed a means of visualizing a RiverWare model on a web page. The technology was developed by another project and borrowed for our use in SJRIP. This will provide non RiverWare user's access to RiverWare data with visualization on a web page that appears similar to an actual RiverWare model.

5. A number of utilities were developed to support RiverWare model creatio, and visualization.

6. Researched options to implement water rights emulation in RiverWare.

7. Updated plan of study data and responded to comments to plan of study.

May, 2001

1. Developed log of first and second generation models and rulesets and created web
access of same. Included in this structure are a model and ruleset naming convention,

links to models and rulesets, links to scenario model runs, and links to documentation.

2. Created a Hydrologic Database (HDB) in Denver to support data access of model input and output data.

3. Met with CADSWES to discuss modifications to HDB to support depletions datatypes. The modifications are minor and non program funded.

4. Met with Ray Bennet of CWCB to clarify how CDSS StateMod water right's algorithm works and to discuss StateMod implementation of the variable efficiency method.

5. Made initial San Juan main stem reconfiguration after discussions with NMISC. Additional discussions with NMISC to clarify some items.
6. Completed software to support mapping of RiverWare nodes to CDSS and DMI's.

7. Built validation model of Piedra basin. Still need to populate and test.

8. Obtained and tested a newer version of RiverWare that corrected a problem with initial conditions for multiple lagged return flows. This version of RiverWare also has a new rules function that should help in SJRIP. It does not yet have the ability to see lagged return flows when estimating reservoir releases. That modification should be available by June 22.

October, 2000 through April, 2001 Activities

1. Previous generation of RiverWare model rules were migrated to run entirely in "new" rules environment. Previous generation of rules was a bridge between "new" and "tcl" (old) rules system. Although actual rules in new model may vary considerably from the previous generation, individual functions may still be used in the new model. Completion of this task enables us to eliminate most compatibility issues between model generations. This task was completed before SJRIP funds became available using other sources of funding.

2. All comments from previous generation of model were incorporated to the extent possible. It was important to complete this documentation before the modelers became too involved in the new model development. This task was mostly completed without SJIRP funds.

3. Two sensitivity runs were made with the previous generation of model to better understand how the system responds. These runs have not been analyzed (post processed) but could provide some information to improve the next generation model.

4. A contract has been arranged for analyzing and correcting gage errors.

5. Reclamation GIS sets have been updated with Colorado, New Mexico, and USGS coverages. In addition, research funds were used to develop a methodology to estimate the portion of return flows that return to subbasins generated using GIS technology. Return flow proportions are important when estimating water supply of individual water users in StateMod. Some programs funds were used to apply this technology to the San Juan basin. The technology has been provided to Colorado Water Conservation Board to use as they see fit to improve the SJRIP StateMod model.

6. Reclamation have acquired all necessary CDSS (Colorado Decision Support System) software, existing San Juan StateMod model, support data, and documentation. Reclamation staff have worked with CWCB to clarify StateMod methods, data, and operating criteria.

7. DMI's (Data Management Interfaces) have been developed to move data between StateMod and RiverWare, between StateMod and two common Reclamation data formats, and between StateMod and HDB (Hydrologic Data Base). A prototype HDB has been installed in Denver.

8. StateMod return flow methods have been created in RiverWare using research funds. The methods have been tested but additional modifications needs to been completed before the return flow methods can be seen by rules when lagging is invoked.

9. Mapping of CDSS nodes to RiverWare nodes is nearly complete. A validation model will be built initially to verify that water moves through the RiverWare model as it does in StateMod. This model should be completed and tested by mid May.