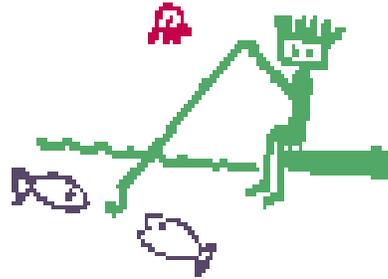


March 21, 2003

**San Juan River Basin
Recovery Implementation Program
Hydrology Committee
February 11, 2003
Conference Call Summary**



Members/Alternates Present:

Pat Page, Chairman
Ray Alvarado
Ron Bliesner
Rick Cox
Dave Frick
Mike Hammand
Steve Harris
John Leeper
Bill Miller
John Simons
Bernadette Tsosie
Brian Westfall
John Whipple

Others present:

Dan Crabtree
Mike Foley
Dave King
Eric Knight
Chuck Lawler
Stanley Pollack
Marilyn Greenberg, Program Assistant
Shirley Mondy, Program Coordinator

Representing:

U.S. Bureau of Reclamation
State of Colorado
U.S. Bureau of Indian Affairs
Water Development Interests
Jicarilla Apache Nation
Jicarilla Apache Nation
Water Development Interests
Navajo Nation
Southern Ute Indian Tribe
U.S. Bureau of Reclamation
Navajo Nation
U.S. Bureau of Indian Affairs
State of New Mexico

Representing:

U.S. Bureau of Reclamation
Southern Ute Indian Tribe
U.S. Bureau of Reclamation
U.S. Bureau of Reclamation
Southern Ute Indian Tribe
Navajo Nation
U.S. Fish and Wildlife Service
U.S. Fish and Wildlife Service

Introductions and Review of Agenda Items

Conference call attendees introduced themselves and approved the agenda.

Review of the October 29, 2002 Draft Meeting Summary

The October 29, 2002 draft meeting summary was approved as amended. ***The Committee agreed to discuss the need for a peer review panel to oversee all Hydrology Committee work at the April, 1, 2003 meeting.***

Review of the Action Item Log

The 10/29/02 Action Item Log was approved as amended.

Budget, Schedule, and Status Report

Ray Alvarado expressed concern regarding items that are over budget. Pat Page explained that BOR intends to stick to their budget and complete the work. Documentation will be completed in April, at the earliest.

There was also a question about whether Dave King is depending on Colorado's documentation to complete RiverWare documentation. King stated that yes, BOR will be adding links to StateMod to enhance and complete the RiverWare documentation. King's intent was that Colorado would be an integral part of RiverWare documentation. ***BOR will revise this schedule and report at the next meeting to indicate that work will be complete this year within budget. Dave King and Pat Page will set up a conference call with Ron Bliesner and Brian Westfall to determine the plan for the rest of 2003.***

There was a question regarding whether the provisional data will become a 2004 item. Dave King explained that the provisional data will have to be included in the model once it is available and will be a part of ongoing updates to the model. When the data becomes available, it should just be a matter of dropping it in and running the model to update data. Ray Alvarado's help in the last three months has been greatly appreciated.

Discussion of Operating Criteria

An update of forecasting for the Animas River Peak flow was discussed by the Committee. Brian Westfall indicated that no parameters have been determined for the timing of when the Animas River really peaks so as to match the spring release from Navajo. Others commented that by not matching the Animas peak exactly with the spring release from Navajo Dam, the duration is actually maintained and gives a more natural condition. It does not appear that the same conditions can be met with less water. Matching the Animas peak with the spring release can help with increasing the magnitude of the flows, but it does not maintain the duration. Would we know when to schedule a release if flow volume is known? The general consensus was that it does not seem to be beneficial to find a method to match the spring release with the Animas River peak. Keller-Bliesner determined that the randomness is good. If it were determined that higher flows were more important than the duration of the flows, then this would become a germane discussion again.

John Whipple asked about the configuration issue from the Model and Data Development Status document dated 2/11/03. Ray Alvarado responded that this is a question of recorded water use - all water use is not being recorded. This affects the baseline more than the natural flows. Dave King commented that Durango's use of Animas River water is missing. When this information is complete it will be shared with the committee.

John Whipple also asked about item 6 of the operating criteria on the last page. ***Ron Bliesner will revise the entire baseflow discussion and get it out to the Committee by Feb 14, 2003.***

Outstanding Data Needs to Complete Modeling Work

Dave King explained that he usually adds outstanding data needs to the Model and Data Development Status report. New Mexico, Arizona, and Utah data is still provisional; everything

except Colorado data would be considered provisional. The power plant data is complete. The Jicarilla data from 1992 - 2001 has been received; it would be nice to have it extrapolated back in history, and to receive some irrigated acreage data. The modelers are waiting for some data from the Salt Lake City regional office. The existing regression data can be used until updated information is available.

There were questions about a “bridge model”. Creating the bridge model ruleset will be useful in reducing errors because it will be an incremental step in the creation of the new decision model ruleset. The new decision model ruleset will vary mostly for Navajo reservoir operations, but the modelers should be able to use some of the data management rules from the bridge model. Dave King noted that the Migration Model development required creation of some rules to compute values of items that did not map directly between StateMod and RiverWare. These rules compute RiverWare values as a function of multiple StateMod values. Most of these are related to imports into the McElmo basin from the Dolores basin.

Grow-out Ponds

Steve Harris suggested that a Hydrology Committee subgroup be available to evaluate water supplies. Others on the Committee felt that this was outside the scope of the Hydrology Committee.

Bill Miller stated that the Biology Committee is looking at biology issues first. Miller added that there is a scope of work out to examine limnological factors. Jim Brooks has a Biology Committee action item to look at the pond criteria. Bill Miller stated that the Biology Committee is interested in getting the fish recovered, but do not want to compromise genetics or other biology issues. Grow-out ponds will be discussed at the Feb 24 - 25 Biology Committee meeting, in addition to discussion of issues/problems with ponds that are already operational - to help determine criteria for new ponds.

Shirley Mondy stated that the rearing pond issue is also on the Coordination Committee agenda, the day after the Biology Committee discusses it. It was suggested that Steve Harris could attend the Biology Committee meeting to find out more about their process on grow-out ponds.

Update on Long Range Plan and Subcontracting Subcommittees

Shirley Mondy stated that the LRP subcommittee has not met recently. A LRP review that was due in December from Tom Pitts has not been received yet. This is in the Coordination Committee at this point. The budget subcommittee is having a conference call on Tuesday, Feb 18 to discuss options on how to contract out scopes of work.

Navajo Reservoir Operations - Shortage Sharing Update, Trigger for Declaring Shortage

Pat Page explained that contractors and direct flow users indicated that they were willing to consider a share and share alike concept. After meeting, major players were comfortable with the share and share alike idea. John Whipple and Pat Page have been meeting with a flow diverters group and the State Engineer's task force regarding the concept of shortage sharing. The concept is that direct-flow diverters could continue to use storage water out of Navajo, although at a reduced rate. It could be considered as a weaning off process for diverters to be more in line with their permits. Some people feel that this should apply to others and not to them. There are also differing legal opinions (mainly from direct-flow diverters) as to what

happens to Navajo Reservoir storage water once it is released into the river. The plan being developed by water users will ultimately be submitted to BOR as a recommended operating plan for 2003. The Service has been involved in these meetings to determine what shortages the endangered fish could handle. A copy of the shortage sharing draft has been sent to Bill Miller because the Service would like input from the Biology Committee. There needs to be some agreement by March 1, 2003 because that is when the Secretary will need to implement the plan.

There was a question regarding how target baseline flows would be affected. Pat Page explained that some of it will depend on what the Biology Committee recommends to the Service. One possible recommendation is for the Service to share in the shortage as everyone else. Currently a water shortage of 40 percent is projected, based on the minimum probable forecasted inflow as of February 1st.

Review of New Action Items

The new action items are bolded and italicized throughout this meeting summary.

Next Meeting - April 1, 2003 at 8:30am in Durango, Colorado

The modelers would like to demonstrate some of the model work at the BOR office for the next meeting. ***Pat Page will reserve the fourth floor conference room for the Hydrology Committee.***

Other

Brian Westfall is noticing a difference between what Simons has and what USGS has on their website. The modelers will disregard this for now and work on programming the model based on what is being done right now. ***John Simons will take a look at the USGS data before Ron Bliesner presents at the Biology Committee meeting.***

The Biology Committee and Reclamation do not agree on how to measure the target base flows. From a modeling perspective, the option needs to be built in to do either of these possible interpretations. It was agreed to implement the model the way BOR ran it, which for now is the two high gages. This is subject to change based upon resolution of this issue. The capability is needed to model it either way.

San Juan Basin Hydrology Model
Model and Data Development
Status – 02/11/2003

The provisional data set was used to develop provisional naturalized flows for the basin. These data were used with historic depletions to complete development of the Mainstem Daily Gains model. These data were used with baseline depletions to complete development of the Validation model. The baseline data will also be used in the Migration model, and eventually, the Daily Decision model.

We have validated the movement of water from StateMod through RiverWare. Some additional configuration issues had to be resolved. These all involved supplemental water supplies or carried water cases. These are cases that were built by hand (rather than programmatically). A number of these cases also required use of rules to aggregate or disaggregate StateMod values into an equivalent RiverWare value. In addition, differences in evaporation were encountered. Documentation of the Validation model is forthcoming.

The Mainstem Daily Gains model computes the daily gains that are needed by the Daily Decision Model. It uses recorded daily and monthly streamflows, flow fractions developed from recorded streamflows, historic monthly depletions, daily depletion fractions, and StateMod extended hydrologic flows as input data. Rules are used to compute daily hydrologic flows and daily depletions. RiverWare then computes the daily gains by mass balance. Documentation for this model is available on the web site.

Most of the DMI's for the Migration model are installed but need to be updated for changes made during validation. We'll have another DMI issue or two to finish in the Migration model due to small configuration differences. The migration model is identical to the validation model except for SJC, NIIP, and numerous data objects to support the migration. The rules are also mostly ready but we intend to add a forecast for Animas at Durango.

After completing the migration model development (data will remain provisional for some time, it appears), we intend to update data and data management documentation before starting to work on the bridge model. This is the model that will use the new hydrology and depletions with the old operating criteria. Another difference will be the return flow lagging. We have decided to use a daily time step for the bridge model. It will basically be the new decision model with the old operating criteria. We will have to convert ALP and Navajo operations to a daily timestep but hopefully we can use most of the code in the revised operating criteria.

One configuration issue remains. We think that CWCB is missing some of Durango's M&I water, both historic and baseline. John Simons and Ray Alvarado are looking into this. Given that we have other commitments, we are looking to get the bridge model going by end of this month, first of March. Then we can start on implementing revised operating criteria. We are probably looking at end of April or so to have the new revised operating criteria fully tested and implemented. Although final analyses will have to wait until the provisional data are revised, we believe that the provisional data are sufficient to continue model development.

Table 2. San Juan Hydrology Model - Data and Model Development Costs

Oct-02

Task	FY2001 Proposal Schedule	Professional time - staff days			FY2001 Funds	FY2002 Funds	FY2003 Funds	Estimated Cost	Target Schedule
		USBR	Consultants	Total					
A. Analyze and correct gage errors.	Nov-00	0.0	20.0	20.0	\$16,000	\$0	\$0	\$16,000	Sep-01
B. CDSS interface	Nov-00	76.5	7.0	83.5	\$28,321	\$23,451	-\$804	\$50,968	Nov-02
C. Data systems development	Jan-01	76.5	7.0	83.5	\$28,321	\$23,451	-\$804	\$50,968	Nov-02
D. Correct 1970 -1993 database	Mar-01	33.0	0.0	33.0	\$4,088	\$16,377	\$1,099	\$21,564	Nov-02
E. Extend data sets to 1929	Apr-01	16.0	0.0	16.0	\$0	\$9,471	\$1,781	\$11,252	Nov-02
F. Extend data sets from 1993 to 1999	May-01	16.0	0.0	16.0	\$0	\$9,471	\$1,781	\$11,252	Nov-02
G. Configure and Calibrate to CDSS	Jun-01	89.0	11.0	100.0	\$20,873	\$33,484	\$13,203	\$67,560	Nov-02
H. Implement functionality in Riverware	Jun-01	26.0	0.0	26.0	\$16,788	\$0	\$0	\$16,788	Sep-01
I. Daily disaggregation	Aug-01	25.0	35.0	60.0	\$0	\$36,855	\$8,320	\$45,175	Oct-02
J. San Juan Model upgrade / calibration	Sep-01	70.5	80.0	150.5	\$0	\$73,307	\$38,666	\$111,973	Feb-03
K. Coordination with stakeholders	Throughout	84.3	13.0	97.3	\$18,939	\$44,300	\$2,822	\$66,061	Jun-03
L. Develop complete documentation	Nov-01	77.0	25.0	102.0	\$13,601	\$28,329	\$27,156	\$69,086	Feb-03
Expenses					\$23,173	\$41,004	\$3,500	\$67,677	
Total		590	198	788	\$170,103	\$339,500	\$96,720	\$606,323	Feb-03

Expenses include travel, contracting costs, software, work station procurement and training, work station support, and RiverWare modifications. FY2002 funds include \$108,465 of consultant work to be performed in 2003. Negative FY2003 costs also reflect contractor carryovers.

San Juan Recovery Implementation Program - Hydrology Model Development
 Tasks By Tasks Status
 02/04/03

Task	Actual Schedule	Target Schedule	Amount Expended	Percent Expended	Percent Completion	Status
A	Sep-01	Sep-01	\$15,335	96%	100%	Initial analysis is complete. Task may be revisited after new model is available.
B		Mar-03	\$53,711	105%	92%	completed.
C		Mar-03	\$53,711	105%	92%	Database interfacing is mostly done but additional database development remains.
D		Feb-03	\$23,954	111%	97%	Reconfiguration is nearly completed and time series data development has begun.
E	Jan-03	Feb-03	\$11,407	101%	98%	Colorado data are completed. Provisional New Mexico irrigated acres, cropping patterns, and power depletions are available. Utah and Arizona data are being developed.
F		Feb-03	\$11,987	107%	92%	Recorded hydrology and diversions are available in usable formats. Irrigation depletion data development is progressing well but non-irrigation depletion data remain provisional for NM, AZ, and UT.
G		Mar-03	\$72,847	108%	77%	Reconfiguration is completed. Validation is mostly completed.
H	Sep-01	Sep-01	\$16,788	100%	100%	StateMod return flow methods are implemented. New RiverWare requests types are implemented. It was demonstrated that StateMod water rights processing can be duplicated in RiverWare if required.
I		Feb-03	\$42,514	94%	99%	Data, models, and methods to support disaggregation are completed. Incorporation of output remains.
J		Apr-03	\$22,613	20%	14%	Some sensitivity testing has been conducted and analyzed. Initial scoping of operation alternatives is complete. Additional scoping, testing, and implementation should commence in October, 2002.
K		May-03	\$63,751	97%	90%	Ongoing. Work plan, schedule, and budget are updated at least monthly.
L		Apr-03	\$31,027	45%	32%	Web page has been implemented that includes links to models, rulesets, and documentation. Links are available to 2nd generation documentation and drafts of several third generation documents. Ongoing.
Expenses			\$48,922			
Total			\$468,567	77%	76%	Monthly Log
Differences exist between percent expended and percent completed due to work funded by other sources of funds and other reporting factors. Percent completions are based upon all work to complete project whereas percent expended are based upon program funds that are budgeted to respective tasks.			The primary activity was completion of the validation model and process. The validation required additional configuration adjustments in both StateMod and RiverWare, additional DMI's, and creation of a ruleset to compute aggregated values and to compensate for differences between StateMod and RiverWare. Additional knowledge of StateMod was also acquired to complete the validation. The other activities were technical transfer from Denver to Durango, moving the publicly available data, models, rulesets, and documentation to ftp.usbr.gov, updating the daily disaggregation configuration, and creating an initial configuration of the daily decision model.			
Expenditures are through -----> 12/28/2002						

FY2002 funds include \$108,465 of consultant work to be performed in 2003. Negative FY2003 costs also reflect contractor carryovers.

Table 4. Estimated Staff Days and Corresponding Costs
02/04/03

Task	Staff Days			Costs			Expenditures			
	BOR	Consultants	Total	BOR	Consultants	Program Budget	BOR	Consultants	Program Total	Percent Expended
A	0	20	20	\$0	\$16,000	\$16,000	\$0	\$15,335	\$15,335	96%
B	77	7	84	\$45,669	\$5,299	\$50,968	\$48,412	\$5,299	\$53,711	105%
C	77	7	84	\$45,669	\$5,299	\$50,968	\$48,412	\$5,299	\$53,711	105%
D	33	0	33	\$21,564	\$0	\$21,564	\$23,954	\$0	\$23,954	111%
E	16	0	16	\$11,252	\$0	\$11,252	\$11,407	\$0	\$11,407	101%
F	16	0	16	\$11,252	\$0	\$11,252	\$11,987	\$0	\$11,987	107%
G	89	11	100	\$59,233	\$8,327	\$67,560	\$64,520	\$8,327	\$72,847	108%
H	26	0	26	\$16,788	\$0	\$16,788	\$16,788	\$0	\$16,788	100%
I	25	35	60	\$18,680	\$26,495	\$45,175	\$16,568	\$25,946	\$42,514	94%
J	71	83	154	\$51,413	\$62,831	\$114,244	\$12,747	\$9,866	\$22,613	20%
K	84	13	97	\$56,220	\$9,841	\$66,061	\$53,398	\$10,353	\$63,751	97%
L	77	25	102	\$50,161	\$18,925	\$69,086	\$24,941	\$6,086	\$31,027	45%
Expenses				\$45,379	\$22,298	\$67,677	\$42,338	\$6,584	\$48,922	
D&MD	590	201	791	\$433,279	\$0	\$608,594	\$375,472	\$93,095	\$468,567	77%
Other									\$29,837	
Total									\$498,404	
FY2001				\$154,103	\$16,000	\$170,103	\$154,103	\$15,335	\$169,438	
FY2002				\$182,456	\$159,315	\$341,771	\$198,016	\$77,760	\$275,776	
FY2003				\$96,720	\$0	\$96,720	\$38,913	\$0	\$38,913	

Expenditures are through -----> 12/28/02

\$60,000 have been obligated by cooperative agreement for work on tasks B, C, I, G, K, and L.
\$99,315 have been obligated by contract for work on tasks I, J, K, and L.

SJRIP Hydrology Model Development - Detailed Tasks and Schedule Timeline



SJRIP Hydrology Model Development - Detailed Tasks and Schedule Timeline
02/04/03

Work Item Durations

Item	Start Date	End Date	Total Duration	FY2001 Duration	FY2002 Duration	FY2003 Duration	Description
1	10/01/00	01/15/01	107	107	0	0	Migrate flushing release computations to RiverWare rules language.
2	10/01/00	09/30/02	730	365	365	0	Complete doumentation of previous SJRIP Hydrology Model.
3	10/01/00	09/30/01	365	365	0	0	Analyze gage errors and correct gage record as required for reasonable water balance.
4	10/01/00	07/15/02	653	365	288	0	Evolve GIS coverages and databases to support new models including return flow apportions where necessary.
5	10/01/00	09/30/01	365	365	0	0	Review CDSS San Juan StateMod model and databases, engineering methods, water rights algorithm, and documentation. Identify RiverWare modifications to reproduce CDSS return flow methods and decision process.
6	04/01/02	02/15/03	321	0	183	138	improve specification of 3rd generation model behavior.
7	10/01/00	04/30/01	212	212	0	0	Develop and test implementation of StateMod return flow procedures in RiverWare.
8	04/01/01	09/30/01	183	183	0	0	Develop and test StateMod water rights procedures in revised RiverWare.
9	04/01/01	03/31/03	730	183	365	182	Develop cross model data sets equivalent. This will consist of transforming CDSS input and output data into equivalent spreadsheet and RiverWare terms. Transformation of New Mexico, Utah, and Arizona data will also be required.
10	01/01/02	02/15/03	411	0	273	138	Identify and quantify incidental losses, efficiencies, and headgate capacities
11	04/01/01	02/28/03	699	183	365	151	Develop data storage, analysis and retrieval system, including Data Management Interfaces (DMI's) between respective applications and databases.
12	10/01/01	02/15/03	503	0	365	138	Update 1929-1973 data
13	10/01/01	02/15/03	503	0	365	138	Extend data sets backward to WY1929.
14	10/01/01	02/15/03	503	0	365	138	Extend data sets forward through WY2000.
15	03/01/02	01/31/03	337	0	214	123	Compute New Mexico La Plata shortages and identify offstream depletions.
16	03/01/02	02/15/03	352	0	214	138	Develop and implement disaggregation procedures.
17	02/01/02	02/28/03	393	0	242	151	Reconfigure StateMod and RiverWare models.
18	03/01/02	03/31/03	396	0	214	182	Build and validate reconfigured RiverWare models
19	05/01/02	02/28/03	304	0	153	151	Formulate and prototype decision model operating criteria including sensitivity testing of identified alternatives for improved performance.
20	03/01/02	04/30/03	426	0	214	212	Build and test revised decision model.
21	08/01/02	02/15/03	199	0	61	138	Recompute naturalized flows for reconfiguration with extended data sets.
22	08/15/02	02/15/03	185	0	47	138	Test models with revised naturalized flows.
23	09/15/02	03/15/03	182	0	16	166	Analyze runs of revised decision model.
24	10/01/00	04/30/03	942	365	365	212	Develop documentation and incorporate comments.
25	10/01/00	05/31/03	973	365	365	243	Program Support And Coordination.

Fiscal Year Start Date 10/01/00 10/01/01 10/01/02
Fiscal Year End Date 09/30/01 09/30/02 09/30/03

San Juan Basin Hydrology Model
Draft Operating Criteria - 2/12/2003

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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. baseflow, (mean weekly non-spring runoff flow) to provide sufficient aquatic habitat for species recovery and 2. flushing flows to create and maintain habitat over time.

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The SJRIP flow recommendations state: "maintaining low, stable baseflows enhances nursery habitat conditions. Flows between 500 and 1,000 cfs optimize backwater habitat. Selecting flows at the low end of the range increases the availability of water for development and spring releases. It also provides capacity for storm flows to increase flows and still maintain optimum backwater area. This level of flow balances provision of near-maximum low-velocity habitat and near-optimum flows in secondary channels, while allowing water availability to maintain the required frequency, magnitude, and duration of peak flows important for Colorado Pikeminnow reproductive success." The target baseflow level is "500 cfs from Farmington to Lake Powell, with 250 cfs minimum from Navajo Dam."

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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

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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

... [1]

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 but for adjusted project sizes depending on the condition being analyzed.
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 were found unusable. The complete set of operating constraints for Navajo Reservoir are:

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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. (Since this is a monthly model, minimum monthly average flow was set at 525 cfs to be met or exceeded at all gages Farmington to Bluff to approximated a 7-day running average of 500 cfs specified in the SJRIP flow recommendations.)

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.

Table 1. Navajo Fish Release Hydrographs

344,000 ac-ft Hydrograph			236,000 ac-ft Hydrograph			166,000 ac-ft Hydrograph		
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
2,000	7	27,769	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
4,000	7	55,537	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
4,500	1	8,926	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
3,500	1	6,942	5,000	21	208,264	5,000	13	128,926
3,000	2	11,901	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
2,000	2	7,934	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
1,000	2	3,967	2,000	1	3,967	2,000	1	3,967
			1,500	1	2,975	1,500	1	2,975
			1,000	1	1,983	1,000	1	1,983
Total Release	63	418,512		35	277,686		27	198,347
Base Release*	600	74,975		600	41,653		600	32,132
Net Release		343,537			236,033			166,215
*600 cfs for 63 days			*600 cfs for 35 days			*600 cfs for 27 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.

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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? Only the 4-corners statistics are evaluated in real-time operation for flow statistics. Using other gages would not agree with

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the flow recommendations as the statistics have only been established for Four Corners. 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: *“Target base flow (average weekly) following spring peak is 500 cfs at Farmington, Shiprock, Four Corners, and Bluff gages, measured as the average of any two of these gages. Minimum release is 250 cfs. The target flow should be maintained between 500 and 600 cfs, attempting to maintain target flow closer to 500 cfs.”* Prior to mid-June 2002, Reclamation operated utilizing the 7-day average of the minimum two gages. Since then, the operation has changed to use the maximum two gages. Some feel that this is a strict interpretation of the flow recommendation. The SJRIP Biology Committee recognized the confusion of the original language, as it did not specify whether “any two” meant any two gages chosen must meet the criteria (the two minimum gages) or as long as the average of any two of the gages were above 500 cfs, the criteria was met (the two maximum gages). The committee submitted a different method of determining when the base flow recommendation was met to clear-up the ambiguity: *“Use the lesser of the average of Bluff, Four Corners and Shiprock and the average of Farmington, Shiprock and Four Corners. If one or more of the gages is missing or is obviously providing incorrect data, use the remaining gages in the set. Extreme conditions (low or high flows) identified by the Bureau of Reclamation will be handled on a case-by-case basis with recommendations from the Biology Committee.”* Some felt that this was a change to the flow recommendation and could not be implemented without full approval of SJRIP although the flow recommendation document states that *“Other operating rules may be employed to achieve the desired river conditions specified in this chapter, if the natural variability provided by the rules presented above is maintained.”* The Hydrology Committee voted to have the rule implemented according to the Bureau of Reclamation interpretation after mid-June 2002 until some agreement is reached as to the correct interpretation or the flow recommendations are officially modified. To remain flexible, it is proposed that the model have the capability of implementing either interpretation of the two-gage rule or the three-gage rule proposed by the Biology Committee. The bridge model will operate to match the generation two rules of meeting 525 cfs monthly average at all of the four gages. Once fully tested, the post-June 2002 interpretation of the two-gage rule will be used until instructed otherwise.

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7. With an 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.

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

9. None of the above implementations that do not specifically agree with the flow recommendation will be implemented in the official model until approved by the SJRIP. The results and recommendations will be provided to the program for evaluation.

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