Modeling Reservoir Storage Scenarios by Consensus

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ABSTRACT

Computer modeling is a powerful scientific tool used to simulate the behavior of systems under a variety of possible future scenarios. Many scientists are involved in simulating the Rio Grande in various conditions, both natural and manmade. This article describes a collaborative process for developing simulations that can be used to understand the probable effects of changed operations of the system of Rio Grande reservoirs. Participants learned that even developing hypothetical model runs can be controversial. It was difficult to achieve consensus among a diverse group of interested parties on how to model future scenarios for management of the reservoirs.

I. INTRODUCTION

In 2001, the Middle Rio Grande Endangered Species Act Collaborative Program (Collaborative Program), a group of federal, state, and local water management officials; Native American pueblos; and other interested parties, formed a water subcommittee to examine how to improve water operations in New Mexico’s Middle Rio Grande Valley.1 Challenged to meet the water supply needs for two endangered species, the group attempted a preliminary analysis of alternative reservoir storage scenarios by testing the effects of various alternatives on the water supply. The group sought consensus on the details of several scenarios and planned to use hydrologic modeling tools to test the viability of each. This article first describes the background, the organization of the group, the geographic setting and water supply regime, and the available modeling tools. The article then summarizes the process and the alternatives that were evaluated. In conclusion, it discusses the roadblocks created by the consensus approach and the outcomes: a broader understanding of the respective positions of the parties, new ideas on potential improvements to

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1. The Middle Rio Grande Valley is defined as the stretch of river between Cochiti Lake and Elephant Butte Reservoir. The broader Collaborative Program area is defined infra in Part II.E.
the water management system, and a commitment to support future hydrologic modeling.

II. BACKGROUND

A. Endangered Species

The impact of the Endangered Species Act² (ESA) in the Middle Rio Grande Valley of semi-arid New Mexico brought one of the most pressing environmental and water supply debates in the southwestern United States³ to the forefront. The Middle Rio Grande Valley is home to both the Rio Grande silvery minnow (silvery minnow), listed as an endangered species in 1994, and the southwestern willow flycatcher (flycatcher), listed as endangered in 1995.

Over time, the silvery minnow's habitat had become concentrated in the middle reaches of the Rio Grande.⁴ For centuries, the Middle Rio Grande Valley was sparsely populated with native Pueblos and, later, Hispanic farming families. Today most of New Mexico's urban development is located in the Middle Rio Grande Valley. As Anglo settlement occurred, dams for irrigation and flood control were constructed and the silvery minnow was trapped or could no longer migrate. A river that had previously receded and gone dry during the frequent periods of drought had become a series of isolated reaches between dams. The decline of the silvery minnow has been attributed to modification of the flow regime, channel drying resulting from impoundments, water diversions for agriculture, stream channelization, predation by non-native fish, and decreasing water quality.⁵

Another sign of the troubled ecology in the region occurred when critical habitat for the flycatcher was designated in 2005 and included the Middle Rio Grande Valley. Reduction or elimination of surface water due to diversion and groundwater pumping are cited as major reasons for the decline of flycatcher habitat.⁶

The water-related problems in the region, including its highly variable seasonal supply, the unquantified water rights of major water users

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5. Id.
and six Indian Pueblos, thousands of individual water rights holders, interstate compact delivery obligations to Texas, and rapid population growth, make compliance with the ESA extremely challenging. This was particularly true in 2004 while the work discussed in this article was underway due to extreme drought conditions. And, although progress has been made, the challenges persist today.

In addition to (and in spite of) the myriad legal proceedings that ensued beginning in 1999, efforts have been ongoing in many different venues to develop strategies to address the needs of the silvery minnow and flycatcher without impacting valid water rights or Rio Grande Compact obligations. One of the most significant efforts was the formation of the Collaborative Program. Within the Program, the water subcommittee attempted to examine one aspect of the problem—reservoir storage and operations—with the objective that improving this important piece of the system would help achieve a sustainable water supply for endangered species without harming other water users. This article is a report on the work of the subcommittee's Preliminary Reservoir Storage Modeling Analysis (Preliminary Analysis) completed in 2005.

B. Middle Rio Grande Endangered Species Act Collaborative Program

The Collaborative Program was formed to seek short- and long-term solutions to aid in the recovery of endangered species in the program area in order to protect water users' plans from the legal obligations of the federal government to protect endangered species. One of the goals of the Collaborative Program is to develop and exercise creative and flexible options under the ESA so that water use and development can proceed in compliance with applicable state and federal laws.

At the time of the Preliminary Analysis (2004/2005), the Collaborative Program provided a venue for many agencies and interest groups to talk with one another about river management concerns. It was comprised of federal, tribal, state, and local governments, as well as non-governmental organizations and universities. Today, with significant


funding from Congress, the Program continues to support projects that
benefit the silvery minnow and the flycatcher in habitat restoration,
scientific understanding of the needs of the species, and water supply and
management. 9

C. Water Acquisition and Management Subcommittee

The Water Acquisition and Management Subcommittee of the
Collaborative Program (WAM) was formed to address how to obtain
sufficient water and adjust operations to meet the minimum flow targets of
the silvery minnow and the habitat needs of the flycatcher. 10 Most of the
many Program participants had a representative on the WAM sub-
committee, which functioned under the direction of the Program's Steering
Committee. 11 The subcommittee's mission was to evaluate water acquisition
and management opportunities to support the goals of the Program.
WAM's objectives included researching, developing, evaluating, and imple-
menting water management alternatives; examining ideas for efficient
water use; and finding strategies to offset depletions caused by program
activities (the latter essentially referring to situations where program-
sponsored habitat restoration projects might require additional water).
Many members of WAM felt it was important to address reservoir storage
and operations (especially focusing on gaining long-term flexibility in
reservoir storage) because they are important components of water
management and supply.

In addition to reservoir storage, the annual renewable water supply
was an overwhelming issue for WAM as a result of the drought conditions
in 2004. Agencies were concerned with meeting the flow targets in effect for
the ten-year Biological Opinion for the silvery minnow and flycatcher. To
this end, WAM initiated and funded many activities: the installation of
gages for quantifying water flow, diversions, and return flows; the
development of a decision support system for rotational delivery of
irrigation water in the Middle Rio Grande Conservancy District (MRGCD);
the creation of a water demand budget; and research on many potential actions directed toward meeting the water needs of the Program.

D. Concept of the Preliminary Analysis

The Water Subcommittee's Preliminary Analysis attempted to develop, by consensus, a range of storage alternatives to be objectively evaluated using an agreed-upon modeling tool. The long-term goal was to propose institutional changes that would allow the Middle Rio Grande Valley to optimize its water supply and take advantage of storage flexibility in wet years. If the preliminary analysis of alternatives demonstrated potential water savings, WAM anticipated making further recommendations on productive directions for the Collaborative Program to pursue. The subcommittee anticipated recommendations that might include program-sponsored studies to more fully evaluate reservoir authorizations and operations; structured negotiations between critical stakeholders; and more detailed development of the legal, political, and environmental issues associated with alternative reservoir management scenarios. The benefit to the Collaborative Program was to potentially improve management of the water storage system and minimize the need for costly acquisition of supplemental water. It was understood that the analysis was preliminary—significant further work would be necessary in order to achieve optimal reservoir management.

The variety of interests in the waters of the Rio Grande and its reservoirs required broad representation in developing the Preliminary Analysis. The Program represented the diverse interests more comprehensively than any other forum at the time. Participation was open to any interest group that chose to participate. The Preliminary Analysis provided a good venue for Middle Rio Grande water interests to look jointly at the reservoir storage system and its constraints and to determine if the region could collectively manage the river's reservoirs more effectively and efficiently by creatively working together. WAM partnered with the Utton Transboundary Resources Center to undertake the Preliminary Analysis.

12. At the present time, San Juan-Chama (SJC) water is the primary source of water available for lease to the Collaborative Program. This water is expected to decrease over time as the SJC contractors begin to use it. Executive Committee, supra note 10, at B-3 n.1.

13. The members of WAM representing Program signatories were usually water managers, technical experts, or water resource professionals and thus were well suited to provide the expertise to develop and evaluate scenarios.

14. The Utton Center, housed at the University of New Mexico School of Law, is charged with carrying on the work of the late Professor Albert E. Utton to promote equitable and sustainable management and the utilization of transboundary resources. See The Utton Transboundary Resources Center, http://uttoncenter.unm.edu/ (last visited July 25, 2007).
The reservoirs in the Middle Rio Grande Valley were authorized by federal legislation that governs the volume of water the Middle Rio Grande can expect to store in the future, depending upon climatic conditions. There are many factors that constrain the operations of the reservoirs, including physical and legal limitations on storage space; congressional authorizations; international treaty and Rio Grande Compact obligations; and the many competing water rights demands. WAM previously developed a paper as part of its long-term plan entitled, Storage and Management of Program Water. As described in that paper, the Program area had a limited amount of physical water storage capacity in reservoirs that could be utilized by the Program.

E. The Geographic Setting

The Collaborative Program area encompasses the headwaters of the Rio Chama Watershed and the Rio Grande, including tributaries, from the New Mexico-Colorado state line downstream to the 4,450 foot elevation spillway crest of Elephant Butte Dam. The area contains land within many counties and cities in New Mexico as well as land within 18 Indian Pueblos and one Indian Nation. The average annual precipitation in the Program area is between 7 and 15 inches. In the high mountain areas, precipitation, much in the form of snow pack, exceeds 25 inches a year. The water supply for the region comes from the natural flow of the Rio Grande and its tributaries and from transbasin diversions from the San Juan-Chama project, which imports water from the Colorado River Basin. In addition, there is significant reliance on ground water, primarily for municipal use.
The majority of the surface water comes from snowmelt. The spring runoff usually begins in April and may continue through June and sometimes into July for high snow pack years. At the Otowi Bridge, where New Mexico’s upper index Compact gage is located, the Rio Grande’s average annual flow is 1.1 million acre-feet. At San Marcial, above Elephant Butte, at the downstream end of the Middle Rio Grande Valley, the average annual flow is 923,000 acre-feet. Generally, the Rio Grande gains water above Otowi and loses water below Otowi. During the summer months, precipitation from thunderstorms may be a significant contributor to streamflow for short durations and many of the Rio Grande’s largest tributaries in the Middle Rio Grande usually flow in response to these events. These tributaries include the Tijeras Arroyo, Rio Salado, Rio Puerco, and Rio Jemez (although the Rio Jemez may more frequently have snowmelt runoff). The greatest flood-producing storms usually occur between March and May and September and October.18

F. Overview of Reservoirs

The Bureau of Reclamation’s (BOR) San Juan-Chama (SJC) Project is a transbasin diversion system that imports water from tributaries of the San Juan River to supplement the native flow of the Rio Grande. This is water that would otherwise flow to the Colorado River. The water is delivered through the Azotea Tunnel that runs under the Continental Divide to Willow Creek. Heron Reservoir was constructed in 1971 as part of the SJC Project on Willow Creek. Willow Creek delivers SJC water to the Rio Chama, which then empties into the Rio Grande. The project has annually imported an average of 94,200 acre-feet since diversions were initiated. This water is not included in accounting under the Rio Grande Compact. The SJC water is primarily intended for municipal/industrial and agricultural uses.

El Vado Reservoir is the next reservoir below Heron and was built as part of the MRGCD works in 1935. El Vado is primarily used to store native Rio Chama flows for use by the MRGCD for irrigation. It is also where the BOR stores prior and paramount water for the Six Middle Rio Grande Pueblos.

Abiquiu Reservoir sits downstream from El Vado on the Rio Chama, about 30 miles upstream of its confluence with the Rio Grande. This reservoir was built in 1962 by the U.S. Army Corps of Engineers (Corps) with legislative authorization to control floods and sediment. In 1981, Congress amended the authorizing legislation to allow storage of SJC water.

18. Id.
Below Abiquiu is Cochiti Lake—the only reservoir in the Middle Rio Grande Valley on the main stem of the Rio Grande. Cochiti Dam was built to protect the City of Albuquerque from flooding. The original authorization was for flood and sediment control purposes, but authorizing legislation was added in 1964 to provide a recreational pool, and 5,000 acre-feet per year of SJC water was allocated for this purpose.

Elephant Butte Reservoir, located at the southern end of the Middle Rio Grande Valley, is where New Mexico’s Compact water is delivered to Texas. About 57 percent of the water delivered to “Texas” under the Compact is actually delivered to southern New Mexico farmers.

G. Overview of Rio Grande Compact

The Rio Grande Compact (Compact)\textsuperscript{19} is an agreement between Texas, New Mexico, and Colorado apportioning the waters of the Rio Grande above Ft. Quitman, Texas. New Mexico’s annual water allocation available for use within the Middle Rio Grande is a maximum of 405,000 acre-feet of the flow of the Rio Grande as determined based upon the measurement at the Otowi index gage located just upstream of Cochiti Lake. New Mexico’s deliveries are measured as the releases from Elephant Butte Dam plus the change in storage in Elephant Butte; thus, the evaporation loss is counted against New Mexico’s Compact allocation. New Mexico is allowed to consume all of the tributary inflows into the Rio Grande between the Otowi gage and Elephant Butte. The Compact requires annual water accounting and provides for a system of annual debits and credits based on a calendar year. Water must be retained in storage in reservoirs constructed after 1929 to the extent of each state’s debits and cannot be used. It must be released upon demand of the downstream state. Article VII of the Compact provides that, if usable storage in Elephant Butte and Caballo Reservoirs\textsuperscript{20} is less than 400,000 acre-feet, neither Colorado nor New Mexico may increase the amount of water stored in upstream reservoirs constructed after 1929. Water imported from the Colorado River Basin, in particular the San Juan-Chama water supply, is not subject to the Rio Grande Compact apportionment. The Compact does not affect the obligations of the United States to Indian tribes or impair Indian water rights.

H. Water Uses—Demands and Projected Trends

Agricultural irrigation is the largest use of surface water in the Program area. It is estimated to account for approximately 40 percent of the

\textsuperscript{20} Caballo Reservoir is approximately 20 miles south of Elephant Butte Reservoir and is operated in tandem with Elephant Butte.
water used in the Middle Rio Grande Valley. This figure does not include evaporative losses on water stored for agricultural purposes, which is approximately 20 percent of the water categorized as evaporative loss. The largest area of evaporative loss is at Elephant Butte Reservoir.

The consumption of surface water for municipal and industrial purposes is less than for agricultural purposes, but in the Middle Rio Grande Valley municipal and industrial water use is a larger proportion of consumptive water use than in other parts of New Mexico. Municipal and industrial use is currently estimated to be approximately seven percent of water used in the Middle Rio Grande Valley. This number will increase as population grows and the delayed effects of groundwater pumping reach the river. Another major component of consumptive water use in the Middle Rio Grande occurs in the riparian zone. Riparian consumption by trees and other vegetation and river and soil evaporation is estimated to be approximately 37 percent of the usage in the Middle Rio Grande Valley.

The Preliminary Analysis focused primarily on the evaporative loss component of water depletion in the Middle Rio Grande Valley. In Elephant Butte, evaporative loss is estimated to range between 50,000 and 250,000 acre-feet per year, depending upon the quantity stored, temperature, wind, etc. Water savings could occur by moving or holding some of this stored water in upstream reservoirs where the evaporative loss is significantly less. WAM also wanted to explore opportunities for changed operations, i.e., different release schedules that could provide water in the river when needed for Program purposes.

I. Upper Rio Grande Water Operations Model

The Upper Rio Grande Water Operations Model (URGWOM) is a computer model that is capable of simulating water storage and delivery operations in the Rio Grande from its headwaters in Colorado to below Caballo Dam in New Mexico. Its purpose is to model flood control operations and facilitate water accounting and planning for water operations alternatives. URGWOM is a cooperative effort of six federal agencies that began in 1996 and is led by the Corps. A vast amount of data has been developed and stored in the URGWOM database since 1996. The data include climatic conditions, riparian evapotranspiration, evaporative losses at reservoirs, evaporative losses on river reaches, seepage, water

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22. Id. at 25.
23. The Bureau of Reclamation, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the Bureau of Indian Affairs, the International Boundary and Water Commission (U.S. Section), and the U.S. Army Corps of Engineers.
operations, water usage, snowmelt runoff, and thousands of other pieces of information related to the hydrology of the Upper Rio Grande watershed.

One difficulty in using the model at the time of the Preliminary Analysis was URGWOM's level of accuracy in quantifying gains and losses after discrete quantities of water are released from reservoirs. In the 2004 to 2005 time frame, gains and losses were difficult to estimate accurately in the Middle Rio Grande Valley, especially during low flow conditions. Further data collection was needed, particularly regarding the connection between shallow groundwater and river flows. It would take time to obtain and integrate these data into the model. WAM saw the importance of continuing to develop data regarding groundwater and surface water interaction in the Middle Rio Grande Valley and has since included support for model development and maintenance in its Program funding priorities. Significant progress in the capability of the URGWOM model has been made since the completion of the Preliminary Analysis.


The Upper Rio Grande Basin Water Operations (URGWOPS) Review is a separate project that utilizes the URGWOM model to conduct a comprehensive system-wide review of water operations activities that are conducted under the existing legal authorities of the joint lead agencies: the Corps, BOR, and the New Mexico Interstate Stream Commission (ISC). These water operations consist primarily of storage and release of water at reservoirs, changing the channel capacity criteria, extension of waivers\textsuperscript{24} at Heron, and operation of the Low Flow Conveyance Channel. In accordance with the National Environmental Policy Act (NEPA), a Draft Environmental Impact Statement (EIS) was written utilizing the URGWOPS review as the basis of the Middle Rio Grande Valley's water operations. The Draft EIS evaluates environmental, economic, and social effects of alternative water operations at federally operated facilities in the Upper Rio Grande Basin within existing legislative authorities.\textsuperscript{25} The Preliminary Analysis planned to look at potential scenarios beyond what is already authorized by existing legislation. Thus, the work was distinct from the ongoing work in the URGWOPS Review.


III. PRELIMINARY ANALYSIS

A. Summary of Process

The Preliminary Analysis project began in January 2004 when confidential negotiations sponsored by New Mexico Governor Bill Richardson between parties to *Rio Grande Silvery Minnow v. Keys* had come to a standstill. As a member of WAM representing the University of New Mexico, the Utton Center suggested that one approach to water management issues might be to develop a variety of water management alternatives and then evaluate these by using an agreed-upon modeling tool. This process would provide a preliminary assessment of which strategies provided benefits to the system and which did not. Then the focus could be narrowed to look at the most promising alternatives in more detail. It was anticipated that this work would lead to a project where Program funding could be used to evaluate water management strategies — minimizing the supplemental water needs for the ESA without impairing water rights. The Utton Center was tasked with developing a scope of work that outlined an approach and this scope of work was modified by WAM as the discussion progressed.

WAM held meetings to formulate the Preliminary Analysis and various models were considered. There was a broad discussion of issues and possibilities, and many approaches were considered. A suggestion was made, for example, to examine a South African process where teams had formed and each created its own planning vision for the future. The different visions were then available for the parties to negotiate long-range solutions. As applied to the Preliminary Analysis, the idea was to form groups, each with its own view of water management practices for the Middle Rio Grande. These groups would develop separate scenarios and agree on an objective model to evaluate the hydrologic implications of each scenario. At this stage, a wide range of river management strategies (including irrigation efficiencies, voluntary agricultural forebearance, riparian restoration, and others) were under consideration.

It became apparent early on that it was necessary to know the capabilities of various models in order to decide how to proceed. The discussion turned to gaining a better understanding of the models available for use in the Middle Rio Grande and a list was compiled of potential tools, including HEC-RAS, a geographic information system based river flow

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27. The Preliminary Analysis, as was true for most Program subcommittee work, was unfunded. It was undertaken by agency personnel and other interest groups in addition to regular job duties or on a volunteer basis.
model being used by the University of New Mexico; the National Heritage Institute Rio Grande/Rio Bravo Basin Model; the Upper Rio Grande Water Operations Model; and the Sandia National Laboratories System Dynamics Model for the Middle Rio Grande. When the Utton Center researched the models, many WAM members who were familiar with these and other tools were able to provide expertise to help evaluate them. WAM discussed the models and whether they could fulfill the needs of the project and focused on URGWOM as the most highly developed modeling tool at that time. The WAM technical issues subcommittee held several meetings with the URGWOM Technical Team (Tech Team), a group of hydrologic modeling experts who were assigned to develop and improve the URGWOM model.

One concern was whether URGWOM would be useful to model river operations (such as agricultural diversions and returns) beyond reservoir operations. The Tech Team also knew that URGWOM had limited capabilities to meet specific daily flow targets as required by the Biological Opinion in effect for the silvery minnow at that time. However, there were no alternative models available that could test a variety of water operations scenarios. For this reason, the project became focused on modeling reservoir storage opportunities. URGWOM was the best tool for this work and WAM had several joint meetings with the Tech Team to develop the Preliminary Analysis approach.

The Tech Team asked that WAM prepare specific scenarios to be modeled so that they could assess how to proceed. It was understood that funding might be needed in order to make the rules adjustments in URGWOM to be able to test scenarios if the scenarios went beyond currently authorized operations. There were different viewpoints on how to approach the Preliminary Analysis. Initially, the Tech Team wanted the project to look at all stakeholder interests, not just endangered species needs. They suggested that WAM obtain broad agreement on how ownership of storage rights, water rights, and releases would be modeled. WAM felt this was beyond what was achievable and necessary at this very preliminary stage. Others were not convinced that any scenarios should be considered that went beyond the legal authorizations for each reservoir. Most participants agreed, however, that this was the main point of the exercise, since the URGWOPS Review was already examining flexibilities under existing authorities.

Some participants were concerned that trying to model improved storage without defining the use of the water for endangered species did 28. URGWOM's ability to model specific target flows has been significantly enhanced since 2004.

29. The ruleset for URGWOM consists of the Tech Team's interpretation of operational policy, regulations, preferences, and other decision-making logic.
not support Program goals. But WAM concluded that, as a first step, the Preliminary Analysis should focus on finding management strategies to maximize water supply. Subsequent phases could include stakeholders in discussions about how to manage any additional water and, later, the negotiation of some portion of the water for instream flows or for other Program habitat-related needs.

During this time, WAM was also working on other related matters, such as estimating the projected Program water demand (the amount of supplemental water needed to meet the terms of the Biological Opinion for 10 years under varying hydrologic conditions) and evaluating whether the flow targets of the Biological Opinion were realistic. WAM decided not to reexamine the flow targets as part of the Preliminary Analysis, but instead accepted them as a given. Article VII of the Rio Grande Compact, limiting New Mexico’s ability to store runoff, was also a topic because it was in effect at that time and projected to be in effect for most of the ten-year Biological Opinion. Some participants advocated that WAM should focus only on short-term water management concerns due to the exigencies of the drought. WAM members finally decided that long-term storage flexibility should be one component of its work.

At this point, WAM made another important decision: any scenario to be modeled in the Preliminary Analysis would be chosen by consensus. Before proceeding with any modeling work, all WAM members had to agree to the scenario and WAM would also obtain the approval of the Program’s Steering Committee. This agreement, although probably necessary to keep the project moving forward, ultimately prevented the Preliminary Analysis from looking at a wide range of viable solutions. The Utton Center tried to focus the project on the physical system at this stage, hoping stakeholders would see advantages in exploring whether URGWOM could show probable water gains by testing changed operations. But it became clear as alternatives were considered that each posed problems to one stakeholder or another and it was not possible to achieve consensus. Even though WAM was not able to proceed with modeling at that time, the alternatives developed and discussed were informative.

B. The Alternatives

All parties were invited to suggest scenarios that might optimize water supply in the Middle Rio Grande Valley or provide water in the system when needed for the silvery minnow. Each scenario had to address Compact delivery requirements. Several scenarios were brought up and quickly dropped because of immediate and strong opposition by a stakeholder. The discussion of these alternatives was short and cursory. Other scenarios were discussed at length and in detail before opposition surfaced. Here is a summary of the alternatives WAM considered.
1. Reauthorization or Re-regulation of Cochiti Lake

Discussion of Cochiti Lake surfaced immediately, but it was brief and the proposals were quickly dropped because the Pueblo de Cochiti was not ready to discuss various operations of the lake. Many participants were interested in the potential of modeling changed reservoir storage operations at Cochiti. Of particular interest was a proposal to model limited storage of native water in Cochiti to smooth releases from El Vado when summer thunderstorms occur below the Otowi Gage. This would preserve native water when releases have been made from El Vado to meet irrigation demand and a thunderstorm in the Middle Rio Grande Valley obviates the need for the water. The released water could be trapped in Cochiti and possibly used subsequently for irrigation, thereby potentially decreasing the need for supplemental water for the Program. Another proposal was to model the creation of a native water pool to be managed for the Program to meet the obligations of the Rio Grande Compact. The concept was to replace the San Juan-Chama pool at Cochiti. Significant detail was presented on this alternative.

The Utton Center suggested that there be no discussion of Cochiti Lake without concurrence of Cochiti Pueblo due to the sensitivity of these issues to the Pueblo. During the summer of 2004 there were indications that the Pueblo was interested in discussing the potential benefits of various operations of the Lake (in particular, the possibility of storing prior and paramount water of the Six Middle Rio Grande Pueblos). The Utton Center contacted the Pueblo on behalf of WAM to determine whether they were interested in working with the Program to model any scenarios at Cochiti. A letter was directed to the Governor requesting a meeting to discuss whether there was an opportunity to model scenarios that would provide beneficial information to both the Pueblo (as input into the baseline study underway with the Corps) and to the Preliminary Analysis. After learning that the Pueblo was not ready to discuss the lake with regional stakeholders until the completion of the baseline study, WAM put this discussion on hold.

2. Rio Grande Project Storage

The New Mexico Interstate Stream Commission (ISC) opposed any consideration of modeling alternative storage strategies for Rio Grande

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30. A discussion of Cochiti had taken place in the Collaborative Program in 2002 and representatives of the Pueblo came to the Steering Committee and voiced objection to any consideration of re-operation or reauthorization of Cochiti pending completion of a baseline study to be conducted by the Pueblo in cooperation with the Corps. The baseline study is still in progress and will evaluate the potential impacts of a range of water management options at Cochiti Lake.
Project water. This position was not discussed in detail but was most likely related to the ISC’s ongoing dialogue with Texas about relinquishments of New Mexico credit water and other Rio Grande Compact-related matters.

3. Closed Basin

A proposal was made to evaluate the timing of the delivery of water from the San Luis Closed Basin Project in Colorado. The idea was to work with the BOR and Colorado to model increased water deliveries during July, August, September, and October. WAM was reminded that the Steering Committee requested that water sources from within Colorado not be considered to meet Collaborative Program needs. A commitment had been made on the part of the State of New Mexico not to seek contributions to the Program from Colorado. There was correspondence from the Division Engineer in Alamosa, Colorado to this effect, and he forwarded it to WAM upon learning of this proposal.

4. Agricultural Forbearance

Modeling an assumed level of voluntary agricultural forbearance in the MRGCD was proposed where farmers with water rights could voluntarily agree not to use their water in certain circumstances—usually during a projected drought year—in exchange for compensation. Modeling of this scenario was opposed by the MRGCD for several reasons. First, the scenario was drafted to model a five-percent MRGCD demand reduction, and although it contemplated compensation to irrigators who would voluntarily forebear, the MRGCD characterized it as an arbitrary reduction in MRGCD water supply.

Because a feasibility study of forbearance was in progress, MRGCD staff felt that any further investigation of forbearance prior to completion of the study would be premature. The MRGCD also maintained that its system has a fixed volume of losses depending upon flow, time of year, and other factors, so that modeling a percentage demand reduction would not accurately translate into additional water in reservoirs. The MRGCD also stated that the water flowing through its system does not belong to the MRGCD, but rather to the individual landowners. Finally, the MRGCD felt that Middle Rio Grande Valley gains and losses were not refined sufficiently in URGWOM to model a forbearance alternative. For these reasons this alternative was dropped pending the results of the forbearance feasibility study.

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31. Rio Grande Project water is water delivered to Elephant Butte and Caballo reservoirs for use in southern New Mexico, Texas, and Mexico.

32. As of February 2007, the Program continues to struggle with whether a voluntary compensated agricultural forbearance (or leasing) program in the MRGCD is feasible.
5. Abiquiu Reservoir

Two of the scenarios that were discussed in detail concerned Abiquiu Reservoir. Under one scenario, Abiquiu Reservoir operations would be modeled to retain water in Abiquiu in lieu of release to Elephant Butte Reservoir in May or June. Storage of native water would take place in unused City of Albuquerque storage space.

Currently, when the inflow to Abiquiu Reservoir exceeds downstream channel capacity, the water is stored but released by July first. However, after July first, when the natural flow at Otowi gage falls below 1,500 cfs, the Corps is prohibited from releasing flood waters until November first and must fully release all flood waters by March 31 of the following year. The release of the carryover flood water in storage is normally set at a uniform rate. Releases in May and June cause higher loss rates through the Middle Rio Grande Valley and higher evaporation rates if the water is stored in Elephant Butte Reservoir. This scenario looked at storing compact delivery water and holding the water until November first. Channel losses, compact deliveries, peak flows in the Middle Rio Grande Valley, and reservoir losses would be compared to determine impacts and benefits.

Holding water until November first raised concerns about brown trout spawning and fishery habitat in the Rio Chama below Abiquiu Dam. Several options were proposed to address this concern. One would be to evacuate storage between November first and December 25 at a uniform rate rather than delivering all the water in late December, as had been done in the past. The second would be to evacuate the storage beginning November first through March first. At all times the release rate from Abiquiu Reservoir during the irrigation season (at times when Abiquiu would be storing) would be set in accordance with MRGCD demand and other demands downstream (such as Biological Opinion requirements) at Cochiti Dam, less mainstream flow. No storage would take place if downstream demands were not being met. The irrigation demand would be set at the 2004 demand, as provided by the MRGCD.

Another proposed scenario for Abiquiu Reservoir was based on retaining water in Abiquiu when it was not needed for delivery to Elephant Butte to meet Compact deliveries. The modeling time frame was to be a 40-year period, with the beginning condition an Article VII year, replicating the current drought cycle. After that, the model would utilize the sequence that URGWOPS uses, which is a random sequence of wet, average, and dry years. The alternative was structured to retain water in Abiquiu "if and when" storage space was not needed by the City of Albuquerque and its
The expectation was that there would be significantly less evaporative loss by storing the water in Abiquiu as opposed to delivering it to Elephant Butte. The first phase of this analysis would quantify the potential gains in water supply over a 40-year period for the Middle Rio Grande Valley based upon this revised operation. A subsequent phase would be required to study how to manage this water.

During the course of WAM’s discussions, the City of Albuquerque objected to pursuing any studies that would change the operations of Abiquiu. According to the City, the Program placed too much emphasis on looking to City-controlled facilities for water supply and management solutions and did not seek solutions from the other involved parties. The City explained that it would be more amenable to working with the Program on alternatives at Abiquiu if other entities would agree to model changed reservoir operations in other reservoirs. In particular, the City believes Cochiti Reservoir offers great potential.

Because WAM could not achieve consensus on modeling changed operations at Abiquiu, it was not pursued. As alternatives at Abiquiu are considered in the future, the following factors will be required in order to implement changes in how the reservoir is managed: agreement on proposed operational revisions and management of any conserved water, approval of the Rio Grande Compact Commission, a detailed environmental analysis, a permit to store water from the State of New Mexico, and legal agreements for water storage.

6. Heron Reservoir

WAM also discussed operations at Heron Reservoir in order to determine the best place to store Program-acquired supplemental water (San Juan-Chama water acquired from willing lessors). WAM hoped to evaluate the ability to carry over San Juan-Chama water in Heron instead of being forced to move the water to Abiquiu or El Vado if not needed in a particular year.

One alternative involved modeling (as a sample pool) storage of the City of Santa Fe’s San Juan-Chama water assuming delivery in 2003 had been taken at Heron Reservoir instead of moving the water to Abiquiu. A comparison of two different ways of managing the City of Santa Fe water

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33. The City holds easements on the land where the reservoir sits and controls the reservoir storage space via a storage contract with the Corps. The City of Albuquerque water utility is now the Albuquerque-Bernalillo County Water Utility Authority.

34. Since the date of the Preliminary Analysis, the City has agreed to work with the environmental Plaintiffs in *Rio Grande Silvery Minnow v. Keys* to create space for a 30,000 acre-foot environmental pool at Abiquiu; the URGWOM Tech Team is working under a contract with the Program on Abiquiu alternatives; and, as of February, 2007, the URGWOPS Draft EIS includes alternatives at Abiquiu within existing authorities.
would provide an example for quantifying the difference in evaporative loss in storing the water in Heron Reservoir rather than moving it to Abiquiu. Currently, SJC water contractors must take delivery of contracted water in storage at Heron Reservoir by the end of the year, either by use, sale, or by contracts for storage elsewhere. Ownership of contracted water that is not withdrawn or transferred from Heron Reservoir by December 31 reverts to Heron as part of the project water supply. In the past, the BOR had negotiated temporary waivers with contractors to allow carryover until April 30 in order to provide release rates on the Rio Chama to enhance the fishery between El Vado and Abiquiu Reservoirs during the winter and provide flexibility in managing river flows. Temporary waivers have extended beyond April 30.

The first Heron alternative would require significant rules changes to the URGWOM model. This alternative is more complicated than Abiquiu due to the connection between the authorizing legislation for the San Juan-Chama Project and the compacts on the Colorado River. The City of Albuquerque argued that any modification of the “no carryover” provision in the City’s San Juan-Chama Project water service contract with BOR for delivery of water at the Heron Reservoir outlet works would require an amendment to its contract. The City of Albuquerque did not support modeling this scenario because it did not want to amend its contract.

A second Heron alternative would have evaluated the capture of native Chama flows in Heron. These flows are currently bypassed because Heron Reservoir is only authorized for storage of imported SJC water. The potential magnitude of native inflow to Heron is relatively small, about 16,000 acre-feet average per year over the past 20 years. Potential operational benefits are minor. The legislative authority to store native water in Heron does not currently exist. Modeling this alternative would require a significant rules change in URGWOM. A new set of hypothetical rules would need to be developed because Heron currently only has accounts for contractors’ San Juan-Chama water.

Changes to Heron’s operations would be difficult for many reasons. Ownership of Rio Grande water rights and the right to store would be required in order to store native water in Heron Reservoir. The acquisition of Rio Grande or Rio Chama water rights would be expensive and, unless the water rights are senior rights, storage in Heron would not be allowed unless all downstream water rights had been satisfied. An amendment of the Heron contract would be required, and as previously discussed, a major stakeholder (the City of Albuquerque) was opposed to seeking congressional changes to the authorization of Heron.

7. El Vado Reservoir

Proposals regarding El Vado were not very fully developed since the preliminary ideas involved relocating the prior and paramount water stored for the Middle Rio Grande Pueblos from El Vado to either Cochiti or Abiquiu. Because discussion of those two reservoirs was taken off the table, discussion of El Vado was fruitless. During Article VII or in drought years, changes at El Vado might be helpful. When Article VII is not in effect, El Vado fills frequently and there is not room in the reservoir for Collaborative Program water storage; nevertheless, operation of El Vado should be evaluated in conjunction with alternatives at the other reservoirs to see if improvements can be made.

IV. CONCLUSION

Much progress has been made on water management and storage in the Middle Rio Grande Valley since litigation concerning endangered species began in 1999. The Collaborative Program’s Preliminary Analysis, concluded in 2005, while not resulting in model runs, illustrated the variety of options, the challenges each faces, and the relative positions of the parties. Talks between the stakeholders and agencies about reservoir storage flexibility have continued and a funded Program project for the URGWOM Tech Team to work with WAM on modeling is underway. Meanwhile the Draft Environmental Impact Statement (EIS) for the Upper Rio Grande Water Operations Review was completed and was still under review as of early 2007. The EIS may provide new directions to look beyond existing authorities.

The environmental Plaintiffs in Rio Grande Silvery Minnow v. Keys settled their suit against the City of Albuquerque, and Abiquiu storage was included as a component of the settlement. The arrangements for how the storage space will be operated have not been developed, and WAM may continue to have some involvement in this issue through the modeling project with the URGWOM Tech Team. The Preliminary Analysis led the Utton Center, in conjunction with the Natural Resources Journal, to sponsor a Rio Grande Reservoir Symposium in 2006, where there were several groundbreaking presentations on the reservoirs. In short, the work of the WAM on the Preliminary Analysis was important to furthering the dialogue on reservoir issues.

Solutions to the water supply problems for the Middle Rio Grande and its endangered species will need to come from a variety of sources and water management strategies. All possibilities should be considered, including changed reservoir operations.

In a drought cycle, it is hard to work on long-range scenarios that might only reap benefits during wet cycles. The reality of long-term climate change on top of the highly variable seasonal supply adds to New Mexico’s water management challenges. But, the Middle Rio Grande Valley must be prepared for wet years when they come.

In 1988, when meetings were held on the Reevaluation of the Rio Grande Operating Plan, there was excess water in the Rio Grande system and every reservoir in the system was at the limit of its legally authorized storage—Elephant Butte Reservoir was overflowing and flooding occurred below El Paso. Eight of the ten years preceding 1988 experienced higher than normal runoff and all authorized conservation space in the basin’s reservoirs was filled. It would have been advantageous to be able to use flood space for conservation purposes, rather than being forced to release water as required by law.

Early in the debates about how to address the water needs of the silvery minnow, six collaborating agencies prepared a White Paper outlining recommended management options. The Program and WAM deserve credit for pursuing and continuing to explore many of these options. It is interesting to note that in the White Paper operational and institutional changes to reservoirs were considered a high priority:

Attention should first be directed towards more immediately attainable actions such as upstream water management options...and efforts should be initiated to make institutional changes as may be deemed appropriate to help accommodate both water users and the silvery minnow in the long-term. Where additional studies are deemed required to fully evaluate a potential action, the agencies and entities represented in the preparation of this paper should cooperate in securing the necessary resources to complete such studies promptly.

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38. Id. at D-29.
Although the Preliminary Analysis was intended to be an objective and technical assessment of viable approaches to complex water management issues, it is obvious that the discussion ultimately turned on other considerations—social, political, and legal. Some criticized WAM for taking on such a contentious issue.

In the long run, the river must have a sustainable supply, not just for endangered species, but for human well-being and survival. Stakeholders in the Middle Rio Grande Valley must work together to optimize the use of the Rio Grande reservoirs: meet the needs of water users, make New Mexico's required Compact deliveries, and meet the water requirements for the endangered species. Objective, scientifically sound analysis of alternative management strategies is the place to start.