MAINTAINING THE MIDDLE RIO GRANDE VALLEY, NEW MEXICO: A LIVE RIVER OR A DEAD DITCH?

by

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The Middle Rio Grande Valley in New Mexico is a region plagued with predictions of projected drought, water shortage realities, subsiding ground water aquifers, decreasing cottonwood riparian habitat, and with inefficient federal and state water management agencies. The channelization of the Rio Grande throughout central New Mexico is necessary in order for the state to meet the demands of all downstream users in southern New Mexico, Texas, and Mexico. Growing populations and increasing development along the Middle Rio Grande river corridor help contribute to the continued degradation of the riparian ecosystem, and place further demands on the limited resource. The New Mexico state legislature continues to reject bills proposed by environmentalists to implement instream flow legislation that would conserve a certain amount of streamflow solely for ecological purposes. All of these factors combine to create a challenging future for the water management and conservation of New Mexico's Rio Grande. By evaluating and analyzing diverse suggestions to solving New Mexico's water issues, I hope to present a clearer vision of what steps are necessary in changing the threatened state of the Middle Rio Grande ecosystem. I propose in my thesis my idea to create a state umbrella organization responsible for the monitoring and organization of the

Middle Rio Grande Valley's management and conservation process. This water watchdog group will ensure that the Rio Grande is protected, restored, and managed efficiently and responsibly for future generations and for ecosystem integrity.

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CHAPTER 1
INTRODUCTION

La tierra es la madre, y el agua es su sangre.
Sin agua, la tierra no vale nada.
The land is the mother, and the water is its blood.
Without water, the land doesn't matter
(Rivera, 1996, p. 496).

Stretching from the Cochiti Reservoir to the Elephant Butte Reservoir, the Middle Rio Grande Valley in New Mexico faces key management problems in its future water policies. The Rio Grande begins 12,500 feet above sea level in the San Juan mountains of Colorado, following a course through Colorado, New Mexico, along the Texas border with Mexico, and then merges with salt water in the Gulf of Mexico (figure 1). This study is concerned with the Middle Rio Grande and how its transformation from a meandering and braided river to a highly channelized and linear channel is attributed to changing economic, political, social, and environmental dynamics in New Mexico. Such dynamics have negatively altered the arid Middle Rio Grande Valley such as placing in jeopardy the integrity of the cottonwood riparian habitat, the endangered silvery minnow population, and the natural physical state of the Rio Grande. Federal and state water agencies' proposals for future growth and development in this region illustrate the disregard for the present limitations on the Middle Rio Grande Valley's water supply and on the survival of the riparian ecosystem. New Mexico's water management denies the reality that the state faces another widespread drought that could persist for twenty years or more, the largest drought expected for the region since the last dry spell peaked in the 1950's throughout the Middle Rio Grande Valley (Fleck, 2000, B1). Charlie Liles, the New Mexico Weather Service's top official revealed the saverity of New Mexico's water shortages. These critical ecological issues threatening the survival of the Middle Rio Grande Valley in New Mexico therefore make it vital to enforce environmental protection and restoration of the Rio Grande as well as utilize the many proposals, suggestions, and plans arising throughout the region for more

efficient water management and conservation.

My recommendations for solutions to New Mexico's future of predicted drought and continued water shortage include the formation of a state umbrella organization responsible for keeping account of river management. This monitoring body would ensure action for river restoration, reestablishment of wetlands, and protection of endangered species such as the silvery minnow. The organization would also enforce responsible riparian management in New Mexico including lobbying for instream flow legislation, returning water rights to ecological purposes, and returning the physically constricted river to a more natural state. Citizen involvement in these procedures is vital to the future of New Mexico's lifeblood.

In the middle of the high and arid desert in New Mexico, water is life. The fight over water rights, water allocation, and water sources has been heightened recently because of the dire water shortage realizations. The overuse, overdrafting, and degradation of the Rio Grande are finally being presented to the mainstream population throughout the state; despite the growing severity of the river's inability to sustain growing populations in the middle Rio Grande valley for over fifty years, the issues have received scant attention. The increase in population has placed a considerable pressure on the Rio Grande ecosystem, the ground water supply, and the water stored in upstream state reservoirs. New Mexico is scrambling in the courts to satisfy all stakeholders for the Rio Grande water, most recently passing measures to allot water for the endangered silvery minnow that resulted from a highly controversial lawsuit. These fights in the state legislature, the lack of habitat restoration along the cottonwood riparian corridor, the lack of realistic foresight into the future sources for Albuquerque's water supplies, and the lack of sufficient fines for overdrafting all miss the real problem at hand with New Mexico's water management and conservation. In order to ensure the Rio Grande's prosperity as a live river and not a dead ditch, the following measures need to be implemented: lifestyle changes, new legislation regarding instream flow rights, more efficient state-wide private and public water use and reuse, fines for public and private overdrafting, the fight against transfers to upstream users, more public education about the water

shortage and depleting ground water supplies, and the formation of community water monitoring organizations. As a state with so much culture and pride, it's time New Mexico concentrated its efforts to save its endangered Rio Grande ecosystem and the disappearing water supplies for its expanding users.

My thesis is an evaluation of the current collection of various water management and conservation plans presented by the Middle Rio Grande Conservancy District (MRGCD), the Albuquerque mayor Jim Baca, specific interagency teams of biologists determining the state of the river and proposals for action, the Alliance for the Rio Grande Heritage (a group of twelve environmental groups throughout the southwest working on Rio Grande issues), and many other proposals from environmental organizations and concerned individuals. I will select certain suggestions for solutions to the Middle Rio Grande Valley's diverse water management and conservation challenges based on my idea of how well they will be effective in the current situation. I will also include my own ideas and suggestions for water management and conservation plans, the methodology of which is based upon other successful national and global plans and my personal reflection on water issues after growing up in Albuquerque.

What is not needed right now in New Mexico is another synthesis on the Middle Rio Grande basin and comparable recommendations for restoration, mitigation, and management and conservation methods. What is necessary instead are ideas on how to implement the many proposed plans for the state of the Middle Rio Grande Valley and continued support of these plans by the state, the citizens, and the federal government. This kind of communal support for environmental protection is difficult in a state that is easily swayed by developers' investments in new regional businesses. I will present obstacles such as this in my thesis and provide suggestions of how to best mitigate the current problems in New Mexico's water struggles.

This paper will be separated into sections highlighting a brief background, history, and geography of the Middle Rio Grande Valley, a presentation of the current problems facing the Rio Grande and the residents of Albuquerque in their

search for water, and an evaluation of the current water management and conservation solutions. This paper will focus on my suggestions for the Middle Rio Grande, and illustrate the real problems at play in the struggle to find a sustainable, realistic, and responsible water management and conservation plan for the Middle Rio Grande Valley.

CHAPTER 2
BACKGROUND

The Rio Grande basin encompasses a 355,500 square mile area, beginning near Creede, Colorado in the San Juan mountains and draining into central New Mexico and on into northern Mexico. The Middle Rio Grande Valley, defined as the stretch between the Cochiti Dam, southwest of Santa Fe, and the Elephant Butte Reservoir, south of Socorro in southern New Mexico, is an area of heated controversy (figure 1).

Water in New Mexico has been revered as a spiritual gift from the gods because of its importance in the existence of many cultures, beginning with the Pueblo people c. 900 AD. The Puebloan culture, called the Anasazi, populated the Four Corners area and migrated further south into northern New Mexico and along the middle Rio Grande basin. The Anasazi excelled in architecture, such as can be seen at the ruins of the ancient city in Chaco Canyon, New Mexico. However, the agriculture of the Anasazi was much more primitive than the Hohokam, "the People Who Are Vanished" of the Pimas, who lived along the valleys of the Salt and Gila rivers in present day Arizona. The Anasazi had more difficulties cultivating the land in the Four Corners area because of the shorter growing seasons, limited supply of water, as well as the tendency of the Anasazi to inhabit cliffs and mesas for protection (Finch, Whitney, Kelly, Loftin, 1999).

Despite these limitations, valley floors were used for floodwater farming which consisted of selecting areas that were periodically inundated with floodwater. Close observation skills and knowledge of how to divert high velocity floodwaters into man-made reservoirs and channels made this method highly efficient and productive for crops. Fields in the path of water runoff were used to create earthen dams that impounded the water. Reservoirs and a system of ditches built with stone reinforcements are found today at sites in the Chaco Canyon complex, proving the Anazasi used stabilized channels of water for their agriculture and water supplies (Finch, et al., 1999).

The arrival of the first Spanish expedition of Francisco Vasquez de Coronado in 1540-1542, and the subsequent violent Spanish occupation of New Mexico by Juan de Oñate in 1598, marked the environmental history of New Mexico (Finch, et al., 1999). Once the Spanish began to colonize areas previously occupied by the Pueblo Indians, cultural practices were either subjugated or implemented into the Spanish colonial model. In regards to the already established irrigation system of the Pueblo Indians, the Spanish used the earthen ditches (translated in Spanish as *acequias*) in order to divert the Rio Grande to sustain their colonies.

This common-property irrigation system still exists today in northern New Mexico and southern Colorado, incorporating community membership and group management. The directly democratic acequia system allows all irrigators the chance to participate in the functioning and operations of their institution (Rivera, 1996).

This Spanish rule in New Mexico came to an end once the United States conquest of the state in 1846 brought a new form of government. Along with this government came the belief that New Mexico needed a centralized authority for water administration instead of the traditional Acequia institution. This centralized authority would make expansion throughout the West much easier for the U.S. government, as explains John O. Baxter (1997) with the following:

> The coming of the railroad in 1878 suddenly integrated New Mexico into the national economy and brought a new surge in population growth. At the same time, politicians in Washington and in state and territorial capitals recognized the tremendous potential for economic advancement throughout the West offered by large-scale irrigation projects (p.108).

These large-scale irrigation projects were made possible in 1907 once members of the United States legislature designated a territorial engineer responsible for state-wide water projects. This state engineer was given power over the allocation of water as well as the approval of new irrigation projects.

In 1923, New Mexico state legislature passed the Conservancy Act that caused the formation of conservancy districts. Responsibilities for these districts include addressing flood control, water drainage, and irrigation. The Middle Rio

Grande Conservancy District (MRGCD) was therefore formed in 1925 in order to help drain New Mexico's farm lands and construct irrigation works such as dams for water storage and flood control. This measure was necessary during this time period of great growth in the Middle Rio Grande Valley as well as during further growth in the early 1940s. Further transformation to the Rio Grande was followed once the state entered a peak drought in the 1950s and measures were taken to meet the state's water obligations to downstream users under interstate compacts (Baxter, 1997). The extreme channelization and impoundment issued under the Middle Rio Grande Project created the current constraints on the Rio Grande (Alliance for the Rio Grande Heritage, 2000).

The three most important water agencies in New Mexico include the Middle Rio Grande Conservancy District (MRGCD), the State Engineer's office, and the Bureau of Reclamation. MRGCD is responsible for the water supply and the drainage facilities from the upper northern reaches of the Middle Rio Grande valley starting at the Cochiti Dam to the lower southern reaches ending at the Elephant Butte Reservoir (figure 2). This conservancy district is responsible for four divisions: Cochiti, Albuquerque, Belen, and Socorro (figure 2). Federal agencies such as the Bureau of Reclamation and the Corps of Engineers are in charge of distributing water to not only the irrigation districts but towards urban and domestic uses. For example, water is distributed to MRGCD's Albuquerque district from the Cochiti reservoir and the Angostura Diversion dam upstream, including water from the San Juan-Chama diversion project in southern Colorado. The Middle Rio Grande Conservancy District oversees the distribution of these reservoir supplies under the jurisdiction of their districts. MRGCD is also responsible for overseeing and collecting taxes on 278,000 acres along the Middle Rio Grande valley.

The State Engineer's main responsibility is to maintain records of all permitted water uses, grant permits for new uses, and supervise applications for proposed water right transfers. The Bureau of Reclamation's most important responsibility is the management of the San Juan-Chama reservoir water in accordance with federal law and in response to delivery requests from water contractors. MRGCD and the

City of Albuquerque are the largest water purchasers of this water. And last but not least, the U.S. Army Corps of Engineers is responsible for flood and sediment control facilities.

CHAPTER 3
CURRENT SITUATION

In this section I will reveal the current physical, political, economical, and social management and conservation challenges the Middle Rio Grande Valley faces today. A background of water use within this region and the following critical issues are described: instream flow legislation, problematic state water policies and water administration, the endangered silvery minnow, inefficient water use by MRGCD, subsiding aquifers and the search for water, and the degenerated Bosque habitat. This information is necessary to understand the many factors that are negatively altering the Rio Grande habitat and depleting the limited water sources.

Water Use in New Mexico, 1990 (USGS report)

Besides the 1990 USGS water use report for New Mexico, the most recent water use summary for New Mexico is the 1995 data available on the USGS water use page online, presented by each U.S. county (http://water.usgs.gov/watuse/spread95/nmco95.txt). Since the 1990 publication is the most recent in-depth coverage of New Mexico's water use data with a full analysis, this report is presented.

The US Geological Survey Water Resources Investigations Report for 1990 (Garrabrant 1994) presents the amount of surface water and groundwater that was withdrawn and depleted within the state in 1990. The New Mexico State Engineer's Office defines withdrawals as the amount of water removed from either surface water or groundwater sources. Depletion is defined as the part of a withdrawal that is either consumed by humans or livestock, incorporated into crops or products, evaporated or transpired, or otherwise removed from the system. Total freshwater withdrawals in 1990 were 4,230,000 acre feet. Of this total amount, sixty two percent was depleted (2,640,000 acre feet) and the remainder was returned to surface or ground water sources. These freshwater withdrawals include irrigated agriculture, reservoir

evaporation, public water supply, mining, power, and other public uses such as domestic, livestock, commercial, and industrial.

Irrigated agriculture constituted eighty percent of the total amount of withdrawals (3,380,000 acre feet) in order to irrigate crops such as alfalfa, wheat, planted and native pasture, cotton, grain, sorghum, and corn. Irrigated agriculture accounted for seventy five percent of the total amount of depletions in the state. The amount of total irrigated cropland in New Mexico for 1990 was 984,000 acres.

Reservoir evaporation was estimated at twenty eight reservoirs with average storage capacities of 5000 acre feet. The net evaporation was 324,000 acre feet, accounting for twelve percent of all the water depleted in the state. Questions of more efficient reservoir construction and proper storage procedures need to be addressed by the federal water agencies in charge of these twenty eight reservoirs. This amount of water evaporating from the system could be more efficiently used for ecological purposes such as instream flow.

Public water supplies include the water withdrawn by public or private suppliers like utility companies, cities, municipalities, and community systems in order to be sold for domestic, commercial, or industrial use. Public water accounted for seven percent of the total withdrawals (306,000 acre feet). Bernalillo county had the largest public water supply withdrawals at 125,000 acre feet. This makes sense because Albuquerque (Bernalillo county) is the largest city in the state and utilizes large quantities of water for the increasing population and the new development for businesses relocating to New Mexico.

Instream Flow Legislation

New Mexico is the third most arid state in the United States, receives an annual 87.7 million acre-feet of surface water and precipitation of which 97% evaporates, and depends mostly on the collapsing and unsuitable ground water for its water supply (DeYoung, 1994, p.1). The overdrafting of the Rio Grande describes the state's idea of water management. Water is already allocated for

multiple purposes even before the water molecules are deposited in the form of rain or snow. In order to provide environmental protection of upstream riparian habitats and of riparian buffer zones along the current central river corridor, it is vital that water allocation measures are passed in the state legislature to strengthen the New Mexico Attorney General's formal opinion on instream flows. Instream flow would support ecologic values, keeping the Rio Grande wet year round for endangered species, other threatened wildlife, and for the health and integrity of the riparian ecosystem. Obstacles in the implementation of instream flow legislation include the repeated rejection of instream flow bills by the Interstate Stream Coalition and the State Engineer, as well as policy arguments over the definition of instream flow administration for key interests such as agriculture and Acequia members.

Environmentalists have proposed bills in the conservative state legislature to legally protect instream flows and to protect these instream flows by prohibiting new diversions in specific regions along the river corridor. These proposed instream flow bills did not pass because most legislators argue that instream flow legislation is not as crucial as advocates suggest. Appeals have been unsuccessful in changing the legislature's decision on instream rights (Fort, 2000, p.155). The formal opinion by the state Attorney General on instream rights and the decisions made by the New Mexico Supreme Court regarding diversion requirements for legitimate water rights complicate any clarification of New Mexico's instream flow legislation.

The difficulty in establishing instream flow legislation begins with the assumption under New Mexico state law that in order to legally protect a water right a diversion of the questioned water is necessary. However, there is no record of this requirement in the state constitution nor the state statutes (Fort, 2000, p.157). The necessity of this diversion requirement in order to validate a water right is vague under the state constitution and is therefore highly criticized because of its many possible interpretations. The state Supreme Court has cited the diversion requirement as a necessary measure for water rights in one case involving pre-1907 rights based on agricultural uses (State *ex rel. Miranda v. Reynolds,* 83 N.M. 443, 493 P.2d 409 (1972)). Water rights issued before 1907 do not require a water

permit from the state engineer, therefore relying mostly on the prior appropriation doctrine (further discussion on this doctrine presented under NM legal procedures). The New Mexico Supreme Court decided in the *Miranda* case that a diversion was necessary for a legitimate water right. However, this rule was announced under circumstances that aren't likely to be repeated. Even though the New Mexico Supreme Court clearly interpreted the status of pre-1907 rights in the *Miranda* case, confusion is still rampant in the state's standing on the diversion requirement. The diversion requirement has been criticized as an inaccurate reading of the state constitution provisions, as C.A. Klein reiterates with the following:

> Western water decisions use the diversion element of appropriation as a convenient, but highly inaccurate, proxy for the constitutionally mandated beneficial use requirement. Thus, courts have elevated the constitutional myth that all water uses must involve diversion in order to receive legal protection. This mythology has undermined the integrity of an entire body of law (Fort, 2000, p.158).

This constitutional mythology has confused New Mexico's law on water rights since there are no state statutory provisions that require a diversion (Fort, 2000, p.158). As well, the state Attorney General has issued an opinion finding that the state constitution does not require a water diversion for a legitimate water right (Fort, 2000, p.157).

The Attorney General, upon pressure from a letter from two New Mexico state senators, Dede Feldman and Carlos Cisneros, that in 1997 requested an opinion on whether instream flow was recognized under state law, issued a response in 1998. After consulting with the State Engineer, the New Mexico Attorney General issued a formal opinion providing a legal basis for the State Engineer to address and allow instream flows. Since the majority of New Mexico's water rights are already appropriated, it only allows instream rights to be proposed from water transfers. This opinion is therefore limited in its applicability. Since designating new water rights for instream flow are unlikely in the state, instream flow is therefore dependent on further legislation in regards to the water market. Denise Fort

(2000), a law professor at the University of New Mexico School of Law explains these limitations of the Attorney General's 1998 formal opinion with the following:

> As long as the proponents of instream flows were required to seek legislation, instream flows were doomed except for very narrowly drawn bills. With the clarification that the existing state constitution and laws need to be changed, legislative efforts can be directed toward measures that will be needed to reallocate water uses to achieve a more balanced system (p.156).

This opinion definitely allows for further discussion of instream flow rights in the state legislature, but it requires much more effort from the legislators and the concerned interests of Rio Grande's water.

However, at least under this formal opinion water rights can be assigned for instream flow without adhering to the diversion requirement. Since instream rights will only be proposed as the result of water transfers, requirements for a legitimate water right such as diversion, beneficial use, and a date of creation would only apply to the original right proposed for transfer. Therefore, the establishment of an instream right does not under New Mexico law require a diversion or any constructed works.

Efforts to educate the two interests most opposed to the implementation of instream flow, agricultural representatives and members of Acequias, is yet another vital measure to ensure instream rights. Water fights arise once the mere suggestion to transfer water rights for ecological purposes is presented. Agriculture plays an immense role in water allocation in New Mexico considering it consumes ninety percent of the total surface water from the Rio Grande each year (DeYoung, 1994, p.1). Steve Reynolds, the director of the organization Rio Grande Restoration, stresses the need to loosen agriculture's grip on New Mexico's water allocation so that more power and control of the state surface water can be distributed throughout to all the region's users (personal communication, October 9, 2000). Agricultural interests are opposed to instream flow protection because of the many possible different meanings of instream flows. For example, there is the belief that protection of instream flows would occur without any regard to already existing ownership rights. However, the reality of the situation under the 1998 formal opinion from the

New Mexico Attorney General requires instream flow rights to be acquired from water transfers and not from existing water rights. Buying and selling of water rights in a market model is the only possible way for water rights to be transferred for instream flow protection because the state's rivers are already fully appropriated (Fort, 2000, p.160). Therefore, agricultural interests are protected under the market model and need not worry that instream flow protection would take rights away from their monopoly of New Mexico's surface water unless they attempt to transfer their water rights.

Acequia interests are concerned about instream flow protection because they fear that new interests trying to purchase water rights held by Acequia members would increase under the proposed legislation. This recent threat to the integrity of the Acequia association incorporates interested developers buying Acequia members' water rights. However, I think that in regards to the implementation of instream flow rights, concerned parties such as environmentalists would advocate for the Acequia association's desire to keep their historic institution intact than encroaching development. In order to integrate instream flow protection into New Mexico's existing water market, I think that a constituency should be built between all interests such as irrigators, environmentalists, cities, agriculture, and the Acequia association.

Problems with New Mexico Legal and Administrative Water Procedures

The main issue at hand in evaluating New Mexico's state surface water appropriation procedures is the state water law that is based on the prior appropriation doctrine, used only by several western states. As it stands, the first user to come across a waterway has the right to use it as long as the first appropriator puts the water to beneficial use. Subsequent users cannot apply for that water once the first appropriator has full legal rights. Beneficial use is described as an agricultural, commercial, industrial, or recreational use that does not waste the

allotted water. The state constitution does not define beneficial use nor are there any state cases that consider recreational, wildlife, or ecological purposes (Fort, 2000, p.157). However, there is record from the past State Engineer Steve Reynolds in a letter from 1984 stating the following, "...it cannot reasonably be argued that instream flows and use of water for fish and wildlife, recreation and aesthetic purposes in the State are not beneficial" (Fort, 2000, p.157).

Water rights are based primarily on their priority dates when works were first initiated to divert water from its location. Water rights have been traditionally permitted if human-made impoundments or diversions such as dams, irrigation ditches, or wells have been added onto the land. Two main problems with these diversion requirements grafted onto the prior appropriation doctrine include encouraged headwater diversions from riparian habitats and encouraged diversions because of the threat to lose water rights if not put to beneficial use. This appropriation procedure came into effect during the colonial and territorial period. The only type of water rights that was recognized during this time was water diverted into a ditch or drawn from a well. Therefore, the first diverters were protected under the diversion requirement so that other appropriators would not try and use their water rights. Part of this recognition of water rights was the requirement for the diversion to be from its natural source, therefore encouraging diversions directly from the riparian ecosystem.

Another harmful procedure still in use today in New Mexico under the prior appropriation doctrine deals with the forfeiture of water rights if no water has been used (DeYoung, 1994, p.5). Water rights owners might divert water from aquifers or surface sources that they don't need just because they fear losing their water rights. Even though the New Mexico State Engineer does not always enforce this rule, there still are water rights holders who have continued unnecessary withdrawals in order to prevent forfeiture of their rights. This kind of law needs to be altered because it does not advocate responsible water use; instead, it only increases the amount of unnecessary diversions in the state.

A disturbing factor of New Mexico's adjudication of water rights (legal action to

protect/establish water rights through quantification) is that the State Engineer has not yet adjudicated the Rio Grande and most of the underground basins. Since water rights along the Rio Grande have not been legally sorted out, no one knows exactly the amount of water to which each user is entitled. The main reason for this is that adjudication is a long and tedious process since all the claims for the questioned water rights have to be made part of the legal action. Controversies and conflicts on users' claims would definitely arise along the main stem of the river if adjudication procedures were attempted.

Yet another state surface water appropriation procedure that needs to be amended is the transfer of water rights. Considering that the state of New Mexico does not recognize instream flow legislation, it is difficult to implement environmental activism at this legal level. However, one successful attempt to incorporate environmental issues into the legislature's agenda is the protest of proposed water transfers. These proceedings offer opportunities for the general public to participate in protecting their local environment.' For example, upon filing an application to the State Engineer to transfer water rights, the applicant must publish a legal notice of the proposed transfer in the local media in the region where the transfer would be effective. This mandatory publication not only invites public participation, but it offers a key opportunity to counteract any proposed environmentally damaging transfers.

Protested transfers can be submitted to the State Engineer after the applicant's legal notice has been in circulation for three weeks only if the protests contain one or more of the following legalities: impairment of any water rights, detriment to the public welfare, or detriment to water conservation within the state. After amendments of the state water law statutes in 1985 that would allow protests based on public interest or conservation criteria, fighting proposed transfers has become a good opportunity to fight upstream transfer battles. "With the inclusion of public interest criteria and relaxation of standing requirements for protesting water transfers, transfer proceedings now provide one vehicle for such involvement" (DeYoung, 1994, p.12). Since only a few transfer applications have been

challenged on the basis of public interest or public welfare, the efficiency of this system has not been finetuned yet to fully be accessible to environmental groups.

The Endangered Silvery Minnow vs. Federal Water Agencies

The struggle for instream flow legislation has taken a turn in the past three months with the decisions made regarding the endangered silvery minnow. The Rio Grande native fish has been on the endangered species list since 1994. Its populations have been threatened this year due to parts of the river channel south of the San Acacia Diversion dam (figure 2) drying up, a region occupied by most of the remaining minnows. Environmental groups filed a suit against the Bureau of Reclamation and the Corps of Engineers alleging that these federal groups had the power and responsibility to allot a certain amount of water in the Rio Grande for the silvery minnow above other allocations (Hume, 2000, p. B2). The argument focused on the lack of this allocation, which endangered the survival of the silvery minnow population. What resulted were lengthy litigations and mediations involving a coalition of environmentalists, the federal water agencies, MRGCD, and the city of Albuquerque.

The complications in this case include the fight over whose water is in question of being diverted or deferred for the silvery minnow in the ensuing injunction. The Bureau of Reclamation asserts that part of the MRGCD's water belongs to the Bureau of Reclamation; however, MRGCD was told to allow a minimum flow of 300 cubic feet per second in the river below the San Acacia dam for the minnow's survival (Hume, 2000, p. B2). Of course, MRGCD does not want to be the sole supplier for the silvery minnow diversions, therefore asserting that all upstream federal water should be diverted before the Conservancy District would have to allot water from the San Acacia dam. The city of Albuquerque did not support this assertion, replying that the federal water being held in upstream reservoirs was restricted to "beneficial" use in the state, which under the state law and the San Juan-

Chama project did not include any use for recreation or wildlife habitat. The block on the expropriation of water for endangered species in accordance with the Colorado and the Upper Colorado River Basin compacts limits the opportunity for instream flow.

The city of Albuquerque depends mostly upon the surface water diverted from the San Juan-Chama interstate project with Colorado. This trans-basin project has strict guidelines for how the water from the San Juan-Chama may be used in the city of Albuquerque and the state of New Mexico. One of the problems with this project is that water is supposed to be put to use in the appointed state, Colorado, and not in New Mexico. As well, there was a forty year limit on the allowed water rights to New Mexico which are coming into question for allocation again in 2007. The most disturbing reason Albuquerque should not be depending solely on this project for increased flow is the recent USGS models of the aquifers that are revealing a much smaller body of water than concerned parties had previously assumed (S. Reynolds, personal communication, October 9, 2000).

The fight to keep the Rio Grande wet for the silvery minnows' survival has been one of the few strategies by New Mexico's environmental organizations to protect the riparian habitat. Utilizing the federal Endangered Species Act and the Clean Water Act are two of the most promising federal laws that can safeguard the Rio Grande from further development and degradation. Therefore, the plight of the silvery minnow is only a microcosm of the Rio Grande's slowly disappearing healthy riparian habitat. Deborah Hibbard of Rio Grande Restoration considers it important to look at the entire ecosystem instead of just one small part of it. She also considers the silvery minnow "a symptom of the degradation of the river system" (Soussan, 2000b, p.12). John Horning of the organization Forest Guardians stresses the real problem at hand in the depletion of the silvery minnow population: "The real issue here is that human demands throughout the basin are causing damage to fish and wildlife that depend on streams, rivers and lakes" (Soussan, 2000b, p.12

Inefficient Water Use by the Middle Rio Grande Conservancy District

> According to various studies the Middle Rio Grande Conservancy District both is an inefficient user of water and has diverted more water than Congress anticipated when it authorized the Middle Rio Grande Project (Alliance for the Rio Grande Heritage, 2000).

The Alliance for the Rio Grande Heritage incorporates several environmental organizations dedicated to the protection and restoration of the Rio Grande including Forest Guardians, Rio Grande Restoration, Defenders of Wildlife, The Land and Water Fund of the Rockies, and Amigos Bravos. These organizations have joined forces to expose the wasteful and illegal water use by MRGCD in the report Diverting the Rio Grande. The fact that the Conservancy District continues to divert more water as the irrigated lands decrease proves that it is "one of the most inefficient farming districts in the western United States" (Alliance, 2000). Forest Guardians has reviewed and analyzed information from annual crop census, water supply, and distribution records from the Conservancy District to the Bureau of Reclamation (1979-1998) that illustrate MRGCD's inefficient farming procedures.

More water has been diverted than the federal water agencies expected under the Middle Rio Grande Project. Total diversions have increased considerably over the past decade as total irrigated acres have continued to decline (Alliance, 2000). Diversions during the 1979-1989 time period were estimated at 535,280 acre-feet per year whereas an average 611,253 acre-feet were diverted from 1990-1998, an increase of 80,000 acre-feet per year (Alliance, 2000). Based on these data, the report Diverting the Rio Grande makes the conclusion that since water diversions continue to increase and farmed acres continue to decrease that the water diversions by MRGCD are "for unnecessary, inefficient and possibly illegal purposes" (Alliance, 2000). Reasons for this conclusion include reports of an increase in spilled water by over 100,000 acre-feet from 1979-1998 (water diverted at one of the four irrigation diversion dams which is returned to the river without being used).

By far the worst case of inefficient water use by MRGCD was the overdrafting of the Rio Grande in 1996 which contributed to the death of thousands of the silvery minnow (Rasband, 1999). MRGCD tried to shirk responsibility for this wasteful diversion by claiming that the cause of the dry river was the Bureau of Reclamation's failure to release more upstream water. After extensive court deliberations, MRGCD was forced to release 3,000 more acre-feet to the Rio Grande (Rasband, 1999) from its upstream reservoirs. This settlement failed to focus on the Conservancy District's lack of responsible water management. Since it is in the Conservancy District's best interests to divert water for political, economic, administrative, and legal reasons, further studies such as this report are essential in revealing the District's environmental responsibility. The Bureau of Reclamation and the New Mexico State Engineer must fulfill their responsibilities to manage the Rio Grande by implementing a checks and balances system of the Middle Rio Grande Conservancy District in order to ensure total efficiency of water diversion throughout the Middle Rio Grande Valley.

Shrinking Aquifers and the Search for Water

As more New Mexicans are being introduced to the reality of the state's limited water supplies, water agencies and local officials scramble to find new sources to satisfy Albuquerque's increasingly desperate need for water. The mayor of Albuquerque, Jim Baca, is sticking his neck out in attempts to curb water use, prevent declining groundwater levels, and get more water from the San Juan-Chama Project in southern Colorado. The dire reality of the ground water depletion deals with the dropping water table throughout the Albuquerque area, especially in the Northeast Heights, the east and the west side of the city. Because of excessive withdrawals from Albuquerque's aquifer, cones of depression have been spreading once the fallen water table starts drawing water from miles around, outside the city

limits, to the depression sites. Subsidence, the collapsing of the land surface due to the phenomenon of cones of depression, will occur throughout the city if nothing is done to find alternative sources of water. Not only will land start collapsing once the aquifers compress under the weight of the overlying rocks, but continued pumping from the aquifer will quickly decrease water quality (Baca, 2000, A11).

Rio Grande Compact

Partly at fault in New Mexico's water shortage is the fact that the state is still depending upon sixty year old concepts of how water should be distributed and used. The state's water allotment is based upon the Rio Grande Compact, an interstate agreement of water distributions between New Mexico, Colorado, and Texas that was decided in 1938. Conflicts have arisen over the allotted water, especially among the strongholds of agriculture in New Mexico. Some say that since New Mexico supported only a small number of Acequias in comparison to the agricultural uses in Colorado and Texas at the time of the 1938 compact, the state was allotted less water than it deserved. Another argument against the compact is that when it was created, environmental factors such as the needs of the native wildlife and riparian ecosystems were not taken into consideration for water allotment. Yet another clash following this compact's formation arises from the unequal profits for larger interests who benefit from the highly efficient agricultural models of irrigation such as high-line canals, drainage ditches, and distribution channels. The smaller interests, such as members of the Acequia Association in Northern New Mexico and older and smaller farms, did not have the right amount of capital necessary to be included in the Rio Grande compact.

Yet another challenge with the Rio Grande Compact is the struggle of New Mexico to distribute the required amount of water to Texas after it has already been diverted in southern Colorado and throughout the entire Middle Rio Grande Valley. Every year the Rio Grande Compact legally binds New Mexico to deliver 707,000 acre-feet of water to Texas via the Elephant Butte reservoir in southern New Mexico near Truth or Consequences. The majority of water that flows south toward the

Elephant Butte reservoir is either evaporated or consumed by vegetation before it even reaches the reservoir. Once this loss is combined with the 180,000 acre-feet of water evaporated on site at Elephant Butte each year, hardly any water is available to the farmers south of the dam and to users in Texas. As Norman Gaume, chief engineer for the Interstate Stream Commission reiterates, "Texas' position is basically, 'We don't care what your problems are. Deliver or we'll sue you'" (Soussan, 2000a, A8).

New Mexico attempts to balance its water debts with the return of pumped ground water in the form of treated waste water as well as water from the San Juan-Chama project. The San Juan-Chama diversions in southern Colorado are part of a federal project that diverts water into New Mexico through tunnels under the Continental Divide. Water is carried in tunnels from three upper tributaries of the San Juan River in southern Colorado, the Navajo, the Little Navajo, and the Blanco rivers. The water from these tributaries is released from the diversion dams to conduits which then flow into concrete lined tunnels into New Mexico to Azotea Creek. From Azotea and Willow creeks in northern New Mexico, water is then delivered to the Heron Reservoir and the Nambe Falls Reservoir (figure 3). The Bureau of Reclamation and the Pojoaque valley irrigation district responsible for Nambe Falls manage the water diversions from this point.

Once Albuquerque and Santa Fe begin utilizing their allotted San-Juan Chama water that until recently has been helping to augment the river's flow, the water diverted to Texas under the Rio Grande Compact will continue to decrease. Albuquerque is also planning to implement more recycling plants for waste water, therefore additionally decreasing the flow further south into the farming areas in southern New Mexico and into Texas. The return of treated waste water into the Rio Grande is the fifth-largest tributary to the river (Soussan, 2000a).

Albuquerque Mayor Jim Baca advocates that the water diversions from the San-Juan Chama compact, water recycling, reduced private and public water use, and the storage of aquifer sources as well as aquifer replenishment will provide the

city of Albuquerque with substantial supplies of water into the near future. Whereas it is definitely a sign of progress that the mayor of Albuquerque is concerned about New Mexico's water strategy and is actually considering implementing progressive changes in state water management, I think that more still needs to be considered in regards to Albuquerque's future water sources. I do not consider the proposed diversions from the San-Juan Chama interstate compact a reliable or renewable water source. Reasons for this include the legal limitations of the Colorado River Basin compacts. However, I do agree with Baca's ideas for water recycling plants that would reuse wastewater for municipal purposes, as well as his plan to enforce fines for overuse.

Degenerated Bosque Habitat

> The river has not flooded meaningfully in decades. This is a profound change, for river floods represent the single most powerful force in structuring the riverine and riparian environment (DeBuys 1999).

William DeBuys is an activist fighting for the protection, restoration, and reformation of the natural course of the Rio Grande. His focus is the question of whether New Mexico would like to pursue the idea of the Rio Grande as a live river instead of a dead ditch. The keystone process of floods is a healthy river function upon which much wildlife is dependent, similar to the need for frequent, low-intensity fires in ponderosa pine forests. The native cottonwood forest (typically along the Middle Rio Grande) continues to disappear because of the lack of floods and summer rain.

An example of the cottonwood dependency on floods is presented in the study of cottonwood establishment along the Missouri River in Montana by Michael L. Scott, Gregor T. Auble, and Jonathan M. Friedman (1997). The purpose of the study was to understand how fluvial processes create the relationship between flow and cottonwood recruitment. Three fluvial geomorphic processes are important in producing suitable sites for cottonwood establishment, channel narrowing, channel meandering, and flood deposition (Scott, Auble and Friedman, 1997, p.678). The transport of enough sediment including sand and gravel to form erodible banks is essential for cottonwood seed recruitment. This type of sediment load is maintained by high flows. As well, exposed portions of the riverbed during periods of low flow are also ideal sites for cottonwood establishment (Scott et al., 1997, p.678). Scott et al. also described the process of how floods produce key sites for these bare and moist deposits on the point bar at a high enough elevation to be safe from riverine disturbance.

Flow alterations such as dams along river channels temporary increase the riparian vegetation, and then produce a collapse in suitable establishment sites for early successional species such as the cottonwood (Scott et al., 1997, p. 679). The narrowing of formerly meandering, wide, shallow, and braided channels such as the

Rio Grande has induced a reduction in the meandering rate, therefore decreasing the river's ability to erode and deposit sediments. This therefore decreases key cottonwood recruitment sites without the presence of high elevation riverbed deposits. This study therefore presents the necessity for high flows such as floods for the survival of cottonwood establishment (Scott et al. 685).

Flood control along the Middle Rio Grande Bosque (Spanish for riparian forest) has negatively altered the natural cottonwood habitat that depends upon frequent inundation for regeneration. The historical flood plain of the Rio Grande has been constrained to a narrow channel scattered with levees and jetty jacks that trap sediment and stabilize the river's bank. The diversion dams and irrigation canals constructed along the river have negated any possibility for the river to run its natural, meandering course. The goal of these irrigation projects was to harness and harvest as much of the natural resource as possible, especially in regards to floods which were considered as wasteful amounts of freshwater running to the sea (Larese, 2000). Therefore, the first dam to be completed in the state was Elephant Butte in 1916, with plenty more dams to follow. The Middle Rio Grande Conservancy District's (MRGCD) plan to manage the river and control flooding included constructing canals, drainage ditches, and distribution channels, as well as continuing to support the building of more dams. This removal of floods required new institutions to control and deal with the changes in order to put water fully to use as they saw fit.

After the last major flood in the Middle Rio Grande valley in 1941 ruined MRGCD's levees and flood control infrastructure, MRGCD authorized the Bureau of Reclamation to instigate the Middle Rio Grande Project, which was completed in 1962. This project included dredging and channelizing the river, reconstructing levees, and confining the river to a chute with steel jetty jacks. Jetty jacks are the same type of crossed metal structures used in World War II to block amphibious attacks (Larese, 2000, p.31). The river would now be tightly constrained in order to meet all the users' demands in central New Mexico and fulfill the requirements of water delivery to Texas under the Rio Grande Compact. This channelization traps

silt, sand, and debris in order to build up the river banks and therefore confine and narrow the river to deliver more water downstream. Otherwise, the river would easily erode into its natural floodplain, a site currently occupied mostly with urban sprawl.

Recently, environmentalists have advocated undoing some of the project's constructions such as the clearing of sand bars and vegetation for the river channel from the San Acacia diversion dam to Elephant Butte Reservoir. The Interstate Stream Commission continues to defend the project with the argument that it allows New Mexico to meet its compact delivery obligations.

The cottonwood Bosque is in danger of extinction not only because of the lack of floods but also because of exotic species. Since cottonwoods have not been able to regenerate in their natural habitat since the last great flood in 1941, non-native species including the Russian olive, the Siberian elm, and the salt cedar have been able to flourish. These non-native species are taking advantage of the altered environment we've created with our own impact on the cottonwood habitat. Russian olive and Siberian elm dominate the Bosque understory along the upper river reaches. Salt cedar (tamarisk) dominates the lower part of the Bosque where the ecosystem is aggrading (accumulating silt). An advantage the exotic species have over the native cottonwoods is the fact that the cottonwood soils lack nitrogen, which is not a problem for the introduced species. The nitrogen-fixing Russian olive is able to survive in these nitrogen-limited soils.

The comparison of nitrogen release from the foliage of cottonwoods and Russian olive in a riparian ecosystem was examined in a study by Stacey B. Simons and T.R. Seastedt. Results of this research found that nitrogen concentrations of foliage from the Russian olive were much higher than that from cottonwoods (Simons and Seastedt 256). Foliage litter of cottonwood was found to function as a nitrogen sink which meant the cottonwood removed nitrogen from its environment. The Russian olive however, contributed higher concentrations of nitrogen to the soil, therefore possibly facilitating the invasion of other exotic species (Simons and Seastedt 256). Research done by Maron and Connors in 1996 found

that nitrogen-fixing species can help facilitate exotic invasions in nitrogen-limited environments once the nitrogen becomes accessible to other species through leaf and root litter decomposition (Simons and Seastedt 256). Other exotic weed species that demand high concentrations of nitrogen would be able to invade areas enriched by Russian olive fixation (Simons and Seastedt 259).

Questions arise whether or not the Rio Grande can be returned to mimic its natural flow prior to the onslaught of dams, diversions, and river stabilization. Obviously, the dams, drains, and diversions cannot be removed because of the heavy dependence on the river throughout the entire Middle Rio Grande Valley. Therefore, mimicking the Rio Grande's natural flow must be implemented within these constraints. I think the reestablishment of what the Bosque used to be is completely impractical once the current water policies and physical constraints are taken into consideration. Instead, it is necessary to incorporate basic riverine-riparian functioning that can help sustain what is left of the surviving wildlife and habitat. One possibility is to implement overbank flooding in the spring throughout carefully regulated buffer zones. In order to ensure ecosystem integrity, an entire ecosystem monitoring program needs to be established, including monitored sites of mature riparian forests and of newly established ones. Another recommendation (Ellis et al., 1996) to improve the bosque habitat is to create diverse wetlands inside and outside the current levee system in hopes that these manufactured habitats will contribute to improved ecosystem health.

The number one obstacle in reestablishing floods in the system besides the physical limits on the river is the question of where will the water go after running through the system. A further question is whether or not management should include prescribed floods. As well, managers of the Bosque must accept the fact of the exotic species' existence since without normal flooding, the cottonwoods will not be able to make a healthy return to their natural habitat. It is impossible to manage every variable in a multi-variant system; therefore, managers must try to let the river processes function in as natural a pattern as possible and let the individual variables take care of themselves. However, at the same time, we cannot let this become a

state of apathy to the river's variables and functions. Instead, it must be an understanding that we will not be able to return the Rio Grande to its past glory, as that is itself an artifact of civilization (Ellis 1996).

Ideally, restoration efforts should be put in place along the entire stretch of the Rio Grande. However, the political reality of the river makes this impossible, especially along the Middle Rio Grande and along the degraded northern riverbeds that would not be able to sustain overbank flooding. Therefore, many groups of scientists such as the collaborators on the "Seasonal Flooding and Riparian Forest Restoration in the Middle Rio Grande Valley" report to the U.S. Fish and Wildlife recommend that only areas south of Belen should be considered for potential restoration (figure 3). This report suggests the area south of the Bosque del Apache National Wildlife Refuge, the San Marcial region, including the floodplain between it and the river's delta at Elephant Butte Reservoir as a key site for potential restoration. This Bureau of Reclamation potential site has high water tables, supports some shallow marshes, and includes some stands of native cottonwood, tree willow and coyote willow, and monotypic stands of tamarisk.

This seasonal flooding report suggests maintenance of established bosque sites with intensive, short duration floods that produce the most desired results of a healthy cottonwood riparian ecosystem. The advantage of this kind of short duration flood is that it consumes less water than a continuous inundation, therefore being more economically feasible and less labor-intensive. Not only will the lack of this annual inundation negatively affect the bosque's chances of reestablishing healthy ecosystem functioning, but as well, if coupled with the current rates of water use throughout the Middle Rio Grande valley, restoration in the Bosque is ensured to fail.

An investigation into New Mexico's records of water use reveals the state water agencies' inefficient water use procedures. This inefficiency is only one of the threats to the future protection and restoration of the Middle Rio Grande Valley. The complex water politics of this region include arguments over instream flow legislation, problematic legal and administrative water procedures, the endangered silvery minnow, and the degeneration rate of the cottonwood ecosystem. The solution to

improve New Mexico's water management and conservation must include the cooperation of all interests of the Middle Rio Grande in the formation of an environmental constituency.

For example, the following parties should be incorporated into this environmental organization: four counties, nine towns and cities, six pueblos, four federal agencies, five state agencies, the Interstate Stream Commission, and the Middle Rio Grande Conservancy District (MRGCD).

CHAPTER 4
SOLUTIONS

This section will present various solutions to river management and restoration problems throughout various watersheds across the globe and local efforts to ensure the future protection of the Middle Rio Grande Valley. Ideas for some of New Mexico's challenges with the management of the Middle Rio Grande include the following: instream flow legislation, water markets, section 7 of the Endangered Species Act, wetland restoration, and river easement. My proposal to integrate such solutions into the agenda of a state-wide umbrella organization would bring all stakeholders to the table.

Agenda for Instream Flow Legislation

Denise Fort's partial agenda for instream flows in New Mexico includes the need for river restoration, further protected habitat based on the Endangered Species Act, the need for scientific research, the education of decision makers in the new language of conservation biology and ecosystem management, and state financed purchase of water rights for stream enhancement. Certain approaches to instream flow legislation might be able to produce increased streamflows and river restoration. For example, any attempt to establish legal rights in New Mexico's state legislature must be accompanied by measures to restore the riparian habitat. The only way that these kinds of measures will be passed in the conservative legislature is by forming a constituency between all concerned interests such as agricultural bodies, Acequia members, irrigators, and municipalities.

For example, yet another proposed instream flow bill to the legislature could be supported with an argument that the instream flow would not only benefit

ecological purposes, but as well provide for further downstream users. Such instream flow protection could help fulfill the state's obligations to delivery requirements on its interstate Rio Grande compact. Amounts of allocation would be discussed in the proposed bill in order for all water interests to be fulfilled, a discussion that most definitely would include compromises by all interests in order for the water to be stretched to all users.

In order for more water to be allocated for instream flow, water rights must be purchased. Given that New Mexico is such a poor state with many rural regions fighting extreme poverty, finding money for these water rights is an impediment. Fort therefore suggests placing a tax on water transfers of which a percentage could be allotted for instream flow. Oregon uses a tax on its water transfers from which twenty five percent of the transferred water is dedicated to streams (Fort, 2000, p.162). The only problem with this proposal is that New Mexico's amount of water transfers is probably too low to effect substantial water conservation.

Other ideas for protected instream flow are implementing water leases by farmers to the state where extra water left in the system could be allotted for downstream uses, allocating a share of lottery proceeds to create a fund for the purchase of endangered habitats based on Colorado's conservation easements, and changing the role of farming in the maintenance of large tracts of land with the possibility for a shared agricultural piece of land and a protected riparian preserve (Fort 162).

Fort's stress on further research and understanding of New Mexico's ecological condition as well as studies of an economic cost and benefit comparison among the river's users could help create more optimal allocations. She reveals disturbing problems with the state's water charges such as the low charges for agricultural water most typically paid to conservancy and irrigation districts, the lack of charges for pumped groundwater, the lack of rewards for water conservation, and the absence of measures enabling the public to purchase instream flows (Fort, 2000, p. 161). As well, the dire need for some kind of state umbrella for river protection is a concern for Fort as is illustrated in the following statement: "Because New Mexico

does not have a broad-based entity to manage river restoration, I would argue that it has been disadvantaged in the competition for federal funds and support" (Fort, 2000, p.161). This necessity for a broad-based river management entity is indeed the focus of my solution for the protection, restoration, and future health and integrity of the Middle Rio Grande Valley.

Revised Instream Flow Regulation Enables Cottonwood Recruitment Along the St. Mary River, Alberta, Canada

This case study in southwestern Alberta, Canada illustrates the promise of cottonwood seed recruitment with the implementation of instream flow regulation for riparian restoration. Poor instream flow management due to insufficient flows and artificially abrupt streamflow reduction caused severe cottonwood mortality along the St. Mary River (Rood and Mahoney, 2000, p.110). The operators of the St. Mary Dam would shut the spillway gates, therefore resulting in a reduction in downstream flow and an equivalent recession of the riparian water table (Rood and Mahoney, 2000, p.110). This instream flow management therefore caused a decline in the riparian cottonwood forest.

Regional water resource managers began to make changes in their flow management once the cause of the cottonwood collapse was identified to their faulty reservoir procedures. Changes to the operation of the St. Mary Dam included an increase in minimum flows, passed under legislature in 1991. As well, "ramping" flows were started in 1994 involving a deliberate gradual flow recession to ensure the potential for downstream cottonwood seedling recruitment (Rood and Mahoney, 2000, p.110).

This study focused on cottonwood seedling recruitment, especially investigating the responses of the cottonwoods to a major flood event in 1995. Rood and Mahoney (2000) concluded that extensive seedling recruitment is consistent with the idea that cottonwood seedling establishment is associated with flood events (p.123). Their report also proved that artificial flow regulation as well as instream flow management and regulation promotes cottonwood recruitment even in

a region that was deficient in recruitment prior to the study. This case study supports the growing necessity along rivers in western North America for more natural instream flow patterns as tools for cottonwood restoration.

Water Markets

Benefits, Costs, and Local Impacts of Market-based Streamflow Enhancements: The Deschutes River, Oregon

> To gain more water for the environment, many who seek changes in water policy would favor increased regulation through the Endangered Species Act, public trust doctrine, initiative petitions, and stricter enforcement of existing laws. Others would favor incentives for voluntary cooperation including water markets: willing sellers (lessors) of irrigation water rights and willing buyers (lessees) for instream purposes might both gain from the transfer of well-situated senior rights (Stevens et al., 2000, p. 89-90).

The use of water markets as an option in protecting instream flows in western rivers is an important tool under the limitations of western water law. The prior appropriation doctrine in western water law creates limitations for environmentalists in attempts to gain more water for ecological purposes. Flow enhancement under this doctrine is nearly impossible unless extensive legislative measures are taken to ensure environmental protection. However, water markets offer an opportunity for change under prior appropriation if all interests are given a voice in the outcome of water transfers. The problems that arise with water markets deals with the lack of equity for all concerned interests and the lack of buyers due to the fear of market failure and free-riding (Stevens et al. 90). An alternative lessee is an organization created solely to buy, lease, and receive donated water for instream purposes, such as the Oregon Water Trust (OWT). This existence of this type of organization would therefore ensure that instream flow would be created for ecological purposes.

Since the enhancement of instream flows comes at a cost to current water right holders, water would be given up only if there would be a return of something of equivalent value. The Stevens et al. case study offers four options, the buying of

senior water rights in order to leave that water instream, voluntary water donations for instream uses, water leasing by commercial irrigators to instream buyers, and the buying or leasing of water rights from farmers. The conclusion of these four options was that water donations would be the most cost-effective way to provide instream flow. Full extent of the overall ratio of benefits to costs was not researched in this study, such as benefits from improved water quality, whitewater boating, and urban water supply. Despite the fact that these potential benefits were not measured, this study illustrated the need for further research of the effects of a water market on the local economy and how the market approach to streamflow restoration can keep costs low for irrigators.

Do Water Markets Promote a Socially Equitable Reallocation of Water?: A Case Study of a Rural Water Market in Victoria, Australia

A social study of the reallocation of water through the water market model is presented in this study by Bjornlund and McKay within a rural farming region, the Goulburn-Murray Irrigation District in Victoria, Australia. Social and community impacts of rural water transfers to urban water transfers was of key interest, as well as the environmental implications of a water market. Environmental groups have been traditionally opposed to the market model because it relinquishes public control of natural resources to individuals (Bjornlund and McKay, 2000, p.144). These transfers to individuals would also complicate any further attempts by the government to withdraw or reduce the water rights to protect environmental interests.

This case study also presented problems with the market model in the rural irrigation district in Victoria such as the polarization of the irrigation community into water-rich and water-poor classes, and the potential for environmental damage by continued irrigation under water limitations. The study suggests an authority to evaluate buyers and sellers to ensure that water is used efficiently and sustainably without causing environmental damage. If the sellers can not prove they can

continue irrigating in an efficient and sustainable way, then the study suggests that they use the proceeds from the sale of water rights to improve their irrigation.

Augmenting Streamflows: How Useful Are Sections 9 and 7 of the Endangered Species Act?

The two most important legal levers in the protection of watersheds are the Clean Water Act (CWA) and the Endangered Species Act (ESA). The National Pollutant Discharge Elimination System (NPDES) permits, the dredge and fill permits, and the total maximum daily load (TMDL) allocation process make the CWA an invaluable asset to water protection in the United States. I focus this section on the ESA because of its heightened importance in recent legislation regarding the endangered silvery minnow in New Mexico. As William DeBuys states, "The Endangered Species Act and the silvery minnow are not a curse on the region; they are a blessing" (DeBuys, 2000, p.B3). One of the most effective starting points in protecting streamflows is protecting endangered fish since they depend on the river for its habitat and survival. The two most important sections of the ESA that ensure the endangered species' protection are section 7, which forces federal agencies to "insure that any action authorized, funded, or carried out by such agency...is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of a species' critical habitat," and section 9 which makes it "unlawful for any person" to "take" an endangered species (Rasband, 1999, p. 50). Even though the ESA exposes the majority of all diverters to legal risk, it does not expose smaller appropriators that are not associated with large irrigation districts or federal projects.

Section 7 of the ESA requires the federal agency involved in the authorization, funding, or the carrying out of the activity in question to consult with the associated wildlife agency, which is either the U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS). If a protected species is present in the vicinity of the proposed activity then the wildlife agency must prepare a

biological assessment to decide whether or not the activity will affect the species. If the species will be affected, then a biological opinion determining the extent of this modification is necessary, which would then lead to a mandatory suggestion of alternatives to avoid negatively affecting the protected species.

The main problem with section 9 and its applicability in riverine protection is the question of what constitutes harm, whether it be injury to the species at the population level or actual proven death of the individual species. Second, the question of causation involves unforeseeable responsibility for negligent acts that becomes difficult to prove where there are multiple diverters.

An example of the complications of section 9 involves the overdrafting of the Rio Grande in 1996 by the Middle Rio Grande Conservancy District that resulted in the death of thousands of the endangered silvery minnow (Easthouse 1996). Once the FWS claimed that MRGCD caused a "take" of the minnow, the Conservancy District claimed that the Bureau of Reclamation failed to release more water from the upstream dams. At the foundation of this dispute is the problem with determining causation under section 9. Despite questions of who was responsible for the death of the minnows, the dispute was settled in court requiring MRGCD to release an additional 3,000 acre feet of water (Rasband, 1999, p. 53).

It is therefore questionable whether or not lawsuits against federal water agencies should be founded upon section 9 stipulations, or focused more on consultation under section 7 of the Endangered Species Act. However, these two sections will hopefully pave the way for further additions to the ESA for protected habitat, or perhaps a proposal for an Endangered Habitat Act sometime in the near future.

Public Water Trusts--Case Studies in Texas and California

Besides the necessity for instream flow legislation, other measures need to be taken to ensure water is left in the river. For example, in Texas water is protected in the Rio Grande by water trusts established under legislation passed for water

banks in 1997. The statute for these water trusts includes four components. The water trust holds water rights dedicated to environmental needs, including in-stream flows, water quality, fish and wildlife habitat, as well as bay and estuary inflows. The statute also dictates that the Parks and Wildlife department, a water trust board, and the water commission answer to established regulations for the process of holding and transferring water rights. The board, the commission, and the Parks and Wildlife would also review proposed water rights to be placed in trust. The final component of the statute states that contractual agreement would determine the amount of time the water rights would be held in the trust. This water trust system offers the ability for environmentalists to acquire water rights either by donation, purchase, or lease and protect them in trust for ecological purposes.

Another possibility to ensure instream flow is to implement the public trust doctrine used in other states for environmental protection. Even though this doctrine depends heavily on litigation strategies, water diversions can be challenged if they are proven to impair public values. For example, in 1983 the California Supreme Court decided that diversions from Mono Lake to Los Angeles were endangering public values inherent to the lake. Litigation strategy is necessary to support this public trust doctrine because state supreme courts will need evidence that the public values do actually protect instream flows. Limited applicability, high costs, and unpredictable outcomes of this kind of litigation make this doctrine difficult to implement, therefore explaining why New Mexico has not yet attempted to employ it.

Middle Rio Grande Bosque Biological Management Plan

Plenty of plans and summaries of the state of Middle Rio Grande basin have been published recently in hopes of finding an answer to the growing needs of the degenerated and stressed riparian ecosystem. One particular plan however, the Middle Rio Grande Bosque Biological Management Plan, created in1993 by an interagency team of biologists, scientists, historians, and other experts on the Middle

Rio Grande valley, includes possibilities for change along the river corridor (Crawford et al., 1993). The bulk of the summary includes details of management for hydrology, aquatic resources, and terrestrial resources of the Rio Grande. The summary is based on an "integrated" management approach to implementing the plan's recommendations. This focus on strong leadership and active federal and local participation is the key to addressing the Rio Grande's dire situation in providing water sources for any future populations of New Mexico.

An example of the Biological Management Plan's focus on forming constituencies within the middle Rio Grande valley is the building of a central coordinating structure to overview the management plans for the river with a coordinating head. The coordinator would be responsible for organizing a system for receiving, storing, and transmitting information in regards to the management of the Rio Grande. Other duties would include directing meetings, creating publications, and presenting annual reports on the structure's success or failure to monitor the river. This type of "clearinghouse" would address key issues in regards to coordination and communication between water agencies and water users, recommend further monitoring and research decisions for the ecosystem, and review and update the Middle Rio Grande Bosque Biological Management Plan. Future monitoring bodies for the efficient implementation of proposed plans is exactly what is needed to ensure the continued participation of interagency teams in the protection of the Rio Grande.

The main obstacle to this plan's implementation involve the political ecology within the Middle Rio Grande Valley. The mere fact that there are so many parties involved in management and legislation creates a difficult arena for a steady monitoring body that would agree on allocation conflicts. The innumerable users and managers of the Middle Rio Grande make it difficult to coordinate all perspectives and interests. However, it might be possible to integrate management of all the watersheds that make up the Rio Grande in a collective group of interests.

Middle Rio Grande Bosque Biological Management Plan Recommendations

Of the twenty-one recommendations under this plan, I considered five essential in consideration for management of the natural ecosystem. I selected the first, second, fifth, eighth and the ninth recommendations from the Bosque Biological Management Plan. These stood out to me because of their applicable uses in the return of upstream reservoir water to the river, the return of certain river portions to their natural state without levees, and the protection of existing riparian habitats and the formation of new riparian zones.

The first recommendation incorporates the use of natural runoff as a cue for releases of water from the two state reservoirs in charge of flood control, the Cochiti and the Jemez Canyon dams. Of course, the main physical constraint in the implementation of this plan is the lack of sufficient water for release due to the amount of winter precipitation, changes in water flows, and the duration of seasonal runoff. The other limiting constraints for this plan include the development in the historic Rio Grande floodplain, levees, and river channelization. Under these limitations, it doesn't seem as if attempting to reestablish the floods is a viable option in the restoration of the Middle Rio Grande, mostly because of the development along the floodplain and the physical channel constraints along the central stretch of the river.

The release of large quantities of flood water from the Cochiti and the Jemez Canyon reservoirs may not be an option, but the second recommendation to move or remove certain levees along the river might help to expand the natural course of the Rio Grande. Development would have to be restricted in flooded areas and land would need to be acquired within the floodplain from willing sellers in order to form riparian zones strictly managed for the reestablishment of floodplain habitat. The areas south of the Isleta Diversion dam including the Belen and Socorro reaches of the Rio Grande (figure 3) are best suited for this recommendation. These reaches are not as heavily constrained with levees and dams as further north and therefore support broader and shallower river beds. Another component of this recommendation is cessation of the use of jetty jacks for channel stabilization.

Instead, the plan suggests using vegetation as a natural stabilization where possible at points of erosion.

The fifth recommendation is to protect and enhance surface water quality by providing sufficient flows in certain river stretches in order to alleviate water quality problems. When the river experiences extreme low flow during the drought season, fish and other wildlife are confined to isolated pools that are high in pollutant concentrations. Despite the obvious reality that pollution should be dealt with directly and not by diluting the problem, this kind of recommendation could be helpful to provide more flow for ecological purposes. Part of this recommendation that might help increase surface-water quality is the use of riparian vegetation or wetlands as natural filtering systems for contaminants of surface runoff such as nitrates and phosphorous.

The eighth and ninth recommendations plan to protect and extend the riparian vegetation that exist outside levees in buffer zones between the river bosque and encroaching development. The eighth recommendation suggests that existing riparian habitat be added with the bosque in order to form larger regions of island habitat or to join separated bosque regions. The ninth recommendation advocates the implementation of buffer zones or agricultural regions between the Bosque and urban development. These zones would provide protection from human disturbances and provide food and refuge for migrating waterfowl and other wildlife. The problem with this idea is the reality that migratory waterfowl lack protection from pesticides and herbicides used by New Mexico's conventional agriculture. If these projected agricultural buffer zones were required to be farmed organically without the use of chemicals in the fragile riparian floodplain, then this recommendation would be an important management tool in protecting migratory waterfowl.

The fifteenth recommendation would protect existing wetlands and extend and create wetlands throughout the Middle Rio Grande. This plan would create four different wetland types: ground water and floodplain (small and large scale) wetlands, drain return channels, and storm water conveyance channels. The most viable management choices for protecting wetlands under this recommendation are

creating ground water or floodplain wetlands. "Ground water wetlands" refer to the existence of a high ground water table in the riparian zone. The limitation for this type of wetland is the lack of sufficient amounts of water due to the demand for water in the state and the critical water shortage at hand. If the water tables are not high enough in floodplain wetlands and excavated riparian wetlands, then steps to locate other water sources would be essential in order to prevent collapsing ground water aquifers and cones of depression. The other two potential "wetlands" depending on discharges from riverside drains and on minuscule flows from a storm-water channel are two inappropriate ideas of what it means to establish a healthy ecosystem.

The most vital piece of information in the Middle Rio Grande Bosque Biological Management Plan is assumptions of future conditions with no active change in biological management. The three most obvious assumptions to those familiar with New Mexico include an increase in population with half of the growth in Bernalillo County, a continuation of converted agricultural, undeveloped, and privately owned lands to residential uses, and water management at a standstill with the current infrastructure still in place. An increase in San-Juan Chama releases to Albuquerque users is projected because of the continued degeneration of ground-water supply and its inability to sustain the state's growing population. With an increase in population, further urban development will ensue, therefore destroying opportunities for wetland establishment and overbank flooding.

Middle Rio Grande Conservancy District Focus 2050

This long range regional strategy for managing growth and development in Bernalillo, Sandoval, Valencia, Torrance, and southern Santa Fe counties aims to prepare local governments for "smart growth" (Archibeque 1999). The main disturbing factor of this focus is the lack of foresight by the MRGCD into the future of water sources after 2050. Basically, their take on the water shortage in New Mexico is to not worry about what is going to happen fifty years from now, and instead, depend solely on diversions from the San Juan-Chama project. Two examples of

problematic policies within this focus include the issue of land use and the lack of tribal input in the decision making process for further development. MRGCD considers "sustainable growth" possible within the Albuquerque reach as long as identifiable urban growth boundaries exist and additional development is allowed every five years after population projections are reviewed. As well, the land use vision incorporates the transfer of development rights from rural or agricultural landowners who want to sell or transfer their development rights to higher density areas. Transfers do present potential environmental possibilities to buy water rights and designate them towards ecological purposes. However, under MRGCD's focus these types of transfers would already be designated for highly populated areas in order to provide more opportunities for the encroaching development on the Rio Grande riparian habitat.

MRGCD's focus considers regional values critical for their plan. However, this mission does not agree with MRGCD's lack of tribal input in an area with twelve Native American tribes. MRGCD's plan to create more development around the tribal land is in conflict with tribal beliefs of land as a communal resource passed down through generations. Therefore, the different tribes decided not to participate with the plan's formulation, leaving MRGCD to go ahead with the development, leap frogging over the tribal areas. This does not incorporate all regional values into the plan's focus, nor does it follow the plan's goal to design its foundation on the regional political, economic, and natural environments. Instead, MRGCD decided to continue with the planning process, with or without tribal input. This kind of disregard for the values and interests of the affected region's users is repeated throughout the entire MRGCD Focus 2050.

The region's users have definitely been outspoken in their apprehension of MRGCD's plans with the Focus 2050. For example, at town hall meetings last fall in Torrance and southern Santa Fe County, landowners stated that they "don't want another government authority dictating how they use their land" (Archibeque, 1999a). Since the plan focuses on how to manage growth in the next 50 years in this region, it allots certain areas of land for development and others for open space.

Landowners were skeptical of this plan because they worried who would end up compensating the farmer or rancher financially for maintaining the open space. As well, residents were concerned about how there would be enough water to accommodate the Focus 2050's proposed growth in the Torrance and Santa Fe counties. Representative Rhonda King of Stanley (D) thinks that water recycling and more efficient farming methods will create more water that the Estancia Valley could use to accommodate new growth (Archibeque, 1999a). She states that this water could be used for economic initiatives, an opinion in alignment with MRGCD's Focus 2050. The water availability for future growth is questionable in this region, an element that MRGCD would need to address in further studies before proceeding with its proposed development plans.

Water issues seem to be a recurring missing component of MRGCD's Focus 2050, a surprising absence considering the demands for more water under MRGCD's proposed future growth. Presently, there are no concrete solutions for water allocation challenges outlined in the plan (Archibeque, 1999b). According to the Focus 2050, there are water management plans currently under creation for the Rio Puerco, Jemez, Middle Rio Grande, and Sandia basins (Archibeque, 1999b). According to the Alliance for the Rio Grande Heritage, this conservation plan submitted to the Bureau of Reclamation is "functionally meaningless in terms of conserving water and does not comply with the substantive requirement to develop a plan with attainable goals that result in the use of less water" (2000).

Since MRGCD plays an immense role in the Middle Rio Grande valley, the Focus 2050 will be placed in full implementation in the near future, therefore placing environmental concerns of water shortage into question since these ecological issues are lacking in the current plan. Environmental activism needs to continue pressuring MRGCD to follow through with their proposed water management plans for the four basins and the adoption of these environmental assessments into the Focus 2050.

Water Transfers as Vehicles for Environmentalism

Environmental opportunities to acquire water rights from proposed water transfers and designate them for protected ecological purposes do exist in the current water politics. However, this type of environmental activism is difficult since there are many interests in acquiring water rights, such as development, agricultural, federal, and private users. Environmental groups who often lack sufficient funds to purchase such water rights would have a hard fight in acquiring water rights against these other interests with plenty of financial support. Fighting for water rights in the state legislature would be a political struggle with the strength of the agricultural constituency and the Interstate Stream Commission. However, it is definitely worth a try, especially since other states such as Oregon have had some success in acquiring more land for ecological purposes through this process.

CHAPTER 5
MY PROPOSAL

New Mexico faces innumerable difficulties in its search for water, its conflicts with creating more job opportunities for the increasing population and the protection of the riparian habitat from more development, and it faces the reality of a devastating drought that would force the state to realize that dreams of more growth are unattainable because of the limitations of living in a desert. The realities of water shortage are in such a critical stage right now that the dire situation has even been exposed to the general public in New Mexico in the past three months through articles in the *Albuquerque Journal*. Despite the fact that this kind of public education is vital to programs cutting private water use, the real exposure of the present situation needs to be focused at the state and federal level. Even though these water agencies know that the Rio Grande cannot sustain all the current demands on its ecosystem, they still continue to allow massive development to move into the drought prone landscape of the middle Rio Grande valley.

The case of INTEL in New Mexico is the epitome of the state's lack of responsible water management and conservation. Despite the 1993 USGS report revealing that Albuquerque was pumping out its groundwater almost three times faster than it could be replenished, the state appealed to INTEL's search for its newest U.S. plant to make the new Pentium and next-generation P6 chips. Under the $57 million in tax abatement, $36 million in waived new-equipment sales taxes, and the $20 million in manufacturing tax credits, New Mexico assured INTEL that the desert landscape could provide more than enough water for its new plant despite the water shortage realities revealed in the USGS reports. No computer chip company will divulge how much water is used in the process of manufacturing the thumbnail-size chips because the rinsing procedures require ludicrous amounts of water. According to a former Texas Instrument industry expert Graydon Larrabee, estimates at how much water is used is an average of 2,840 gallons to produce one

six-inch wafer that yields the computer chips (twice as much for an eight-inch wafer). Since INTEL manufactures an average of 30,000 eight-inch wafers a month, six million gallons of water could be used a day (Howarth 1994).

This reality of New Mexico's dependence on corporate money and the promise of thousands of jobs puts the hope of environmental stewardship into question. The fact that the state will continue to grow presents obstacles for environmentalists because with an increase in population follows the need for more jobs and therefore the need for more development. However, the harsh reality of this situation is that the land and the Rio Grande will not be able to sustain this growth. It is therefore vital for the state legislature, water agencies, and officials to become realists and put aside economic gain for water conservation in a desert losing its life source. There will be no opportunities for further development if there is no longer any water to divert from the San Juans in Colorado, the groundwater aquifers, the state reservoirs, or the surface water from the heavily constrained Rio Grande. "People are willing to conserve if they see it as an equitable, community-wide effort; and Albuquerqueans, especially, know they must change their wasteful ways. But if they see water hogs being lured to the desert, they will know that politics and money still control their future" (Selcraig 1994). This quote sums up the overuse of New Mexico's water sources and the potential for public involvement in solving the state's water issues. Not only does the Rio Grande need a central organizational body that will be fully responsible for monitoring the management procedures for the river, but as well, further responsible riverine-riparian management from the state government is necessary to ensure the survival of the Middle Rio Grande and all its dependent users.

Of all the solutions I evaluated in this thesis, the suggestions I consider essential to a more efficient and successful management agenda for the Middle Rio Grande Valley include upstream water releases from the Cochiti reservoir, cessation of jetty jacks, implementation of water trusts such as system used in Texas, dependence on section 7 of the ESA to ensure consultation between all involved

interests, implementation of "ramping" flows such as was illustrated in the Alberta, Canada case study, and special consideration regarding instream flow legislation. By far one of the more important steps toward protecting the Rio Grande's integrity and future survival, instream flow legislation is the key to creating constituencies between all water interests. This kind of constituency is the answer to creating an environmental umbrella for river management and conservation throughout the entire state. Components necessary to instream flow success include suggestions from Denise Fort such as water leases, taxes on water transfers like Oregon's system of allotting water for conservation, and the necessity for meeting all stakeholders' interests.

My proposal for a state-wide water monitoring organization and further divisions of water watchdog organizations throughout the entire Middle Rio Grande Basin under its control is not an unreasonable solution. Considering the number of suggestions, ideas, and plans being published recently to ensure the Rio Grande's protection, the creation of a strong environmental network is realistic. It is only time that will bring forth the necessary connections between all concerned interests in the Rio Grande's water supply whether it be irrigators, ranchers, farmers, environmentalists, private individuals, municipalities, or other downstream users. The reality of this disappearing water supply will force these diverse interests to incorporate all their ideas for water management so that the diminishing resources can be allocated. Since the future of the Middle Rio Grande valley will be plagued by this water shortage, it is vital that a state-wide effort begin to connect stakeholders into an organization that would monitor management and conservation of the Rio Grande. Without this proposal, New Mexico's water future looks bleak with future projections of more growth and development. Interests along the Middle Rio Grande Valley might only begin to worry about the lifeblood of their desert community once it is already too late to save its remains. We must act now to create a constituency, an environmental network, and a New Mexican water monitoring umbrella organization that will ensure responsible water management and conservation of the Middle Rio Grande Valley.

My idea for this kind of monitoring group for the Middle Rio Grande are based on my personal interviews with Steve Harris from Rio Grande Restoration and Susan George from the Defenders of Wildlife during which they both agreed New Mexico lacks a stronger environmental network. The various plans and proposals I reviewed lacked any future monitoring or analysis of the implemented recommendations. This absence of a regulatory body ensuring the most efficient water use, administration, management, and conservation of the Middle Rio Grande Valley has been detrimental in the river's survival. However, the main challenge in the creation of a state-wide umbrella organization is the question of what kind of incentives and leverage one should employ to bring all stakeholders to the discussion.

I think it is important to create an organization that involves certain federal legalities but as well a cooperative group of concerned local representatives. This kind of constituency between all stakeholders will not be an easy task since most interests would not be willing to sacrifice their water supplies to augment other stakeholders' supplies or to support instream flow. This assertion is based on the reality of the Middle Rio Grande Valley's political ecology and the desperate fight for water. What is necessary then to incorporate all stakeholders, even those interests who are currently not feeling the effects of the water shortage and are benefitting from a higher water allocation is the presentation of a future without the current water supplies. For example, efforts to force large bussinesses such as INTEL to become more environmentally efficient in their procedures should focus on the fact that in order to manufacture computer chips, clean and high quality water is necessary. If the Middle Rio Grande Valley continues diverting water at the current rates, clean and high quality water will become a rarity. As well, other efforts to force powerful state water agencies such as the Middle Rio Grande Conservancy District to curb their inefficient water use will need to focus on the threat of using the federal Endangered Species Act as a tool to protect the Rio Grande's future integrity. One more incentive to incorporate all users of the Rio Grande into a stronger environmental network is the opportunity for financial rewards for more efficient water

use by public and private users.

It is idealistic to hope that all stakeholders along the Middle Rio Grande Valley would want to join a state wide environmental organization that would protect the Rio Grande ecosystem just because they want to promote a higher level of environmental stewardship. However, once presented with the reality of the region that includes limited water supplies, convoluted state water law procedures and administration, inefficient public and private water use, destruction of native cottonwood vegetation, and the necessity to meet all users demands upstream and downstream, it is difficult to implement my proposal. The prospect for the formation of an organization headed by representatives of all stakeholders creates a better opportunity to address the Middle Rio Grande Valley's management challenges than no discussion at all. The creation of the Rio Grande Alliance is a reassuring sign that creating a constituency in the region will not be far off in the future. I do not feel I have all the answers to protecting and restoring the Middle Rio Grande Valley in New Mexico, but I do know that all users of the lifeblood need to collaborate their ideas for better water allocation and water management in order for the Rio Grande's ecological integrity and health to maintain intact into the future.

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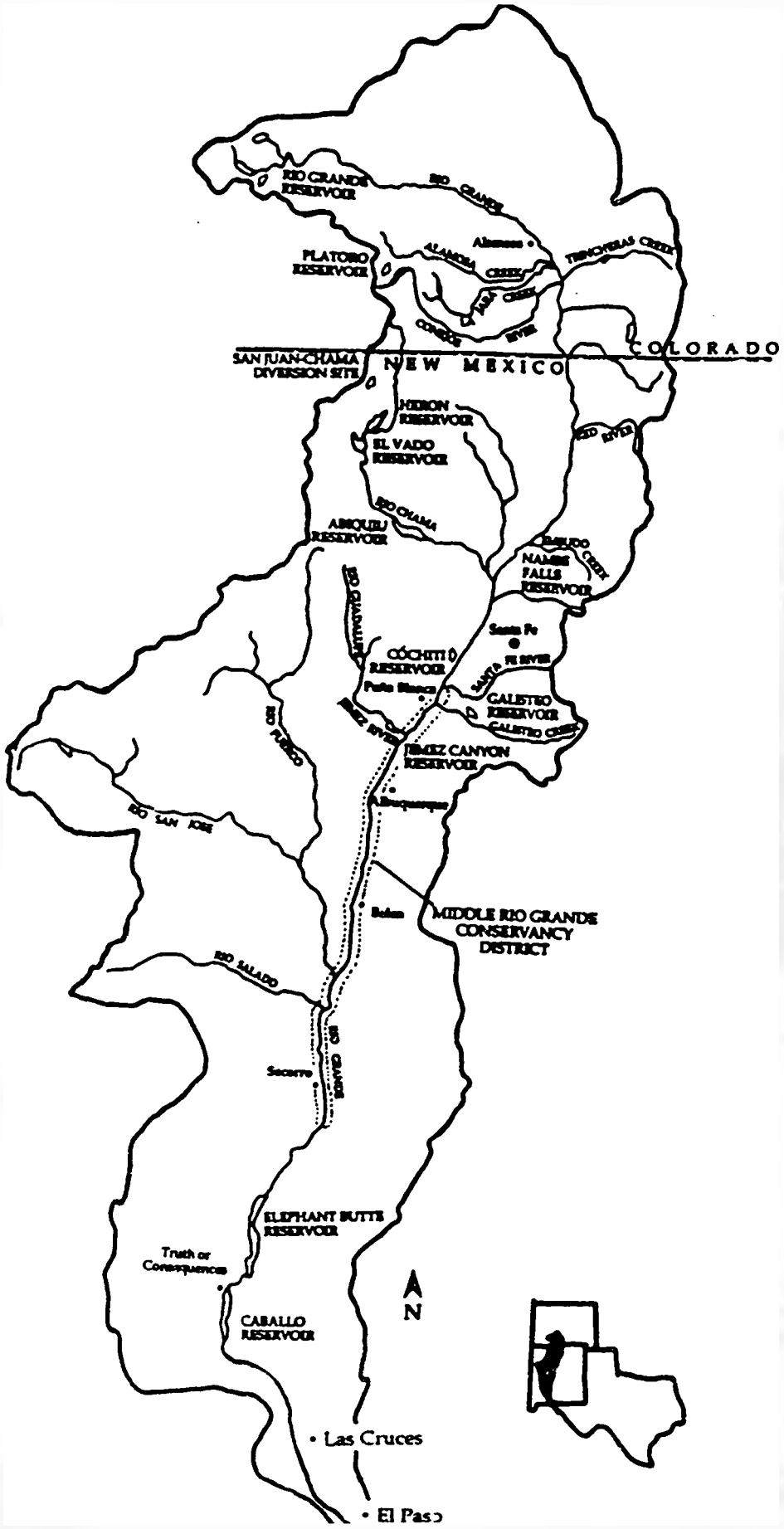

Figure 1: Rio Grande Basin in CO, NM including the Middle Rio Grande Valley from the Cochiti Reservoir to the Elephant Butte Reservoir (U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Forest & Range Experiment Station, General Technical Report RM-GTR-268, Finch and Tainter 1995)

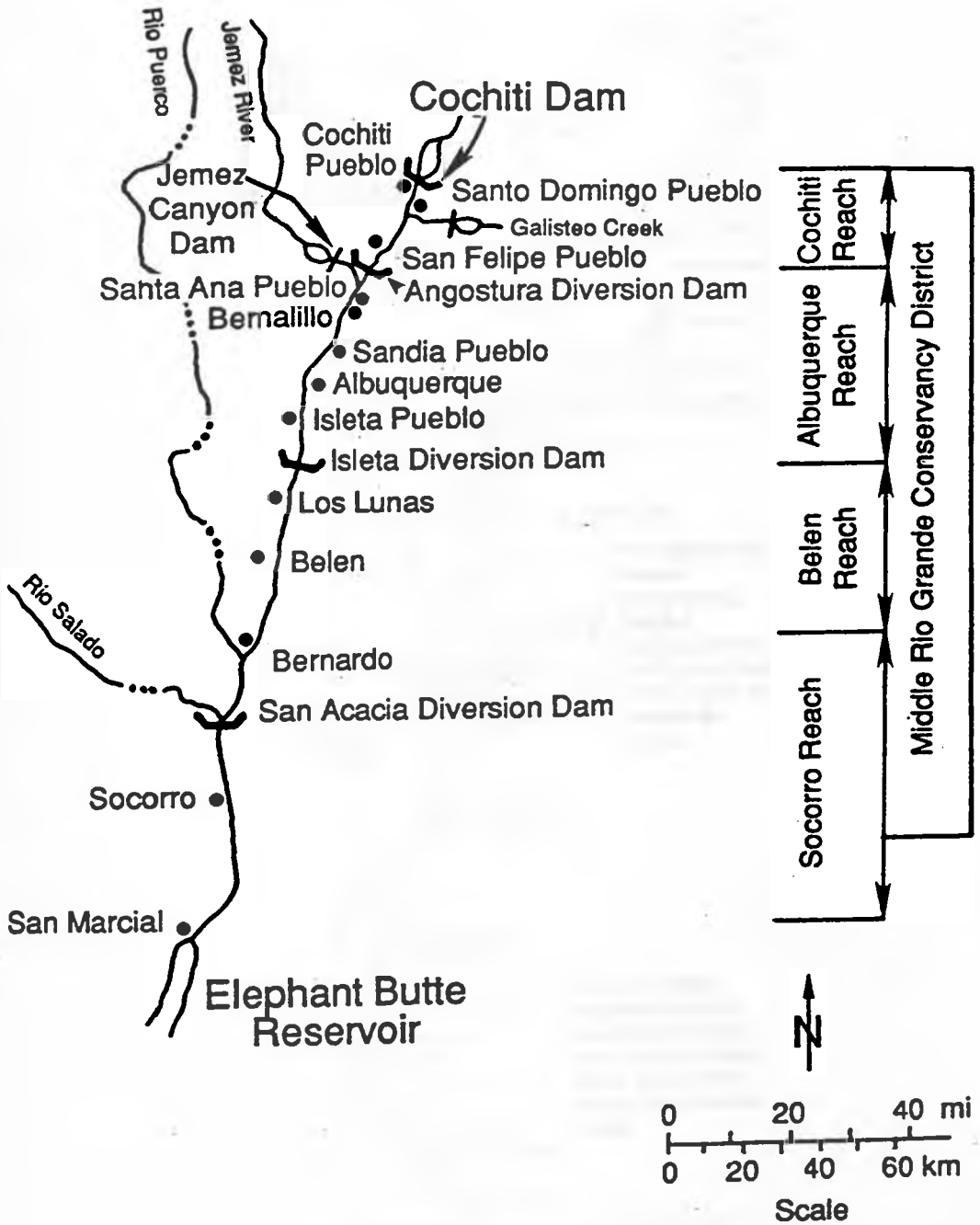

Fig. 2. Map showing Middle Rio Grande Conservancy District limits, division, and reaches for the Middle Rio Grande (U.S. Bureau of Reclamation 1977, Bullard and Wells 1992).

Figure 3: Map showing the San Juan-Chama Project, the Middle Rio Grande Valley, and potential restoration areas (Cooperrider, Carol. 2000, July 16. Overdrawn at the Riverbank. The Albuquerque Journal, p. A9)