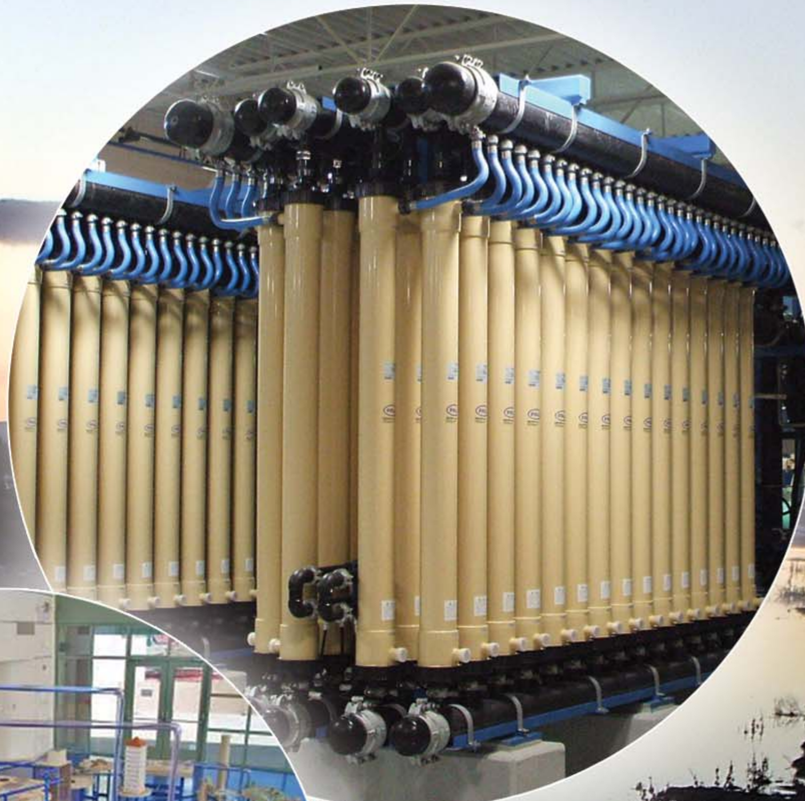
53RD ANNUAL NEW MEXICO WATER CONFERENCE PROCEEDINGS



Surface water opportunities in New Mexico

October 20-22, 2008
Embassy Suites
Albuquerque, NM

53rd Annual
New Mexico
Water Conference

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New Mexico
Water Resources Research Institute

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53rd Annual New Mexico Water Conference

Surface Water Opportunities in New Mexico

Albuquerque Embassy Suites

Tuesday, October 21, 2008

8:30	Welcome by WRRI *Karl Wood*, Director
8:45	Welcome by Albuquerque Department of Municipal Development *John R. Castillo*, Director
9:00	Overview of Albuquerque's Vision and Projects *John Stomp*, Albuquerque Bernalillo County Water Utility Authority
9:45	Break
10:15	Economics and Legal Limitations of Using Surface Water for Municipal Supply *John D'Antonio*, New Mexico State Engineer Regulatory Challenges of the State's Shift from Groundwater to Surface Water as a Source of Municipal Water Supply *Robert Pine*, New Mexico Environment Department, Drinking Water Bureau
11:00	Return Flow Efficiency *Phil King*, Department of Civil Engineering, New Mexico State University
11:30	El Paso's Experience in Surface Water Treatment – Lessons Learned *Ed Archuleta*, El Paso Water Utilities
12:00	Luncheon: Albert E. Utton Memorial Water Lecture, "100 Years of Water Management in New Mexico – Stories about the People Involved" *John W. Hernandez*, Water Resources Consulting Engineer
1:30	SECURE Water Act – Senate Bill 2156 Legislative Intent *Mike Connor*, Office of Senator Jeff Bingaman Impact on USGS Programs *Matthew Larsen*, Associate Director for Water, USGS Impact on USBR Programs *Michael Gabaldon*, Director, Technical Resources Office, Denver, USBR

2:30 Rio Grande Salinity Management – First Steps Toward Interstate Solutions
Dale Doremus, New Mexico Environment Department, and
Ari Michelsen, Texas AgriLife Research Center at El Paso

3:00 Break

3:30 New Mexico Municipal Representatives on the Use of Surface Water for Their Cities
Claudia Borchert, Santa Fe
Frank Armijo, Las Vegas
Jorge Garcia, Las Cruces

5:00 Adjourn

Wednesday, October 22, 2008

8:00 The Evolution of Markets for Water Rights and Bulk Water
Lee Brown, H2O Economics

8:30 Just Add Water: Eastern New Mexico Rural Water System Status Report
Scott Verhines, Eastern New Mexico Rural Water Authority and
Greg Gates, CH2M HILL

9:00 Update Regarding the Navajo Settlement and the Navajo-Gallup Pipeline
Tanya Trujillo, New Mexico Interstate Stream Commission, and
John Leeper, Navajo Nation

9:30 Mutually Supportive Uses of Gila Settlement Water and Money
Craig Roepke, New Mexico Interstate Stream Commission

10:00 Break

10:30 The Bear Canyon Recharge Demonstration Project
Stephanie Moore, Daniel B. Stephens and Associates, Inc.

11:00 Lower Rio Grande Project Operating Agreement: Settlement of Litigation
Gary Esslinger, Elephant Butte Irrigation District
Jesus Reyes, El Paso County Water Improvement District #1
Filiberto Cortez, Bureau of Reclamation

12:00 Adjourn

John M. Stomp III is a registered professional engineer in New Mexico and has been the Water Resources Manager for the City and now the Albuquerque Bernalillo County Water Utility Authority for more than eleven years. John was born and raised in New Mexico and has bachelor's and master's degrees in civil engineering from UNM. As the Water Resources Manager, he is responsible for water conservation, water reuse and reclamation, and implementation of the Drinking Water Project. He is also responsible for compliance issues related to the new drinking water standard for arsenic including the construction of a new arsenic treatment facility on Albuquerque's westside. John has more than 20 years of experience dealing with water and wastewater issues in New Mexico and throughout the southwestern U.S.

Overview of Albuquerque's Vision and Projects

John Stomp
Albuquerque Bernalillo County
Water Utility Authority
PO Box 1293
Albuquerque, NM 87103-1293

Thank you for having me here today, and it's a pleasure to be in Albuquerque. We started these talks about 10 years ago, not really knowing where we were headed or where our water resources management strategy would take us. We started with five paragraphs back in 1997, when the city council adopted about a 220-word statement that instructed us to start projects like the diversion of San Juan-Chama water.

It's been 10 years since that time and we've been blessed with people like Karl Wood and Bobby Creel from the Water Resources Research Institute. Yesterday people attended the conference tour, and it was a lot of fun to show what we have been doing in the last four or five years during project construction. Today I'm going to talk about our next step as we bring the Drinking Water Project online.

The impetus for this project was a 1993 report that redefined our understanding of water resources in the Middle Rio Grande, but it actually started many years before that. I'd like to remind you of Kelly Summers, a groundwater hydrologist who worked for the City of Albuquerque in 1987. Kelly looked at wells and when wells were turned off in winter, he measured drawdown and compared the results to the Office of the State Engineer's (OSE) predictive models. He found that we had significantly more drawdown than expected. He continued his research and was subsequently fired for bringing his findings to the attention of the City's administration because his findings contradicted what they wanted to hear. Administration did not want to face up to the reality of the water situation in the Rio Grande. Luckily, we have been blessed with an administration, such as Mayor Chavez, that has not been afraid to step out in front of people and not only admit to the problem but also has vowed to find a solution. So in honor of Kelly Summers, we named the road after him that leads out to the water pump station down by the river. We will dedicate the station in the next few months and we will honor the man who stood up to city government at a time when it was not popular to do that, and he got fired for that stand.

Figure 1 shows the cone of depression that has resulted primarily from our own heavy pumping. In the late 1990s, we would have shown this figure and you would not have seen the cone of depression on the west side nor the impact from Rio Rancho. Now we have a cone of depression from Rio Rancho, one on the west side near the Taylor Ranch Community Center, and the largest on the east side centered around Los Altos Golf Course. The goal of our Water Resources Management Strategy is to stop sole reliance on the aquifer and transition to renewable water resources, namely our San Juan-Chama water.

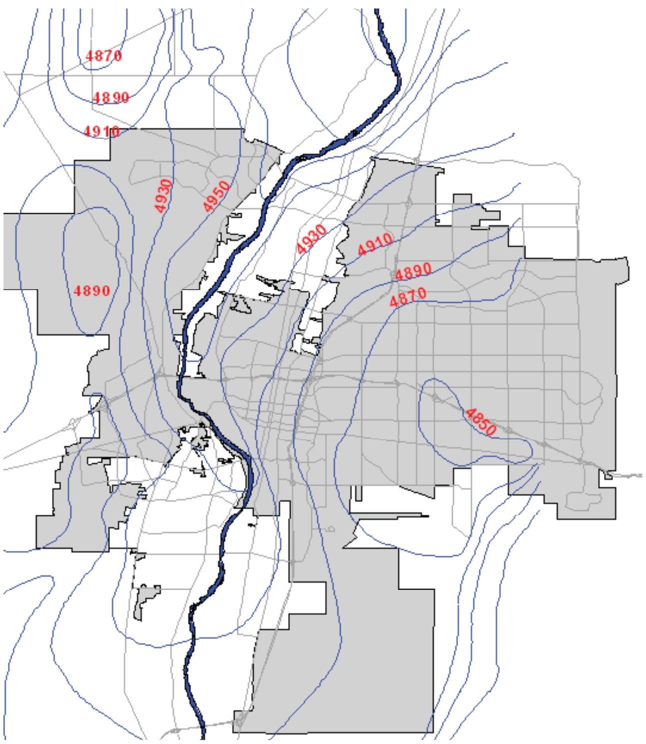


Figure 1. Albuquerque Groundwater Levels Show Huge Declines. Pumping Cone of Depression in 2002.

We have been working with the USGS for more than 10 years and have spent several million dollars studying the water resources of Middle Rio Grande. One of these studies was to determine the extent at which ground water pumping would cause land surface subsidence. We also looked at the difference in land surface comparing both winter and summer months and to see if there is a difference. The color change on the map in Figure 2 shows the changes: the land shifts down in summer as we pump heavily, coming back in winter when pumps are turned off. This is known as elastic land surface subsidence; inelastic land surface subsidence occurs when the land goes down from pumping and does not return when pumping is reduced or stopped. Thirteen years ago we were seeing this change in the land as a response to our pumping, and it is a good thing that the land surface still comes back up. This is a very real phenomenon. Tucson has experienced this; their downtown area has dropped about 6 inches in the last 20 years. In southern California, there are actually signs along the road indicating how much land is expected to drop in the next 40 years as a result of excessive groundwater pumping. Obviously we don't want that to happen here.

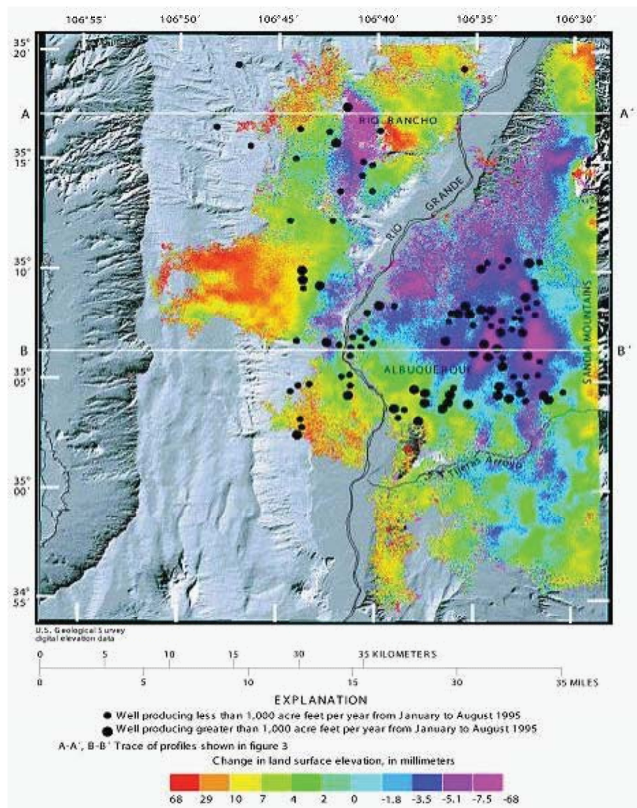


Figure 2. USGS - Land Surface Subsidence Estimate

The City of Albuquerque purchased rights to 48,200 acre-ft per year of San Juan-Chama water back in 1963, and thank goodness we did. The Albuquerque Tribune called it a boondoggle at the time, because they couldn't figure out why the City would buy water when the idea back then was that Albuquerque was sitting on an aquifer the size of Lake Superior. Here we are in 2008 and we have an actual project that consists of three diversions from the southern Colorado, namely the Rio Blanco, Little Navajo, and Navajo Rivers. The last structure is a 26-mile long, 12-foot diameter tunnel that goes under the continental Divide and brings in about 100,000 acre-ft of water per year, about half of which is for us (Figure 3).

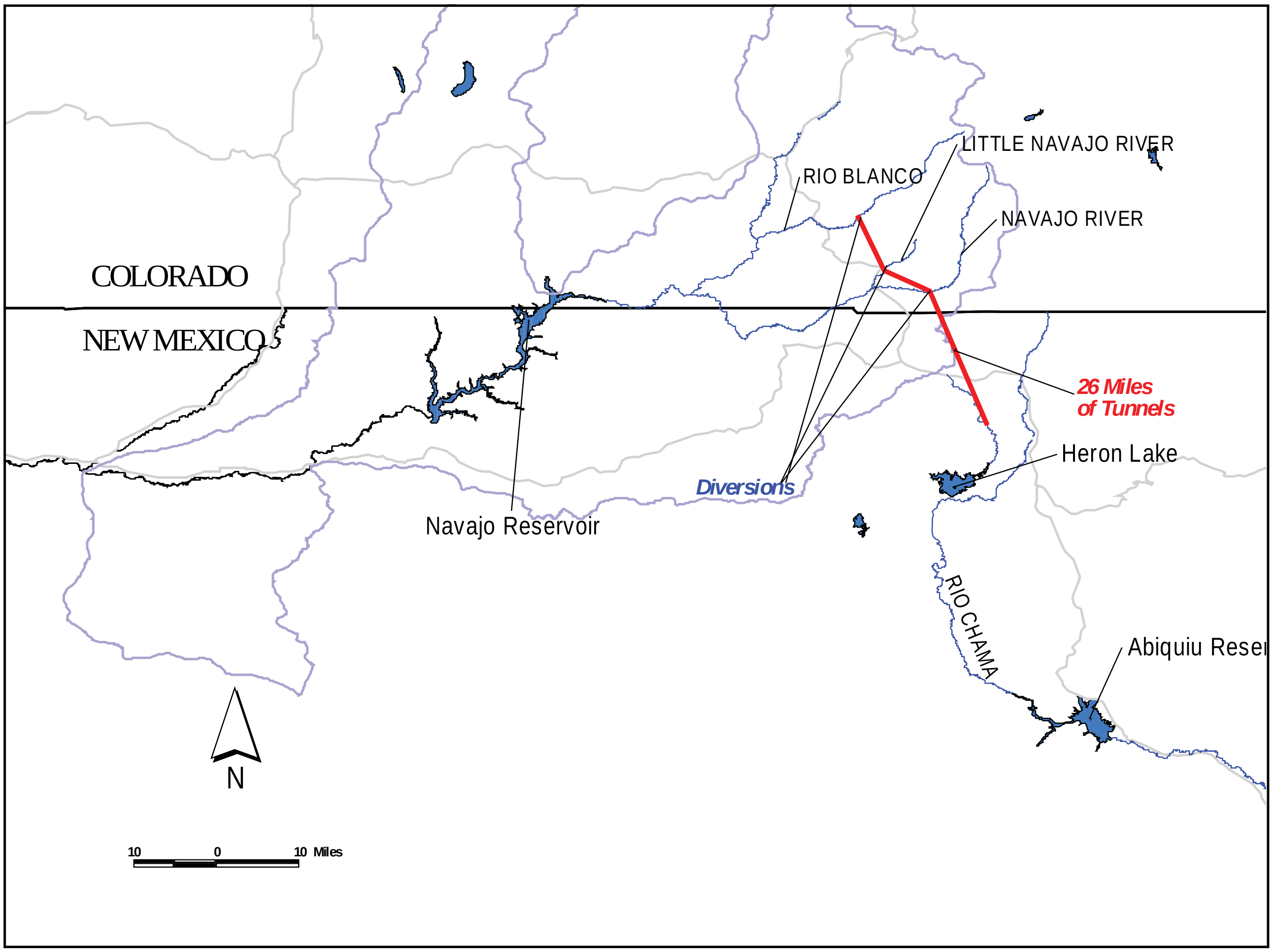


Figure 3. San Juan-Chama Project area.

Figure 4 depicts our water resources plan, a very conceptual, simple plan that provides for transition away from the aquifer. Once we bring the Drinking Water Project online, we will have a significant reduction in groundwater pumping. In the future, our water supply needs will be met more by surface water – although we will always rely somewhat on groundwater – and through reuse and recycling we will meet total water needs. We never want to pump more than 60,000 acre-ft a year, which is the predicted natural recharge, although it may change over time, but we will not pump more than the aquifer can replenish.

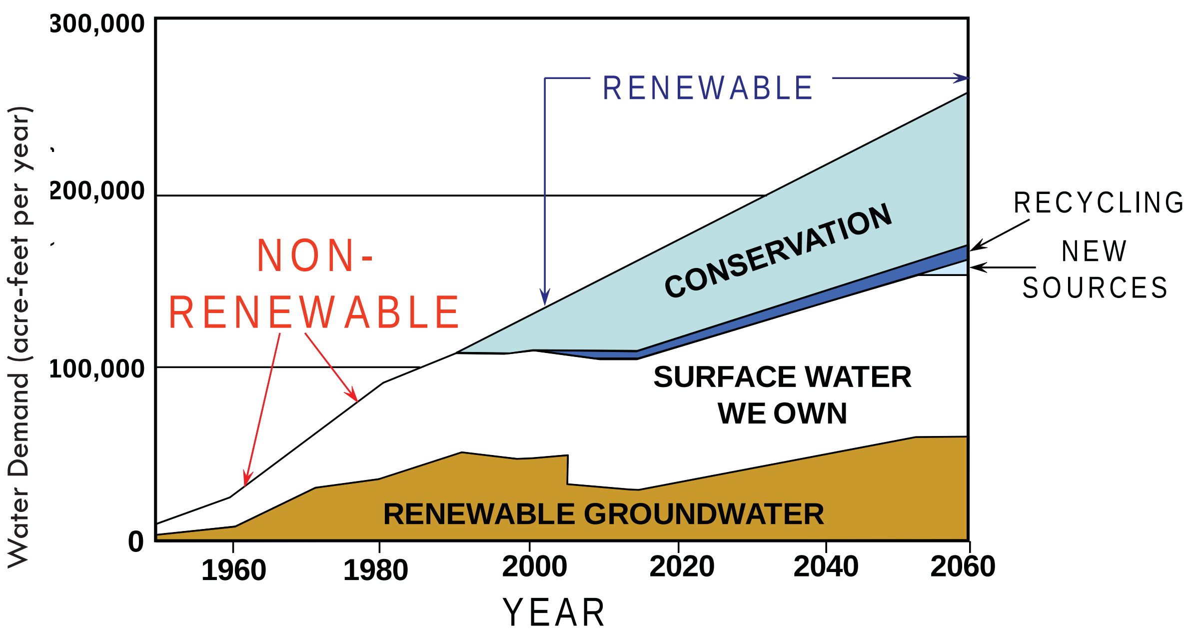


Figure 4. Albuquerque's Projected Water Demand and Available Supplies

For the next few years, the Water Authority will be working on developing new sources of water supply and these new sources are another part of meeting our future water needs. Conservation is the cornerstone of our planning and really is the basis where all water planning efforts start. We started with a per person per day water use of 250 gallons in 1995, which has been reduced to 167 gallons/person/day currently, which was over our 30 percent reduction goal to be completed by 2005. Now the Water Authority's goal is to reduce overall usage to a total of 40 percent reduction to 150 gallons/person/day by 2014. Our permit for the Drinking Water Project requires that we achieve a overall use goal of 155 gpcd by 2040. Therefore, we have time to reach these OSE permit goals, but we are trying to reach them sooner.

Figure 5 shows our big Drinking Water Project, a $385 million project that includes a diversion and a pipeline along the river and Paseo del Norte, a new water treatment plant, with 38-miles of transmission pipelines to connect the purified surface water to seven existing reservoirs on the east and west sides. The construction of the infrastructure is complete. Over the past several months, we have successfully moved ground water pumped from the eastside of town to the westside to supplement supplies and to comply with the new drinking water standard for arsenic. This may not be good over a very long-term, but it works in the short-term during the summers or during droughts. We also have a new treatment plant on the westside that is capable of treating 5 million gallons per day of high arsenic water to water that has no detectable arsenic that can be used for blending and drinking water.

The diversion dam south of Alameda was built by a contractor from Colorado who specializes in construction in rivers; they knew what they were doing and they were organized. They first moved the river to the east side and built on the west side; they waited until summer passed, and then moved the river back to the west side and subsequently went back and built on the other side, finishing the dam. The dam was built during two consecutive winters with no complications, which is really remarkable.

The dam has 21 sections across the river that can be raised and lowered independently or altogether. The use of different segments is a way to deal with sediment management; if we increase the velocity through small areas, we can push large amounts of sediment through quickly. A fish passage channel allows for free movement of silvery minnows. The dam has two intake structures and each can divert 120 million gallons a day. There are 3 mm openings in grates on intake structures for free movement of fish eggs.

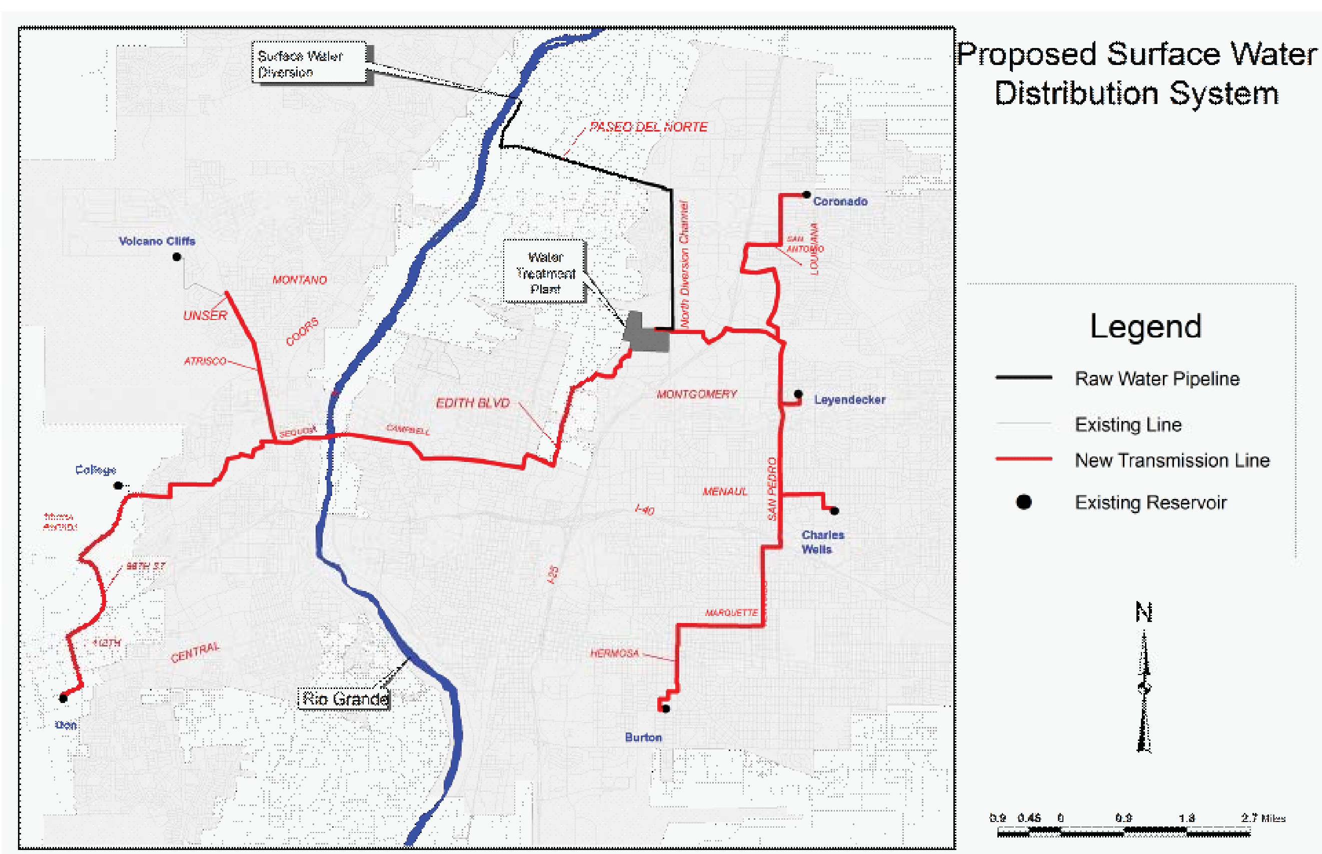


Figure 5. Proposed Surface Water Distribution System

The water pump station has a capacity of 240 million gallon/day, with each side pumping 120 million gallons/day. The building was designed to look like an old Spanish style church. Most people did not want a pump station in their neighborhood, but now people really like it, and we joke about when church services are starting.

After lots of research, we designed the water purification process at the new water treatment plant to meet water quality challenges posed by upstream development and also regulatory issues that could be implemented by EPA over time. Figure 6 shows the water treatment process, which is a very robust, state-of-the-art treatment process. We also have room to grow with UV treatment, or any other necessary changes based on regulations, standards, or customer feedback. The facility is located on over 90 acres. All the solids are handled on one side of the facility so we can recycle them. For example, we have a lot of iron in the solids removed from the process and those will be blended with our compost to create a ironite of sorts for our customers.

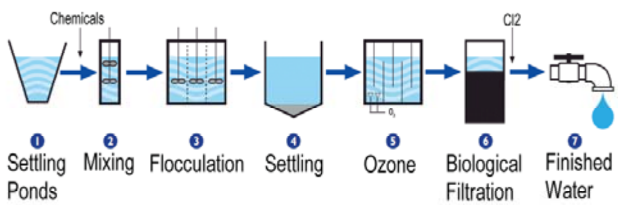


Figure 6. Water Treatment Process

The construction of the water treatment plant is complete and we are working to complete the final testing of the ozone system. After the 10-day performance test, the plant will be turned over to us, and we'll practice a little and bring the system online the first week of December 2008. We want to avoid the situation Tucson had with the immediate changeover from ground water to surface water. We are looking at providing 25 percent of our daily demand from surface water in 2009, 50-percent in 2010 and make the full transition in 2010 or 2011 after we determine what reactions and feedback are during the transition period.

So what is next with our water plans? If we look at a bell shaped curve of water use over time (Figure 7), we start in January with lower demand, and run the plant at full capacity storing water underground during winter, then use the aquifer to make up the difference during the summer when demand increases. The steady horizontal line represents a treatment capacity of 84 million gallons/day.

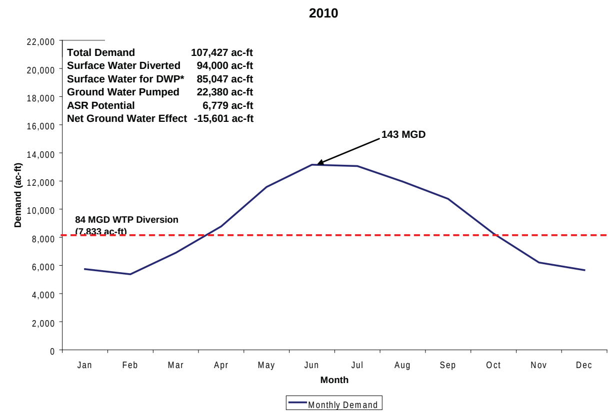


Figure 7. Water Use Over Calendar Year 2010

As demand increases with population growth, the ability to store water during the winter decreases; about 7,000 acre-ft is projected to be available to store in winter 2010 and 5,000 acre-ft in winter 2020 (Fig. 8). The more conservation we can achieve in the winter months, the more aquifer storage and recovery we have – it is almost a 1:1 ratio; as much as we reduce demand, we can increase aquifer storage.

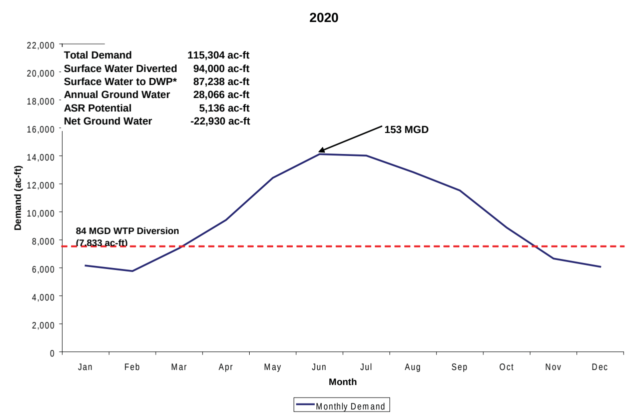


Figure 8. Water Use Over Calendar Year 2020

Figure 9 shows groundwater demands over time increasing as population grows. In dry years when we are totally dependent on groundwater, we have an increase in return flows. Our transition to San Juan-Chama water use over time is going to increase return flows, providing us with opportunities in the future to use return flows as a water source. Golf courses, for example, are a potential reuse site that will use excess return flows on large turf areas on the west side, just like on northeast side (Fig. 10).

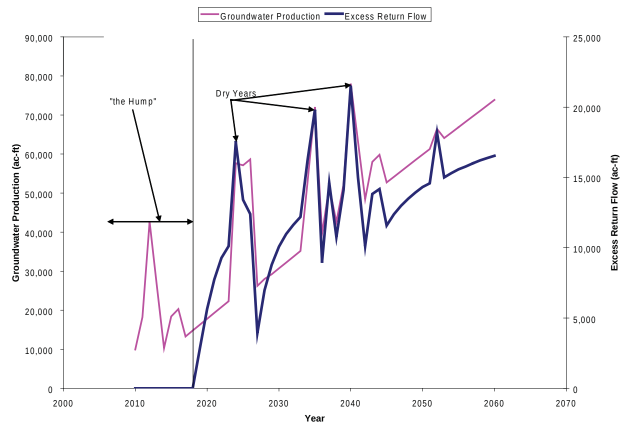


Figure 9. Groundwater Demand Over Time.

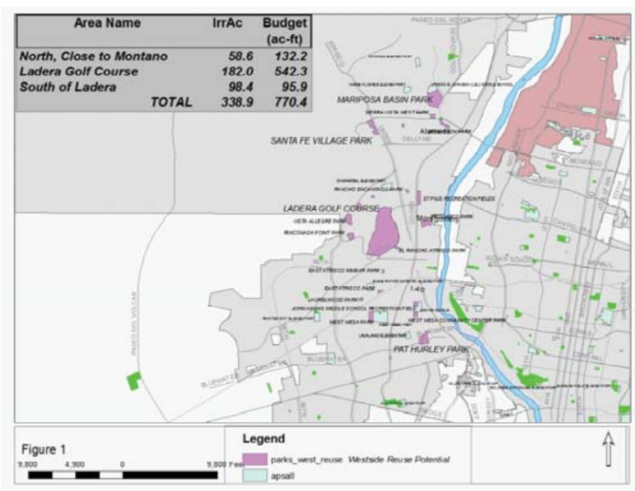


Figure 10. Westside Reuse Potention

Water reuse and recycling is a key issue in our future, much like aquifer storage and recovery, not only today but 40 years from now by reducing use can still store San Juan Chama. Desalination also is a potential new source. There are a lot of projects on the west side, and the big question is: Are desalination projects connected to the local aquifer? We need to characterize the brackish water sources in the Middle Rio Grande and sources outside the Middle Rio Grande. The New Mexico State Engineer has no jurisdiction over some wells; the only way to resolve a potential infraction on our water rights is to go to District Court, which is a problem because the judicial system does not always have the technical expertise needed, and this can lead to a battle of "dueling experts."

For the large scale ASR project, we will be constructing infiltration ponds on the 90-acre water treatment plant site and then applying the water and allowing the water to infiltrate into the aquifer. If we are able to store 10,000, 20,000 or even 30,000 acre-ft per year, and monitor it, such as how fast it reaches the aquifer, which is really the next step in our project, then it will help us understand the possibilities and opportunities for future use of that water.

John D'Antonio, New Mexico State Engineer, is a registered professional engineer in New Mexico and Colorado, and has experience in hydraulic design, acequia rehabilitation, water resource management, and water policy development. Before he was appointed by Governor Bill Richardson to the state's chief water post, John was Cabinet Secretary of the New Mexico Environment Department in 2002. He served as the Director of the Water Resource Allocation Program for the Office of the State Engineer from 2001 to 2002 and served as the District I Supervisor in Albuquerque from 1998 to 2001. For 15 years, John worked with the U.S. Army Corps of Engineers as a hydraulic design engineer, as the Chief of the Hydrology, Hydraulics, Sedimentation, and Floodplain Management Program, and was the project manager for the Acequia Rehabilitation Program. A native New Mexican, John received a bachelor's degree in civil engineering from the University of New Mexico in 1979. He has been a member of the Governor's Blue Ribbon Task Force on Water Issues from 1998 to the present. In his post as State Engineer, John is the Secretary of the Interstate Stream Commission, Chairman of the Water Trust Board, Governor's Water Infrastructure Investment Team, and the Governor's Drought Task Force. He is also the New Mexico Commissioner to the Rio Grande, Costilla, and Upper Colorado river compacts.

Economics and Legal Limitations of Using Surface Water for Municipal Supply

State Engineer John D'Antonio, Jr.
New Mexico Office of the State Engineer
P.O. Box 25102
Santa Fe, New Mexico 87504-5102

Introduction

Good morning everybody. Today I am speaking on the economics and legal limitations of using surface water for municipal supply. This topic really focuses on municipalities and their use of surface water and its many limitations. Today's presentation will discuss several examples.

Figure 1.

When I first received this topic, I thought about the little Dutch boy trying to use his fingers and toes to plug holes in the US economy (Fig. 1). Quite frankly, our economy is really hurting and we need to fund extensive infrastructure projects using renewable surface water, to accommodate municipal growth. A typical surface water project contains many structural elements: a diversion dam; an intake structure; fish passageways; raw water transmission pipelines; raw water pump stations; water treatment facilities; water storage facilities; booster stations; and a final water pipeline to get water to individuals who are consumptively using the treated water. I will describe a few examples of projects in the state, discuss their costs and who's paying, and point out rights and limitations of those particular projects.

Albuquerque Bernalillo County Water Utility Authority's (ABCWUA) San Juan-Chama Drinking Water Project (DWP)

John Stomp has done a great job leading the design and construction phases of the DWP. This is a $385 million project and completely rate-payer funded, which is unique these days. The project allows for a consumptive water use of 48,200 acre-ft per year, and the project will be ready to divert water later this year. I toured the plant recently and it looks great.

There are legal limitations to using the DWP water and I will discuss those now. The history of the DWP goes back decades. First, Colorado River water was apportioned to New Mexico for beneficial consumptive use by the Colorado Compact of 1928 and the Upper Colorado Compact of 1949. But it didn't stop there, we also needed a contract from the Department of Interior (DOI) and the Bureau of Reclamation (Reclamation) to be able to use that water, and those contracts were signed from 1963 through 1965. To use surface water, a permit from the Office of the State Engineer (OSE), was also required. Permit 4830 allows the ABCWUA to divert surface water from the Rio Grande under a specific set of conditions.

The ABCWUA has done a great job in complying with those conditions. A few of those conditions include: 130,000 acre-ft of water must be stored in Abiquiu Reservoir for offsetting residual and ongoing effects to the Rio Grande from past and current groundwater pumping; they must limit their daily diversion rate to 130 cfs; and prior to diversion, the ABCWUA must reduce its average per capita water use to 175 gallons, and in 20 years, they must reduce that to 155 gpcpd. ABCWUA's overall goal is to get to 150 gpcpd, and it looks like they are on track to get there quicker than required. Maybe we will give them extra credit for accomplishing that goal sooner, perhaps allowing them to store underground in aquifer storage and recovery projects.

Another permit condition requires maintaining stream flows of not less than 122 cfs in the Rio Grande between the point of diversion and the Albuquerque-Central Avenue Gage. This condition helps meet the biological opinion requirements to maintain critical habitat for the endangered silvery minnow, and will protect the river's ecology even as water is diverted and used.

Santa Fe Buckman Direct Diversion Project (BDD)

The BDD also uses San Juan-Chama water. Santa Fe has similar economic and legal constraints and limitations as the ABCWUA. The construction cost estimate is $215-$230 million, with the City and County of Santa Fe paying the majority of construction and start-up costs. Funding and loans to date include: $15 million loan from the New Mexico Finance Authority; $6 million from the Water Trust Board; and $400,000 from other grants. The San Juan-Chama Diversion accounts for 5,605 acre-ft per year, which is about 64 percent of the total water use, with a permanent capacity of about 8,730 acre-ft of water per year. Many of the same legal limitations apply here: The Colorado Water compacts were negotiated, which allowed the use of water initially. Contracts with the Department of the Interior and Reclamation were signed. A permit from the OSE was obtained to allow the diversion of 5,605 acre-ft of San Juan-Chama water. In order to attain full capacity (8,730 acre-ft/yr), other transfers of water rights must be approved which requires filing additional applications with the OSE. Typically, projects must have an Environmental Impact Statement, and one was issued in May 2007. Compliance with environmental laws are required prior to constructing these projects. And finally, a Record of Decision was required, and for this project it was published in January 2008.

Eastern New Mexico Rural Water Association's Ute Pipeline Project (ENMRWUA)

ENMRWUA's Ute Pipeline Project, on the Canadian River, has an estimated construction cost of $436 million. This project does not have as large a residential base like Albuquerque or Santa Fe. The State's cost share for the project will be about $65 million (15 percent of the total cost), the local share will be about $43 million (10 percent), and the federal government will provide 75 percent of the cost, $327 million. These are the dollar amounts currently being discussed.

To date, the State has appropriated about $12.4 million towards the project. It is important to point out that back in 1962, the State contributed a present day cost of $140 million to build Ute Dam. When added together, the State has contributed over $150 million in today's dollars toward the $436 million total project estimate. Therefore, the State has a significant stake in the project. Hopefully, the federal government will provide the 75 percent cost share contemplated. The completed project will provide 16,000 acre-ft of renewable water per year to eastern communities in New Mexico.

Legal limitations of the project include the need to prepare nine technical memoranda to select the best technical alternative. Requirements include the following: an Environmental Impact Statement; compliance with the NEPA process, which is a legal process that has taken two years to date. Existing appropriations (the $12.4 million I mentioned earlier) satisfy a 30 percent design level study, and ongoing ecological studies. A contract with the Interstate Stream Commission to use the water will also be required. Federal legislation is pending as part of the Omnibus Land Management package that is currently in front of the Senate, and hopefully will be approved during the lame duck session beginning November 17th.

Gila Project

Regarding the Gila Project on the Gila River, the construction cost estimate is still unknown.Tomorrow, during this conference, Craig Roepke will talk in more detail about the status of that project. The 2004 Arizona Water Rights Settlement Act provided potential benefits to New Mexico including an average of 14,000 acre-ft of water per year, and between $66 and $128 million in federal funding. To date, the State has appropriated $800,000 and the federal appropriations are about $600,000 to perform the required ecological studies.

Now we need to determine how to develop additional water in the Gila Basin without impairing the Gila River's unique ecology – it is one of the last free-flowing rivers in the state and in the United States. Ongoing studies are being conducted on the ecological, demographic, and hydrologic aspects as required by the Arizona Water Rights Settlement Act. In 1964, a lawsuit was filed, *Arizona v California*, and that corner of the state didn't fare well because there was no additional water for future development as a result of the lawsuit. In 1968, an amendment was added to the Central Arizona Project authorization giving New Mexico an exchange priority on the Gila River. Use of that water required a contract with the Secretary of the Interior, which will allow New Mexico to put water to beneficial use if a project is feasible.

The 2004 Arizona Water Rights Settlement Act, was made possible with the assistance of Senators Domenici and Bingaman, to whom we are extremely grateful. In the last couple of years, a multi-stakeholder planning process has begun and will prioritize conservation and socio-economic studies. Estevan Lopez, Director of the Interstate Stream Commission, has been instrumental in holding together the process amidst some funding challenges. By 2010, we hope to have a few project options to consider. By 2012, a Record of Decision is due. Assuming a viable project is identified, OSE permits may be required to divert or store water, depending on the specific project details. If a viable project is identified, as much as $128 million dollars would be available to the State. All funding is indexed to 2004 dollars, and again, a contract with the Interstate Stream Commission will be required before using the water.

Animas-La Plata Project (ALP)

We have learned a lot from the ALP Project on the Animas River in Southwest Colorado. The original construction cost estimate, at authorization, was $338 million dollars. In 2003, the estimate went up to $500 million, and in 2006, it went up again to $552 million. Non-Indian sponsors are not responsible for repaying any of the estimated increase in payment contracts. There are cost sharing/repayment provisions for non-tribal entities including the San Juan Water Commission repayment of about $7 million, and the La Plata Conservancy District repayment of about $3.6 million. The project provides for allowable New Mexico depletions as follows: 2,340 acre-ft per year for the Navajo Nation; 10,400 ac-ft per year for the San Juan Water Commission; and 780 acre-ft per year for the La Plata Conservancy District.

The ALP also fulfills the water rights settlement requirements of the two Indian tribes in Colorado; the Ute Mountain Utes and the Southern Utes. The project will also provide benefits to the Navajo Nation within the state of New Mexico. There are significant legal limitations with this particular project and it has long and interesting history.

Authorized in 1968, it took until 1980 for Reclamation to release the Final Environmental Impact Statement. In 1988, Congress passed the Colorado Ute Indian Water Right Settlement Act, which authorized the implementation of a 1986 water rights settlement agreement. In 1990, the U.S. Fish and Wildlife Service issued a draft biological opinion, concluding that the project would jeopardize the continued existence of the Colorado Pike Minnow. When that opinion came out, Reclamation had to take another look at the scope of the project. In 1991, the U.S. Fish and Wildlife Service issued a final biological opinion that contained a reasonable and prudent alternative limiting project depletions to 57,100 acre-ft per year, which was considerably downsized from the original project. This opinion allowed construction of the project to begin, except in 1992 a lawsuit was filed by environmental organizations and construction was halted. In 1996, Reclamation released a Final Supplement to the Final Environmental Statement. In 1998, the Department of the Interior recommended construction of a scaled down project that was designed to satisfy the intent of the Colorado Ute Tribes' 1986 Water Right Agreement. In 2000, Reclamation released a Final Supplemental Environmental Impact Statement (EIS) and Record of Decision that identified the selected alternative for the downsized project. Going into 2000, Congress authorized construction, with amendments to the Colorado Ute Settlement Act. Reclamation granted permission to initiate construction, and finally, in 2002, construction began.

Now fast forward to last week. Mike Gabaldon is here today speaking for Reclamation's Commissioner and last week, along with many dignitaries, attended the ALP ribbon cutting ceremony in Durango, Colorado. Components of the project that are all substantially complete are the Ridges Basin Dam, the Durango Pumping Plant, and the Ridges Basin Inlet Conduit. We are now looking at 2009 for the Navajo Nation Municipal Pipeline construction to begin in New Mexico. It has taken 40 years to get surface water into this project. Hopefully the Navajo-Gallup pipeline and the other future projects will proceed at a faster rate.

Navajo-Gallup Pipeline (NGP)

The Navajo-Gallup Pipeline, principally to serve the Navajo Reservation and City of Gallup, is nearly a billion dollar project, with the State share being $50 million. So far, New Mexico has funded $32.1 million, with about half of that going to the Cutter Lateral Project, and the other half to the Gallup Regional Water Supply System. The federal cost is estimated to be $867-$886 million. The project will provide about 21,000 acre-ft per year of consumptive use water. Federal legislation is pending to authorize construction. The legal limitations to the Navajo-Gallup Pipeline include: State and Navajo approval of the settlement agreement; Reclamation issuance of a Biological Assessment for the project; the Upper Colorado River Commission approval of the Hydrologic Determination, which says that water is reasonably likely to be available for that NGP project. That approval was particularly challenging as we had to deal with the states of Colorado, Utah, and Wyoming – taking into consideration their future water projects.

Additional limitations are: Reclamation's issuance of a final Hydrologic Determination; the final EIS and the Record of Decision for Navajo Dam operations; the introduction of federal legislation in Congress; the DOI release of the draft EIS to cooperators; the Secretary must approve the final EIS and issue the Record of Decision; Congress will need to enact the Settlement Act and the Secretary will need to sign the Act; the New Mexico legislature will need to begin appropriating funds, the Secretary will need to sign the contract; the partial final decree must be entered into; the joint hydrographic survey must be completed; the supplemental partial final decree must be entered into and the project will then be constructed.

Hopefully construction will begin in 10 years. That lengthy schedule should allow funding to be set aside. The State has already appropriated $10 million to the Indian Water Right Settlement Fund and hopefully additional funding will be appropriated. But first, we need an authorization bill to get through Congress. We anticipate a lame duck session beginning November 17, 2008, and if we don't get it through this time, it remains to be seen what will happen. But we have a very good chance this year.

Summary and Conclusions

There is a huge demand for water infrastructure projects in New Mexico. Not only is there a tremendous cost of repairing old infrastructure, but as you can see, there is a tremendous cost of funding the new projects as well. An additional economic impact will be paying for the tools necessary to manage water for certainty of supply. And what about warming temperatures, which could lead to changes in snowpack, thus reducing snowmelt and timing of run-off? Obviously, this could exacerbate the hydrologic variability, and would complicate future water management. Other complications include requirements of interstate water compacts, federal and state contracts, and additional water requirements for compliance with the Endangered Species Act. There are also State Engineer permitting requirements with conditions for protecting existing senior water rights from impairment.

We are also concerned with the status of adjudications in New Mexico. Currently, we have 12 active adjudications – six in federal court, six in state court, and about 65,000 defendants. We have another 15 years before these 12 active adjudications will be completed. Adjudications are important when we have water shortages because according to state law we should be administering water based on seniority status. The Prior Appropriation Doctrine should be followed when any of our basins are short of water.

During a water short year I would like to incorporate my Active Water Resource Management initiative. However, my ability to manage actively has been somewhat limited due to a District Court decision that said if the State Engineer wants to administer based on priority, he must have an adjudication decree or licensed water rights. In other words, the State Engineer is not allowed to manage water by priority during shortages based on the best information available. If that District Court decision stands, we would be required to start licensing water rights or finish adjudications in order to manage by priority.

Our office has been investigating some options to implement adjudication reform in New Mexico to reduce the cost and expedite the process. The Middle Rio Grande adjudication is the 800 pound gorilla in the room. How do we get the adjudication done in a reasonable amount of time and are there enough resources? We are trying to take the best adjudication procedures in New Mexico while considering what other states like Colorado, Idaho, and Montana are doing, and try to incorporate some of what they are doing into our process.

To give you an idea of the cost of current adjudications involving 65,000 defendants (our 12 current adjudications), our annual Litigation and Adjudication Program budget is about $6.5 million. In the Middle Rio Grande, we have identified at least that many defendants and you must add in the complexity of dealing with six tribal entities, the largest municipalities (Albuquerque and Rio Rancho), Bernalillo, Sandoval and Valencia Counties, and the Middle Rio Grande Conservancy District. We cannot jump into that adjudication until we are absolutely ready. Our adjudication reform strategy is not to change any of our existing adjudications, but instead to look prospectively to the state's remaining un-adjudicated areas and to consider setting up a market structure and possibly a more structured licensing process. We may be considering legislation in the next legislative session concerning the licensing statute. We hope to start the final Middle Rio Grande adjudication when the timing is proper. Thank you. I would be happy to answer any questions that you might have.

Robert Pine is a manager with the New Mexico Environment Department Drinking Water Bureau where he oversees the Capacity Development Program and the Enforcement Program. He is currently working on the Uniform Funding Application for infrastructure financing. Robert has been with the Bureau for over four years. He has worked for the State of New Mexico for over 15 years doing mining reclamation, groundwater contamination investigation, discharge permitting, and software development. He holds a master's degree in hydrology from New Mexico Tech and a master's degree in mathematics from the University of Utah.

Regulatory Challenges to Shifting from Groundwater to Surface Water as a Source of Drinking Water Supply

Robert Pine
New Mexico Environment Department/Drinking Water Bureau
Santa Fe, New Mexico 87505

BACKGROUND

The drinking water systems of the State of New Mexico have historically relied primarily on groundwater, which is to be expected in an arid state with a relatively small number of perennial surface water bodies. Of the 1254 Public Water Systems (PWS) in the state, 1194, or 95%, rely entirely on groundwater for their water supply. From a population perspective, it looks somewhat different. At this point in time with Albuquerque still a groundwater system, we have 84% of the population connected to a PWS relying solely on groundwater. When Albuquerque switches to surface water, we will have 41% of the population connected to a PWS relying at least in part, on surface water (curiously, Albuquerque will be the first water system to use the main stem of the Rio Grande as a water supply). This is shown graphically in Figure 1. The current distribution of surface water systems, including surface water purchase systems that purchase some or all of their water from surface water systems, is shown in Figure 2.

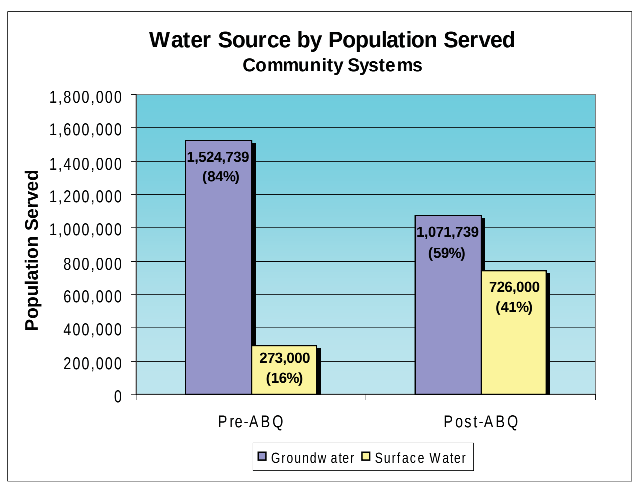


Figure 1. Distribution of population served by Public Water S by water source type before and after the Albuquerque-Bernalillo County WUA converted to surface water.

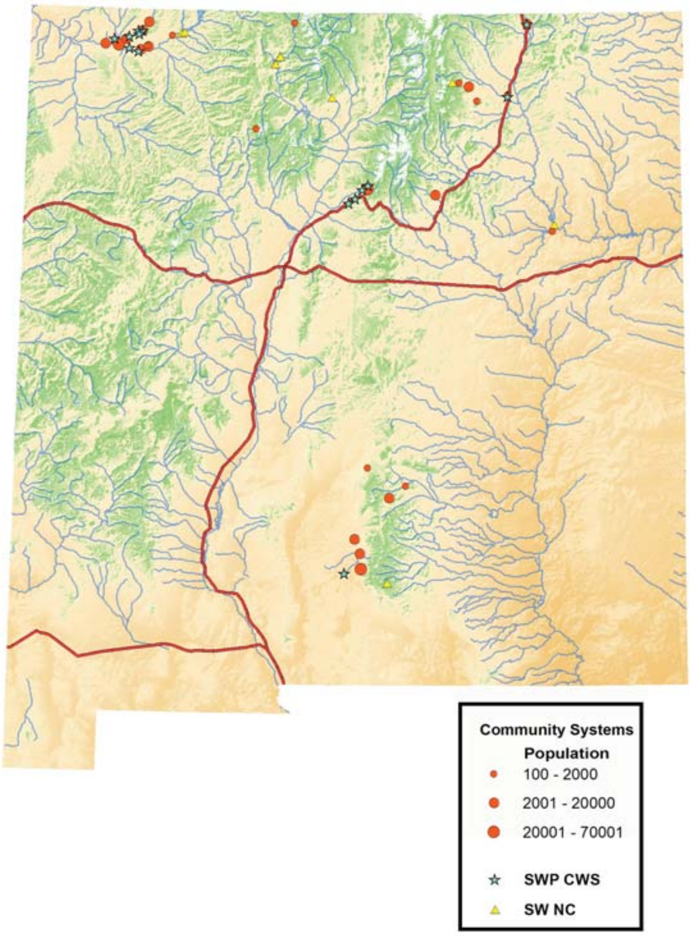


Figure 2. Surface water systems in New Mexico (SWP = Surface Water Purchase System, CWS = Community Water System, NC = Non-Community Water System)

Other groundwater systems in the state are in the process of converting to or increasing their usage of surface water or are considering such a conversion. This would include Santa Fe, Gallup (via Navajo-Gallup Water Supply Project), Flora Vista MDWCA, Doña Ana MDWCA, and several eastern communities via the planned Eastern New Mexico Water System (i.e., the Ute Pipeline), to mention a few. There are many reasons drinking water systems may consider developing a surface water source including concerns for the long-term sustainability of a groundwater source, inadequate groundwater quality or quantity, or to increase the diversity of the water supply. However, there are many factors to be considered that make the development and operation of a surface water system much more complex and costly. These factors are the topic of this paper.

Before discussing these factors, it is worth reviewing the basic elements of surface water quality and treatment.

SURFACE WATER AND TREATMENT

All surface water contains microorganisms, though most are not pathogenic (i.e., causing disease). The three types of microorganisms commonly found in surface waters that may be pathogenic are bacteria, protozoa, and viruses. Some of the most common waterborne pathogens are listed in Table 1. From a regulatory standpoint, the primary goal of surface water treatment is the removal or inactivation of pathogens (secondary goals include improving taste, odor, and clarity). Removal of pathogens is accomplished through filtration while inactivation of pathogens is accomplished through the addition of a disinfectant (e.g., chlorine or ozone) or UV radiation. Table 1 indicates that protozoa are not effectively inactivated by chlorine so treatment only by disinfection is not sufficient.

Table 1. Pathogenic waterborne microorganisms and their response to conventional disinfectants

Microorganism Type	Examples	Disinfection Effectiveness
Bacteria	E. Coli, Cholera, Shigella	Excellent
Viruses	Hepatitis A, Enterovirus	Excellent
Protozoa	Giardia, Cryptosporidium	Limited

Under the federal Safe Drinking Water Act (SDWA), all surface water supply systems are required to treat the raw water with both filtration to remove pathogens (except under certain limited circumstances) and disinfection to inactivate pathogens. Filtration must be sufficiently effective to remove specific percentages of the various organisms. Disinfection (other than UV) must meet requirements for inactivation of Giardia (which will also satisfy disinfection requirements for bacteria and viruses).

The two factors that determine the effectiveness of inactivation of Giardia by chemical disinfectant are disinfectant residual concentration (denoted by C) and contact time of the water with the disinfectant (denoted by T). Since either a higher C or a higher T will result in greater inactivation, the product of the two, CT, is the measure of satisfactory inactivation and has been tabulated by EPA. The required amount of CT is dependent on pH, temperature and, the particular chemical disinfectant.

It is fairly expensive to quantify a specific pathogen in water and impossible to do so in real time. So a surrogate for pathogen content that was easily measured continuously was needed. The surrogate that has been used traditionally and is used as the regulatory standard in SDWA is turbidity (as measured in Nephelometric Turbidity Units or NTU). By decreasing turbidity, there is a reduction of all particles including suspended sediment and pathogens.

Conventional treatment of surface water utilizes a series of processes to reduce turbidity. The first step may consist of a settling process in a reservoir to remove sand and some silt-size particles (often considered pre-treatment). Next, flocculation chemicals are injected followed by a flocculation and settling process that will remove a significant amount of the remaining silt and smaller sized particles, including a significant amount of the organic carbon that is a precursor to Disinfection Byproduct production (as described below). The settled water is then filtered through a sand filter to remove the majority of remaining particles. Disinfectant is added at this point. There are many factors that can affect the quality of the finished water including raw water chemistry (temperature, pH, turbidity, organic carbon content, etc.), choice of flocculation chemicals, chemical dosage, loading, and mixing rates. To meet regulatory compliance requirements for surface water requires frequent attention to the treatment process. To get optimal treatment (i.e., to produce the best finished water quality water that a given plant is capable of for a given raw water quality) requires even more attention to the treatment process and water chemistry.

There are many variations on the conventional treatment theme as well as alternative treatment approaches such as membrane technologies (nano filtration and reverse osmosis). Membrane technologies can be very effective at removing particles and chemicals from water, but create a significant waste stream (which must be disposed of and can put a dent in a systems water rights) and are expensive.

CHALLENGES IN THE UTILIZATION OF SURFACE WATER

There are several areas of concern that should be carefully considered when a water system is planning to utilize surface water as a source of drinking water supply. Capital costs and water rights will not be considered in this paper, but are very significant practical matters.

1. Availability of Qualified Operators

The New Mexico Utility Operator Certification Act requires that all public water supplies employ a certified operator to operate and maintain their water system. As the size or the complexity of the water system increases, so does the required level of operator certification. Systems that treat surface water require operators to have the highest level of certification (Level 3 or Level 4 for systems serving over 500 customers) as result of the significantly greater complexity of a surface water treatment system in contrast to a typical groundwater system. Larger groundwater systems may also require high level certification, but these Level 3 and Level 4 operators aren't likely to have the knowledge and experience to operate surface water treatment systems (note that there is no certification distinction between surface water and groundwater). Thus, systems converting from groundwater to surface water will be required to retrain their operators and/or hire additional operators with the necessary skills.

Hiring an operator with sufficient certification and appropriate surface water treatment experience could prove to be a challenge. Approximately 1/3 of the certified operators in New Mexico are certified level 3 or level 4 (see Figure 3). Only a small percentage of these operators have any experience with surface water treatment. The majority of these operators are currently employed by water systems so hiring a Level 3 (W3) or Level 4 (W4) operator with sufficient knowledge and experience in surface water treatment would likely require hiring them away from another water system or hiring from out-of-state where salaries are often higher. This puts an upward pressure on salaries for skilled surface water operators in New Mexico. Smaller surface water systems in New Mexico are thus having a difficult time finding qualified operators (larger systems can generally pay higher salaries). Some systems have reported hiring lower level operators and training them so they can obtain their higher level certification at which point they are hired away by larger or out-of-state systems that pay higher salaries. Thus the problem is not just one of finding skilled operators, but also one of employee retention.

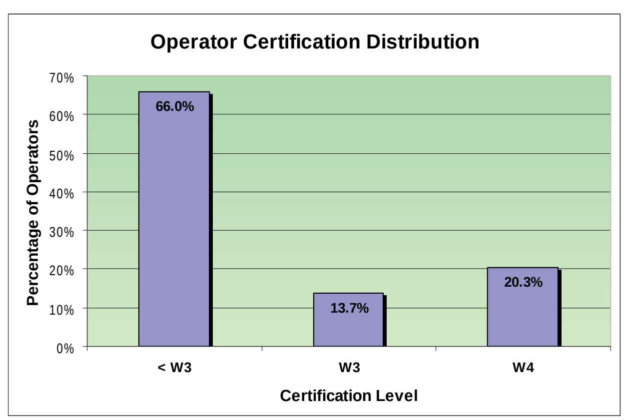


Figure 3. Distribution of operator certification levels in New Mexico. W3 and W4 operators are the levels generally required for surface water treatment.

To further complicate this shortage of skilled surface water operators, the certified operator workforce nationwide is aging because not enough young people are looking at water system operation as a desirable career. The primary reason for this is the relatively low salaries being paid by water systems. In addition, the work can often involve long hours and work on the weekend. The American Water Works Association has estimated that 30 – 50% of the currently certified operators will retire in the next 5 – 10 years. In New Mexico, the average age of Level 3 operators is 48.6 years old and the average age of Level 4 operators is 49.6 years old. Figure 4 shows the age distribution of Level 3 and Level 4 operators in New Mexico. Clearly, the situation that AWWA has identified nationwide is also a problem in New Mexico. The number of Level 3 and 4 operators certified in the past three years is shown in Figure 5. Although the loss of Level 3 and 4 operators will be partially offset by newly certified operators each year, there will be a wealth of knowledge and experience retiring along with the operators that may not get transferred and will take many years to replace.

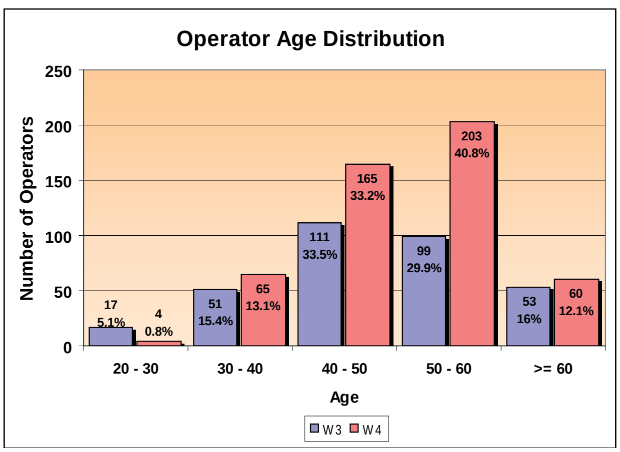


Figure 4. Age distribution of Level 3 and 4 operators in New Mexico as of September 2008. The number of operators and the percentage within each certification level is given.

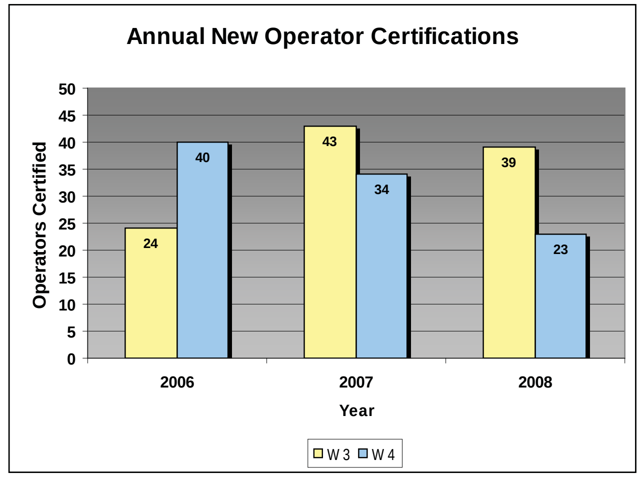


Figure 5. Number of New Level 3 and 4 operators certified from 2006 - 2008

For all the reasons mentioned, small to moderately sized surface water systems will find it difficult to find qualified operators in the future. Those surface water systems that are geographically more isolated will have an additional challenge to attracting surface water operators. Water systems will need to pay competitive wages in order to retain their operators. It will also be necessary to have a concerted effort in New Mexico to increase the number of new water operators by attracting more young people to the profession so there can be a transfer of knowledge from the experienced operators that are within a few years of retirement.

2. Regulatory Burden

The SDWA regulations are quite comprehensive currently consisting of 270 pages. The portion specific to surface water systems is approximately 56 pages (though portions may or may not apply depending on the population size served by the water system). In addition, there are 26 pages of regulations regarding disinfection byproducts that apply to systems that disinfect, but have the greatest impact on surface water systems (this will be discussed in more detail below). The surface water regulations are the most complex of all the SDWA regulations.

It takes a considerable amount of effort for surface water systems to remain in compliance with the monitoring, reporting, sampling and treatment requirements of SDWA. Larger systems frequently employ part or full time compliance manager to ensure compliance requirements are being met. Periodic training on the regulatory requirements is strongly recommended for operators and compliance managers.

There is always the potential for new and revised federal and state rules that will add to the regulatory burden. In the last year, the Long Term 2 Enhanced Surface Water Treatment Rule and the Stage 2 Disinfection Byproducts Rule became effective, both of which have a significant impact on surface water systems. It is a reasonable assumption that there will be new rules or revisions to existing rules that impact surface water systems in the future.

3. Disinfection Byproducts

SDWA requires that a disinfectant be used by all surface water treatment systems, not only to try to inactivate those pathogens that managed to survive the filtration process, but to also to create and maintain a residual disinfectant concentration within the distribution system in the event of contamination downstream of the treatment process. By far, the most common disinfectant used by surface water systems in New Mexico and nationwide is chlorine due to its relative low cost, ready availability and ease of use. Chlorine has been the single biggest factor in reducing waterborne disease worldwide since it was first used as a disinfectant in the early 1900s and has saved millions of lives over that time period.

However, chlorine's evil twin is the creation of disinfection byproducts (DBPs) that are formed when chlorine reacts with certain forms of organic carbon nearly always found in surface water. Many of the DPBs are known carcinogens and so are regulated under SDWA. The two classes of regulated DBPs are Trihalomethanes (THM) and Haloacidic acids (HAA).

The formation of DBPs is dependent on the type and concentration of organic carbon, chlorine concentration, water temperature, pH and contact time. These relationships are sufficiently complicated that it is nearly impossible to predict the forms and concentrations of DBPs that will result when a dose of chlorine is added to a water sample. However, one can make the following generalizations:

- DBP formation increases with increasing water temperature (DBP concentrations are often higher in the summer months)
- DBP formation requires time so that DBP concentrations correlate to water age (DBP concentrations are frequently higher at the farther reaches of the distribution system)

The best way to prevent DBPs is to remove DBP precursors, i.e., organic carbon, prior to chlorination. Although conventional treatment systems may be in compliance with SDWA turbidity requirements, they never remove all organic carbon and frequently enough passes through the treatment system so that DBP production is a compliance issue for the system. Frequently, a combination of chemical modification (change of flocculent and/or adjustment of flocculent and chlorine dosage), control of loading rates or other operational changes can improve precursor removal, but this takes increased skill and attention on the part of operators and is often beyond the capabilities of many operators with their existing level of training.

Membrane technologies are more effective at removing DBP precursors, but generally have higher capital, operation and maintenance costs than conventional treatment and result in a significant waste stream.

4. Source Water Protection and Alternative Sources

Protecting a water system's source of supply from contamination is never easy, but can be extremely difficult with surface water sources. The watershed for most surface water intakes is quite large and generally not within the control of the water system (Santa Fe being a notable exception). Nevertheless, it is worthwhile for water systems to work with state and federal agencies to identify potential point and non-point sources of contamination and to participate in collaborative efforts to maximize routine water quality and minimize the likelihood of a catastrophic event that could result in shutting down water intake to the system (e.g. forest fire or contaminant release).

Spring runoff and large precipitation events can cause turbidities to spike dramatically. Systems that have intakes off a river may be required to shut down intake until turbidities fall, depending on pretreatment storage capacity of the system and the capabilities of the treatment system. Drought conditions can also cause water quality and/or quantity to be reduced to the point that the surface water source is no longer adequate to meet the systems needs for extended periods of time. If the water storage capacity of the system is insufficient to outlast the high turbidity or drought event, an alternative source would be needed. This can be accomplished through a groundwater supply or through an emergency connection to a nearby system that does not share the same risk of loss of supply, if such a system exists. Such an alternative or emergency source should always be a part of a surface water system's water supply.

5. Administrative Support

It is not uncommon for operators of smaller drinking water systems to do a variety of tasks including some that do not qualify as operating a drinking water system. Such tasks could include operating a wastewater system, reading meters, mowing the lawn, driving the garbage truck, and so on. If the system is a relatively simple groundwater system, it may be feasible for the operator to include several such tasks. But as discussed above, the operation of a surface water system requires significant time on the part of the operators just to meet compliance requirements, let alone getting optimal performance from the treatment plant.

It is essential that system administrators understand the time commitment required for the operation of a surface water system in order to meet the SDWA requirements. The priority for surface water system operators must be the operation of the water system. It must be understood that even with automated treatment systems, there is still an important role for the operators and that a certain amount of daily plant time is essential, especially during times of changing raw water quality.

6. Emerging Contaminants

Currently, a relatively small number of the universe of potential contaminants are regulated under SDWA. EPA has a process it goes through on a periodic basis to review unregulated contaminants for possible inclusion in SDWA. Every five years it publishes a Contaminant Candidate List which contains all the contaminants it will review for SDWA inclusion.

One class of contaminants that has received considerable attention in the press recently is pharmaceuticals, which are often grouped with hormones and personal care products. Many of these organic compounds, if present in source water, are only partially removed or degraded by conventional water treatment systems. Thus far, EPA's process to review unregulated contaminants has not addressed the large number of these chemicals, but it is almost certain that in the next round of review of potential contaminants, EPA will include some pharmaceuticals, hormones and other household chemicals. If such a review results in any of these chemicals being regulated under SDWA, surface water systems will likely have to augment their monitoring regimes and possibly modify their treatment systems to meet SDWA requirements.

On EPA's most recent Contaminant Candidate List, nine microorganisms were included. It is not yet known if any of these "emerging" pathogens will become regulated under SDWA or what the implications are if any are included.

SUMMARY

Public water systems are regulated under a variety of federal and state laws, all to ensure that the public is protected from waterborne illness. Being a public water system is a challenge for all water systems, regardless of size or water source. Due to the complexity of surface water treatment and the numerous SDWA requirements for surface water systems, there are many issues that a surface water system must consider that are lesser or nonexistent issues for groundwater systems. All of these considerations can probably be addressed by a surface water system, but at a significant cost. To ensure a successful transition, all of these issues should be taken into account starting at the earliest planning stages when a water system is considering utilizing surface water as part of its water supply.

J. Phillip King is an Associate Professor in the Civil Engineering Department at New Mexico State University, where he has been since 1990. He also serves as the Associate Director for NMSU's Institute for Energy and the Environment. Phil specializes in water resources and agricultural engineering and was recently honored with the Donald C. Rousch award for excellence in teaching. His research has included irrigation, hydrology, and water quality studies of the Rio Grande and related groundwater systems. Phil has worked with Elephant Butte Irrigation District since 1991 in the development of flow monitoring systems and organizational infrastructure to allow the District to manage its water supply more effectively, and he provides technical support for dispute resolution on area water issues, including the recent landmark settlement between New Mexico and Texas on the Rio Grande. He has worked with irrigators, municipalities, Native American tribes, and World Wildlife Fund to develop new approaches to water management, including intersectoral transfers and reuse among agricultural, municipal and industrial, and environmental interests. Phil serves as a Director for the Leasburg Mutual Domestic Water Consumers Association, as a Supervisor and Chair for the La Union Soil and Water Conservation District, and he is Governor Richardson's designee on the New Mexico Soil and Water Conservation Commission. He served as a Peace Corps volunteer in Malawi, where he met his wife of 24 years, Rita. They have two daughters, Kisa and Towela. Phil has Ph.D. and M.S. degrees in agricultural engineering from Colorado State University, a B.S. in civil engineering from the University of California at Berkeley, and an M.B.A. from NMSU.

Return Flow Efficiency

Phil King
IEE & Department of Civil Engineering
New Mexico State University
Las Cruces, NM 88003

This morning I'd like to start with talking about the hydrology of riparian systems, although I will touch a bit on some non-riparian systems. When trying to think of a good analogy for this topic, I first thought that explaining this is like explaining derivative securities, but then there are some things you shouldn't joke about. But now I'm thinking that really is a good analogy, all joking aside.

First let's start with a few definitions, beginning with consumptive loss. A consumptive loss is water that is lost or removed from the local hydrologic system where it essentially goes over and rains on Texas, it is gone from here and we have no more access to it or it becomes unusable for other reasons. I am going to simplify this as much as I can, but there are also issues concerning locations of returns that we will get into in a bit.

Secondly we have non-consumptive losses, water that is removed from a control or delivery system, but not lost to the local hydrologic system. An example would be a canal system where you have a little control over seepage that recharges the local groundwater system but it just changed from surface water to groundwater.

Return flow is water that is diverted from a source that is not consumed and can be reused. This could be water from a river or aquifer system that is not consumed and can be reused and essentially recaptured by the local hydrologic system.

Finally, when we talk about return flow efficiency, we are talking about the ratio of the actual return flow: the amount of water that is actually reused and returned to the source to the non-consumptive losses. Think of the non-consumptive losses as potential return flows; whether or not they actually make it back is another issue.

I will start with an example that is adapted from a 1996 paper David Seckler presented and this concept goes back long before that. You find the same concept of the return flow built into the Rio Grande Compact and you find it in irrigation texts dating back to the 1930s. It is an old concept but often one that gets kind of swept under. We have inflow into a source (Fig. 1), let's say the Rio Grande is the source. If someone takes a 50 gallon shower, they turn on their shower, 50 gallons comes out of the source, the water then goes into a surface water treatment plant, and then back to the shower. But that's not the end of it. Of course we have drain flows and the example I cite here has a return flow efficiency of 100 percent. That drain flow is the potential non-consumptive loss, it goes to the wastewater treatment plant, which then returns it to the source. The net impact on the source in this case is zero. We took 50 gallons out and put 50 gallons back in. However, if I put a low-flow shower head on that shower, again assuming 100 percent return flow efficiency, and I only have a 25 gallon shower, I only take out 25 gallons, and I only treat 25 gallons of wastewater, yet the net impact on the river is precisely the same.

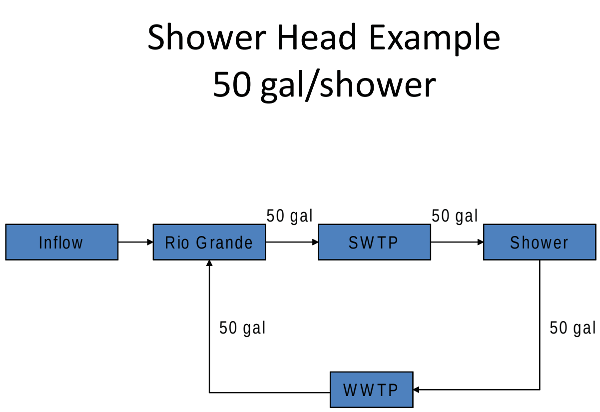


Figure 1. Shower Head Example

Now you might say there are some consumptive losses here, the water that you dry off with your towel for example, but I would maintain that is the same amount of water whether you take a 50 or 25 gallon shower. In fact, what we are looking at in most of these discussions is a differential analysis: the difference between some existing management measure and some water conservation, some improved water management measure.

Taking this same kind of generalized hydrologic approach, I have been trying to develop a generalized irrigation hydrology and I don't think I am done with it yet (Fig. 2). First, we have our inflow to a source. The inflow may be natural recharge or it may be snowmelt runoff, but the source is essentially a river, an aquifer, or a river/aquifer system. We have consumptive losses that occur directly from the source and we also have non-consumptive losses during conveyance. The non-consumptive losses, if we are talking about a riparian irrigation system, would primarily be canal seepage. It is a very big loss, but there are also losses from operational spills. Excess water within the canal system is dumped directly back to the river without ever going through the seepage process. We then apply the water to the field, which is the real objective — diverting the water down to the field and, of course, we have very significant consumptive use here. That is different from the shower example, however, this is not a bad thing. That consumptive use is what drives the yield formation, that's why you irrigate, that's what provides the economic production of the whole system. We also have non-consumptive uses on the farm, for example, deep percolation, and runoff. These non-consumptive losses from conveyance and application have some losses associated with them but whatever isn't lost in return to the source, goes back to the source and the ratio between what is actually showing up in the source against non-consumptive losses is the number I am calling "return flow efficiency."

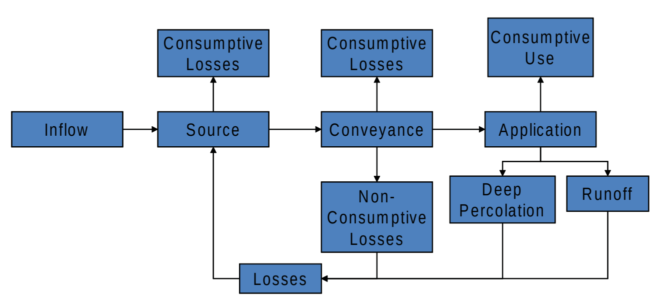


Figure 2. Generalized Irrigation Hydrology

Let's look at riparian irrigation systems. I have worked on a few of them around the state and since there is no such thing as a typical irrigation system, I'm not calling these typical, but I think most of what I'm going to say later applies to these systems. The primary source of non-consumptive losses (potential return flow) is canal seepage. I know for a fact that this is the largest potential source in the Elephant Butte Irrigation District (EBID). I'm not quite sure about the Middle Rio Grande but it is a big non-consumptive loss there also.

Another source of non-consumptive losses is operational spills where excess water diverted into the canal system is dumped directly back to the river. And the third source is deep percolation where excess water applied to the field percolates through the root zone to the local groundwater. If the excess water doesn't percolate through the root zone, we assume the plant gets all of it and uses it for evapotranspiration as a consumptive use to generate yield. In these systems, we have a relatively high return flow efficiency.

I haven't quite figured out all the details yet on this concept, but if we look at, for example, the drain flows in the Middle Rio Grande relative to the diversions, it's a pretty significant amount. But there are other return flows that are not measured in the Middle Rio Grande. We obviously have the drains that return water at discrete points, which can be measured. We also have deep percolation that recharges the hydrologically connected aquifer and that is a whole lot harder to measure. The returns that do go back into the river can be reused by industrial water users or they can be used to meet downstream water delivery obligations. There is also groundwater pumping in these systems. The primary source of recharge is these potential return flows. This is one of the things I haven't quite worked out in my mind: does groundwater recharge constitute actual return flow that was captured and reused? I tend to think, probably, yes.

If we look at a few water conservation measures in terms of these hydrologic components, let's see what they really address. First, canal lining primarily reduces seepage, a non-consumptive loss. Recently EBID lined about 22-23 miles of canals, and that has resulted in a reduction of seepage. No, that doesn't mean that you shouldn't line canals. Let me make that clear. I think there are canals that really need to be lined — canals that are used intermittently and perhaps have very high seepage rates. It's true seepage is not lost, but it's requiring excessive deliveries to the lateral in order to fill up, make the delivery, and then drain. So there are timing and management issues aside from the recharge. However, I hope most of the districts are not going into heavy canal lining phases because of their downstream considerations. As Steve Vandiver said in Colorado, they got a little too tight on their water conservation measures and they conserved themselves right out of an aquifer.

If we look at on-farm irrigation technologies like advanced high efficiency measures through drip and flood irrigation and LEPA, what they are really focusing on is non-consumptive deep percolation as the primary reduction. They may reduce the incidental evaporative losses, a consumptive loss. For example, if you are flood irrigating, you reduce the evaporation that takes place during flooding particularly before you have a full crop cover. So there is some effect on consumptive use but, in fact, what you are really doing is reducing your non-consumptive losses. For lower water use crops, this is a case where we really are reducing both applied water and consumptive losses. The trouble is that people don't pick their crops solely on the basis of how much water they use. However, the number one criteria for crop selection is whether someone can make any profit from the crop. There are many other considerations that go into a crop selection other than water use.

Another aspect to look at is forbearance. Back in 2005, Dr. Ronachan Odiff of Colorado State University and I did a small study for the Middle Rio Grande and looked at the effect of forbearance on making water available for in-stream management of silvery minnows. It was a very interesting study and we found that forbearance had both consumptive and non-consumptive impacts. A nice summary of what we determined is in Figure 3.

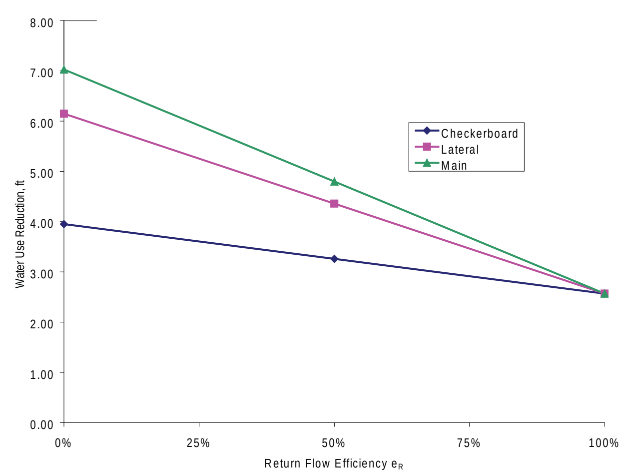


Figure 3. Return Flow Efficiency and Forbearance

There is return flow efficiency in the Middle Rio Grande no matter how you calculate it. It is a very complicated: you have the Bosque taking some of the potential return flow out, you have groundwater pumping, you have all sorts of things going on. Many of the drains aren't very well metered, so it is hard to assess what the actual return flow is and what the potential return flows are as well. We estimated the canal seepage and deep percolation from irrigation, and we may both be PhDs, but what we determined was that the return flow efficiency would be somewhere between 0 and 100 percent. That is to say, it is possible that all of the potential return flow makes it back, or that none of it makes it back, but it will probably not be outside of that range.

What we did was to look at the different strategies of forbearing water and let me explain what these are. You can provide incentives for farmers to forebear; you get one farmer here and one farmer there, not contiguous, not organized, just whoever will buy into the program. That is the checkerboard effect as shown in Figure 3. The lateral effect is where you get all the farmers on an entire lateral to enter into the forbearance program. The main effect is where you get everyone in a main river diversion unit out — how much water would be saved per acre of forbearance? You can see that if we assume a return flow efficiency of 100 percent, that is all available non-consumptive losses are getting back to the river and are available for downstream use, that all you save is the consumptive irrigation requirement. You don't get credit for any of those non-consumptive losses because, again, we are looking at it as a differential. Even if you take those areas out of production, there is still somebody downstream that is expecting that quantity of water and has a right to it. If we assume that none of the water makes it back, down at the zero end, you will notice that for the checkerboard system, what you get is the total applied water. We assume none of it makes it back and you save the total applied water. If you go to the lateral system, you save the entire application plus the losses within the lateral. And if you can take out an entire main system diversion, you get the whole diversion from the river. If you were diverting about 7 ft/acre as they were doing at the time we did this study, you would save all of that at 0 percent return flow efficiency. Somewhere between the space representing the loss of laterals and the on-farm losses, you have some semblance of reality and no doubt it changes dramatically with location and time. For simplicity, we assumed 50 percent. Why? Because it was between 0 percent and 100 percent.

Figure 4 is a diagram that I found useful, especially talking to civil engineers and explaining what a surface irrigation probe looks like. The diagram graphs the distance down the field from the head to the tail and after a surface irrigation event, the infiltrated profile. The blue line is a function of infiltrated depth as a function of distance down the field. At the far left, at the head of the filed, you have a little more than 4.5 inches infiltrated, and at the tail of the field you have about 3 inches. In this case, I am assuming a pre-irrigation deficit of 3 inches.

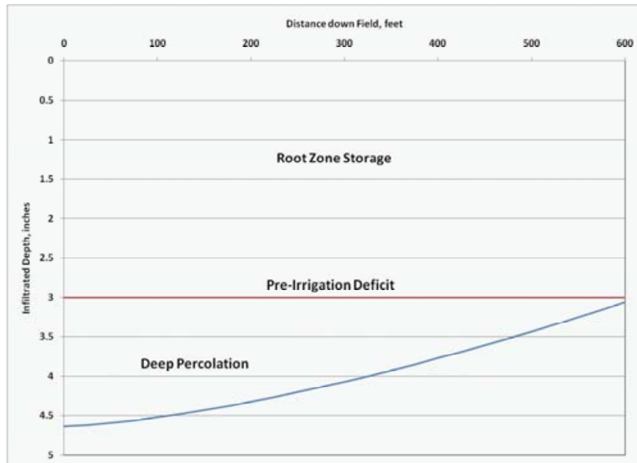


Figure 4. Basic Surface Irrigation Infiltration

What that means is that the root zone of the soil can hold 3 inches of water, anything in excess of that deep percolates. The reason you have more infiltration at the left of the graph than you have on the right side of the graph, is that you start watering from the left side. You have water at the left side the whole time you are pushing water down the field until you get to the right side. Thus, the water has been infiltrating on the left side longer than it has on the right side by the time it is over.

Suppose you improve your irrigation and you apply the water faster and for a shorter duration (Fig. 5). What that does is push the water down the field faster, thereby reducing the discrepancy between the head of the field and the tail of the field and lo and behold, you can apply less water, still get a full irrigation, and you have water left over. You actually apply less water in this case. What have you done? Before and after irrigating, you have reduced the deep percolation. Now if we look at Figure 5, instead of taking this excess water out, which reduces the return, assuming the losses would be unaffected by the change, you are reducing the recharge back to the source.

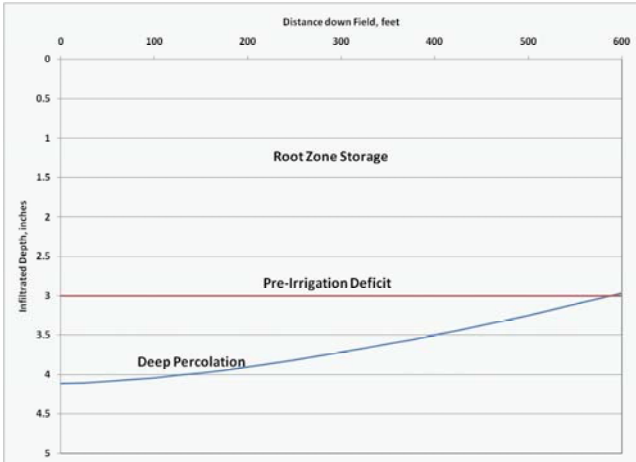


Figure 5. Improved Surface Irrigation Infiltration

Here is another fact of life: the more water a crop uses, the higher the yield. Take green chile as an example (Fig. 6). This figure was adapted from a study by Wierenga back in the late 1970s/early 80s, where he measured the amount of water consumed (actually this was water applied but it was a very high efficiency system so we take it as water consumed). You will notice that the more water a crop uses, the more yield you get. Well that's what farmers are supposed to do — use their resources as efficiently as possible and get the most yield they can out of it.

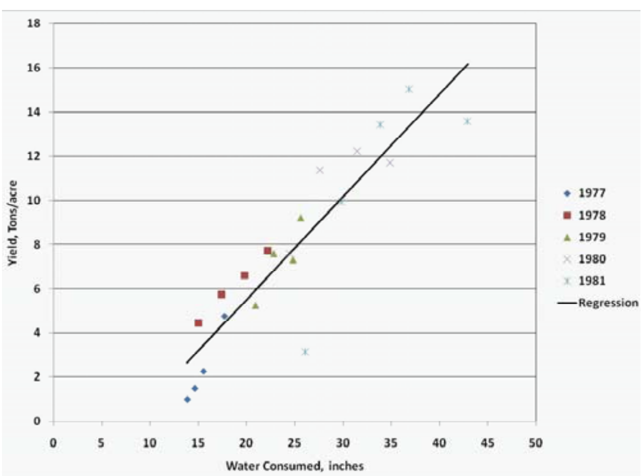


Figure 6. Water Production Function - Green Chile adapted from Wierenga, 1983

What happens if you reduce non-consumptive losses? If you have a fixed allotment and you use less water per irrigation, you can irrigate more. What that does is to make more water available for consumptive use. You get increased production and profit, which is exactly what you are trying to do. However you decrease the return flow, and this then has the potential for impairing downstream water rights.

Let's take a quick example (Fig. 7). If I have 3 feet on a traditional application with 65 percent application efficiency (I took Wierenga's relationship and found that it uses 23.4 for consumptive use, so the rest, 12.6, goes back for return flow), I get 7.1 tons/acre out of that function. If I upgrade my system to 85 percent application efficiency, I get 10.4 tons/acre. However, I have increased my consumptive use and decreased my return flow. And that is where you can get into problems — conserving yourself out of an aquifer or creating downstream problems. The net result is 3.3 increase in yield, 7.2 increase in consumptive use, and a 7.2 decrease in potential return flows.

Traditional Practice
- 3 ft
- 36 inches
- 65% application efficiency
- 23.4 inches consumptive use
- 12.6 inches potential return flow
- 7.1 tons/acre

Improved Practice
- 3 ft
- 36 inches
- 85% application efficiency
- 30.6 inches consumptive use
- 5.4 inches potential return flow
- 10.4 tons/acre

Net Result
- 3.3 tons/acre increase in yield
- 7.2 inches increased consumptive use
- 7.2 inches reduction in potential return flow

Alternative
- 76% of acreage planted
- 3 ft
- 36 inches
- 85% application efficiency
- 30.6 inches consumptive use
- 5.4 inches potential return flow
- 10.4 tons/acre
- 113% of traditional total yield

Figure 7. Chile Example

Here is an alternative, and this is what a person who is trying to convince the farmer to live within his means would suggest. If you use 76 percent of the total acreage, you actually have exactly the same depletion with the 85 percent efficiency that you would with the 65 percent. You are just stacking water on less land. You have 30.6 inches of consumptive use and the same amount of total volume, but you are using it on less acreage. You get 10.4 tons per acre, which even on 76 percent of the acreage, you end up with 113 percent of your traditional yield. That is the general sort of accountant's explanation of how we should go about handling this.

Now you do have conflicting perspectives. You have a statement that you have heard many, many times in many, many water presentations: "Beneficial use shall be the basis, the measure and the limit of the right to the use of water." But the ambiguity of the meaning of "beneficial" has long been argued. Nobody ever defined "beneficial." To tell you the truth, that is only the first part of the ambiguity: "use" — I hate to sound like Bill Clinton — but it depends on what your definition of "use" is. To a production irrigator, it means applied water. That's what irrigators work with, that's what they measure, that's what they are allotted, that's their currency. If you are dealing with a regulator or a manager who has to consider downstream impacts, what he is really trying to do is to maintain the hydrologic balance and equity among water users by manipulating the *applied* water that he allots for permits to users to control *consumptive* use. But as you see, they are not the same thing.

Here is a quick example. If you have mined groundwater such as what is on the east side of the state, you have a weak or long-term connection between the surface water and the groundwater. I liked John Shomaker's explanation: by the time the recharge gets there from the irrigation, the aquifer will be gone. Therefore, the return flow efficiency is very small in human time scales. Maybe if we wait until the next ice age, things will be better; some of that water will work its way down, but I don't think that is a functional business. Thus the reduction of these non-consumptive losses is generally less important. In other words, if you do improve your efficiency, and turn mined water straight into yield, that is a good thing. What you do in this example is a very different conceptual approach than from a riparian system.

The other quote you see at every water conference is from 11 Samuel 14:14, "...water spilt on the ground ... cannot be gathered up again." Of course you can!

Edmund G. "Ed" Archuleta has been manager of the El Paso Water Utilities Public Service Board since January 1989. He is responsible for all aspects of water, wastewater, reclaimed water service, and storm water to the greater El Paso metropolitan area. He reports to and implements strategic policies set by the five-member Public Service Board. A registered Professional Engineer in Texas, New Mexico, and Iowa, Ed earned B.S. and M.S. degrees in civil engineering from New Mexico State University and a Master of Management degree from the University of New Mexico. He is an American Academy of Environmental Engineers Diplomat. He was appointed in June 2006 by President George W. Bush to the National Infrastructure Advisory Council. Ed is currently involved with several technical and professional organizations, including the American Water Works Association, the Water Environment Federation, Water for People, WateReuse Foundation, the National and Texas Societies of Professional Engineers, the Texas Water Conservation Association, New Mexico/Texas Water Commission, Far West Texas Planning Group, and Regional Economic Development Corporation. He is a past Chairman of the American Water Works Association Research Foundation, and current Trustee of the Association of Metropolitan Water Agencies, Water for People, and the WateReuse Foundation. He serves as chairman of the Multi-State Salinity Coalition.

El Paso's Experience in Surface Water Treatment – Lessons Learned

Ed Archuleta
El Paso Water Utilities
P.O. Box 511
El Paso, TX 79961-0001

Good morning. I appreciate the opportunity to be here. Before I talk about using surface water in El Paso, which we've been doing for a long time, I want to talk about the watershed and where the water supply comes from – the Rio Grande Project from Elephant Butte to Fort Quitman. In 1989 when I moved to El Paso, one of the things I recognized very early was that we did not have a long-term water plan for El Paso. We were relying primarily on groundwater, mostly from the Hueco Basin on the eastern side of the Franklin Mountains and to some extent the Mesilla Basin on the west side. We used some surface water from the Canal Water Treatment Plant located in Central El Paso. For our long-term plan, El Paso Water Utilities needed to diversify our portfolio significantly. One of the lessons learned as a city utility is to be diversified to deal with emergencies like climate change or drought. In order to deal with these issues, we diversified significantly and have been implementing programs concerning these types of issues over the past 19 years.

Our priorities for additional water supplies started with conservation. As most of you know, El Paso has a very aggressive water conservation program. In 1991, El Paso used 201 gallons per person per day. Last year consumption was reduced to 134 gallons per person per day, and this year it is estimated that consumption will be reduced even further. Conservation has been very important, but it was also very difficult to explain to customers in 1991 why they needed to comply with an outside watering schedule. But we have been very successful. Our peak demand has fallen from about 195 million gallons per day in 1990 to about 155 or so on a hot summer day in El Paso. That is because of our conservation program, as well as with our next priority, which is reclaimed water.

We have significantly expanded our reclaimed water program. We want to thank the Bureau of Reclamation's (BOR) Eluid Martinez who has helped us, as well as others within the BOR, including Mike Gabaldon and members of his staff, and former Commissioner Keys. We developed a master plan for reclaimed water, and now all four of our wastewater treatment plants reclaim water. Our Fred Hervey Wastewater Treatment Plant treats water to drinking water standards, while the others are advanced secondary plants that treat water to a standard used primarily for industrial use and for turf at school grounds, parks, cemeteries, golf courses, and some apartments. Reclaimed water use has grown from about 200 million gallons per year to about 2 billion gallons per year with infrastructure of about 40 miles of pipeline, holding tanks, ground storage tanks, and pump stations. Reclaimed water has become a big part of our portfolio.

Surface water is my main discussion and I want to talk about the Mesilla Basin. The Mesilla Bolson has been stable for many years and serves our customers in the Upper Valley and West El Paso. The Hueco Bolson is the basin that is being depleted as years go by. When it was reported that El Paso was running out of water, it was the Hueco Bolson that was losing 8,000 acre-feet of water due to the growth in East El Paso. We were taking about 20,000 acre-feet out of the Hueco, but as part of our plan, have weaned ourselves from the Hueco. The groundwater table was dropping 2 to 4 feet a year, and now has actually risen and is stable. It is our intent to keep it stable and use the renewable sources that we have available to minimize the amount of groundwater use, particularly from the Hueco Bolson.

Desalination is another priority and our new Kay Bailey Hutchison Desalination Plant has been running very well. We have ramped up its production all the way to its designed capacity of 27.5 million gallons per day. We have a plentiful surface water supply which is our intent to use first, then reclaimed water for non-potable uses, and to augment surface water with groundwater. As a result, we have only been using one skid out of five at the desalination plant, so approximately 4 million gallons of desalinated water per day is actually being processed currently from the plant. The plant was built to meet future needs with the Fort Bliss expansion and is predicted to triple in size. Many military families will be relocating to El Paso, so we expect significant population growth in that part of El Paso to be serviced by the desalination plant.

In 1943, El Paso built its first surface water treatment plant, the Robertson Plant, and in 1967, the Umbenhauer Plant was built right next to the Robertson Plant. This second plant doubled the size of the capacity to 40 million gallons per day. Back in 1989, we had only one water plant in Downtown El Paso and our other plants could no longer expand. As part of our long-term plan, we decided to work with the El Paso County Water Improvement District #1 (EPCWID #1) to try to buy more property and lease more water rights in order to build a second water treatment plant. We have had a very cooperative relationship with EPCWID #1, and in fact, the long-term plan I talked about was developed in cooperation with the Irrigation District. I want to thank the Irrigation District and their General Manager Chuy Reyes, who is also a speaker at this conference, along with Filiberto Cortez from the Bureau of Reclamation, and Gary Esslinger, manager of the Elephant Butte Irrigation District. They played a significant part in the Lower Rio Grande Project Operating Agreement Settlement that has been reached.

We wanted to double the surface water treatment capacity from 40 to 80 million gallons per day by building the Jonathan W. Rogers Water Treatment Plant in 1993, and then we expanded that plant in 2002 and added another 20 million gallons per day. Between the two plants, we now have 100 million gallons per day, with a demand similar to that of Albuquerque. We have about 100 million gallons per day or about 100,000 acre-ft per year, and we have had this capacity for almost 20 years. The amount has not changed much because of our water conservation efforts that allow us to use about the same amount of water annually as we did 20 years ago, despite the fact that we have grown by about 180,000 people. That is the proof in the pudding that water conservation does work. We also feel we have avoided about $300 million in capital costs because of what we have done. Otherwise, our per capita consumption would have stayed the same or even increased. Those are the basic reasons why we are at where we are today - because we diversified and implemented a program.

Most of the surface water that is available to us is only available between March and October. I think most of you know that Elephant Butte and Caballo are Bureau of Reclamation (BOR) dams, so they are operated, maintained, and regulated by the BOR. Our supply depends on how much water is in the Rio Grande in a given year, and the BOR works with the irrigation districts to allocate flows for the irrigation year. The BOR is about to close the gates for this season, and after that return flows are received. At that time, we shut down our two major water plants and convert entirely to groundwater. Some customers transition from groundwater to surface water daily, but have not had any significant issues with these customers. Depending on the location of the customer, some customers remain on groundwater year round, but a good part of our customer base switches from surface to groundwater. The surface water quality does deteriorate significantly, and from the headwaters to El Paso, the salt content is a significant concern. Our agencies in El Paso are working with others in New Mexico to begin to better quantify and identify salt loadings and salt contents. We deal with salinity, total dissolved salts (TDS), and sulfate, particularly in late releases, and, of course, from time to time depending on thunderstorms, we do have taste and odor changes.

As mentioned, the operational issues include the seasonal surface water instability as we transition customers from source to source, and in blending different water types in the distribution system, which calls for careful planning and attention to detail. Over the years, we have learned how to operate the system in order to provide the best water quality possible for our customers. Besides salts, TDS, and sulfates, we also now have to be concerned about disinfection byproducts, total organic carbon (TOC), and bromide, which all must adhere to EPA and state standards.

With regard to salts in the El Paso area, we receive a significant amount of salt, TDS loading, and sulfates (Figure 1). We have our own wastewater treatment plants in the region and have upstream wastewater treatment plants, but because of the discharge, we have poorer water quality in our area.

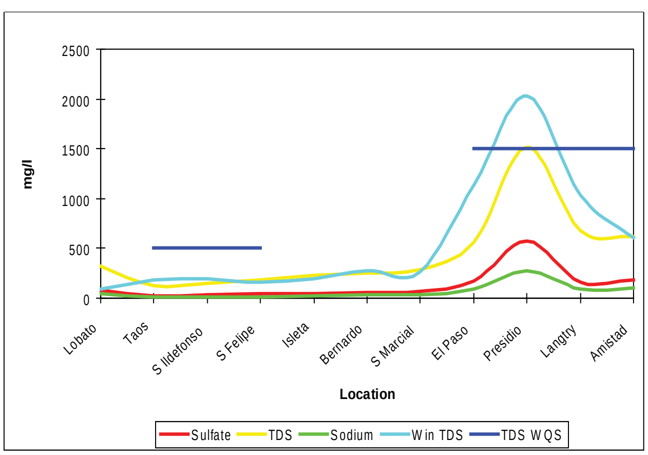


Figure 1. Rio Grande Quality

The TDS from drain inflows and water treatment plant effluents by miles from Elephant Butte is depicted in Figure 2. The first red bar represents the Las Cruces wastewater treatment plant followed by our plants; there are also various drains that come into play. This information was taken from a study that the Coalition is going to be working on in order to better quantify locations, amounts, and what can be done in the future. Comparing data, total organic carbon (TOC) in Albuquerque is about 3 while in El Paso, the TOC is 8; bromide is .02 in Albuquerque and is about .20 in El Paso. These substances are precursors to disinfection byproducts. A portion of the TOC becomes trihalomethanes (THMs) upon disinfection. A portion of the bromide becomes bromate as we go through ozonation.

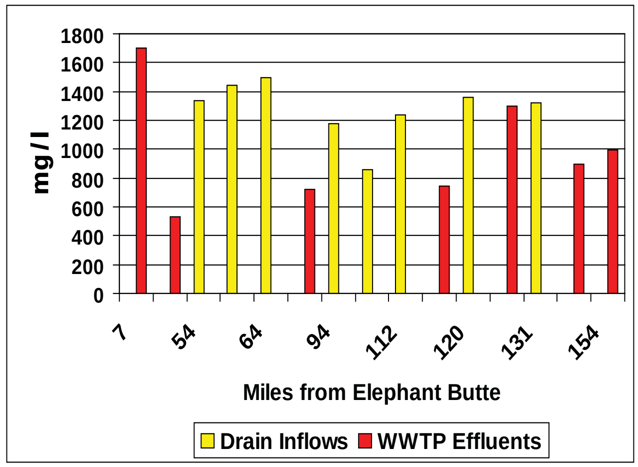


Figure 2. Inflow Streams TDS

So what's the good news? My staff provided me with Figure 3, and I thought it was interesting enough to share. We have a lot of fish despite all of our issues, and in looking at the fish species, you'll see that we don't have the silvery minnow. I remember Rumsfeld saying you don't go to war with the army you wish you had, you go to war with the one you have. And that's what we are dealing with – what we have. We have water quality that is not necessarily pristine, but it is the water we have, and we have been able to work with it for a long time.

There was a question this morning about water delivery costs, as opposed to the cost of treated surface water. Groundwater costs us about 50 cents per 1,000 gallons to process while surface water costs about $1.00 per 1,000 gallons. Desalination costs about $1.65 per 1,000 gallons, and reclaimed water is over $2.00 per 1,000 gallons. We expect reclaimed water costs to come down once we finish building our distribution system and add more customers. We subsidize the cost in delivering reclaimed water and price it lower in order to get people to use it. The overall cost to us is probably in the range of $2.20 per 1,000 gallons.

Fish Common Name	Rio Grande near Del Norte, CO	Rio Grande at El Paso, TX
Gizzard Shad		X
Red Shiner		X
Common Carp		X
Fathead Minnow	X	X
Bullhead Minnow		X
Longnose Dace	X	
River Carpsucker		X
White Sucker	X	
Rainbow Trout	X	
Brown Trout	X	
Channel Catfish		X
Flathead Catfish		X
Brook Stickleback	X	
White Bass		X
Bluegill		X
Longear Sunfish		X
Sunfish		X
Largemouth Bass		X
TOTALS	**6**	**13**

Figure 3. Fish Collected

The cost of treated surface water has increased very sharply (Figure 4). We have different contracts with the BOR including one negotiated in 2001 that is scheduled to be re-negotiated in 2011. There is an annual increase in that cost, which is pretty significant and is driving the increase in water purchase costs. When talking about treating surface water, you have to be wary of the escalating costs of chemicals. We have had double or triple digit increases in chemical costs, as well as high power costs. El Paso Electric has partial ownership in the Palo Verde Nuclear Plant and some ownership in the Four Corners Power Plant. Most of their energy is natural gas driven, so as fuel adjustments in price occur, the cost of treatment goes up.

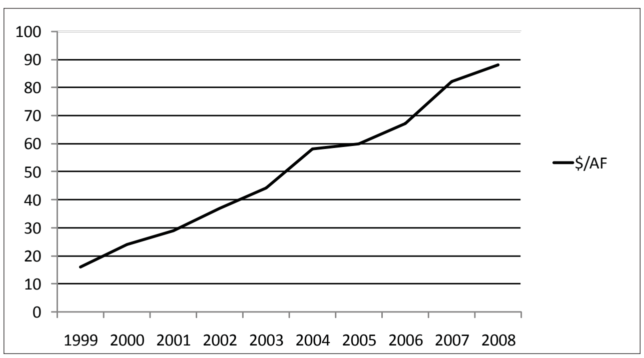


Figure 4. Cost of Treated Surface Water (O&M cost only)

The Jonathan W. Rogers Water Treatment Plant is our newest plant, and our water quality goals include less than .15 NTU, pathogens 2-Log *giardia* inactivation and 1-Log *cryptosporidium* inactivation; no detectable taste and odor; low corrosivity for lead and copper; and the free chlorine distribution system disinfectant. We detect from time to time spores of *cryptosporidium* in the source water, but of course, not in the finished water because we remove it. I believe that part of the problem comes from upstream dairies in New Mexico between El Paso and Las Cruces. I also believe that better source water protection would help a great deal. EPA, EBID, and TCEQ are trying to do a better job of source water protection.

We have highly variable turbid water, particularly during the summer months, going down to .15 NTU from 90 NTU. The dissolved organic carbon or disinfection byproduct precursor removal ranges from 8 to 1.5 mg/L. We also remove and inactivate pathogens. We must deal with taste and odor issues and, of course, stabilize the finished water.

We use a process very similar to what Albuquerque uses starting with presettling, then pre-ozonation, rapid mix, flocculation, coagulation, sedimentation, more ozonation, and then finally, the biological granular activated carbon (GAC) filtration with activated carbon and chlorination. We did extensive pilot plant testing because our source water has a fair amount of wastewater treatment plant effluents, which in El Paso, comes through the American Canal.

Figure 5 shows some of our ponds. We have 45 acres of presettling ponds that provide 146 million gallons of raw water storage and remove 75% of the raw water turbidity. In the last couple years, with all the rain and flooding El Paso has received, we have taken out tons of material from these ponds. The good news is between the months of October and March, preventive maintenance is being done including removal of silt from ponds. On the one hand, it would be nice to have year-round flow and year-round operation, but on the other hand, we do a lot of maintenance to make sure that during the seven or eight months of production, we don't have disruptions or loss of service due to mechanical or electrical failures.

Figure 5. Presettling: 45 acres of presettleing ponds provide 146 million gallons of raw water storage and remove 75% of the raw water turbidity.

Pre-ozonation works very well for us. It provides microflocculation benefits that reduce coagulant usage, precipitates soluble iron and manganese, and aids in taste and odor removal. Chlorine dioxide is added to minimize bromate.

Figure 6 is part of the pilot plant work. The rapid mix, flocculation, and settling again, work very well. Ferric chloride coagulation destabilizes turbidity and disinfection byproduct precursors, providing 95% turbidity removal and up to 50% disinfection byproduct precursor removal.

Figure 6. Rapid Mix Flocculation, Settling: Ferric chloride coagulation destabilizes turbidity and disinfection byproduct precursors, providing 95% turbidity removal and up to 50% disinfection byproduct precursor removal.

Post-ozonation is the process ahead of the filters and, of course, the filtration. It provides primary disinfection for pathogen inactivation, taste and odor removal, and conditions water for enhanced biological removal of disinfection byproduct precursors across the GAC filters.

GAC filtration provides the final barrier to turbidity, taste and odor removal, an additional 25% biological removal of disinfection byproduct precursors, nitrification of trace ammonia, ozone byproducts removal, and synthetic organic chemicals removal. Carbon also is very expensive. We have eight filter galleries at a particular plant; we rotate on a three to four year cycle. At first our operation was more conservative and we rotated every other year. Carbon is very expensive in today's market, but is the heart of water treatment. Ozonation obviously also plays a big role in water treatment. At one plant rather than chlorine, we use chlorine and oxide and it does fine with disinfection and control. The challenge is to meet the new disinfection byproduct standard. Hopefully at some point when we will get rules from the EPA, we'll also receive funding to meet their standards. In Albuquerque, John Stomp talked about moving water from the east side to the west side, which is a very expensive process. We have spent $76 million in capital expenses and $4 million in operation and maintenance on our arsenic removal effort, even though we had no real evidence that we had an arsenic problem. As you know, no epidemiological study has shown that we needed to go to that extreme. Some have argued that our arsenic levels are at 20 parts per billion, not 50. At 20 ppb, we would probably not have spent any money; at 10 ppb, we spent $76 million.

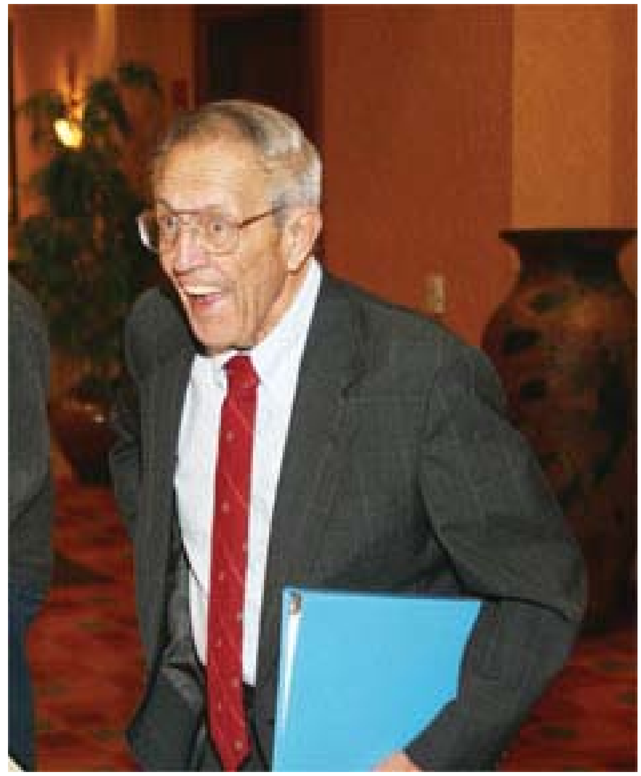
As a utility manager, it's hard to explain to the public, to the ratepayers, why their water bill just keeps going up. I'm not against safe drinking water, but I've been in business for a long enough time that I know people aren't dying because of drinking tap water. We have some of the safest, if not the safest, water in the country. And even today, everybody's drinking tap water, right? You're not drinking bottled water. You go to a restaurant and ask for iced tea. You don't ask for bottled water iced tea. You get tap water iced tea. It's a huge marketing effort to get everybody to consume bottled water. But if we are going to treat our tap water, we must recognize the value of water and convince our customers of its value.

Now let's talk about disinfection byproducts and why we have to meet the strictest standards. Just like in Texas, we have to meet every standard. In my case, I live on the west side of El Paso, but I drink water on the east side where I work. And I'm here and I'm there, in Albuquerque today and yesterday I was in Chicago. What's my exposure? While in Chicago, I was at a meeting where during the opening session, a professor, who is a member of the Stockholm Project, talked about the "water footprint." Now we are talking about virtual water, embedded water. When I arrived in El Paso years ago, we had garment industries that used a lot of water. I wondered, why did they bring garment finishers to El Paso to take groundwater to wash jeans? It was based on jobs though, in fact, based on low-paying jobs. A lot of people, including me, were glad when those jobs went to Asia because now they are using the water over there. So that's the embedded water. Whether you are in agriculture or manufacturing, whether you are importing or exporting, whether you are growing pecans or lettuce, there is a net exchange. I think states are becoming more cognizant of their water footprint and the value they get for a particular commodity. It was an intriguing discussion and don't be surprised if, before too long, somebody asks you what your water footprint is. How much water a year are you as a community, you as an individual, you as a company, you as a farmer, you as an irrigator ... how much water are you using and is that water being used for the benefit of the area or is it just being exported?

We face a challenge with the Stage 2 DBP Rule. Our historical average treatment process removal of TOC ranges from 30-40%, which is not enough of itself to guarantee compliance with the rule. We are working on this and have done a lot of pilot plant and modeling work throughout the system. We may have to go to some type of air stripping, and a distribution system might be the most economical way to do it. My staff is working on this, along with CH2M Hill consultants. We have done a lot of bench-scale testing, as well as small testing in columns. It's a very complex process to make sure to meet the standards without causing harm to some other part of the process.

In summary, El Paso is glad to have a surface water treatment program. Whether we have a full supply or less than full supply, we are in good shape. We are going to use surface water first, and if we find ourselves in a drought in the future, will implement a new agreement between the districts and the BOR. We will then turn to desalination and groundwater. As our population continues to grow, we will expand to additional surface water use. For now, we are in very good shape, and I would say our biggest success has been that we diversified our portfolio.

John W. Hernandez has been chosen to present the 2008 Albert E. Utton Memorial Water Lecture at this year's conference. New Mexico State University Professor Emeritus John Hernandez has been associated with the New Mexico Water Resources Research Institute for many years, most recently as a consultant on several projects. Recently, John worked with senior hydrogeologist John Hawley and others on determining the feasibility of reducing the transmission losses by Conchas Canal in the Arch Hurley Conservancy District. Since retiring from the Civil Engineering Department at NMSU in 1999, John has remained active in water resources management issues, particularly those related to water quality. He has produced several recent reports for the Bureau of Reclamation through the WRRI on conveyance alternatives to San Acacia from the Isleta Diversion; Pecos River management alternatives that minimize impacts to endangered species; and a study of institutional considerations for managing water in the Middle Rio Grande. John received a B.S. in civil engineering from the University of New Mexico in 1951; an M.S. in sanitary engineering from Purdue University in 1959; an M.S. in environmental engineering from Harvard University in 1962; and a Ph.D. in water resources from Harvard University in 1965. John was a faculty member at NMSU from 1965 to 1999, including Dean of Engineering in the late 1970s. John has broad experience regionally, nationally, and internationally in water resources issues and has published extensively. He received many awards throughout his career including the prestigious Donald C. Roush Excellence in Teaching Award from NMSU in 1990, and the Civil Engineering building at NMSU is now named Hernandez Hall in his honor. In 2005, John was made a Distinguished Member of the American Society of Civil Engineers.



Albert E. Utton Memorial Water Lecture

100 Years of Water Management in New Mexico — Stories about the People Involved

John W. Hernandez
Water Resources Consulting Engineer
Box 3196
Las Cruces, NM 88003

*"The basic physical circumstances of our water resources are timeless.
They assume meaning only in terms of the people
who came to develop and to use them."*

Stolen, in part, from Paul Horgan's *The Great River*

My talk today is not about New Mexico's limited water resources, but about the limitless energy of the people who have played a significant role in the development and beneficial use of our supply. Today, I want to focus on three dozen or more of the many people who have made a lasting but perhaps unintended impact on our understanding and on our use of New Mexico's limited water resources.

A year ago, Emlen Hall talked about Morris Bien (Fig. 1), the Reclamation or USGS lawyer who wrote the Territorial War Act of 1907, leading to the provisions that were made permanent in the state's 1912 constitution, giving us the mantra that I heard so often from Steve Reynolds: ". . . priority of appropriation, gives the better right . . . beneficial use shall be the basis, the measure, and the limit of the right to the use of water."

Figure 1. Morris Bien, lawyer; BOR/USGS author of the 1907 Territorial Water Appropriations Act - the 1907 New Mexico Water Code

I start my list of significant and lasting contributors to water development with Morris Bien for a water code that has withstood at least 50 sessions of the state legislature — an enduring feat! And of course, Steve Reynolds (Fig. 2) makes my list, not for his management of the Office of the State Engineer, but for the many never enacted administrative rulings that have become precedent and that are still with us; for his courage in closing the Middle Rio Grande Basin to the appropriation of groundwater without permit; for his efforts in making the Navajo Irrigation and San-Juan Chama projects realities; and for the many important legal battles that he fought, losing only once, in protection of the State's water resources.

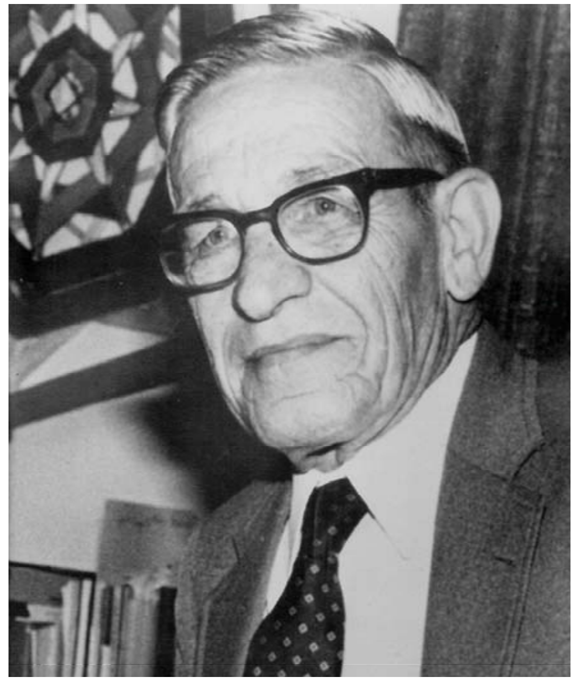


Figure 2. Steve Reynolds, New Mexico State Engineer, 34 years of leadership in the development of New Mexico's water resources

The 1907 Water Code had a major impact on the development of the state's water resources. If you read the First Biennial Report of the Territorial Engineer, 1907-1908, you will find that the new law opened up a flood-gate of requests for appropriations of water. From May 17, 1907 to December 1908, there were requests for over 2,000,000 acres of newly irrigated lands. In 1907-1908, the territorial engineer approved the appropriation of water for 700,000 of those 2,000,000 acres. The list of requests in the First Biennial Report covers four pages of small type (they came from every county), all from private individuals or water development companies on creeks I have never heard of — Tortilla Creek, anyone?

The First Biennial Report did not include already approved requests by the Reclamation Service: 20,000 acres in Carlsbad; 19,000 acres on the Hondo; 10,000 acres at Las Vegas; 180,000 acres in the Rio Grande Project; and 60,000 acres at Urton Lake, which I had never heard of either. It seems as if everyone requesting a new water appropriation tended to greatly overestimate the supply available to them. As statehood approached in 1912, the Territorial Engineer predicted that within the next 10 years, irrigated acreage in New Mexico would grow to 4,000,000 acres. I think that a true accounting of the acre-feet involved in all these applications will show that the state's surface water supply was already over-appropriated by 1912 — my bad! Fully appropriated, sorry Phil Mutz.

The next group that I will recognize for their contributions are the "risk takers," the many folks who put their money and their hard work on the line in the development of the beneficial use of water. Very few of the early private ventures were profitable; almost none remain in private hands today. Most evolved into the ignominy of being a Reclamation project.

One of the earliest of the many private irrigation projects was that of the Pecos Irrigation Company. It had other names that I have forgotten, but that's what it was called at the time it was purchased by the Reclamation Service in early 1904 to become one of their first projects. In 1887 or so, C.B. Eddy (Fig. 3), a man with empire ambitions, and Pat Garrett (Fig. 4), an out-of-work sheriff after he killed Billy the Kid in 1881, started corporate irrigation in the Carlsbad area as an under-capitalized Pecos Valley Land and Ditch Company. There were many associates: Joseph Stevens, Robert Tansill, Charles Greene, and Francis Tracy (Fig. 5), but Pat Garrett was soon eased out. The talk was of irrigating 400,000 acres. Bonds were sold and more and more capital was raised. The real money came in 1889 when J.J. Hagerman (Fig. 6), a Cripple-Creek Coloradoan, joined the gang. The original company built two dams on the Pecos (Avilon and McMillan), miles of canal, and at least one large wooden flume, and then rebuilt them after the flood of 1893. The floods of 1904 washed-out parts of their dams again. But it was debt and more debt that doomed the project to be a federal take-over case. Risk takers J.J. Hagerman, C.B. Eddy, Pat Garrett, and Francis Tracy make my list of significant water resources developers.

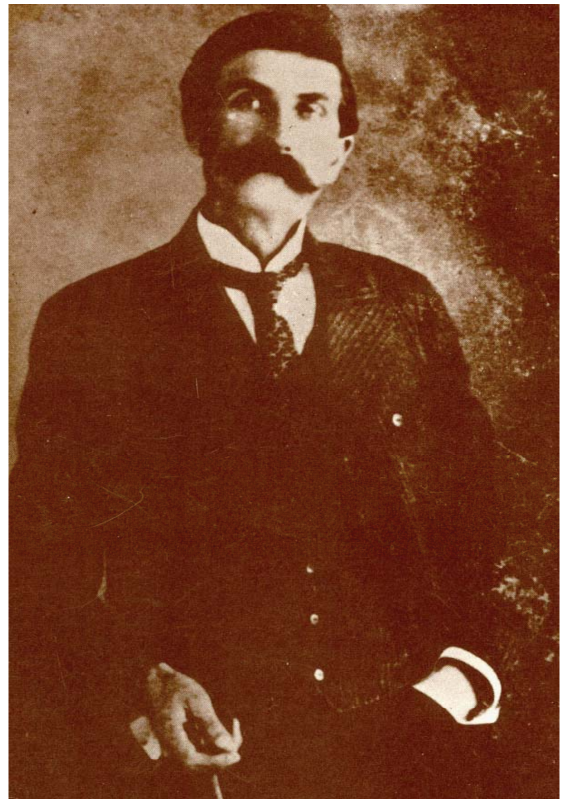


Figure 4. Pat Garrett, Ex-Sheriff; Pecos Irrigation Company risk taker in too many ways

Figure 3. C.B. Eddy, an entrepreneur; a risk taker in a dozen projects including railroads and the Pecos Irrigation Company

Figure 5. Francis Tracy; risk taker and long-time manager of the Carlsbad Irrigation District (his son followed him in the job)

Figure 6. J.J. Hagerman; Pecos Irrigation Company Colorado Miner and railroad entrepreneur; a real risk taker, he threw money at the Pecos River

Figure 7. Matias Romero, an educated, experienced ambassador for Mexico in Washington D.C.; a champion for Mexico's right to Rio Grande water at Juárez

The least successful risk-capital project, but one of the most interesting, was that of Nathan Boyd and the Rio Grande Dam and Irrigation Company. In discussing the Boyd controversy, historian Doug Littlefield was driven to state that: "one is almost driven to account for its extraordinary irrelevancy" and now I am driven to tell you about it. The history of the venture had its roots in the 1880s and 1890s 'drying' of the Rio Grande in the Mesilla Valley and in the Juárez/ El Paso Reach. Matias Romero (Fig. 7), Mexico's plenipotentiary in Washington D.C., complained and complained as Mexico became more and more irritated as the U.S. consistently failed to act to constrain upstream use. In 1890, Major John Wesley Powell (Fig. 8), a famous and greatly respected scientist, and an outspoken advocate for preserving the arid public-domain lands in the West, was sent by the Interior Department to Colorado to investigate claims that the river had gone dry because hundreds of thousands of new irrigated land had been put into service in Colorado. Major Powell found this to be true, and in 1890 reported to Congress that he believed that the waters of the Rio Grande were much better used on a million acres in Colorado than used less efficiently on two or three hundred thousand acres downstream in New Mexico and Mexico. Powell's findings did little to settle Southern New Mexico's and Mexico's concerns. It became clear that a dam and reservoir were needed to store Rio Grande flood waters. About that time, an

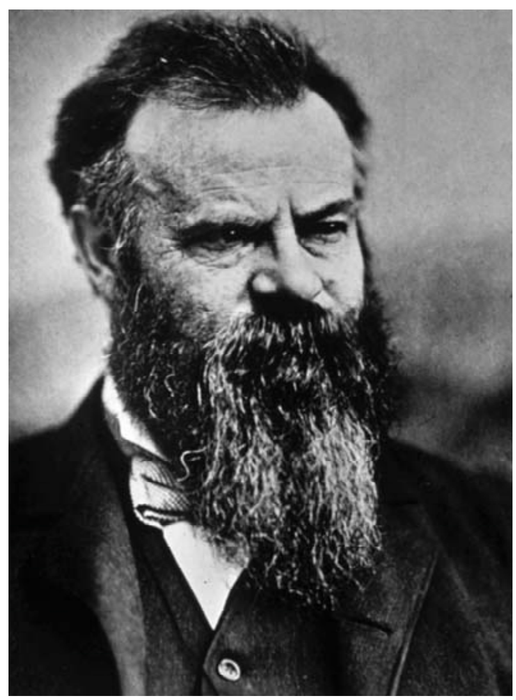


Figure 8. John Wesley Powell, a scientist who worked for limited western lands development

El Paso leader Anson Mills (Fig. 9) called for a dam to be built four miles above the narrows at El Paso that would flood 40,000 acres of the Mesilla Valley in New Mexico. That idea didn't go over too big in Las Cruces.

Figure 9. Major Anson Mills was an El Paso leader and first U.S. International Boundary Commissioner; he helped make Elephant Butte a Reclamation Project

Figure 10. Nathan Boyd, Rio Grande Dam and Irrigation Company risk taker and victim

A group of El Paso and Las Cruces businessmen who opposed the Mills dam had heard that Doctor Nathan Boyd (Fig. 10) had a pocketful of British money and was looking for a water project in New Mexico. They asked for Boyd's help. In 1893, the Rio Grande Dam and Irrigation Company was formed. Shares were sold and the owners of much of the existing irrigated lands joined. A USGS engineer, W.W. Follette, had made a study of possible dam sites in Texas and New Mexico and the Boyd Company picked the most likely Rio Grande site — the one upstream at Elephant Butte. In 1894 or so, Boyd applied to the U.S. Department of the Interior for a permit to build a dam, on the federal domain at that site and to build other diversion dams and canals to support irrigation. The permits were granted and Boyd and Company went to work and started to build a dam at Elephant Butte and a diversion dam at Leasburg.

The people in Mexico were not enthralled with the idea of a private dam company and in 1895 Matias Romero sent the U.S. a bill of particulars as to why water deliveries to Mexico from the Rio Grande were justified. U.S. Secretary of State Richard Olney made a mistake and sent Romero's rational to Attorney General Judson Harmon (Fig. 11) for an answer. The result was the much hated (in Mexico) Harmon Doctrine of the Absolute Sovereignty that sounded like something out of the Bush Attorney General's Office. The Harmon Doctrine held that every drop of water that fell on the U.S. was ours and that we had no obligation to share it with any other country. Anson Mills could see that a privately owned irrigation company was not the answer to the U.S. problems with Mexico. In 1896, he recommended that the U.S. and Mexico solve their differences with a treaty. Boyd's bad luck was that, by that time, Mills had been named the first U.S. Commissioner for the International Boundary Commission. Mills worried others. As a result, in 1897 the U.S. Secretary of the Interior, David R. Francis, revoked Boyd's permits to build a dam and instituted an embargo against any development of the water supply of the Rio Grande anywhere on the public domain in New Mexico or Colorado. His rational was that the Rio Grande was a navigable river and that the 1848 Treaty of Guadalupe Hidalgo required that the U.S.

Figure 11. Judson Harmon, U.S. Attorney General; author of the much hated (in Mexico) Harmon Doctrine

maintain navigation on the river. The Boyd project was dead. The rest is history. In 1902, the Reclamation Service was formed, they obtained a permit from the New Mexico Territorial Engineer in 1907, and they built the dam on the navigable Rio Grande at Elephant Butte, paid for in part by the U.S. State Department. And yes, there was also the Treaty of 1906 that promised 60,000 acre-feet to Mexico each year. And Boyd spent the next 25 years in U.S. courts where the answer was always "NO!"

Now to my list: first, Matias Romero for consistently complaining; John Wesley Powell, since Reclamation would never have built a dam at Elephant Butte had Powell recommended that water use in Colorado be constrained; next, Judson Harmon and his unintended effect on the process; Anson Mills who blew the whistle on Boyd's private development; and finally Nathan Boyd, the "risk taker." Yes, put Boyd, Romero, Mills, Harmon, and Powell on my list of those having a major impact on the development of our water resources — as I said some made an unintended impact.

Although in the minority, there were some successful risk takers. I add Frank and Charles Springer (Fig. 12) to the list; their Land and Cattle Company was a success. In the early 1900s, they built Eagles Nest Lake and an irrigation project on the Vermejo River. The lake now belongs to the Game and Fish Department, but irrigation by Charles' heirs continues. The most successful irrigated farmer was the Rio Grande Project's Dean Stahmann (Fig. 13), who developed the world's largest pecan farms, 6,000 acres, here and in Australia. His off-spring continue to be "risk-takers." Dean Stahmann is certainly on my list.

The next group on my list is those who helped New Mexico make the best of a bunch of not very favorable interstate compacts. Interstate compacts have had and will continue to have an impact on water use in New Mexico. Compacts are fertile grounds for lawyers! Where New Mexico has done well (for a state with so few votes) is in the Congress — in getting Congressional appropriations and funding for new water projects. Those in Congress who did the most to help the state benefit from its interstate compacts were Dennis Chavez (Fig. 14), Clinton P. Anderson, Carl Hatch (Fig. 15), and Tom Morris. Add them to my list.

Figure 12. Charles (left) and Frank Springer, successful early water resources developers — Eagles Nest Lake; successful risk takers

Figure 13. Dean Stahmann, pecan farmer and water developer, successful risk taker

Figure 14. Senator Dennis Chavez, COE generals were regular visitors to his office; he would invite any New Mexican to join them and have a seat

Figure 15. Senator Carl Hatch, author of the Hatch Act that kept federal employees from political activies; a good senator in the 1930s and 1940s

Work on the Rio Grande Compact started in 1929 when the framework for an eventual agreement was signed in 1939. The only New Mexican that I found who had a profound and lasting impact on the drafting of the Rio Grande Compact was State Engineer Tom McClure (Fig. 16), and he makes my list. McClure was successful in getting provisions in the Compact to allow the transfer of San Juan water into the Rio Grande Basin; a method of accounting for water salvaged from the San Luis Basin in Colorado; and a means of allowing the construction of new reservoirs for flood and sediment control. New Mexico made use of this last provision in the early 1950s, when Senators Chavez and Hatch introduced legislation to aid in the rehabilitation of irrigation facilities in the Middle Rio Grande Basin.

An interstate compact on the Pecos was a long time in coming — a really long time. After about 1910, groundwater development really got going in the Roswell area. Water use in New Mexico increased. As early as 1916, Texas complained to the Interior Department as Reclamation was responsible for the Carlsbad Irrigation District. A "cold war" set in. Real work on a Pecos River Compact started in 1923. A compact was signed in 1925, but lots of things got in the way — competing interests in New Mexico (Roswell's groundwater vs. Carlsbad's surface supply) lead to a governor's veto. Multiple efforts in the 1920s failed. In 1935, in order to get federal appropriations for a flood control and storage reservoir at Ft. Sumner, Congressman Dennis Chavez swore on bent knee, on the floor of Congress, that New Mexico would enter into a compact agreement. Through the forceful efforts of lawyer Irwin Moise (Fig. 17), legal advisor to New Mexico's compact commissioner, and Royce Tipton (Fig. 18), a Colorado

Figure 16. Tom McClure, State Engineer 1932-46; an engineer with a vision of the future water needs of New Mexico and acted to set the table for projects to meet these demands

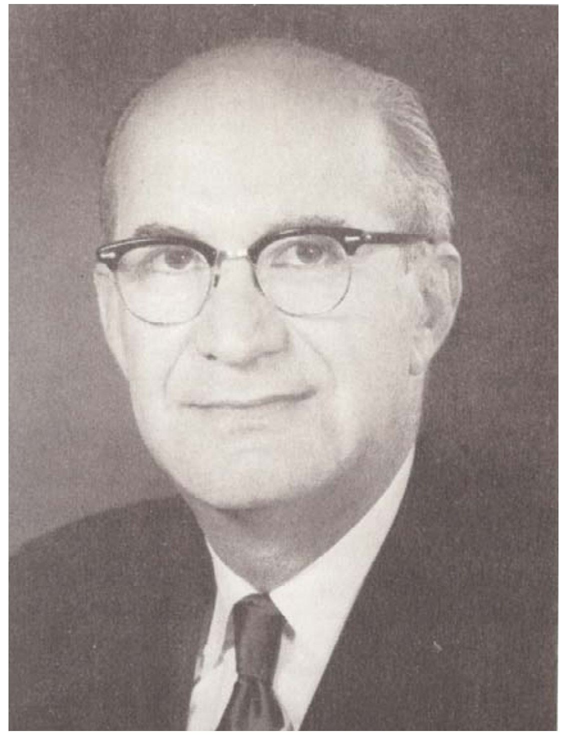


Figure 17. Irwin Moise, legal advisor on the Pecos; a water-knowledgeable State Supreme Court Justice who Steve Reynolds really admired

engineer, a compact agreement with Texas was finally reached in 1948. From New Mexico's point of view, the compact has been a dismal failure. Still, I put Judge Moise and Royce Tipton on my list, because they successfully managed the adoption of a compact. Royce was not the first or the last to believe that salvation on the Pecos lay in water salvage through salt cedar eradication. McClure thought it possible; John Bliss (Fig. 19) and Steve Reynolds did too. I worked water salvage a couple of times at the OSE. The only one at the Office of the State Engineer Office who was at all pessimistic was Carl Slingerland (Fig. 20) who believed salt cedar control to be a zero-sum game. Carl was also the technical source of the Pecos River buy-out plan of the 1990s. I just pushed his ideas. Slingerland goes on my list. I will also add Alfred G. Fiedler, a USGS groundwater geologist, and State Engineer Herbert W. Yeo to my list of contributors for their work in regulating groundwater use in the Roswell basin. Both were strong supporters of the "groundwater appropriations code" that finally became law in 1931. Without a groundwater code, New Mexico's water rights could never have been administered.

Figure 18. Royce Tipton, a beat-upon engineer; an internationally recognized authority on water resources and an advisor to the 1942 U.S. Pecos River Joint Investigation Report

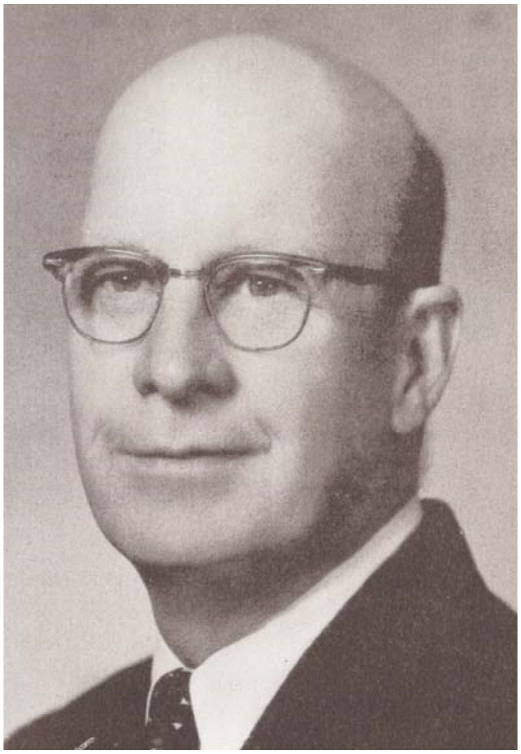


Figure 19. Engineer John Bliss, a long time laborer in the water field as State Engineer 1946-53, and other duties as assigned; a good engineer and a fine man

The Colorado River Compact of 1922 was based on an agreement that the Colorado River would be divided into an Upper and a Lower Basin at Lee's Ferry — each basin to get half of the flow. Both groups thought they had won, but it turned out that Reclamation had over-estimated the normal flow at Lee's Ferry. New Mexico came off "OK" as we are both an Upper Basin (the San Juan) and a Lower Basin state (Gila and Little Colorado), but we failed to get a share of the power revenues from major Colorado River dams.

An Upper Colorado River Basin compact was a long time in coming. When it came in 1949, it was filled with complex conditions, as it is based on the allocation of anticipated consumptive use of water and not on historical river flows and diversions. New Mexico got less than any other state in the Upper Basin — only 11.25 percent of the apportioned depletions. While the jury is still out on how New Mexico will fare in the long-term, thanks to Senator Dennis Chaves we got a 17 percent share of the excess profits from power generation. In 1953-1954 Governor Ed Mechem (Fig. 21) and Senator Clinton P. Anderson (Fig. 22) worked, most of the time together and sometimes not, to ensure that the Navajo Irrigation Project and the San Juan-Chama diversion project were included in legislation authorizing and funding various upper basin projects. Add Clinton P. and Governor Mechem to my list.

Figure 20. Carl Slingerland, engineer advisor, on the Pecos River, short-time State Engineer in 1990, and a friend who I greatly admired

Figure 21. Ed Mechem, a good natured multi-time governor, a one-term senator, and the long-time judge in the Aamodt case that moved the case almost to closure; a fine man, too!

Figure 22. Clinton P. Anderson, a champion of the San Juan-Chama diversion and water for Navajo lands; famous for his political action on Gila water

Figure 23. Engineer Eluid Martinez, ex-student, Martinez followed Reynolds as State Engineer in a period of change and then went on to Reclamation as Commissioner; a good friend

Opposition to the San Juan-Chama project developed from all sides. It took the efforts of everybody: Chavez, Anderson, and Tom Morris, until June of 1962 for the project to finally be authorized. John Bliss and Steve Reynolds were both greatly involved in a lot of arm-twisting in the Congress and all over the state. Tom Morris and John Bliss join my list. The staff at the Office of the State Engineer worked hard to conclude needed hydrographic surveys of farms on the many acequias on the Chama and Rio Grande. This work was driven by Eluid Martinez (Fig. 23). The "Mission Impossible" was moving stream-system adjudications through the Northern New Mexico courts. This activity was directed by the head of the small legal staff at OSE, Paul Bloom. Both Martinez and Bloom join my list. Without successful adjudication of existing rights, the accounting for San Juan water would have been impossible. In 1963, Albuquerque signed up to pay $30 million for its share of the 110,000 acre-feet authorized for annual transfer, and the Middle Rio Grande Conservancy District agreed to pay $3.4 million for its allocation.

In 1956, Steve Reynolds had declared the Middle Rio Grande a groundwater basin. The relationship between surface and groundwater was a key issue in the 1962 case of the City of Albuquerque *v.* Reynolds where the State Engineer held that underground waters in the Rio Grande Basin were hydraulically connected to the surface flows of the Rio Grande and thus subject to regulation. The New Mexico Supreme Court found that statutes gave Reynolds the authority to regulate both. To regulate the basin two things were needed: a mathematical solution to the complicated partial differential equations that related groundwater potential to surface water flows, and geologic studies that identified the basin boundaries, the geologic structure of the aquifer system, and the aquifer characteristics. Don Akin (Fig. 24), a civil engineer at the Office of the State Engineer, modified the basic equation developed by C.V. Theis and wrote the programs to provide solutions. The geologic analysis was put together by Zane Spiegel (Fig. 25) who worked for Steve in those years. He went on to author a large number of studies, two in 1962 on stream connected aquifers, and an earlier one on the Santa Fe Basin. Understanding the relationship between groundwater in the Roswell Basin to the flow of the Pecos also depended on Akin's work. I add both Don Akin and Spiegel to my list of "good guys."

At the start of my talk, I put Steve Reynolds on the top of my list for having defended New Mexico's limited water resources in various court actions, losing only once. Well, he had help. Lawyer Richard Simms was at Steve's side for about ten years fighting interstate compact quarrels and the federal government's claims of reserve water rights. And he was very successful, particularly in fending off the feds. He sent me a col-

Figure 24. Don Akin, engineer; a very smart man, a very quiet man, and very nice man, who got along well with Steve Reynolds for those reasons

ored drawing of him standing before the U.S. Supreme Court. As I didn't recognize all of the other folks in black robes in the picture, I decided not to include it in my story. No picture, but add Richard Simms to my list of significant contributors.

Figure 25. Dr. Zane Spiegel, geologist; a man who was a thorn under the saddle of many engineers; a good friend

I need to close by talking about two groups of folks who helped make the most of the limited water resources that we have. First, New Mexico's geo-hydrologists: a group of scientists who are unknown to many in our field and who are the most under-appreciated professionals in water resources development. Without their field work and insight, we would never come to appreciate our groundwater resources or to even fully understand that our surface water and groundwater are one and the same. First to be added to my list is Dr. John Hawley (Fig. 26), the complete geo-hydrologist. He has done fundamental work in most water basins in the state. He incorporates geologic structure with his understanding of groundwater flows and system recharge. He talks, and people listen and trust him. Incredible! I learn more and more every time I work with him. John certainly belongs on my list, as does Vince Kelley (Fig. 27), who was a professor of geology at UNM in the 1950s and '60s. I was in his engineer geology class in 1948- I certainly don't blame him for my not knowing more. Dr. Kelley authored geologic reports on many sections of New Mexico that are still the best source available. I also add the very gentle Frank Kottlowski (Fig. 28), director of the New Mexico Bureau of Mines and Mineral Resources for about 15 years and responsible for the fine body of work the Bureau produced and its archives of basic groundwater data that remains in use.

Figure 26. John Hawley, geo-hydrologist; author of *Five Million Years of Landscape Evolution in New Mexico*; if you listen to John long enough, you can learn all the geohydrology you need to know

Figure 27. Vince Kelley, geologist; introduced UNM civil engineering students to geology in the late 1940s; a good teacher

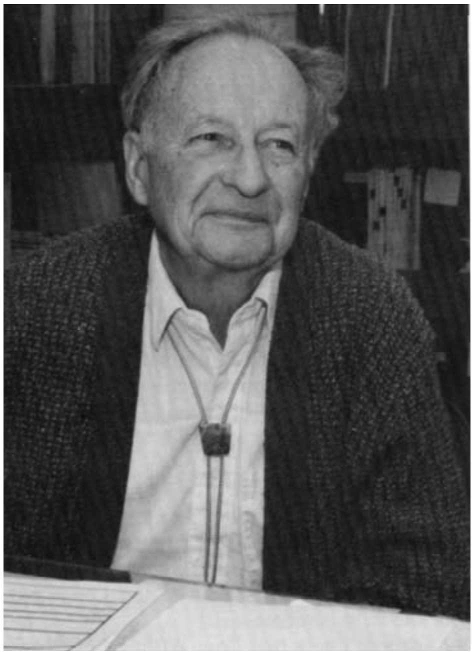


Figure 28. Frank Kottlowski, economic geologist; the man responsible for the high quality work done by the Bureau of Mines and Mineral Resources

Figure 29. Elliott Barker, New Mexico Game and Fish Director; Barker added dozens of fishing lakes to the State's inventory — he liked dam builders

And to my final group of those who made lasting contributions to water resources development in the state, a group that I think of as conservationists, people who added to the resource instead of diminishing it. I think of them as leaving something ahead for the future. First, a real conservationist, Elliott Barker (Fig. 29), longtime head of the New Mexico Game and Fish Department. Barker led the agency into the ownership of fishing lakes across the state and to the employment of engineers who just wanted to build dams. I also add another man that I worked for to my list: Charlie Caldwell (Fig. 30), the engineer who created the mutual domestic water development system that now provides safe drinking water in over three hundred small villages in the state.

Next, two legislators, who after Steve Reynolds died listened to all sides and lead the legislature away from willy-nilly activities to the formation of an effective water committee. They are G.X. McSherry (Fig. 31) and Joe Stell (Fig. 32).

Next, the writers and historians who have left ahead for the future records of our progress, and our setbacks, in the development and use of our water resources: Ira Clark (Fig. 33) and Em Hall (Fig. 34).

If there is such a thing as a research entrepreneur, then Ralph Stucky (Fig. 35) was one. Interdisciplinary water research became a reality under Boss Stucky. He would get us all together, lay out the sketchiest plan, find the money and say "GO!" And we went to work. Ralph worked hard at the national level for a system of water resources research institutes in every state and he was successful. Stucky was never fazed by the word "NO." When Stucky struck, Stucky stuck! He's on my list!

Figure 30. Charlie Caldwell, State's first sanitary engineer, creator of mutual domestic water consumers program

And finally, I recognize Al Utton (Fig. 36), a man who championed regional water planning for New Mexico; an educator who fostered the study of water law at UNM and the excellence of the *Natural Resources*

Figure 31. G.X. McSherry, legislator; knew agricultual water issues; he worked well with other legislators to make the legislative water committee effective

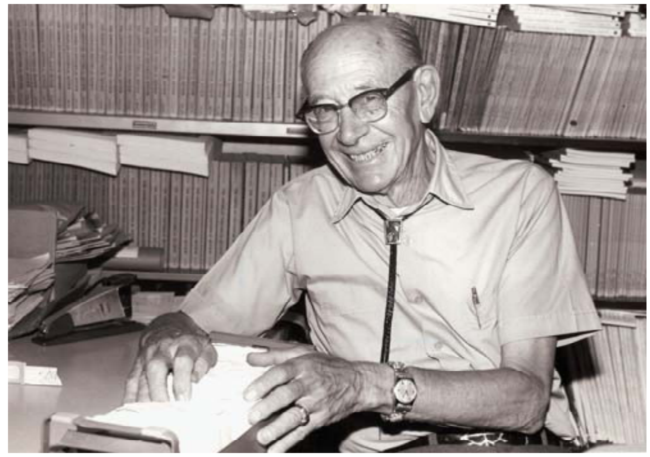


Figure 33. Ira Clark, historian at NMSU; this talk would have been an empty vessel had I not consulted Clark's book, *Water in New Mexico*, again and again

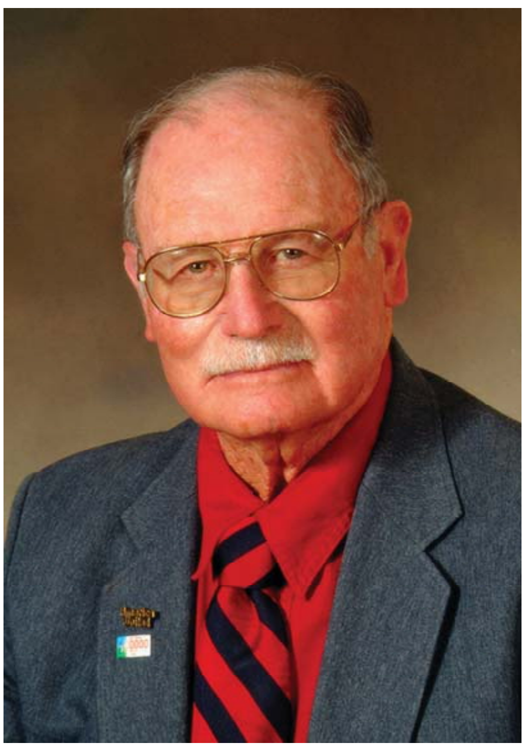


Figure 32. Joe Stell, effective legislative leader; a hard worker who listened to all sides of many water issues, supported mediation measures

Figure 34. Em Hall, writer and UNM law professor; wrote about the history of the water wars in the use of the water resources of the Lower Pecos

Journal, and a man who was recognized by Mexico with the Aztec Eagle Award for his work on conflict resolution on border water issues. Al was a good friend who I came to appreciate in his years as a steady hand at the Interstate Stream Commission. I am delighted to add him to my list of outstanding contributors.

Figure 35. Ralph Stucky, water economist, educator; director of the Water Resources Research Institute and founder of the long running annual water conference

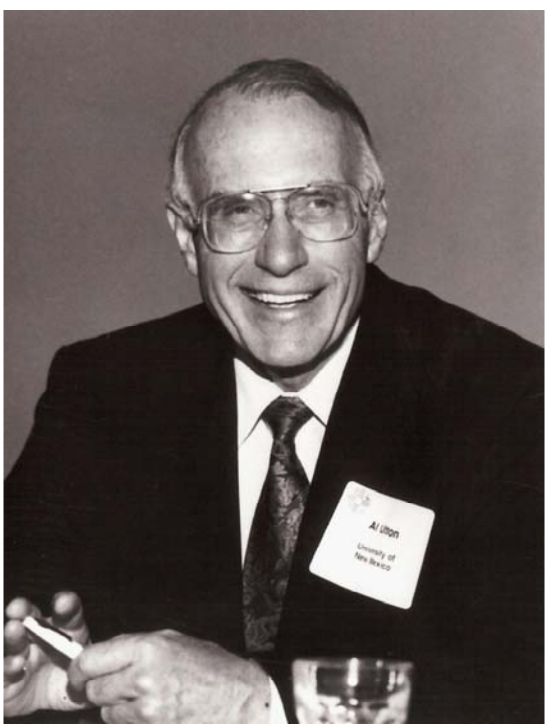


Figure 36. Al Utton, educator, lawyer, civil servant, outstanding contributor to water resources management; a friend and an easy-going man who was always looking for the "perfect Margarita"

A SPEAKER'S DISCLAIMER FOR YEA OF LITTLE FAITH

You may think that much of what you
have heard and seen today is not true
and you may be right — all that I claim is
that I believe that most of what I
have had to say is more or less based on
the facts as I know them.

John Whitlock Hernandez

THOSE TO BE THANKED FOR HELPING ME!

Cathy Ortega Klett, WRRI editor
Peggy Risner, WRRI Do-it-All
John Hawley, a good friend
Walt Hines, water resources engineer
Virginia Dodier, museum curator
Francis West, understanding geologist
Scott Boyd, water-right defendant
Paul Bloom, water-law lawyer
Gary Daves, water-right administrator
Wayne Canon, OSE
Polly McCord, OSE librarian
Julie Maas, OSE
Tracey Kimball, Legislative Council
Leslie Coleman, N.M. Game & Fish
Kirk Davis, C.S. Cattle Ranch
Tim O'Neill, Rancher
Sally Stahmann, pecan entrepreneur
Sally Spener, International Boundary & Water Comm.
Martin Frentzel, N.M. Game and Fish
Caroline Martinez, Utility Operators
Kristina Eckhart, OSE

Mike Connor works for Senator Jeff Bingaman, the Chairman of the Energy and Natural Resources Committee in the United States Senate. He is Majority Counsel to the Committee and is responsible for all issues before the Water and Power subcommittee, as well as the Native American issues that are within the Energy Committee's jurisdiction. Prior to working with the US Senate, Mike was with the US Department of the Interior (DOI) where he served as Director of the Secretary's Indian Water Rights Office (1998-2001), representing the Secretary of the Interior in negotiations with Indian tribes, state representatives, and private water users to secure water rights settlements consistent with the federal trust responsibility to tribes. Before joining the Secretary's Office, he was employed with the DOI Solicitor's Office in Washington, DC, and Albuquerque, New Mexico. Mike received his J.D. from the University of Colorado School of Law and is admitted to the bars of Colorado and New Mexico. He previously received a B.S. in chemical engineering from New Mexico State University and worked for GE.

SECURE Water Act - Senate Bill 2156 - Impact on USGS Programs

Mike Connor
Office of NM Senator Jeff Bingaman
703 Hart Senate Office Building
Washington, DC 20510

I appreciate the opportunity to speak today at this annual event. I want to start off my discussion of the SECURE Water Act with the need for honesty at all times. I'll begin by reading a portion of an editorial that was in the *Santa Fe New Mexican* on April 21, 2008. The editorial was entitled "Putting science to work on water issues" and in the editorial it says, "It is great to see the congressional delegation in our part of New Mexico once again when it comes to water. Late last year, Jeff Bingaman, chairman of the Senate Earth and Natural Resources Committee, and Pete Domenici, ranking Republican on the same committee, cosponsored a bill which, among other things, would replace the many myths about water with real figures on which sensible policy can be built. It's got one of those too cute acronyms as a name, SECURE - Science and Engineering to Comprehensively Understand and Responsibly Enhance Water Act. Westerners, long in need of such legislation, will forgive whoever thought up that mouthful, as long as it doesn't turn away prospective supporters." So I guess in the spirit of true disclosure, my contribution to the New Mexico Water Act is coming up with a "too cute" acronym. I am not going to ask you for forgiveness but I will apologize. I won't ask for forgiveness because from the editorial here, enacting the bill into law and putting it to work for water users and everybody alike is a good thing. So I hope you guys don't hold it against me.

I want to talk to you a bit about the genesis of the SECURE Water Act – what went into our thinking in putting it together, some of the overarching goals that Senator Bingaman laid out in his charge to us to put some meat into the program, and then finally talk about some of the provisions in the bill itself. It is still alive for the 110th Congress – there's not a lot of legislation that is still pending, and this is still alive.

During the period 2002-2006, there were a number of reports generated talking about the challenges we are facing in the area of water resources and recommending that certain actions be taken. I think the common themes are that we have drought, we have population increases, and we have a new understanding of environmental needs and the allocation of water for those environmental needs. And finally, we face the challenges of climate change and its impact on not only the timing and mix of precipitation, but actually the precipitation patterns themselves and whether certain countries will be wetter and certain countries will be drier. Based on those concerns, a lot of people started looking at water resource programs more closely and some of their reports that contained really good information. This should be comforting to the folks in academia – somebody actually reads those reports and takes them into consideration.

One of the reports we looked at was the National Research Council's report on confronting the nation's water problems through research, which was published in 2004. The National Resource Council did a report with the USGS on estimating water use in the United States. The National Resource Council also did an assessment of the National Stream Flow Information Program back in 2004. The White House Office of Science and Technology, through their subcommittee on water availability and quality, put together a very good report on science and technology. In 2006, the Western Governors Association put together a very good summary of challenges and recommendations of strategies for a sustainable future. Around this same period, the Inter-government Panel on Climate Change in 2007 came out with a series of reports describing the evidence of climate changes, not only warming temperatures but also following up on that and talking about the impact on certain resources.

All these reports settled in with us and with Senator Bingaman in particular. He charged us with coming up with some kind of an appropriate response of what the federal government should be doing to address those issues highlighted in those reports and hearings. We also had a hearing with the Water and Power Subcommittee in June of 2007 where we brought in a panel of scientists to talk about the latest evidence of the impact of climate change on global resources. We followed up with a panel of water users representing the municipalities, agricultural, environmental needs, sportsmen, and so on. I think what we took away from that hearing was that whatever you think about climate change or the basis of climate change, there was a pretty broad consensus among those various water user groups that something was happening to affect water supply and something needed to be done to better understand and react and adapt to those changes.

We decided to come up with some broad goals and put together legislation. From somebody who had been in Washington D.C. and working for the federal government, our initial goal is always, how do we have a federal role that is an appropriate one to deal with water resources that respects the respective water resources institutions and the state and local communities? I think that notion has shifted over time. With a program like the SECURE Water Act, back in the 1980s, people would have said thanks but no thanks, this is a little too much federal involvement. But I think now the challenges are so great and the need so great that there is a recognition of a need for a very workable partnership between the federal government and state and local communities. That's what we were trying to strive for when putting together a bill.

I have to tell you, Senator Bingaman, for several years now, has been very concerned with the overall direction of the federal government's role in water resources. I think particularly with the current administration, and more philosophically than budget driven, there has been a desire to step away from water resource programs and that is evidenced by the funding levels that we see. Let me give you a couple of quick facts and figures to justify that statement. In 2008, overall water resource programs, Bureau of Reclamation's total budget, Corps of Engineer's total budget, the EPA's Clean and Safe Water Program, USGS Water Resource Program, and USDA's Water Utilities Program, overall those programs are at about the $10 billion range. In 2008, those programs represented about 1.1 percent of the overall federal budget. Back in 2001, those programs represented out of the total federal discretionary budget, 1.5 percent. So there is a downward trend in the overall discretionary budget funds applied to water resources. If the President's 2009 budget were implemented by Congress, it would go down to .9 percent of the overall discretionary budget. For some figures related to that 09 budget: the 09 budget when you account for inflation, represents a 26 percent decrease in those same water resources programs between 2009 versus 2001. People may say we have budget deficits, and that it is to be expected that we would see that downward trend, but between 2009 and 2001 when talking about the overall discretionary budget and accounting for inflation, there is a 23 percent increase. So we have an overall increase in the discretionary budget while water resources programs are being cut. This represents the trajectory that we are seeing overall with respect to water resources budgets. That is part of what Senator Bingaman wanted to address is a comprehensive program that outlines some necessary items that the federal government should be involved in and to try and gain support for funding for those programs.

Some of the other goals are very basic in nature. They include improving water data collection and monitoring on the idea that better data lead to better decision making. The most common example of not having those numbers or good data is the Colorado River Compact, which as everybody here probably knows, is based on assumptions about the amount of flow in the Lower Basin. We are all trying to do a good job with the Compact we have, but the assumptions about the basic Compact were in error.

A second goal was to improve water management strategies, which is necessary with increased competition for water resources. We must increase the efficiency with which we use water.

Finally, our last goal had to do with the idea that we need to better understand and adapt long-term changes in water resources. The obvious example is if we better understand what's going on with climate change and how that might affect water resources availability – like the mining of aquifers when we know that that water supply will not be there forever – we can start dealing with the timeframes involved and how to react in that situation.

With that, I will move on to some of the provisions in the SECURE Water Act. There are six major elements of the Act itself. First, there is a climate change adaptation plan from the Bureau of Reclamation, which is designed to allow the Bureau access to available information and how water resources are being affected in Reclamation basins and how that might affect Reclamation projects. The big step there was to preauthorize Reclamation feasibility studies that will allow them to assess and create adaptation strategies to deal with those issues.

A second program is known as the Bureau's Water Treatment Act, which is really a codification of Reclamation's Water 2025 program with our own little spin on it as far as what parties should be part of Reclamation's grant program. The intent is to implement water conservation acts and improvements. It now authorizes funds and grants for major species conflicts and maps out strategies to deal with those items. We worked very closely with the Bureau of Reclamation and USGS on this and I think it was a great effort on everybody's part. We dramatically improved the bill that is now being introduced and that is a credit to these guys here today for being able to roll up their sleeves and give us some good technical recommendations.

A third program was the Hydro-electric Power Assessment from the Department of Energy to monitor water availability and changes as well as the impact on hydropower generation. We had a climate change and water inter-governmental panel specifically look at the best science out there about climate change and to project how climate change would impact water resources overall from a federal perspective. We brought in people from NOAA and combined it with what the USGS has done and even included the Forest Service, which operates snow sites. We brought these folks together with the actual water people from the Bureau of Reclamation and Corps of Engineers so that the water sciences people are interacting in a formal way with water users and water managers.

Finally, we included a couple of USGS programs that are absolutely critical and very proudly supported. The USGS is strengthening and expanding their National Streamflow Information database. The data are invaluable. The NSIP reports their goal is to get up to 4,700 sights being gauged as part of that program at federal expense. They currently are at about 2,700 or 2,800. This bill would mandate that increase over a ten-year period and provide resources to do it. We are also looking at improving groundwater monitoring and better understanding surface/groundwater interactions, which is becoming ever more critical. And there are incentives to create new methodologies. It may be that it is not always the traditional stream gauge – maybe there are better ways out there that could be implemented. We need to get everybody thinking, whether they are from private industry or academia, on how to improve measurement of water resources.

The last element was to codify formally and elevate the Water Use and Availability Program. With the National Research Council recommendations for a formal science program for USGS, we have better data being acquired by USGS to help state and local entities with water availability in the future.

Lastly, I will mention briefly the status of the bill. On September 11 of this year, our bill came out of the Senate's Natural Resources Committee. The bill has very broad support reaching out to two bases and all those entities we talked about. We worked closely not only with the current administration but with the House's

Natural Resources Committee, which is our counterpart, and I think that committee is also very supportive of the bill as well. The bill is pending currently as part of the overall omnibus public lands package. This is a comprehensive bill that has 152 individual bills. We want to bring this before the Senate when we reconvene on November 17 and try to get this massive piece of legislation through and on to the President's desk. There are a whole host of public lands bills, science bills, and other bills out of our committee. Even though the Senate has announced it will come back in a lame duck session, we are very unsure of the status of the bill because we don't know what the House of Representatives is doing. It appears we will reconvene over the economic stimulus package to help deal with the financial state of affairs. So if the House reconvenes for that reason, I think we have a good chance of bringing this bill up and getting it passed. Only a few things can be considered in a lame duck session and this happens to be one if the House reconvenes. A majority of leaders will give some of their time to try and get this enacted into law.

Matthew C. Larsen is the U.S. Geological Survey's Associate Director for Water. He earned a B.S. in geology from Antioch College and began his USGS career with the Branch of Pacific and Arctic Marine Geology, Geologic Division, Menlo Park, California. Matt served as a physical science technician on a study of natural hazards to petroleum development in the Northern Bering Sea, Alaska. In 1987, he was hired by the USGS Water Resources Division in Puerto Rico, where he served as project chief on a study of landslide hazards before becoming the Luquillo, Puerto Rico Water, Energy, and Biogeochemical Budgets (WEBB) project chief. Matt earned a Ph.D. in geography at the University of Colorado in Boulder in 1997 and continued his WEBB project responsibilities until 2000. In 2000, Matt served as a coordinator and researcher on a USGS international mission that responded to the 1999 landslide and flashflood disaster in Venezuela. He became the USGS Caribbean District Chief in 2000 and led USGS water resources programs in Puerto Rico and the U.S. Virgin Islands. In 2005, Matt was selected to be the Chief Scientist for Hydrology, USGS headquarters, Reston, Virginia. In this capacity, Matt led the USGS National Research Program in hydrology and was selected as Chair of the U.S. National Committee for UNESCO International Hydrological Programme. Matt became the USGS Associate Director for Water in June, 2008, and he is the author of 66 scientific reports and journal articles.

Secure Water Act – Senate Bill 2156
Impact on USGS Programs

Matthew Larsen, USGS Associate Director for Water
MS-409
U.S. Geological Survey
12201 Sunrrise Valley Dr.
Reston, VA 20192

Thank you. I am here to represent the USGS and it is a pleasure to be back in NM. I have been here a few times in my life and it is one of my favorite places. In college I used to come to NM to go camping at Chaco Canyon and to visit a cousin in Gallup. I went to graduate school next door at the University of Colorado. I want to thank the NMWRRI for hosting this event. It is great to see the water resources family here and we heard a great speech at lunch by Dr. Hernandez, talking about all of our extended family and the interlinking of so many of us across agencies and boundaries in the private sector and state and Federal communities. I really do feel like the water resources community is a family and I am happy to be here with this large gathering of folks from the New Mexico contingent.

Of course I would like to particularly thank senators Domenici and Bingaman for their leadership in the preparation of the SECURE Water Act. Now I know it was Mike Connor who came up with that very clever acronym, which I always have to refer to my notes to remember. We really do owe a lot to Mike Connor and his leadership in helping to put this bill forward. And I am glad to share the podium with our Bureau of Reclamation partners. You may know that about 100 years ago we actually were all one agency and we became separate agencies in the early 1900s. Quiero decirles que es un placer estar en esta parte del pais donde hay una mezcla tan grande y buena de culturas, historia, y lenguas. I said in Spanish that it is a pleasure to be in this part of the country where there is such a great mixture of cultures, history, and languages.

Before I talk about the USGS role I want to talk about this hat I brought. This is my optimist hat for the SECURE Water Act. I'm a native Philadelphian, this is a Philadelphia Phillies hat, and we are going to be in the World Series. If you know anything about sports fans, you know that most of us suffer most of the time because most of our teams never advance to that final prize, sort of like the World Series or the passing of the SECURE Water Act. So in spite of the Wall Street meltdown and all of the new challenges that will face the next Congress and the new administration, I am optimistic. The Phillies have been around for 125 years and we have won one World Series and there is a chance starting tomorrow that we may win another one. But we will see. In any case, I am forever optimistic being a Philadelphian and a sports fan and I am hopeful that the SECURE Water Act will also see success.

I wanted to point out a couple of things. Just north of us is the Rio Grande streamgage at Embudo, the first USGS streamgage in the history of the whole USGS network. It was established way back in the 1800s and it is sort of the Mecca for those of us in the surface-water community. If you haven't gone up there and had your picture taken next to the gage, I encourage you to do so. Maybe you aren't as excited as I am about it, but to me it is a great testament to the longevity of the record and the importance of long-term records and data that advise us on how we manage our water resources. Now, about 120 years later, we have almost 7,500 streamgages all over our country that transmit data via satellite. These data are available on the internet so anyone in the world can see how streams are flowing in their or anyone else's neighborhood.

These gages are operated at a cost of about $120 million in partnership with 850 different organizations. Mike Connor gave you some sobering statistics a minute ago about the decrease in funding for water-resources data and science over the last decade and that is an increasing challenge for us. Our federal funding for those gages has been relatively constant at best and costs have risen, so our partners have had to cover more and more of the costs of maintaining that network and it is more and more difficult for them to do so. The SECURE Water Act would be a major step forward in trying to redress the cost sharing and appropriate federal role in supporting basic hydrologic data. The goals of this bill, expanding data acquisition and analysis to improve water management and insuring that decision makers have reliable information about water resources as well as climate change impacts on water availability and energy production are critically important. Those of you here in New Mexico, I would argue, are already facing climate change because of the many demographic and land use changes that have been occurring here for a number of years and in the whole southwestern region of the U.S. where state populations are growing at about three times the rate of other parts of the country. You are already living in the future with respect to the challenges of water resources management and addressing the increased usage and population stresses.

The SECURE Water Act helps us face those challenges in a more comprehensive way. Specifically, for the USGS, there are a number of sections in the bill that fully implement the National Streamflow Information Program, which is only partially implemented now in terms of the support for streamgages around the country. It would develop a systematic groundwater monitoring program to assess major U.S. aquifer systems. This is something we do now, however we do it with a tiny amount of funds and cannot do it adequately. The Act would identify significant U.S. brackish groundwater sources and in the talks this morning we heard about the importance of those resources in the portfolio of water resources in the region and in the Nation. Very importantly, the Act would establish a water availability and use assessment program. This is something the USGS has been doing for a number of years but we never have been well funded to do it. We compile data from a wide variety of sources across the Nation and every five years publish a National Water Use Summary. The SECURE Act would substantially improve the effort and fund it at the level where we could do the job we have wanted to do. The bill establishes funding for the base network of 4,700 streamgage goal of the National Stream Commission. Doing so would free up funds from our Cooperative Water Program, which authorizes us to partner with state and local agencies both for data collection and for hydrologic studies. By funding the National Streamflow Information Program at its full level, we would have a much more of our Cooperative Water Program funds available to partner with state and local agencies on investigative studies and other data efforts.

Another major component of the bill is the National Groundwater Resources Monitoring Program that calls for USGS to work with federal, state, and local agencies to implement a systematic groundwater moni-toring program. This would significantly expand U.S. groundwater programs and would enable us to provide stable, consistent real time information about the Nation's groundwater resources required by water managers. If you go to USGS pages, you will see real-time data for the streamflow network but you will see very little data for groundwater. Of course aquifer levels don't change too dramatically so you don't need minute to minute reporting but real-time reporting of those levels would be a great asset for the water managers around the country. They would not have to wait for weeks or months for reports to be released. Instead they could find out on a daily to weekly basis. With consistent, comparable information for the whole country, the USGS will be able to develop a broad study of groundwater conditions and how those conditions vary locally, regionally, and nationally, whether conditions are getting better or worse over time, and how natural processes and human activity affect the quantity and quality.

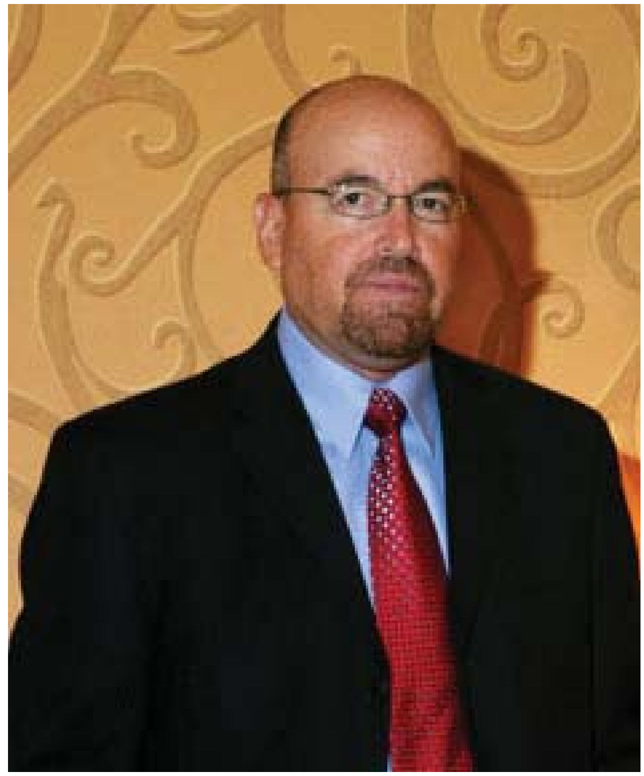
The SECURE Water Act's section on groundwater, which is so important in this part of the country, also calls for assessment of the brackish groundwater resources of the U.S., including a report describing each significant brackish aquifer and fills in data gaps on current uses of brackish groundwater. USGS has done modest amounts of work on brackish groundwater, primarily things like literature searches and local reports and New Mexico is one of the areas we looked at. This assessment would be a major step forward for both the state and the Nation. Brackish aquifers are in demand for two competing reasons: the possibility of treating the water to make it suitable for some uses, and the possibility of using the aquifer for CO_2 sequestration, which is of growing interest around the country. These issues are likely to become more important in the future and the USGS would welcome the opportunity to provide detailed analysis for such an important and overlooked national resource.

It has been said that you can't manage what you don't measure. The last overall assessment of water resources in the Nation was published by the Water Resources Council in 1978. Since that time, dramatic changes in water availability and use have occurred as a result of demographics and environmental impacts, economic issues, technology, changing climate, and of course the rise of biofuels. Section 9 of the SECURE Water Act directs the USGS to implement programs designed to provide a more accurate assessment of the status of water resources in the U.S., to identify long-term trends in water availability, and develop a basis for an improved ability to forecast future water availability for economic and energy reductions and uses.

During the time the Senate has worked on this bill, the history of which you got from Mike Connor, the Department of Interior has also been working on a budget initiative for 2009, the Water for America initiative, which could provide significant increases for the Bureau of Reclamation and the USGS. The initiative calls for a number of actions, and I will touch on a few key ones before I close. It would support the conducting of a nationwide assessment of water availability by 2019 through a series of regionally scaled and focused studies; a water census. It would improve our understanding of water use information, (a goal of the SECURE Water Act), cooperate with states to map the geologic framework in the Nation to improve characterization of the Nation's aquifers, and finally, modernize the Nation's streamgages by replacing obsolete telemetry to insure real-time continued operations and provide more timely information for better water management. The responsibility for management of course will continue to rest at state and local government levels. The federal government does not own or manage the water but will provide resources for partners at local levels to do so. But knowledge of the system is needed across state lines and that is a key part of the federal role. The initiative will use state assessments and federal studies accomplished through federal and other USGS water programs. There is a close match between these two efforts, the Legislative Branch with the SECURE Water Act and on the other end on Pennsylvania Avenue, the Executive Branch, with the Water for America Act. This is a logical outcome of the increasing concern about the long-term availability and reliability of the Nation's water supply.

In summary, the SECURE Water Act will authorize substantial investments in our Nation's understanding of water resources and their importance to our way of life. The U.S. population is growing quickly in regions of water scarcity and irrigated agriculture is moving into new areas, including the humid eastern states. Our increasing interest in biofuels will lead to significant increases in associated water uses. Additionally, climate change is predicted to change evapotranspiration, precipitation types and amounts, runoff, and groundwater storage, particularly here in the western United States. The SECURE Water Act is a major step forward in providing the tools we need to understand and manage the Nation's most essential natural resource. The USGS looks forward to working with the Bureau of Reclamation, Congress, water resources research institutes, and our partners in state agencies to achieve these results. Thank you.

Michael Gabaldon became Director of the Technical Resources Office in the Denver office of the Bureau of Reclamation in 2008. He oversees the Technical Service Center, Research and Development Program, the Power Office, and the Dam Safety Officer/Design Engineering and Construction Office. Since 2006, Mike had been Director of the Technical Service Center in the Denver office. He began his career with Reclamation in 1982 as a Rotation Engineer at the Montrose Projects Office in Colorado. He worked in various positions in the Northwest region until 1998 when he was selected as the Area Manager for one of Reclamation's largest area offices, the Albuquerque Area Office. He was responsible for Reclamation program activities in the Rio Grande basin, the Pecos River basin, and the Canadian River basin - spanning three states from southeastern Colorado through New Mexico and south to west Texas. In 2001, Mike relocated to Washington, D.C, to serve as the Deputy Director of Operations. He remained in that position until 2003 when Commissioner John Keys promoted Mike to the position of Director of the Policy, Management, and Technical Services organization in Denver, CO. A native of Belen, New Mexico, Mike received a B.S. degree in civil engineering from the University of New Mexico and an associate's degree in Water Technology/Utilities from New Mexico State University.



SECURE Water Act – Senate Bill 2156
Impact on USBR Programs

Michael Gabaldon, Director
Technical Resources Office
Bureau of Reclamation
PO Box 25007
Denver, CO 80225

Thank you Karl for that great introduction. The important part of Karl's introduction is referring to me as "our own" Mike Gabaldon and I appreciate that. I did grow up in the Middle Valley just south of here in Belen. I grew up on a small farm, and many of you who have been around New Mexico for awhile either lived through or are aware of the pretty bad drought we had in mid 1950s. In the mid '50s, my father was farming downstream and because of the drought, there wasn't a whole lot of water around. Therefore, there wasn't a whole lot of farming. My father wasn't too busy and since my mother was helping my father on the farm, she wasn't busy either. They were pretty bored during this drought period, and out of this boredom they got together and had me. And 52 years later, here I am, a direct product of the drought and it may have been inevitable that I would be working in water one day. But to show how bad the drought was, I have six brothers and six sisters!

Matt Lawson used some of his Spanish a few minutes ago and I will start off with a dicho. Those of us in New Mexico know that dichos are the little lessons that our parents usually tell us. One that I was reminded of that my father told me was "Buenos son mis vecinos, pero me faltan dos gallinas," translates to "I have great neighbors, but I am missing two chickens." I don't know how that relates to water and what we are all doing here, but the lesson of that is – hey I have really good neighbors, and if I happen to have some spare chickens, feel free to take them. Working in collaboration and cooperatively with each other I think is the best way to go.

On behalf of the Bureau of Reclamation (BOR) and Commissioner Bob Johnson, who couldn't be here today, we do also want to acknowledge and thank Senators Bingaman and Domenici for their leadership in the SECURE water legislation that we see as very rewarding and critical to our country, especially here in the West. As Mike Connor mentioned, the BOR has been working closely with him, we have suggested some language for the bill, and the bill is looking pretty good. Hopefully, it will go through Congress.

The legislation would authorize substantial new investments in western water management. I'm going to repeat some of the things that have already been said but I will mention a few other things. S-2256 does contemplate a number of task forces, basically data gathering efforts. The data can then be used by water managers to figure out what to do with the water resources that we do have. In fact several of the initiatives in the SECURE water bill line up with the Water for America initiative that Secretary Kempthorne is supporting. We believe that many, many of the goals in this bill expand the data acquisition effort, and following analysis of that data, ensure decision makers in water management on critically important operations.

The congressional subcommittee on Water Availability and Quality and the White House subcommittee on which I serve prepared a report in 2007 that contained many of the goals that line up with the SECURE Water Act. Five elements in the 2007 report do a really good job of lining up with the act. For example, the report calls for implementing a national water census, developing a new generation of water monitoring techniques, developing and expanding technologies for enhancing the available water supply, and improving our understanding of water ecosystems, thereby improving hydrologic prediction models and how those models are applied.

It is easy to forget that water is finite. New Mexico is very fortunate to have two senators who understand that water is finite and that we need to do something about it. The U.S. population is growing at an incredibly fast rate especially in the West. Nevada over the last 10 years has grown by 60 percent. Arizona is not too far behind. Areas of population growth like New Mexico and Colorado happen to be where water is very scarce. The SECURE Water Act contains several measures that are dedicated and designed to take proactive steps to meet the water needs of the 21st century.

I will talk about a couple of specific sections of the act that apply to the Bureau of Reclamation. The climate change adaptation, Section 4 of the legislation, authorizes the Secretary to implement climate change adaptation programs and requires the Secretary to report to Congress on how climate change is affecting water resources and water supplies in the West. It directs and requires the Secretary to collect this information and supply reports to Congress on a regular basis. I think right now it is set up as an annual report. We recognize and agree with the premise set forth in that, and that it is important that we assess the potential impacts of climate change to our water supplies, reservoirs, and river systems.

Effective adaptation will also depend on better monitoring, better knowledge, and that is where the USGS kicks in that information. We will work with the USGS, as we always have, plus the Corps of Engineers, EPA, and the National Oceanic and Atmospheric Administration. We are working together to develop some strategies to try and get ahead of some water planning issues. The SECURE Water Act is going to plug right into those areas.

Another area in the SECURE Water Act, Section 5, provides new permanent authority for the BOR to issue water conservation grants to qualified entities. This is kind of a takeoff from the Water 2025 program that we have been using. Many of you are familiar with the program and have taken advantage of it and been funded through Water 2025 cost sharing. Water 2025 focuses attention on the reality that we have a limited water resource, populations are growing, and we have aging infrastructure that may not be adequate to meet the demands of the 21st century. Basically, Water 2025 focuses attention and funding on resources where there might be some confidence coming up, such as the clam issue we had a number of years ago, or the silvery minnow issue. Those are actually the genesis of Water 2025. The initiative was kicked off by then Secretary Gale and Commissioner John Keys, who at the time recognized a need to get ahead of these issues. The first few years of that program were funded through an annual appropriations process. The SECURE Water Act would give us permanent authorization, thereby improving the long-term effectiveness of that program so that the water users and local governments can take advantage of that and know that the funding is coming.

Effects of climate change on hydro-electric power generation are dealt with in Section 6 of the SECURE Water Act. This section talks again about predicting what is coming up as far as climate variability and how that may affect hydro-electric generation. It actually directs the Secretary of Energy to work with power and marketing administration to assess and look at how climate change may have an effect on hydro-electric generation. We very much want to be part of that consultation. We are, along with the Corps of Engineers, the number one and the number two largest hydroelectric producers in the country, with BOR number two and the Corps number one. It is important that we also consult with the Secretary of Energy on those issues. We are the ones that schedule the releases into the system, and we are the ones who work hand in hand with the Corps of Engineers to do that, so it's important that we be part of this.

Climate change and the water inter-governmental panel has already been addressed. Section 7 of the SECURE Water Act just brings together a lot of different government entities and brings them to a panel to look at what is out there from a water management standpoint. Secretary Kempthorne in fact has already taken action on this front. He has put together a Department of Interior panel that is already working on this, so we look forward to expanding that into other federal agencies such as NOAA, the BOR, and the Corps of Engineers.

Let me switch over to the Water for America program for a minute. That's the initiative that Secretary Kempthorne kicked off a few years ago and moved forward with the fiscal year '09 request. It establishes a major partnership among the USGS and BOR and others, and it again goes back to gathering data and making sure we have the right tools for water management and we are prepared for the future. The initiative includes three strategies. First is to plan for our nation's strategy for the future. Second, is to develop a strategy to expand, protect, and conserve our nation's water resources to make sure we keep and protect and expand what we already have. The first deals with the future and the second with protecting what we already have. The third strategy is to enhance our nation's water knowledge. That goes back to USGS. Matt Larsen mentioned earlier that while the Senate was working on the SECURE Water Act, we were working on another act so it's great that we have the two lined up. The two acts have very similar parts and pieces and several components that are similar.

The plan for our nation's water future, that first strategy, will include the BOR's longstanding investigations program and will also introduce a new basin studies program to look at basin-wide systems. A study will be done to see what the supply and demand is in those basins, which is something we really haven't done in the past. The second strategy to expand, protect, and conserve our nation's water resources will incorporate the best elements of a few other systems we have in place, including the Water 2025 program that I mentioned along with the Water Conservation for Services Program that a lot of you have probably benefited from in the past. It is a program we used at the BOR that died down but we are picking that back up, at least the very good pieces of it. We requested $31.9 million for FY 2009 for the Water for America program; $4 million for basin studies, $4 million for investigations, $11 million for Challenge Grants – and by the way, a request for proposals was just announced yesterday so if you haven't seen that yet and want to participate, take a look at our website. There is another $4 million for the Water Conservation Services Program and $8.9 million for the acceleration of critical ESA compliance activities. It is important to note that BOR will be able to fully implement these programs only if Congress approves the appropriations as well as some authorizations.

In addition, two new grants are being developed by the BOR. One grant promotes advanced water treatment such as reverse osmosis on brackish groundwater. It will look at what to do with concentrated disposal; looking at anything that has to do with desalination. We are working with New Mexico State University with Karl Wood and Bobby Creel on our Tularosa desalination facility that we dedicated about a year ago. We are working with NMSU on how we are going to operate the research facility. If anybody has potential desalination research, come talk to me or to Karl. The second new grant that we are looking at is called Species of Concern Grant and this grant will provide an avenue for collaboration with the stakeholders and water users to encourage actions that will improve the status of species before the water supply is credited. Again, this is something where we want to be proactive and get ahead of the issue. Those grants benefit federally listed species that are limited to ESA listed species, BOR projects, or actions.

In conclusion, through the strategies and programs described in Water for America and in the SECURE Water Act, we see that we are going to provide a vision and leadership that is very much necessary to help meet the needs of the American people, especially those in the West, to expand and enhance the finite water resources that we all live with. Water is life, and it is part of our economy and we are all focused on the economy these days. You can't have a good economy without good water, without good agriculture, and without clean water. We will continue working with Congress and USGS and other organizations in moving these forward. Thank you.

Dale Doremus is currently the coordinator of the Lower Rio Grande Water Quality Program with the New Mexico Environment Department's Surface Water Quality Bureau. She holds an M.S. degree in geology/hydrogeology from the University of Wyoming and a B.S. degree in geology from Georgia Southern University. For the past 21 years she has been managing programs and projects associated with water quality, groundwater protection, and water resources in both state and local government. Dale joined the New Mexico Environment Department in 1987 where she held various technical and managerial positions including Program Manager for the Ground Water Pollution Prevention Section. She has also served as Groundwater Program Coordinator for the Oregon Department of Environmental Quality and project manager of regional water supply projects for the City of Santa Fe, Water Division.

Ari M. Michelsen, Ph.D., is Director of the Texas AgriLife Research Center at El Paso and a professor of agricultural economics, Texas A&M University System. His research focuses on watershed resources management, valuation, conservation effectiveness, water markets, and decision support systems for policy analysis in the U.S., China, and Chile. He serves on the Board of Directors and is President-elect of the American Water Resources Association, Board of Directors and Past-President of the Universities Council on Water Resources, Southwest Hydrology Advisory Board, and Paso del Norte Watershed Council Executive Committee.

Rio Grande Salinity Management - First Steps Toward Interstate Solutions

Dale Doremus
New Mexico Environment Department
PO Box 5469
Santa Fe, NM 87502

Ari Michelsen
Texas AgriLife Research
Texas A&M System
1380 A&M Circle
El Paso, TX 79927

Good afternoon, I am Dale Doremus with the New Mexico Environment Department, Surface Water Quality Bureau. I am part of an interagency group that focuses on Rio Grande salinity issues and includes the Interstate Stream Commission (ISC), Office of the State Engineer (OSE), and the Environment Department. Dr Michelson and I will share this time slot to talk about an interstate salinity management program for the reach of the Rio Grande from San Acacia to Ft Quitman, TX.

Figure 1 shows the area of interest, from San Acacia to Ft Quitman. The study area includes the Rio Grande Project area. Initially we were focused only on the Rio Grande Project area (Elephant Butte to Ft. Quitman) but research from NM Tech and the USGS indicated significant salinity inputs in the San Acacia region, so we expanded the study area to include that reach.

As most of you know, there has been long-term concern and contention over the elevated Rio Grande salinity in the Texas-New Mexico border region. Salinity increases in the reach from Elephant Butte Reservoir to Ft. Quitman, TX have been documented for more than 100 years. Evaluation of historical data shows that Rio Grande salinization predates the construction of the reservoirs, canals, and drains of the federal Rio Grande Project. Recent research by NM Tech, NMSU, SAHRA, (SAHRA is a consortium of universities in Arizona, New Mexico, and California funded by the National Science Foundation) has identified natural upwelling of sedimentary brine and geothermal waters as principal salinity contributors in the region. The research also shows natural salinity inputs appear to be localized at the terminus of sedimentary basins in the region. In addition to these natural sources, anthropogenic sources such as municipal wastewater discharges and agricultural return flows also contribute, but to a lesser degree. Many of you have seen presentations on

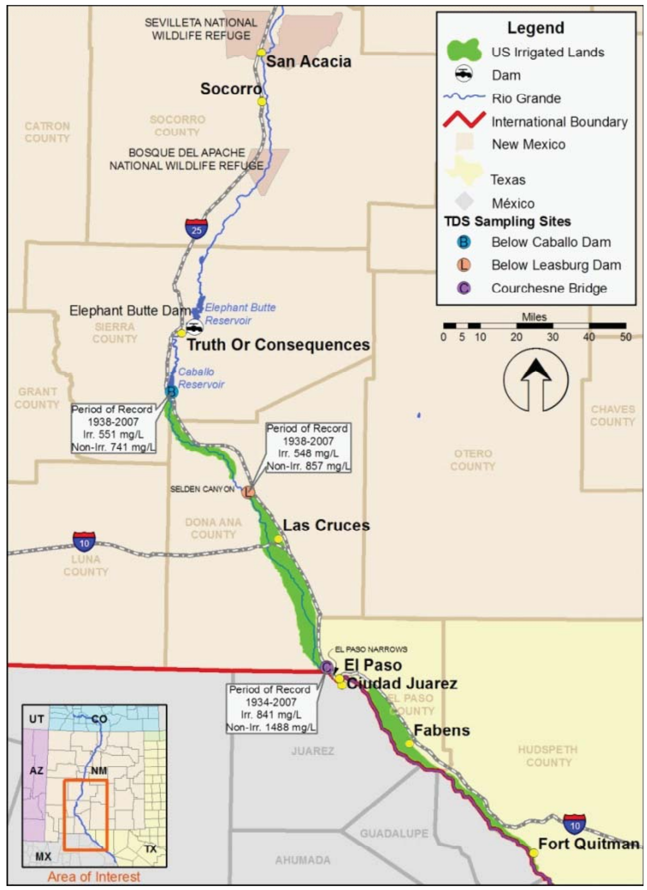


Figure 1. Rio Grande Salinity Management Study Area

this Rio Grande salinity research by Dr. Fred Phillips of NM Tech and others, so I won't get into the technical details, but I will give an example of an area at the southern terminus of the Mesilla Basin where sedimentary brine inputs have affected Rio Grande water quality.

ISC-4 is a well just above El Paso Narrows and the city of El Paso that has been completed at the top of the bedrock. Figure 2 shows a series of deep nested piezometers and shallow wells that span from Anthony to El Paso. The wells were installed by USGS in cooperation with ISC and the Elephant Butte Irrigation District to measure water elevations and water quality. Cross section shows ISC-4 at the southern end of the Mesilla Basin is less than 200 ft deep and is completed at the top of bedrock at the terminus of the basin (Fig. 3). Investigations by the NM Environment Department and the Interstate Stream Commission identified extremely saline groundwater in this area, with concentrations at ISC-4 as high as 31,000 mg/L total dissolved solids and14,000 mg/l of chloride. This investigation points to the possibility of managing salinity inputs to the Rio Grande. Intercepting saline point sources such as that encountered by ISC-4 has potential to result in significant freshening of river water in the winter non-release season.

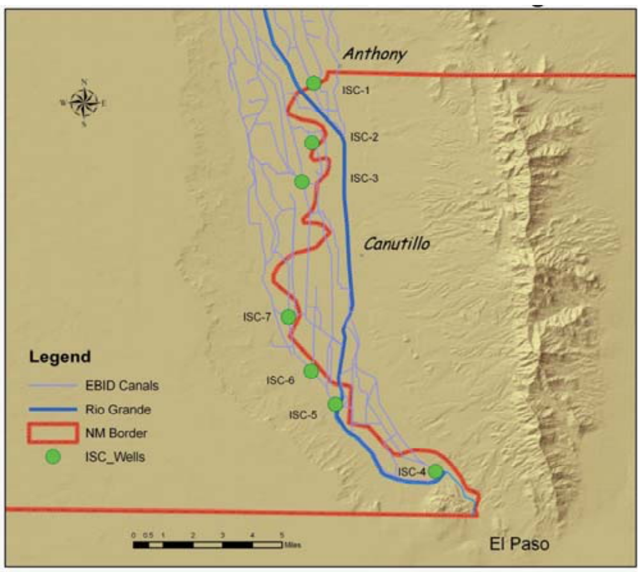


Figure 2. ISC Wells in the NM-TX Border Region

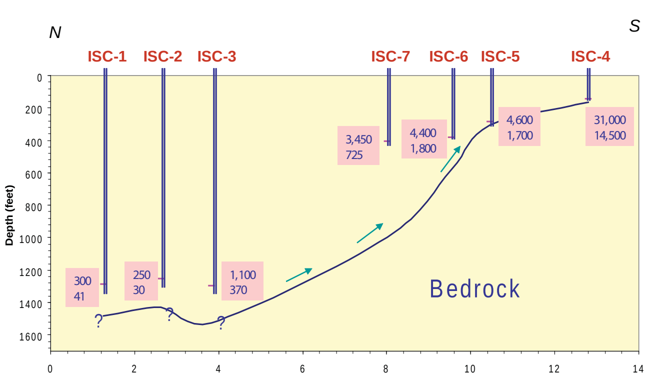


Figure 3. TDS and Cl concentration Cross Section

What steps have been taken toward interstate management of Rio Grande salinity? In 2006-2007 the Rio Grande Compact Commission, in collaboration with local water management entities, initiated a multi-state effort to create a Rio Grande salinity management program. The Commissioners hosted a salinity workshop, held in El Paso in May of 2007 with the goal of identifying ways to improve Rio Grande water quality by reducing salinity in the New Mexico -Texas border region. The participants formed what is now known as Rio Grande Project Salinity Management Coalition. Who are these folks who are so interested in salinity management? In addition to the Rio Grande Compact Commissioners, the group includes state water management agencies from TX, NM, and CO, including the Texas Commission on Environmental Quality, Texas Water Development Board, the Interstate Stream Commission, Office of State Engineer, New Mexico Environment Department as well as the Colorado Division of Water Resources. The local water utilities and irrigation districts are key players including the City of Las Cruces and El Paso Water Utilities, Elephant Butte Irrigation District, El Paso County Water Improvement District #1, and Hudspeth County Conservation and Reclamation District #1). University research organizations in the area that have been involved include NMWRRI, Texas Agri-life Research and Extension Center in El Paso, and UTEP Center for Environmental Resource Management. The Rio Grande Salinity Management Coalition met three times in 2008, and developed objectives and a plan to move forward with a salinity management program for the area from San Acacia, NM to Ft. Quitman, TX. The group's primary goal is to develop a plan to fund and implement target salinity reduction projects that will increase the useable water supplies and improve Rio Grande water quality.

The coalition envisions the plan in four phases. The first phase is the Rio Grande Project Salinity Assessment, which is basically to pull together existing information and establish the current state of knowledge today about this study area. This will be used as a basis for Phase 2, which is to develop salinity management alternatives. Phase 3 will be to implement actual projects on the ground, Pilot-Scale Testing, and Phase 4 will evaluate project effectiveness.

At the first coalition meeting in early 2008, the NM State Engineer and NM ISC offered the Coalition $250,000 for the first phase of salinity management work. This is the non-federal cost share for US Army Corps of Engineers (USACE) WRDA (Water Resources Development Act) §729 project that has 75% federal match, which results in $1M total budget. The

USACE has contracted with researchers from USGS in Albuquerque and Austin offices, Texas Agri-Life Research and Extension Service, NMWRRI, NM Tech and other SAHRA researchers to implement the Phase 1 workplan developed by the Coalition.

The first phase that I mentioned earlier is the Rio Grande Salinity Assessment, which consists of four tasks. The first is to document and integrate salinity data and information. This includes a geospatial salinity database that will be developed by the USGS Water Science Center in Ausitn. The second task is to develop a baseline salinity budget. This is a synthesis of current state of knowledge regarding dissolved solids loads and includes development of a dissolved solids budget for defined reaches along Rio Grande. The third task is a preliminary economic damage analysis for residential, agricultural, municipal and industrial uses which Ari will discuss in more detail. Task 4 will identify critical data gaps based on information from the first three tasks. These are the key issues which will direct future study for the development of salinity management alternatives.

Phase 2 is the development of the actual salinity management alternatives. In this phase of the project we will attempt to fill critical data gaps; conduct an environmental and economic assessment; and, based on stakeholder needs and priorities, identify the most promising locations for salinity control projects, including conducting feasibility and cost analysis for specific projects. The third phase is the design and implementation actual pilot scale testing of salinity control projects. Part of the pilot projects will include quantifing salinity reductions and potential increase to usable water supplies. The fourth and final phase is to evaluate the project effectiveness. Here again we will monitor and document improvements in water quality and quantify associated benefits of reduced salinity.

So with that, I will turn this over to Ari to talk about economic damages and benefits of a salinity management program.

Ari Michelsen

Why do we care about salinity? We go out of our way to put salt on our food, but salinity is an economic burden, there are huge cost increases, reductions in income, and there are other impacts such as environmental impacts.

What do we need to know about salinity? A lot. For a salinity program or even a study, we need to know who is affected, what are the impacts, are the impacts large or small, and how the economic impacts are related to changes in salinity. If we are able to control salinity, and reduce it by 100, 200, 500 parts per million, what are the benefits? How do damages decrease if salinity is reduced? Is investment in salinity control warranted? How much investment is warranted? These are all essential questions. An economic assessment is needed when we begin to talk about any salinity investments.

There are many different types of economic impacts due to water salinity. While I won't go into all of the economic impacts shown on Figure 4, what I am going to do in this presentation is summarize what has been done in other areas. There has been very little work on salinity economic impacts in the Rio Grande Basin with some minor exceptions. We need to look at lessons learned from other areas and also look at the differences in the Rio Grande Basin to set up the framework for salinity assessment here. Examples of economic impacts include increased costs, such as equipment replacement costs, shorter lives, salinity tolerant equipment, added cost of alternative sources such as desalination, and higher water use costs, for example leaching to get salts out of the soil profile so plants and crops can survive. Other impacts are reductions in income from reduced crop yields and less profitable industries – for example, why don't we have microchip manufacturing plants in El Paso? Well salinity is one reason, why did manufacturers move to Albuquerque - because of a good clean water supply. Other types of damages include lower value and less desirable landscapes, damages to the environment, impacts on recreation, and long term non-sustainable productivity in water use. You can't just keep irrigating with elevated salinity in the water.

Increased costs due to higher salinity
Higher equipment replacement costs (shorter life)
Higher cost of salinity tolerant equipment
Added treatment cost/higher alternative source (desalination)
Higher water use/cost to avoid damages (leaching)

Reductions in income and other benefits
Reduced crop yields
Restricted to less profitable industries and crops
Lower value/less desirable landscape/riparian/recreation/environment
Non-sustainable (long term) productivity and water use

Figure 4 Economic Impact Examples

One of the things that is critical for doing any kind of economic impact assessment is knowing the relationship between the levels of salinity and the damages. How do they change as you move from 500 parts per million to 1000 parts per million to 1500 parts per million? In the El Paso area there is shallow groundwater that is 2000, 3000, 5000 parts per million. This was used for agricultural irrigation during drought, but this water quality was having a detrimental impact on crop yields and soils and is not sustainable in the long term.

There have been a few economic studies nationally or internationally on salinity impacts. One of the major studies was conducted in 1988, and results from this study are the basis for almost all the other studies in the U.S. What they did is estimate damage coefficients for different types of water use and salinity levels. What these coefficients basically said is when you have a specified concentration of salinity, you have X amount of damage to equipment, to residential fixtures, to industry, and they went through each of the water use categories shown earlier. That study was the basis for the 1998 study in southern California with the Metropolitan Water District and the US Bureau of Reclamation. They used the same 1988 Milliken-Chapman coefficients, and estimated damages for the Metropolitan Water District. A more recent study in 2003 also used the same damage functions. In this more recent study they tweaked some of these damage functions but didn't make much of a change overall. And we will look at some of the damage estimates from these studies. They are very significant, but vary from location to location, depending on the industries, number of residents, types of appliances, the salinity level, soil conditions and crops. The results are very location specific. Again, all of the above studies used the same damage functions.

Let's briefly look at summary results of a more recent study in the United States, the Central Arizona Salinity Study. In this study, impacts in five categories were considered: residential, commercial, industrial, agriculture, and water utilities. There are other impacts too, for example environmental, but they didn't consider those impacts. Residential damages estimated included reduced life of appliances, and as somebody mentioned earlier, damage to faucet fixtures, and damage avoidance costs such as bottled water or use of softeners. Water usage was categorized as cooling, irrigation, kitchen, laundry, and so on. Impacts to irrigation and residential landscape irrigation were assumed to be zero. We know that is not the case and in El Paso we have evidence that if you don't manage your water correctly, water with elevated salinity will damage your landscape and golf courses and so on. But there are also ways to avoid those damages through management and landscape plant selection. The Central Arizona Salinity Study used local data for population, the number of household appliances, and for water demand. An important point, population growth, is not considered in their damage estimates. If there is population growth, these future damages should be taken into account in making current water quality investment decisions. Under the Central Arizona Salinity Study, base residential water quality for Tucson at that time was 316 mg/L TDS. For comparison, in El Paso typical delivered M&I water has 600 to 700 mg/L TDS, so we are already double the concentration analyzed for the impact damages in Tucson. In Arizona they had a drinking water TDS standard at that time of 500 mg/L. While they are looking at changing that standard, in El Paso the current standard is 1000 mg/L, so you really have to look at all the conditions and differences. In Arizona the agriculture base TDS water quality was 907 mg/L. One of the critical things for irrigation of plants is soil condition, and soil conditions really vary. While farmers are very aware of the importance of soil, urban landscape developers are beginning to use soil maps in terms of irrigation and salinity to look at where we should be placing schools, parks, golf courses, and how you manage your urban landscapes. Figure 5 is an example where there were a lot of problems resulting from poor land use placement on areas that don't leech or drain well. You can see what happens if you do not have good drainage through the soil profile, you see turf damage and bare spots because of higher salinity concentrations where the salts just stay in the soil and accumulate.

Figure 5. Clayey Enntisols and Petro-calcic Aridisols are poor for salt leaching

Industrial and commercial damages: the Central Arizona Project used economic census data (a five- year census) to identify local industries, the categorized uses by process, boiling, cooling, and so on, and used the 1988 damage functions applied by water use category. They didn't make changes to the original coefficients.

For agricultural damages two major areas were considered: reduced yield using University of California Riverside salinity lab equations and estimates, and the added cost of leeching salts. In order to get the salts out, you have to use more water and there is a cost for the additional irrigation needed.

Studies acknowledged that the estimated values were approximate, because different crops have different tolerances for salinity. Well this is good and bad, you can shift crops to a certain degree, but as you shift to more salt-resistant crops, they are usually lower income crops. These impacts, while real, were not included in the damage estimates.

In one of the few studies on salinity damages in the El Paso area, Ejeta, McGuckin and others published in 2004, the authors estimated returns from EBID farmers on the New Mexico portion of the Rio Grande with better water quality averaged $258 per acre and returns to farmers on the Texas side in the El Paso County Water Improvement District were almost $50 less per acre. This was largely attributed to the reduction in water quality (salinity). These are significant impacts. In this case there are about 50,000 acres of irrigated crops impacted, and, this doesn't include the switches already made to salt-resistant, lower income crops.

Figure 6 is just an example, on the left you see pecan leaves from salt impacted soil and water that are much smaller and on the right a typical healthy much larger pecan leaf. The leaves are what produces the quantity, size, and quality of pecans and determines farmer profits.

Figure 6. Pecan leaves impacted by salty soil (Miyamoto)

Figure 7 shows onions, and you can see in this salt affected field in El Paso there is much lower germination, much less viability of plants, and lower yields and growth. You can really see how spotty the onion crop is across the field. These are just examples of the various salinity impacts and how you have to consider local conditions in estimated damages.

Figure 7. Onion field in El Paso affected by salty soil

Figure 8 is a photo of an irrigation head gate. I included this because it gives an indication of salt affects and damage most people wouldn't necessarily notice. This is on the Mexican side. Irrigation district head gates are typically made out of metal. Well why is this one made out of plastic? It is because of the salt corrosion and damage, so they are trying plastic head gates to reduce the damages. But the replacement of damaged head gates and plastic require additional money to be spent – that is economic damages.

Figure 8. Irrigation head gate damage by salt

Water utility costs of salinity vary with location and utility, but there can be shorter equipment life that needs to be considered. In the case of the Central Arizona Study, no costs for utility corrosion were assumed because other studies had indicated that in this system, salinity was not the reason for corrosion, there were other factors. But there are utility and consumer associated costs of salinity such as the need for alternative supplies. For example, if you can't take the water from the river, you need to look for other sources. That may be desalination or it may be importing water.

Figure 9 is an example of a reverse osmosis desalination unit in El Paso installed because of elevated salinity and other reasons (arsenic).

Figure 9. Reverse osmosis desalination unit in El Paso

Figure 10 is an example of a change and impact to environmental conditions - everyone's favorite plant, salt cedar. Salt cedar does well under higher salt concentrations, replaces native vegetation and consumes large quantities of water. There is also a question of whether salt cedar plants contribute salt to the soil surface.

Figure 10. Salt cedar grows well under higher salt concentrations, replacing native vegetation

So what were some of the economic impact results for other areas? The impacts in the Central Arizona Study were estimated to be $30 million per year for each 100 mg/L change in salinity. These values are in year 2000 dollars, and when adjusted for inflation over the last eight years, the damage estimates would be higher, even without considering increases in population.Who is suffering these damages? In the Arizona area, the burden on residents, that is individual homeowners, was estimated to be 45 percent of the total damages.

The Metropolitan Water District study of 1998 estimated annual urban damage costs (not agricultural) of $.50 per acre-foot of water for each 1 mg/L change over a threshold of 100mg/L. In El Paso, the typical urban water supply, the salinity concentration is 600 to 700 mg/L, which is substantially above the California damage threshold of 100 mg/L.

Water from the Colorado River was separately estimated to result in damages of $.68 per acre ft per 1 mg/L change. This emphasizes the importance of considering local sources and conditions.

As Dale Doremus described in the first part of this presentation, the Rio Grande Salinity Management Coalition has developed a multi-phase work plan and acquired initial funding for a first phase of hydrologic studies and preliminary economic impact assessment. The preliminary economic assessment will use existing data and adjust it to the extent possible within the study's resources and time frame. In this first phase, the objective will be to develop first-cut estimates of the types and magnitudes of impacts, who is getting impacted and the approximate value of impacts. This will help determine the worth of investing funds for further study and measures to control salinity. The plan is to provide a good big picture image of the conditions and impacts by building on work from previous studies.

As noted earlier, local conditions vary such as concentrations, chemical composition, types of use and residential appliances and industrial equipment, and are important in developing accurate damage estimates. Other factors that should be addressed in subsequent studies include area specific damage functions and population growth. These population projections for the El Paso/Juarez area illustrate why population growth is an important factor in estimating damages (Fig. 11). The top growth projection line is not cumulative, this is for just the city of Juarez, and you have to add all these up for the total growth and population. In considering salinity impacts, you can't just say, here we are in 2008 and these are the damages. You need to look ahead and consider, with elevated salinity, how much should we be investing to reduce the salt concentrations with the impacts of increasing population?

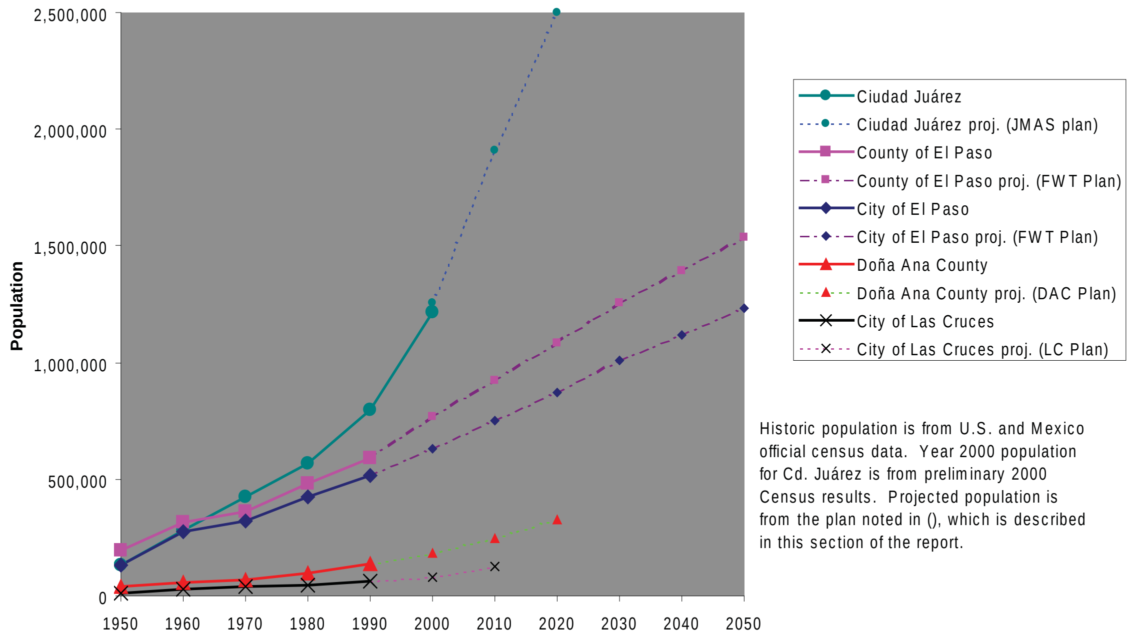


Figure 11. Historic and Projected Population in the Paso del Norte 1950-2050

This is the framework for the assessment that we will be conducting. Thank you and if you have any questions I would be glad to answer them.

Claudia Borchert has been working on water resources issues in New Mexico for 14 years. She has spent the last 5½ years working for the City of Santa Fe Sangre de Cristo Water Division. Her main focus is providing water for the City's long-range needs, restoring a living Santa Fe River, managing the City's existing water rights portfolio, and developing conjunctive and sustainable management strategies. Claudia received her master's degree from the University of New Mexico's Department of Earth and Planetary Sciences in 2002, and a geology bachelor's degree from Amherst College in 1990. Off the job, Claudia enjoys spending time with her kids, hiking and biking in the Santa Fe area, eating fajitas on the Plaza, rafting western rivers, and traveling the world.

New Mexico Municipal Representatives on the Use of Surface Water for Their City: Santa Fe

Claudia Borchert
Sangre de Cristo Water Division
801 W. San Mateo Road
Santa Fe, NM 87505

Hello. It is a pleasure to be here like many speakers have said. I am a newcomer to these conferences, but I have been very pleased and felt that I have learned a lot by coming to these conferences, especially because of the broad cross-section of people that are here as well as the geographic distribution throughout the state and our neighbors. It is really a great way to learn about what is going on in New Mexico and the surrounding area. Today I will be telling you about Santa Fe's surface water use in the past and future. I will also tell you about we have learned about using surface water in the past and considerations for using surface water. The themes in my topic you have already heard today, but there is one thing I will talk about that you have not heard today. True to our form that Santa Fe is different, we are also different in water resource management.

Figure 1 is an old sketch of Santa Fe from 1882. The first surface water use in Santa Fe began in 1881, just before this was drawn. You can see where the Santa Fe River flows through town. When I say the use of surface water, I mean for municipal purpose. Obviously the Native Americans and Spanish colonists used the Santa Fe River for agricultural and other uses prior to 1881 when the first dam and distribution system were built.

Let's take a look at that history in graphic format (Fig. 2). On the bottom of the figure are years 1881 to 2007, and along the y-axis is acre-ft per year. This is our water use over that time period. Over the first 50 years, you can see that the amount of water was primarily under 2,000 acre-ft, and beginning in the 1940s and 1950s, what we see throughout the state is an increase in demand as the population grew. One thing I will talk about a little later is the decline and what happens to the line when you implement conservation programs and your demand decreases.

Figure 1. Santa Fe, NM 1882

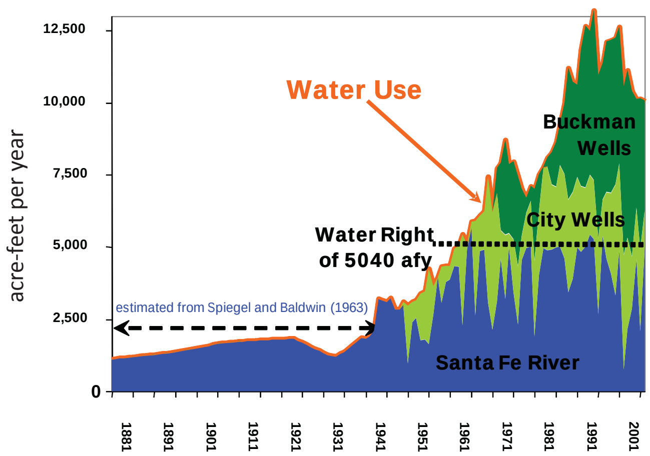


Figure 2. Historical Use of Surface Water

Let's take a look at what role surface water has played in filling that demand over time (Fig. 3). The blue is Santa Fe River use since 1881. For the first 50 years, the Santa Fe River was adequate to meet all of Santa Fe's needs, and then beginning in 1951, demand exceeded available surface water supply. Nonetheless the use of the Santa Fe River did give the City a license to use 5,040 acre-ft of water, which I have shown here in the black line. Another thing to note that has not been mentioned as much today is variability. You can see that over the last 50 years, flow has been highly variable, including the worst year on record (2002), where the watershed yield was around 700 acre-ft. Now this of course means that to rely on surface water, you have to have something else to supplement supply. That is where the City wells came in the 1950s, the wells within the City limits along the Santa Fe River. The City's most recent supply was drilled in the 1970s. It also marks a shift that occurred in most municipalities from using surface water to groundwater. Currently we get between 50 and 75 percent of our water from groundwater, which is not sustainable.

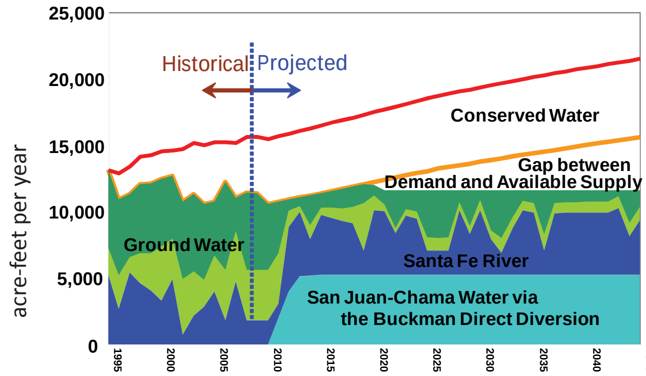


Figure 3. Santa Fe's Future Surface Water Use

There are two things that led the City to change from what is our current water use to what will be our future water picture, which I will show next. The other reason to change, besides unsustainable use of groundwater, was because we had an unused asset in our portfolio. We have 5,230 acre-ft of San Juan- Chama water but no way to use that water as a source of supply. So we needed to build an infrastructure project to access that water, and that is the Buckman Direct Diversion Project, which several people have mentioned today. Figure 4 is a view from the White Rock overlook, which is on the eastern side of the Jemez Mountains looking north. You can see the Rio Grande in the near foreground and the Sangre de Cristo's in the background and where the diversion site will be. We broke ground on the project a month ago. Our project is at the confluence of the Rio Grande and this big arroyo. It is not like Albuquerque with a dam across the river; it will only be a riverside diversion facility.

Figure 4. Santa Fe Future Surface Water Use: Buckman Direct Diversion Project

John D'Antonio gave some details on this project so I don't know if I need to repeat those. The regional project partners are allowed to divert 8,730 acre-ft per year, of which 64 percent is San Juan-Chama water, the rest is native water. This is a project with regional partners, City of Santa Fe, Santa Fe County, and Las Compañas, which is a private development in the area and we are scheduled to be online in 2011.

Let's see what role the combination of San Juan-Chama water and Santa Fe River water will play in our future. First I want to go back to the demand that would have been had we continued to use water at 1995 water levels (Fig. 3). In 1995, we were using 168 gallons per capita per day, and that projected out into the future is this red line. Aggressive conservation measures have brought down consumption down to about 105 gallons per capita per day total use, which has resulted in all this conserved water. Ed Archuleta mentioned how much you can save in infrastructure costs. We project that out 40 years and see how much we have reduced our supply needs by 33 percent, and that is a lot of projects we don't have to build in the future. We take away all the demand that we don't have and look at how we will fill the demand that we do project. Note the combination of Santa Fe River with the San Juan-Chama supply in 2011. You can see that the variability of the Santa Fe River continues, however, we consider San Juan-Chama water to be fairly drought resistant for three reasons. One, if you know the project, the amount of water contracted is already a firm yield, meaning seasonal variability has been taken out of San Juan-Chama. The City has an additional contract for leased San Juan-Chama water with the Apache Nation, and we can use that to supplement any shortages we might foresee. In addition, we also use stored water to supplement any shortages. Groundwater will continue to play a role in meeting our future demands. As you can see, we are going to reduce the amount of groundwater we are currently using by two-thirds of our portfolio to less than one-third or one-fourth of our portfolio using groundwater as a drought backup when surface water is not available. We still have a gap, even though we are spending $210 million on the new Buckman Direct Diversion Project. The gap begins in 2021, and is approximately 2,700 acre-ft by 2045. We have some options on how to fill that gap that include increased conservation, purchasing water rights on the Rio Grande, or using the effluent we are not utilizing at the moment.

What issues are there to consider in using the Santa Fe River water that we have learned? First of all is adjudication. We have a license for 5,040 acre-ft, but we don't really know how many other water rights there are in the basin and that makes it hard to plan our water resources, but that isn't a new thing at all. Also I mentioned variability. If you are going to rely on surface water you have to have alternative supplies, by 2011 we will be lucky enough to have that. We will have both surface and groundwater, but it is expensive to have two systems for water sources in order to meet demand one time under varying conditions. Also vulnerability is something to worry about. Many watersheds are susceptible to catastrophic fire as ours was. Our watershed was closed in 1932. There had been no fire in over 100 years. We are fortunate that there have been $10 million dollars spent on thinning projects to reduce our risk of catastrophic fire in that area, but there are still 10,000 acres that have not been treated. Any watershed that supplies surface water is vulnerable to fire. Source water protection is also an issue as Robert Pine mentioned earlier. Any surface water is more vulnerable than groundwater.

These next two topics that I will go into greater detail on are ecosystem impacts and unpredictability. This is where the City is different. We have the dubious distinction of having the Santa Fe River being named America's most endangered river in 2007. Looking at the photograph in Figure 5 would make you wonder if it even is a river. One of the mayor's top three priorities is to bring the Santa Fe River back to life. That is a tall order for a river that looks like this. So what are we doing to try and accomplish this priority? I should mention it is not just his priority, it is also a community priority. We have instituted a River Check-Off Program that allows community members through their water utility bills to donate money to the river fund that will be used to purchase water rights and dedicated to instream flow. The fund is also matched dollar for dollar with City money. To date we have collected around $40,000, which in today's water rights market buys you about 2 acre-ft. And if any of you don't know how 2 acre-ft translates into flow, it would be about 1.5 cfs for a day or two. So this is a long path if this is all we were doing to bring the river back to life.

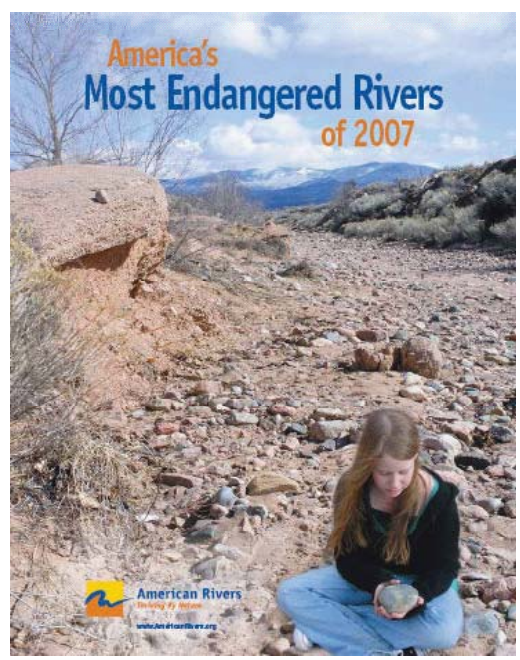


Figure 5. Santa Fe River

We are doing river and watershed restoration because a healthy watershed means a healthy river and vice versa. We are currently doing environmental flow studies to ask the question, how much water does this river want for it to be living or healthy? That necessitates defining "healthy" and "living," which is about as tricky as defining "sustainability," but we are trying to do that.

- Monitoring: stream flow, groundwater, water use, tree-rings, ...
- Models: Dynamic system, groundwater, stream forecasting, climate, ...
- Regulations: the Rio Grande Compact, water rights administration, endangered species, ...
- Partnerships: local, state, federal agencies, NGOs, native American, acequias, community members, ...

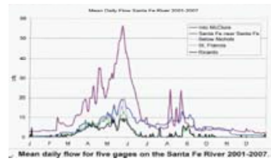



Figure 6. What has helped Santa Fe Manage surface water issues?

The last thing that is significant is that the City has recently adopted its long range water supply plan. In that plan, the City dedicated 1,000 acres of its water rights portfolio to the river, so that water will run down the river for an instream flow, and that is a condition under normal, wet years, but it is a large step toward getting water in the river. What we haven't figured out yet is what our options are concerning recovering that water. In light of the Bear Canyon Recharge Project, we certainly will be looking at how we can recover that water. We are not ready to do that yet, but we will be looking into how that water can serve multiple purposes. One is to keep the Santa Fe River alive and second is to have it serve as a source of supply after it meets its first purpose. Also, we heard Mike Connor and others speak about the SECURE Water Act this morning. There are people who have been arguing that releasing water into the Santa Fe River sets us up for a secure water future because it puts water into the system that will be there for a long time. I don't think we have figured that out hydrologically yet, but we believe it will bear out in a long time frame even if it is hard to justify now. But there could be a security benefit to releasing water now.

Finally, I will say a word on the unpredictability that comes with climate change and the impacts to groundwater resources. We know that water supplies are vulnerable to changes. You may disagree on the causes of climate changes but there is positive proof that things are getting warmer.

So what has helped Santa Fe manage our surface water issues? Figure 6 is also right in line with what we heard about the SECURE Water Act. We have been monitoring and collecting stream flow data, groundwater data, water use data, and treatment data. We have done this with the USGS in some cases and in other cases on our own. I'm sure I am forgetting all kinds of things on the list, but the fundamentals of understanding our system is really important to us in order to use surface water.

We also use models; we have a dynamic systems model for our water supply system that really helps us understand the ramifications of "what if" scenarios. For example, we are using it right now to answer questions about how much storage should we carry over from year to year in our reservoirs, or what happens if our demand increases because of global warming. We plan to use study data to expand our understanding of past stream flow data and to see if it makes any sense to use maybe a 500-year reconstructed stream flow record as a proxy for the future (even though we realize the future will probably be different). It is also important to understand regulations because they provide the framework in which we can make decisions and see opportunities. We are affected by the Rio Grande Compact on the Santa Fe River because about three quarters of our storage is post- Compact water so we have to comply with the Rio Grande Compact on 3,000 acre-ft of stored water. Finally, something that is not to be underestimated is partnerships. Our Buckman Direct Diversion project is a partnership with regional entities, and everything that we work on that deals with water issues requires that we work together with our larger community.

In conclusion, Santa Fe recognizes the need to rely on renewable surface water for supply. We have in the past and plan to continue in the future. Some final questions to ponder are what are our decisions and the associated tradeoffs. There are always tradeoffs in water supply, only one of which is expense. Surface water comes with responsibility to have a drought resistant backup supply. Drought requires the responsibility to figure out who owns what water. Stewardship requires that we make wise use of the resource and the ecosystem, and protect our watersheds. Whose responsibility is this? Relying on surface water requires monitoring and models to understand the resource and the opportunities, recognition of the regulations we must work within, and collaboration. Thank you.

Frank Armijo is the Water Treatment Plant supervisor in Las Vegas, New Mexico. He has been with the City for about 18 years and has been in the water industry for a little over 25 years. Frank has worked in distribution, supply, and operations. He has managed the water treatment plant supply operations for the City for the past 7 years.

New Mexico Municipal Representatives on the Use of Surface Water for Their City: Las Vegas

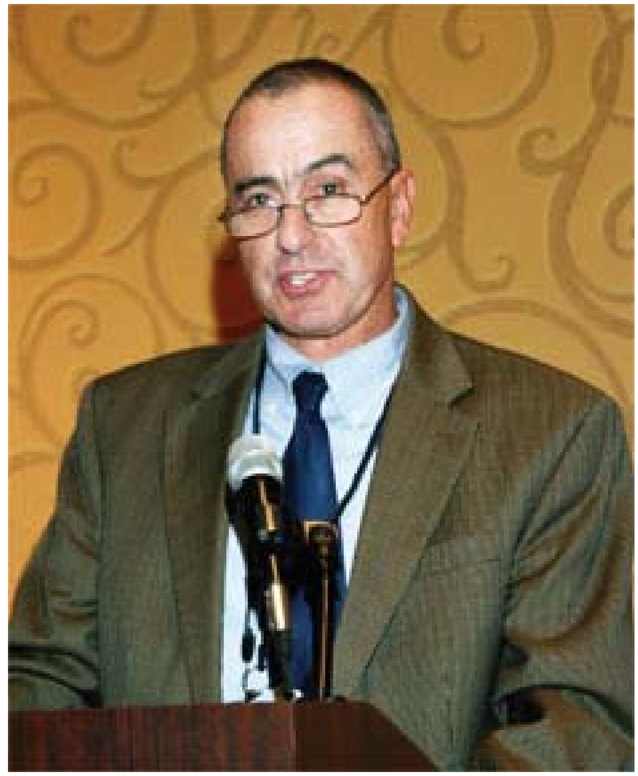
Frank Armijo
Utility Department
City of Las Vegas
905 12th St.
Las Vegas, NM 87701

I was notified at about 11:30 today that I was going to be presenting this so bear with me. I have been with the City of Las Vegas for about 18 years and have been in the water industry for a little over 25 years. I have worked in distribution, supply, and operations. I have managed water treatment plant supply operations for the City for the past 7 years. The water treatment plant in Las Vegas serves a population of about 19,000. The City's source of surface water is the Gallinas River, which can most of the time not even be considered a river, it is more of a creek. The City has two reservoirs, Peterson and Bradner, which combined provide a total of about 500 acre-ft. We also lease 500 acre-ft of storage in Storrie Lake, which is also in a state park, which at times worries me because it is a state park and we allow boating on it. The dam itself is a highway, which has its own risks of contamination.

Up until 2004 we managed our water under the pueblo rights doctrine, which meant we were managing under rights granted by Spain. In 2004 those rights were taken away by the Supreme Court and fell back to the lower court decision granting the City only 2,600 acre-ft per year. In the past 3 years, we have managed to keep within the 2,600 acre-ft by supplementing our water with the Taylor Well Field. We have three wells operational in the Taylor Well Field. This year we have dealt with aquifer problems and dropping water levels and we have had limited use of the well field. The well field is City owned and we are working to find out what caused the problems. Right after drilling Taylor well #7 in June of 2007, we noticed the drop in water levels. We have also had complaints from residents nearby about their water levels and the loss of the use of their wells. Around November 15, 2008, we are going to be coming into 2,600 acre-ft, meaning that we are going to be short this year and it leaves no room for growth. There is a diversion located approximately 3 miles from our closest reservoir that gives us the opportunity during storm advance or spring runoff to divert the water around and not use it and then we'll rely on our storage to catch up later. This allows us the treatment capability to stay within the same chemical dosages. Our treatment costs would be impacted if we had to change our backwash rates. The City is currently utilizing treated wastewater to water golf course, parks, and sports fields.

Our per capita water use per day, before we lost water rights and went into conservation projects and plans, was about 165 gallons per person per day. Currently it is down to 115 gallons per person per day. Our conservation program includes going to schools and speaking to kids between 3rd and 5th grade. Those kids are at the age where when they are told something, they will take it home and use it against you. That has been real handy for us and works very well. We have noticed that after giving tours and going out to the schools with our classroom presentations, the next day we can usually see a drop of about 300,000 gallons, which if we could maintain that, it would be really great. Our production levels back in the 1980s were up to 6 million gallons per day during the summer max production. Last year, production was 3.2 million gallons and the reason it was that high was because we had a leak. Other than that, our max day was 2.8 million gallons. We are currently working with a ranch that is southeast of Taylor Well Field that has wells to different aquifers and good quality of water and high yield. We are working with them on a deal to supplement our water. That's pretty much all I have, but I would be happy to answer any questions.

Jorge A. Garcia has been the Director of Utilities for the City of Las Cruces since 2001. He is responsible for management, operation, planning, and development of water, wastewater, natural gas, and solid waste utilities. He supervises 232 employees, a $61.9 million operating budget and $24.9 million capital budget, serving 78,000 customers. He received a B.S. in agricultural and irrigation engineering and M.S. and Ph.D. degrees in civil and environmental engineering, all from Utah State University. Jorge's doctoral dissertation was entitled "Evaluation of Search Techniques and Parameter Estimators in the Automatic Calibration of Rainfall Runoff Models."



New Mexico Municipal Representatives on the Use of Surface Water for Their City: Las Cruces

Jorge Garcia
Utilities Department
680 Motel Blvd
Las Cruces, NM 88005

Thanks Karl. Thank you for inviting us to talk about our surface water supply. It was mentioned this morning that El Paso started using surface water in 1943 and I know that Santa Fe has been using it for 100 years. History shows that the City of Las Cruces used water from the Cinco de Madre in the late 1800s. But history also tells us that the water quality was so bad that they started drilling wells. The city utility really started by buying wells from the electric company and we are still in the groundwater business today.

Let me tell you a little bit about what we are doing with surface water and some of the progress we have made. Like several presentations you have heard here, most 40-year water plans have certain minimum requirements and ours (the updated version is under final review by the state engineer) always has some form of conjunctive use component. Sometimes it is just surface and groundwater use but other times it is coupled with conservation efforts. Reclaimed water use and ASR or importation of water are also included. Our plan with the present goal projections is to concentrate on three elements: conjunctive use of surface and groundwater, which is what we all are talking about, along with water conservation and reclaimed water use. We are building a $9 million reclaimed water plant that eventually will be used for treating tertiary water for irrigation. Finally Las Cruces will join the rest of the West in recycling water.

Today let's talk about some of the conjunctive uses of surface water. Figure 1 shows more or less the distribution of our water supply wells in two different bolsons or aquifers. One is the Mesilla aquifer located along Highway 25 and Highway 10, and we also have the Jornada aquifer. The wells we show here are on the East

Mesa. We have some existing wells and some have approved water rights on that aquifer. They are pumping approximately 3,000 acre-ft right now from our original water right, the LRG 430. We have an additional 10,200 acre-ft in the basin. This is a mined basin, the water is there and has been there since geologic times, and you can keep pumping for a while but at some point the water supply will run out. We like to think of that basin as a drought reserve and hence the effort to go toward surface water.

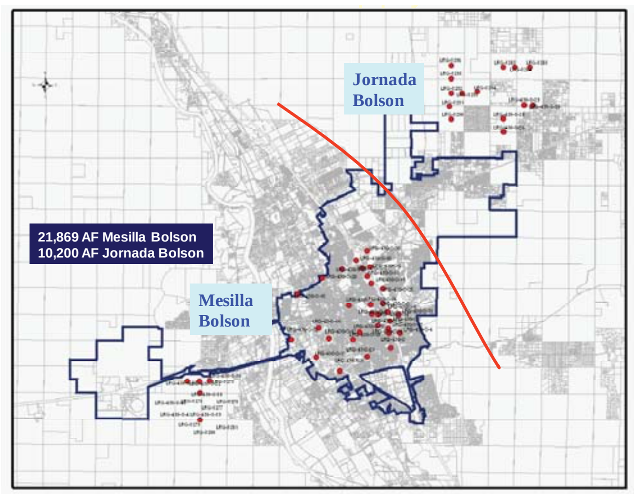


Figure 1. Groundwater supply basins

The Mesilla Bolson has some existing wells on the West Mesa but we still have some pending applications there that date back to 1981 to complete our water portfolio. We have contracted with the Water Utility Board earlier in the month.

Figure 2 gives you an idea of the current and projected growth patterns in Las Cruces. It turns out that we are growing toward the east where the mined basin is located. That is the best land available for growth and the City just annexed about six sections. Growth projections to 2025 are almost all on the east side, a few on the west, and very little to the north and south. The good news is that we can preserve our land. The bad news is that we have to move the water from the valley up the hill or use the water supply in this basin. Since it is a mined basin, we must arrange for the hydraulics of the system to transfer water from a more sustainable source that is connected to the Rio Grande to the growth areas.

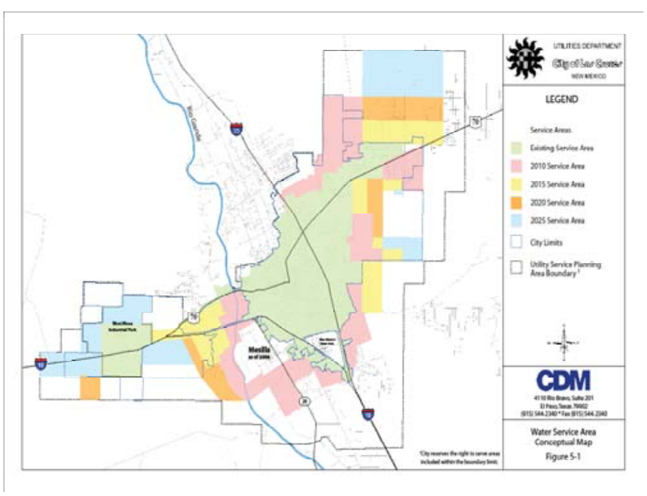


Figure 2. Water Service Area conceptual map

Goundwater makes up 100 percent of our current supply. We have had a capacity for about 44 to 46 million gallons a day. The current peak demand in summer is about 30 million gallons per day. In terms of supply and the hydraulics of the system, we are doing fine. We are getting approximately 3,000 acre-ft last year of that mined water from the East Mesa and Jornada aquifer.

Figure 3 shows our current proposal to the state engineer in our 40 Year Water Plan. The top curve represents the 2045 high growth scenario projection of about 260,000 in population and about 53,000 acre-ft of demand. There are three levels of growth in that curve. Our growth until about 12 months ago was the high end curve. The growth rate has recently declined but we are still growing. That puts us somewhere below this curve, but again we have different levels of growth scenarios. In terms of infrastructure planning, we are planning on the high use projection.

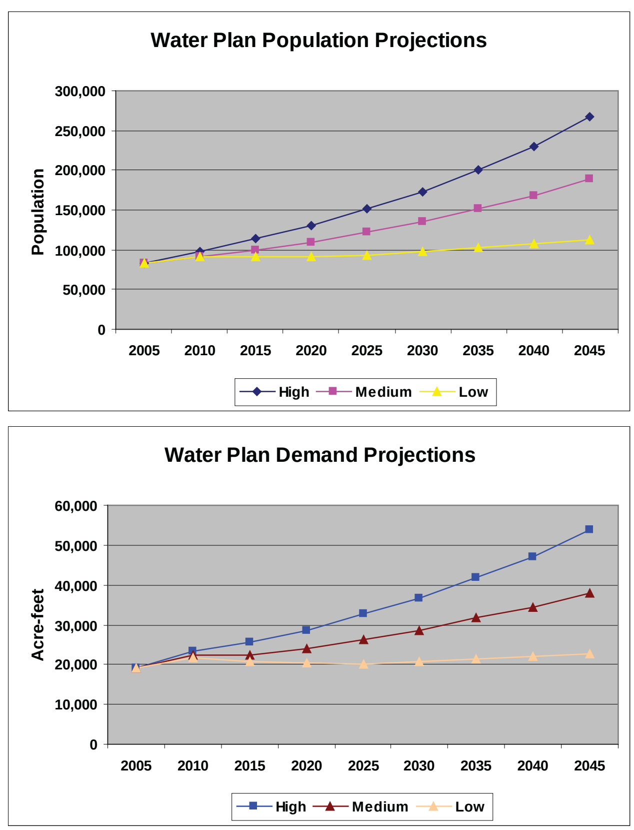


Figure 3. Water plan population projects and water plan demand projections

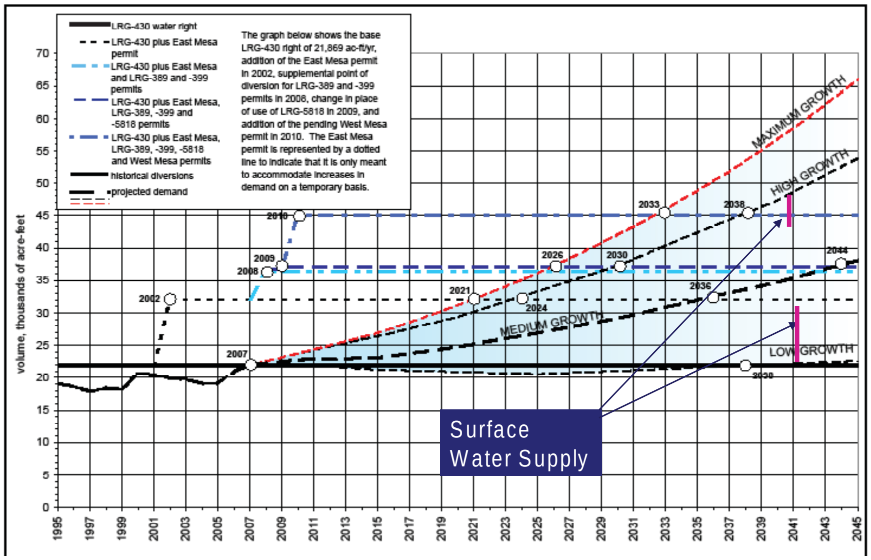


Figure 4. Graph showing City of Las Cruces historical water diversions for 1995 to 2005 and projected water demands from 2006 to 2045 represented by a band representing low to maximum growth rates, City of Las Cruces's total existing adjudicated water rights, and current and pending permits. (John Shomaker & Associates, Inc.)

Figure 4 is also from our 40 Year Water Plan. It shows the City's different water rights and demands. An old City water right of 21,690 acre-ft dates back to 1907. We have 10,200 acre-ft on the Jornada Bolson and 1,450 acre-ft of valley water but we have to use wastewater or other rights to negate the impact on the hydrologic system. An application is in process with the state engineer for another 8,000 acre-ft. A big issue for us, however, is Spring 39 and additional growth that could be surface water or groundwater. It is critical though that the sooner we move to surface water the less we mine this basin. And that is our justification; yes, we have groundwater rights but we would like to shift as soon as we can afford to and as soon as we have all the different contracts in place. Then we can use the Jornada aquifer as a drought reserve.

Before you build a plant to treat surface water, you need water rights. In 1985 the City had the vision to place a fee on rate payers for future surface water rights acquisitions. I don't think there was a lot of discussion in 1985 about water rights in this area. There is also an ordiance that requires water rights as a condition for development within the city limits. In other words, if you want to be within the utility service, you need to convey water rights in one of several forms: one being the conveyance of surface water righted land, where the utility has the right to purchase or lease the right. This requires EBID approval as well as verification that an offer of judgment has been made on that tract by the Office of the State Engineer. As a utility, we have parallel processes: one that we file with EBID and one with the state engineer. We acquire the rights and we pay for the rights (although we recover some of that money from the fund through the meter fee).

There are certain water righted lands where a fee is paid:

- Non-water righted
  Development pays water right fee based on meter size
- Utility purchases other water rights not related to land development
- Groundwater rights require offsets
  Wastewater return flows
  Surface water
  Importation

We can acquire and lease some water rights that are not related to a specific tract of land, if the tract of land is within a special user association. We must get approval through the EBID board of directors to lease these rights. We have only acquired these groundwater rights on a small scale because they would require wastewater return flows to offset or use some form of surface water reparation for making up those effects. We are concentrating on surface water supply for two reasons: because of its sustainability and because of the priority of surface water in the Lower Rio Grande.

The state engineer mentioned earlier today that some municipalities have spent 40 years looking at transitioning to surface water. About 10 years ago in Las Cruces, we started the process of moving the City of Las Cruces to surface water. Working with EBID, we were successful in implementing what is called the Special Water Users Association. These associations were created by state law to allow municipal and other users access to EBID surface water. The mechanism to acquire water rights is in place but the mechanism to utilize "wet" water is yet to be developed. The amount of water is dependent on an annual allotment. The water allotment currently being used in irrigation is 1,000 acres or 3,000 acre-feet of water.

There are still a few things we need to do with EBID in terms of the transition of the water once it goes through surface water rights and to the agriculture pool with EBID. One of the requirements for surface water within the Project is that the surface water right be appurtenant to land that is transferred to City-owned property. When we acquire or purchase rights, instead of leasing them, we will convey them to City owned property. The property must be part of the EBID and payment is based on water righted acreage and size of parcel.

When we do a surface water transaction, the seller by ordinance must sell their water rights to us if they want utility service. They need to execute all required documents including those required by the state engineer. The paperwork goes through us so that we can make sure that the water rights are actually there and no double accounting is done. We make sure that we are actually paying for something of value. We then execute the documents with EBID as well.

The process was streamlined recently. We used to have a water committee that included a few city council members on a subcommittee of the Special Water Users Association. Now we have the Las Cruces Utility Board. The board is allowed to acquire and lease water, making the acquisition process much more streamlined.

Our lease concept is basically a lease purchase concept. First, the surface water right appurtenant to the land remains in the developed parcel. The lease agreement identifies the City Utility as the owner of the water right. The Lease agreement contains several elements: prepaid rent (same dollar value as the purchase price); the well allotment; EBID tax assessments; and a term (40 years with an option to renew).

As part of the transaction, we have an exclusive option to purchase or renew the lease. We follow District policies (EBID 2003 GA7, NMSA 73-10-48), and the assignment is binding on successors and assigns. We then start paying allotments to the irrigation district. These are forty-year leases and are renewable every forty years.

How do we pay for all of this? We fund the water rights acquisition by new customers as well as existing customers. New users pay a one-time water rights fee based on their meter size. Existing users pay a volumetric charge as part of their monthly water bill. This funding mechanism is also used to support legal funding of water rights adjudication.

What are we doing with the infrastructure? This is a major subject of discussion. We had a great tour yesterday of Albuquerque's facilities. About 12 months ago, we commissioned CH2M Hill to conduct a feasibility study to look at possible sites for a plant. There are still other procedures that need to be done, too. For example, we still need to develop procedures to change the place and purpose of use with the Office of the State Engineer. We also need to develop necessary contracts with the U.S. Bureau of Reclamation and EBID for use of surface water for municipal and industrial use. Our plan is to be part of EBID and work with EBID and take the water, not for irrigation use, but as surface water. We will continue the acquisition of surface water rights because we need at least another 2,000 acre-ft for the first phase of the actual treatment process.

The feasibility study contains three tasks. The first task will take 15 months and is an evaluation of alternatives for water treatment plant infrastructure. The task includes data collection and evaluation; evaluation of EBID infrastructure that may be viable for the use and conveyance of surface water to the plant; evaluation of alternative plant sites and diversion facilities; evaluation of alternative treatment processes and diversion facilities; and defining the best technical alternatives. This will be a cooperative endeavor with EBID so that the district can benefit from some of the structures we put in place.

The second task of the project deals with supporting studies and services. Basically, this deals with project management; developing operational and conjunctive use plans for surface and groundwater; investigating water rates and funding alternatives; treatability testing and water quality evaluation; and public involvement and presentations made to stake-holders.

Task 3 of the project concerns the conceptual design and feasibility. This includes basically delineating design criteria and generating certain levels of treatment plan specifications. Also, we'll be identifying environmental impact statement (EIS)/environmental assessment (EA) needs and permitting requirements. We will then produce a summary feasibility document.

In general, water supply planning requires multiple options that include conjunctive use of surface and groundwater. Water rights can be purchased or leased. Currently, leases are mainly associated with surface water rights. As described, we are conducting a comprehensive feasibility study that begins the infrastructure planning process and that will make a surface water plant a reality. Before surface water can actually flow into a plant, we will need to finalize agreements with the Office of the State Engineer and other pertinent entities. With that, I'll end this presentation. Thank you.

F. Lee Brown is Professor Emeritus of economics and public administration at the University of New Mexico and principal in his consulting firm, H2O Economics. His academic and consulting work has specialized in water resource economics, policy, and management with particular emphasis on markets for water and water rights. He has published numerous books and articles in the field.

The Evolution of Markets for Water Rights and Bulk Water

F. Lee Brown
H_2O Economics
3200 El Toboso NW
Albuquerque, NM 87104

Introduction

Markets for water rights have become a staple ingredient of the water management landscape in New Mexico and numerous other western states, including our neighbors, Colorado and Utah. In other western states, most notably California, it is less common to see outright sales and transfers of water rights from one party and use to another. Instead, greater reliance has been placed on contracting for bulk water through major distributors such as the Metropolitan Water District in southern California or bilateral agreements such as the recent one between San Diego County and Imperial Irrigation District.[1] Regardless of whether the water transactions have involved water rights or only the bulk water controlled by entitlements to water, the markets for accomplishing the reallocation task have largely been informal in character with few organized exchanges as frequently exists for other commodities.

In times of drought, California has turned temporarily to an organized exchange for bulk water as it did in 1991 and 1992,[2] and California is preparing to do so again with its own Department of Water Resources serving as the exchange agent.[3] And a quasi-exchange for bulk water has long existed for Colorado Big Thompson (CBT) water in the Northern Colorado Conservancy District above Denver. There, the District facilitates transfers by maintaining a website on which parties may post bids or offers to "rent" water.[4] The District, however, does not actively serve as a broker or market-maker for CBT water and explicitly disavows any liability associated with the sales process.

In New Mexico there commonly exist one or more brokers, in those basins exhibiting water right sales, to which a party can turn if they wish to buy or sell rights. However, the escalation of prices for water rights in many basins, coupled with the increased difficulty of consummating actual changes in the place or purpose of use of a right, raises the possibility that organized exchanges for bulk water might facilitate the movement of water among users and uses.

New Mexico briefly opened a window for such exchanges in the Lower Pecos a few years ago,[5] despite strong opposition, as basically an insurance policy against the possibility that the water right purchase program there might not succeed in achieving compliance with the U.S. Supreme Court decree in *Texas v. New Mexico*[6] and priorities would have to be administered. Whenever administration of priorities becomes a real possibility, the risk arises that high valued uses of water for municipal and industrial purposes could be trapped holding junior rights which could be curtailed. Although such users have been quite adept at securing sources for water, under an unexpected priority call much scrambling could still occur without any certainty in the short run that all needs will be met.

The Drought Emergency Water Bank in California was generally judged to be a successful short-term response to drought in 1991-2, but there is less assurance that it will be as successful today now that 1) much of the least valuable agricultural water has already been moved to municipal and industrial uses under long-term contracts and 2) agricultural irrigation practices have already become increasingly efficient, with less water available for short-term leases in the face of higher commodity prices.

Longer-term, recent research reveals that irrigators may be significantly more willing to sell bulk water than they are to sell their underlying water entitlements themselves.[7] The latter activity is a one-time event, irreversible for practical purposes, and doesn't ensure the best price for the bulk water commodity being sold. Consequently, organized water exchanges may have utility on a longer-term basis as well as a short-term response to drought. Organized exchanges which could offer both spot and future contracts for bulk water present attractive instruments for improving the efficiency with which bulk water moves from one use to another.

The third section of this paper explores some of the obstacles to the creation of organized exchanges for bulk water, and the fourth section briefly reports on an initial effort in New Mexico to create such an exchange. The second section below begins, however, with an account of the emergence of informal water markets in the Middle Rio Grande and Lower Pecos basins. This section emphasizes that the origin of basin water markets rests on the underlying hydrologic and legal conditions which give rise to the utility of markets.

Lower Pecos and Middle Rio Grande Water Rights Markets

Two of the earliest markets for water rights in New Mexico emerged in the Lower Pecos and Middle Rio Grande basins as the result of hydrological conditions and legal/administrative responses to them. In the Lower Pecos, declining water levels in the Roswell Artesian Basin led to the adjudication of water rights, metering of wells and the introduction of conservation measures including the permanent retirement of almost 7,000 acres of irrigated farmland with their appurtenant water rights through market purchases by the Pecos Valley Artesian Conservancy District between 1958 and 1985.[8] This practice of achieving hydrologic balance through market purchases and retirement of water rights was most recently extended by the New Mexico Interstate Stream Commission to the entire Lower Pecos basin as part of the State's effort to comply with the U.S. Supreme Court decree in *Texas v. New Mexico*.

In the Middle Rio Grande, the combination of drought and the necessity of complying with the Rio Grande Compact led State Engineer Steve Reynolds to declare the Rio Grande ground water basin in 1956 and condition future expansion of ground water pumping by requiring offsets to the eventual effect of that pumping upon the flow of the river. A principal means for obtaining the required offsets became the purchase and retirement of existing rights, chiefly from irrigation. The resulting informal market for water rights has led to a historical pattern of increasing prices for pre-1907 rights, as reported in Table 1 and Figure 1.

The prices reported for the earliest years in Table 1 are either individual prices for particular transactions of which there were not many, or they are interpolations of prices from neighboring years when no direct price data was available. During the 1980s and early 1990s, the constant price of $1,000 for the right to consume an acre-foot of water per annum reflects the standing offer by the City of Albuquerque which was the principal buyer during that period of time.

Table 1

Middle Rio Grande Water Right Prices

(dollars per acre foot per annum of consumptive use)

Year	*Price ($)*	Year	*Price ($)*	Year	*Price ($)*
1960	***214***	1976	***786***	1992	***1000***
1961	***243***	1977	***802***	1993	***1000***
1962	***276***	1978	***818***	1994	***1000***
1963	***214***	1979	***833***	1995	***1617***
1964	***214***	1980	***889***	1996	***2233***
1965	***267***	1981	***945***	1997	***2720***
1966	***214***	1982	***1000***	1998	***2963***
1967	***214***	1983	***1000***	1999	***3689***
1968	***214***	1984	***1000***	2000	***4105***
1969	***250***	1985	***1000***	2001	***4141***
1970	***252***	1986	***1000***	2002	***4577***
1971	***254***	1987	***1000***	2003	***4793***
1972	***280***	1988	***1000***	2004	***5498***
1973	***500***	1989	***1000***	2005	***7815***
1974	***492***	1990	***1000***	2006	***10751***
1975	***532***	1991	***1000***	2007	***18071***

Although transactions with prices both above and below $1,000 occurred during that period, the standing price offered by the City was dominant. By 1995, however, competition for rights had grown to the point that the City could no longer maintain the set price. From that year on, the listed prices are averages of a sample (non-random) of transactions weighted by the size of the transaction. In both basins, as well as others, there have also been sales of bulk water, also known as leases of water rights. But, the focal point of market activity in most New Mexico basins has always been on the sale and change of use for the water rights themselves. The recent fifty year contract between the Jicarilla Apache Nation and the City of Santa Fe for 3,000 acre-feet per annum of San Juan-Chama Project water is a conspicuous exception to this pattern.[9]

The sharp increase in prices paid for Middle Rio Grande water rights since 2004 underscores the potential utility of an organized exchange for bulk water in this basin. There are a number of reasons for the increase, but two are especially pertinent here.[10] First, the number of protests to transfers of water rights has increased and increased the difficulty of obtaining administrative approval for the transfer even though willing buyers and sellers have agreed upon the terms of the sale. Second, the quantity of rights offered for sale has not increased at the same rate as the price of rights. Both of these factors could potentially be alleviated by an organized exchange for bulk water.

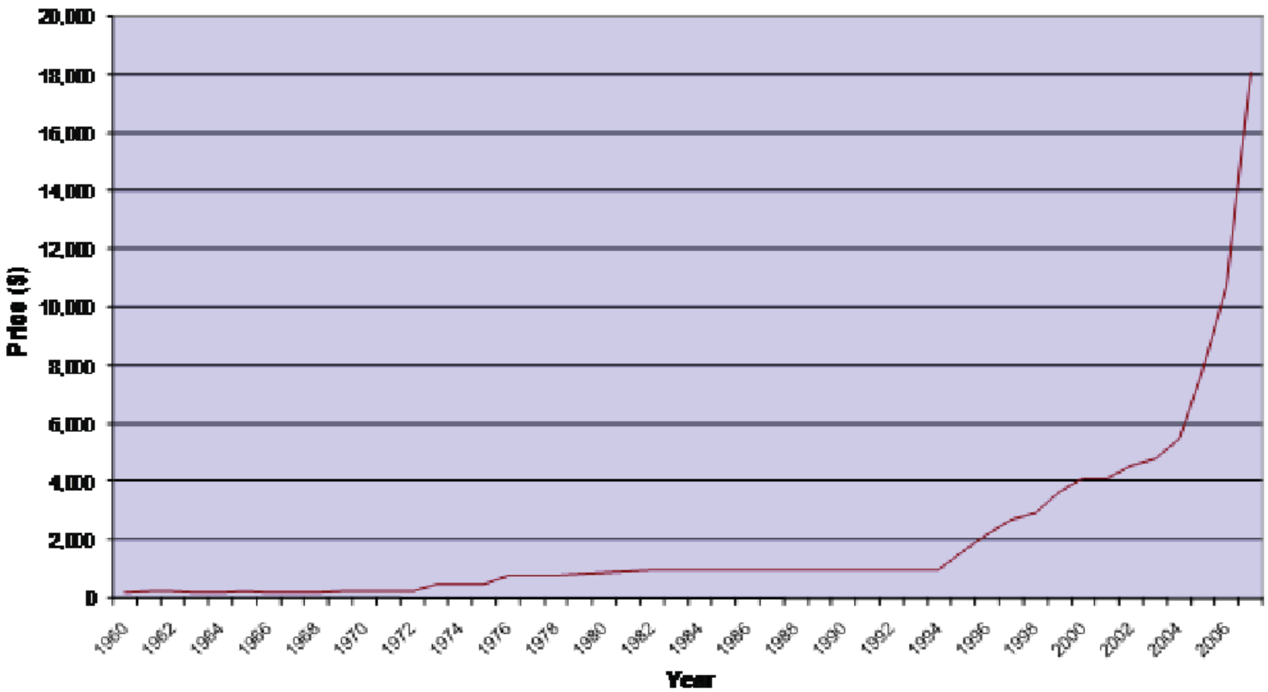


Figure 1. Middle Rio Grande Water Right Prices (dollars per acre foot of consumptive use per annum)

With regard to protests, the permanent change in location or use of a water right is likely to be much more strongly opposed than a single year shift in bulk water withdrawal and use. Moreover, practically speaking, the single year shift offers a learning opportunity for determining if the perceived adverse consequences of a permanent change in location or use of the right will, in fact, be realized. If so, then the necessary adjustments could be made to future sales of bulk water under the same right. With regard to supply, as reported above, current irrigators are more likely to sell bulk water, i.e., effectively leasing their water right, than to part irrevocably with their rights.

Obstacles to the Formation of Organized Exchanges for Bulk Water

Suppose for the moment that active, organized exchanges for bulk water existed through which willing buyers and sellers could readily purchase and sell contracts for the delivery of a fixed quantum of water at a fixed delivery point in a specified current or future year. Moreover, suppose that administratively the State Engineer were willing to recognize a large class of rights to water in a given basin as amenable to the acceptance of short-term leases of those rights under specified conditions without the necessity of further scrutiny by his office due to their short-term nature.[11]

Then, potential buyers and sellers could make individual decisions about the current and future disposition of bulk water contracts traded on the exchange based upon prevailing market conditions. If for a given year an owner of water rights did not want to exercise the rights for their current purpose of use, the owner would have the option of selling a bulk water contract for that year at the prevailing market price under the administrative conditions specified by the State Engineer. Similarly, a municipality seeking assured access to water for some year or period of years could purchase contracts for the desired bulk water under known conditions while it developed or implemented a longer-term strategy for accommodating change.

At this juncture in the evolution of water markets in New Mexico such a hypothetical exchange obviously does not exist. Moreover, there are numerous obstacles to their formation hidden in the hypothetical suppositions just made. For purposes of discussion, however, many of the obstacles can be identified, and some possible remedies considered. To lend concreteness to the identification task, the Middle Rio Grande basin will be used as a potential locus for the exchange.

1. *Adjudication.* To begin with, there has been no adjudication of water rights in the Middle Rio Grande, which certainly is less than an ideal condition for the creation of a water exchange for bulk water contracts. However, it should be noted that

the basin has managed to reallocate water rights without adjudication, a much more formidable endeavor, for forty-five years or so before current protests have slowed the process. The administrative measures the State Engineer has adopted to allow reallocation to preceed have not been universally popular, but they have been conservative. And, to the extent that previous adjudications or settlements have been precursors to an eventual Middle Rio Grande adjudication, the de facto outcome of previous reallocation transactions approved by the State Engineer have been largely confirmed or expanded rather than reduced.

2. *Homogeneity of contracts*. Depending on what is counted, there may be somewhere between five and ten different types of water rights in the Middle Rio Grande including tribal rights, pre-1907 appropriative rights and San Juan-Chama Project rights. For a water exchange to work, bulk water contracts need to be completely homogeneous if possible and certainly have at most a few distinguishable forms. Otherwise, each transaction inevitably becomes an individually negotiated trade which negates much of the efficiency of the organized market. While rights themselves will likely remain disparate, contracts to deliver one acre-foot of water at a specific location at a specific time could be made much more homogeneous. The Jicarilla-Santa Fe contract specifies a delivery point and time, and bulk contracts for delivery of other water could be standardized as well.

3. *Priorities.* The priority of a given right under which a bulk water contract was sold would have to be made an explicit part of the contract, and buyers would assume the risk that drought or other conditions could prompt priority administration in the year of the contract. Contracts derived from the most senior rights would likely command premium values.

4. *Impairment.* Prevention of impairment requires the existence or construction of a hydrologic model of the pertinent basin that is officially and broadly recognized as the basis for whatever conditions the State Engineer imposes upon the changes in place or purposes of use of bulk water.

5. *Public welfare.* Maintenance and enhancement of the economy of a given basin is perforce conducive to the public welfare. In those basins for which there is a consensus or a preponderance of opinion that other values conflict with economic values, the formation of organized water exchanges could be excluded.

6. *Conservation of water.* Accurate pricing of the scarcity value of water may be the most important factor ensuring adequate conservation of it. And, organized water exchanges offer efficient institutional mechanisms for establishing and publicizing accurate prices.

7. *Logistics of administration and accountability.* Establishment of a coordinated process for maintaining a smooth relationship between the organized water exchange and the administrative process of the State Engineer is essential to the success of the exchange. Ideally, the State Engineer would specify necessary conditions to which bulk water contracts must conform and then delegate responsibility for compliance with those conditions to the exchange itself. Of course, the exchange would be required to report all trades to the State Engineer and be accountable at all times. Such a delegation of responsibility was contemplated by the draft operating rules established previously for the Lower Pecos water banks.

8. *Enforcement.* Consistent with the above condition, the State Engineer retains ultimate enforcement authority for impairment, public welfare and conservation of water criteria. The exchange assumes legal enforcement responsibility for contracts traded under its supervision.

9. *Public opinion.* Water is often seen by public opinion as different from other natural resources which are traded as commodities in the normal course of business. Obviously, the consent of the public, explicit or implicitly granted, is necessary to the successful formation of organized water exchanges.

10. *Regulation.* As is usually the case with most commodity markets, sufficient public regulation is required to ensure against abuse of the market process.

Current Activity

As noted above, the State of California is re-establishing an emergency drought water bank which will be run by its Department of Water Resources. In New Mexico, researchers at the University of New Mexico[12] have obtained federal funding to research and potentially implement an organized water exchange in the Mimbres Basin. Organized exchanges may be the next evolutionary step in New Mexico water markets.

Endnotes

[1] http://www.iid.com/Media/IID-and-SDCWA-Amended-Joint-Petition.pdf

[2] Morris Israel and Jay R. Lund, "Recent California Water Transfers: Implications for Water Management," *Natural Resources Journal*, Vol. 35, pp. 1-32, Winter, 1995.
[3] http://www.water.ca.gov/drought/docs/2009water_bank.pdf

[4] http://www.ncwcd.org/hot_topic/rentalwater.asp

[5] http://www.ose.state.nm.us/doing-business/rules-n-regs/ISC-regs/wb-regs-mcf-12-12-2002.pdf

[6] 462 U.S. 554 (1983).

[7] Ereney Hadjigeorgalis, "Managing Drought through Water Markets: Farmer Preferences in the Rio Grande Basin, *Journal of the American Water Resources Association*, Vol. 44, No. 3, pp-594-805, June, 2008.

[8] Shomaker, J.W., "How we got here—a brief history of water development in the Pecos Basin," *Water Resources of the Lower Pecos Region, New Mexico*, New Mexico Bureau of Geology and Mineral Resources Decision-Makers Field Conference, 2003, pp. 61-64.

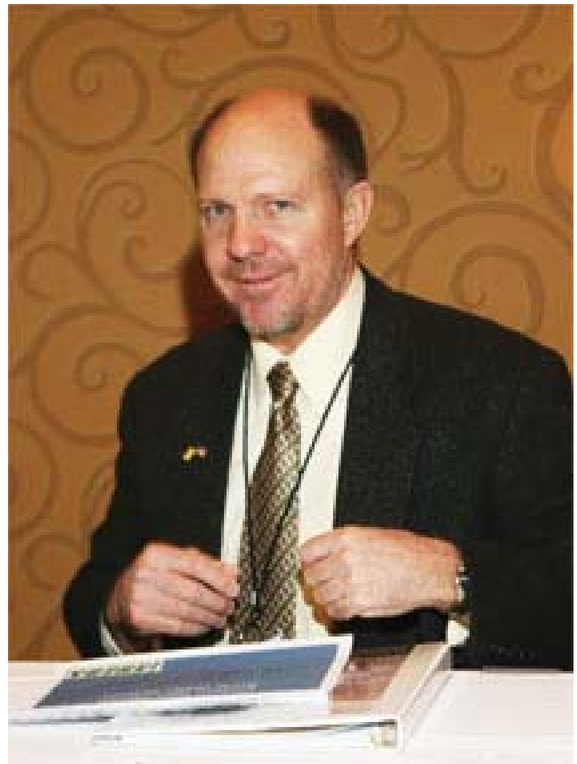
[9] Water Supply Agreement between the City of Santa Fe and the Jicarilla Apache Nation, September 2, 2004.

[10] For a fuller discussion of the reasons, see F. Lee Brown, "Market Prices as Measures of Scarcity in New Mexico and the West," *Beyond the Year of Water: Living within Our Water Limitations*, Water Resources Research Institute, New Mexico State University, November, 2007.

[11] The Office of the State Engineer had actually begun drafting regulations which would effectively allow such temporary changes in use in the Lower Pecos pursuant to the enactment of the water banking legislation in the Lower Pecos, but they were never promulgated.

[12] Professor David Brookshire, Department of Economics, University of New Mexico, is the principal investigator for this research project.

Scott Verhines is a New Mexico native and resident of Albuquerque. He is a consulting civil engineer with over 30 years experience focusing on water resource, transportation, and public works projects. He has managed and participated in the preparation of over 200 hydrologic/hydraulic studies ranging in size from individual residential lots to over 500 sq. miles of watershed. Scott has overseen the analysis and design of drainage/flood control infrastructure projects from $5,000 to over $15 million in construction cost, transportation projects to over $30 million, and water supply projects to over $400 million. His experience lends particular strength in the areas of program management, public involvement, collaborative decision-making, and coordinating multi-task and multi-discipline projects involving a variety of local, state and federal agencies. He currently serves as program manager to the Eastern New Mexico Rural Water Authority. Scott received a B.S. in civil engineering from Texas Tech University, an M.S. in civil engineering with an emphasis on water resources engineering from the University of New Mexico, and an MBA from the University of New Mexico.



Greg B. Gates is a senior water resources engineer. He graduated from the University of Texas, Austin, with a master's degree in environmental engineering in 1994. He served in the Peace Corps in Lesotho, Southern Africa, before joining CH2M HILL in 1996. Over the past 12 years, Greg has been involved in a number of major water projects in New Mexico including the Ute Pipeline Project, the Albuquerque Water Resources Management Strategy, the Buckman Direct Diversion Project, and the Aamodt Settlement. Greg specializes in groundwater modeling and hydrology and serves as a project manager and technologist for a wide variety of water resources related projects.

Just Add Water: Eastern New Mexico Rural Water System Status Report

Scott Verhines
Program Manager, ENMRWA
10010 Indian School Rd NE
Albuquerque, NM 87112

Greg Gates, Greg Gates
CH2M HILL
4041 Jefferson Plaza NE, Ste 200
Albuquerque, NM 87109

Good morning everybody and thanks for coming back. We thought we could scare you away with that fire alarm but I guess not. On behalf of the eight city and county council members of the Eastern New Mexico Rural Water Authority, we appreciate the opportunity to speak to you this morning and really thank the institute for putting us on the schedule. Greg and I are going to tag team a little bit as we talk about the project. The project is more affectionately known as the Ute Pipeline Project but the official name is the Eastern New Mexico Rural Water System and it really does fit the conference theme. This is one of those surface water opportunities that has been trying to happen for many many years and I will talk to you about some of the history of the project.

Figure 1 shows the project area. You can see the Texas-New Mexico state line, Interstate 40, Ute reservoir, and Ute dam and Tucumcari. The dark to light area is the cap rock of about 800 or 900 ft of dirt to lift. It is the most imposing part of our project from a physical feature point of view. Note Clovis, Cannon Air Force Base, Roosevelt County, and Quay County, just so everybody understands what we are taking about and where we are.

Let me give you a quick review of why we are doing this project, the background of the project, the alternatives that were looked at, and how we came up with what we call the best technical alternative to deliver water to these eight cities and counties. I'll then discuss some of the challenges of doing a regional rural water project that has never been done in New Mexico quite like this before. I'll mention some of the successes that we had. Secretary D'Antonio talked yesterday about where we are in the federal process and I will try to elaborate on where we are.

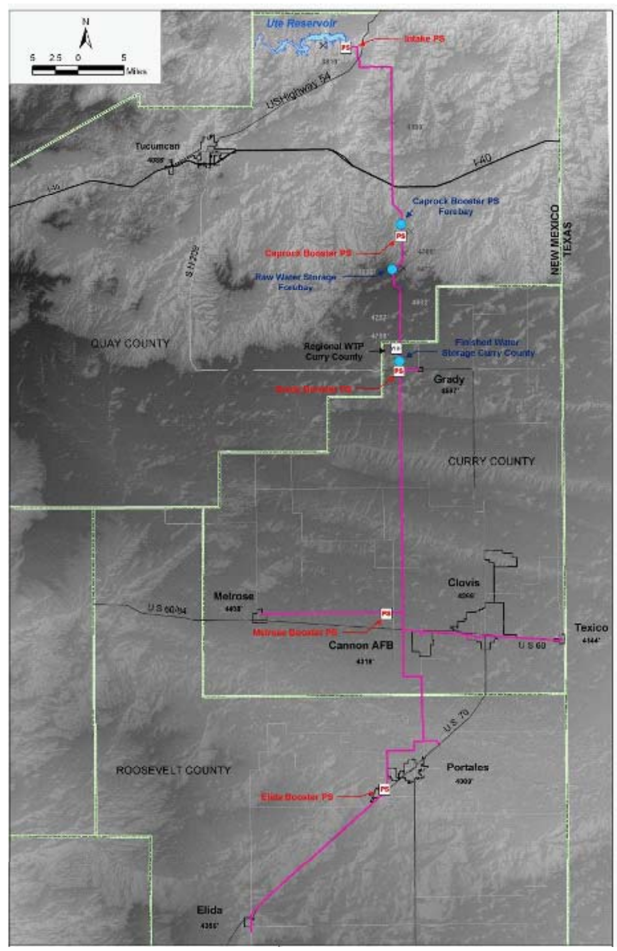


Figure 1. Project site

So why are we doing this? The western edge of the Ogallala Aquifer encroaches into eastern New Mexico and you can think of it as a saucer and New Mexico sits out on the very thin edge of the saucer. They have known for many years going back to the 1930s and 1940s that water would be problematic over time. Ute Reservoir was built to capture a share of water on the Canadian River under the three state Canadian River Compact from Texas, Oklahoma, and New Mexico. The Ogallala Aquifer is very problematic and Greg is going to get into the technical details of why. The aquifer continues to decline in this part of the state. We are seeing declines in water quality as well. One of the reasons for converting to surface water is to offset that decline in quality. Even today they are starting to see the economic implications of running out of groundwater in the aquifer. This project will offset that.

Right now, all of the water for agricultural and municipal interests is 100 percent groundwater out of the High Plains Ogallala Aquifer formation. One of the reasons we are doing this project is to disconnect that competition between municipal and agricultural interests so they are not both competing for the same resource.

Also, state engineer D'Antonio talked yesterday about putting to use this investment that was made back in 1959 and 1960. I think in those days Ute Reservoir was built for around $28 million and the value today is closer to $140 or $150 million. We are talking about delivering 16,450 acre-ft to these entities. Figure 2 is a little sketch for when we talk to a layman audience in our communities. For the folks without a strong technical background, we sketched this some years ago and I still find it useful to explain to folks why the project is being done. If you look at the graph with cost on the y-axis and time on the x-axis, as the aquifer continues to decline over time, the cost of providing water out of that resource somewhat mirrors that curve. The Eastern New Mexico Rural Water System would start at a higher initial cost to the water rates and end users. Over time you are better off being a part of this project then not. There are some who are saying that we are already approaching the point where if something doesn't happen in the near term, it will be economically disastrous for the area. Greg has a few graphs that he will talk about shortly on that as well.

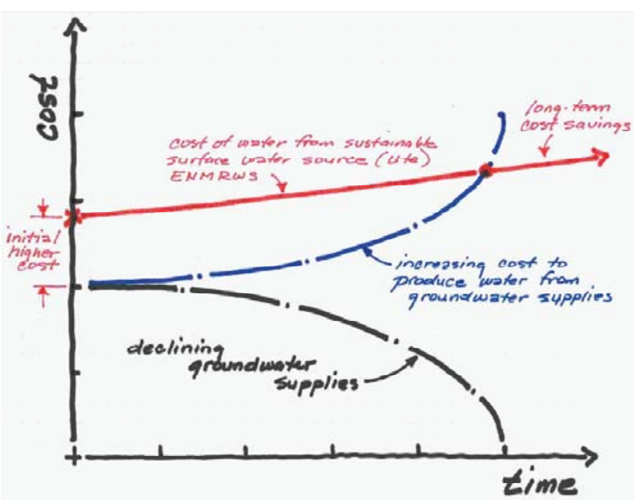


Figure 2. Eastern New Mexico Rural Water System Project

A little bit about the project history: the Canadian River Compact goes back to 1951 and regulates the water and who gets what on the Canadian River in the three states. The project was conceived in a feasibility study in 1963. It is almost 50 years old now and these entities have been trying to make the project happen over there for a long time. I have been working on it pretty diligently now for 10 years. I had a full head of hair when we started all of this and I think Greg may have been 6'3 or 6'4 back in those days. It has required a lot of effort to try to make this thing happen. We recognized that the aquifer was going to have trouble back in the 1960s. The reservoir really was built for municipal and industrial water storage in New Mexico.

There are two entities at play right now. One is the Ute Reservoir Water Commission. It is made up of 12 members and includes four from Quay County and two from the Village of Logan, Quay, Curry, and Sandoval counties. It is a joint powers agreement, and exists for the purpose of contracting with the State of New Mexico to purchase raw water out of the reservoir. Four members from Quay County in 2005 elected not to participate in the development of the pipeline project but they continued to reserve their share of water out of the reservoir for other purposes. The eight members that I just described are the active members that make up the Eastern New Mexico Rural Water Authority that are actively developing the project. With that I will let Greg get into the next few slides.

Greg Gates

For those of you who don't know me, I think Scott's joke about my height decreasing over time might not have made too much sense until I stood up. As Scott pointed out, the Ute Reservoir was constructed to use New Mexico's water allocated in the Compact for municipal and industrial purposes. It was completed in 1959 and 1960 and the reservoir filled with water. The Canadian River Compact is a little bit different from some of the other compacts in that it is actually a storage compact. It allows for New Mexico to store 200,000 acre-ft of water below Conchas Dam. Once that storage level is reached, any additional water goes to Texas. The Compact is unique in that sense. New Mexico can consume all the water that it can put to use up to that point, but it cannot store anything beyond the amount specified in the Compact.

The reservoir is owned and operated by the New Mexico Interstate Stream Commission (ISC), which is also unusual when compared to other reservoirs in the state. In 1987 the ISC estimated Ute Reservoir would have a firm yield of about 24,000 acre-ft. That 24,000 acre-ft was assumed to be available about 90 percent of the time. Communities reserving water recognize that based on the hydrology, the supply will be available most of the time and will take steps to deal with the times when that total water supply will not be available. The firm yield was updated in 1994 as the basis for the contract with the Ute Water Commission. Currently, the Ute Reservoir Water Commission contract with the ISC fully allocates that 24,000 acre-ft.

The communities that are developing the Eastern New Mexico Rural System account for 16,450 acre-ft of the Ute Water Commission contract. The contract is set to expire in December 31, 2008 and the Commission has asked for extensions on a one- or two-year basis over time. As long as they are showing progress in developing the water resource, the ISC has historically been generous in granting those extensions. There has been a fair amount of progress made in the last couple years and we are hoping to get another extension granted. The remaining portion of that water is held by Quay County interests – that is 7,550 acre-ft of water.

As part of the decision making process and looking at alternatives, we put together a fairly simple spreadsheet model of the reservoir. We wanted to look at what the impact of various alternatives would be as opposed to a baseline condition. The baseline condition was calculated by examining release and storage data along with evaporation to estimate inflow. The blue line in Figure 3 shows the scenario that is the actual reservoir volume over time that we used to develop the baseline in the model. Up until about 1984, the dam had less capacity. The spillway height was increased in the 1980s to allow for more storage capacity. The baseline scenario is shown in dark blue and does not include any use of the water by the project. The green line shows withdrawal of 16,450 ac-ft of water per year on a peak month basis.

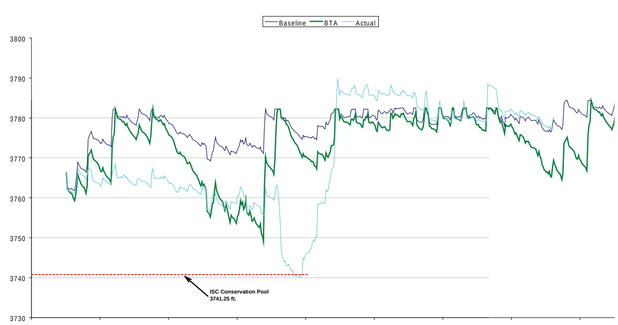


Figure 3. Ute Reservoir Model Simulation and Background Results

This is the alternative that we chose in the decision making process and is referred to as the “best technical alternative” (BTA). You can see that as you use that 16,450 acre-ft of water, you get some declines in the reservoir. At other times, the results of the BTA are similar to the baseline. What we found is that on average, the reservoir elevation was about 3 ft under the baseline condition and there was a maximum of 20 ft difference between BTA and baseline.

The other thing to remember is that when you are not taking that water out and using it, it builds up in the reservoir and is eventually released to Texas. We found that over a 60-year period, looking at the historic hydrology, if you didn’t use that water, an additional million acre-ft of water would go downstream to Texas when compared to the BTA project scenario.

The BTA was derived from a decision process that evaluated four surface water and two groundwater alternatives. Non-monetary benefit scores of the alternatives considered in the decision process are shown in Figure 4. You may note that the alternatives considered are not entirely equal. The “no project” alternative is essentially a continuation of current practices and would not be sustainable. The current estimated life of the aquifer is on the order of 20-50 years.

New Mexico American Water, who provides water for the City of Clovis, had about 28 wells in 2000 with a capacity of about 10,500 gallons per minute (gpm). By 2004, they had increased the number of wells to 33 but had lost capacity to achieve a total capacity of about 6,500 gpm. In 2008, NMAW had nearly doubled the number of wells used in 2000 but has less capacity. Figure 5 presents NMAW capacity and number of wells over time.

The BTA had the greatest non-monetary benefit to overall cost ratio. The BTA includes a pipeline from Ute Reservoir to a water treatment plant in Curry County with pump stations to boost flow over the caprock. There are raw and finished water storage tanks and the diversion structure and raw water overall system are designed to operate on a peak day basis. The 2006 cost of this project was about $436M with a 75 percent federal, 15 percent state, and 10 percent local cost share resulting in a wholesale water rate of about $2.42 per 1,000 gallons of water to users. The Preliminary Engineering Report and 10 percent design are complete. The 30 percent design is in progress.

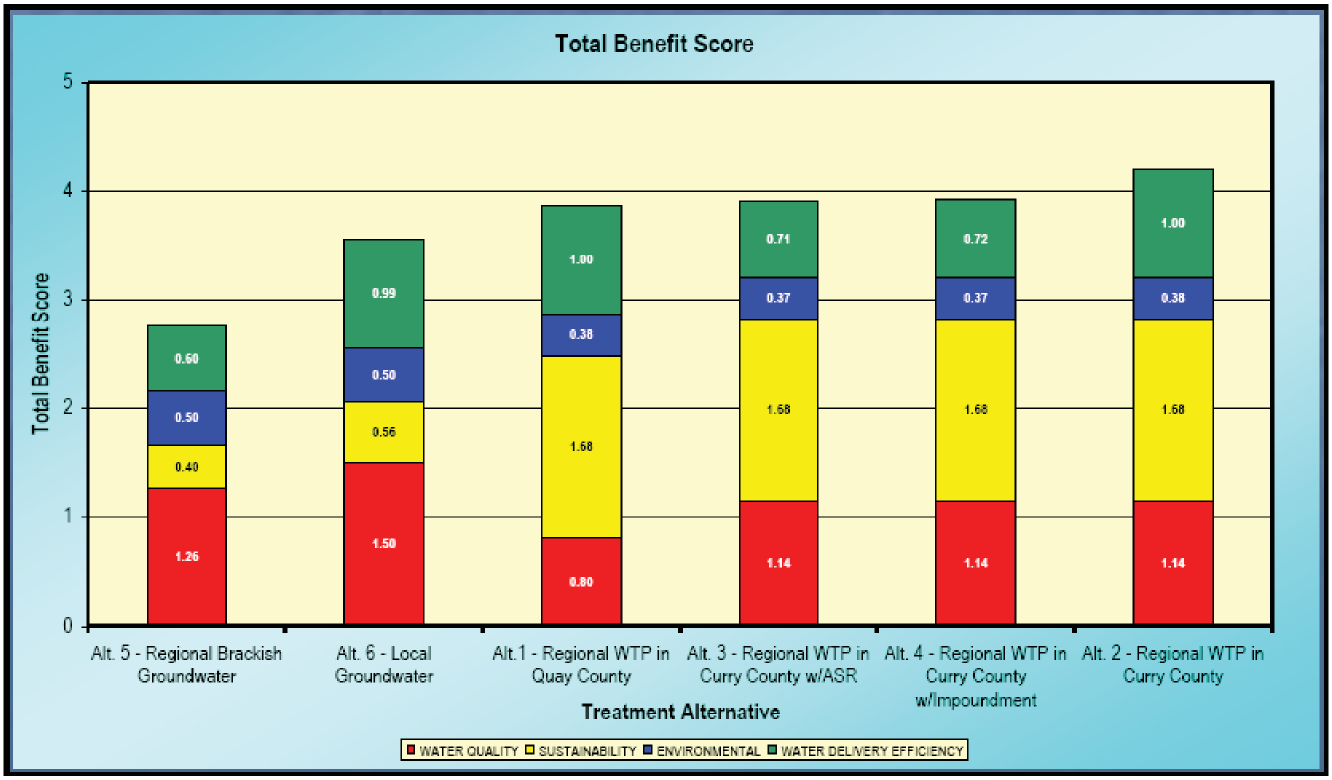


Figure 4. Benefit Scores of Alternatives

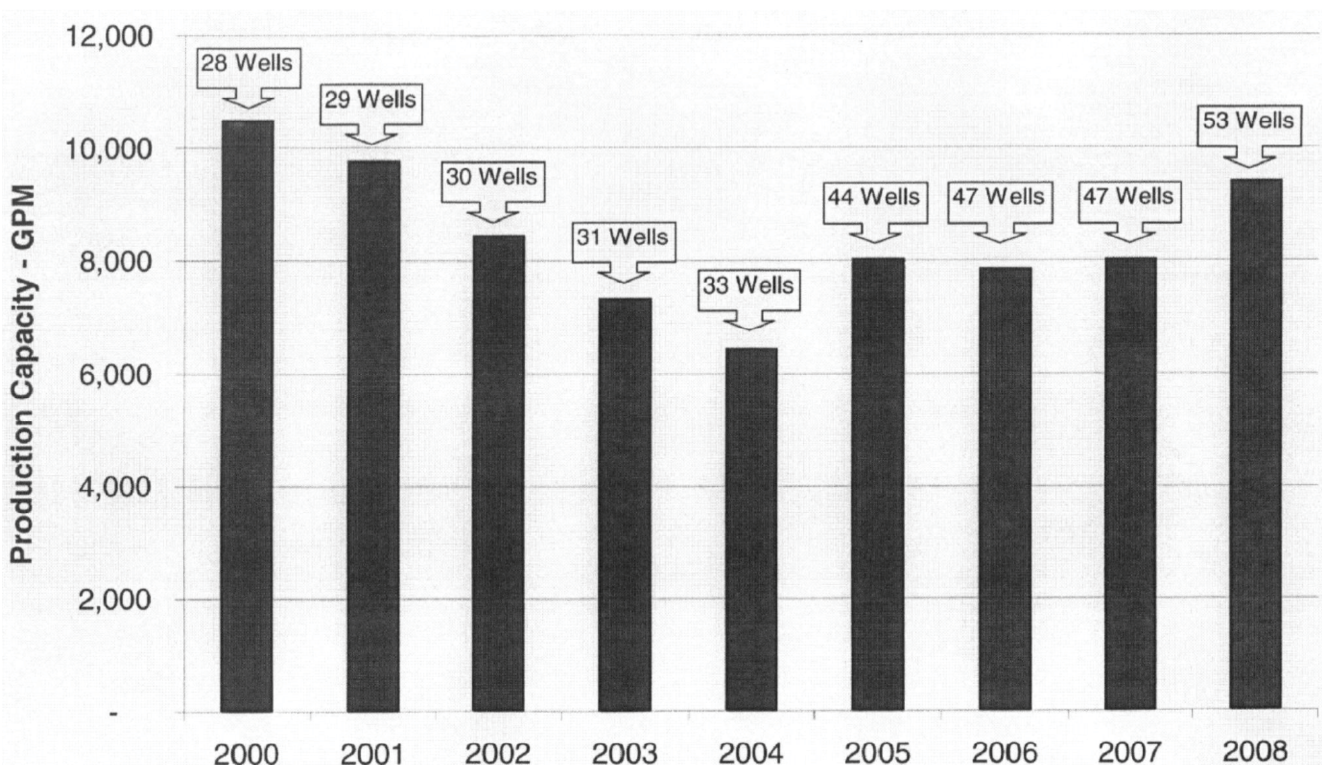


Figure 5. NMAW Wells Capacity and Number Over Time

Scott Verhines

Thanks, Greg. So again, I mentioned that Rural Regional Water Supply projects are a little bit different than what the Albuquerque Bernalillo County Water Utility Authority did, and although there are some similarities, there are significant differences. Some of those challenges are that we have eight cities and counties; we have mayor's councils and commissions that turn over every few years. We have backed up and started the education process with everybody many times now over that 10-year period. This is the most complex, largest public works project those entities will probably ever undertake. They are used to having projects that are planned, designed, and built all in a year; we are 10 years into this project and are just getting out of the planning stages and into the design stages. Perseverance and keeping everybody at the top of their game is part of the task I have right now. Some days are better than others, but I think for the most part, everybody is very strongly on board and recognizes the consequences of not putting this project together.

I won't go into all the details of the challenges. The obvious one is we are working on federal authorization right now for that 75 percent federal commitment. Whether or not it will happen before this Congress recesses at the end of the year has yet to be seen. We do understand that there will be a lame duck session right after the election, the week of November 17. We also understand that the omnibus Public Lands Bill, Senator Bingaman's bill that John D'Antonio talked about yesterday, contains our project and it will be a high priority for that lame duck session.

I want to point out that Cannon Air Force Base is a major economic benefactor to the area as you can imagine; it is a very strong part of the community. They have a new special operations mission coming in and the base is growing. We have a very fine line that we have to walk with Cannon Air Force Base. On one hand we need to be able to recognize the problem and decide what we are going to do to fix it. At the same time, we don't want the problem of being able to provide water to the military installation to impact their ability to keep their mission growing. We are very conscious of that, as is all of the New Mexico delegation.

We put together a strategic plan a couple of years ago, and there are eight main elements that we have underway right now in order to keep the project moving ahead:

- Infrastructure Project Development
- Momentum Building
- Financing and Funding
- Federal Authorization
- Project "Campaign" (Full Court Press)
- Coordination Cooperation
- Organizational Capacity/Structure
- Public Awareness and Support

Greg described the infrastructure project development, the technical pieces of the project. Greg also mentioned that we have 30 percent design underway and expect that to be delivered in May of 2009. We have an environmental assessment that is well underway, which should be delivered about the same time. We will follow that up with a value engineering analysis to re-evaluate the cost of the project, and then we will develop a phasing and implementation plan.

Federal authorization is our number one goal right now. In the House of Representatives this year, we went through the Resources Subcommittee Hearing and the Resources Full Committee Markup Hearing. We then went to the floor of the House and the bill was passed by a two to one margin. We had an identical bill working its way through the Senate. Last year, we had a field hearing with Senator Domenici and Senator Bingaman in Clovis. This year we had a hearing before the Energy and Natural Resources Committee in Washington D.C., which we followed a couple weeks later with a Markup Hearing, both of which passed the bill unanimously out of committee.

The bill is now included in Senator Bingaman's omnibus Public Lands Bill. That is the one that we are waiting for and we are cautiously optimistic that it could happen before the end of the year.

We have also had a number of successes over the last few years, not the least of which is support by the State of New Mexico, which has invested $12.5 million in the project so far. We have had about $3 million in federal write-in support through the Bureau of Reclamation. The state agencies have been terrific to work with including the Office of the State Engineer, the Interstate Stream Commission (ISC), New Mexico Water Trust Board, and the New Mexico Finance Authority that operates the Board. Greg mentioned that we are looking to extend our water purchase beyond December 31, 2008 and as long as we show progress that we are getting this project done, the ISC has been very willing to work with us. I would like to thank our congressional delegation, the staff at the state agencies, some of whom are in the room today. Without them we wouldn't be here today.

Tanya Trujillo is currently the General Counsel for the New Mexico Interstate Stream Commission and has served in that position since 2004. Before that, Tanya was a partner at the Santa Fe law firm of Holland and Hart, where she practiced natural resources litigation and water law. She attended college at Stanford University and law school at University of Iowa. Tanya has been in practice since 1993.

John W. Leeper has been Branch Manager of the Navajo Nation Department of Water Resources since 1997. He supervises a staff of more than 20 water resources professionals, manages an annual budget of more than $2 million derived from more than six funding agencies, and provides technical support for the Navajo Nation's water rights litigation and negotiation, including representing the Navajo Nation on the Navajo Gallup Water Supply Project Steering Committee. John has also assisted the Navajo Nation with a broad array of San Juan River Basin issues including assisting the Nation with formulating positions with respect to the Navajo Indian Irrigation Project, the Animas-La Plat Project, the San Juan River Recovery Implementation Program, the negotiations between the Navajo Nation and the State of New Mexico, and regional water planning. John received a B.S. in civil engineering from the University of California, Davis, an M.S. in civil engineering from California State University, Los Angeles, and a Ph.D. in civil engineering from Colorado State University.

Update Regarding the Navajo Settlement and the Navajo-Gallup Pipeline

Tanya Trujillo
Interstate Stream Commission
PO Box 25102
Santa Fe, NM 87504-5102

John Leeper
Water Management Branch
Navajo Nation Department of Water Resources
P.O. Box 678
Fort Defiance, Arizona 86504

Hello my name is Tanya Trujillo, and I am general counsel for the Interstate Stream Commission. I am pleased to be here today and present with John Leeper from the Navajo Nation regarding the status of the Navajo settlement and the Navajo-Gallup pipeline project. The State of New Mexico and the Navajo Nation signed the settlement in April of 2005, and that settlement was negotiated for approximately 10 years before then so it was a very complicated settlement that involved a lot of back and forth negotiations but it achieved a very positive settlement for both the State of New Mexico and non-Indian water users in northwest New Mexico and for the Navajo Nation. The settlement quantifies the Navajo Nation's water rights from the San Juan Basin and will provide approximately 360,000 acre-ft of depletion, which in New Mexico is a large amount of water. The settlement water will be quantified through a decree in the San Juan adjudication court and that will serve the goal of advancing that adjudication and I know that there is a lot of pressure in New Mexico for us to make progress in these adjudications and these Indian water rights settlements are a great way to do that. The settlement will quantify water rights for the Navajo Nation for irrigation, municipal, and industrial purposes. Some of the key elements of the settlement are construction of one water supply project that involves many different components and John Leeper is going to provide more details on those components. I will provide to you some of the highlights of the settlement agreement and provide a little bit of background about some of the interstate issues that we dealt with in negotiating settlement elements, and highlights relating to federal legislation authorizing the settlement.

The main benefit or purpose of the settlement project is to provide safe, reliable drinking water for people who currently do not have water. It is sometimes difficult for us to appreciate that there is a significant sector of our population in New Mexico who currently do not have running water in their homes. The benefit is to provide drinking water for people who do not have water in their homes. It is very moving to travel to northwest New Mexico and visit some of the homes of the Navajo Nation residents where the main wish or desire of that household is to have running water in their home and to someday have things like washing machines and be able to take showers in their homes, which is something that most of us take for granted.

It was interesting a couple years ago when we were at a Colorado River water users meeting in Las Vegas at Cesar's Palace. Estefan Lopez, our director, was presenting a video on the situation of the Navajo Nation. It was a striking contrast presenting pictures of people traveling 30 or 40 miles to haul water from a hauling station to their home and making that presentation in the context of the lavish accommodations at Cesar's Palace. It was a very moving presentation and several hundred people were just silenced at the stark reality that exists within our country today.

The purpose of the project will be to provide a reliable surface water supply to Navajo Nation residents and to tie into the existing regional water system that the City of Gallup has. The City of Gallup is relying on a diminishing supply of groundwater and this project will supplement and replace their supply. So this is not an Indian-only system; it will tie to the non-Indian systems and John Leeper will provide more details on that but the cooperation has been very successful. Other provisions of the settlement are very good administrative provisions that will preserve existing non-Indian uses in the basin and will allow the state engineer to serve as a water master and to administer the water rights and implement metering programs that are beneficial throughout the state. The settlement ensures that those provisions will be in place in the Northwest area of the state. The settlement also provides for protection of San Juan Chama contract water, which as you know extends through the Rio Grande basin and includes provisions for funding for non-Indian irrigation improvements in the San Juan Basin.

I want to provide a little bit of background and highlights relating too the federal legislation implementing the settlement. The legislation was introduced in late 2006 and again in 2007 and is titled the Northwest New Mexico Rural Water Project Act. Hearings were held in 2007 in the House and Senate and were co-introduced by Senators Bingaman and Domenici and Representative Udall on the House side. The legislation ties into other existing laws, for example the Navajo Reservoir was authorized in the Colorado River Storage Project Act back in 1956. In addition, the San Juan Chama Project Act and the Navajo Irrigation Project Act were authorized in 1962. So our current legislation for the Navajo settlement amends both those acts and involves tying into those existing pieces of legislation. This summer the Navajo legislation was combined into the omnibus Public Lands Act. Scott Verhines talked a little bit about that act because there are several other pieces of New Mexico-related legislation that are included in that act. It is actually now part of a House bill, and as Scott mentioned, it is pending for the lame duck session expected to occur this November. We all have our fingers crossed for that.

The legislation will authorize the settlement and authorize construction of the projects. One of the key elements is funding. And I know in this budget climate, funding is always one of the most difficult obstacles. The Navajo settlement legislation contains a creative funding mechanism that creates the Reclamation Water Settlements Fund, which can be used to implement settlement agreements approved by Congress for water supply projects, habitat restoration projects, or projects requiring reclamations involvement. The fund taps into or diverts from what is an annual average surplus of approximately $900 million in the existing reclamations fund. The current total surplus is estimated to be about $7.6 billion. I am not an expert on federal budget issues so I am not exactly sure where that stands in today's climate, but it's something that has been evaluated by western states and by federal representatives and it is anticipated to be a successful funding mechanism should this legislation pass.

The federal cost for the Navajo settlement is over $800 million so we will definitely need some creative funding mechanisms to get it done. The State contribution is about $50 million and New Mexico has already contributed about $30 million towards funding projects through the Water Trust Board in the Gallup area or direct funding for the eastern portion of the project pipeline called the Cutter Lateral. I believe John will provide more details on those, but the State of New Mexico stepped up even without finalizing the federal legislation and has tried to make progress towards this important project.

In addition, there will be local cost-share contributions from the City of Gallup and the Jicarilla tribe, which is also a participant in the project. Those contributions will be at least $30 million and the City of Gallup should be commended because they have undertaken a rate analysis and are planning for how to pay for their portion of the cost. Again, we have our fingers crossed that the legislation will go forward both on the Senate and House side and hopefully will be signed by the President but those are all still pretty big hurdles to get through in the next few months.

I did want to highlight a couple of the controversial interstate issues that came up in connection with the Navajo Gallup project and the Navajo settlement. The State of New Mexico worked very hard with the Navajo Nation to try to ensure that the settlement water quantities would fit within the context of our Upper Colorado Contract Apportionment. It was very highly scrutinized by engineers from throughout the Colorado River basin and took approximately two to three years just to double check the accounting and the hydrology.

One of the biggest projects they worked on was a report called the Hydrologic Determination, which was prepared by the Secretary of the Interior and required by the 1962 legislation creating the San Juan- Chama Project and Navajo Irrigation Project. That hydrologic determination was an evaluation of whether water was reasonably likely to be available for the settlement and the Secretary of the Interior required a review and participation in the analysis by all of the seven Colorado River basin states. That analysis was ongoing in the context of very complex negotiations amongst the Colorado basin states leading to a short-sharing agreement. It involved a lot of scrutiny from what I call engineer's engineers because the details of that analysis are very complex. But eventually in May of 2007, the Secretary of the Interior completed that process with concurrence by all seven basin states. We are very comfortable with the water supply outlook for the Navajo Gallup project.

Another interesting problem that we dealt with was that the Navajo Nation and New Mexico involves land that is in both the upper basin of the Colorado River basin and the lower basin. Specific provisions in the Colorado River Compact, which was entered in 1922, cause restrictions on the transfer of water from an upper basin use to a lower basin use. In the context of the Navajo settlement, the Navajo reservation extends across three states – Arizona, Utah, and New Mexico – and also involves property in the upper basin and in the lower basin. We are looking at mechanisms to try to get water to people, notwithstanding the fact that there are interstate issues and inter-basin issues. We worked with our other upper basin states and got their concurrence for our ability to use some of our upper basin apportionment in the lower basin within the Navajo reservation. In 2005, the Upper Colorado River Compact Commission authorized a formal resolution, and we also have a specific provision in our federal legislation authorizing that use as well. That sets a precedent for other Colorado River projects such as the ongoing negotiation of the Navajo Nation's settlement with the State of Arizona for its water rights, which has similar issues dealing with upper basin uses and lower basin uses. Also, the State of Utah is proposing a large water supply contract that involves transportation of upper basin water to lower basin locations. So all of those are still ongoing and our settlement legislation will present a precedent for how the states expect to negotiate relating to their future projects.

And finally at the last minute, when we were hoping to finalize our legislative language and move the legislation, there were specific requests from the State of Arizona relating to a portion of the project that extends from New Mexico into Arizona to supply water to the Navajo Nation's capital of Windowrock. From an engineering perspective, it makes a lot of sense because Windowrock is right on the New Mexico border. If we are constructing a pipeline to extend to Gallup, which is very close to Windowrock, it also makes sense to supply the Navajo Nation's capital. The complex issues of use of upper basin water in the lower basin were even more compounded because what we were dealing with is a request from Arizona to use their lower basin apportionment, diverted from an upper basin reservoir in a neighboring state, and we spent several months trying to negotiate with all the other Colorado basin states on language that would make everyone comfortable with that situation. The Navajo Nation and the State of Arizona are still working on the details of their settlement so we don't know exactly how that will play out but it was an interesting process involving Colorado interests, Arizona interests, and California interests to try to make amendments to our New Mexico settlement bill for issues that will be related to the Arizona settlement. I guess that is how the process works in the Colorado River basin these days.

In conclusion, I think we are very hopeful that the settlement legislation will go forward and that we can finally start some of the construction that would be needed to implement this project. I am pleased to hand over the microphone to John Leeper, who has been great to work with from the State's perspective and will provide more of the engineering details and background.

John Leeper

The Navajo Gallup Water Supply Project (Project) is more than just a pipeline. Instead the Project is a collection of components that will provide a comprehensive water supply to the region. For the Environmental Impact Statement, Reclamation assessed 11 different project alternatives, along with non-structural alternatives. The proposed Project configuration and components have been demonstrated to be the most cost effective way of serving this region.

The Project will divert 37,764 acre-feet of water from the San Juan River for a project population of approximately 250,000. It will have 1,200 acre-feet per of capacity for the Jicarilla Apache Nation, 7,500 acre-feet of capacity for the City of Gallup, 6,411 acre-feet of capacity for Window Rock, and 22,653 acre-feet of capacity for the Navajo communities in New Mexico. It will include more than 260 miles of pipelines and 24 pumping stations. The Project alignment is shown in Figure 1.

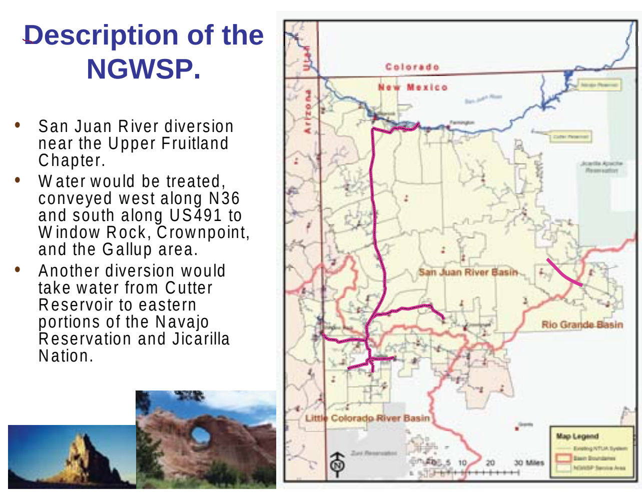
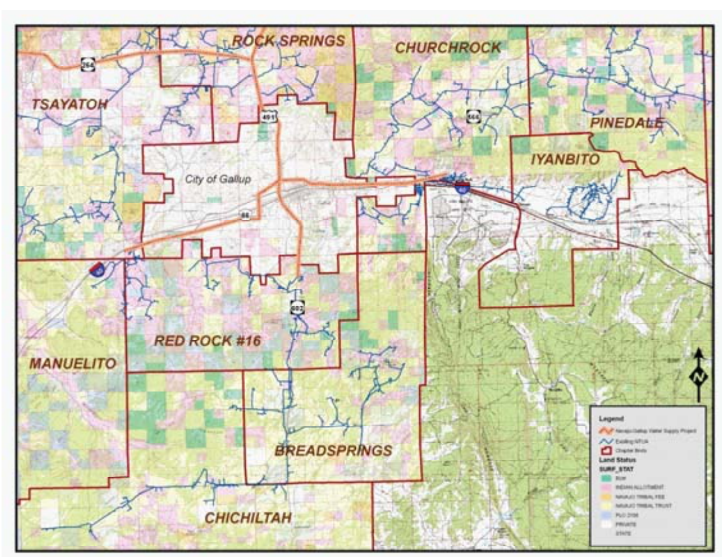


Figure 1. Navajo Gallup Water Supply Project Map

The Navajo San Juan River Settlement legislation includes, and the Project's water budget is based on, a conjunctive groundwater component. The conjunctive ground water component is critical. Many communities, for instance Crownpoint, will use more groundwater even with the Project than it is using today. The conjunctive groundwater component reduces the overall demand for water on the San Juan River, assures that water will get to real people sooner, and improves the Project's redundancy.

The Project includes a water treatment plant at Nenahnazad which is near Kirtland. This water treatment plant will have a capacity of 38 million gallons per day (59.19 cubic feet per second). If that water treatment plant were built today, it would be one of the largest ones in New Mexico. This treatment plant will have the authority to treat non-Project water. It has the potential to become a regional water treatment plant in the Kirtland area. The point of diversion is at an existing weir used by the San Juan Generating Station. This point of diversion has numerous advantages. First, because this stretch of the San Juan River is critical habitat for the Colorado Pikeminnow, constructing another large diversion and weir would be extremely difficult due to the environmental impacts. This point of diversion takes advantage of the existing weir. Second, this point of diversion is downstream from the Animas River and the La Plata River confluences with the San Juan River. This location enables the Project to divert almost half of its water supply from flows that are generated downstream from Navajo Reservoir. This downstream water supply takes some of the demand off of the Navajo Reservoir water supply. Third, this point of diversion is upstream from the Chaco Wash which contributes a very heavy sediment load to the San Juan River making the San Juan River water below the Chaco Wash very difficult to treat. And finally, with the point of diversion downstream from Navajo Reservoir, Project demands that are met from Navajo Reservoir storage will help to augment San Juan River flows downstream.

Another critical Project component is the Gallup Regional System. The City of Gallup is an important partner in the Project. The Project will have capacity for 7,500 acre-feet of water. The Project will also convey more than 4,800 acre-feet of water through the City, to the Navajo chapters that surround the City. The construction of this infrastructure is already underway. The Gallup Regional System will be supplied by the local groundwater until the surface water from the San Juan River is available. One of the goals of the regional system is to have the ability to get the San Juan River water to the Navajo residents that surround the City the day it becomes available. The Gallup Regional System is shown in Figure 2.



2002-2006 New Mexico State Funding
$7,600,000

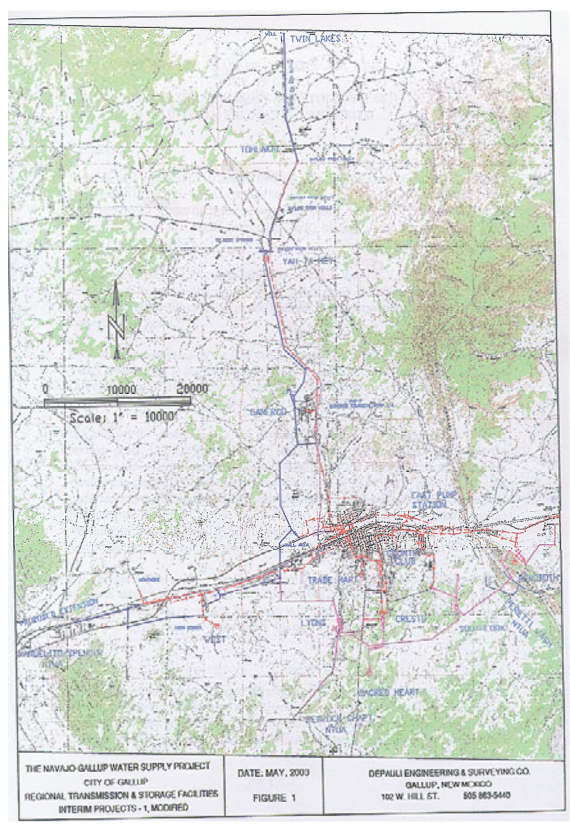


Figure 2. Navajo Chapters on the Gallup Regional System

The San Juan Lateral is another major component. The general alignment is along Highway 491 (formerly Highway 666). This pipeline will range from 48 to 12 inches in diameter. This lateral will convey water from the water treatment plant at Nenahanzad south to the Gallup Regional System, to the Window Rock Lateral, and the Crownpoint Lateral. It will also provide water to the Navajo Tribal Utility Authority (NTUA) public water systems along the route. The primary intention of the main Project laterals is to convey water to the NTUA systems which will then convey water to the individual customers. With this strategy, the day the San Juan Lateral reaches, for instance the Mexican Springs Chapter, the local NTUA system will be able to deliver water to the residents.

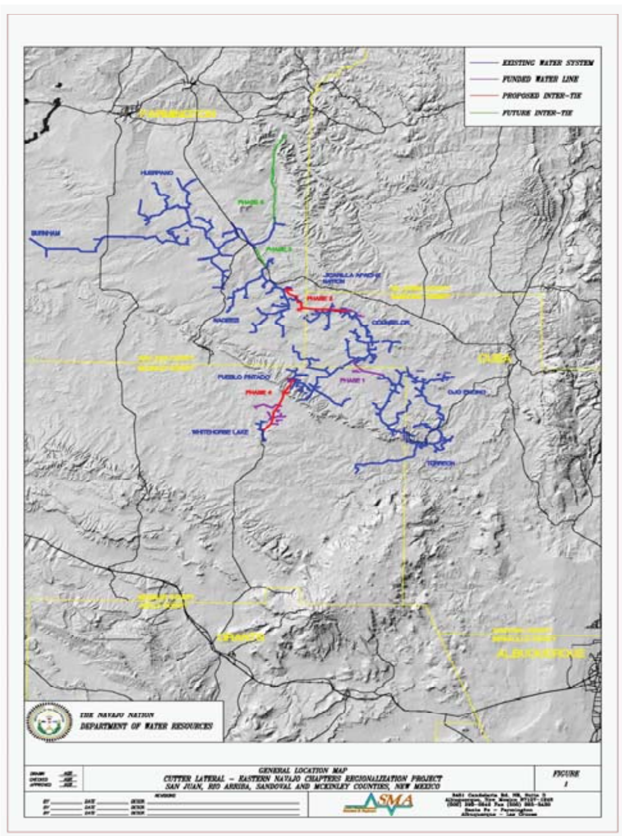


Figure 3. Cutter Lateral NTUA Phases: Six Chapters = $20,000; New Mexico = $19.3 M; Navajo Nation & USDA = $8.6 M; Water Volume: 5.4 mgd

The preferred alternative includes the Cutter Lateral, which will convey 4,645 acre-feet per year from the existing Cutter Reservoir to some of the Eastern Agency chapters, and includes 1,200 acre-feet of capacity to serve the southern portion of the Jicarilla Apache Reservation. The pipeline will range from 24 to 10 inches in diameter. The NTUA systems in parts of the Eastern Agency are very water short. A conjunctive groundwater component will improve the water supply in the short term, and will take some of the pressure off the San Juan River. The Cutter Lateral System is shown in Figure 3, and the groundbreaking is shown in Figure 4.

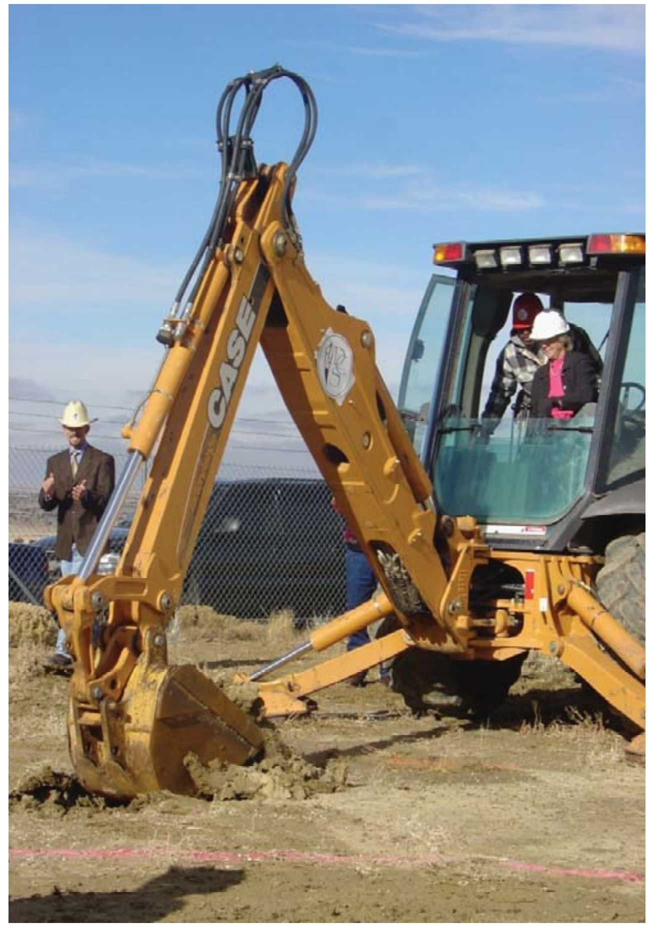


Figure 4. Cutter Lateral Phase 2 Ground Breaking; Project Cost: Project Construction (in 2007 dollars) $870,000,000; 2002-2008 New Mexico State Funding $30,000,000 (for Gallup Regional System, Twin Lakes Well and the Cutter Lateral)

Reclamation estimates that the Project will cost $864 million. Is this cost realistic? First of all, the Project passes the principles and guidelines that Reclamation has established. It has a direct benefit to cost ratio greater than 1.16, and including other benefits is greater than 1.46.

However, the benefit to cost ratio is not the most important number to consider. Whether this Project is worth $800 million to the federal government depends on what happens if there isn't a settlement with the Navajo Nation on the San Juan River in New Mexico. The Navajo Nation's claims to the San Juan River could be very disruptive. It is difficult to put that claim into perspective without sounding threatening. However, 80 percent of New Mexico's power is generated in the Four Corners area using water from the San Juan River. A Navajo claim of hundreds of cubic feet per second could leave the power generation, irrigation and municipal demands vulnerable for many days during the summer. That power goes to communities all over the Southwest. The settlement provides explicit shortage protection for the San Juan-Chama Project. Without the settlement, the durations during which the San Juan-Chama Project could divert water could be reduced. The settlement essentially eliminates that risk. All kinds of doomsday scenarios can be conjured up if there was no settlement. However, instead of dwelling on all of those gloomy scenarios, the Navajo Nation is discussing partnerships with the City of Gallup, the City of Farmington and many others to make this Project, and this settlement, a reality.

There is another cost to consider when evaluating the benefits and the costs of this Project, and this settlement. The greatest cost occurs when these communities end up litigating and fighting over this issue. It tears communities apart. In my career as a smarmy consultant, probably the most shameful thing I ever did was drive around the Silver Creek watershed in Arizona as part of the Little Colorado River general stream adjudication with a van load of federal experts looking for things to object to. It can be distasteful work. The purpose of the exercise is to look for discrepancies in the way the state has described the various water uses. The experts meet with the local water users, often rural folks, and scrutinize the information that describes their water rights. The team scrutinizes the tabular data, spatial data, significant dates, and other records. And much of the time the experts will find things to object to. In a contested case, a tremendous amount of time and energy is spent on preparing objections. And then the other side spends their time and energy figuring out what to do about those objections. In the San Juan Basin, with many thousands of potential stakeholders involved, a contested process could last forever. This process tears communities apart. So, when one considers the cost of this settlement and this Project, yes the Project has a benefit/cost ratio greater than one. Yes, this settlement and this Project will eliminate a lot of disruption on the San Juan River. But, most importantly is eliminates the battle that would tear communities apart.

Instead of battling, the biggest community in the basin, the City of Farmington, is a partner in the settlement. The City is assisting the Navajo Nation convey water to Shiprock. It appears that the City of Farmington has realized that one of the best things for the City is a prosperous thriving Shiprock.

The State of New Mexico is not just saying "yeah, go do it." Instead, the State of New Mexico has adopted a philosophy that if working together, the Navajo Nation and the State can solve some of the small problems, which will lead to the solutions for very big problems. The State of New Mexico has stepped forward with resources to begin these ambitious Project components. For instance, Manuelito, a Navajo community on the west side of Gallup, has a very difficult water supply problem. The State of New Mexico and the Governor were instrumental in developing a well at Twin Lakes north of Gallup. The connections between this well, the City and Manuelito are being constructed today. This work is one more small step in regionalizing the system. So, real people are getting real water, in real time. The residents in Manuelito are not being told to wait until 2026 to get water. The day that the San Juan River water gets to Twin Lakes, the connections will be in place to convey water to Manuelito.

There are Navajo enclaves of allotted land that are interspersed in and around the City of Gallup that do not have access water. In one case Navajo homes were right next to the City of Gallup golf course. A good golfer could hit a golf ball from the course to some of these Navajo homes where the resident, until recently, were still hauling water. These Navajo residents can see $200,000 or $300,000 homes nearby. The City of Gallup has worked with the Indian Health Service and NTUA to serve these folks. Today they have drinking water. Just like with the City of Farmington cooperating with Shiprock, the City of Gallup has been cooperating with these area residents. The system is being regionalized. Once the waterline to Manuelito is completed, connections with Church Rock on the eastside of Gallup will begin. And, eventually connections will be constructed on the southern side of City of Gallup. This strategy increases the number of customers that the Project can serve; so that when the lateral from the San Juan River is complete, there will be a large enough customer base to make the Project a success.

The Cutter Lateral is the same kind of story. At an appraisal level the Project appears to be just a purple line on a map. It could take many years to make that line on a map a reality. However, the Indian Health Service proposed a series of phases and interties among the existing NTUA systems. The NTUA systems in the southern end of the service area are chronically short of water. One of the first phases will connect the Ojo Encino and Councilor systems. At first, connecting water-short systems with each other provides fairly limited overall benefits. But, there is some excess groundwater capacity on the Huerfano system at the north end of the service area. By connecting these systems together, it will be possible to meet short term water demands in the south, while creating the alignment that will eventually convey San Juan River water. The State Water Trust Board has been remarkably supportive of this concept. And in 2008 the Governor and the legislators supported $12 million for the second phase of this project. The final phases will connect all of these NTUA systems with the Cutter Reservoir. That phase is the most expensive of the phases.

The lack of infrastructure, the lack of economic development, and poverty are linked. The Navajo unemployment rate has skyrocketed compared to Arizona and the rest of the U.S. The per capita income is much lower compared to the rest of the US. These statistics are shown graphically in Figures 5 and 6. The result of this situation is that people are leaving. Between 1980 and 1990, on reservation population increased by 20%, while the off reservation population increased by more than 100%. From 1990 to 2000, on reservation increase was about 20%; off reservation increase was about 50%. The Navajo Nation today has a need for 20,000 homes. Thirty percent of the household's haul water. People are leaving because they cannot find a livelihood.

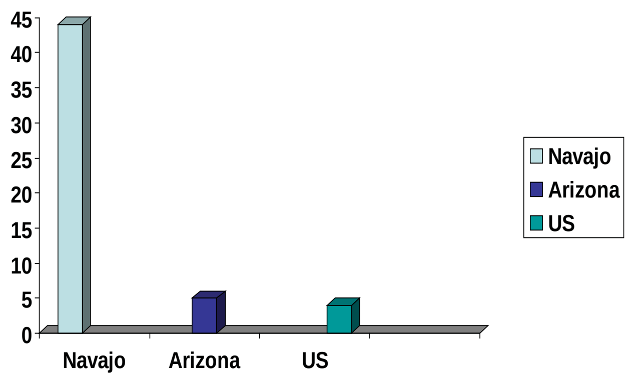


Figure 5. Comparison of Unemployment Rates

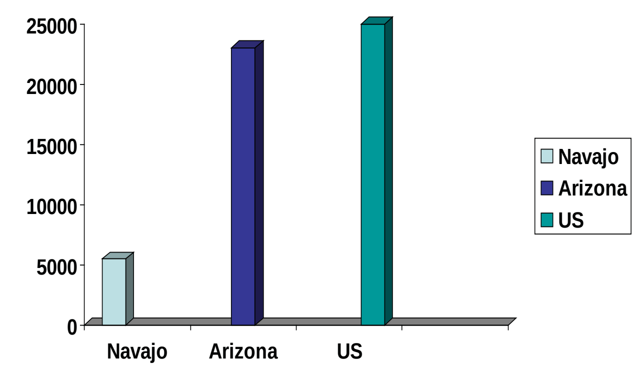


Figure 6. Comparison of Per Capita Income

These proposed Navajo water projects are all pieces of a puzzle. If the Navajo Nation cannot serve Window Rock with water from the San Juan River, then the Window Rock demands will need to be served by conveying groundwater from Ganado. But, the Ganado area cannot sustain the populations of both communities. Some of the Colorado River water mangers see this Project as a challenge to the Colorado River Compact and the Upper Basin Compact. Some of these mangers believe that the Navajo Nation and this Project are doing violence to the Compacts. But, who is doing violence to whom? Out on the Navajo Reservation the basin boundary lines, and even the state boarders, are quite arbitrary. If a person was blindfolded and dropped off in the middle of the Navajo Reservation, and given a compass, that person would not be able to tell if he was in the Upper or Lower Basin. Driving from Farmington to Gallup one can cross the Continental Divide three times. The compact boundaries seem less relevant on the Reservation. The pieces of this water puzzle need to fit together. If the Navajo Nation can serve Window Rock with water from the San Juan River, then the Ganado groundwater can serve the residents in the Ganado area. The other proposed projects serve the Western Navajo Agency out of Lake

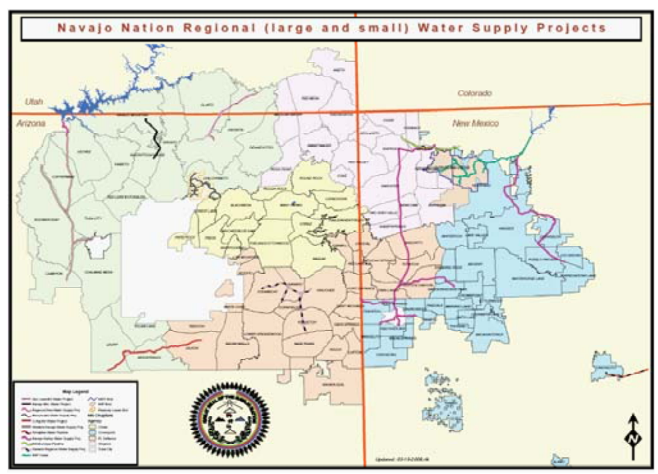


Figure 7. Navajo Regional Projects

Powell, and the San Juan River diversion serve the Navajos in Utah. The puzzle pieces need to fit together. Some of these other projects are shown in Figure 7.

I love pipelines. I have never seen a pipeline I have not liked. But the Project and the settlement is not about engineers and pipelines, it is about people. The Navajo people have been waiting for a very long time for this to happen. Someday they will get this water. Figure 8 shows a blessing ceremony at White Horse Lake. The poster shown in Figure 8 was part of a contest where the kids were asked to draw pictures of water. One student drew a picture of a pickup truck hauling water. The Project is really about people. It is about the Na-

Figure 8. It is about the People

Craig S. Roepke has been a resident of New Mexico since 1950. He earned a master's degree in hydrology from New Mexico Tech. Craig has worked for Sandia National Laboratories, a number of consulting companies, and Indian Tribes in South Dakota. He has been working for the New Mexico Interstate Stream Commission since 2000.

Mutually Supportive Uses of Gila Settlement Water and Money

Craig Roepke
NM Interstate Stream Commission
PO Box 25102
Santa Fe, NM 87504-5102

Good morning. What I'd like to communicate today are some thoughts on concepts and dynamics related to the Gila Settlement in the 2004 Arizona Water Settlements Act.

I'll talk about water uses, available sources, diversions, and so forth, but I need to emphasize that what you'll see is NOT a plan or proposal by the Interstate Stream Commission. What I'm going to try to do, and all that I'm trying to show, is that projects can be arranged so that meeting the needs of one party or interest can actually help another interest, one that is often seen as an opposing use.

In 1964 during the Arizona *v.* California case, the U.S. Supreme Court Decree limited depletions in the Gila Basin to approximately 30,000 acre-feet. In December 2004, the President signed the Arizona Water Settlements Act. That Act, among 62 other settlements, gave New Mexico 14,000 acre-feet of additional depletions in the Gila Basin above those in the 1964 decree. The 2004 Act also gave New Mexico up to $128 million in non-reimbursable funding. The 14,000 acre-feet represents a 47 percent increase in available surface water use in southwest New Mexico. Even in these days of $700 billion bailouts, $128 million and 14,000 acre-feet of water has generated a little interest.

With just a few figures, I'm going to try and to give you a conceptual idea of one mutually supportive combination of uses of the Gila Settlement water and money. Again, what I'm going to present doesn't represent a proposal by the Interstate Stream Commission. That decision should reside with the citizens of Southwest New Mexico. All I've done with this presentation is tried to arrange a bunch of ideas that different interests have come up with in a way that creates a synergy between projects that helps everyone.

For the purposes of this presentation, I'm going to focus on one small location, the Cliff-Gila Valley, within the four counties of Grant, Luna, Hidalgo, and Catron counties (Fig. 1) [slide 2]. However, the dynamics we'll be talking about can be transported anywhere within the region.

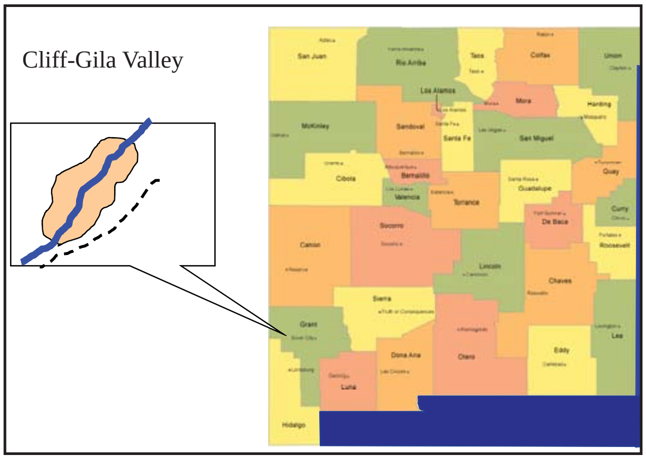


Figure 1. Mutually Supporting Projects

The Cliff-Gila Valley is about five miles wide and 30 miles long (Fig. 2). Nothing you're going to see is to scale. All we're interested in is the conceptual relationship between demands, interests, and supplies.

Running through the Cliff-Gila Valley is the Gila River. Upstream and generally northeast is the Gila Wilderness. Downstream are the Middle Box and the Bird area. Both the Bird area and the Cliff-Gila Valley itself are important habitat areas for a number of listed species and a prolific intersection of major regional scale eco-habitats.

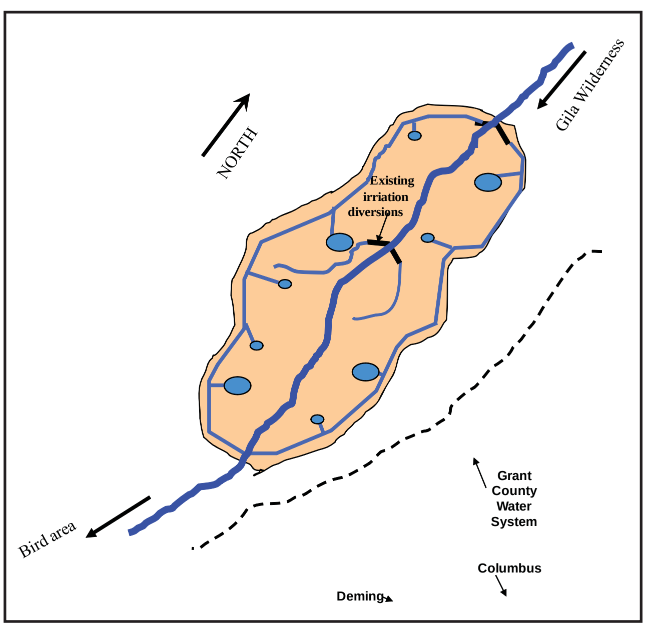


Figure 2. Cliff-Gila Valley (not to scale)

The Cliff-Gila Valley itself is home to a generations-old agricultural community. In fact, the Gila Valley was once the food source for much of central Arizona. In the Valley, these agricultural diversions represent the most senior water rights.

To the east of the Cliff-Gila Valley is the Continental Divide. Just over the Divide is the Silver City/Grant County water system, and farther south we have Deming and Columbus.

One of the first proposals that stakeholders brought forth was a gravity diversion at the head of the Valley. Canals or pipelines – or a combination – could be used to convey the additional water throughout the Valley. I've drawn it in Figure 2 to show how that could happen using just gravity, no power needed. The Gila Settlement limits us to diversions only during high flows. Well, when the flows are already high, a farmer can already divert more than enough water and it probably doesn't help much to be able to divert additional water.

What would be needed is a way to store the additional water that is available during high flows. What I've shown here are a series of small storage ponds that store water during high flows and provide farmers a supply during water shortages. That would give us better return crops, longer growing systems, and a more reliable water supply. So far it might seem that all we've created are benefits to agricultural communities.

Actually that's not true. For instance, these storage ponds have a number of environmental benefits. Storage ponds would reduce or even eliminate the need to pump supplemental wells during low flow periods. Supplemental wells, as we all know, aren't the best friends a stream has, especially when flows get low. The ponds would also reduce energy consumption. Unlike supplemental wells, they could utilize both gravity feeds and releases.

There are other very important advantages as well (Fig. 3). For instance, the greatest concentration of Southwest Willow Flycatchers, an endangered species, resides in the Cliff-Gila Valley in habitat Dave Olgilvie created on his farm and ranch. Each of these storage ponds and the associated conveyance systems would provide similar habitat for the Flycatcher, Apache Leopard Frog, and other at risk species.

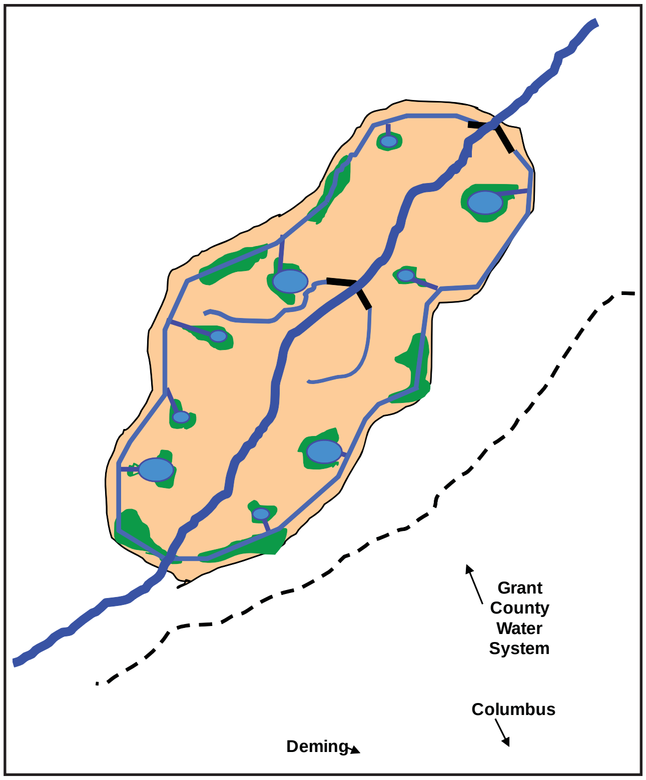


Figure 3. The Cliff-Gila Valley provides habitat for endangered species.

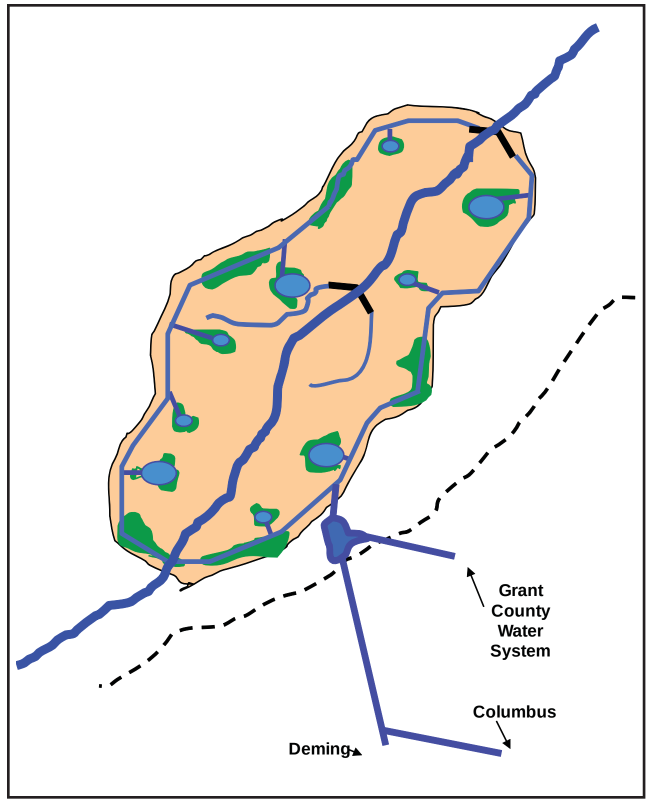


Figure 4. Hypothetical storage facility down gradient in the Cliff-Gila Valley

Another benefit we should recognize, but one that's often overlooked, is that an economically robust agricultural community is one of the best defenses against unrestrained development. Conversely, if a farmer is losing money, it makes sense for him to sell out to the first developer that flashes a wad of cash. I get calls from developers almost every month. Rio Rancho on the Gila is not a far-fetched scenario.

One of the more controversial proposals that stakeholders have made is off-stream storage for municipal supply.

In the late 1980s, Reclamation presented just such a plan. It required pumping capacity capable of diverting more than 600 cfs. Quite simply, that would require a huge investment in power infrastructure and energy costs.

What I've drawn in Figure 4 is a storage facility sufficiently down gradient from a diversion that it would fill by gravity. Again, no energy costs.

Pumped over the Divide, the water could flow down to Silver City, Deming, Columbus, and other municipalities. I haven't included Las Cruces on this schematic, but if the water isn't used in the four-county area, there's about 400 feet of net head that could be used to convey Gila River water even as far as Las Cruces. And again, please don't think of this schematic as anything to scale, simply a picture of general relationships.
But what about periods when water is short? In many, if not most summers, there isn't enough flow to meet current demand. The result is that the Gila often dries up below diversions. Obviously, this isn't good for riparian habitats or at risk species.

Storage is usually built just to meet municipal supply. And in truth, that's where the resources lie to build storage. But that's just one of the possible uses for storage. Some interests have suggested that water could be pumped back up to the diversion and used to rewet the river (Fig. 5). Storage could then also be used to maintain the agricultural and environmental benefits attained by the canal/storage pond system.

In addition, maintaining a wet river would ensure that a healthy riparian environment could also be protected.

So what does this conceptual arrangement of different projects provide?

What I've tried to show in Figure 6 is that by helping a different interest, perhaps even an interest that you usually find in opposition, you can actually help yourself. These same concepts and synergies can be applied throughout the region.

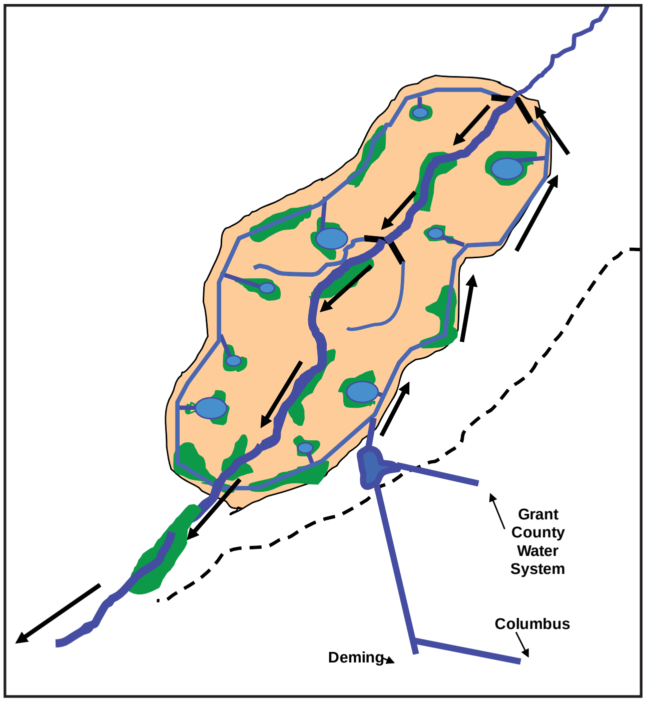


Figure 5. Water could be pumped back up to the diversion and used to rewet the river

- **Improved agricultural economy**
  - More reliable water supply
  - Higher return crop types possible
  - Safer, more reliable food supply
  - Buttress against unconstrained growth
- **Renewable water supply**
  - Gravity diversion - low energy draw
  - Supports present and future demand
  - Supports economy
  - Reduces demand on aquifers (drought supply)
- **Improved environment**
  - Supplement low stream flows
  - Greater riparian habitats
  - Reliable aquatic habitats
  - ESA protection/recovery

Figure 6. Mutually Supporting Projects

It was easy for me to assemble these concepts in a way that everyone benefited. And it should have been. With 14,000 acre-feet of water and $128 million, if we can't help meet current and future supply, improve agriculture, and protect and enhance the environment, I don't think we're trying very hard.

Thanks for listening. Questions?

Stephanie Moore is a senior hydrologist with Daniel B. Stephens & Associates in Albuquerque. She holds an M.S. degree in earth and planetary sciences from the University of New Mexico and a B.S. in environmental sciences from Texas Christian University. Stephanie spent eight years with the U.S. Geological Survey (USGS) New Mexico District before joining DBS&A in early 2005. Her research interests include quantitative analysis of stream-aquifer interactions, vadose-zone processes, and spatial and temporal variations in water quality. Stephanie is project manager and technical lead for a variety of water resources projects for local and state governments. She serves on two advisory boards regarding water conservation and planning issues in the Albuquerque/Bernalillo County area, and is an active volunteer in Water for People's World Water Corps.

An Overview of the Bear Canyon Recharge Demonstration Project

Stephanie J. Moore[1]
Daniel B. Stephens and Associates
6020 Academy NE, Suite 100
Albuquerque, NM 87109

John M. Stomp, III[2], John T. Kay[1] and James A. Kelsey[1]
[1] Daniel B. Stephens & Associates, Inc.
[2] Albuquerque-Bernalillo County Water Utility Authority

Abstract

Artificial recharge and underground storage and recovery are management tools that allow for the efficient and conjunctive management of surface-water, groundwater, and reclaimed water sources. In New Mexico, legislation authorizing artificial recharge and underground storage was passed in 1999, after a multi-year educational and consensus-building process led by Albuquerque. Rules were adopted in 2001. Despite the many benefits of artificial recharge, no entity has been granted the right to recover recharged water and few have even begun to pursue permits, perhaps because of the complex regulatory requirements. Ultimately, it is the Office of the State Engineer and the Environment Department that will determine whether the benefits of artificial recharge will be fully realized in New Mexico.

The Bear Canyon Recharge Demonstration Project is the first permitted, operating artificial recharge project in the State of New Mexico. The Project was implemented by the Albuquerque/Bernalillo County Water Utility Authority with funding provided by the State of New Mexico. Goals of the Project are to (1) use surface water to recharge the aquifer via an in-stream infiltration system, (2) use the aquifer to store surface water and establish a drought reserve, and (3) establish

the right to recover the recharged water. In preparation for the Project, extensive work was conducted to characterize the vadose zone, and to design and install a suitable monitoring plan to track recharged water along its entire flow path from land surface, through approximately 500 feet of vadose (unsaturated) zone, to the regional aquifer.

Data collected during the first recharge period clearly demonstrate that in-stream infiltration is a viable option for recharge. The first recharge period was conducted in February and March of 2008. Recharge water reached the regional aquifer in less than 54 days, almost no water was lost to storage in the vadose zone, and very little water was lost to evapotranspiration.

Background

Artificial recharge is a water resources management tool that allows for the efficient and conjunctive management of surface-water, groundwater, and reclaimed water sources. Despite their growing use in communities throughout the United States, no artificial recharge projects have yet been implemented in New Mexico.

Two types of permits are required for enhanced recharge projects:

1. Underground Storage and Recovery (USR) permit from the New Mexico Office of the State Engineer (NMOSE)
2. Groundwater discharge permit from the New Mexico Environment Department (NMED)

To date, the NMOSE and NMED have not yet issued a permit for artificial recharge. This may be due, in part, to the rigorous requirements to demonstrate how much water is being recharged and to ensure that groundwater quality is being protected.

Artificial Recharge and ABCWUA

Artificial recharge is a major part of the Albuquerque Water Resource Management Strategy (AWRMS), which was developed to provide a sustainable, long-term water supply for the Albuquerque-Bernalillo County Water Utility Authority (the Authority). The Authority plans to use artificial recharge to address one of the Authority's most critical issues: providing adequate water supplies during times of drought.

The Authority funded several feasibility studies to evaluate artificial recharge alternatives; these efforts, combined with a review of the available literature on hydrogeology and geochemistry of the Middle Rio Grande Basin (MRGB) aquifer, indicated that in-channel infiltration systems appear to be an effective method for artificial recharge in the Albuquerque area. The reach of Bear Canyon Arroyo between Wyoming and Louisiana Boulevards was identified as an ideal location for artificial recharge through in-channel infiltration systems. Existing infrastructure is available to deliver raw Rio Grande water to this unlined reach of the arroyo. The existing channel is wide and has reasonably high infiltration rates; aquifer materials beneath this reach of Bear Canyon Arroyo are some of the most transmissive in the Albuquerque area (Thorn et al., 1993). Groundwater levels in this area have declined between 80 and 120 feet since 1960s pre-pumping conditions (Bexfield and Anderholm, 2002), and the direction of groundwater flow is generally from north to south, toward the major cones of depression, so all recharged water would easily be captured.

Project Description

The Bear Canyon Recharge Demonstration Project (the Project) is designed to demonstrate the effectiveness of artificial recharge through an in-stream infiltration system. The goals of the Project are to (1) implement the existing aquifer storage and recovery policy of the Authority, (2) use surface water supplies to recharge the MRGB aquifer, (3) use the aquifer to store surface water and establish a drought reserve, and (4) establish the right to recover the recharged groundwater.

As part of the Project, water will be delivered from the Rio Grande via the existing infrastructure of the North I-25 Reclamation and Reuse System, to the Arroyo del Oso non-potable reservoir tank (Figure 1). The source water is a combination of San Juan-Chama water diverted from the Rio Grande and a small amount (less than 0.2 million gallons per day [mgd]) of highly treated industrial wastewater. Water will be released from the reservoir into the arroyo and allowed to flow down the channel, where it will infiltrate into the streambed sediments, flow through the vadose zone, and eventually reach the aquifer. The 2,800-foot long infiltration reach is located in the unlined segment of the arroyo between Wyoming Boulevard and Arroyo del Oso Dam; the channel is approximately 50 to 70 feet wide. The maximum discharge volume is 3,000 acre-feet, which will be released from the Arroyo del Oso reservoir into the infiltration reach over a maximum period of six months (October through March), with the majority of releases occurring during the months of November through February. The maximum discharge rate is limited to 5.6 mgd.

Figure 1. Bear Canyon Recharge Demonstration Project site

Overview of Monitoring System

The study area will be monitored extensively to track recharged water along its entire flow path from land surface, through approximately 500 feet of vadose zone, to the regional aquifer. Data collected during the project will help determine the long-term feasibility of the recharge method and establish the means to calculate the recoverable groundwater right.

The plan includes monitoring of the source water discharged to the arroyo, the vadose zone, and the underlying aquifer. Because each artificial recharge project is site specific, we have employed an adaptive management program, which means that additional instrumentation may be installed based upon review of data collected during the first season of recharge. Continuous data collection has been automated for remote monitoring of streamflow, groundwater levels, streambed temperatures, and vadose zone moisture contents. A brief overview of the monitoring system is provided below.

Surface water flow will be measured at several points to determine the amount of water transmitted downstream and the amount of water entering the study area. Streamflow measurements upstream from the area of hydrologic effect will allow for quantification of any ephemeral flow entering the study area. In general, ephemeral flows are not expected during the primary recharge periods (November through February); however, ephemeral flow is expected during the late summer to early fall monsoon season. The quality of source water introduced to the arroyo for recharge will be evaluated by analysis of samples collected at the above-ground storage tank outfall.

A combination of temperature sensors, heat dissipation sensors, lysimeters, and neutron logging will be used to monitor water as it moves through the vadose zone to the water table. Data collected will be used to determine the lateral extent of spreading and the rate of percolation. Transect location and sensor placement (Figure 2) were selected to define and track the wetting front, characterize the amount of lateral spreading, and evaluate temporal changes in moisture content in the vadose zone (including changes in storage in the vadose zone). Three water quality lysimeters were installed at various depths so that soil water samples can be collected for water quality analysis. This data will allow for evaluation of changes in water quality as recharge water moves through the vadose zone.

The aquifer will be monitored in and around the "estimated area of hydrologic effect," as defined in the NMOSE permit application. Three groundwater monitoring wells were installed around the study area to measure the water table response to increased recharge. Pressure transducers will be used to measure continuous water levels (at an hourly interval). The monitoring wells will also provide additional information about the vadose zone through the use of a neutron probe to measure soil moisture in the vadose zone.

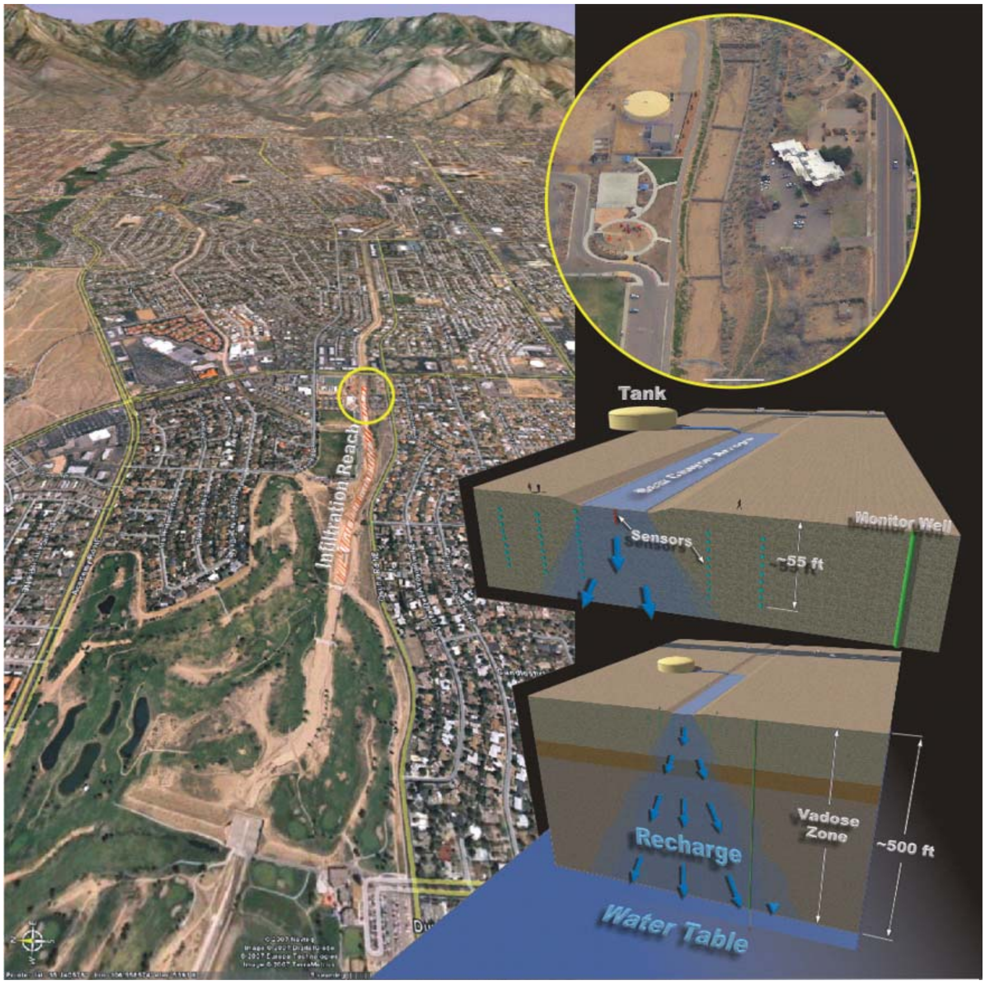


Figure 2. Transect location and sensor placement

Water quality of both the recharge source water and groundwater from each monitoring well will be monitored throughout the demonstration project. Water quality samples will be analyzed for major ions, nutrients, trace elements, and selected isotopes.

Summary

The Bear Canyon Recharge Demonstration Project is the first artificial recharge project in the State of New Mexico. The Authority's primary interest in artificial recharge is to establish a drought reserve; the intent of this demonstration project is to collect necessary data to establish the right to recover recharged water. Monitoring began in late summer of 2007, as soon as instrumentation was in place, and will continue throughout the demonstration project. The first recharge period was from February 6, 2008 through April 2, 2008. Data collected during the first recharge period clearly demonstrate that in-stream infiltration is a viable option for recharge. The first recharge period was conducted in February and March of 2008. Recharge water reached the regional aquifer in less than 54 days, almost no water was lost to storage in the vadose zone, and very little water was lost to evapotranspiration. The second recharge period began October 11, 2008 and is scheduled to run through March 31, 2008.

Selected References

Bexfield, L.M., and S.K. Anderholm. 2002. *Estimated water-level declines in the Santa Fe Group Aquifer System in the Albuquerque Area, Central New Mexico*, Predevelopment to 2002. Water Resources Investigations Report 02-4233, U.S. Geological Survey.

Thorn, C.R., D.P. McAda, and J.M. Kernodle. 1993. *Geohydrologic framework and hydrologic conditions in the Albuquerque Basin, central New Mexico*. Water-Resources Investigations Report 93-4149, U.S. Geological Survey. 106p.

Gary L. Esslinger has been the Treasurer-Manager of the Elephant Butte Irrigation District since 1987. Gary is a third generation member of a pioneer farming family living in the Mesilla Valley. His grandfather, J. L. Esslinger, Sr., settled in La Mesa in 1913 prior to the completion of the Elephant Butte Dam. Gary's father, J. L. Esslinger, Jr., also farmed for over fifty years. Gary kept his roots in farming as well as other agricultural based industry and lives on the family farm with his wife, Tina. Gary and Tina have three daughters. Gary earned a bachelor's degree in business administration from Northern Arizona University in 1973. He returned to the Mesilla Valley and began working for EBID in 1978, where he has been for the last 30 years. Gary has had the honor of being appointed by Governor Bill Richardson to chair the search committee to select the State Engineer for New Mexico as well as being appointed to the Office of the Dona Ana Flood County Commissioner, a position he held from 2002 until 2006.

Lower Rio Grande Project Operating Agreement: Settlement of Litigation

Gary Esslinger
Elephant Butte Irrigation District
PO Drawer 1509
Las Cruces, NM 88004-1509

Good morning and thank you for this opportunity to speak to you about the operating agreement that was signed down in the Lower Rio Grande in Southern New Mexico.

John Hernandez spoke yesterday about a distinguished group of risk-takers and today I would also like to add to these famous risk takers a few of my own. I have my own version of a group of men that I believe did a lot in the Rio Grande Project to settle on this operating agreement, so if you will allow me to read something.

A WATER LINE DRAWN IN THE RIO GRANDE

Wild stories, like weeds, spring up out of the West,
Spirited by folklore, legends, and history at best.
Most recent of all, the tale of a water allocation claim,
Uniting the Rio Grande Project farmers with historic fame.

In the Valley of El Paso, where the Rio Grande does run,
Grew up the El Paso County Water Improvement District, Number One.
Johnny Stubbs, the Chairman, was called out and elected to lead,
His character, convictions and family roots, they knew they would need.

In the Valley called Mesilla, where three crosses stood,
Elephant Butte Irrigation was upstream, with a reservoir in their hood.
The Salopeks, Arnolds and Garys names became known,
Where their Grandpa's roots were as deep as the pecan trees grown.

The stage was set for the greatest duel on the Rio Grande,
Each District's Board drew their lines in the wet silty sand.
Twenty nine years of bleeding because each side was sued,
'Whiskey for drinking, water for fighting," the battle pursued.

A West Texas lawyer, wily and cunning, they called him Jim Speer,
Drew his sites on New Mexico and put his jurisdictional claim in gear.
Yet ready and able were Hubert and Hernandez, the dynamic duo,
To counter the claim for New Mexico and argue 'esta agua es mio".

A hired hand from Texas, called out from the City of Austin,
A technical wizard, Al Blair, dealt carryover storage to bargain.
From upstream 'New Mexico' they hired from Aggie Land,
Phil King, the professor, who countered a D-3 curve ace in hand.

Reyes, Esslinger and Cortez, the Wranglers, the best on each side,
Were called to be time keepers and clock this wild ride.
Who would have thought, from the Rio Grande Compact would come,
Pat Gordon, the peacemaker, to step in and 'getter done'.

Who could forget Reclamations role and their government hitch,
"We're here to help!" they say, so they called in Chris Rich.
And where would the West be without justice so swift,
They called upon Lee Leininger from D.C. to give them a lift.

The dust has all settled, and the Rio Grande will still flow,
An operating agreement spells out the direction the water will go.
A compromise and settlement was added to end all the grief,
Rio Grande Project farmers will get back their lifeblood, a welcome relief.

Happy Valentines Day
February 14, 2008
Gary Esslinger

John D'Antonio, our state engineer, is always asking, because we give him such a hard time down south, "Where's the love?" and this first figure (Fig. 1) represents the EBID and EPCWID#1 board members from down south signing a Valentine Card to send him. Actually this is the official Operating Agreement signing ceremony that took place on February 14, 2008.

Figure 1. Operating Agreement signing ceremony

The Rio Grande Project, which I won't go into a lot of detail about here, was authorized in 1905 and largely completed by 1916. The water was divided between New Mexico (90,640 irrigated acres) and Texas (60,010 irrigated acres) 57% and 43%, respectively. The Treaty with Mexico was also very important in that authorization and allowed 60,000 (ac/ft) to be delivered to Mexico in perpetuity. The Project was operated by Reclamation from1916 up until 1978. The Districts paid off their entire debt to the U.S. and began operation maintenance of the Project in 1979 to the present. During those historic dates, there were more dry years than wet years. There was a full allotment (3 acre-feet) of water between 1979 and 2002, but then returned to the drought of 2003, and in my opinion still exist today.

The Rio Grande Compact was another institutional development that took place during this period of time that laid out the division of water between the three states. The Rio Grande Compact apportions water between Colorado, New Mexico, and Texas. It is also important to point out that the Bureau of Reclamation operated the Rio Grande Project as a single unit at this time, but I will talk about that a little bit later. The other important feature is that the entire Rio Grande Project is located in Texas, so that makes EBID sort of a an island to say the least. No provisions for apportioning water were contemplated in that Compact for the Rio Grande Project, so actually the operating agreement, as it now has been developed, is really a mini-compact within the Rio Grande Compact.

Post compact years represented in Figure 2 are what we refer to as D1 and D2 curves. The blue regression line is the historic D1 delivery curve and the green line is D2 historic diversion curve. As you can see, the post-Compact problem was the sustained drought period from 1950 thru 1975, and the Bureau measured the release from Caballo reservoir and delivery to the head gate. When the districts took over the Bureau realized that they would have to rely on the diversion curve measurements instead, since the districts were taking over at the diversion dams and then measuring the water to the head gate. The two linear regression curves represent the historic period of time during the drought as measured and accounted for future allocation to EBID, EPWID and Mexico. So, for a given release of 600,000 acre-ft, you get to divert 713,000 acre-ft. The plus amount is due to accretions. This is a little bit of what Dr. Phil King was talking about yesterday. On the other hand, when you release 600,000 acre-ft and you try to deliver it, you will only be delivering 393,000 acre-ft because of what we lose from seepage and evaporation in our canal system.

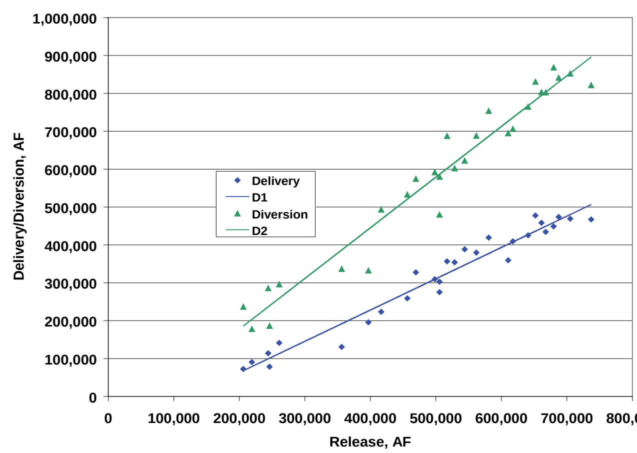


Figure 2. Post Compact

Let's talk about the Post Reclamation years. In 1979-1980, the districts pay off construcion loans. This is very important because when we began taking over the operation of the Project in 1979, both districts agreed to sign an Operation/Maintenance contract with Reclamation that obligated the Bureau to develop an allocation and operating plan. In 1980, the City of El Paso applied for groundwater well permits in the New Mexico portion of the Mesilla Bolson in the Lower Rio Grande. It was a major lawsuit for the young district, and when the dust settled the State of New Mexico denied the application and the ensuing lawsuit was finally dismissed in 1991. So the plan to put the operating agreement together was put on the back burner once again, and we let the operating agreement simmer for a while longer. The period from 1979 to 2002 also helped because that was a 23-year period of full water supply for EBID, EPCWID #1, and Mexico, so no one was really worried about water shortages at that time.

However, we started seeing things begin to happen in1997. The United States government filed a Quiet Title lawsuit; EPWID #1 filed a cross claim alleging inequitable allocation of Project water by Reclamation because of groundwater pumping in New Mexico. This created negotiations among the districts, Reclamation, and other interested parties. That started in 1998, but collapsed in 2000. In 2001 the Quiet Title suit was dismissed, but EBID felt like it was important to keep the suit going in federal district court in Albuquerque based on the fact that Reclamation still hadn't implemented the operating agreement.

Then comes the return of the drought in 2003, after 24 years of full supply. This created big problems for my district as well as for Chuy Reyes's district and for the Bureau because none of us had ever operated in a drought under the new operating rules and regulations of releasing the water, diverting it, and measuring it at the farms not as a single unit but instead to separate units, in two different states. Reclamation tried different methods during that period of time, but they were really operating without a legitimate plan, to which all parties were in agreement. Mexico's allocation was based on useable water in Project storage and the remaining diversions were divided between EPCWID #1 and EBID in 43% and 57% proportions, respectively. This created major problems as the drought deepened.

As a manager, Figure 3 is easy for me to describe. The problem is the diversion from the river to the farm gate altered by groundwater pumping. If you understand this, then you will know why it's important to have an operating agreement in place that everyone has bought into. As you can see by this Diversion/Conveyance diagram, you divert water from the Rio Grande, put it in the canal system, the canal seeps, some water gets delivered to the fields, the crop uses water, the fields drain into the drain system, and it is returned to the river. I have a pretty good system of managing the surface water flow, along with metering and measuring. Unfortunately in our particular area, there's seepage and drainage that returns to our groundwater and recharges the aquifer. There is a hydrologic connection between the groundwater and the surface water, so I have to consider how to balance the two together. When you complicate matters by sticking a well in the aquifer, what happens is that you get a cone of depression occurring, and its hard to move this water through the system without the water filling those cones of depression before it gets to the state line. EBID saw this coming. You can visualize this from Figure 4. The D2 curve, the diversion curve, shows that we have plenty of water before the impact, even during wet and dry years. But look at the start of the last drought in 2003 up until now. You can see we are way below our standard deviation.

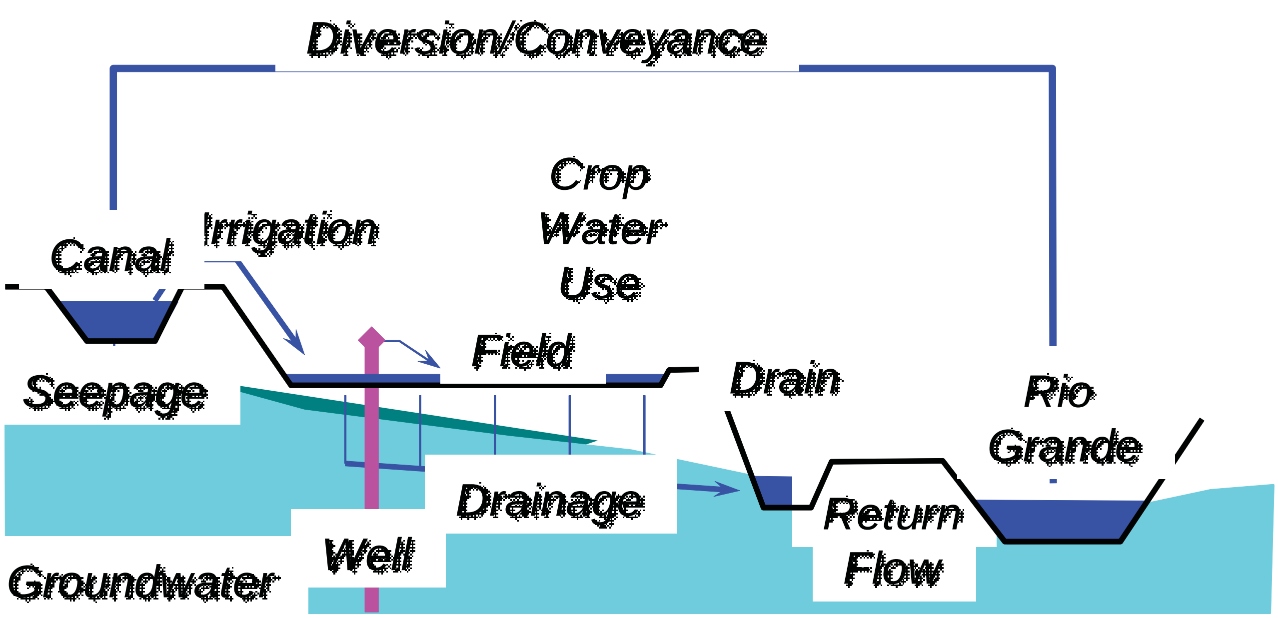


Figure 3. Problem: Release to diversion hydrology altered by groundwater pumping in New Mexico

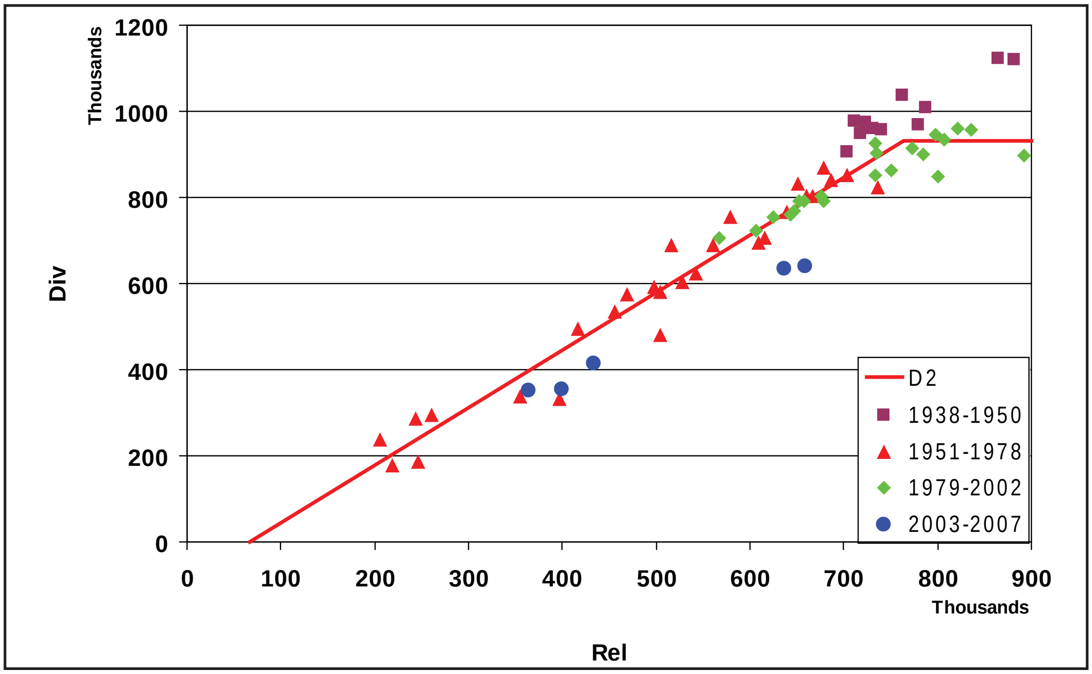
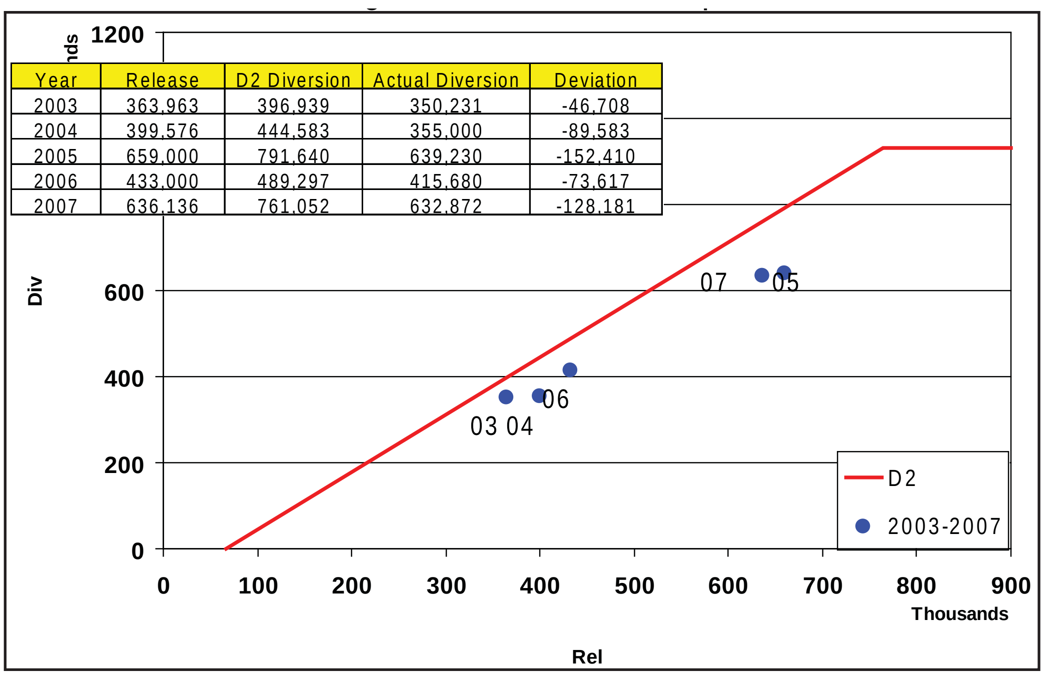


Figure 4. Visualizing Groundwater Impacts

Visualizing the groundwater impacts from 1979 to 2000 indicated that we still had a lot of water, so we had nothing to worry about. However, things began to change from 2003 to 2007. You can see that we were considerably further away from the D2 historic line, which concerned EBID. We knew we were fixing to go to federal court or the U.S. Supreme Court. In Figure 6, the D2 red line represents the drought of the 1950s and 1978. The blue dots represent the new drought of 2003-2007. You can see that in 2005 we were way below the deviation of D2 because of the current drought. So as tension started to brew between the districts and the Bureau of Reclamation, the ad-hoc method the Bureau of Reclamation was using and an unwritten operating plan all brought that simmering pot from the back burner up to the front burner and things started boiling. In 2006, EBID proposed a reallocation methodology tying EPCWID#1 and Mexico's allocations to the Project release based on those historic D1 and D2 curves. In 2006, Reclamation implemented this new methodology called D3, but also tried to introduce in 2006 and 2007 a concept called carryover storage. This was contrary to assurances to EBID that they wouldn't. The Bureau promised to one district that carryover would not happen while promising the other district that carryover storage would happen.



Year	Release	D2 Diversion	Actual Diversion	Deviation
2003	363,963	396,939	350,231	-46,708
2004	399,576	444,583	355,000	-89,583
2005	659,000	791,640	639,230	-152,410
2006	433,000	489,297	415,680	-73,617
2007	636,136	761,052	632,872	-128,181

Figure 5. Visualizing Groundwater Impacts

In 2007, EPCWID#1 filed a lawsuit in federal district court in Texas based on Reclamation's inability to address the carryover issue equitably. It looked like this was all heading down a litigious trail. The settlement talks started in the first part of 2008 because farmers realized they would be the most impacted on both sides of the state line and if they didn't come to the table and decide what to do, some judge was going to do it for them.

We began negotiations in January on Martin Luther King Day. Reclamation brought in their lawyers from D.C. and the regional office in Salt Lake City, and the two boards, technical teams and lawyers met down in the El Paso, Texas at the Texas Compact Commissioner's Office. Pat Gordon was a great mediator; he did a wonderful job in keeping the parties focused. There were times when negotiations got a little heated, but we finally addressed all the issues on January 31 and we worked out the details up until Valentine's Day, February 14, 2008.

So what did we do on Valentine's Day? The operating agreement settlement gave an annual water allocation using 1951 to 1970 hydrologic conditions to quantify equitable allocation to EPCWID#1 based on releases from Caballo Reservoir. The allocation methodology protected EPCWID#1and Mexico from groundwater impacts in New Mexico. The 1951-1978 level of everyone's groundwater pumping in New Mexico was grandfathered into the agreement.

Concerning carryover, the unused allocation will equal 60 percent of a full allocation and may be accumulated by each District: 306,000 acre-ft for EBID and 233,000 acre-ft for EPCWID#1. Excess carryover will go into the account of the other district if these amounts are exceeded. EBID can capture new storm water instead of releasing it downstream and EPCWID#1 will benefit from improved upstream flood protection.

Both districts dismissed their lawsuits in New Mexico as well as the one in Texas. Reclamation agreed to an internal review of operations in the El Paso Field Office under the Managing for Excellence program. The allocations and operating procedures specifically tell each district how to divide and charge the water at time of release. Nothing in the agreement can change without consensus agreement by all the parties.

In terms of benefits, we avoided mass court costs and compliance costs. It didn't cost the State of New Mexico anything other than some studies that they participated in with us. Resources that we have internally can now be focused on improving productivity rather than on litigation. Equity in the Project water allocation is clearly defined between New Mexico and Texas irrigation districts. The potential for the Lower Rio Grande to develop innovative management of water resources is there. Primary motivation for OSE's Active Water Resource Management implementation is eliminated. We'd rather manage our resources in our area then have them regulated out of Santa Fe. With that I will leave you. Thank you.

Jesus A. Reyes is the General Manager for the El Paso County Water Improvement District #1 in El Paso, Texas, being tapped for the position after serving on the EPCWID#1 Board of Directors. Jesus was raised in a small farming community in Canutillo, Texas, graduated from Canutillo High School, and attended UTEP. In addition to being involved with law enforcement with the El Paso Sheriff's Department for 15 years, he has also been a business owner who understands management and the importance of leadership. During his tenure at the Sheriff's Department, Jesus started out as a patrolman, moved on to become a Detective, Sgt. of Detectives, was then promoted to Captain of Detectives, and went on to become the youngest Chief Deputy in the El Paso Sheriff's Department. He and his wife, Martha, also opened King Buildings of El Paso in 1996, a metal building business that they sold in 2004. Jesus has always been involved in the community, has served on several Boards, and has been instrumental in managing several political campaigns including those for his brother, Congressman Silvestre Reyes, Judge Gonzalo Garcia, and his wife, Martha Reyes who currently sits on the Ysleta School Board. He has served on the El Paso County Parks Board, El Paso Airport Board, Alivane Board of Directors, the newly formed Storm Water Committee, and he is also a member of the Paso del Norte Planning Group.

Lower Rio Grande Project Operating Agreement: Settlement of Litigation

Jesus A. Reyes
El Paso County Improvement District #1
294 Candelaria Street
El Paso, TX 79907-5599

Thank you. I would like to recognize Karl Wood and his staff. I think they have put on a very good program and I am impressed with everyone staying until the last presentation. I will try to go pretty quickly; Filiberto has about an hour-long presentation I think, and Gary did an excellent job in his opening.

I will cover a little bit more about the issue of carry-over. As you all know, our water comes from 120 miles away until it is diverted into the El Paso system and from there we start delivering water to our water users. Our water district is divided in two by the Franklin Mountains; we have the Upper Valley section and the Lower Valley section, and believe me, the problems that we encounter are quite different in those two sections. The people in the Upper Valley hassle me about not cutting the weeds on the bank, not cutting the salt cedars, leave them for the birds, leave them for the turtles, don't mess with the fox they tell me. And then the people in the Lower Valley are after me to get the drains and canals to look like flattop - we want everything cut, we have a problem with the mosquitoes. So it becomes a balancing act. In the Upper Valley I made a deal with a large group called "Save the Valley" and what I did was to trim one side of the canal banks and drains and I left the other side alone. When the trimmed side starts coming up, I go in and cut the other side.

We have about 400 miles of canals, we were created in 1917, and our project includes an international boundary. We are a political subdivision of the State of Texas, part of the federal Rio Grande Reclamation Project. We work very closely, I am proud to say, with Gary Esslinger of the Elephant Butte Irrigation District, and I have an excellent working relationship with Bert Cortez of the Bureau of Reclamation. We have an excellent working relationship and we get along great with the International Boundary and Water Commission also. Carlos Marin was a great friend, he did a lot for our area in addressing flooding issues, and he will be highly missed.

The purpose of the irrigation district is to supply water to the agricultural lands, provide groundwater drainage to the ag lands, provide raw water to Ed Archuleta and the El Paso Water Utility, and we also provide limited stormwater drainage, although it is not so limited now. Ed has gone into the stormwater business and he has caught a lot of flak over the fees, but people forget really rapidly what the 2006 flooding problems caused us in El Paso. We are trying to work with the water utility. I will cover a little bit about what we are trying to do. We have some drains within the city limits that the City of El Paso utilizes for stormwater. I want to build a capturing facility so we are doing some trading there.

Gary is absolutely correct when he said the Rio Grande Compact Commissioner played a great role in coming up with an operating agreement. Commissioner Pat Gordon was tremendous; he helped us address issues like Mexico's allocation based on the treaty, maximum annual allocation based on a release of 790,000 acre-ft, and also with the limited carryover. Carryover for us was a very important issue because we wanted to be assured that we could plan for the future, and we wanted to let our water users know what the water levels were looking like, and what water allocations we would have for the following year. As Gary said, the settlement resulted in the dismissal of the federal litigation and although our attorneys were sad, we were glad.

The operating agreement conserves water stored at the reservoir for future use, minimizes the impact of drought on the Rio Grande Project, addresses groundwater depletions in New Mexico, increases the reliability of the Project water supply, eliminates "use it or lose it," and encourages conservation. That was a big step for me in El Paso. Farmers wanted to know why they should conserve if they are going to lose it anyway, so carryover was a big hammer for us as far as convincing our water users to conserve. It also allows for the conjunctive use of groundwater. It does not change the Compact accounting procedures or the Compact language in any manner, and it does not change the spill calculations or accounting of credits or debits.

What it gives EPCWID #1 is five major conservation and drought mitigation efforts that we have been working on: 1) we have been changing policy to help us conserve water; 2) we have reworked our information management system; 3) we have upgraded our automation system of gates and canals; 4) we have worked on on-farm conservation; and 5) we have made improvements to our conveyance system.

Improvement to our convenance system include more accurate flow measurement sites. We have 60 supplemental well fields that helped us tremendously during the drought. We have converted open channels to pipeline; they are expensive but there is a huge problem with debris and sedimentation issues and it usually requires a safety issue to justify the cost. We have been lining some canals with concrete and using the EPDM material, which is an inner tube like material that has been very successful. The only problem we have had with that material is when kids run down the quads, get into the canal, and rip the liner, which has caused some problems. Our big dream is to build a reservoir, which I will touch on later. We have a federally authorized project, the Riverside Canal Improvement Project, where we are going to concrete line and narrow our riverside canal. That is one of our biggest feeders into the Lower Valley area and it also feeds water into the Jonathan Rodgers Water Treatment Plant.

We have built a new cableway station in Anthony at the state line (Fig. 1). It was a $400,000 project. Gary Esslinger is working on a similar system.
As I mentioned, we have drilled 60 shallow alluvium

Figure 1. Anthony Cableway Station

aquifer wells (Fig. 2). Our wells are in the shallow aquifer about 100 feet deep but they work tremendously well during the drought. We were able to mix three sources of water: Project water, our well water, and sewer treated water. In the Lower Valley we mixed all three and were able to provide an allocation of 2 acre-feet during the driest year in El Paso. In drilling those wells we had some complaints as to what the impacts were going to be. The majority of our wells are in the Lower Valley. By the way, the farmers did a lot of work to refurbish their wells during the worst years of the drought four or five years ago. We power our wells with an 80 horsepower diesel engine with a cost of about $32 per acre-ft.

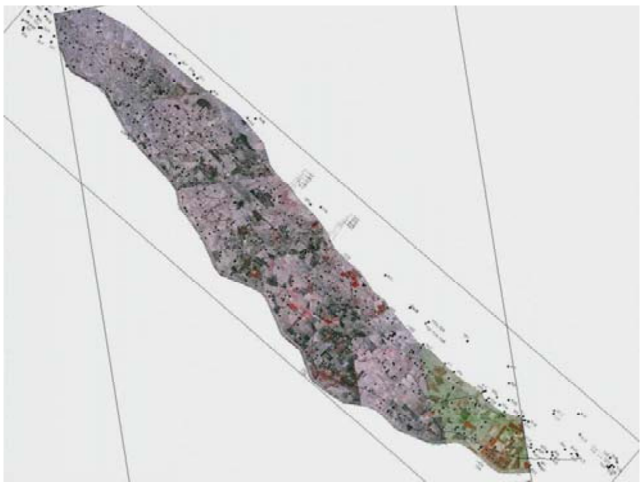


Figure 2. 60 Shallow Alluvium Aquifer Wells

We have also been working on other projects like placing canals underground in pipelines. I mentioned that this usually calls for a safety plan. We have a canal in the Upper Valley that is a joint project that I was able to sell to the Canutillo school district. They decided to build a new elementary school right next to one of our biggest canals and we had issues and concerns with kids walking up and down our canal banks. The school district provided some money and we did all the work with our equipment. The project turned out great. We sold the school district the easement on top, which they plan to use for a school bus drop off point for students. The project turned out great and this is the third project that I have done with school districts in last few years.

We have also worked on concrete lining. Figure 4 shows the American Canal extension. We are going to work on a seven mile stretch of narrowing our Riverside Canal and line it with concrete. We had some issues that came up with the Rio Bosque Park as they were concerned, of course, because they got used to the seepage from the canal feeding into the park. We solved that concern by having our driller donate and drill a well for them. When Ed Archuleta found out what I had done, he had El Paso Water Utilities buy the motor and pump for them. Right now we are in the process of running electrical power to that well. So it worked out well.

Figure 3. Underground pipelines

Figure 4. American Canal Extension

Figure 5 shows the capturing facility reservoir that is located just outside El Paso County. El Paso Water Utilities has about 400 acres where the Socorro treatment plant is located, which hasn't been utilized in years. We want to utilize about 300 of those acres for a capturing facility to capture some of the stormwater that comes down the Rio Grande that nobody makes use of. The Jonathan Rodgers Plant is only about a mile away from this area. We want to capture the water, use some of it for irrigation, and then pipe water back to the Jonathan Rodgers Treatment Plant for the City of El Paso. So it is a win-win situation for both sides.

In summary, the Rio Grande Project Operating Agreement promotes conservation, increases the reliability of water supply, allows for better conjunctive use of groundwater, avoided years of litigation and millions of dollars for both sides, and keeps water in Elephant Butte for recreation. Last year we carried over 106,000 acre-ft of water, this year we are probably going to carry about 200,000 acre-feet. Our cap is 230,195 acre-feet; if I go over that cap, that excess water automatically goes to EBID. If they are capped out, then that water remains in the Project. If Gary Esslinger and Elephant Butte Irrigation District is capped out and I am low, then automatically that water comes to me. So it is a win-win for both sides. And most of all this operating agreement promotes cooperation between New Mexico and Texas and it allows us to give allocations to our water users, so it has been a huge win for both sides as well as for the Bureau of Reclamation. I think we have a great working relationship. We meet twice monthly, once for allocation issues and once for management issues so there is plenty of communication.

Figure 6. Regulating Reservoirs

Filiberto (Bert) Cortez, a native of El Paso, Texas, attended Bel Air High school and served in the U.S. Air Force during the Vietnam War era. While completing a B.S. in civil engineering at the University of Texas at El Paso, he began working for the Rio Grande Project, Bureau of Reclamation, and upon graduation worked as a staff engineer with the Project. Over the course of his career he has held various positions in the El Paso office, which include design engineer, hydraulic engineer, safety engineer, information resources coordinator, and planning engineer. Bert is now the manager of the El Paso office, which manages the water supplies for the Rio Grande Project. He is the principal Reclamation representative in various negotiations on water operations procedures, water rights adjudications, negotiation conversions of irrigation water to municipal and industrial water use, and resolution of environmental issues.

Lower Rio Grande Project Operating Agreement: Settlement of Litigation

Filiberto Cortez
Bureau of Reclamation
10737 Gateway West, Suite 350
El Paso, TX 79935

I want to start off by thanking WRRI for inviting me to speak at this conference. The people here are at the top of the water industry and I appreciate being included with them. I was looking forward to the conference because I was going to be last on the agenda and I was assured there wasn't going to be time for rebuttal. But then I found out that Gary and Chuy were conspiring against me for me to go first, so I almost lost my train of thought but I will go on with my presentation. A lot of it will be repetitive but I find you have to hear something at least three times before you really understand it.

I want to start out by giving a little bit of the history of the Project. We had a very good introduction to that yesterday during lunch when we heard about how we got where we are. We have droughts, floods, and not just in the Rio Grande Project. These are common in the western United States, which was the reason Theodore Roosevelt recognized the flood/drought reality and supported the establishment of the U.S. Reclamation Services. As somebody mentioned earlier, we were originally part of the Geological Services, so we come from the same agency but were separated out. Our initial mission was to capture the springtime floods from snowmelt runoff and store for the benefit of settlers, ranchers, and farmers in the arid West. The sign in Figure 1 says something like "thank God and U.S. Reclamation."

The Upper Rio Grande/Rio Bravo Basin experienced early agricultural development under Native American Pueblos that to this day exercise their water rights in northern New Mexico. The basin underwent a rapid period of development during the Spanish Colonial period, but for the most part, rapid development and diversion of the Rio Grande for agricultural purposes occurred after the construction of railroads into

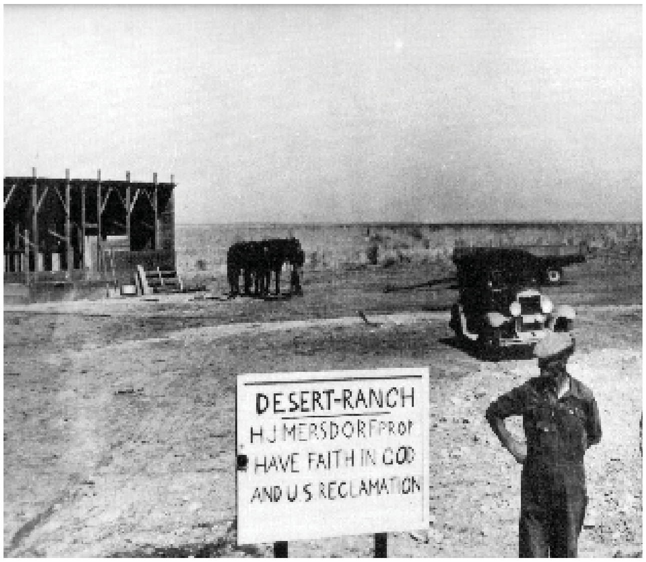


Figure 1. Western farmers and ranchers benefitted by the establishment of the U.S. Reclamation Services.

the San Luis Valley of Southern Colorado between 1860 and 1890, when about 400,000 acres of land were converted into agricultural development. This agricultural development had an adverse impact on the flow of the river in the El Paso Valley. One of the first indications of water supply problems was recorded in an official report from Major O.H. Ernst, U.S. Army Corps of Engineers, to the Chief of Engineers in 1889, basically saying that "At El Paso, ... the water ceases to flow and except at detached pools the bed becomes entirely dry. The diminished flow is probably due to evaporation and to the abstraction of portions of [the river] for irrigation purposes. In my judgment, the stream is not worthy of improvement by the General Government." I think that thought permeates throughout the hundred-year history of the Project.

Comparatively, when we look at the flows of other major western rivers, we see 150 million acre-feet on the Columbia River, which is 10 times the Colorado River at 15 million acre-feet, which is 15 times the Rio Grande at 1 million acre-feet. The United States Congress passed a resolution on April 29, 1890 calling on the President of the United States to negotiate with Mexico to settle the international aspects of the Rio Grande. In 1894, Mexico formally complained to the Secretary of Agriculture that increased diversions in the state of Colorado were causing damages to the farms in the Juarez Valley. So in 1896, Mexico and the United States agreed to a joint commission to investigate the water resources of the Upper Rio Grande/ Rio Bravo and report on the "best and most feasible mode...of regulating the use of the waters of said river as to assure to each country concerned and to its inhabitants their legal and equitable rights and interests in said waters." I might mention that we don't even call the river by the same name; depending on where you are located, we refer to it as the Rio Grande on the U.S. side and Rio Bravo on the Mexican side. It is the Upper Rio Grande in Texas, Lower Rio Grande if we are in New Mexico.

The Joint Commission on November 25, 1896 found that development of irrigated acreage in the San Luis Valley of Colorado had depleted the flow. Construction of a reservoir to capture the flood waters of the Rio Grande would provide the best and most feasible mode of affecting an equitable distribution. It further recommended that the United States prevent the construction of any large reservoirs on the Rio Grande in New Mexico or restrain any such reservoir hereafter constructed from the use of waters to which the citizens of the El Paso and Juarez Valleys had right. Basically, this established the senior right on the river at El Paso and Juarez.

On December 5, 1896, the Secretary of Interior suspended all applications for right of way for irrigation in New Mexico and Colorado. It remained that way until 1925. While it was in effect, the development of storage facilities was prohibited. The objections by upstream states were the impetus that led to the negotiation of the Rio Grande Compact.

The 1904 Compromise of the 12th International Irrigation Congress was to find a solution and suggested the Reclamation Act of 1902, from which the Reclamation Services was created, be enacted or authorized. It was to provide an interstate and international solution. In November 1904, the Reclamation Service presented a compromise at the 12th International Irrigation Congress held in El Paso, Texas. Reclamation presented plans for the Rio Grande Project, which stored waters at Elephant Butte Reservoir and supplied southern New Mexico, West Texas, and the Juarez Valley.

So what is the Rio Grande Project? It was constructed by the U. S. Bureau of Reclamation, an agency under the Department of Interior. It was authorized by the passing of the Reclamation Act of 1902 by Congress. It was the first civil engineering work to affect international allocation of water between the United States and Mexico. In 1907, Congress appropriated $1million to start project construction which would provide 60,000 acre-feet of water annually to Mexico.

Figure 2 is a map showing the project; Truth or Consequences is where Elephant Butte Reservoir is located, and right below is Caballo Reservoir, constructed in the mid 1930s. Percha Dam is our first diversion point that irrigates the Rincon Valley. Leasburg Diversion Dam is our next diversion point that irrigates the upper portion of the Mesilla Valley; the Mesilla Diversion Dam irrigates the lower portion of the Mesilla Valley. Then we have the American Diversion Dam that irrigates the upper portion of the El Paso Valley and Riverside Diversion Dam that actually no longer exists but was built to irrigate the lower portion of the El Paso Valley. The water is diverted to Mexico at the International Diversion Dam. That is where they get their 60,000 acre-ft under a full allocation.

Figure 2. Rio Grande Project area.

As stated before, we irrigate about 178,000 acres of land and supplemental hydroelectric power to south-central New Mexico. The Project features are Elephant Butte and Caballo storage dams, four diversion dams, 586 miles of canals and laterals, 484 miles of open drainage ditches, and a hydro-electric plant. Water provided by the Rio Grande, along with improved irrigation methods, has transformed the desert land in the valley into a productive region.

When we first sent astronauts up to circle the earth, one of the man-made features they could readily discern was the Rio Grande Valley, the Rio Grande Project, and its irrigated acreage. The Rio Grande Project has helped stabilize the water supply by minimizing flooding and providing water storage. Water from the Rio Grande Project is allocated by Reclamation to Elephant Butte Irrigation District in New Mexico, El Paso County Water Improvement District #1 in Texas, and delivered to each respective irrigation river head works. Water is allocated to Mexico under the Convention of 1906 and delivered at the "Acequia Madre" in El Paso.

Water is used to grow cotton, chile, pecans, and other valuable crops that flourish where once only sagebrush and cactus would grow - I took that off of a travel brochure. The project extends from 165 miles north to 80 miles southeast of El Paso. The Rio Grande meanders these approximately 200 plus miles providing water for the primary purpose of irrigation and additional purposes of municipal and industrial water supplies, and hydroelectric power generation. I think I need to interject at this point that when the Project was authorized in 1905, it was strictly for irrigation. There were no other uses of the Rio Grande Project water supply until 1925 with the Municipal Water Users Act that enabled us to go and provide the City of El Paso with water and then for other uses that were authorized under that Act.

The Project provides for flood control, fish and wildlife enhancement, outdoor recreation, research on water-related issues, construction, materials, atmospheric management, and wind and solar power. Figure 2 is a photo of Elephant Butte Dam just after it was completed. The dam provides agricultural and municipal uses in New Mexico, Texas, and Mexico. Reclamation has a good history of dam construction. In 1915 we went into a relatively wet period and filled the dam pretty quickly - Reclamation knows what it is doing.

Figure 3 is a graph of the historical end-of-month elevations on the Project starting in 1915. At the top it shows that the Bureau of Reclamation delivered water to farms from the inception of the Project in 1915 all the way to 1978. The period between 1951 and 1978 will be called D1 and D2 years, and those are the dates used to develop the curves for delivery to the irrigation districts and to Mexico. Why D1 and D2? They don't stand for delivery curves. I was actually on the Project when we started working on these curves and started analyzing all the data we had gathered from

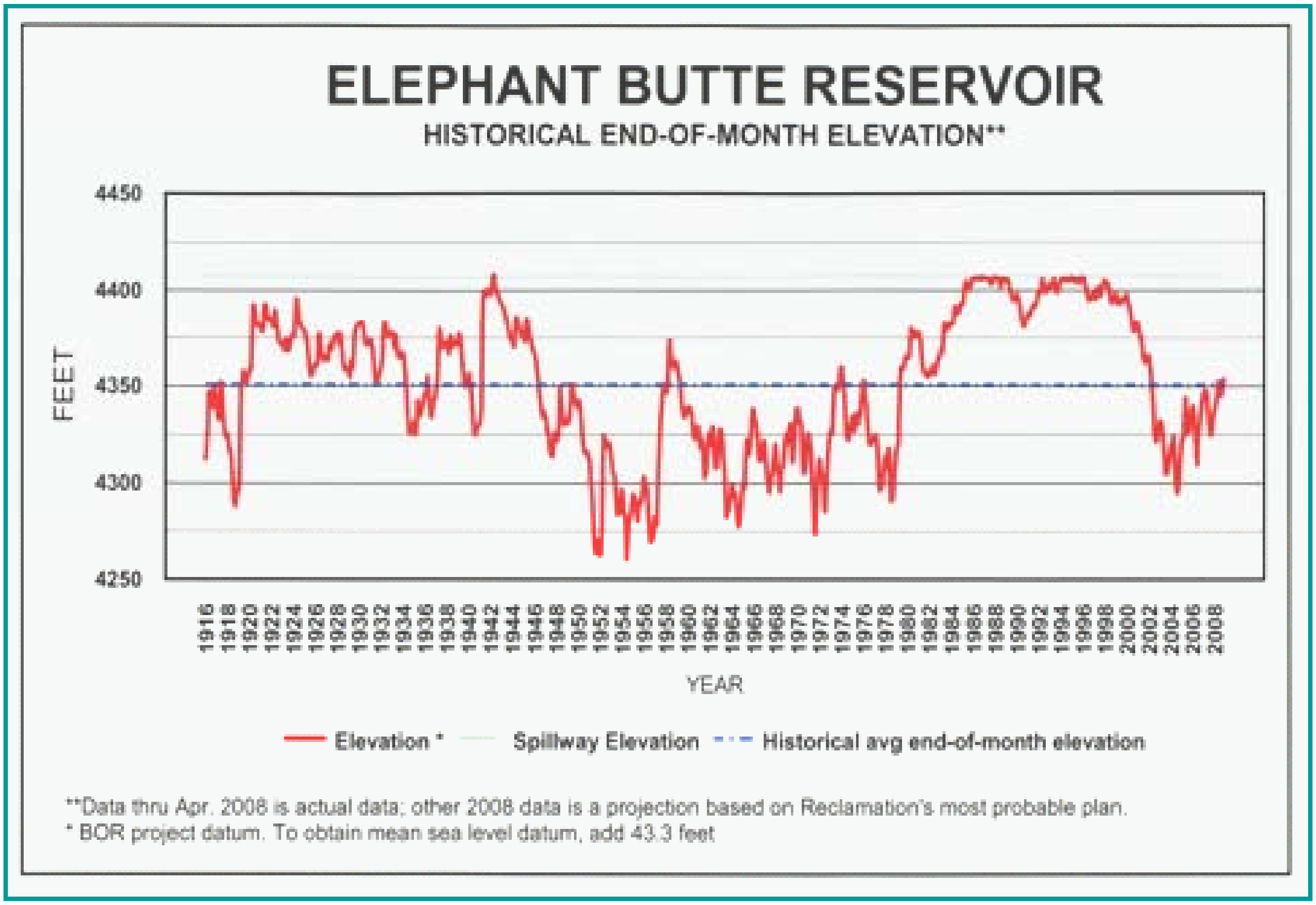


Figure 3. Elephant Butte Reservoir historical end-of-month elevation from 1915 to 2008.

1950 to 1951. We looked at evaporation curves, that was probably A1; we looked at bank storage, that was probably B1; we looked at differences in evaporation from month to month, so we just had a series of lettered curves. When we finally started looking at the release and delivery ratios and efficiencies, that's when we got to the Ds and thus why we have D1 and D2. I know because I was there. It was interesting because this was before calculators and every time that we ran a regression analysis, we had to punch every number in one at a time, over and over again. There was no storage on calculators. Or we used a tablet. That was the way it was done and this was done in coordination with the irrigation districts at the time and also with the International Boundary and Water Commission. The IBWC had a large interest in how we were going to re-manage the Project after we turned it over to the districts.

After 1978, when the districts took over the deliveries to the farms from the headings, the Bureau of Reclamation was responsible to get the allocation to the heading at the head gates, whereupon the districts took their block of water and set the allocation to the land. From 1951 through the present, we allocated an acre-foot per acre to the land before we turned it over to the districts. After that we allocated blocks of water to each district; from there they allocate it to the land based on what they thought their efficiencies were and the amount of water they could deliver based on what Reclamation had allotted to them.

Now Mexico's allocation has always been based on the delivery to lands, which is the language in the 1906 Treaty. The full allocation to land on the Project is 3.0412 acre-ft per acre, and the fact that we drew it out that far when you had ditch riders going out and visually judging what the deliveries were, and then using that data to go out to the tenth power doesn't make any sense but 3.0421 acre-feet per acre was determined to be a full allocation.

Whenever we didn't have enough water to make that full delivery, let's say we could only deliver 2 acre-feet per acre based in the short water supply in storage, then Mexico was reduced by percentage to 40,000 acre-feet, if my math is correct. Table 1 shows the relative allocation and then the allocation to Mexico. What we found when we were doing the analysis is our records show that we were very, very consistent in how we de-

Table 1. Allocation of Water Supply

ALLOCATION OF PROJECT WATER SUPPLY — 03/05/2008

YEAR	EO FEB. TOTAL RIO GRANDE PROJECT STORAGE (acre-feet)	SAN MARCIAL SPRING RUNOFF (Mar-Jul) (acre-feet)	INITIAL ALLOTMENT TO PROJECT LANDS (acre-foot/acre)	FINAL ALLOTMENT TO PROJECT LANDS (acre-foot/acre)	INITIAL ALLOTMENT TO PROJECT CANAL HEADINGS (acre-feet)	FINAL ALLOTMENT TO PROJECT CANAL HEADINGS (acre-feet)	EO OCT. TOTAL RIO GRANDE PROJECT STORAGE (acre-feet)	MEXICO DIVERSION AT ACEQUIA MADRE HEADING (acre-feet)	INITIAL RELEASE DATE FROM CABALLO DAM	CABALLO DAM TOTAL YEARLY RELEASE (acre-feet)
1951	452,730	17,877	1.00	1.75			32,900	33,059	03/06	469,450
1952	103,920	832,160	0.21	2.50			370,950	49,890	03/20	543,975
1953	468,600	143,170	1.00	1.90			99,990	37,760	03/10	528,628
1954	184,460	76,720	0.42	0.50			91,480	10,147	03/20	244,165
1955	169,850	68,920	0.21	0.42			129,700	8,185	03/20	219,157
1956	212,180	59,885	0.33	0.39			31,040	7,864	03/18	246,140
1957	77,130	600,680	0.10	1.17			645,760	23,290	03/20	397,103
1958	857,510	988,030	1.75	**4.00**			1,007,170	60,050	03/01	737,125
1959	1,185,120	72,590	3.00	**3.50**			575,670	60,110	03/02	687,414
1960	713,550	410,900	2.25	**3.25**			405,820	60,320	03/02	705,162
1961	492,870	269,550	1.25	2.45			223,080	48,610	03/10	561,697
1962	486,570	448,250	1.75	**3.25**			269,580	60,057	03/05	651,941
1963	513,170	116,765	1.85	2.00			109,440	39,693	03/05	517,172
1964	194,790	67,930	0.25	0.33			58,670	6,653	03/15	206,085
1965	172,340	596,290	0.17	1.85			340,940	36,658	03/20	505,596
1966	627,430	328,380	1.75	2.50			312,910	49,618	03/05	610,341
1967	454,710	74,090	1.25	1.50			223,340	29,829	02/27	456,517
1968	386,860	238,560	1.00	2.00			277,530	39,677	02/27	505,691
1969	466,970	358,710	1.25	**3.00**			387,410	59,884	02/27	667,669
1970	614,620	257,960	2.00	**3.00**			223,870	60,065	02/23	661,125
1971	435,640	112,837	1.50	1.75			75,540	34,847	02/26	496,375
1972	283,380	77,630	0.60	0.80			258,910	16,077	03/01	260,911
1973	457,960	914,090	1.00	**3.00**			707,340	60,000	03/09	617,461
1974	915,650	95,430	3.00	**3.00**			376,650	60,050	03/02	640,843
1975	507,700	617,850	1.00	**3.00**			534,490	60,052	01/24	580,617
1976	762,230	204,260	2.50	**3.00**			353,910	60,172	01/16	679,676
1977	482,460	43,374	1.00	1.25			140,460	24,824	03/03	416,496
1978	268,220	248,610	0.25	0.75			112,160	14,903	03/10	356,167
1979	328,690	1,148,880	0.67	**3.00**		**790,000**	855,640	60,055	03/08	568,687
1980	1,080,400	861,894	3.00	**3.00**		**790,000**	1,178,400	60,033	01/17	658,686
1981	1,339,860	54,256	3.00	**3.00**	**750,650**	**750,650**	774,380	60,262	02/04	608,166
1982	878,660	548,573	3.00	**3.00**	**790,000**	**790,000**	866,140	59,257	01/27	635,642
1983	1,070,130	920,545	3.00	**3.00**	**790,000**	**790,000**	1,289,750	60,621	02/03	648,386
1984	1,424,200	831,291	3.00	**3.00**	**902,000**	**902,000**	1,515,500	58,588	02/09	653,150
1985	1,747,700	1,133,599			**902,000**	**902,000**	2,121,600	60,276	02/20	677,398
1986	2,322,200	812,686			**902,000**	**902,000**	2,290,800	66,163	04/01	1,396,165
1987	2,336,900	1,003,319			**902,000**	**902,000**	2,168,400	65,866	02/03	1,376,099
1988	2,383,900	419,098			**902,000**	**902,000**	2,060,100	61,935	01/20	838,008
1989	2,151,900	378,144			**890,900**	**890,900**	1,705,300	58,854	02/13	736,866
1990	1,801,000	159,213			**931,841**	**931,841**	1,319,400	58,353	02/12	680,107
1991	1,509,660	656,638			**931,841**	**931,841**	1,580,080	59,242	02/19	625,956
1992	1,830,380	745,950			**931,841**	**931,841**	1,802,720	58,080	01/09	734,962
1993	1,980,230	742,508			**931,841**	**931,841**	1,976,640	63,763	01/12	823,263
1994	2,155,690	852,845			**931,841**	**931,841**	2,003,860	60,167	01/11	893,384
1995	2,203,730	991,736			**931,841**	**931,841**	2,083,050	63,618	01/17	1,096,146
1996	2,263,420	131,980			**931,841**	**931,841**	1,689,550	60,063	01/12	774,335
1997	1,814,910	600,666			**931,841**	**931,841**	1,814,980	59,442	01/21	798,621
1998	2,036,000	447,172			**931,841**	**931,841**	1,636,860	60,628	01/16	808,661
1999	1,803,410	384,225			**931,841**	**931,841**	1,658,810	58,308	01/27	735,467
2000	1,804,980	159,000			**931,841**	**931,841**	1,243,900	60,611	01/20	751,373
2001	1,359,370	241,000			**931,841**	**931,841**	856,910	61,037	02/02	786,549
2002	974,610	61,095			738,139	**931,841**	323,190	60,324	02/19	801,147
2003	456,140	62,029			74,860	317,495	170,490	26,948	03/17	364,528
2004	288,480	240,387			43,667	353,944	128,010	27,613	03/12	398,612
2005	331,000	738,095			138,549	**931,841**	362,060	58,091	03/09	676,031
2006	517,170	92,521			351,560	472,426	436,950	27,112	03/08	434,228
2007	644,990	316,979			369,466	760,391	346,170	51,245	03/07	636,730

bold number means full irrigation supply for Rio Grande Project water users.

* derived from International Boundary & Water Commission (IBWC) - U. S. Section, Yearly Flow Data Publications.

livered water to the districts and how we delivered water to Mexico in compliance with the Mexican Treaty.

Water prior to 1951 was released to irrigation lands on an as-needed basis. During the drought in the 1950s, we needed to figure out how to allocate water; we didn't have enough water to meet all the needs. We did an analysis of the deliveries that remained from 1946 to 1950, when farmers were able to call for all the water that they needed and we determined that they were calling for about 3 acre-feet per acre. That was established as a full allocation and was also used to make the delivery or the cut in the delivery to Mexico. This was the case prior to 1951. The Project was operated by Reclamation from 1951 to 1980 with the added responsibility of determining the allocation of water to lands in the United States from Acequia Madre heading for delivery to Mexico. Because of the drought, the allocation was available based on the water in storage at Elephant Butte and Caballo, which doesn't mean any water there - there is Compact water and water that we can't allocate, there is San Juan Chama water we can't allocate, also native Project water available for the Project to use for allocation and release to the Rio Grande Project users.

Since the allocation was to the lands, U.S. and Mexico's river heading the Rio Grande conveyed losses in wells and losses were utilized in making the allocation. In other words, what we are saying is based on contemporary river efficiencies, we would determine on an as needed basis how much water we were able to release and how much water was actually given to the land. Extensive water data were collected by Reclamation during this period because of the need to insure that the U.S. was complying with the 1906 Convention. This data became very important when a need for a revised allocation procedure arose.

From 1979 to 2007, Elephant Butte Irrigation District and El Paso County Water Improvement District #1 paid for their portion of the Project and completed that payment in 2007. The operation and maintenance of irrigation and drainage system was then turned over to the districts. Reclamation changed the allocation delivery point from the lands to each district's respective headings. The delivery and allocation to Mexico

remained the same as before. Respective contracts with each district called for the development of an operating agreement.
Right after the transfer, we started working on the operating agreement. The D1 and D2 curves became the backbone of what ultimately became the signed operating agreement, which was developed as a result of this work. The operations by Reclamation during the years 1951 to 1978 became the baseline for the final Operating Agreement. We talked about many baselines but this was agreed upon by negotiations between the two districts and Reclamation. Because of the need to comply with the 1906 Convention with Mexico, there needed to be consistency in regards to the deliveries to Mexico and the U.S. The final agreement also had to comply with the Rio Grande Compact and the historical releases that were made for irrigation of the Project and in the definition of Project water. So nothing there changes, even though the two districts might have a carryover account, it's all Project water, and it's all counted in relation to the Rio Grande Compact. All releases made are Compact releases, they may be divided up differently to the two districts based on carryover, but it is still a Compact release. There were many interruptions in the work to finalize an operating agreement. Throughout those years though, water was delivered to the farms, the districts, and Reclamation continued to work together in various levels of agreement. So even though we were battling at the negotiation table or suing each other, the main objective was to get water to the farms and that never stopped.

The final 2007 Operating Agreement happened because of the commitment from individuals within Elephant Butte Irrigation District and El Paso County Water Improvement District #1 and all levels of government in the Department of Interior. All levels were involved up to the Secretary. There was a feeling of urgency generated and also an understanding that the personalities that could get it done had come together at the right time. This included the board members, the managers, the management in Albuquerque, Salt Lake, Washington; everybody was committed to getting this done. There were many days of reaching consensus, usually on a Friday, followed by days of no agreement, usually on a Monday, but persistence by the parties kept bringing them back to the negotiation table. The agreement was finally signed February 14, 2007.

To summarize the Operating Agreement: each district may carry over unused water allocation year by year and accumulate up to 60% of a full allocation. When one district reaches their 60% limit on carry- over allocation, the remainder will be placed in the other district's allocation account if that district has not reached its limit. If both districts have reached their limits, then it goes into the project account. Mexico and El Paso County Water Improvement District #1 will be allocated their yearly amounts by using the D1 and D2 regression curves, respectively. Elephant Butte Irrigation District will receive their allocation based on the latest release from Caballo Dam to delivery at the canal headings ratio or the present ability of the Rio Grande to deliver water. If we are in a short water allocation situation, Elephant Butte Irrigation District gets their allocation based on D1 and D2. This delivery ratio reflects the effects of groundwater use in New Mexico on the river. This was an issue finally solved by the Operating Agreement. The Bureau of Reclamation shall perform a review of the Operation of the El Paso Field Division under its Management for Excellence program.

The Rio Grande signed Project Operating and associated documents are a significant achievement not just in this area but also West wide and within the Departments of Interior and Justice. District Board members, managers, and legal and technical staff are to be commended on a significant achievement. The benefits are increased year to year certainty on the allocation for both irrigation and municipal use, increased flexibility in each district's use of their allocation, and well defined areas of responsibility for each agency responsible for the operations of the Project, and more water in storage for recreation.

The task now is to take these documents and make them work for everyone affected by the operations of the Project. We have a year under our belt now and we are working out some of the details and glitches that didn't quite work out how we thought they would work out. What I find is that cooperation between the two districts from the operators on the ground all the way up to management makes it easy to get changes done that need to be done. There is a provision in the agreement that it will reviewed on a yearly basis and if anybody wants to make any changes, their request will be reviewed. Thank you.

PARTICIPANT LIST

William C. Ahrens
Carlsbad Irrigation District
5117 Grandi Road
Carlsbad, NM 88220
575-236-6390
cid@plateautel.net

Greg Alpers
PVACD
PO Box 1346
Roswell, NM 88202-1346
575-622-7000
bb@pvacd.com

Mike Applegate
Applegate Group, Inc.
1499 W 120th Ave, Ste 200
Denver, CO 80234
303-452-6611
mikeapplegate@applegategroup.com

Edmund G. Archuleta
El Paso Water Utilities
1154 Hawkins
El Paso, TX 79925
915-594-5501
earchuleta@epwu.org

Frank Armijo
Utility Division
City of Las Vegas
905 12th St
Las Vegas, NM 87701
505-545-0265
franklarmijo@yahoo.com

Scott M. Armstrong
Bohannan Huston, Inc.
7500 Jefferson St NE
Albuquerque, NM 87109
505-798-7832
sarmstrong@bhinc.com

William N. Ast
Northwest Pipe Company
891 E Warner Rd, Ste 100 PMB 208
Gilbert, AZ 85296
480-252-6949
wast@nwpipe.com

Reid F. Bandeen
Truchas Hydrologic Associates
PO Box 541
Placitas, NM 87043
505-867-5477
RBandeen@aol.com

Reed D. Benson
MSC 11 6070
UNM School of Law
1 University of New Mexico
Albuquerque, NM 87131
505-277-1119
benson@law.unm.edu

Claudia Borchert
Sangre de Cristo Water Division
801 W San Mateo
Santa Fe, NM 87505
505-955-4203
ciborchert@santafenm.gov

Charles Braden
US Bureau of Indian Affairs
PO Box 90691
Albuquerque, NM 87199
505-453-5007
charles.braden@bia.gov

Elizabeth Bradley
6 Camino Osito
Santa Fe, NM 87505
505-995-0204
bradmeri@earthlink.net

Hilary Brinegar
MSC APR
NM Department of Agriculture
PO Box 30005
Las Cruces, NM 88003-8005
575-646-2642
hbrinega@nmsu.edu

David Brookshire
Dept of Economics MSC05-3060
University of New Mexico
1 University of New Mexico
Albuquerque, NM 87110
505-277-1964
brookshi@unm.edu

F. Lee Brown
H2O Economics
3200 El Toboso NW
Albuquerque, NM 87104
505-897-5910
flbrown@unm.edu

Gary L. Bryant
Texas Water Resource Institute
Texas AgriLife Extension
PO Box 1298
Fort Stockton, TX 79735
432-336-8585
glbryant@ag.tamu.edu

Brent Bullock
PVACD
PO Box 1346
Roswell, NM 88202-1346
575-622-7000
bb@pvacd.com

John Burkstaller
Daniel B. Stephens & Associates, Inc.
6020 Academy NE #100
Albuquerque, NM 87109
505-822-9400
jburkstaller@dbstephens.com

Jack Byers
Applegate Group, Inc.
1499 W 120th Ave, Ste 200
Denver, CO 80234
303-452-6611
jackbyers@applegategroup.com

Gary Carlson
49 Verano Loop
Santa Fe, NM 87508
505-466-7683
journintl@prodigy.net

Rick Carpenter
City of Santa Fe and Buckman Direct Diversion
801 W San Mateo
Santa Fe, NM 87505
505-955-4206
rrcarpenter@santafenm.gov

John R. Castillo
Dept of Municipal Development
City of Albuquerque
PO Box 1293
Albuquerque, NM 87103
505-768-3830
jcastillo@cabq.gov

Aaron Chavez
GIS Coordinator
San Juan Water Commission
7450 E Main St
Farmington, NM 87402
505-564-8969
sjwcoffice@sjwc.org

Calvin Chavez
NM Office of the State Engineer
1680 Hickory Loop
Las Cruces, NM 88005
575-524-6161
Calvin.Chavez@state.nm.us

Mike Connor
Office of NM Senator Jeff Bingaman
703 Hart Senate Office Bldg
Washington, DC 20510
202-224-5521
michael_connor@energy.senate.gov

Filiberto Cortez
US Bureau of Reclamation
10737 Gateway West, Ste 350
El Paso, TX 79935
915-534-6300
fcortez@uc.usbr.gov

Lisa Croft
US Bureau of Reclamation
555 Broadway NE, Ste 100
Albuquerque, NM 87102
505-462-3542
lcroft@uc.usbr.gov

John D'Antonio Jr
NM Office of the State Engineer
PO Box 25102
Santa Fe, NM 87504-5102
505-827-6091
john.dantonio@state.nm.us

Donald Dayton
AARP - Water Resources Comm.
3 Manzano Ct
Santa Fe, NM 87508
505-466-4348
nad.dad@att.net

Dale Doremus
Surface Water Quality Bureau N2053
NM Environment Department
PO Box 26110
Santa Fe, NM 87502
505-476-3026
dale.doremus@state.nm.us

John Draper
Montgomery & Andrews, PA
PO Box 2307
Santa Fe, NM 87504-2307
505-986-2525
jdraper@montand.com

Craig T. Erickson
Sheehan, Sheehan & Stelzner
PO Box 271
Albuquerque, NM 87103
505-247-0411
cte@ssslawfirm.com

Gary Esslinger
Elephant Butte Irrigation District
530 South Melendres St
Las Cruces, NM 88005
575-526-6671
gesslinger@ebid-nm.org

Amy Ewing
Daniel B. Stephens & Associates, Inc.
6020 Academy Rd NE, Ste 100
Albuquerque, NM 87109
505-822-9400
aewing@dbstephens.com

Rodger F. Ferreira
US Geological Survey
5338 Montgomery NE, Ste 400
Albuquerque, NM 87109
505-830-7902
ferreira@usgs.gov

Kevin Flanigan
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
kevin.flanigan@state.nm.us

Joseph J. Fluder
SWCA Environmental
5647 Jefferson St NE
Albuquerque, NM 87112
505-254-1115
jfluder@swca.com

Michael Gabaldon
Director Technical Resources, 86-60000
US Bureau of Reclamation
PO Box 25007
Denver, CO 80225
303-445-3750
mgabaldon@do.usbr.gov

Jorge Garcia
City of Las Cruces
680 N Motel Blvd
Las Cruces, NM 88005
575-528-3636
jogarcia@las-cruces.org

Greg B. Gates
Senior Water Resources Engineer
CH2M HILL
4041 Jefferson Plaza NE, Ste 200
Albuquerque, NM 87109
505-855-5238
Greg.Gates@ch2m.com

William S. Goebel
RR 1 Box 41
Maxwell, NM 87728
575-375-2972
bgoebel@bacavalley.com

Homer Gonzales, Sr.
Water Administration
Jicarilla Apache Nation
PO Box 507
Dulce, NM 87528
575-759-1198

Grace Haggerty
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
grace.haggerty@state.nm.us

Steve Hansen
US Bureau of Reclamation
555 Broadway NE, Ste100
Albuquerque, NM 87102
505-462-3542
shansen@uc.usbr.gov

John W. Hawley
Hawley Geomatters
PO Box 4370
Albuquerque, NM 87196-4370
505-255-4847
hgeomatters@qwestoffice.net

Elaine Hebard
1513 Escalante SW
Albuquerque, NM 87104
505-247-8767
ehebard@yahoo.com

Rick Hendricks
Archives and Special Collections MSC 3457
New Mexico State University
PO Box 30006
Las Cruces, NM 88003
575-646-7281
rickhen@lib.nmsu.edu

Shelly Herbst
Marron and Associates, Inc.
7511 Fourth St NW
Albuquerque, NM 87107
505-898-8848
shelly@marroninc.com

John Hernandez
PO Box 3196
Las Cruces, NM 88003
575-524-2980
hernandez0025@att.net

Steven L. Hernandez
Hubert & Hernandez, PA
2100 North Main
Las Cruces, NM 88001
575-526-2101
slh@lclaw-nm.com

Walter G. Hines
CH2M HILL
12504 Mountain Ridge PL NE
Albuquerque, NM 87112
505-298-8408
wbhines@comcast.net

Mary Humphrey
Humphrey & Ode, PC
PO Box 1574
El Prado, NM 87529
575-758-2203
humphrey@newmex.com

Russell A. Isaac
NM Environment Department
PO Box 5469
Sante Fe, NM 87502-5469
505-827-2912
russell.isaac@state.nm.us

Janet Jarratt
Board of Directors
Middle Rio Grande Conservancy District
2520 Los Lentes Rd
Los Lunas, NM 87031
505-865-1430
jj@jjwater.info

Alvin F. Jones
Hennighausen & Olsen, LLP
PO Box 1415
Roswell, NM 88202-1415
575-624-2463
ajones@nmproattorneys.com

Dudley C. Jones
Carlsbad Irrigation District
5117 Grandi Road
Carlsbad, NM 88220
575-236-6390
Dudley.Jones@cidistrict.com

David Jordan
INTERA
6000 Uptown Blvd NE, Ste 100
Albuquerque, NM 87110
505-246-1600
djordan@intera.com

Susan Kelly
MSC11 6070
Utton Center
713 Camino Espanol NW
Albuquerque, NM 87107
505-277-0514
skelly@law.unm.edu

Susan C. Kery
Sheehan, Sheehan & Stelzner, PA
PO Box 271
Albuquerque, NM 87103
505-247-0411
sck@ssslawfirm.com

J. Phillip King
Civil Engineering MSC 3CE
New Mexico State University
PO Box 30001
Las Cruces, NM 88003
575-646-5377
jpking@nmsu.edu

Dick Kreiner
Tetra Tech Inc.
6121 Indian School Rd NE
Albuquerque, NM 87110
505-881-3188
dick.kreiner@tetratech.com

Matthew C. Larsen
MS-409
US Geological Survey
12201 Sunrise Valley Dr
Reston, VA 20192
703-648-5215
mclarsen@usgs.gov

John Leeper
Water Management Branch
Navajo Nation Department of Water Resources
PO Box 678
Fort Defiance, AZ 86504
928-729-4004
johnleeper@navajo.org

Andrew Lieuwen
Water Resource, Engineering & Planning
ABCWUA
PO Box 1293
Albuquerque, NM 87103
505-768-2570
alieuwen@abcwua.org

Beiling Liu
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
beiling.liu@state.nm.us

Eddie C. Livingston
Livingston Associates
500 Tenth St, Ste 300
Alamogordo, NM 88310
575-439-8588
elivingston@livingston-associates.com

Estevan Lopez
NM Interstate Stream Commission
PO Box 25102
Santa Fe, NM 87504-5102
505-827-6103
estevan.lopez@state.nm.us

Amy Louise
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
amy.louise@state.nm.us

Anders Lundahl
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
anders.lundah@state.nm.us

Rick A. Lusher
Water Rights Division
NM Office of the State Engineer
PO Box 25102
Santa Fe, NM 87504-5102
505-827-6120
rick.lusher@state.nm.us

Jeanette Lyman
Office of Congressman Tom Udall
811 St. Michaels Dr
Santa Fe, NM 87505
505-984-8950
jeanette.lyman@mail.house.gov

Hugo A. Magaña
Rocky Mountain Research Station
USDA Forest Service
333 Broadway Blvd #115
Albuquerque, NM 87102
505-724-3682
hmagana@fs.fed.us

Aaron Manwell
Jicarilla Apache Nation
PO Box 507
Dulce, NM 87528
575-759-1198
lefevreandrea@yahoo.com

Yorgos D. Marinakis
Journal of Sustainability
1600 Blackhawk River Dr NE
Rio Rancho, NM 87144-6416
505-867-6115
g_marinakis@hotmail.com

Eluid L. Martinez
Former NM State Engineer
1795 Paseo de Vista
Santa Fe, NM 87501
505-670-6345
eluid@excite.com

Douglas P. McAda
US Geological Survey
5338 Montgomery NE, Ste 400
Albuquerque, NM 87109
505-830-7943
dpmcada@usgs.gov

Karen S. McAda
Montrose Consulting, Inc.
410 Green Acres Lane
Bosque Farms, NM 87068
505-480-4380
ksmcada@comcast.net

Barbara McCrimmon
Quemado Soil & Water Conservation Dist
PO Box 136
Datil, NM 87821
575-772-5722
loretta.rael@nm.nacdnet.net

Dwight Menefee
PVACD
PO Box 1346
Roswell, NM 88202-1346
575-622-7000
bb@pvacd.com

Ari Michelsen
Agricultural Research and Extension Ctr
Texas AgriLife Research
1380 A&M Circle
El Paso, TX 79927-5020
915-859-9111
a-michelsen@tamu.edu

Paul Montoia
City of Farmington
800 Municipal Drive
Farmington, NM 87401
505-599-1393
pmontoia@fmtn.org

Les Montoya
San Miguel County, County Manager
518 Valencia St, Ste 100
Las Vegas, NM 87701
505-425-9333
smcmanager@smcounty.net

Stephanie Moore
Daniel B. Stephens & Associates, Inc.
6020 Academy NE, Ste 100
Albuquerque, NM 87109
505-822-9400
smoore@dbstephens.com

Robert MoQuino
Haaku Water Office
Pueblo of Acoma
PO Box 309
Acoma, NM 87034
575-552-5161
rmoquino@usgs.gov

Jeremiah T. Morse
Hydrology Program
New Mexico Tech
PO Box 2947
Socorro, NM 87801
616-481-0151
jmorse@nmt.edu

Hiram S. Muse
9 Tumbleweed Trail
La Luz, NM 88337
575-430-6828
hmuse@zianet.com

Nathan Myers
US Geological Survey
5338 Montgomery NE, Ste 400
Albuquerque, NM 87109
505-830-7942
nmyers@usgs.gov

Bill Netherlin
PVACD
PO Box 1346
Roswell, NM 88201-1346
575-622-7000
bb@pvacd.com

Edward L. Nickerson
MSC 3ARP
US Geological Survey
PO Box 30001
Las Cruces, NM 88003
575-646-7618
nickerso@usgs.gov

Connie Ode
Humphrey & Ode, PC
PO Box 1574
El Prado, NM 87529
575-758-2203
code@newmex.com

Adrian Oglesby
Living Rivers Program
The Nature Conservancy
212 E Marcy St, Ste 200
Santa Fe, NM 87501
505-280-7958
aoglesby@tnc.org

Jeffrey K. O'Hara
Chicago Climate Exchange
190 South LaSalle St, Ste 1100
Chicago, IL 60603
312-229-5136
johara@theccx.com

Arnold J. Olsen
Hennighausen & Olsen, LLP
PO Box 1415
Roswell, NM 88202
575-624-2463
aolsen@nmproattorneys.com

Stanley Paytiamo
Haaku Water Office
Pueblo of Acoma
PO Box 309
Acoma, NM 87034
575-557-5161

Page Pegram
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
page.pegram@state.nm.us

Lee E. Peters
Hubert & Hernandez, PA
PO Drawer 2857
Las Cruces, NM 88004-2857
575-526-2101
lep@lclaw-nm.com

Robert Pine
NMED Drinking Water Bureau
1190 St. Francis Dr, Ste N4050
Santa Fe, NM 87505
505-476-8642
robert.pine@state.nm.us

Heidi M. Pitts
MSC05 3060
University of New Mexico
1 University of New Mexico
Albuquerque, NM 87131
505-277-0646
hpitts@unm.edu

John R. Poland
US Bureau of Reclamation
555 Broadway NE, Ste 100
Albuquerque, NM 87102
505-462-3542
jpoland@uc.usbr.gov

Edward A. Polasko
WFO Albuquerque
National Weather Service
2341 Clark Carr Loop SE
Albuquerque, NM 87106
505-244-9147
ed.polasko@noaa.gov

Jeff L. Pompeo
NM Office of the State Engineer
PO Box 25102
Santa Fe, NM 87504
505-827-6194
jeff.pompeo@state.nm.us

Loretta J. Rael
Quemado Soil & Water Conservation Dist
PO Box 136
Datil, NM 87821
575-772-5722
loretta.rael@nm.nacdnet.net

Anna Rael-DeLay
Office of Congressman Tom Udall
811 St. Michael's Dr
Santa Fe, NM 87505
505-974-5103
anna.raeldelay@mail.house.gov

Bhasker Rao
NM Interstate Stream Commission
PO Box 25102
Santa Fe, NM 87501
505-827-6105
bhasker.rao@state.nm.us

John Reid
City of Las Cruces
PO Box 20000
Las Cruces, NM 88004
575-528-3636
john.reid@las-cruces.org

Jesus (Chuy) Reyes
El Paso County Water Improvement
District No. 1
294 Candelaria
El Paso, TX 79907
915-859-4186
jreyes@epcwid1.org

Craig Roepke
NM Interstate Stream Commission
PO Box 25102
Santa Fe, NM 87502
505-827-6160
craig.roepke@state.nm.us

Birdian Rogers
Water Administration
Jicarilla Apache Nation
PO Box 507
Dulce, NM 87528
575-759-1198
rogersbirdian@yahoo.com

Craig Runyan
Extension Plant Sciences MSC 3AE
New Mexico State University
PO Box 30003
Las Cruces, NM 88003
575-646-1131
crunyan@nmsu.edu

Shawna R. Russo
Tufts University
W 407 F Sophia Gordon Hall
Medford, MA 02155
505-269-0431
shawna.russo@gmail.com

Doug Sayre
Water/Wastewater Operations
Santa Fe County
PO Box 276
Santa Fe, NM 87504
505-992-9870
dsayre@santafecounty.org

Rolf Schmidt-Petersen
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
rolf.schmidt@state.nm.us

Herman Settemeyer
MC-160
Texas Commission on Environmental Quality
PO Box 13087
Austin, TX 78711-3087
512-239-4707
hsetteme@tceq.state.tx.us

Augustine Seymour, Sr.
Haaku Water Office
Pueblo of Acoma
PO Box 309
Acoma, NM 87034
575-557-5161

Nabil Shafike
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
nabil.shafike@state.nm.us

Sharon Shaheen
Montgomery & Andrews, PA
PO Box 2307
Santa Fe, NM 87504
505-986-2678
sshaheen@montand.com

Marc C. Sidlow
US Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, NM 87109
505-342-3381
marc.c.sidlow@usace.army.mil

Richard A. Simms
PO Box 3329
Hailey, ID 83333
208-788-4282
richardsimms@cox.net

James T. Smith
NM Office of the State Engineer (Retired)
9904 Academy Knolls Dr NE
Albuquerque, NM 87111-1733
505-292-2946
takajts@aol.com

Kate Southard
Kate Southard Real Estate
601 Griegos NW
Albuquerque, NM 87107
505-344-0741
kate.southard@gmail.com

Robert Sparks, Jr.
1404 Wheeler Ave SE
Albuquerque, NM 87106
505-247-2501

Chris Stageman
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
chris.stageman@state.nm.us

Charles B. Stanford
Library MSC 3475
New Mexico State University
PO Box 30006
Las Cruces, NM 88003-8006
575-646-6323
cstanfor@nmsu.edu

Daniel B. Stephens
Daniel B. Stephens & Associates, Inc.
6020 Academy Rd NE, Ste 100
Albuquerque, NM 87109
505-822-9400
dan.stephens@dbstephens.com

John Stomp III
ABCWUA Water Resources Division
ABCWUA
PO Box 1293
Albuquerque, NM 87103
505-768-3631
Jstomp@abcwua.org

Bill Tai
NM Interstate Stream Commission
121 Tijeras NE, Ste 2000
Albuquerque, NM 87102
505-764-3880
bill.tai@state.nm.us

Cheryl S. Thacker
NM Office of the State Engineer
1680 Hickory Loop
Las Cruces, NM 88005
575-524-6161
Cheryl.Thacker@state.nm.us

Bruce Thomson
Water Resources, MSC05-3110
University of New Mexico
1 University of New Mexico
Albuquerque, NM 87131
505-277-4729
bthomson@unm.edu

Iris A. Thornton
Advocates for Community and Environment
129-C Kit Carson Road
Taos, NM 87571
575-758-7202
iris@communityandenvironment.net

Julian W. Thrasher
Pecos River Compact Commission
PO Box 340
Monahans, TX 79756
432-940-1753
j.thrasher@sbcglobal.net

Todd Tillman
US Bureau of Reclamation
555 Broadway NE, Ste 100
Albuquerque, NM 87102
505-462-3652
ttillman@uc.usbr.gov

Karen Torres
Water/Wastewater Operations
Santa Fe County
PO Box 276
Santa Fe, NM 87504
505-992-9870
ktorres@santafecounty.org

Wayne Treers
US Bureau of Reclamation
10737 Gateway West, Ste 350
El Paso, TX 79935
915-534-6300
wtreers@uc.usbr.gov

Tanya Trujillo
General Counsel
NM Interstate Stream Commission
PO Box 25102
Santa Fe, NM 87504-5102
505-476-0558
tanya.trujillo@state.nm.us

Bill Turner
Middle Rio Grande Conservancy Dist
610 Gold Ave. SW
Albuquerque, NM 87102
505-843-7643
wturner@waterbank.com

John C. Tysseling
E3c, Inc.
5600 Eubank NE, Ste 200
Albuquerque, NM 87111
505-822-9760
jct@e3c.com

Peggy Ulman
Marron and Associates, Inc.
7511 Fourth St NW
Albuquerque, NM 87107
505-898-8848
peggy@marroninc.com

John W. Utton
Sheehan, Sheehan & Stelzner, PA
PO Box 271
Albuquerque, NM 87103
505-247-0411
jwu@ssslawfirm.com

Scott A. Verhines
GC Engineering, Inc.
10010 Indian School Rd NE
Albuquerque, NM 87112
505-263-4520
sverhines@gc-engineering.com

Max Vigil
Jicarilla Apache Nation
PO Box 507
Dulce, NM 87528
575-759-7405
lefevreandrea@yahoo.com

Cliff Waide
Mayor, Town of Hagerman
PO Box 247
Hagerman, NM 88232
575-752-3204
hagerman@leaco.net

Larry Walkoviak
Department of Interior
US Bureau of Reclamation
125 S State St, Rm 6107
Salt Lake City, UT 84138
801-524-3603
lwalkoviak@uc.usbr.gov

Michael J. Walsh
Chicago Climate Exchange
190 South LaSalle St, Ste 1100
Chicago, IL 60603
312-554-3350
mwalsh@theccx.com

Bill Warmack
Applegate Group, Inc.
1499 W 120th Ave, Ste 200
Denver, CO 80234
303-452-6611
billwarmack@applegategroup.com

Larry Webb
Utilities Division
City of Rio Rancho
3200 Civic Center Circle NE
Rio Rancho, NM 87144-4501
505-896-8715
lwebb@ci.rio-rancho.nm.us

Bob Wessely
Water Assembly
270 County Road A3
Las Vegas, NM 87701
505-908-9400
Wessely@SciSo.com

Adrienne L. Widmer
Utilities, City of Las Cruces
680 N Motel Blvd
Las Cruces, NM 88007
575-528-3636
awidmer@las-cruces.org

Charles Wohlenberg
PO Box 27010
Albuquerque, NM 87125
505-345-0918
cwohlenberg@cnm.edu

Betsy Woodhouse
Southwest Hydrology
UA SAHRA
PO Box 210158-B
Tucson, AZ 85721-0158
520 -626-1805
mail@swhydro.arizona.edu

Mark E. Yuska
US Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, NM 87109
505-342-3608
mark.e.yuska@usace.army.mil

Dean A. Zimmerman
Water Resources, MC 461
Bureau of Indian Affairs
PO Box 26567
Albuquerque, NM 87125-6567
505-563-3422
Dean.Zimmerman@bia.gov

Roger M. Zimmerman
Engineering Analyses, LLC
1600 Torribio Ct NE
Albuquerque, NM 87112
505-292-3009
rmzimme@aol.com