Community Stakeholder Panel: Inputs to New Mexico's Water System and Stakeholder Needs from a Statewide Water Assessment

Editor's Note: The following papers represent a transcription of the speakers' remarks made at the conference; no follow-up papers were submitted by the speakers. Remarks were edited for publication by the editor. The speakers did not review this version of their presentation, and the editor is responsible for any transcription and editing errors.

Alamogordo

Eddie Livingston, Livingston and Associates

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Thank you very much, it is a pleasure to be here. What I would like to do this afternoon is to give you an overview of the City of Alamogordo's water planning.

The City of Alamogordo has been very innovative and proactive in their water resource planning for quite a number of years. They were involved with the first comprehensive plan in the Tularosa Basin, the Tularosa Basin and Salt Basin Regional Water Plan 2000-2040 (Figure 1). In that plan, the City chose their water supply alternative of choice as the desalination project. We have been involved with this project for the City since about 1998. The regional plan really formulated and tied down the desalination project.

A lot of information was in the plan - it is a two-volume regional water plan that helps to support the desalination project and the other alternatives that were considered. Along with the regional water plan, the City developed a water development plan with John Shomaker and Associates as sub-consultants. In 2000, we began working on the local plan, and that plan was then integrated into the regional plan, which supported the desalination project. The latest version of the plan was published last August and looks at the 2015-2055 planning period. Figure 1 shows the progression of plans that gets us to where we are today.

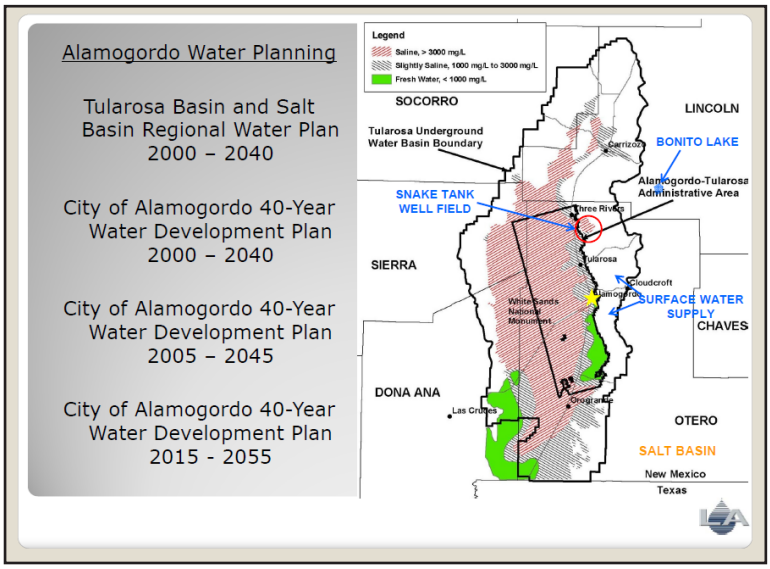


Figure 1. City of Alamogordo water plans and map of the Tularosa Basin.

Concerning the graphic in Figure 1, first give credit to John Shomaker. I have added a bit to it. You can see the Tularosa Basin; Alamogordo is centrally located with a population of about 36,000, projected to grow to about 68,000 by 2055. The city has two surface water supplies with about 70 percent of water coming from east of Alamogordo via the La Luz and Alamo Canyon watersheds, which are on the western slopes of the Sacramento Mountains. That is of course a very important supply for the city. The city also has two well fields located near the city that supply groundwater.

As we move north (on Figure 1), we see the circled area about 26 miles north of Alamogordo. That is the Snake Tank Well Field, and it is the brackish water supply for the desalination plant. The State Engineer granted about 4,000 acre-feet of water for the plant; the quality of the water is about 2500 ppm dissolved solids (primarily calcium sulfate). That water will be pumped down through the city and used in the desalination plant. It was quite a process to go through the water rights application process–the hearing, the trial, and so on. It has been about a 10-year process to get to where we are today. You cannot start the process when you begin to run out of water–you have to plan long ahead so that by the time you get to the point where you need the water, you have it.

Bonito Lake, east of Carrizozo, provides 15-20 percent of Alamogordo's water supply. It is very good quality water with less than 500 total dissolved solids (TDS). It took about 90 miles of pipeline to transport that water. However, you can't always count on things that you think you can count on. In 2012, the Little Bear forest fire completely burnt out the watershed to Bonito Lake and subsequent rains delivered about 200,000 cubic yards of sediment into the lake rendering it completely unavailable as a supply. One day it was a supply, and the next day it was not. You have to incorporate and anticipate these things in your plans.

In the southeast corner is the Salt Basin, which is included in part of the regional water plan and is an important resource that has been largely ignored. It is, however, a potential long-term supply for the city. When we look at the surface water sources to the east of the city, they are just as vulnerable to fire as Bonito Lake. It is important to decide how much to rely on your surface water sources given the potential for losing them almost overnight.

If we look at the water balance in the plan (Figure 2), we consider two different scenarios. One concerns normal conditions where both surface and groundwater are available. Then there is the extreme condition where you do not have any surface water available for whatever reason–whether due to extreme drought or due to forest fire or another catastrophic event that leaves no surface water at all. When we do a water balance on both scenarios, keep in mind that both of these scenarios show the "firm" supply of surface water and groundwater, which is the amount of water that you guarantee 24/7 and 365 days a year in all conditions. The "average" supply is higher than the firm supply, but when you plan, you must look at what you can guarantee. All water suppliers are mandated by the public to supply drinking water in all cases – so you have to approach planning with the "firm" supply attitude.

Looking at normal conditions for both surface water and groundwater (Figure 2), the 2015 water requirement demands are about 7,000 acre-feet. Thus, from that standpoint, we are already about 70 acre-feet short. You want to build your water system so that you can guarantee water supply. If

Water Source	Normal Condition Firm Supply AFY	Extreme Condition Firm Supply AFY
Surface Water	2,525	0
Ground Water*	3,909	3,909
Total	6,434	3,909
2015 requirement	7,185	7,185
Balance[t]	<751>	<3,276>
2055 requirement	11,584	11,584
Balance[t]	<5,150>	<7,675>

* - not incl desal
t – made up with desal

Figure 2. Surface and groundwater supplies under normal and extreme conditions for Alamogordo.

you look at the 2055 requirement of almost 12,000 acre-feet, we are 5,000 acre-feet short. The desalination plant would move immediately into supplying the water required to balance demands. On the other side, let's consider the extreme condition. If there were no surface water supply at all, or if it was rendered inoperable or unavailable, the demand would be the same. Right there we would be about 3,200 acre-feet short and we would require the entire desalination plant supply that we have online today. By 2055, we would be almost 8,000 acre-feet short, which is twice what the desalination plant can produce. When we talk about the extreme condition, we say ok, we lose the entire watershed for perhaps five or ten years. We still do not know exactly when Bonito Lake is going to be back online. They are just now coming up with the engineering for the dredging and cleaning of that lake. The last estimates were up to possibly ten years. You may think that ten years does not sound long, but out of a forty-year plan, it is a lot. Also, which ten years do you want–the first ten, the last ten, or the middle ten? You don't know and you won't know, but you have to plan for it nevertheless. That way by the time something happens, it isn't too late to do something about it.

These figures are shown graphically in Figure 3. Surface water is shown in green, groundwater supply in brown, and you can see immediately that we need to implement the desalination plant to cover the demands beyond firm supply. By 2040, we are out of current Snake Tank rights for desalination supply, so we need to start looking for additional sources for beyond 2040. Will that supply come from the same well field? This is likely as the field is surrounded with observation wells and the State Engineer wants these in place before the City starts pumping. The wells need to be monitored to make sure that the drawdowns do not impair downstream users. Long-term data will tell us if that well field can be expanded. If not, we will need to look elsewhere for brackish water.

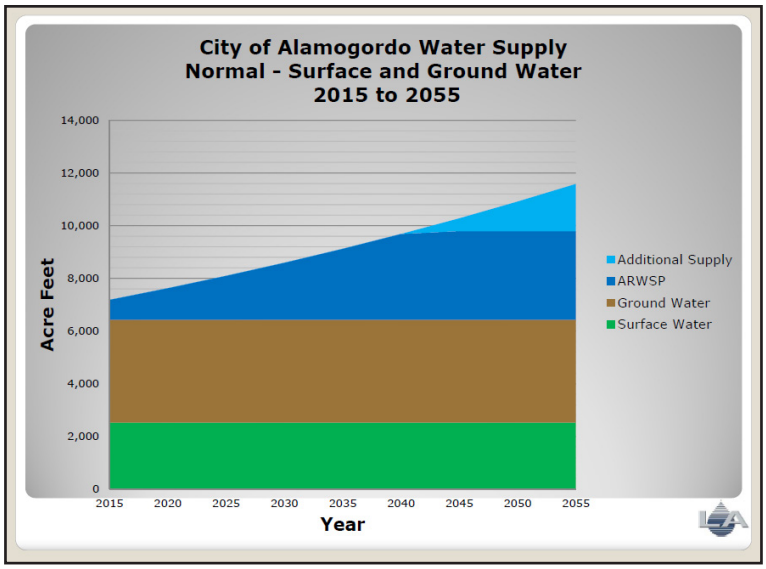


Figure 3. Normal surface and groundwater 2015 - 2055; City of Alamogordo water supply.

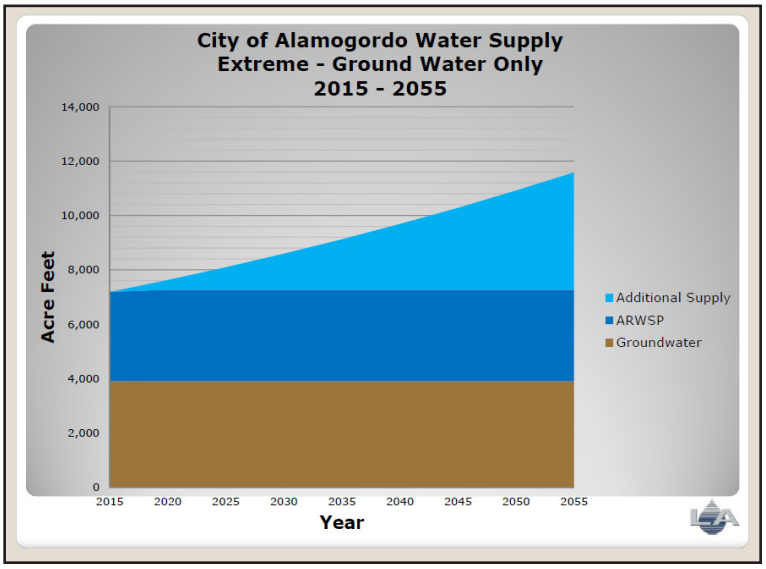


Figure 4. Extreme surface and groundwater 2015 - 2055; City of Alamogordo water supply.

So, under the extreme condition (Figure 4), Snake Tank water rights are used up immediately, and we need to start looking for additional brackish water or consider importation. Both of these situations require not only the desalination project, but also must consider "firm" supply. You must be ready for extreme events. You cannot count on what you cannot count on.

Some major water development projects are coming out of the latest plan (Figure 5). The first phase of the desalination project is a one million gallon a day replacement for Bonito Lake. That supply can be put back into the system and we can count on it. We are a sub-consultant to CDM Smith, which is a prime consultant on the project now under design. Ultimately, we will have 5,000 acre-feet of desalinated water under the normal condition, and up to 7,600 acre-feet by the year 2055 under the extreme condition. Looking at both situations, that is roughly 50 percent of the capacity in the system. Under normal conditions, are we going to be running the plant that long and that much? Probably not, but you must have the capability. Again, if the supply is not there when you need it–and it took us 10-15 years to get where we are–it would definitely be too late.

Figure 5. Major water supply development projects for Alamogordo, 2015 - 2055.

The second item on Figure 5 concerns Aquifer Storage and Recovery (ASR). In 1997, we did a pilot study with John Shomaker and Associates to look at ASR. We have a recommendation to implement fully the ASR program for a conjunctive use management program where we could use the desalination plant and surface water to recharge the La Luz Well Field.

We also have a reclaimed water supply and Alamogordo uses all of this supply. There is a brand new wastewater treatment plant compliments of Bohannan Huston, and the City has been using all of this water on its green spaces for several years. That supply is what helped drive their GPCD (gallons per capita per day) down to about 130 now. You do not want reclaimed water counted in your GPCD, otherwise it is a double whammy and a disincentive. You do it because it is the ultimate in water conservation. If you want to build a golf course, great, but don't use drinking water for it. Use reclaimed water for these sorts of things, and the City uses all of that supply except perhaps in the winter when there is about a 1,000 acre-feet not used. The City has been building more storage, and the plan calls to use that remaining water in a potable water reuse project. The only downside to using this water on a golf course is that you cannot drink it, but using it for green spaces is probably the first and best use for it rather than using it for drinking water.

Agricultural water trade may be another possible opportunity. Some of the reclaimed water could be traded for water from local farmers. In other words, drink the agricultural water and let farmers irrigate with the reclaimed water–it is a win-win situation for both sides.

We are also looking at bulk-water importation in long-term planning. This is where the Salt Basin may come into play. It was discussed in the Tularosa Basin Regional Water Plan. By some accounts, there is 100,000 acre-feet of water in the Salt Basin. Some of it is pretty good quality with less than 2,000 ppm in TDS. Some parts are less than 1,000 ppm TDS. What opportunities lie there? Can that water be piped to Alamogordo? Can that water be piped to the Rio Grande and used in some fashion to help with deliveries to Mexico and/or Texas? This is unencumbered water and may help with a long-term brackish water supply for the city of Alamogordo.

As far as assessment needs, the City is looking at additional brackish groundwater availability for the future. Quantifying the supply in the area would be valuable. There is also a bulk-water importation strategy, which includes identifying possible regional partners and determining the quality and quantity to be imported. These are the sorts of items that the City's plan is considering with the desalination plant being the primary project now underway.

Thank you.

City of Las Vegas

Ken Garcia, Utilities

Ken is currently the Utilities Director for the City of Las Vegas, NM, and has worked in a variety of areas within the water field beginning in 1998. His management and technical experience extends to a variety of settings including private, tribal, and municipal utilities.

Good afternoon. I would like to start by acknowledging our mayor Alphonso E. Ortiz Jr. The mayor has been instrumental in pushing forward water projects from the funding and implementation perspectives. Anytime you are being innovative, there are a lot of barriers to get over to the construction phase of the project. I am going to add a little twist to my presentation and focus a bit more on the historical perspective for the community and how that has led to the current understanding of our water resources. I think the technical part of it is only a reality on the ground for the utilities. Historical, political, and other aspects greatly impact our success.

For the community of Las Vegas, the first 100 years were marked by the settlement of the Mexican Pueblos, and hence Pueblo water rights claims (Figure 1). When I say Pueblo, I am talking about the Mexican Pueblos not the Native American Pueblos. By rapid development of land and water with the arrival of the railroad, Old Town customs were rapidly impacted by the U.S. expansive settlement on the east side of the Gallinas, which is called "new town." Both towns remained separately governed for over 100 years east and west of the Gallinas, and are distinct to this day.

In 1835, the Mexican government approved a petition to establish a community land grant on the historic Santa Fe Trail. For those of you who may not know this, we are at the end of the Santa Fe Trail (Figure 2). We are also at the beginning of the Camino Real, which is

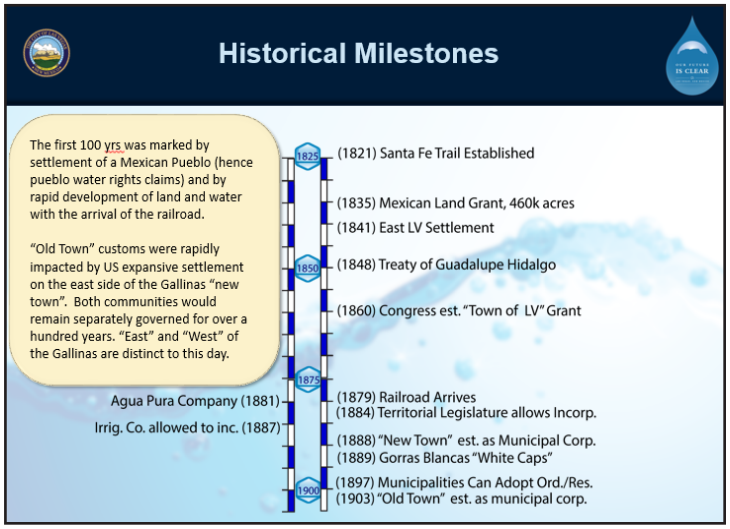


Figure 1. Water supply planning needs: land and water development (1st 100 yrs, 1835-1935).

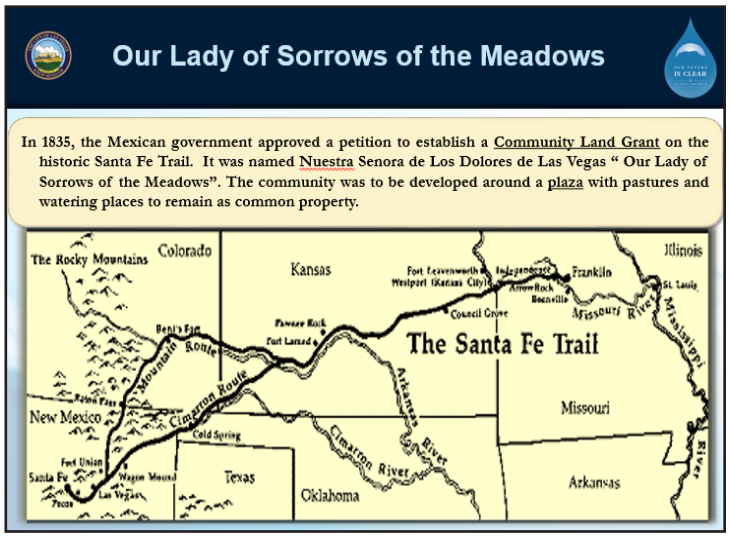


Figure 2. Land and water development (1st 100 yrs, 1835-1935).

Figure 3. The Plaza ca. 1870 on the west side of the Gallinas River.

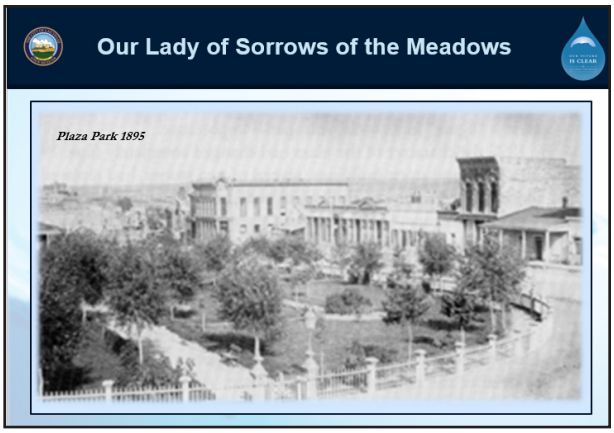


Figure 4. The Plaza Park 1895 on the west side of the Gallinas River.

the trail between Santa Fe and Mexico City. The community was named Nuestra Señora de los Dolores Las Vegas, which translates to Our Lady of Sorrows of the Meadows. It was developed around a plaza with pastures and watering places that were to remain common property. Figure 3 is a picture of the plaza in 1870. Figure 4 shows what the plaza in 1895 looked like, a bit more like what it looks like today. Figure 5 is a picture of what the plaza looks like today. Both sides of the plaza have retained most of their architectural historic style and they are distinctly different because the east side has always been heavily influenced by the English settlement.

Figure 5. The Plaza, present day, on the west side of the Gallinas River.

Shortly after the land grant was established, Texas colonists declared independence from Mexico and formed the Republic of Texas (Figure 6). In 1846, after numerous conflicts, the US annexed Texas and declared war on Mexico. So Las Vegas was part of Texas at one point in time, and the Treaty of Guadalupe Hidalgo in 1848 brought the community into the United States. Texas subsequently transferred a portion of the land to the U.S. government and Las Vegas became part of the eastern part of the New Mexico territory. In 1860, Congress confirmed the Las Vegas Land Grant and the settlement was officially called the Town of Las Vegas. The town received a patent in 1903 in which they received 431,651 acres of land.

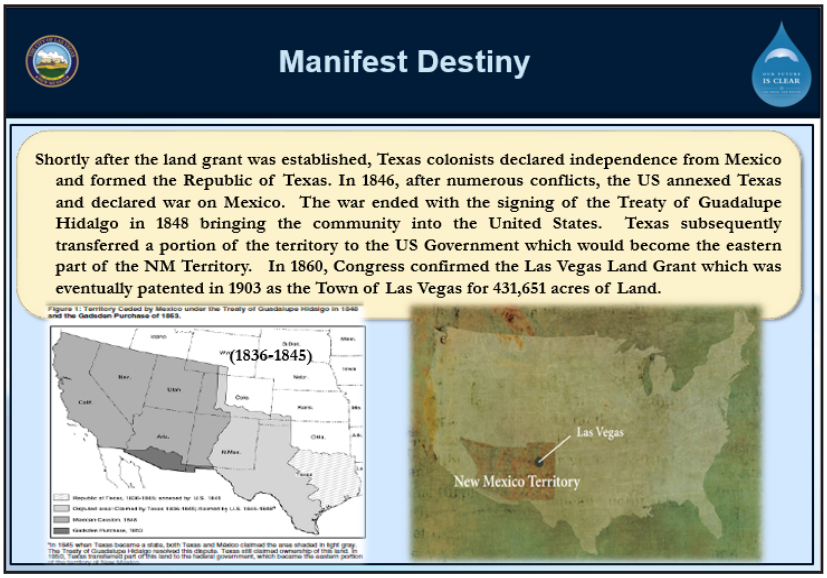


Figure 6. Land and water development (1st 100 yrs 1835-1935).

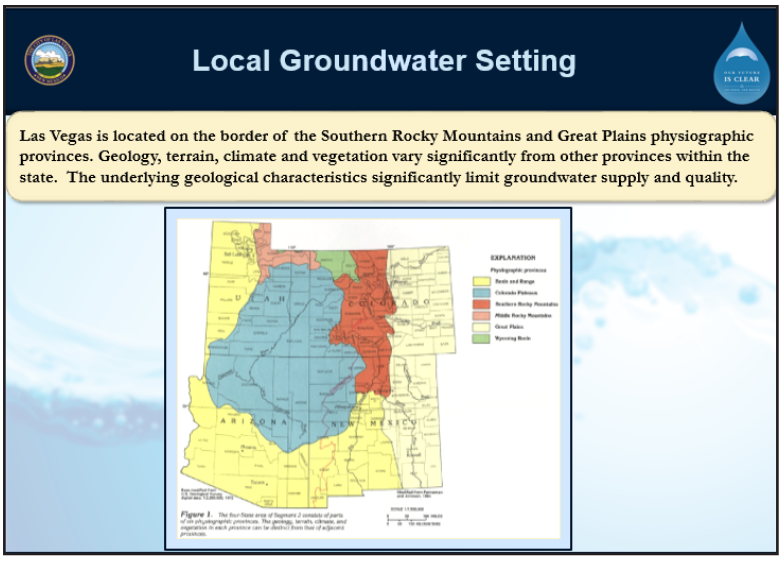


Figure 7. Geomorphology.

Concerning local groundwater, Las Vegas is located on the border of the Southern Rockies and Great Plains (Figure 7). The geology, climate, terrain, and vegetation vary significantly from other provinces within the state. When I look at what has happened in Rio Rancho, Las Cruces, and Albuquerque, they are significantly different as far as the hydrogeology. The underlying geological characteristics of Las Vegas significantly limits groundwater supply and quality.

Figure 8 is a 3-dimensional model of our groundwater. Our well field is on the west side of the outcrop on the edge of the Rockies. The community is on the east side of the outcrop and you can see that the geology varies significantly on both sides. Right now we have four active wells on the west side and we don't have any on the east side because of poor water quality and low supply. Figure 9 is an example of the fractured limestone that we have at the Taylor Well Field, where the supply is highly variable due to the fracturing.

The 1835 settlement on the west side of the Gallinas River would later become known as the Town of West Las Vegas (Figure 10). In 1841, the east side of the river was settled and became the City of Las Vegas, or East Las Vegas, and they are divided by the Gallinas River. There was also a community known as Hot Springs where a castle is located today. Both communities remained under separate governance until the Town and City were consolidated into the City of Las Vegas in 1970. Since we had two communities, progression from Mexican to U.S. governance, and private utilities

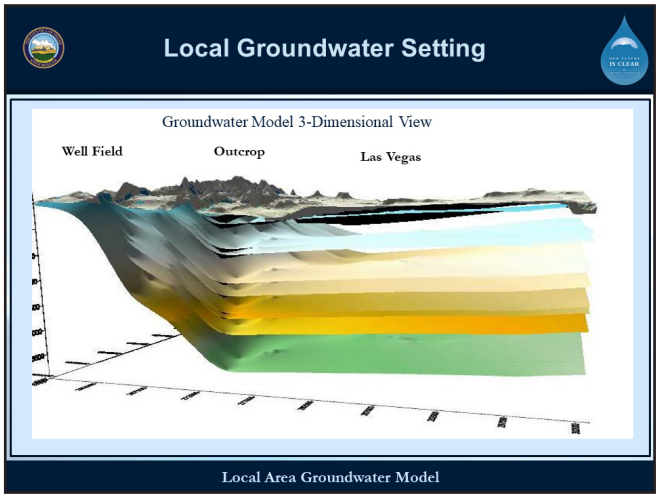


Figure 8. Local area groundwater model.

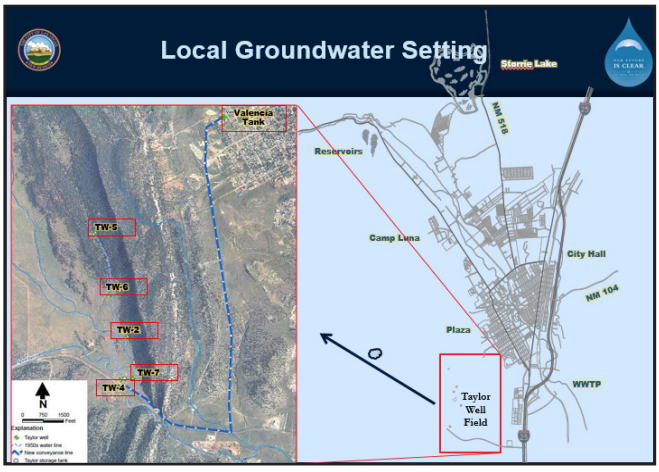


Figure 9. Groundwater supply, Taylor Well Field.

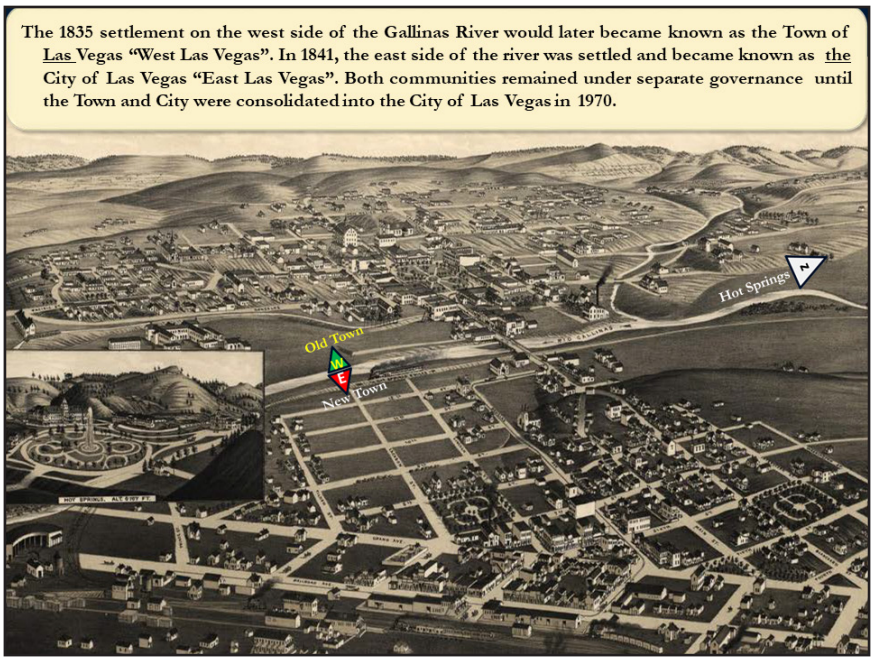


Figure 10. Las Vegas, NM, known as West Las Vegas in 1835, and East Las Vegas in 1841. In 1970, both communities were consolidated into the City of Las Vegas.

that dominated the service, we were significantly impacted on how water service was provided to the community. The other impact concerns water rights.

In 1879, railroads replaced the rutted trails and over time the Santa Fe Trail and evidence of it faded from sight and memory. The changes that the railways brought made trade along El Camino Real much easier and in some cases made travel quite luxurious. This was a time of great expansion in the community. For the next twenty to thirty years it remained one of the largest in the Southwest and enjoyed great prosperity. Along with the prosperity came development and increased conflict over exploitation of land and water. The 461,000 acres of land grant was pretty much gone in the first twenty years after it was granted by the county board that had received an amount of roughly $600,000 for it, which at that time may have been a lot of money; people were looking at the exchange of land for farming and development in what is now called Storrie Lake. When you look back at the history between 1835 and now, we have undergone significant changes in the community. I can expect that between now and the next 200 years, we will undergo additional changes, and that impacts the way we look at future planning. When in litigation, the courts want to decide things into perpetuity, and when it comes to water rights, it is a very difficult decision for the community because it will affect the community forever and not just the near future.

Figure 11 is an ad for Hot Springs. You can see the castle in the photo. The first company to provide water was the Agua Pura Company. Their biggest commodity was ice production for the railroad. They were advertisers of the ice which made Las Vegas famous. The photo shows what the upper town or the Hot Springs area looked like. They actually had fire protection in the 1880s. They had a steam driven pump to pump water to a reservoir above the castle. Despite this, the first hotel burned

Figure 11. The railroads brought prosperity to Las Vegas, NM.

down after only two years. The current day castle is the third iteration of those hotels.

Figure 12 shows the ice ponds that made up Agua Pura and which are located about nine miles northwest of Las Vegas. This is where we divert the water. Each one of the dashes indicates where a dam was located at one time. You can see our sedimentation pond and the diversion is probably about three miles up from the castle.

Figure 13 shows what the ice ponds looked like at the time. Figure 14 is a picture of the ice cutting in the pond areas. An article in 1913 indicated in the U.S. Record, that the Agua Pura Company was cutting nearly a thousand tons of ice daily from the ponds in Hot Springs canyon. Nine ice houses were filled and contained 25,000 tons of ice for the Santa Fe Railway system from Dodge City, Kansas to El Paso, Texas.

Figure 15 gives you an idea of major droughts that we have had over the past centuries. One thing you notice is that Agua Pura provided water service as well as ice production. In the drought during the early 1900s they actually built a dam called the Peterson Dam, which holds 200 acre-feet. After the drought of the 1950s, Bradner Reservoir and Taylor Well Field were build. Then, in the 1990s the City signed a 20-year lease with Storrie Lake for about half of its storage.

Figure 16 is a graph showing the mean flow in the river during the past year. In the red you will see the runoff coming from spring melting

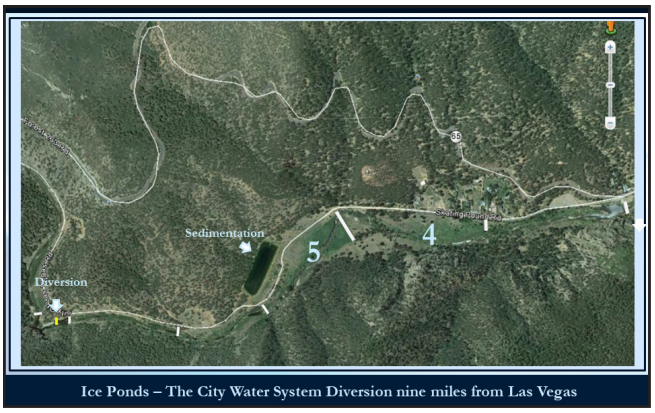


Figure 12. Ice Ponds - The city water system diversion nine miles from Las Vegas.

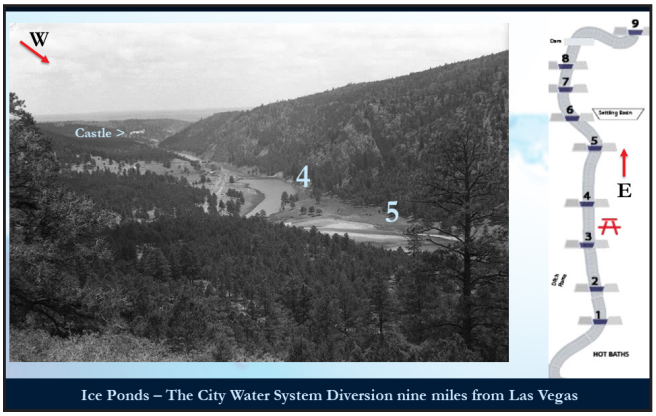


Figure 13. Ice Ponds – #4 & #5.

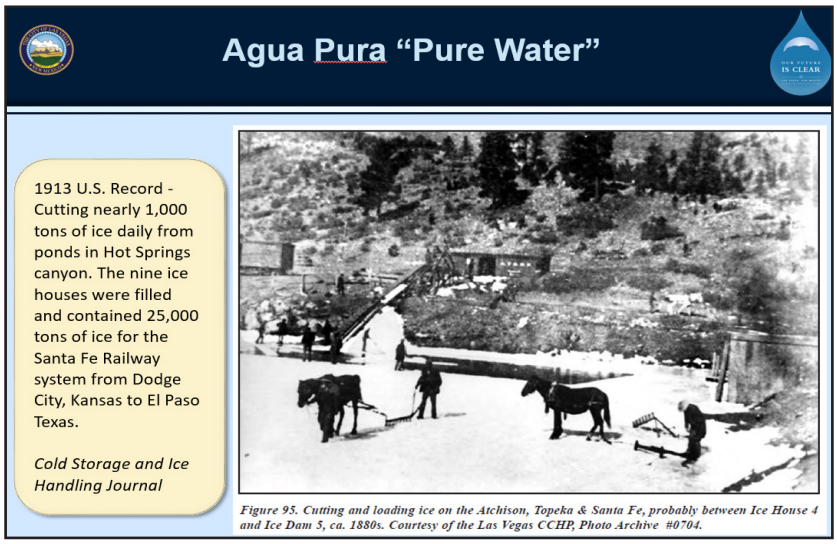


Figure 14. Ice Ponds - Agua Pura Company was formed shortly after the arrival of the railroad.

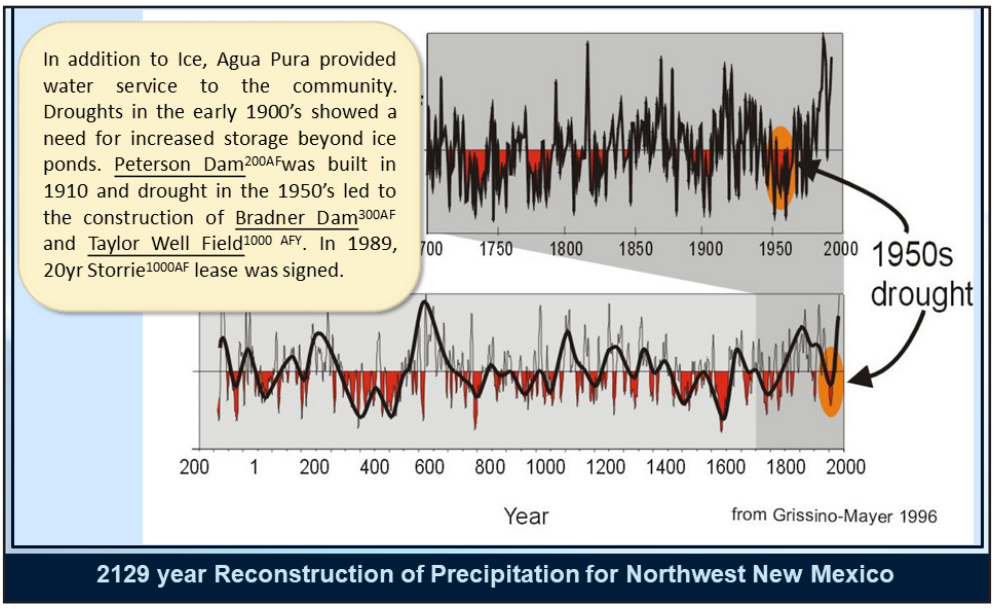


Figure 15. Improvements in drought resiliency.

of snowpack. Normally you will see a peak in the later part of summer from the monsoons. In 2012, there was a peak, but in 2001 there is no peak. This affects our reservoir storage. In 2013, we saw no runoff and had some significant rainfall events in September. Then in 2014, there was still very little snowpack runoff. One of the things you will also notice over the years is the snowpack runoff coming sooner during the year.

Figure 17 is a compilation of the litigation history. I'm going to thumb through the next slides. Figure 18 is a picture of our water system components. Figure 19 shows low flow at Gallinas Creek, while Figure 20 shows the September 2013 flooding. Figure 21 shows the sedimentation pond and Figure 22 shows Peterson Reservoir, which was built by hand using a wheel barrow. Bradner Reservoir is shown in Figure 23.

I won't go into the details today about groundwater. As far as our 40-year plan goes, we are working on the first four years and the costs are an estimated $80 million; we have been able to raise $45 million for construction and $6.5 million for design. We are still looking at a $28 million gap that will come from rate increases or future funding. Figure 23 shows preliminary results useful in evaluating various drought pumping scenarios and in groundwater management. There are many areas where we still need additional information.

Thank you.

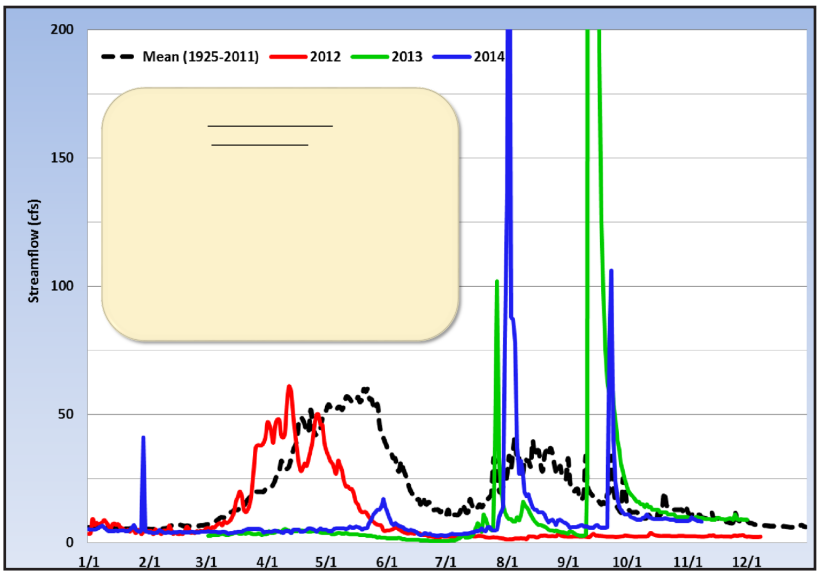


Figure 16. Rio Gallinas flow condition.

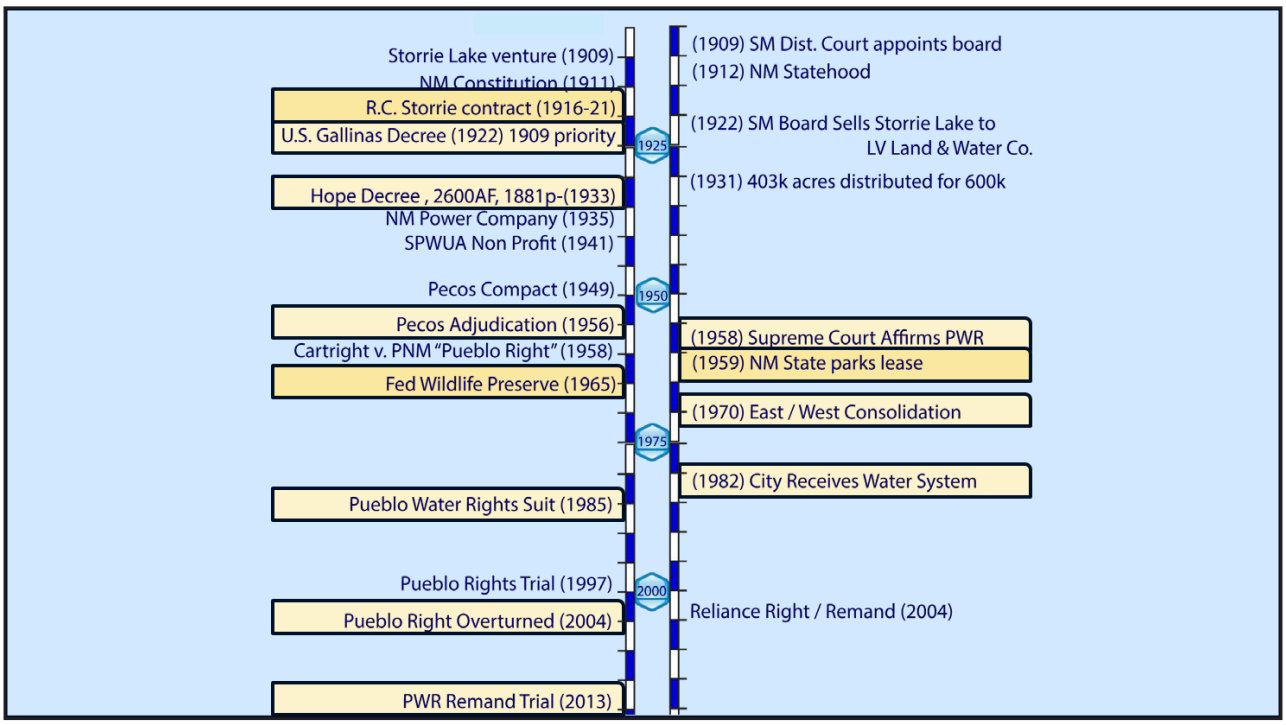


Figure 17. Water Rights Litigation History. Litigation – the 2nd 100 years has been plagued by Continued Water Rights Uncertainty.

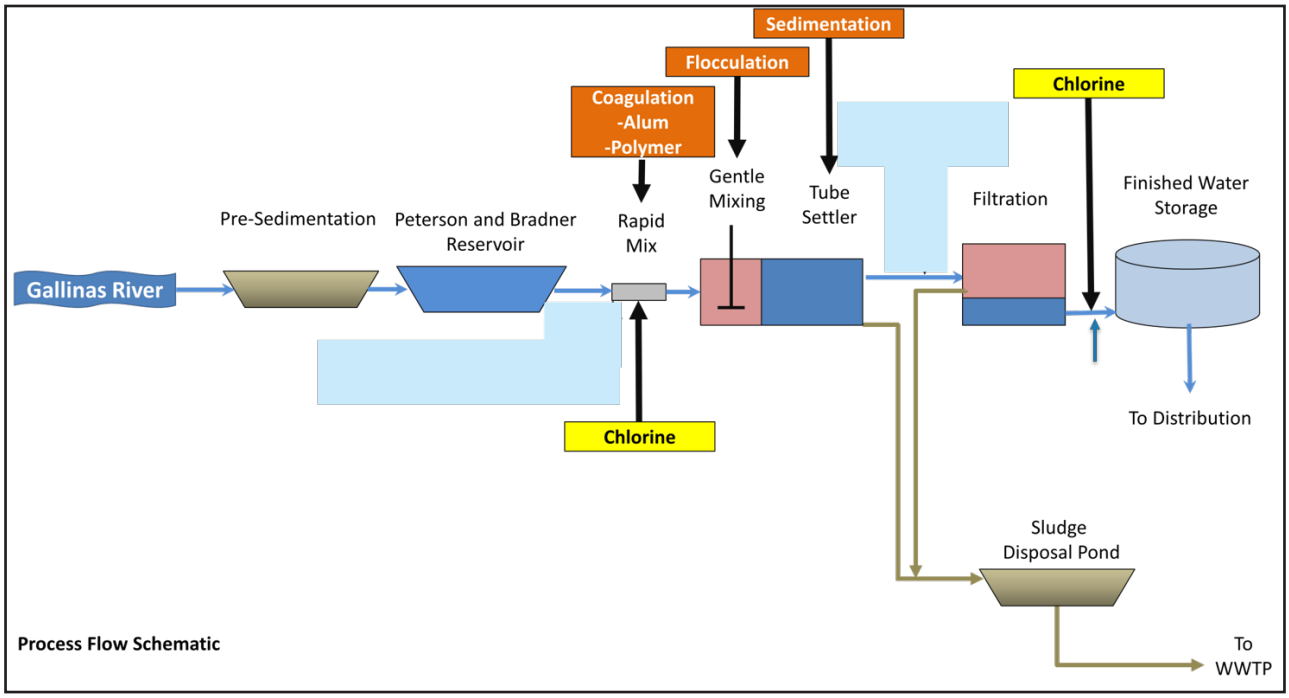


Figure 18. Water System Components. Infrastructure – in 2011, the city completed a comprehensive system study.

Figure 19. Low flow at Gallinas Creek.

Figure 20. September 2013 flooding of Gallinas Creek.

Figure 21. The sedimentation pond reduces sand and silt loading on city reservoirs.

Figure 22. Peterson Reservoir (view from NW bank).

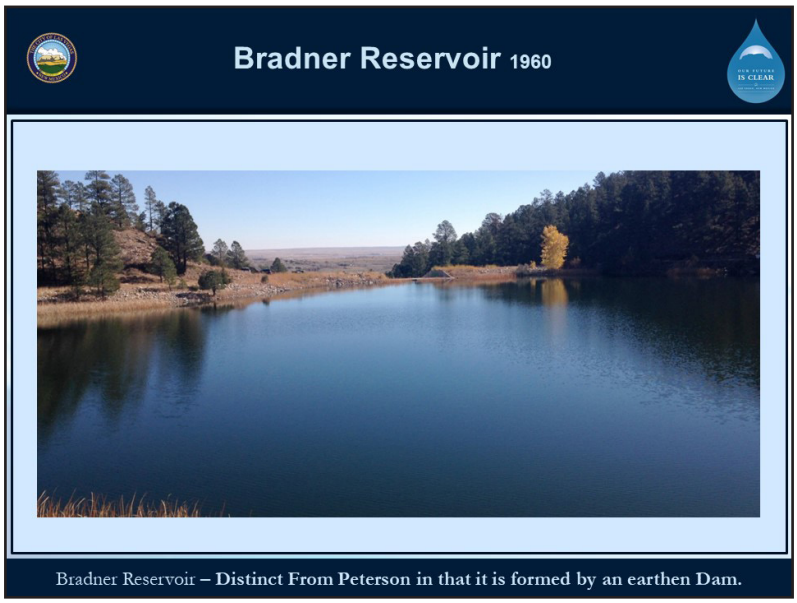


Figure 23. Bradner Reservoir.

Assessing Environmental and Nature Tourism Water Needs

Steve Harris, Rio Grande Restoration

Steve Harris is Executive Director of Rio Grande Restoration non-profit river conservation group dedicated to the protection of the ecological and economic values provided by the Rio Grande. In this capacity he writes, speaks and advocates for the resolution of river issues, especially policies to protect flowing water. He participates in public policy forums, such as regional water planning and manages the Rio Chama Flow Project. Steve is also, since 1976, the owner of the river touring company Far-Flung Adventures, which has introduced thousands of persons to the Rio Grande. He resides in a small riverside village in northern New Mexico, at the bottom end of the acequia del ojo.

I'm truly grateful that Cathy Ortega Klett has again invited me and Sam Fernald has again consented, to my exploring for the next 10 or 15 minutes the water needs of New Mexico rivers, how to assess these needs and how, in policy, New Mexico might better accommodate such non-consumptive uses.

I've accepted the assignment to represent "Environment" as a stakeholder with identifiable needs. I'm probably better qualified to represent the "eco-tourism" industry (river-running, fly-fishing and hunting guides and their avocational counterparts), which together comprise a substantial portion of the state's present economy, as well as one whose future potential is much more significant than its present state of development would suggest.

In fact, as a practical matter, the water needs of nature and nature tourism are identical: supply a river's minimum needs and you also supply a river-runner's, as well. As one boater participating in the Rio Grande Restoration's Rio Chama Flow Optimization Project put it, "we see how natural rivers function and that's part of the appeal of our sport."

I'd go one step farther and say that the health of rivers is important to all water users, as an array of monetizable "ecosystem services" enjoyed by petroleum, farming, ranching and water supply industries and all of us. Critical functions such as water and nutrient distribution, flood attenuation, sanitation, sediment removal, and provision of habitat for fish and wildlife contribute tremendously to human economies, not to mention important intangibles such as the spiritual, recreational, and quality of life values supported by the hydrologic system.

In 1988, when I first became fully-aware of how poorly our legal/administrative system was adapted to supplying the water needs of nature, there was a broad consensus in the state that so-called "in-stream flows" (or water flowing in river channels) were NOT, legally speaking, "Beneficial Uses" of water (were more like "Non-uses").

Who here today believes that environmental flows are not a beneficial use? Clearly, the old consensus on the in-stream flow question is no longer much in play. Having seemingly cleared the conceptual hurdle about rivers-as-water-users, we may now be free to address the more complicated question of whether (and what) we can do about it. Given sufficient attention to the issue, we can probably make a satisfactory arrangement for permitting water rights for rivers in New Mexico in the next 27 years.

An opportunity for beginning to move in that direction would be to begin to conceive of nature as a water-using sector, like agriculture, municipal, industrial and domestic sectors, and in state and regional water planning exercises. Unfortunately, the current round of water planning has been designed to continue to not examine this issue.

And so I wonder whether WRRI's Statewide Water Assessment might be an appropriate framework for beginning to tackle the issue. Surely, no one's "ox will be gored" by simply exploring the dimensions of a problem that many of us here today consider an important part of the water challenge that confronts us.

So far as I know, the State of New Mexico has never undertaken an assessment of the condition of its rivers. However, in 2011, Rio Grande Restoration, with assistance from the Nature Conservancy and Tetra-Tech, obtained a Watershed Assessment Grant from the EPA and commissioned an Index of Hydrologic Alteration study of changes in stream flow at USGS stream flow gauges in our five major river basins.

The results indicated that natural functions of more than two-thirds of rivers in New Mexico have been dramatically altered by dams, surface water diversions, groundwater pumping, and/or channelization and suggested that many of these impacts could be eliminated or reduced by greater attention to stream ecology by water managers. Figure 1 from the study shows the general degree of alteration: the darker-colored watersheds being least altered, the lighter ones more altered. It suggests that the dark-blue, least altered streams–the Rios Chama, Costilla, Red and Gila might be most easily protected, while the others are in need of restoration.

What this study did not do, and what we now need, is an assessment addressing the question: "How Much Water Do our Rivers Need?"

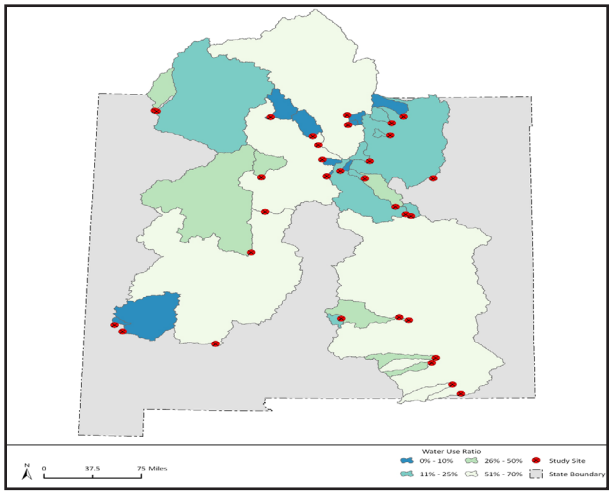


Figure 1. Intact vs. altered river segments in NM.

There are some well-developed assessment tools for answering this question. A method developed in Australia and used there to establish stream flow prescriptions during the "Millennium Drought," as well as by our neighboring state of Colorado in their Instream Flow Water Rights Program, is called ELOHA (Ecological Limits of Hydrologic Alteration.)

Figure 2 shows the main components of the process. This method has been applied a couple of times in New Mexico–by us on the Rio Chama and by The Nature Conservancy on the Gila River. If ELOHA assessments on New Mexico's other four river basins were to be included in the NM WRRI Statewide Water Assessment that we have been discussing here today, the "New Mexico Evaluation" I just talked about what would give investigators a leg up on a statewide assessment by having synthesized hydrologic data. This would leave two major tasks:

- Acquiring ecological data (some of which exists-especially on the Rio Grande) and
- Constructing, by means of an expert workshop, the Flow-Ecology Relationships that are the ultimate output of such a study.

(Note: Figure 2 also illustrates the concept of "Flow Thresholds," below which river and riparian ecosystems come unraveled. This river reach has clearly sunk below the threshold, though the tipping point between river health and river mortality has yet to be determined.)

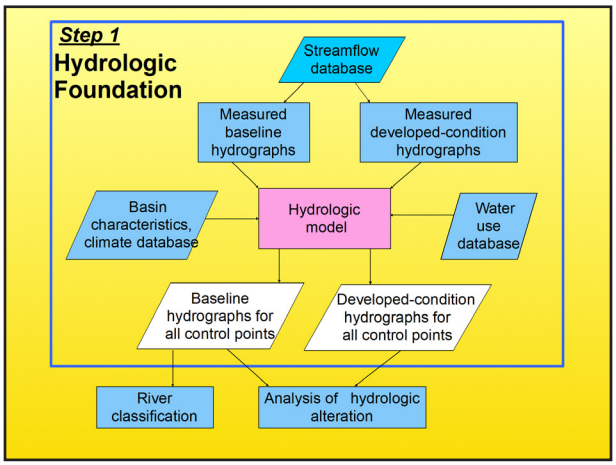


Figure 2. Flow thresholds. *Credit to The Nature Conservancy website:* http://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/MethodsandTools/ELOHA/Pages/ecological-limits-hydrolo.aspx.

An assessment does not quite get us to a river protection program, but DOES give us data and useful information to talk about. Colorado is in a process of performing ELOHA evaluations on all of its 13 river basins (Figure 3). Texas has initiated a process similar to ELOHA, with a unique implementation program; the TCEQ Environmental Flow Program has two tracks:

- An expert science team determines flow targets for each river basin and
- A stakeholder team, with representation of major water user interests, proposes practical implementation measures.

The point is New Mexico does have relevant models for addressing the minimum water needs of its rivers. But, as in many other fields, we are lagging behind. The experience throughout the West is that to attend to nature in the way I'm suggesting, society begins to learn how to turn conflict into cooperation and uncertainty into cold-eyed view of our water resource challenge.

As we catch up in understanding our highly integrated hydrologic system, we should also move toward a deeper understanding of the limits and boundaries of, and our many opportunities to better secure, the functional condition of our rivers. Before we can hope to protect and restore the foundation of our water system, we need to focus some of our research budgets on determining flow needs, starting now.

> Environmental flows help to preserve the innate resilience of aquatic ecosystems, and thereby offer the promise of improved sustainability and well-being for people as well as for ecosystems.

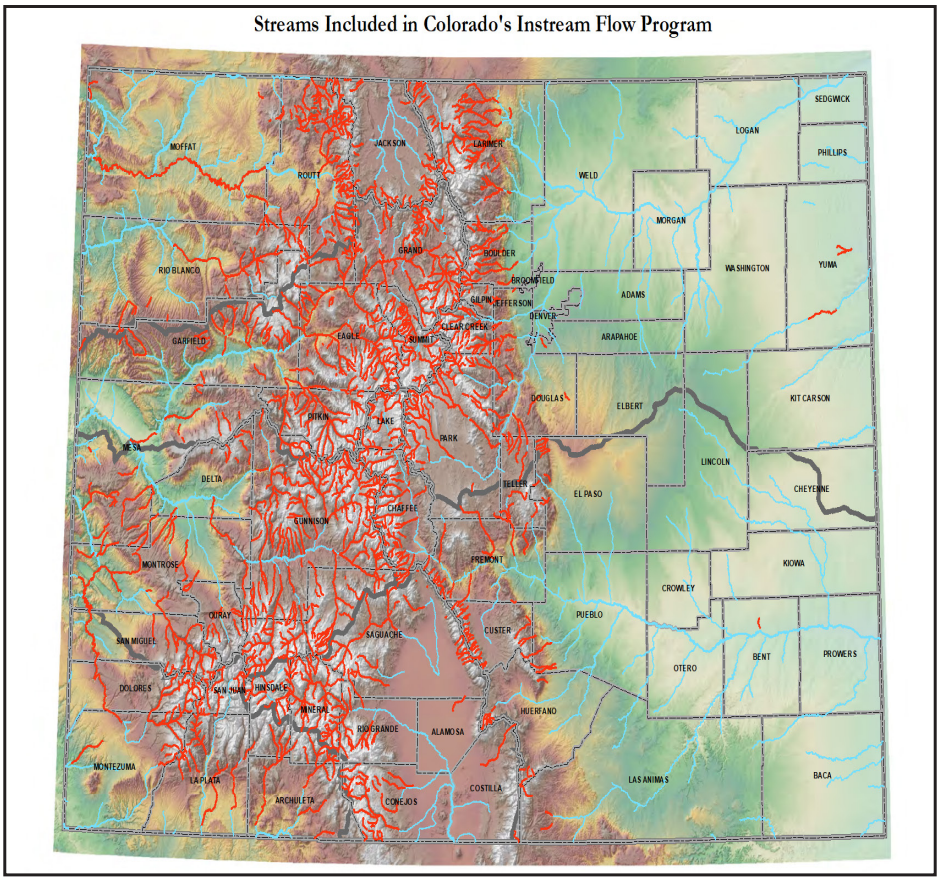


Figure 3. ELOHA evaluations by Colorado on all of its 13 river basins.

Oil and Gas

Steve Henke, New Mexico Oil and Gas Association

Steve Henke was selected as President of the New Mexico Oil and Gas Association in August 2010. Steve has lived and worked in New Mexico for close to 50 years. He graduated from Alamogordo High School and from New Mexico State University in 1977, with a BS in agriculture. Steve had a 34-year career in New Mexico with the Bureau of Land Management culminating with eight years of service as District Manager for the Farmington District. Steve consistently practiced and promoted collaborative resource management on a variety of contentious issues while with the BLM, including: oil and gas leasing and development in the San Juan Basin; balancing endangered species protection with natural resource use; and balancing traditional land uses with environmental initiatives.

Steve previously served as Executive Director and BLM Coordinator for the Southwest Strategy, an interstate, interagency, intergovernmental effort to develop capacity for collaborative resource management conflict resolution in Arizona and New Mexico. He has been recognized for his contributions to New Mexico, and is known for his ability to balance competing interests with workable solutions. Steve appreciates the contributions the oil and gas industry makes to the quality of life of all New Mexicans, not just in jobs, income and taxes; but in the generosity and commitment member companies and their employees have in their communities. He looks forward to the challenge of protecting and promoting New Mexico's vital oil and gas industry while working productively with legislators and regulators within the state.

Thanks, it is a pleasure to be here. I am the president of the New Mexico Oil and Gas Association and I represent 300 employee companies that drill for and produce 95 percent of the oil and gas in New Mexico. I will talk a bit at the end of this presentation about our water use, but I want first to frame the amount of water that we are using with some industry perspective in terms of where we are at, where we are headed, and some of the economic impact that the industry has on New Mexico. Figure 1 shows the producing basins in the state. Natural gas production is primarily in the San Juan Basin. There is oil and associated gas in the Permian Basin, a little bit of coalbed methane in the Raton Basin on Ted Turner's place, and then CO_2 out of the Bravo Dome.

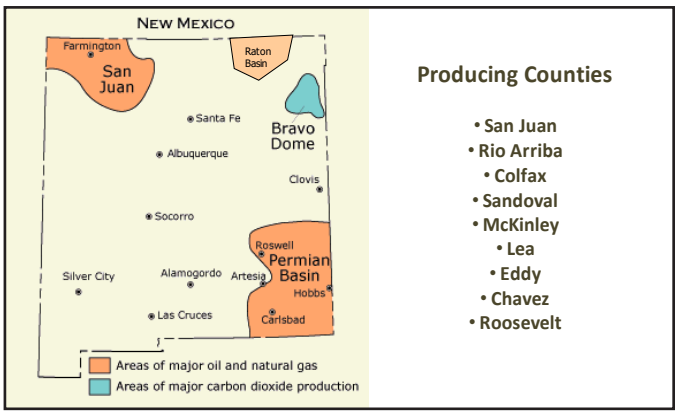


Figure 1. New Mexico, an oil and gas producing state.

In terms of production trends, natural gas is going down primarily because there is a glut of natural gas in the United States due to the revolution brought about by horizontal drilling and hydraulic fracturing (Figure 2). Natural gas is cheap and projected to be cheap for a couple decades. So we are likely to see continued production of natural gas out of the San Juan Basin. The only growth area we see is the gas out of southeastern oil wells. When you drill oil and bring it to the surface, you also get some associated natural gas; we peaked in

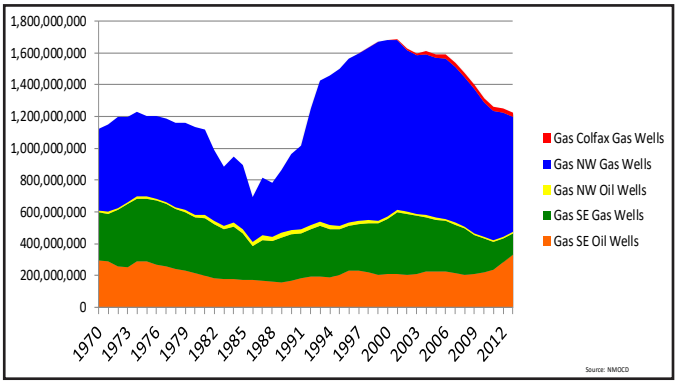


Figure 2. Natural gas production (mcf).

the early 2000s with the northwest gas wells, which are primarily coalbed methane. That trend is not likely to be reversed anytime soon.

Oil on the other hand is trending upwards (Figure 3). We produced over 100 million barrels in 2013 and we will exceed that in 2014. That trend is likely to continue. Although, as you are aware, with $2.50 per gallon gasoline prices and with a barrel of oil in the high $70s, if prices continue to slide, we might see a reduction in drilling for oil in southeastern New Mexico.

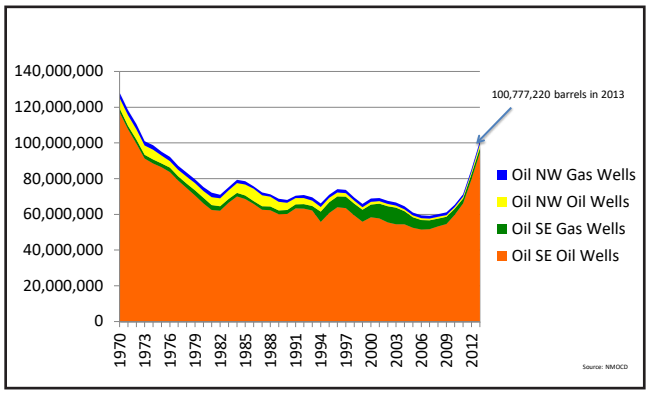


Figure 3. Oil production (barrels).

In terms of jobs and economic impact, there are over 100,000 direct, indirect, and induced jobs in New Mexico. There are 99 drilling rigs currently operating in the state. Each one of those rigs employs roughly 50 employees at twice the average salary level in New Mexico. Figure 4 has one of my favorite charts. The bottom line is that we have a $5.4 billion state budget and $1.4 billion of that comes from the oil and gas industry,

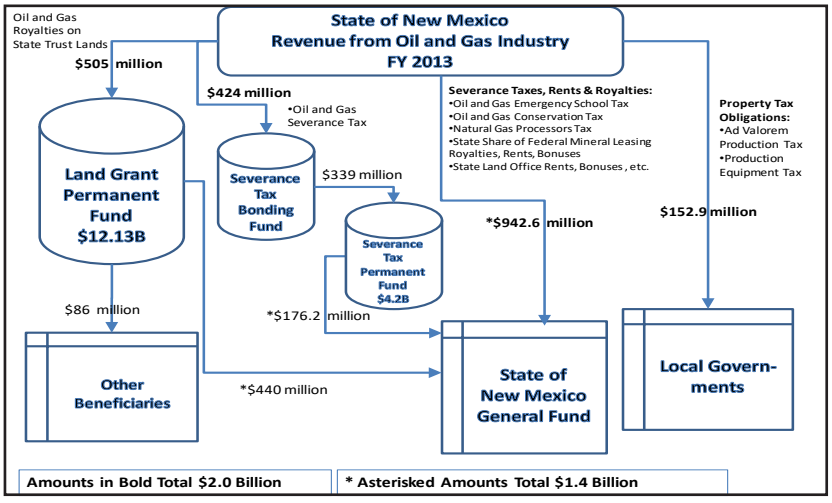


Figure 4. Revenue from the oil and gas industry, FY 2013.

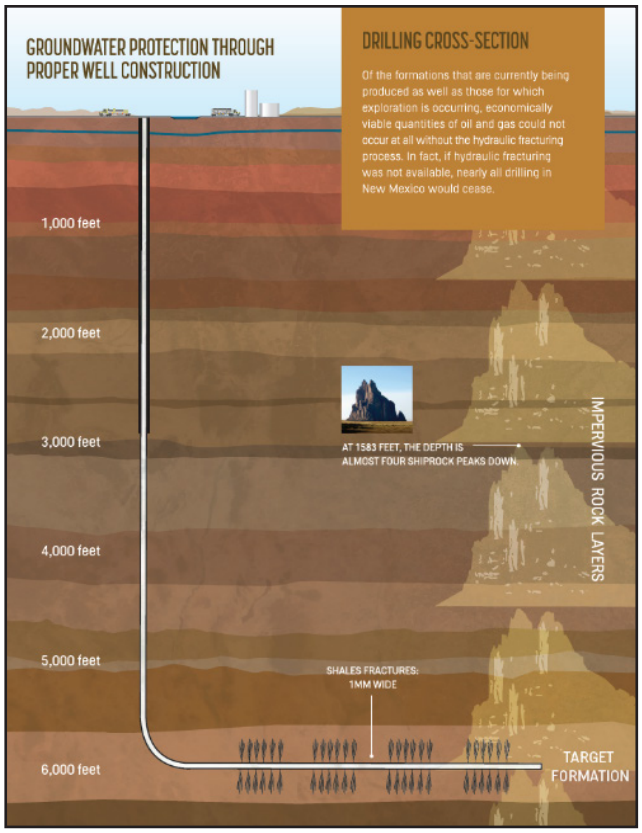


Figure 5. Horizontal drilling and hydraulic fracturing.

primarily in the form of royalties. All citizens of New Mexico are royalty owners on state land that accounts for 30 percent of the production. You are royalty owners on federal land as well, which accounts for 50 percent of the production in New Mexico. That money goes right into the state's general fund. The state Land Grant Permanent Fund has over $12 billion and is built primarily from royalties on state land from the oil and gas industry—that is about 31.5 percent of the general fund that our legislature appropriates year in and year out. It is largely attributed to royalties and taxes paid by the oil and gas industry.

I wanted to talk briefly about the new technology that is vital to this industry - horizontal drilling and hydraulic fracturing (Figure 5). This new technology is needed to make these unconventional resources able to be developed. We drill down 6,000-7,000 feet and then kick off horizontally and go out as far as two

miles now. Then we shoot off small fractures in as many as sixteen stages. We then inject a gel at very high pressure that fractures the shale rock. That gel has fine sand particles in an emulsion that shoots into those fissures and holds those cracks open where hydrocarbons can then flow into that bore hole. Most of the time we are 5,000-6,000 feet below the fresh water aquifer.

There is a lot of concern about hydraulic fracturing and potential contamination of groundwater. I want to assure you that my member companies are very concerned as well, and it is well regulated by the state. There are at least two layers of cement and steel between the well bore and the fresh water aquifer (Figure 6). It is inspected by state and Bureau of Land Management inspectors with a high level of compliance. It is safe. There are tens of thousands of wells that are hydraulically fractured in this country every year, and there is not a single documented case of contamination between the production zone and what goes in and out of that bore hole and the fresh water aquifers.

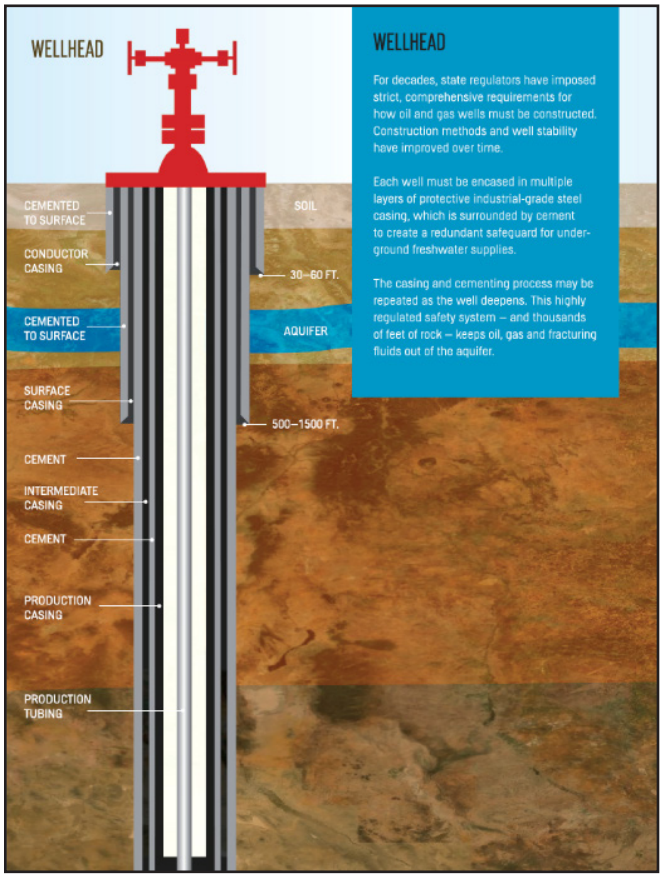


Figure 6. Safety through proper wellhead construction.

We do use water for hydraulic fracturing, and we get all that water from permitted sources within the adjudicated system in the state of New Mexico. We use surface water, fresh water wells, and municipal systems. We are also reusing flowback water and utilizing produced water as well. All the wells in 2013, according to the State Oil Conservation Division, used 5,325 acre-ft of water to hydraulically fracture about 1,700 wells that were drilled in the state (5,325 acre-ft x 325,851 gallons per acre-ft = 1,735,156,575 gallons used for hydraulic fracturing in 2013). So, if it was all fresh water, which it is not, that is still less than two tenths of one percent of the total water appropriated in the state (5,325 acre-ft used for hydraulic fracturing /3,815,945, or total water use in acre-ft, = .14% water used for hydraulic fracturing in 2013). I would say that is a pretty good return on your investment if you get over 31 percent of your fiscal budget from two tenths of a percent of the appropriated water.

Figure 7 is a pie chart that illustrates this point. Oil and gas is lumped with mining in this chart and together they are less than one percent of the water use in the state.

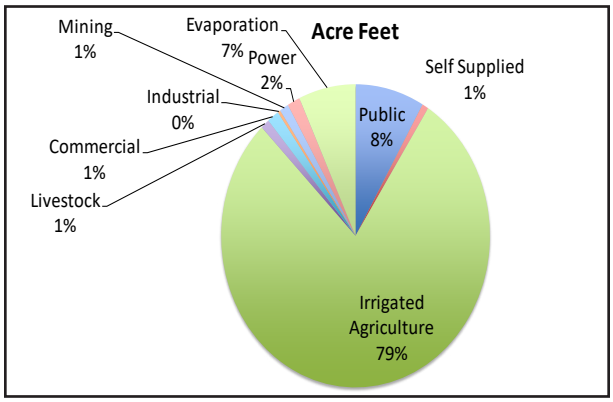


Figure 7. New Mexico water use by categories 2010; Source: New Mexico Office of the State Engineer Technical Report 54.

My message is that the oil and gas industry is trending downwards in terms of water use in the state. Chemists for the service industries such as Haliburton or Schlumberger are completing these wells and figuring out how to use produced water. For each gallon of oil that comes to the surface through a pump jack, there is about six or seven gallons of very salty water that comes up as well. Rather than looking at all of that as a disposable waste, we want to look into the increased use of that water for hydraulic fracturing. Chemists are working on that issue and are making headway.

Rather than dispose of what is used in one hydraulic fracturing job, we have gotten approval now to use large pits through rule making to reuse and recycle that fracturing flowback. Some of that rule making is in progress with the Oil Conservation Commission, particularly the use of produced water.

Increased technology and innovation in fracturing fluid chemistry will continue to reduce our use of fresh water in the state. We understand that we need a social license to operate in the state and even though our water use is fairly small, any fresh water use in the state that we can save is beneficial. Also, the oil and gas industry will pay anywhere from a 20 to 30 percent premium to make produced water or recycle water suitable for hydraulic fracturing. That is an investment the industry is willing to make for community support and social license to operate in the state. We are a participant in the state and we want to work cooperatively to ensure that we protect the precious water resources in the state through engineering, well-bore design, and safe practices. Secondly, we want to reduce our overall impact on the system that is obviously under stress. I appreciate the opportunity to be here today.

Thank you.

Alcalde Acequia Commission

Lucia Sanchez, Rio Arriba County

Lucia Sanchez is a native of Alcalde, New Mexico. Like several generations before her, Lucia is a farmer who raises many traditional agricultural crops and livestock with her family. For the past ten years, Lucia has served her traditional community irrigation system as an elected official on Acequia De Alcalde commission. The Acequia De Alcalde is one of many centuries-old irrigation and water governances systems in New Mexico. Lucia currently works for the County of Rio Arriba as the Director of the Planning and Zoning. For Lucia, no one-day is ever alike. Her responsibilities range from the oversight of technical and clerical personnel to the administration of the various codes and ordinances related to land use planning in the County. Lucia's earned degrees include a 2004 B.A. in Anthropology and a 2004 B.A. in Spanish from the University of New Mexico. Most recently in April of 2014, Lucia was selected by the New Mexico Floodplain Manager's Association as Floodplain Manager of the Year for outstanding dedication and achievements displayed in floodplain management issues to better serve the citizens of Rio Arriba County. In addition to her work for the acequia and Rio Arriba County, Lucia's passions include advocating for the protection of irrigated agricultural lands, beekeeping, traveling and teaching her young nephew about traditional agricultural practices.

Good afternoon everyone and thank you for having me here today. Today, I would like to focus primarily on Rio Arriba and its land use and how partnerships between New Mexico State University and the Alcalde Science Center have helped water managers like myself better manage our water system.

Rio Arriba County is almost 6,000 square miles in size. Of that land base, only 22 percent is held privately. The remaining portion is Bureau of Land Management (BLM), Forest Service, tribal lands, and a small amount of state lands. Of the 22 percent privately held land, a large portion is irrigable. Rio Arriba County policy throughout its land-use history has been a pioneer in its ability to preserve irrigated agriculture through its land-use governance. I do not believe that there is another county like it anywhere in the country.

Because of the very small portion of private lands within the county, and the fact that they are irrigable, private land owners are allowed, by ordinance, to develop up to 30 percent of the private land, leaving 70 or more percent of the land for open space. One of the main reasons for that [open space] is because of the issues we have regarding acequias, mutual domestic water systems, and other utility infrastructure.

Most of New Mexico, as you know, remains very rural. I would like to see a show of hands as to how many of you caught the *60 Minutes* show this past Sunday evening with Lesley Stahl. She had a very interesting 15-minute piece on how groundwater is being depleted in the state of California, and how groundwater is being pumped at an alarming rate. As you may know, California is responsible for 25 percent of the nation's food supply. Realities facing California make me appreciate partners like Dr. Fernald and the research being done at the Alcalde Science Center because it makes us better water managers and better equipped to handle the demand of downstream users.

Rio Arriba County is home to almost 300 acequia systems. Figure 1 has an image of those taking part in our annual *limpia* that we have as an acequia commission at Alcalde. We have close to 200 community members that come out annually for the cleaning. It is a great opportunity for community members to come together to socialize, get caught up on events in the community, and to have another social event before it is time to hunker down for the winter. Acequias provide a lot of social and cultural significance to the communities. For most of the communities, the annual cleaning is a sort of rite of passage for many folks. One of the rules on our commission is that if you are tall enough to hold a shovel then you are old enough and tall enough to come out and work. As you can see in Figure 2, it is often a lot of young folk integrated with older members of the community having a chance to get together, work, and talk. Over the last ten years, I have walked the acequias as a commissioner, and that is one role that I never thought I would be doing. Traditionally, it was my role and my mother's role

Figure 1. La Limpia.

Figure 2. Rite of Passage.

to stay home and prepare the meal for the workers, and make sure it was ready for Dad to come in and eat. But with the transition that we experienced on our commission, almost ten years ago I was tasked with the role of actually being on the governing board. Part of my responsibilities is to help other elected officials and our Mayordomo with the annual cleaning to make sure that the work is equitably dispersed among land owners and that we keep good records on who showed up to clean. That information will later go into our financial records for billing and so forth. The commission is run very much like a utility. We estimate that a large portion of our revenue comes from the annual cleaning and upkeep throughout the year. It also pays the salary of the Mayordomo who is tasked with making sure that the water passages are clear of debris and at maximum capacity.

The acequia in Figure 3 is over 6 miles in length, almost 20 feet wide, and in some areas about 8-10

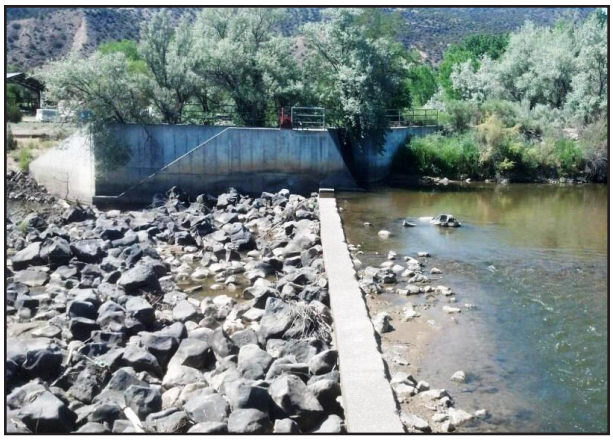


Figure 3. Cooperation matters... especially in times of drought. Rio Grande 2012.

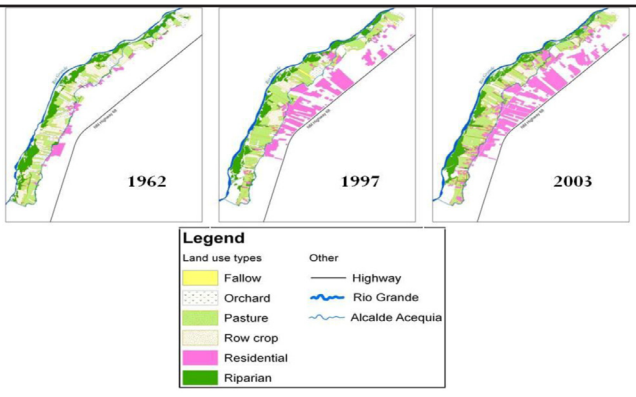
feet deep–it is almost a miniature river. Figure 4 shows me, our record keeper Alfredo Montoya who is also a county commissioner, another commissioner Robert Garcia who helps us on the board, and our Mayordomo who helps us make sure that on the days that we are conducting these types of activities, we are well organized, prepared, and able to anticipate any major projects that may need to happen later in the year.

Figure 4. Organization and cooperation.

I took this photo of the Rio Grande in 2012 (Figure 3). How many of you have ever seen the river this low in northern New Mexico? Normally this is an image that you would see down south. I was actually standing on the presa, which is the inlet to our acequia, and I was able to walk across the river to the other community on the western side without getting wet. At this point, we were still diverting enough water into our acequia system to the point that we were not forced to go into a water sharing schedule at Alcalde. We do have a sharing system planned and anticipated for in our bylaws–from one section of the acequia to another, people would only be allowed to irrigate on certain days. Fortunately, the rains came, and we were not forced to go into a water sharing situation. Had we needed to though, we had called several emergency meetings, and we included Steve Guldan who is the superintendent from the Alcalde Science Center because we wanted to make sure that when we were deciding on the schedule, we would not be interrupting the research and science that was being done with test crops and so forth. It was a tense time for us given that we had never had to share water before, but fortunately, we got through it. I think that planning and a sense of community and cooperation prepared us well as water managers to anticipate any of those wars that tend to break out over water. One of the first things that Lesley Stahl said was that it has been said that the wars of the twenty-first century will be over water. I thought to myself, geez, she hasn't been to New Mexico or an acequia meeting in northern New Mexico.

Figure 5 shows a graph based on research that Sam Fernald and his team have done on land use in the Alcalde corridor. If you look at the first set of imagery in 1962, it shows development in magenta and below that are the irrigable lands. In 1997 you see an increase in those populated areas and again in 2003 with even more population.

Going back to Rio Arriba County, the communities of Alcalde and Chimayo are in the Jemez and Sangre de Cristo regional planning area. I have to send a quick shout out to Angela Bordegaray and her herculean effort in trying to get 16 regional water plans updated. It is no small task, especially when you are dealing with such complicated and diverse systems and issues. In Figure 6, you can see why I say that partnerships matter so much. If you look at the highlighted areas bordered in yellow, you see the Alcalde Science Center at the bottom and above it is about seven-tenths of a mile along the acequia where my family farm is located. You can see the Rio Grande running down the middle. All of the imagery that you see in blue is the FEMA designated flood zone. What is most significant about this image, compared with the previous slide, is that irrigable lands and open space are being encroached upon by the developable drylands. The two white parts



Ortiz, M.A.; Brown, C.; Fernald, A.; Baker, T.; Creel, B.; Guldan, S. Land use change impacts on acequia water resources in northern New Mexico. J. Contemp. Water Res. Edu. **2007**, 137, 47–54.

Figure 5. Land use.

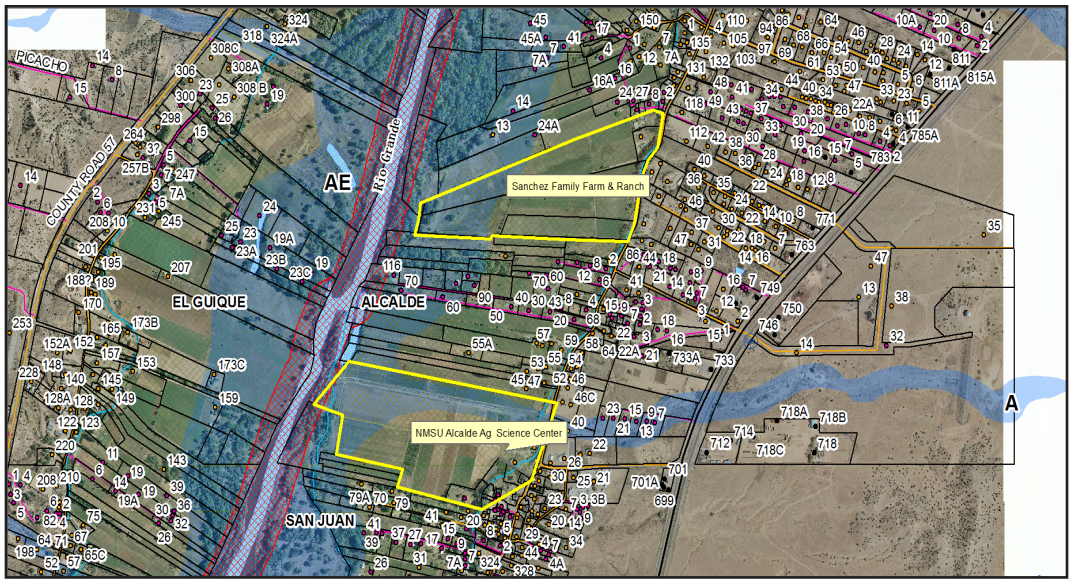


Figure 6. Partnerships matter.

of the map are BLM lands. Development is forced to occur along the riparian corridor. Right now a big part of the research that is being done at the Alcalde center demonstrates to me as a farmer and a water-right user how significant it is to have open space when you do not have infrastructure like sewer systems. On the *60 Minutes* show, Lesley Stahl talked about drinking reclaimed water that comes from a sewage plant. So if you live next to a municipality that reclaims water, that is pretty much what you are drinking.

Figure 7. Groundwater and surface water.

Figure 8. Riparian and ecological health.

Figure 7 is an image of Sunday's snowfall. Our acequia is still running. Part of what we, as water users, are looking to Sam and his team for is information about how we can continue to contribute to the health of the riparian areas–how to positively affect groundwater, because most houses are on separate septic systems. If it wasn't for this open space, the designation of land use, and the county's foresight to protect this space, we would all be super saturated in poop. That is pretty much what we have learned from the studies. The significance of groundwater is phenomenal. It is important to note that even though Rio Arriba County is home to the mighty Rio Chama, Rio Grande, several other streams and rivers, as well as almost 300 acequia systems in Rio Arriba County, the only water that is owned by the county is owned by private land owners on their private parcels. That is how we are using land use regulations to control land development on that precious resource. We depend on it for recharge, riparian health, and also to grow the food and fiber products that have been so much a part of many generations of land owners on the land.

Figure 8 is a picture of some of the land on my farm in the fall. You can see the acequia running in

the foreground with the vegetation on the stream bank, and down below you enter into another tier of agricultural production with alfalfa fields, some more water tolerant grasses below that, and then at the end, which is in the flood plain, is what we call vega or stedo. Those are areas with supersaturated soils that are not suitable for conventional septic systems, infrastructure, or housing. So in reality, as a land owner, I think it was a real shock to learn what Rio Arriba County had pioneered as far as land use. I can't imagine the cost and impact to the riparian areas of putting in a home on land that is totally unsuitable for development.

Figure 9 has a couple of images of my farm that shows how we are able to divert water from the main acequias to the lateral acequias, and then with control methods we are able to irrigate row crops for food production. Another interesting fact is that while California produces 25 percent of our nation's food and fiber, Rio Arriba County supplies a large part of the food supply for Santa Fe County while Rio Arriba remains a food desert. Rio Arriba County has embarked on getting farmers and producers access to more USDA resources, which has helped us address the need and concerns of our own people who do not get the dietary nutrition that they should from crops grown locally. We are starting to reverse that trend. It is similar to the City of Las Vegas and the railroad. Likewise, Española, along the corridor of the Rio Grande, used to have the Chile Express and it was a large economic stimulator.

Figure 9. Food and fiber production.

Through the Alcalde center studies, we are also learning about better management practices for maintenance and erosion control. The ecologist's

Figure 10. Maintenance and erosion control.

motto is that we are all downstream. The better we manage the water up north, the better off downstream users will be. Figure 10 is an image of our acequia and beyond this area are tribal lands. In times of drought, plan for flooding, and in times of flooding, plan for drought. That is exactly the type of situation that we are in right now. Lands that are largely fallow have eroded and caused damage to many of our stream banks. Instead of doing what many people try to do by putting a band-aid on a shotgun wound, we are trying to better manage and place erosion control projects along our own system. While some say that all we need to do is get a backhoe in there, or throw in some tire bales, we just shake our heads and say no. All we need is for one of those wires to break, and we will have tires all over the place. We ended up getting several one-ton straw bales, rip rap, some metal posts, and realigning that section of the acequia. Just a couple of months later when there was water in the acequia, you could see the vegetation, regrowth, and stabilization of the stream bank. We know that there are better methods for erosion control and better ways to conduct maintenance.

A large part of what we do as water managers is because of our quality of life. Most people don't know where their food comes from or where their

water comes from. Rest assured, the work that is being done at Alcalde is going to impact the state of New Mexico in a phenomenal way because it impacts everybody in the state. If you eat, it affects you. If you drink water, it affects you. Ultimately, our food security and our way of life with our customs, culture, and traditions will be enhanced by better management practices (Figure 11).

That is all I have today. I thank you for giving me a listening ear, and if you would like to see all this in person in early March, we will be having the annual cleaning. If you are old enough and tall enough to hold a shovel, I welcome you to come on over, and I'll give you a tour.

Thank you.

Figure 11. Food security and quality of life.

Ranching

Jose Varela Lopez, New Mexico Cattle Growers' Association

Mr. Varela Lopez is president of the New Mexico Cattle Growers' Association, which in 2014 is celebrating 100 years of work on behalf of the state's cattle industry. He is a member of several local and national cattle associations, and ranches near the village of La Cieneguilla in northern New Mexico, where his family has been since the early 1600s. He is also the executive director of the New Mexico Forest Industry Association, having held that position since the spring of 2011. He is the immediate past chairman of the New Mexico Soil and Water Conservation Commission having served as Region II commissioner since 2007. Mr. Varela Lopez has also served as a supervisor on the Santa Fe-Pojoaque Soil and Water Conservation District as an elected official since 2005, is a former Santa Fe County Commissioner and holds a BBA degree from the Robert O. Anderson School of Business at the University of New Mexico.

Inputs into the state's water system vary widely across agriculture and much is made about water use, but rarely is the value of the end product to society considered when discussing agricultural water use.

New Mexico's ranches vary widely in terms of size, vegetative productivity, stocking rates, water availability and infrastructure. However, it is a certainty that ranchers rely on groundwater, surface water, or both, to bring a product to market.

Another aspect of the overall water equation is the on-going debate about the amount of water cattle use to satisfy their needs. Although the question is a simple one, the answer is dependent on a number of factors that literally change on a daily basis.

The one certainty is that cattle need water, and if the current drought has finally broken, it is reasonable to assume that ranchers will begin the process of re-stocking the range to better serve people's nutritional needs, and that's going to require water.