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Karl Wood *was named director of the New Mexico Water Resources Research Institute in June 2000. He joined the NMSU faculty in 1979. Prior to his tenure at the WRRI, Karl was assistant department head and range coordinator for NMSU's Department of Animal and Range Sciences. Much of his research over the years has been related to water resources, and for 20 years, he was a member of the Range Improvement Task Force, which provides scientific expertise to help resolve disputes over management of water and other natural resources. Karl completed a B.S. in 1974 in forestry and range management and an M.S. in 1976 in range science with field emphasis on soils and range improvements both from the University of Nevada/ Reno. In 1978, Karl received a Ph.D. in range science with field emphasis on watershed management from Texas A&M. Karl has nearly 150 journal articles, research bulletins, special reports, and conference proceedings publications to his credit, mainly in the areas of range hydrology, range vegetation and soil assessment, and rangeland management, including reclamation of disturbed lands, range improvement techniques, grazing systems and management of rare and endangered species. At the WRRI he has represented NMSU as chair of the Lower Rio Grande Water Users Organization, co-chair of the New Mexico-Texas Water Commission, and chair of the regional Paso del Norte Water Task Force.*

OPENING REMARKS FOR THE 51ST ANNUAL NEW MEXICO WATER CONFERENCE

Karl Wood, Director
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Las Cruces, New Mexico 88003

Good morning. I would like to welcome you to the 51st Annual Water Conference. The 50th, as you remember, was held in Las Cruces last year. We had about 300 people attend. We started off with Lowell Catlett and ended with Baxter Black and had a little bit of truth in between. This year, we have about 100 registrants. Why are there fewer this year? I do not think it is because we do not have Baxter. Someone pointed out that it is a wet year, and in a wet year we do not need to know as much about obtaining water because we have plenty. During drought years, people come out of the woodwork looking for some water. It is amazing. I was hired at New Mexico State University because of a drought year. I cannot do much during a drought, but I am very valuable. I got all of my raises during drought years. Drought is not always a bad thing.

Today, the honorable Martin Chavez, the Mayor of Albuquerque, will give us welcoming remarks. We thank the mayor very much for attending our water conference this year. It is time we had a mayor who understands the water quality problems and the opportunities of the city.

Water quality is the theme of our conference this year. I would first like to talk about water supply. Water supply is quite visible. Floods like the ones in Alamogordo and Hatch earlier this year are quite photogenic and easily recognized (Figs. 1 and 2). It is quite obvious whether we have lots of water or not. Water supply is a lot easier to measure than water quality. And it is easy to say if we have too little or too much.

Figure 1. Hatch after August 2006 flood

Figure 2. Rio Grande June 2006

With water quality, contaminants may not be visible, and what is visible may be deceiving. Often, it is difficult to measure water quality. It is difficult to say if it is too little or too much. Do we have too much of something or too little of something? Water quality is often poorest when the runoff is the lowest. We know that, but when the runoff is low, quality is of a lesser concern. That is just the nature of it. During the drought, all we hear is that we need more supply. We did not hear much concern about water quality.

Some of the present initiatives, what I see going through Congress, and what I see going through the New Mexico Legislature deal with water supply. We have a growing population, mined groundwater, exhausted surface water, and drought suppressing surface and groundwater recharge (Fig. 3). However, with water quality, there are some initiatives, but they are few and generally center on the Clean Water Act, health concerns, arsenic standards, and other contaminants such as perchlorate.

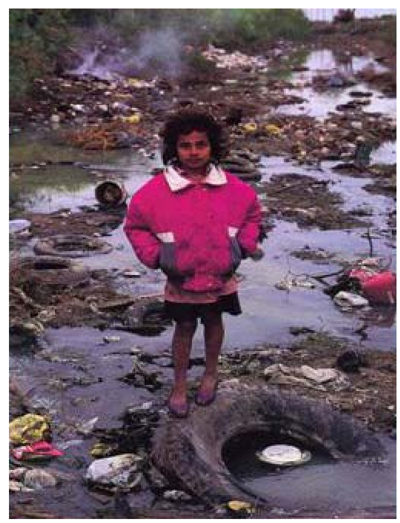

Figure 3. Water quality is often poorest when the runoff is lowest

For any given response variable, such as sediment load, dissolved solids, stream temperature, arsenic content, and so on, there are some questions that should be asked. I see this as a major failing of people involved with water quality as I travel around New Mexico and the nation. Number one, what are the natural levels of sediment, elements, or compounds with variations between hours, days, months, and years? Too often, water quality people are accused of going out with a mayonnaise jar, taking a dip out of a stream one time during the year, and characterizing the stream for the entire century by that one mayonnaise jar grab sample. There are natural levels of many constituents in the water, and they vary between hours, days, months, and years.

Figure 4 is a picture that is often shown in classrooms throughout the west put together by a professor at Colorado State half a century ago. He showed sediment loads as a function of precipitation. You can see that if there is no precipitation as on the left, then there is no sediment load. That makes sense as it takes water to carry sediment. The sediment load goes up until there is about 10 to 14 inches of precipitation, and then the sediment load comes back down again as precipitation continues to increase. Someone might ask why the sediment load is so high here from 10 to 14 inches of precipitation. At this point there is enough precipitation to cause erosion, but not enough vegetation to protect the soil. Over on the right side of the figure, there is enough precipitation to cause erosion, but it doesn't happen because there is a lot of protective vegetation. How much precipitation is received on most of the lands in New Mexico? Most of New Mexico receives from 10 to 14 inches. Because of that, we need to keep in mind that we have high sediment contents in our water flows because of the nature of our state. The Rio Puerco was called the Rio Puerco at the very beginning of settlement by Europeans because it was always a dirty river. By its nature, sitting on an ancient ocean bed, the Rio Puerco has high sediment loads.

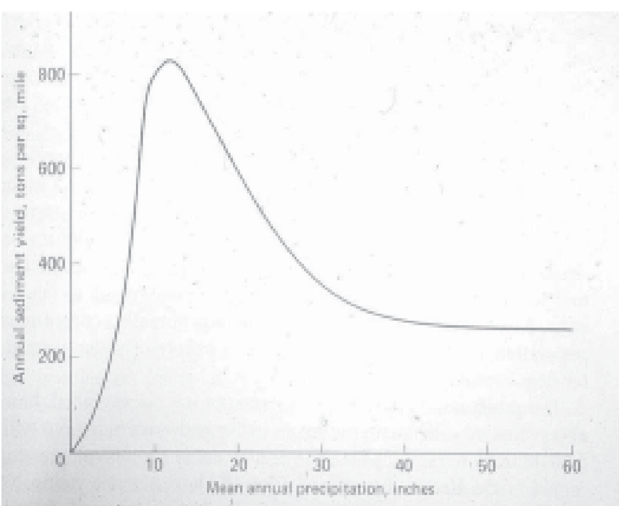

Figure 4. Sediment loads as a function of precipitation

We should also ask what the sources of the natural loads are. Many times we do not know. We find dissolved salts in the Rio Grande. They were attributed to irrigation return flow for decades. Recently, we are finding out more and more that there are natural occurrences of salt in our river beds. How much of the total at any one time is due to human influence? We have that which is natural and that which is human induced. How much is attributed to each? Those are difficult questions to answer. What are the sources of the human induced loads? We hear that lots of bacteria in the Rio Grande come from people walking their dogs in Albuquerque. We should also ask what are the maximum potential levels. How high could it get? Is that a concern? What are the tolerable levels? Maybe we are adding 50 percent of the sediment to a river, but is it still tolerable? That comes back to what the goals of the river are. We should ask what are the desirable levels? And are the desirable levels achievable with the present technology, time, legal, political, and economic constraints?

Here are many questions that when put together are a model that can be used to assess water quality problems and opportunities in our state. We hope you enjoy the conference.

WATER CONFERENCE ADVISORY COMMITTEE

Wayne Cunningham, retired, *Arch Hurley Conservancy District*

John D'Antonio, *Office of the State Engineer*

Jim Davis, *New Mexico Environment Department*

Tom Davis, *Carlsbad Irrigation District*

Gary Esslinger, *Elephant Butte Irrigation District*

Susan Fry Martin, *Los Alamos National Laboratory*

Chris Gorbach, *U.S. Bureau of Reclamation*

Matt Holmes, *Rural Water Users Association*

Fidel Lorenzo, *Pueblo of Acoma*

Nathan Myers, *U.S. Geological Survey*

Bill Rinne, *U.S. Bureau of Reclamation*

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Mark E. Yuska, *Army Corps of Engineers*

51^{st} Annual New Mexico Water Conference

WATER QUALITY FOR THE 21^{ST} CENTURY

Hotel Albuquerque at Old Town

Tuesday Morning Session, October 3, 2006

8:30 Welcome and Opening Remarks
Director Karl Wood, Water Resources Research Institute
Martin J. Chavez, Mayor of Albuquerque

9:00 A Brief History of the Development of New Mexico's Water Quality Standards and Steve Reynolds' Role in That Development
John Hernandez, WRRI at NMSU

9:20 New Mexico's Current Water Quality Standards and Significant Issues Facing the Water Quality Control Commission
Howard Hutchinson, Water Quality Control Commission

9:40 New Drinking Water Regulations
Dzung Kim Ngo Kidd, USEPA, Region 6 Drinking Water Section

10:10 BREAK

10:40 Coordination of Water Quality and Water Quantity Issues in New Mexico
Perspective of John D'Antonio, New Mexico Office of the State Engineer
Perspective of Ron Curry, New Mexico Environment Department

11:30 New Mexico Environment Department's Water Quality Goals
Marcy Leavitt, New Mexico Environment Department

12:00 Luncheon

Tuesday Afternoon Session, October 3, 2006

1:30 Albuquerque’s Drinking Water Project
John M. Stomp III, Albuquerque-Bernalillo County Water Utility Authority

2:00 Regulatory Challenges Faced by New Mexico’s Small Communities
Matt Holmes, New Mexico Rural Water Association

2:30 Water Quality Challenges of the Irrigated Agriculture Community on the Lower Rio Grande
Gary Esslinger, Elephant Butte Irrigation District

3:00 BREAK

3:30 Isleta Pueblo’s Perspective on NPDES Permitting and Storm Water Runoff
Jim Piatt, Isleta Pueblo

4:00 Industry and Water Quality – Panel Discussion
Electric Power: Marc Christensen, Public Service Company of New Mexico
Oil & Natural Gas: Frank W. Yates Jr., Yates Petroleum Corp.
Mining: Tom L. Shelley, Phelps Dodge
Produced Water: David Brooks, Oil Conservation Division, EMNRD

Wednesday Morning Session, October 4, 2006

8:10 NRCS Water Quality Programs
Linda Oyer Scheffe, Natural Resources Conservation Service

8:30 Groundwater Contamination by Septic Tank Effluents
Dennis McQuillan, Liquid Waste Program, New Mexico Environment Department

8:50 New Mexico's 319 Program: An Overview and a New Mexico 319 Success Story, the Cimarron Watershed Alliance, Inc.
David Hogge, NMED and Michael Bain, Cimarron Watershed Alliance, Inc.

9:10 New Mexico Environment Department's Pursuit to Establish Primacy for NPDES Permitting in New Mexico
Marcy Leavitt, New Mexico Environment Department

9:30 BREAK

10:00 Natural Sources of Saline Water on the Rio Grande
Fred Phillips, New Mexico Tech

10:30 Water Quality Issues on the Navajo Nation
Arvin Trujillo, Navajo Nation Division of Natural Resources

11:00 Albert E. Utton Memorial Water Lecture
The 1907 Water Code at 100 Years Old
G. Emlen Hall, UNM School of Law

12:00 Adjourn

__John Hernandez__ is New Mexico State University Professor Emeritus and has been associated with the New Mexico WRRI for many years, most recently as a consultant on several projects. 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. John received a BS in civil engineering from the University of New Mexico, an MS in sanitary engineering from Purdue University, an MS in environmental engineering from Harvard University, and a PhD in water resources from Harvard University in 1965. John was a faculty member at New Mexico State University from 1965 to 1999, including Dean of Engineering in the late 1970s. He has broad experience regionally, nationally, and internationally in water resources issues and has published extensively. He has received many awards throughout his career including the prestigious Donald C. Roush Excellence in Teaching Award from New Mexico State University in 1990, and the civil engineering building at New Mexico State University is now named Hernandez Hall in his honor.

A BRIEF HISTORY OF THE DEVELOPMENT OF NEW MEXICO'S WATER QUALITY STANDARDS AND STATE ENGINEER STEVE REYNOLDS' ROLE IN THAT DEVELOPMENT

John W. Hernandez, PE
510 W. Court Ave.
Las Cruces, New Mexico 88005

In 2008, New Mexico's stream standards will have been in effect for 40 years, and it has been a lot of fun to have been a part of the process from development, to maturity, through modifications of intent, and now to an era of uncertainty. Most of the early participants in the process are now dead. I want to assure you that I'm still here and still active. One of the principal, long-term players is not: my old boss Steve Reynolds. This is a short story of the early development of the stream standards and Reynolds' involvement.

In 1956, the US Congress passed the first in a series of water pollution control acts. This initial effort provided federal grants, administered by the U.S. Public Health Service (PHS), for new wastewater treatment plants and for major outfall sewers. Many states had a serious problem: most had inadequate or no regulations on the quality of the effluent produced by treatment plants. State laws and regulations often failed to define "pollution." In 1956 most states had only the most basic water pollution laws that required states to show that a public nuisance or a serious health hazard existed. The Public Health Service tried to help, but they were not a regulatory agency by nature, and the PHS preferred to stress cooperation and education. It was the 1956 act that made it possible for the State Health Department to hire me and for me to leave the

Office of the State Engineer and Reynolds' domination. I mean this in the best possible sense. Steve was a dominating personality – over most of the OSE staff – not just me.

In spite of the lack of regulations and standards, the old State Health Department did a good job of controlling water pollution: educating and jaw-boning, using the power to review plans for treatment plants, providing federal money for municipal sewer plants, and using some unintended help from Steve Reynolds. Two of his favorite dictums that we used to require of secondary treatment plants were: "get your sewage out of my river" and "dilution is not the answer to pollution."

The 1965 law required the state to adopt state stream standards for its interstate waters based on scientific chemical, biological, and physical water quality criteria that would make all existing and potential uses of a state's surface waters possible and to adopt a plan for the implementation and enforcement of the standards.

The relationship between the SHD and the OSE staff was never "very warm," but it was not belligerent either. The Health Department was always the "weak sister." There was more than one case of groundwater pollution where the two agencies cooperated fairly well. For example, in 1959, the Health Department found and monitored groundwater pollution caused by seepage from a uranium mill pond. U.S. Public Health Service drinking water standards were used to prove that contamination was occurring. The company involved agreed to solve the problem by using deep-well injection to dispose of their wastewater. Because of the lack of competency in the Health Department, Reynolds agreed to provide primary oversight for the installation and operation of the injection-well.

The personality and strength of the old Health Department changed with the passage of the Federal Water Quality Act in 1965. The movement from a health agency to being a health and environmental protection agency started with the 1965 Federal Act that required every state to adopt a set of standards for its interstate streams by June 30, 1967 – just 19 months after the law was signed by President Johnson. The act also took water pollution control authority away from the PHS and moved it into the Interior Department. This proved to be a short-lived mistake.

The 1965 law required the states to adopt state stream standards for its interstate waters based on scientific chemical, biological, and physical water quality criteria that would make all existing and potential uses of a state's surface waters possible and to adopt a plan for the implementation and enforcement of the standards. When stream standards were mandated, New Mexico did not have a water pollution act, did not have any water quality standards by which to prove that pollution existed, did not have a water pollution control agency, did not have a board that could adopt standards, and had only a two-man water quality group in the old State Health Department. New Mexico was able to overcome all of these obstacles, to hold hearings, and to adopt a set of stream standards for interstate streams by 1968. By 1965, Steve Reynolds had been in power as the State Engineer for 10 years, and I had left the Health Department for a Harvard PhD and an associate professorship at NMSU.

Under a contract with the Health Department, I was asked to help prepare and propose a set of stream standards for each of our interstate streams. It was a team effort: the Health Department provided federal money and scheduled hearings; the USGS provided a summary of the chemical characteristics for each stream; the feds provided the water quality criteria; and an ad hoc group wrote New Mexico's first water quality act. Reynolds was a member, and Governor Dave Cargo threatened to keep two of the gang (John Wright of the SHD and Fred Moxey, a lobbyist for commerce and industry) in his office until the language of a law was agreed upon.

Reynolds was a major force in the writing of the State's first Water Quality Act. Enacted in 1967, it provided for a commission to hold hearings and to adopt standards. Reynolds liked some elements of the 1965 federal act, particularly the section that affirmed the right of a state to administer the use of its waters, but there were a number of differences in language and intent between the federal and the state laws. The 1965 federal act referred to stream standards as "regulations" while the 1967 state law called stream standards "a guide to water pollution control." The federal law made stream standards enforceable, but the state act made only "regulations" enforceable and not stream standards. Reynolds was successful in inserting two limitations into the state law, the last of which resulted in considerable federal opposition, then and now:

- "this Act does not grant to the commission or other entity the power to take away property rights in water," and
- "in the adoption of regulations and water quality standards and in any action for enforcement of the Water Quality Act and regulations adopted there under, reasonable degradation of water quality resulting from beneficial use shall be allowed."

Standards were proposed, hearings on each stream were held, and in June 1967, the new Water Quality Control Commission adopted standards for the Chama and Rio Grande, Pecos River, San Juan, La Plata, and Animas Rivers, Gila and San Francisco Rivers, and the Canadian River. At a hearing on December 13, 1966 on the proposed standards for the Rio Grande stream system, Steve Reynolds presented a statement that did three things:

- he defended the concept of "reasonable degradation" as a consequence of beneficial consumptive use,
- he spoke to the apportionment of the Rio Grande in the 1939 Interstate Compact, and
- he outlined anticipated changes in salinity as a result of Corp of Engineers and Bureau of Reclamation projects, the San Luis Closed Basin Project and Albuquerque's use of San Juan-Chama water.

Reynolds did not endorse the proposed standards, nor did he propose any changes. In summary he said, "I respectfully urge that the water standards proposed for the Rio Grande fully accommodate the development and reasonable use of waters within the limitations of the Rio Grande Compact."

Reynolds did want one particular concept placed in the stream standards; he wanted the term "where practical" inserted in the objectives clause of the standards, in the sentence dealing with the need to maintain the original water quality of a stream. He and I both believed that the phase was in keeping with Congressional intent of the 1965 Federal Act. The words "where practical" have resulted in opposition by environmental groups over the years, but the phrase remains in the standards today. A common element in most state stream standards were the so-called "Free-From" statements that described what streams should be:

> "free of obnoxious odors; floating solids, oils, and grease; esthetically undesirable color; bottom deposits; turbidity; toxic substances; and radionuclides in concentrations inimical to aquatic life."

Reynolds insisted that the "Free-From" section include a statement that naturally occurring conditions were not subject to the standards. His provision has been the subject of periodic attacks, but a modified version remains in place. Reynolds' provision was:

> "Naturally occurring turbidity caused by silt or suspended sediment or by the reasonable operation of irrigation and flood control facilities are not subject to these standards."

The standards included some numeric values that were "reach specific" and that were subject to special conditions such as the season or the volume of stream flow. Each interstate stream was divided into a series of sections or reaches that were somehow different from the stretch above or below. Numeric values were set for temperature, dissolved oxygen, fecal coliform bacteria, and for ionic species such as sulfates, chlorides, and total dissolved solids (TDS). If, in a statistically significant number of samples, a numerical standard was exceeded, the standards called for the Water Quality Control Commission to launch an investigation into the cause. Problems with some of our initial salinity standards were soon manifested.

Reynolds was a major force in the writing of the State's first Water Quality Act. Enacted in 1967, it provided for a commission to hold hearings and to adopt standards.

Each set of New Mexico standards was to include a statement showing consistency with the standards of the contiguous state. This meant coordinating the development of New Mexico's standards with those of Texas during a period when both states were occupied with completing their own standards. The failure of Texas and New Mexico to adopt common salinity standards on the Rio Grande at El Paso initially lead to partial federal rejection of New Mexico's standards. On August 7, 1967, Secretary of Interior Stewart Udall wrote refusing to accept New Mexico's standards on the Rio Grande for lack of "compatibility of standards with those of the adjacent state for the same waters." On July 9, 1968, Governor Dave Cargo received a letter from Udall commending the State "on the development of good water quality criteria" and stating that New Mexico's standards had been approved except for three major items:

- the lack of an anti-backsliding clause in the standards;
- concern that the section in the State Water Quality Act that stated that "reasonable degradation of water quality resulting from beneficial use shall be allowable" did not meet the intent of federal law; and
- the lack of coordination between Texas and New Mexico on the salinity of the Rio Grande at El Paso.

New Mexico's stream standards at the state line provided that the average annual concentration for chlorides was not to exceed 400 mg/l, sulfates 500 mg/l, and total dissolved solids 2,000 mg/l. Our state line standards were set to apply at flows above 350 cfs, and that the salinity standards did not apply below that flow. The Texas standards for El Paso were to apply at all times and the average concentrations were not to exceed chlorides of 200 mg/l, sulfates 350 mg/l, and total dissolved solids 1,000 mg/l. A fundamental problem with the Texas standards was a lack of a statistically defensible sampling and averaging procedure. It was easy to show that the average daily water quality in the river at El Paso would exceed one or more of the Texas values on at least 100 days per year.

The failure of Texas and New Mexico to adopt common salinity standards on the Rio Grande at El Paso initially lead to partial federal rejection of New Mexico's standards.

New Mexico could not accept the Texas salinity standards as that would mean having to forego the storage of irrigation water in Elephant Butte in the winter months and to make continual releases on the order of 300 to 400 cfs. This would clearly reduce the supply available for irrigation to both Texas and New Mexico. This was not the intent of the Rio Grande Compact, nor was it the intent of Congress in passing the 1965 Federal Act.

What happened next remains a mystery as most of the participants are now dead, and those who are still with us can't remember who did what. A good guess would be that Steve Reynolds was involved. In mid-January 1969, a copy of a telegram, the original being sent to J.R. Smith, the Acting Secretary of Interior, came from the Texas Water Quality Board saying that Texas had reviewed the New Mexico standards for dissolved ions on the Rio Grande at El Paso and that Texas believe them to be essentially the same as the Texas standards. On August 21, 1969, a letter from Acting Secretary Smith was sent to Governor Cargo fully approving New Mexico's stream standards. What did change were the Texas standards. By 1973, Texas had increased the allowable average annual levels for salinity at the state line for chlorides from 200 to 500 mg/l, for sulfates from 350 to 700 mg/l, and for total dissolved solids from 1,000 to 1,800 mg/l. The 1973 Texas values for chlorides and sulfates exceeded New Mexico's limits and the TDS figure was about 10 percent lower than ours. More important, in 1973 Texas included a sampling and flow averaging definition.

The New Mexico salinity standards at El Paso and the phrase "where practical" both remain, unchanged, in the standards. Reynolds' "reasonable degradation" clause has been modified by the USEPA's "anti-degradation" regulations, but it is still in the state standards. Reynolds "reasonable operation of irrigation and flood control dams" is now both in the standards and in the State Water Quality Act.

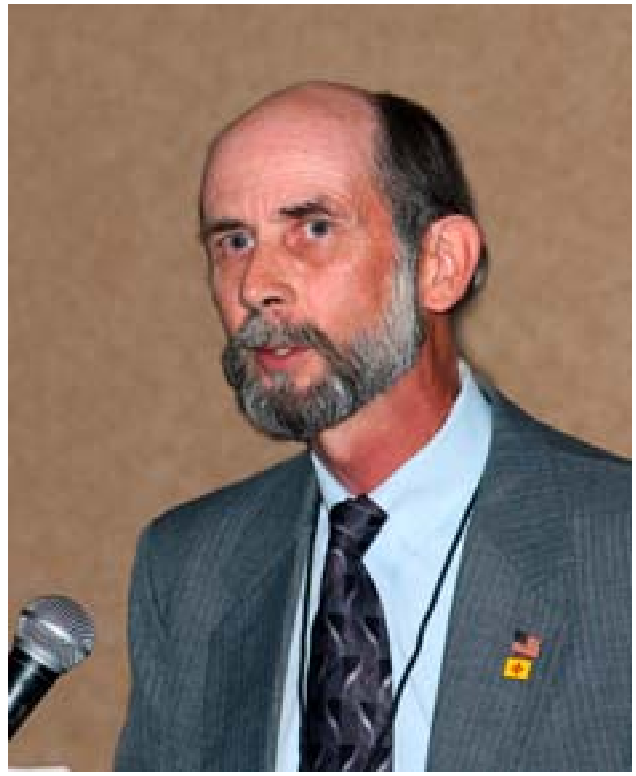
I also think that Steve Reynolds was a force in the Congressional adoption of two sections of the 1972 Federal Water Pollution Control Act:

- "Section 101 (g). It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State."
- "Section 402 (l). The Administrator shall not require a permit under this section for discharges composed entirely of return flows

> from irrigated agriculture, nor shall the Administrator directly or indirectly, require any State to require such a permit."

Prior to 1985, there were few major changes to New Mexico's stream standards, although minor changes were made every year or so. Steve served on the Water Quality Control Commission from 1967 until his death in April 1990. He was an active voice of reason on the Commission. After Steve's death, the management of the Surface Water Bureau of the NMED became more aggressive and more assertive. The leadership seemed to be determined to gain total control over the management of the water in state streams. Sides were drawn on the Water Quality Control Commission, pitting state agencies against each other. It was a difficult period in water resources management in New Mexico. The situation is better now, but differences between water users and some of the environmental groups may lead to future conflicts over the state's stream standards. Steve Reynolds, where are you, when the state needs you?

Howard Hutchinson *has lived in Glenwood, New Mexico for 31 years and for the past 15 years has been the Executive Director, Technical Writer, and Media Liaison for the Coalition of Arizona/New Mexico Counties, representing 16 counties in the two states. He has been involved in many water-related activities including: Commissioner, New Mexico Water Quality Control Commission; Member, New Mexico Governor's Blue Ribbon Water Task Force; Vice-Chair, San Francisco Soil and Water Conservation District; Chair, San Francisco River Basin Water Advisory Board; Chair, Catron County Water Advisory Board; Chair, Catron County Land Planning Committee; and Member, Southwest New Mexico Regional Water Planning Task Force. In 2006, Howard received Glenwood Community's Long Time Service Award for 2005.*



THE CURRENT NEW MEXICO WATER QUALITY STANDARDS AND MAJOR ISSUES FACING NEW MEXICO'S WATER QUALITY CONTROL COMMISSION[1]

Howard Hutchinson
Designee of the Soil and Water Conservation Commission to the
New Mexico Water Quality Control Commission
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The New Mexico Water Quality Control Commission (WQCC) is charged under New Mexico's Water Quality Act with adopting water quality standards for surface and ground waters of the state based on credible scientific data and other evidence appropriate under the Water Quality Act [74-6-1 NMSA 1978]. The standards shall include narrative standards and as appropriate, the designated uses of the waters and the water quality criteria necessary to protect such uses.

Before trying to describe New Mexico's water quality standards (WQS) it is necessary to understand several terms. They are water quality standard, designated use, and criteria.

[1]Portions of this paper were adapted from the summary of changes to New Mexico's Water Quality Standards composed by Felicia Orth, WQCC hearing officer for the 2005 changes. To view the new 2005 standards go to: http://www.nmenv.state.nm.us/swqb/Standards/index.html

A water quality standard consists of the designated use or uses of surface waters of the state and the water quality criteria necessary to protect the use or uses.

Designated use means a use specified in Sections 20.6.4.101 through 20.6.4.899 NMAC for a surface water of the state whether or not it is being attained.

Criteria are elements of state water quality standards, expressed as constituent concentrations, levels or narrative statements, representing a quality of water that supports a use. When criteria are met, water quality will protect the designated use.

The WQCC completed its last Triennial Review on June 13, 2005. The hearings lasted for four days beginning in November of 2004 and continued in December of 2004. Three days of deliberations concluded with the adoption of the statement of reasons. The new water quality standards (WQS) became effective on July 17, 2005.

The WQCC submitted the revised WQS and supporting documentation to EPA on July 7, 2005. According to 40 CFR 131.21(a), EPA is required to approve the WQS revisions within 60 days or disapprove the WQS revisions within 90 days of receipt. As of today, EPA has not provided formal comments on the WQS changes.

While there were a number of changes to the WQS, this presentation will only cover some of the more significant changes. Those changes are:

- Amendment of the definition of "surface waters of the state" to remove the constraint imposed by a U.S. Supreme Court decision on the definition of waters of the United States that was adopted into the WQS in the 2000 Triennial Review. [20.6.4.7.CCC]

> **"CCC. "Surface water(s) of the state"** means all surface waters situated wholly or partly within or bordering upon the state, including lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, reservoirs or natural ponds. Surface waters of the state also means all tributaries of such waters, including adjacent wetlands, any manmade bodies of water that were originally created in surface waters of the state or resulted in the impoundment of surface waters of the state, and any "waters of the United States" as defined under the Clean Water Act that are not included in the preceding description. Surface waters of the state does not include private waters that do not combine with other surface or subsurface water or any water under tribal regulatory jurisdiction pursuant to Section 518 of the Clean Water Act. Waste treatment systems, including treatment ponds or lagoons designed and actively used to meet requirements of the Clean Water Act (other than cooling ponds as defined in 40 CFR Part 423.11(m) that also meet the criteria of this definition), are not surface waters of the state, unless they were originally created in surface waters of the state or resulted in the impoundment of surface waters of the state."

- Adoption of a new use—"limited aquatic life"—for naturally poor quality waters that may not support a full community of aquatic life, but perhaps a more limited macroinvertebrate community. Sulphur Creek is a prime example. [20.6.4.7.HH, 20.6.4.11.H]

- Approval of the first Outstanding National Resource Water (ONRW) in the state, the Rio Santa Barbara, and making the nomination process for ONRWs somewhat more accessible by requiring the submission of baseline water quality data only if it is available, and requiring a discussion of economic impact rather than a rigorous analysis. Criteria for designating an ONRW were also added for clarification. The Rio Santa Barbara is a stream of exceptional ecological and recreational significance and deserved protection from degradation. [20.6.4.8.D]

- Replacement of the fecal coliform bacterial criteria with E. coli to conform to current EPA guidance and the latest studies. [20.6.4.7.V]

- Regarding compliance with water quality standards and the evaluation of water quality criteria, the WQCC rejected a number of changes such as averaging periods, frequency of exceedances, and minimum number of samples.

- Revision of the procedure for approving the application of a piscicide to surface water, particularly for fish restoration, and addition of a rebuttable presumption that EPA and New Mexico Department of Agriculture label determinations are valid. Time lines for processing the petition were also added for clarification. [20.6.4.16]

- Making determinations of primary vs. secondary contact criteria for several Rio Grande stream segments in New Mexico where there was substantial evidence of such contact, such as swimming as an existing use. [20.6.4.105, 106, 110]

- Change to the designated use of the perennial reaches of Las Huertas Creek from coldwater to high quality coldwater aquatic life; it is an existing use. [20.6.4.111]

The Commission also clarified a number of terms. A few of the more significant were:

- Best Management Practices (BMPs) are voluntary for nonpoint sources, except in limited circumstances. [20.6.4.7.E]

- "Standard" consists of the uses of water and the supporting criteria. "Criterion" describes the concentration of a constituent representing a quality of water supporting the particular use. [Corrections were made throughout the standards.]

- "Fishery" was changed to "aquatic life" to conform the definition to its intended breadth. [20.6.4.7.N and several other sections]

- "Ephemeral" was changed to broaden its application to surface waters other than streams, such as lakes, playas and ponds, with or without a self-sustaining population of fish. [20.6.4.7.W]

- Adding the word "natural" to modify references to flow and temperature such that a designated use will not be interpreted to exclude waters affected by man-made conditions. That is, if a stream is degraded by human-caused conditions, it should be listed as impaired rather than classified with a less protective designated use.

- Broadening the term "perennial" to include waters other than streams, such as lakes, ponds, and reservoirs. [20.6.4.7TT]

- After considerable deliberation, the definition of "practicable" was adopted from the Black's Law Dictionary to mean that which may be done, practiced or accomplished; that which is performable, feasible, possible. [20.6.4.7.WW]

- Clarification of the applicable requirements for effluent-dependent waters: although the default uses of livestock watering and wildlife habitat apply to all unclassified ephemeral and intermittent waters, more stringent criteria apply whenever ephemeral streams enter classified waters. [20.6.4.11]

- Clarification that Section 20.6.4.11 is used only to guide enforcement determinations, not assessment determinations for 303 (d) lists and TMDL development. Rejected a proposal that samples taken when streamflow is less than critical low flow not be considered, on the grounds that uses are still occurring when there are low flows, the Commission should be able to use all available data, and there are no flow gages on most streams in New Mexico. [20.6.4.11]

- Consideration but rejection of the application of chronic aquatic life criteria to ephemeral waters; acute and chronic do apply to intermittent waters. [20.6.4.97 and 98]

- Consideration but rejection of the explicit acknowledgment of site-specific ambient standards. [20.6.4.12]

- Updates to criteria and references in the tables to reflect current knowledge. [20.6.4.900 I and J]

Major issues facing the WQCC

New Mexico's Water Quality Act and the Clean Water Act charge the WQCC with performing a balancing act between protection of water quality and giving weight to economic value, property rights, and accustomed uses.

One of the main issues for the commission is the recognition that each river system and water source in our state is unique. Our standards do not recognize the natural differences of our diverse geography and climates. The future challenge will be to use the data collected over the years to develop segment specific standards that recognize those differences.

Like all rule making entities in New Mexico, the WQCC's regulatory charge is challenged with dealing with our population growth. More people equal more conflicting values and interests and an increased demand on finite quality water sources.

The conflict over values often brings emotional rather than scientific conflict before the WQCC. This commission and future commissions will increasingly play a Solomon's role in making decisions.

I have puzzled over the ten years of service on the WQCC why there seems to be so little interest in the proceedings. Very few public or regulated interests attend the meetings and hearings. Raising public awareness over the importance of the quantity and quality of our water is a major challenge for the WQCC and all of us.

Certainly the Water Resources Research Institute is to be commended for advancing and disseminating the knowledge of the resource that is only second to air in its importance for life.

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DRINKING WATER REGULATIONS

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Good morning. I appreciate being here today. The Safe Drinking Water Act was first enacted in 1974 under the Nixon administration. There have been two amendments since. It instructs us, the U.S. Environmental Protection Agency (EPA), to write regulations for drinking water. Those regulations are codified under the Code of Federal Regulations 40, parts 141 through 143. Part 141 is the National Primary Drinking Water Regulations, which public water systems have to follow. Part 142 is the state primacy requirement, and part 143 is just the secondary standards that are not enforced in public water systems. Some states do adopt part 143 as well.

New Mexico has adopted all of the federal drinking water regulations. The following is a list of some of the regulations. The newest rules that came out were the Long Term 2 Enhanced Surface Water Treatment Rule and the Stage 2 Disinfectant/ Disinfection Drinking Byproducts Rule. The Ground Water Rule is set to be signed on October 11, 2006. I do not know where the Radon Rule is right now.

- Total Coliform Rule 1979
- Phase I & II & V Rules (VOCs, SOCs, IOCs, NO3/NO) 1980s
- Surface Water Treatment Rule 1989
- Interim Enhanced SWTR 1998

- Stage 1 Disinfection ByProduct Rule 1998
- Consumer Confidence Report Rule 1998
- Variances & Exemptions Rule 1998
- Lead & Copper Minor Revisions 2000
- Public Notification Rule 2000
- Radionuclides Rule 2000
- Filter Backwash Recycle Rule 2001
- Arsenic Rule 2001
- Long Term 1 ESWTR 2002
- Long Term 2 ESWTR 2006
- Stage 2 DBPR 2006
- Ground Water Rule —
- Radon Rule —

Here is a quick overview of the flow of drinking water regulations. Congress writes an act and authorizes us to write regulations. The regulations pass on down to the state agency that adopts the regulation. The public water systems have to follow the regulations. How do they do that? They take samples. They send samples to the lab for analysis. The results are shared with the primacy state agency. They determine compliance and report back to the EPA. EPA compiles a report and sends it back to Congress. In the end, Congress sees the violation data.

Money also flows that way. Congress appropriates funds to the EPA that are passed on to the primacy states. The primacy states use that money to run the drinking water program and contract some of those technical systems to rural water associations and other organizations.

In New Mexico, there is something called the water conservation fee, which someone mentioned yesterday on the tour. Water systems pay into this fee to have the state take the samples for them.

New Mexico, Texas, Oklahoma, Arkansas, and Louisiana are part of EPA's Region 6. All of the states in Region 6 EPA have primacy and enforcement authority over their water systems. New Mexico has about 1,300 public water systems, Texas has 6,600, Oklahoma has 1,600, Arkansas has 1,200, and Louisiana has 1,700.

More recently, the department here has reorganized into five districts. However, for drinking water purposes, the drinking water program is still housed under four districts in the department (Fig. 1). The drinking water program also has a website where you can look up your local water systems information by water system name or by a different search. It is http://eidea.state.nm.us/SDWIS/.

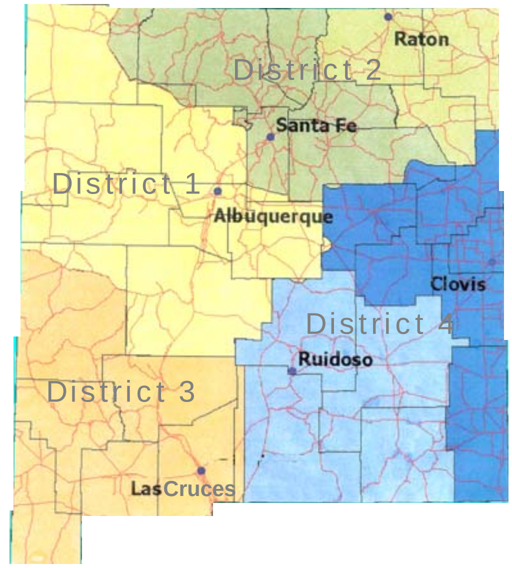

Figure 1. Map of NMED DWB area office location and coverage

As I said, New Mexico has adopted all of our federal EPA regulations and in some cases are more stringent than our regulations. This year, 2006, represents the year that the Long Term 2 ESWTR and the Stage 2 DBPR regulations were published in the federal register.

As of August 2006, New Mexico has 1,284 public water systems. About 650 of those are community systems that serve residential areas. The non-transient systems serve schools, places where you work, nursing homes, and so on. The transient systems serve rest stops, gas stations, and campgrounds.

If you break this down by size, New Mexico has, relatively speaking, only a few large water systems. Large systems serve greater than 10,000 people. Medium systems serve between 3,300 and up to 10,000. Small systems serve populations less than 3,300.

Breaking it out by source, 95 percent of public water systems in New Mexico derive from a ground water source. Of the 1,284 systems, I think 1,030 of them are served by ground water sources and ground water purchase sources.

To keep the rules straight in my own head, I cluster them into groups. Before I go into the new rules, I wanted to talk about a few of the old rules that currently affect New Mexico. Under the Clinton administration, the Safe Drinking Water Act was written to have a consumer right-to-know provision. A CCR is a consumer confidence report. If you have a water bill, every year your water system has to send you a report by July and tell you what is in that water. They basically publish contaminants that were detected in the previous water year. Some water systems post their quality reports on our site. Albuquerque has their own water quality site and posts its own report.

One of the rules that affects New Mexico is the total coliform rule. This is basically an acute contaminant rule. We are looking at indicators that pathogens are present in your drinking water. We require monitoring every month. There is not a waiver for this monitoring. Monitoring is based on system size. Albuquerque, which serves more than 500,000, takes about 210 samples every month. It costs about $30 per sample. New York would probably take close to 500 samples a month. Las Cruces takes probably 80 samples a month. Most systems in New Mexico take fewer than 5 samples per month based on their population.

Of the chemical/radionuclides contaminants, a few of them are an issue in New Mexico. Nitrate is one of them. The health threat is mainly for infants and babies. For adults it is not a problem, but a baby's alkali stomach converts nitrate to nitrite, and that competes for oxygen binding sites in the blood. It suffocates the baby. It is known as Blue Baby Syndrome.

Some interesting inorganics are fluoride and asbestos. Fluoride has two MCLs. One of them is the enforceable health standard at 4 mg/L. The other is a non-enforceable cosmetic standard as well. If you go to west Texas, you see a lot of people with brown teeth, and that is because the water there is high in minerals. The people who grow up with that water get brown teeth.

Arsenic has a huge impact in New Mexico. The level set is at 10 ppb, not 10.0 ppb. If you get a sample that is 10.59, you are still in compliance based on rounding.

There are roughly 80 to 90 systems that will exceed 10 ppb come the end of December 2007 when the compliance period ends. Thirty percent of these systems have come in for exemptions, which is something that we allow. The other 30 percent are installing treatment facilities, and another 30 percent the NMED is going to have to deal with and help. There is a non-treatment option. If you have wells high in arsenic on the west side and wells not so high in arsenic on the east side, you could do a blending option. You can install treatment, or you can use an exemption or variances, which basically allows you more time to come into compliance. Albuquerque has an exemption until 2008. Small systems have up to nine years total to extend the exemptions. During the time of the exemption, you are not in violation in our eyes, because you have more time to comply.

Radionuclides also affect New Mexico. The recent rule is basically the same, except for a new introduced uranium standard at 30 ppb. These require gross beta analysis for all surface water systems serving greater than 100,000. That was during the scare of nuclear fallout and those issues. It is not so anymore. We have only limited it to the goal of contaminated systems.

There are roughly 80 to 90 systems that will exceed 10 ppb [arsenic] come the end of December 2007 when the compliance period ends.

One of the issues that comes out of arsenic and radionuclides is not just treating the water and sending it to homes, but also the waste residuals that accompany the treatment of the water. That is something we have to deal with. We call our radionuclides treatment residuals NORMS or sometimes TENORMs. That means naturally occurring radioactive materials or technically enhanced NORMs. It is an issue that we are trying to deal with at the federal level. I just want to bring to your attention that the Nuclear Regulatory Commission (NRC) is proposing a new rule. I will tell you about it in just a second.

When you treat for radionuclides or even arsenic, for example, you get both kinds of liquid and solid waste residuals. If it is radioactive or hazardous, you have to dispose of it properly. The Clean Water Act regulates the discharge to a body of water or a publicly owned treatment work. The Safe Drinking Water Act regulates disposal of waste by underground injection. The Resource Conservation and Recovery Act (RCRA) regulates landfills and hazardous waste landfills. The Atomic Energy Act regulates radioactive waste landfills. Currently NORMs produced by water treatment plants are not regulated federally. I have found that to be a problem. As of right now, it is left up to the states to decide what to do with it. If you are producing radionuclides that do not exceed these levels then you can still dispose of them in a solid waste landfill.

The NRC is proposing a general water system license. In the spring of 2007, look for proposed language that will require water systems to do something with this waste. You have an opportunity to provide comments. They are going on a fast track to finalize it in 2008.

The two new rules are Stage 2 and LT 2. These clusters balance treating for microbial and treating for disinfection. The Surface Water Treatment Rule cluster basically attempts to filter and disinfect the water. You are just building on top of each rule. Where we are at is LT 2 Enhanced Surface Water Treatment Rule. These apply to surface water systems of which there are not that many in New Mexico. For the DBPs, you are looking at the entry point and the source treatment as well as the distribution and the pipelines. DBP formation occurs when you have disinfectants such as chlorine and naturally occurring organic matter (TOCs) in the source water. We regulate the trihalomethanes, a kind of DBP, and also for HAA5s, another kind of DBP. Basically, we are saying that out in the distribution system you do not want to exceed 80 ppb and 60 ppb, respectively for each one. You still want to maintain a chlorine residual level to kill microbials in the distribution system, but you do not want that chlorine level to be too high either. We have maximum residual levels for chlorine and other disinfectants.

If you are a town of 50 people and you buy from another town that disinfects its water, you are going to have to start sampling for DBPs.

What is the difference between Stage 1 and Stage 2? Stage 1 regulates systems that have added a disinfectant. If you chlorinated the water, you had to monitor for DBPs in the distribution system. Stage 2 now captures purchasers of these systems. Purchasers typically do not add extra chlorine. They are going to be covered under this rule. If you are a town of 50 people and you buy from another town that disinfects its water, you are going to have to start sampling for DBPs. That is basically all this rule covers. It is covering one more part of the system. Distribution pipes were not covered before. There are early implementation requirements. Most of our rules are effective three years after they are published. This one has an early implementation part to it. The important thing to know is that even if you serve small systems, you have to follow the same schedule in the loop that is the largest system. In this case, whatever schedule this system is on, this system has to do the same amount of time block. Since the large system is on schedule 1, the small systems also have to do things by certain deadlines in that same time frame. What they do is different. They can actually do things that make their work a lot easier.

In New Mexico, there is only about one schedule and one system, and that is for Albuquerque. It sells to three or four systems, so there is a total of maybe five systems that are schedule 1 systems that have to do early implementation at that same frequency. There are probably about ten to twelve schedule 2 systems, which are the next round. Everyone else is a schedule 3 or 4. Probably in 2008 they are going to start having to do something.

Early implementation runs from 2006 to 2010. After that, 2012 is when the compliance monitoring will begin for Stage 2. You are basically selecting sites to monitor come 2012. Remember I said what it is you have to do. There are two methods, the Very Small System Waiver and 40/30 certification. You can have existing data that is lower than 40/30 for TTHM and HAA5s. You do not have to do a lot of this implementation work. You can waiver yourself out of this if you are small enough.

The Stage 2 rule basically requires that you maintain Stage 1 monitoring sites in the distribution system, but you also test Stage 2 sites in the early implementation part to see if they are good sites. In the end, come 2012 you pick the sites. It may be the same sites that you had for Stage 1.

We have examples of a 40/30 Certification Letter in our IDSE Guidance Manual. We work as an honor system. When you send the letter to us, you are saying that you are below 40/30 levels and that you are certifying yourself out of the work. The VSS waiver is allowed if you serve less than 500 people. There are a lot of those systems in New Mexico that can qualify.

The LT 2 rule basically applies to source water that uses surface water sources. It is on the same schedule and track as DBPs. If you take in surface water sources and treat it, you have to monitor for LT 2, which includes cryptosporidium, E. coli, and turbidity. If you are buying water from a surface water source, you do not have to monitor at all. You are not even subject to this rule. Only systems that take in surface water and treat it are subject to this rule. There are only 60 surface water systems in New Mexico. A good number of these are actually purchasers, so there are only a few that have to abide by the LT 2 Surface Water Rule. The system can monitor crypto, grandfather data, or treat without monitoring. The reason is because crypto monitoring is really expensive. I have heard figures anywhere from $500 to $1,200 depending on if you want to filter the sample yourself or send gallons of water to the lab for filtration. E. coli is enumeration. It is not presence/absence. It is a little bit more expensive than presence/absence. Then there is turbidity.

After you do crypto monitoring, it basically classifies you into certain categories. If you have a low crypto level, then you do not have to do anything. If you go beyond a certain level, then you are going to have to start providing extra treatment.

I want to talk a bit about the Ground Water Rule that is supposed to come out. I hear the rumor that October 11th is the date when it will be signed. Once it is signed, it will probably take a couple of weeks to be published in the Federal Register. Look for that in probably late October. This rule will apply to all ground water systems in New Mexico. Remember I said New Mexico has 1,284 systems, 95 percent of which are from ground water sources. The rule is going to cover systems that do not disinfect. Sanitary surveys are, by the way, inspections of water systems for different areas to make sure they are structurally sound and that the integrity is still there to provide safe water. Again, 95 percent are ground water sources.

The Ground Water Rule basically wants to encourage ground water systems to provide disinfection for ground water systems that do not provide 4-log treatment to inactivate viruses. When you do an inspection in one of these ground water systems, they are supposed to look at eight areas: the source, the treatment plant, the distribution pipes, the storage tanks, the pumps and facilities, the data, operation and maintenance, and the certified operator.

Part of the rule requires that these ground water systems do what we call an HSA, a hydrogeological sensitivity analysis. It basically determines if the aquifer is sensitive to contamination. The aquifer is sensitive to contamination if it contains coarse gravel, limestone, that type of aquifer. If it is deemed sensitive, then you have to take action. If it is deemed sensitive, then you have to monitor. This is not distribution monitoring. It is source monitoring. You monitor your well water for a fecal indicator. There are three that the state can choose from. The state will probably choose E. coli as an indicator for monitoring because it is a quicker, cheaper, and a faster way to do it then trying to sample and analyze for coliphage for example. If the state chooses to pick E. coli, the water systems would have to do two types of monitoring if they do not provide 4-log inactivation, meaning that they do not treat and disinfect, and they are sensitive. They do have to do this type of monitoring.

For source water monitoring, there is routine monitoring that occurs every month. Every month they must take samples of their source water. There also is triggered monitoring. If they have a total coliform positive in the distribution system pipelines, then they must do source monitoring. There are two types of monitoring. If they monitor the source and they have a fecal positive test, they have to take corrective action within a certain amount of time. The corrective action can be any of these, one of which is to go ahead and provide 4-log treatment. As you can see, the rule is trying to encourage ground water systems currently not disinfecting to go ahead and disinfect. The corrective action is something that is worked out by the state. I do not know if the rule still allows 90 days. I think it may be longer than that. It is two years since the rule has been posted, and now it is being finalized, so there might be small changes in the rule.

The Ground Water Rule basically wants to encourage ground water systems to provide disinfection for ground water systems that do not provide 4-log treatment to inactivate viruses.

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COORDINATION OF WATER QUALITY AND WATER QUANTITY ISSUES IN NEW MEXICO
PERSPECTIVE OF THE OFFICE OF THE STATE ENGINEER

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Good morning. It is always nice to be at the WRRI conference. I look forward to it more than any other conference. You all are probably glad that I am going to be talking about something besides Active Water Resource Management, since I seem to be talking about it every time you guys see me. And, I see all the water groupies in the room.

I did spend a stint in the Environment Department as the department secretary at the end of the last administration. It was really good for me to do that, even though I was only in the office for half a year. Essentially it exposed me to the work that the Environment Department does with water quality issues and the surface water and groundwater bureaus. They had some really good people. We have had the pleasure of being able to work with them on some of our studies with respect to salinity issues in the Pecos River and the Rio Grande.

I think that interaction between the Office of the State Engineer and the Environment Department is essential; quality and quantity are intertwined as we move forward. We just do not have enough good quality water in New Mexico not to involve quality issues. Now let's talk about quantity issues. As New Mexico's demand for water continues to grow, supplies are pretty much the same. We have a variable supply that we have to deal with on a year-to-year basis, but those concerns of quantity and quality are obviously going to be interconnected. Water quality issues are a significant portion of the Office of the State Engineer and the Interstate Stream Commission's (ISC) work and are factors in many decisions including interstate compact deliveries, endangered species management, and desalination of brackish and saline waters. Integrated water quality and quantity management has also resulted in much closer working relationships between our office and the Environment Department. I am going to highlight a couple of instances in which we have had the ability to work on water quality and quantity concerns within the state of New Mexico. I am going to be pretty brief on both of these. One of them involves the Pecos River and the other one involves the Rio Grande and looking at some salinity issues.

First is Malaga Bend. Figure 1 shows the location of Malaga Bend. If you look at the state map, the area is at the very bottom corner south of Carlsbad. If you look at the map of the Malaga Bend area, you see the Pecos River as it comes down the curve in the river to where Malaga Bend is located. The Red Bluff gage where New Mexico makes its compact deliveries to the state of Texas is down at the southern boundary. The Rustler Formation is a problem in the area. It discharges brine, saturated with sodium chloride and some other things, into the Pecos River through the springs in the Malaga Bend area. The average discharge of the springs is about 200 gallons per minute, and water in the brine aquifer ranges in quality. The water quality there is pretty bad containing from 187,000 mg/L chloride to about 125,000 mg/L. The sulfate content ranges from 13,100 mg/L to about

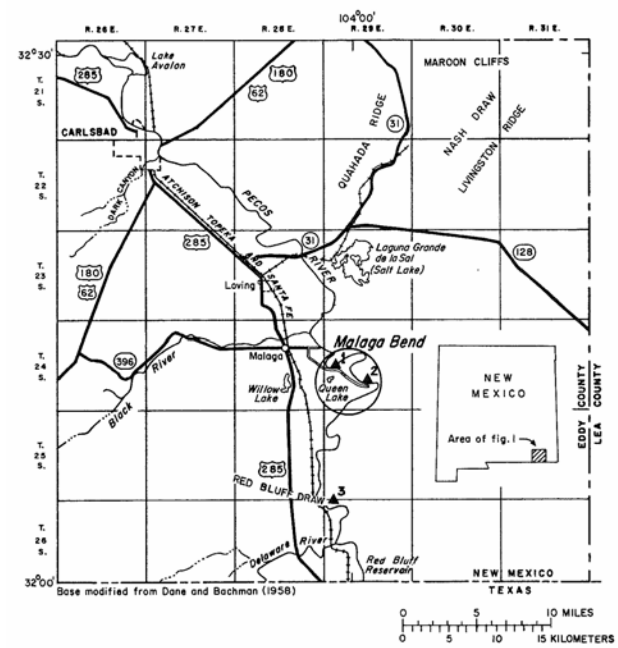

Figure 1. Malaga Bend Salinity Alleviation

10,000 mg/L. Figure 2 shows the salt loading in that particular area from the 1960s to the mid 1970s. The y-axis indicates the gain in chloride loads in tons per day. You are looking at an excess between 300 and 400 tons per day in the years when there was a large contribution. A public law that was passed as a result of this—Public Law 85-33 dates back to February 1958. It provided authorization for the Malaga Bend Salinity Alleviation Project. That project has been and was fairly functional for a period of time.

It was reasoned that the brine spring inflow could be reduced by pumping the brine from the aquifer to a nearby depression where it would evaporate. The project itself, in concept, was supposed to accomplish this. The project was implemented in the early 1960s. However, it failed due to brine leakage from the ponds. After the ponds failed, there was project reactivation in the early 2000s. It was activated for a period of time because we continued to understand the importance of some decent deliveries to the state of Texas from a water quality standpoint. In the early 2000s, the ponds were lined, and we started pumping brine again into those lined ponds. The salt reduction goals for the reactivated project were to reduce the salt flow by about 25 percent, not more than 367.7 tons per day. Data gathering since that time has not been consistent, but for the last quarter of 2004 the salt reduction goal was achieved about 86 percent of the days.

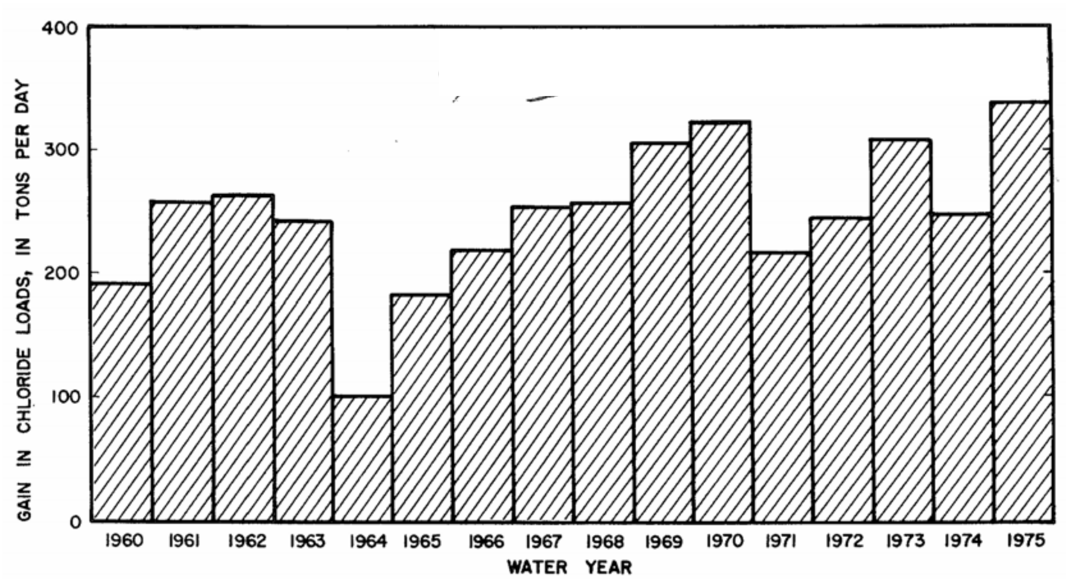

Figure 2. Salt Loading 1960-1975

The Pecos River Compact obligations themselves do not require the State of New Mexico to deliver water of a certain quality, which is a good thing. The quality downstream in the Red Bluff area in Texas is really pretty poor. The total dissolved solids (TDS) of the Pecos River water averages between 8,000-9,000 mg/L. Current water right permitting allows pumping of about 645 acre-feet per year of brine for this particular project. All of the water that is pumped is lost to evaporation. All of the water that is pumped is considered delivered to the state line as part of New Mexico's water quantity obligation, but it is important to get the quality to at least a respectable level. They do not actually do much farming anymore in that Red Bluff area in Texas because the water quality is so bad.

The next thing I want to talk about is Rio Grande salinity in the Texas/New Mexico border region. If you look at the lower Rio Grande on Figure 3, the lower Rio Grande is really considered to go from Elephant Butte Reservoir, which is at the top of this particular map, through the Caballo Reservoir, down through the Hatch and Las Cruces area, and down to the state line at El Paso. We have just recently made the Lower Rio Grande area into a Water Master District. We are starting to look more at that area regarding water quality.

For a long time, there has been contention over the quality of the Rio Grande water that is received by Texas. In 2002, there was a big meeting between

Figure 3. The Lower Rio Grande Master District

Texas and New Mexico. A technical committee put together a compilation review of water quality issues from that particular meeting. From 2000 to this year, SAHRA, which is the center for Sustainability of Semi-arid Hydrology and Riparian Areas, has done research on salinity in the Rio Grande with National Science Foundation funding. Studies by SAHRA and others conclude that natural upwelling of sedimentary brine is the dominant source of salinity in the Rio Grande, as opposed to some of the thinking that it is a result of a lot of the agricultural irrigation that has gone on upstream. That is important. It is important for us as an agency in dealing with Texas. We are in the unenviable position of being upstream of a downstream state that relies on and utilizes our return flows.

If you look at historical lawsuits, there are always issues with the amount of water delivered and also the quality of water that is delivered. We have been working closely with the Environment Department and the New Mexico Attorney General's office. We have some good contract attorneys as well as our staff attorneys looking to stay out of litigation with Texas, making sure we make our compact deliveries, and trying to make sure the water quality issue is not a factor.

Figure 4 is a graphic of the basin groundwater system that was prepared by SAHRA and New Mexico Tech researcher Fred Phillips, who will be talking tomorrow. It shows the basin groundwater systems and the systematic hydrogeologic cross sections that we use in looking at this information. We start from the San Luis Basin up in Colorado and move across the New Mexico/Colorado state line. Here is an aerial depiction of the river from Colorado down through El Paso to Fort Quitman. If you look at the cross sectional schematic, you see the San Luis Basin and the upwelling of that water. Those saline sources come from the Española, Albuquerque, Socorro, Palomas, and Mesilla basins.

The Interstate Stream Commission and New Mexico Environment Department have an ongoing collaborative salinity study. It is a joint study that was initiated to review previous investigations. It will require a current picture of salinity conditions in the Lower Rio Grande. The results of sampling are consistent with historical values. The results support those of other independent researchers. SAHRA has been heavily involved. Researchers Phillips, Hogan, and Eastoe have done the majority of the work.

If you look at some of the chloride concentrations versus time, the plot in Figure 5 shows chloride concentrations at the San Marcial station in red and

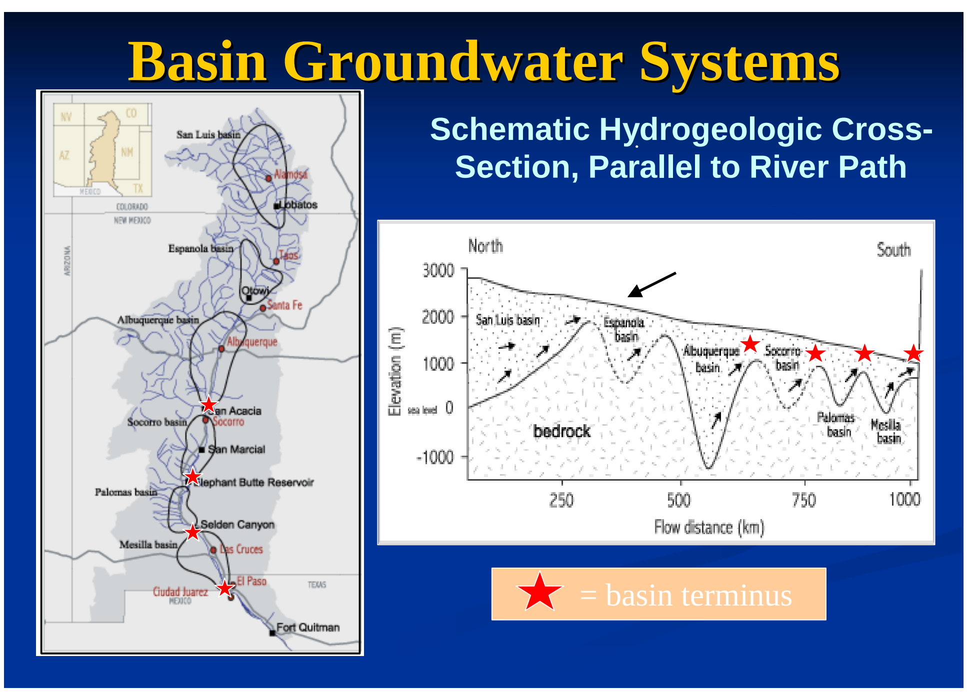

Figure 4. Basin Groundwater Systems

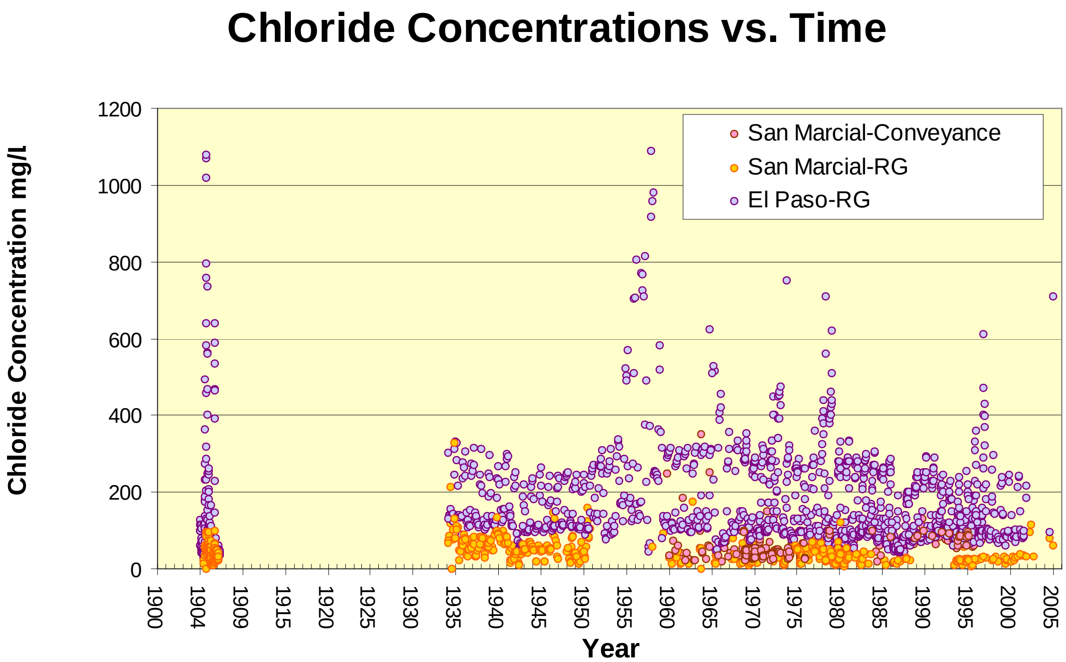

Figure 5. Chloride Concentrations vs. Time

orange and then El Paso in the periwinkle colors, including data collected before construction of the Rio Grande Project and Elephant Butte Dam. If you look at the bottom axis of this particular graph, it goes from 1900 to 2005. You can see this information before the project was actually constructed in the early 1900s and the quality issues back then. Note that no trends are apparent beyond brief concentration increases during drought periods like that of the 1950s. If you look at the 1950s, the concentrations are in this area. In the 1970s we had an additional drought. In the 2000s, we actually have those concentrations going up during periods of drought. The data suggest that the Rio Grande Project has had little impact on salinity levels in the Rio Grande.

What did we learn from the historical data? Salinization along the Rio Grande occurred before the reservoirs, agricultural drains, and wastewater treatment plants were present. Little change in chloride concentrations over time and observed increases in downstream loads cannot be caused by evapo-transpiration alone. It must be due to inflow of deep saline or geothermal groundwater.

The Interstate Stream Commission has installed wells in the New Mexico/Texas border region in cooperation with the Elephant Butte Irrigation District (EBID), over the period from 2002 to 2004 (Figure 6). We have installed a groundwater monitoring network of nested piezometers and shallow wells near the Texas border to monitor both water-level elevations and salinity. The well ISC-4, which can be seen in Figure 6 at the bottom of this system, located at the terminus of what is called the Mesilla Bolson near El Paso, intercepted extremely saline water at that particular point. Recent investigations by the Interstate Stream Commission and New Mexico Environment Department identified extremely saline groundwater in the El Paso area from that particular well site. The numbers are pretty high: 31,000 mg/L TDS and 14,000 mg/L chloride. This suggests that there is upwelling

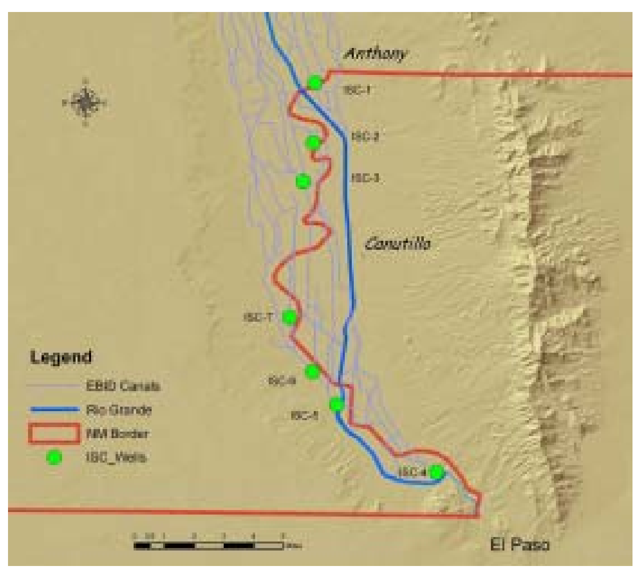

Figure 6. ISC Wells in the NM-TX Border Region

of the deep-circulating saline groundwater, as suggested by SAHRA researchers. We do think that is a problem, and we think it is probably a solvable problem.

We hope we have an opportunity for saline management. There is a potential for reducing river salinity by intercepting the saline point sources, such as intercepted by the Well ISC-4, that could result in significant freshening of river water in winter non-release seasons. It requires further feasibility studies. It is a possible opportunity to foster regional interstate salinity control authority that is patterned administratively after the Colorado River Salinity Control Forum.

Studies show that salinity damages in the United States portion of the Colorado River basin range between $500 million and $750 million per year and could exceed $1.5 billion per year if future increases are not controlled.

I would like to talk briefly about that salinity control forum that is underway in the Colorado River system. An increase in heavy metals in western rivers is really not a unique situation. Water quality problems in the Colorado River were recognized as early as 1903. The Colorado River salinity problem has been the object of several studies and investigations. Numerous surveys of salinity sources and control measures have been pursued by the Bureau of Reclamation, United States Geological Survey, Environmental Protection Agency, Water Resources Council, the Colorado River board of California, the basin states, and several universities. The seven basin states make up the Colorado Compact. New Mexico is part of the lower basin and the upper basin, but for purposes of delivery, we are really part of the upper basin with Utah, Colorado, and Wyoming. The lower basin states are Arizona, California, and Nevada.

In the early 1960s and 70s, the seven Colorado Basin states' federal representatives discussed the problem of increasing salinity levels in the lower reaches of the Colorado River. In 1972, Congress enacted the Clean Water Act, which mandated efforts to maintain water quality standards in the United States. At that same time, Mexico and the United States were discussing the increasing salinity of the Colorado River water being delivered to Mexico.

In 1972, there was a joint federal/state enforcement conference on the subject of pollution of interstate waters in the Colorado River and its tributaries. They initiated formal efforts to establish an overall salinity control policy. The conferees concluded that such a policy would have as its objective the maintenance of salinity concentrations at or below levels found at the lower main stem of the Colorado River in 1972. It was also recognized that states had the right to continue development of the compact portion of the waters and that temporary rises in salinity might occur until the salinity control program became effective.

Again, if you look at the upper basin states, they have not developed their full apportionment on the Colorado River, so states, especially like Colorado and Wyoming, have additional projects that will be put in place, and there could be increased salinity introduced by those projects. New Mexico is really in good shape, and if we can follow through with the Navajo Indian water rights settlement, New Mexico will be using their full apportionment of Colorado River water.

High salinity levels make it difficult to grow winter vegetables and some popular fruits, because salt and water systems plug and destroy municipal household pipes and fixtures. Studies show that salinity damages in the United States' portion of the Colorado River basin range between $500 million and $750 million per year and could exceed $1.5 billion per year if future increases are not controlled. Damages have also occurred in the Republic of Mexico that have not been quantified, but many expect them to exceed $100 million per year.

Colorado does have a salinity control program, and we have learned some things from that program. Perhaps we can apply those lessons to the Rio Grande and put some programs in place to help isolate and control the salinity and stay out of issues with the state of Texas with respect to quality.

One other thing I would like to mention is that our new domestic well regulations have a part that deals with water quality. Under section 19.27.5.13 under action of the State Engineer, it indicates: "The state engineer may reject an application for a 72-12-1.1 permit [a domestic well permit] when the proposed domestic well is to be located in an area of water quality concern, where prohibition on or recommendation against the drilling of new wells has been established by a government entity." That allows us to work with the Environment Department if there is a problem with water quality issues. We can actually use that as a means to reject an application for a domestic well permit without going through a special order.

Question: Concerning the treatments for salinity that John mentioned and others that the Environment Department is involved with, is there any concern with making the water too clean and affecting systems that are naturally evolved with the higher salinity and TDS?

John: I think there is in some respects, especially when you are looking at sediment loads. We see that all the time in flood control situations where you have clean water being released and you put a dam in place and you don't allow that natural sedimentation to flow through the system. That water becomes sediment hungry, and it takes out banks and scours rivers down. From my standpoint, I think it can be too clean with respect to sediment load.

Question: What types of legislation might the Governor be considering for the Bureau of Water?

John: There are a few pieces. The promulgation of the domestic well regulation has stayed some of the legislative fray that has happened over the last few years. There's an enforcement bill that is pretty minor that we are looking at. It helps underline some of our processes in the State Engineer's office to make it a little more clear on enforcement issues. We introduced it last year, and it went through most of the committees, but it just ran out of time.

Some of the other legislation that we are thinking about concerns the Strategic Water Reserve. In the Pecos River, we are looking at making that statute a little more friendly to allow augmentation well pumping infrastructure cost to qualify as an expenditure. There are not many significant items regarding new legislation. Most legislation is introduced by others, and we have to respond on the fly. We typically have tens of bills that we review on a daily basis.

There are another two pieces of legislation anticipated. In working with the Governor's Water Infrastructure Investment Team (WIIT) and the Water Trust Board, we are looking at water and wastewater projects that would be done in conjunction with the Environment Department, as it has been done in the past. We will be looking at how to improve the capital outlay process, which to me, in certain respects, is broken in this state. There is a lot of piecemeal funding that goes out to a lot of different types of projects. We are trying to look at the water and wastewater projects and needs throughout the state of New Mexico. We are looking at regionalization of projects and water systems. We have started looking at drinking water projects that are in compliance with the Safe Drinking Water Act. They need to have water rights, valid water rights, before they go in and start asking for funding from their legislators and from the governor. We will start looking at putting some of the regional systems together that really are the best way for us to spend our money.

We are starting to treat the water projects and water supply systems as businesses, looking at asset management plans and leak detection and things of that nature that would help us conserve water and actually put a good business practice in place that allows us to build good projects.

We are starting to treat the water projects and water supply systems as businesses, looking at asset management plans and leak detection and things of that nature that would help us conserve water and actually put a good business practice in place that allows us to build good projects. There is a capital outlay process that is in place that was put into place for the public schools. We are looking at that process to see if it warrants some consideration with regard to the water and wastewater treatment projects. We can distribute money and funds throughout the state in a more regional, business-like manner that really allows us to get a whole lot further with respect to our money and the drinking water needs throughout the state of New Mexico. So there are two bills that will be introduced in that regard: a water and sanitation project act and a modification of the water/wastewater authority.

Question: Earlier in the morning the Mayor mentioned the expected pattern of growth for the state, the use of desalinated water to perhaps meet the needs of drinking water in future developments, and the way that the current rules are in place. I believe if you go below 2,500 feet with a well and take out water with TDS in excess of 1,000 ppm there are no water rights restrictions on that unless it affects or changes the aquifer in some way. Do you see any changes in that in the near future?

...we have literally $2 to $4 billion worth of infrastructure needs in the state, if you look at the age of infrastructure and/or new water supplies.

John: No, I do not. It is an old law that has been there forever. There are not many people who use the technology to drill and pump from that depth because it is very expensive. I understand there are some people looking at it in a development west of Albuquerque to try to have a self-contained development. They are talking about energy issues and pumping that water up and using it. I think the reality is that no matter how deep you go, you will probably have some interaction with some aquifer depending on where you are. I think desalination is really the future for many areas of the state to consider.

If you look regionally at the Colorado River issues and look at the upper basin and lower basin states, California, Arizona, and Nevada have overused their supply and apportionment. The seven basin states have been meeting and trying to stay out of litigation. Essentially, what the upper basin has been successful at doing is having the lower basin look away from the river for additional water sources.

Desalination technology really needs to be expanded and reviewed. New Mexico has a lot of brackish water. The biggest area of concern with me as the State Engineer is where those applications are filed and what water source they may affect. Again, I think there is a lot of water that is brackish in nature that is pretty good quality with respect to levels of salinity, but needs to be cleaned up. The sources are fairly shallow in some cases, so we do not necessarily have to go below that 2,500 ft. level to get and treat some of that salty, low-quality water. The technology is there right now. The cost is less than $3 per thousand gallons to produce that water. We just need to make sure that the points of diversion of that water do not impair senior water rights. I think there are plenty of locations in the state of New Mexico that would be desirable for desalination projects.

It is a matter of identifying aquifers that are the most suitable to clean up, generally those with the least amount of solids. A portion of the problem is where you dispose of the solid material generated by cleaning up the water. There are many environmental issues, but my feeling is that brackish water is so prevalent throughout New Mexico that you do not necessarily have to go to that 2,500-ft. level to try to extract it because the drilling costs will be enormous. You have clean-up costs and disposal costs that will add to that equation. It is better to take the shallower water.

Question: The 2,500-ft. level gets you out of the requirement of having to purchase a water right. The upfront cost of getting the water is not just the well, but the water right to go with it. Am I incorrect on that?

John: Not necessarily. Again, it depends on where the 2,500-ft. well will be located. Since I have been State Engineer, we have entertained an application that has broached that particular issue. There will still be a permitting fee. In that particular case, you may be able to go after the water. My issue would be whether there is still some interconnectedness between some of those aquifers, depending on the location. There could be a substantial cost. The cost of drilling and pumping is pretty excessive when you go down that deep.

Question: The well that went to 2,500 ft. was $250,000. The well produces about 150 to 200-gallons per minute, and it is 11,000 ppm.

The last number I saw for statewide municipal and industrial water use was about 195,000 acre-feet. Of that amount, how much is actually consumed by humans? I am not talking about agricultural water, but just potable water that people actually drink. A lot of these projects being contemplated cost hundreds of millions of dollars. I was at the World Water Forum in Mexico City in March, and one of the comments that came out of that had to do with the privatization of water systems. There is a worldwide movement against that. The conclusion that was coming out of the World Water Forum was that a lot of these big water companies that provide municipal water are getting out of the game. Strange as it may seem, serious commentary from the World Water Forum was that they are getting out of the game and the bottled water companies are moving in. How much water is actually consumed by people in New Mexico, and is it less expensive to build a bottled water plant, as some municipalities are doing? There are municipalities around the United States and elsewhere that are building bottled water plants for human consumption and relaxing the treatment and so forth for the rest of the water. Why treat water that will be used in car washes or for watering parks? So the question I asked was: of the 195,000 acre-feet municipal treated water used in New Mexico annually, how much is actually consumed by you, the people in this audience, and the people in New Mexico?

John: The domestic well use in the state is less than 2 percent of the total use. The total use of New Mexico is in excess of 4 million acre-feet a year. I don't have the answer for you. I think we could figure it out pretty readily just based on consumptive use of individuals. But it is not a lot, and I think that is your point. About 75 percent of the state's water is in agriculture, and only 5 to 6 percent is in municipal systems. But the actual consumptive use of that water is far less than that. Your point is a good one. There are so many areas in the western states that have been over-appropriated, and when you get into a short supply, people are always trucking in drinking water supplies to those areas that got cut-off, so it is a consideration.

Question: In your role as the chairman of the Water Trust Board, will you talk about the importance of the proposed constitutional amendment for the Water Trust Fund? Do you envision any changes in the roles and responsibilities of the trust board coming in the near future?

John: The constitutional amendment is to make the Water Trust Fund into a permanent fund, which is extremely important. In November it is going to go on the ballot. Last year, $40 million was appropriated to the Water Trust Fund. It was the first time that the Water Trust Fund actually had money appropriated to it. The water project fund is really what the Water Trust Board administers, and that has been roughly between $17 and $27 million per year over the last couple of years. With money going into that Water Trust Fund, it would generate interest, and that interest will be applied toward projects. Hopefully, there will be some other revenue sources that can be bonded against, because we have literally $2 to $4 billion worth of infrastructure needs in the state, if you look at the age of infrastructure and/or new water supplies. We need to start looking at funding those projects.

To answer your question with respect to how the Water Trust Board will function—we are actually trying to get away from being just another piece of the capital outlay process and trying to look at coordinated funding. The Water Trust Board was essentially set up to fund large regional water supply projects to leverage federal dollars to help keep New Mexico's water for use within the state. New pipeline projects, like the Navajo-Gallup pipeline project, and the Ute Pipeline project, are some of the big infrastructure needs within the state, and two particular items that the Water Trust Board is looking at funding. We have been looking at various other projects. There is annually $100 million worth of needs that we have applications for. We will start phasing in these projects, but a lot of them are not ready to be built and are not meeting the required standards. Hopefully, through this process that involves the Water Infrastructure Investment Team, we can start looking at setting up a technical team to help projects become ready for funding. There are discussions about setting up an office that would have a director, a deputy director, and a project manager for the large water infrastructure supply projects and for the water and wastewater treatment projects. We would like to manage those projects so that we have deliverables and money that goes toward those most deserving projects.

Cindy Padilla *is the Director of Water and Waste Management Division of the New Mexico Environment Department. Appointed by Governor Bill Richardson on May 2, 2005, Cindy comes to the position from the Solid Waste Bureau where she was the Bureau Chief since 2002. Cindy has twenty years of experience in program management, solid waste, environmental education, public outreach, marketing, and grants management. Prior to NMED, Cindy was the Field Support Bureau Chief for the State Parks Division of the Energy, Minerals and Natural Resources Department managing the marketing, volunteer, concession and recreational trails programs. She is a graduate of St. Michael's High School in Santa Fe and received a social science degree from St. Mary's College in Kansas. Cindy has also done graduate work through the University of New Mexico's College of Public Administration.*

COORDINATION OF WATER QUALITY AND WATER QUANTITY ISSUES IN NEW MEXICO
PERSPECTIVE OF THE NEW MEXICO ENVIRONMENT DEPARTMENT

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Good morning. I would first like to start by sending Secretary Curry's regrets for not being able to be here this morning. Unfortunately, he was called away by the governor for a meeting this morning. In the last year or so in this position, his misfortune has always been my gain because I get to attend great conferences or workshops or talk to a lot of really neat people who are working on incredible and wonderful projects in New Mexico. I say that as a New Mexican. When we talk about water quality and the things that all of the people especially in this room and throughout the state are involved in, we are talking about incredibly great, wonderfully good things because we are focusing on water. We talk about a sustainable water resource for our state and maintaining that sustainability. We must look at water quality as well as water quantity.

I was thinking about pinch-hitting for Ron this morning, and I was able to get his talking points about half an hour before the presentation. I want to say that working in the Environment Department has been a great experience. We have such a great staff who are very committed and dedicated to what they do. All of the points that I am going to bring up today I feel very comfortable talking about because we have been working on them for a long time.

When we talk about quality and quantity, it made me think about the Bundy show called "Married with Children." You have love and marriage, and you cannot have one without the other. That is kind of what we are talking about here, a loving marriage. We cannot have quantity without quality. Sometimes you can have problems. Sometimes it entails funds. Sometimes you have to deal with it. But you definitely cannot have one without the other.

On numerous issues and situations, the Environment Department embraces the opportunity to work with Secretary D'Antonio and the Office of the State Engineer. In many more programs we are trying to strengthen the coordination between water quality and water quantity. We look at those issues because we know it is going to benefit New Mexico in the long run. We definitely have to look at one and not without looking at the other.

Every year is the "Year of Water" at the NMED, because the majority of the programs that we work on focus on water quality or the remediation, clean up, and identification of groundwater contamination.

The majority of the New Mexico Environment Department's (NMED) programs have focused on water quality. The governor has proclaimed 2007 as the "Year of Water" for the legislative session. We are looking to see what we can do in terms of water quality and water quantity in 2007. Every year is the "Year of Water" at the NMED, because the majority of the programs that we work on focus on water quality or the remediation, clean up, and identification of groundwater contamination.

For example, the NMED is in charge of the liquid waste program, which includes all of the septic systems throughout the state. Most of you have heard presentations before that indicate that almost 90 percent of our groundwater contamination in the state is caused by leaking, improper, or unpermitted septic systems. When we look at the new regulations we have passed, we are looking at residential contributions to groundwater contamination.

The NMED also has the superfund oversight program. We have plus or minus ten superfund sites in the state. We focus a large amount of our time on superfund sites. We have a staff that is dedicated to working on and coordinating with the EPA to address those areas.

Our groundwater pollution prevention program is our permitting section. Our discharge permits come out of the Groundwater Bureau. We have about 900 discharge permits in the state. Not only are we looking at cleanup and remediation, but through permitting and addressing these discharges before they happen, we are focusing on prevention.

Our remediation oversight program is a voluntary remediation program. We look at soil cleanup and how it affects and impacts groundwater. We have a strong program. Our monitoring environmental compliance section works with all of the hard rock mines in the state. These mines are located in Silver City and Questa primarily. Mining, as we all know, is of great economic benefit. In terms of economic benefit in New Mexico, I think we need to recognize how to balance New Mexico's future in economic development and environmental protection. How do we make sure that in sustaining economic development that we are going to sustain environmental protection as well?

Our Hazardous Waste Bureau is very busy also with groundwater contamination and protection. They provide permits to all of the hazardous waste facilities and landfills, although New Mexico currently does not have any. We issued one permit, but the facility was never constructed. Bureau staff also conducts a lot of inspections making sure that treatment source disposal facilities in the state are focused on groundwater protection. They also have a very strong involvement with our national laboratories. They work on permitting at Los Alamos National Laboratory, Sandia National Laboratories, and all other federal facilities in the state, such as the Department of Defense, and our consensual reserve cleanup orders in Los Alamos. Groundwater cleanup in Los Alamos is a very important focus of our Hazardous Waste Bureau.

Our Petroleum Storage Tank Bureau looks at the underground storage tanks in relation to groundwater protection. Our Solid Waste Bureau looks at cities, municipal landfills, and private landfills. We permit all of those facilities in the state. We definitely have a very strong focus on groundwater protection.

We currently are working on some programs with the Office of the State Engineer. A really strong partnership is the Middle Rio Grande Collaborative Effort. We also work with the Bureau of Reclamation, the Middle Rio Grande Conservancy District, and the City of Albuquerque. Many other partners are working on this effort. We recognize the need to provide a water quality perspective in interagency forms so that we can partner and strengthen our relationships and focus on water efforts.

The long-term monitoring assessment interpretation documentation of water quality in the Rio Grande is evidence of the success of collaborative programs to protect and invest in water-wise resources that serve so many needs including our drinking water supply. When we talk about our drinking water supply, we must focus on water quantity, water quality, and access to a drinking water supply. We cannot work on water programs without looking at drinking water.

One of the other programs that we are working on is the Gila River Collaborative Effort. Our Surface Water Quality Bureau provides water quality support to the Interstate Stream Commission (ISC) on priority water projects. Our role in this type of project is to provide input on water quality and potential aquatic ecosystem impacts of project activities. In our partnership with the ISC and the Office of the State Engineer, we have technical expertise and scientists who work in the Environment Department in those areas. We work very closely with them.

As Secretary D'Antonio mentioned, we have a Lower Rio Grande Initiative on salinity control and on developing a water quality assessment in that area that assists the Office of the State Engineer in what they are doing on the Lower Rio Grande. We work on the interstream flow strategic water reserve. We are considering ways that water quality and quantity issues can be coordinated to address current and future stream impairments. We definitely need to look at the future.

ISC is exploring the potential for creating a strategic water reserve in order to assist New Mexico in its ability to make compact deliveries and manage efforts to protect endangered species and avoid additional listings. Reduced flows contribute to the degradation of the state's water quality, and the strategic water reserve could have a corollary benefit by reducing the number of stream impairments that are caused in part by drought and low-flow conditions.

The Environment Department is also working on building and strengthening other relationships. We have made presentations to many organizations throughout the state. What I continually hear is that we have many incredible, wonderful things going on in the area of water, but we do not have a lot of coordination and communication. Many organizations are collaborating with each other. But when you are considering the state as a whole, you cannot look at one area of the state without looking at the north, or the south, or the east, or the west. I think that one thing that the Environment Department can do, and I know Marcy is going to talk a little bit more on our water quality goals, is to figure out how to bring all the organizations together. This may be through an e-mail listserve describing projects that will allow us to bring together people from different areas with a focus on water quality as well as water quantity.

If we do not focus on water quantity, water quality, and environmental protection generally and water sustainability, economic development and business really only mean something in the short-term, not in the long-term.

The NPDES program is an example of a program where we are working on relationships and getting information to each other. About two years ago, the state undertook an effort to take over primacy for the NPDES, the national pollutant discharge elimination system. Through that process we developed and created a working group that included all interests. We had industry, environmental groups, public interests, and other state agencies involved. We talked about what the delegation from the EPA would mean for the state and how it would affect the people who would be regulated. Through that work group we have realized that we need to take the time necessary to listen to everybody and get all of the concerns and issues on the table and then address them. It may be that we agree to disagree. Industry or special interest groups may have a whole other point of reference than the environmental groups or the Environment Department. Unless we sit down and talk about these issues, we will never be able to come to any kind of resolution so that we can move forward.

That being said, the NMED has considered going to the 2007 legislative session with this statutory delegation or request for the legislature. We realize that we still have work to do. We continue to have information that needs to be shared and discussed. The devil is always in the details. If we do not work through those as best we can, then we are not going to move forward on a better program for the state. By looking at those relationships and how we can talk to each other, we have decided we need a little more time. We will not be pushing that legislation this year.

Before I turn the podium over to Marcy Leavitt to talk about some of our water quality goals, I would like to say some things from a personal perspective of working at the NMED. I am a native New Mexican. I was born and raised here. I guess we stop counting after several generations, but our forefathers and ancestors and all people who live in New Mexico whether it's been for a hundred years, a thousand years, or just two years, have the same goal. If we do not focus on water quantity, water quality, and environmental protection generally and water sustainability, economic development and business really only mean something in the short-term, not in the long-term. I really appreciate the opportunity to be at the Environment Department for the last three years. I kind of grew up in the garbage business. I am the resident garbage lady as I say, having managed the Solid Waste Department in Santa Fe for about eight years. It is really interesting because it gives you such a broad perspective. In the Environment Department, what we do reaches every single person's life in the state. Our agency, and Secretary D'Antonio's agency, and many other state agencies do this as public servants. We reach out to New Mexicans. We are doing incredibly, wonderfully, really good things. We need to call you all to the table and listen to you, what your concerns and your issues are, so that we can address them in a comprehensive and collaborative way. I want to thank you all and congratulate you for the work that you do in water quality and water quantity in New Mexico.

Question: What types of legislation might the governor be considering for the Bureau of Water?

Cindy: From the Environment Department perspective, we have a couple of different bills that we have presented to the governor's office. We need to talk about coordination for the legislative session. One of the things that the governor's office is going to be doing and that we need to do is to meet with other state agencies so that we look at all of the different considerations and the projects they are proposing.

The governor convened a community water conversation; he actually has done several, but I attended only one of them. It brought together a lot of different people with water agendas, and it focused on what kind of bold initiatives we should consider as a state, doing something that is different. We have been involved in a lot of programs for a long time focusing on quantity and quality. I think Governor Richardson is now trying to have a more concerted, coordinated effort in terms of the legislation on quantity and what it means to the legislation on quality.

One of the pieces that we are going to be considering is a hazardous waste act, amendments that would give us authorization to impose criminal penalties for illegal disposal of used oil. Right now that is part of the hazardous waste program that we do not have primacy for from EPA because we do not have criminal penalties. It is a small piece of legislation.

Fines collected from illegal disposal or septic systems would go into a fund that would help people come into compliance if they cannot afford things like septic tank replacements or upgrades.

We will be looking at some funding bills in terms of the state revolving loan fund and hopefully creating an indigent fund. Fines collected from illegal disposal or septic systems would go into a fund that would help people come into compliance if they cannot afford things like septic tank replacements or upgrades. We are going to be working with the governor's office to coordinate that agenda for the legislation.

Some other legislation that is not necessarily a part of the governor's "Year of Water" proposals includes legislation that will be coming from industry groups. They are going to be putting it in under the title of Regulatory Justice, including ten statutes and one memorial. Those look at the permitting processes, public participation processes, and how all of the state agencies either work together or do not work together. I cannot tell you a whole lot more about these initiatives, but we have received copies of those bills, and we will be looking at them. It might be something that you will want to get a handle on or look at for what they will mean to not only state agencies but your organizations.

Marcy Leavitt *has worked for the New Mexico Environment Department for 18 years in a variety of water quality programs. Currently she is the Bureau Chief of the Surface Water Quality Bureau. Prior to her current position, Marcy was Chief of the Environment Department's Ground Water Quality Bureau for ten years.*

NEW MEXICO ENVIRONMENT DEPARTMENT'S SURFACE WATER QUALITY GOALS

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The topic I was asked to speak on today is the Environment Department's water quality goals. What I would like to do is give you a brief introduction to our role in surface water quality and to talk a little bit about some of the interesting and challenging issues we face in our quest to serve the public while protecting and improving the state's surface waters.

The objective of the federal Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." This objective has been in place for many decades, but what does it really mean and how does it apply to New Mexico? How can New Mexico continue to work toward this objective regardless of the changing federal landscape and the potential for prolonged drought? How does the state advance its own priorities when the state's surface water quality programs are largely funded with federal dollars? These are issues that may not be on the minds of most New Mexicans, but they are critically important if our water quality decision makers are going to be successful in ensuring the long term sustainability of our state's waters.

First, like most states, we follow a framework for surface water quality protection that meets the requirements of the federal Clean Water Act. Each of these steps is integral to our process. We propose water quality standards to the Water Quality Control Commission for approval. We use those standards to monitor and assess the condition of our surface waters. We determine which water bodies are impaired. We develop total maximum daily load planning documents to establish specific goals to restore water quality. The state and EPA use these goals to develop NPDES permits and as the basis for funding priorities for non-point source pollution restoration projects. Then we use the data we gather along the way to go back and revise the standards where appropriate as well as develop new standards, and the process starts all over again.

Water quality standards set general, narrative goals and designated uses for all water bodies and then assign criteria to protect those uses. The state standards are required by the Clean Water Act to meet the national water quality goal to "provide for the protection and propagation of fish, shell fish, and wildlife and for recreation in and on the water." These are commonly referred to as the Clean Water Act's fishable/ swimmable goals. The state has other uses that are important that we need to protect as well.

> **We use a variety of sample collection techniques, including continuous recording devices. This results in hundreds of data points that help us to evaluate both naturally occurring and anthropogenic sources. As you can see, we have progressed far beyond the mayonnaise jar that Karl [Wood] and Dr. Hernandez described.**

New Mexico standards include designated use for economically important activities, such as livestock watering, irrigation, and municipal water supply. They also can be used to describe the habitat or ecosystem needed to support the local aquatic community. An example of this type of designated use would be high quality, cold water aquatic life or marginal, warm water aquatic life uses.

Another tool in the state's water quality standards and Clean Water Act that has been available to help New Mexico protect its truly special waters is the designation of Outstanding National Resource Waters (ONRW). ONRWs are waters that merit special protection due to their outstanding ecological, recreational, or natural resource values. Prior to 2004, no waters in New Mexico had been granted ONRW status. Since then, the state has designated the headwaters of the Río Santa Barbara and the waters of the Valle Vidal as meriting this special status. It is also important to point out that the efforts to establish these first ONRWs were largely driven and funded in part by environmental advocacy groups. This is one area where the state could decide to focus resources to identify additional waters that merit this special level of protection.

As I mentioned earlier, another of the state's responsibilities under the Clean Water Act is to monitor the quality of our surface waters to determine which waters meet their assigned designated uses and which do not. Water bodies that do not meet their designated uses are referred to as impaired. In general, our goal is to monitor every watershed on a seven to eight year rotating cycle. That may seem like a long time between survey events, but in a state as large and ecologically diverse as New Mexico and with our limited resources that is realistically how long it takes to rotate around the entire state and to perform adequate characterizations of the chemical, physical, and biological components of water quality. Each survey includes detailed and ongoing collection of samples during the survey year. Samples are collected over a period of eight to ten months at numerous sampling stations to ensure that we characterize seasonal and temporal changes as well as changes due to geology and geography throughout the watershed. We use a variety of sample collection techniques, including continuous recording devices. This results in hundreds of data points that help us to evaluate both naturally occurring and anthropogenic sources. As you can see, we have progressed far beyond the mayonnaise jar that Karl and Dr. Hernandez described.

So what are we looking at when we do our annual water quality surveys? Surface water quality assessments are quite a bit different than those done for groundwater quality. We are not necessarily comparing a numerical or analytical result against a numerical standard. In some cases, our standards are numerical, and in some cases they are narrative. Our goal is to find ways to use quantitative and qualitative information to determine whether a stream reach is impaired. In some cases, we see the need to move from qualitative studies to assessments that can be quantified and compared to a numeric benchmark. For example, we are working towards the development of numeric benchmarks and criteria for nutrients and biological communities. Nutrient criteria would focus on phosphorous and nitrogen species that contribute to the growth of algae. Biological criteria would focus on the health of the aquatic community, including fish and bugs.

Another area of surface water quality assessment that has recently received more attention by the state is the evaluation of the potential public health impacts from ingesting fish caught in New Mexico's surface waters. Several years ago EPA did a national evaluation of levels of mercury and other persistent contaminants in fish. Mercury was found in some New Mexico fish in concentrations that could lead to adverse human health effects. This led to a multiagency effort to develop fish consumption advisories. Advisories allow those who fish to make an informed decision about what fish they could safely eat. To update and expand the advisories, this past year the state collected fish tissue data in the state's most fished reservoirs. This data led to new rules for Brantley Reservoir that recommend only catch and release fishing due to elevated levels of DDT. We hope to expand this program to other areas of the state in the upcoming years.

So what do we do with all of the data that we collect from our lakes and streams? Some of the data we collect supports special studies that are of particular interest to New Mexico. One of these is a cooperative project in the lower Rio Grande, where recent investigations by the Interstate Stream Commission (ISC) and NMED have identified extremely saline groundwater in the El Paso area at relatively shallow depths. This area needs further study, but there is promise of improving non-irrigation season or winter water quality by intercepting such saline sources. These technical investigations also point to an opportunity to foster a multistate salinity control forum patterned after the successful Colorado River Salinity Control Forum as a vehicle to evaluate potential mechanisms for mitigating salinity issues in this critical border region.

Another new initiative that we have undertaken is the development of a state wetlands program. We recently received funding from EPA that will help the state's efforts to protect and restore New Mexico's remaining wetlands and riparian areas. The program is also working toward increasing wetlands protection through monitoring and strengthening water quality standards that pertain to the state's wetland resources.

Our monitoring efforts also lead to development of the Clean Water Act list of impaired waters that is prepared every other year. This list is commonly referred to as the Clean Water Act Section 303 D list. It drives many federal and state decisions. One of the important results of the 303 (d) list is the development of total maximum daily load planning documents that are commonly referred to as TMDLs. TMDLs include water quality goals and targets and information and suggestions for control measures to restore the chemical, physical, and biological integrity of the water body. A TMDL is not a regulatory document. The loading calculations can be used for regulatory activities such as National Pollution Discharge Elimination System (NPDES) permits and non-regulatory activities such as implementation of Best Management Practices (BMPs) non-point source pollution controls.

EPA's role as protector of the nation's waters is in flux. States await guidance from EPA on what waters will be protected by the federal government and what waters will not.

In New Mexico, most of the identified impairments, and therefore most of our TMDLs, are caused by non-point sources of contamination. For example, sediment from unmaintained roads is considered non-point source pollution, while a discharge from an outfall pipe is considered point source. TMDLs for non-point sources are implemented through the Clean Water Act Section 319 Program by providing funding to local watershed groups and stakeholders for watershed restoration projects.

On the other side of the aisle are regulatory requirements that stem from TMDLs. Implementation of TMDLs through NPDES permits has been an issue that the state and EPA have been working on for the past several years. EPA, as the agency authorized to issue NPDES permits in New Mexico, takes TMDLs developed by the state and uses them to require permit limits for point source discharges that meet the targets defined in the TMDL. The state then has the responsibility to certify whether the permit will meet all state standards so that the permit can be issued by EPA.

But what happens if the EPA decides that a particular water body in New Mexico is no longer protected under the Clean Water Act? Do TMDLs for those streams become irrelevant? Do dischargers even have to obtain NPDES permits for those water bodies? These are important issues that we are struggling with. Federal Supreme Court cases such as the 2001 Solid Waste Agency of Northern Cook County (SWANCC) decision and the more recent Rapanos Carabell decision from June of this year are shaping national water policy. EPA's role as protector of the nation's waters is in flux. States await guidance from EPA on what waters will be protected by the federal government and what waters will not.

I think it is imperative that the state decide which waters it wants to protect, that we do not tie ourselves to the federal government, and that we take a creative approach because we are depending on this water.

In New Mexico, we have already seen EPA back away from storm water permitting in the state's closed basins and elsewhere. The Supreme Court's recent decisions also throw into question future Clean Water Act protection for ephemeral and intermittent waters. In the last few weeks, Cannon Air Force Base requested that it be relieved of its NPDES permit obligations due to these Supreme Court decisions. It will be up to the state and our water quality decision makers to decide how to fill the gaps left by the federal government.

Tomorrow I will be talking about NPDES primacy, which is one way the state can fill these gaps. If you would like more information on any of the topics I have discussed today, there is a tremendous amount of information on the Surface Water Quality Bureau's website, which you can get to from the NMED homepage at http://www.nmenv.state.nm.us/.

In closing, Howard mentioned that there does not seem to be much public interest in water quality issues. I ask all of you, how effective our efforts to provide a sustainable water supply can be if we do not have the support and tools to ensure that water quality is safe and clean?

Question: Concerning the treatments for salinity that John mentioned and others that the Environment Department is involved with, is there any concern with making the water too clean and affecting systems that are naturally evolved with the higher salinity and TDS?

Marcy: With particular respect to salinity and sediment, as John mentioned, most of those efforts are dealt with through the 319 Program. The goal of that program is to restore the natural functioning of the channel of the water body. We hope in those efforts that we are putting things back, if there is an impairment, to where it should have been. I think we are a long way, especially in terms of salinity, from making water too clean. We are really in the infancy of addressing that issue.

Question: We have some transboundary waters and some of those are in closed basins. With the recent federal Supreme Court decisions and all the other things that are going on within the federal government, how can the state and EPA think outside the box to address those issues?

Marcy: I would say that EPA is not thinking outside the box, and therefore, it is really up to the state to do that. We are extremely concerned about what is going on in the Mimbres and the Tularosa and those other closed basins that do have interstate and international connections. I think if we do not all get together and figure out how to protect our water quality and if we continue to depend on the federal government, we are going to be in trouble ten years down the road. The regulated community has different goals than the public and the regulatory agencies. We need to be thinking in terms of taking responsibility on a state level to make sure that those waters are protected and working with our neighboring countries and states to make sure that we do that successfully.

Question: I think part of John's question and your answer deals with what Howard talked about in a way, and that is the definition of the waters of the state of New Mexico. As I understand the New Mexico Water Quality Act, the state of New Mexico can, based on what the Water Quality Control Commission does, adopt any definition that is totally inclusive for all of those enclosed basins and everywhere.

Marcy: That is correct. Right now, the Water Quality Control Commission has moved forward through the triennial review, as Howard mentioned, to adopt a very comprehensive definition of the waters of the state. That definition was immediately appealed by a number of parties. Even though it is in effect right now, that appeal has not yet been decided. We do not really know what is going to happen. Through the NPDES program development process, we talked about incorporating that definition into what waters would be protected under the state surface water quality protection program. That immediately met resistance. There are a lot of constituents in the state that want to limit the state to the federal definition of the waters of the United States and what waters would be protected under that definition. That does not get the state anywhere. We might as well just let EPA regulate our waters if we are going to go with the federal definition. Our concern is the gap that would be left as the federal government moves farther and farther away from protecting waters in arid states like New Mexico, where we do have a large percentage of ephemeral and intermittent waters. We could probably lose protection for 90 percent of the waters in the state if the federal government continues on the path that it is on. I think it is imperative that the state decide which waters it wants to protect, that we do not tie ourselves to the federal government, and that we take a creative approach because we are depending on this water.

Question: Marcy, you had mentioned that the 319 Program is the mechanism for addressing some of the non-point source pollution problems in the state. While I applaud the 319 Program and Amigos Bravos implements the 319 Program projects in northern New Mexico, I wonder if the state has thought about implementing other mechanisms for controlling non-point source pollution, specifically utilizing the power under the Water Quality Control Act to enforce water quality standards, so that we can begin to address the non-point source pollution problems of the state. I do not see the 319 Program addressing that very large pollution problem.

Marcy: The 319 Program is a very, very functional and a well received program. We have a limited amount of money that we give out each year, and therefore, we have a limited number of projects that are addressed. We do have authority under the Water Quality Act right now to enforce in situations where there is a water quality standards violation of a non-point source. But just by the very nature of being a non-point source, it is usually very difficult to pin back the pollution to a particular discharger who is causing the problem. Non-point sources are generally diffuse sources. There are also political realities to turning that program into a regulatory program. I think nationally the program works well because it is a voluntary program, and I do not see it changing to a regulatory program in the near future.

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ALBUQUERQUE'S DRINKING WATER PROJECT

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Thank you very much. First, I would like to thank the Water Resources Research Institute, Karl, Bobby, Cathy, and all of the people involved behind the scenes that make this conference possible. I also want to thank them personally for allowing me the opportunity to present a status report on where we are with the Drinking Water Project. I know for many years I have been talking about when we get to the construction, when we get here, and when we get there. It has been a long road. My job today is to talk about where we are. Hopefully you will learn a little bit and see some interesting construction slides. No matter what hill we get over, there always seems to be another hill to climb. I am going to talk about what I think is going to be a challenge for us at the end of this project. At the beginning of this project, we would have been thankful to be there. Now we are here, and it is going to be a lot of fun and a big challenge. I will present photos of the facilities themselves, talk about the public acceptance plan, which I think is one of our biggest challenges, and I will talk about some of the problems that Tucson had when they brought their surface water plant online, and some of the things we are going to try to do to educate and get our public ready for it.

Figure 1 is a large picture of the drinking water project. The cost is $375 million, which is being financed by our rate payers and solely by our rate payers through seven dedicated water rate increases that started back in 1998 and just ended in 2004. The water treatment plant is capable of treating 100 million

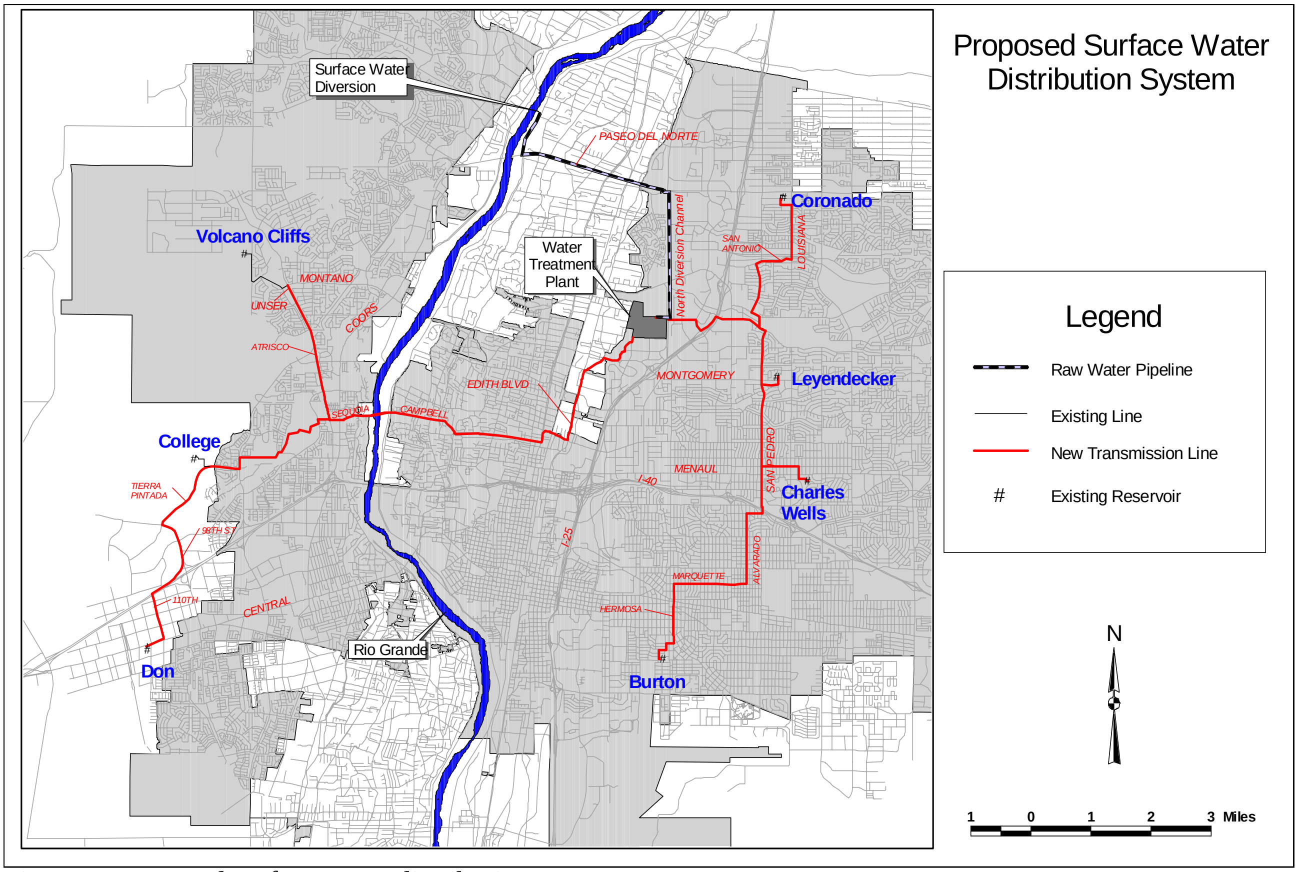

Figure 1. Proposed surface water distribution system

gallons a day, 120 million expandable in the future. We have a diversion dam on the river. There are about 50 miles of large diameter pipelines. If you have been to Albuquerque, certainly you have run into the construction of one of the pipelines, whether it is laying on the side of the road or maybe you have been to San Pedro or the west side.

When we started out this project we had huge environmental issues associated with diverting the water out of the river. We still have those issues, but when we came down to the actual construction of the project, it was the pipelines that the neighborhoods and the people really put their arms up in the air about. They said, “Hey! You are putting a 54-, 60-, 72-inch diameter pipe in front of my house. How is that going to work?” It has been an interesting challenge to try to educate them, but also to get them prepared for what the construction will be like.

For those of you who went on the tour yesterday, the diversion dam located just south of Alameda Bridge is operational. It has been completed since April 2006. We have a couple of minor additions and changes that we are going to be making to the facility in Fall 2006. In January, we are going to start a pilot program to operate the facility. Figure 2 shows the actual diversion dam during construction in the river in two different phases, in two different wintertimes. We built the west side in one wintertime, and we came back the next winter and built the east half of it.


Figure 2. Diversion dam construction

Figure 3 is a picture of what the bladder dam looks like in the river. The dam spans 660 feet across the river, but it is built in 21 different sections. The whole point of that is to be able to (1) let the sediment through the dam, which is going to be a tremendous challenge, and (2) to protect fish species and allow fish to move freely up and down the river at the same time that we are diverting our water. This slide shows a depiction of the dam, the steel plate structure. It has supports, and then there are two bags behind the dam that are about an inch thick of rubber and reinforced steel that have air tubes to them that raise and lower the dam. You can raise or lower the dam sections all at one time or individually, like a piano.

As we finished the west side and the testing of the facility, we raised the dam when there was sedimentation that occurred over the wintertime period. As you can see in Figure 3, the little island in the middle was connected before we ran this test, but it was torn apart. The whole purpose of this test was to see if sedimentation would fill up over the top of the dam, whether the air bags would be able to lift the dam with sediment on it. We raised the dam, and the island was removed. It was a very promising thing to see, not to see that the sediment would pass beyond the dam but to see that we could operate the dam in a way that would free up and move sediment.

Figure 3. Diversion dam looking west

Figure 4 is the picture of the intake structure. It is about 15 or 20 feet high, and inside of that intake structure there is a trash rack in front. Those little concrete pillars are Iowa vanes that we are using to push sediment away from the dam. The intake structure takes water in as the dam is raised. We got a really good picture of what is going to happen this summer. Everyone here is aware of the huge rain storms we had, but we had a tremendous amount of sediment wash through the section. If you were out there yesterday, you could see that those Iowa veins that are about three feet high are all filled with sediment. It did help and assist to move sediment away from the intake structure.

Figure 4. Diversion dam - intake screens and Iowa vanes

Figure 5 shows two intake structures. One is capable of taking the water that we need. We have two so that if we have a problem with one, such as needing to clean the sediment out, we can move to the other one. Again, we have the dam section there that shows

Figure 5. Diversion dam intake control gates

you what it looks like looking on top of the grated structure.

One of the biggest challenges that we have obviously is sediment. If you have been out on the river and have seen the dam, there is a tremendous amount of sediment accumulation. You may have been lucky enough to see Middle Rio Grande Conservancy District (MRGCD) facilities over the years dealing with the sediment issues that they have. Operating this facility and making sure we can move the sediment is going to be the bigget operational challenge.

Figure 6 is what I talked about with respect to the pipelines. We have about 50 miles of pipelines. Each one of these had its own little challenges. The bottom right hand corner depicts the area where we had to cross the river. This drinking water project is going to allow us to integrate our water system on the east side of the river with our water system on the west side of the river. They used to be independent, separate systems. Now we can move groundwater or surface water from the east side of the river to the west side. The photo on the right shows the area that we crossed the river. Campbell Road is in the background. There are two 54-inch diameter pipelines that go underneath the river at 25 feet deep. They are concrete encased structures, and that kind of just gives you a picture of some of the impacts of the project. Some people were very upset when we cut this swath through the bosque. It is about 100 feet wide. You can see the impact right there on the left photo. That swath is something that you are going to see for a very long period of time, because we have cut out plants and trees, and we have only planted grasses and other plants on top of our pipelines, but no new trees. People will remember when John Stomp cut those trees out of the river valley. That is one of my legacies that I will have to deal with forever.

Figure 7 shows the valve vaults where the two 54-inch lines come back together. We built two 54-inch pipes across the river so that if we ever had a leak or a problem with one we could switch back to the other one and still get water across the river. This shows where the two 54-inch lines come to a very large valve head that is the size of most homes here in town. It is about 1,500 square feet, and it shows how the two 54-inch lines come back together into one line.

Figure 7. Rio Grande crossing, bottom of the west bluff 54-inch connection

Figure 8 is a picture of the raw water pipeline being installed. This is a 72-inch steel pipeline with concrete on the outside of it for corrosion protection along the Paseo del Norte. We used as many of the existing right of ways as we could to install the transmission lines so that we did not have to tear up roads. We are on the north side of Paseo del Norte. The MRGCD provided a significant amount of land for us to place our pipelines so that we could avoid tearing up existing roads. Obviously you can see the tremendous impacts. This pipeline is six feet in diameter. That trench is 22 feet deep. You can imagine the scale of that with the excavator on top setting that pipe. It was a tremendous challenge to construct the pipeline in the sandy materials and the soil conditions that we had. Again, Figure 9 is just a different picture of the trench box that is coming from the pipeline at Rio Grande Boulevard.

Figure 6. Transmission pipeline construction

Figure 8. Raw water pipeline (72 inch) - looking east along Paseo del Norte

Figure 9. Raw water pipeline (72 inch) - looking west along Paseo del Norte

We tunneled under Rio Grande Boulevard and hit a fiber optic cable. The contractor stopped and pulled the tunneling head out of the machine when sand started falling into our trench. We almost lost the roadway at Rio Grande just north of Paseo. Luckily we were able to save that, but we ended up having to rebuild the roadway. Those are some of the tremendous challenges that we face every single day when we are out there building this project. There was some tremendous excavation required to build these pipelines (Fig. 10).

Figure 10. Excavation along Paseo del Norte

Figure 11 is another photo of the support that is necessary for these pipelines. This is a bridge support structure for a new drop manhole as we bring the water into the water treatment plant. Figure 12 is one of the bore pits. In a lot of the tunnels in these transmission pipelines, we tunneled under a significant amount of roadway. For those of you that live in Albuquerque, we are on Phoenix right now just east of San Pedro. There is a 1,100 foot tunnel that we are building. It is 30 feet deep underneath the roadway. We are pushing a new transmission line underneath 30 feet deep next to these homes. It is a tremendous operation. You cannot really get a sense of that from a picture like this, but the reality is that the tunneling operation is very dangerous and kind of interesting if you are an engineer. At the same time, you have problems with these things and they sometimes collapse. Figure 13 is some more pipeline construction.

Figure 11. Raw water pipeline #2 72-inch RCP, pipe cradle support for raw water drop manhole

Figure 12. Bore pit at the south side of Carmony and Edith Blvd

Figure 14 is the raw water pump station that is being built just south of Alameda. This is the pump station that is going to be taking the water from the diversion facility up to the water treatment plant. This pump station has about the same capacity of all of our 96 wells combined. It can pump about 120 million

Figure 13. Raw water pipeline #1 delivering carrier pipe to east side of 2nd Street bore

gallons a day. This pump station is about 35 feet tall from the surface. It is about 60 feet deep and 70 feet wide. It is a 105 feet long building. This massive pump station is located in an open space. We have worked with the neighborhoods to try to figure out what it should look like. We presented four or five different architectural choices. The neighborhood association chose this to look like an old Spanish style church. When we are done, this big pump station is going to look like an old church, sitting in an area where there used to be a church on that same property about 100 years ago. Obviously this is going to be significantly larger than that. The idea was that we try to build these facilities on local land so that we do not have to buy a lot of land. There were significant neighborhood concerns along with that.

Figure 14. Raw water pump station wet well slab, rebar setting preparations

We broke ground on the water treatment plant in August 2004. We had about six months' worth of dirt work that we had to do. We moved about 1.5 million yards of dirt at the water treatment plant, converting an old gravel pit site into the water treatment plant. That was finished in about March 2005, then we started the full construction of the water treatment plant, with the goal of bringing the plant online in July 2008.

Figure 15 shows some of the facilities that are already constructed. That is the administration building, just a small picture inside. The administration building is one of the projects that we phased into the water treatment plant so that we could occupy portions of the water treatment plant site prior to 2008. We hope to locate all of our central control for all of our water facilities at this building in October 2006. All of our reservoirs, pump stations, the new diversion facilities, all of our drinking water projects, and our existing facilities will be operated at this new administration building. Then you can see the big 200 feet tall tower. By the way, if you drive north on Interstate 25, you can see the construction of the water treatment plant.

Figure 15. Completed administration building

Figure 16 shows an overview of the site. This was taken several months ago. You can see the rain water from the storms that we had. The two tanks on the left are 10 million gallon storage tanks. That is where the finished water from the water plant will be stored. The other basins to the north are where the two 50 million gallons of storage are located, for a total of 100 million gallons of storage at the plant. The plant has changed a lot since March 2005. We have spent about $100 million on the plant so far.

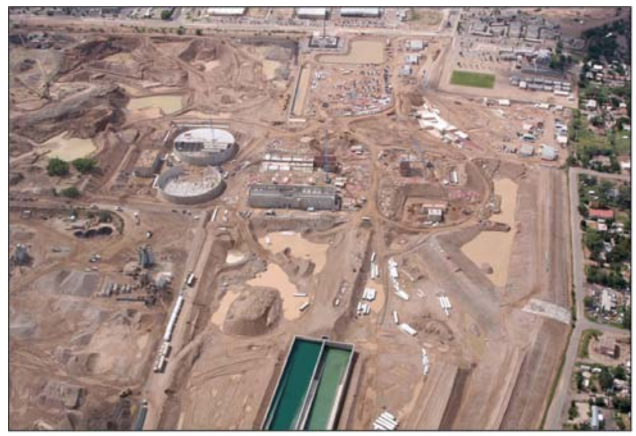

Figure 16. Overview of the site

Figure 17 is a picture of the chemical building. All of the chemicals for this site will be located in a central location. There is one place where all of the chemical deliveries will be taking place. This is one of those results of September 11 that a lot of people do not talk about. We will not be able to give any tours of the facility. We will be showing people these facilities from the administration building, because EPA and the National Security Council will not allow you to take people on tours of these facilities. This is probably the best that you are ever going to see of the water treatment plant. All of the chemicals are housed in one building now, where chemicals are delivered on site. We have complete access and control of where those people are going, and they should only be in one area of the site.

Figure 17. Chemical building onsite

Figure 18 shows some aerial views of the tanks themselves. It is very hard to appreciate the massive construction at the water treatment plant. If you were on the tour yesterday, you were able to kind of see that. Those two tanks themselves are 60 feet high and 400 feet in diameter. To stand there and look over it is pretty awesome.

Figure 18. Aerial views of the tanks

That reminds me of the story of the cement shortage and the steel prices recently. This project used to be a 275 million dollar project, and it went to a 375 million dollar project in the course of about four months, a result of China buying all of the steel and the cement issue that occurred recently. All who are in construction know that there are shortages of cement coming from Mexico. We are pouring 90,000 cubic yards of concrete at the water treatment plant, so you can see a 10, 20, or 30 dollar premium on a cubic yard of concrete makes a huge difference. The drinking water project requires 30,000 tons of steel. On the market, the raw quantity of that is about 30 million dollars.

Figure 19 is the settled water pump station at the water treatment plant. All the water will be lifted up through this pump station and gravity fed all the way through the rest of the process.

It is hard to show the magnitude of this project. One of the biggest challenges we have left is the public acceptance plan, and that is getting people in Albuquerque and the metropolitan area to be prepared for drinking surface water in 2008. We brought in Tucson so they could tell us the story of how not to do it.

For those of you who are not familiar with the Tucson story: Tucson brought in their Central Arizona Project water from about 200 miles away, and they did not look at the chemical compatibility of the surface water with the groundwater. They mixed the two and in fact turned over half of the entire city in one night to surface water. In downtown Tucson, they had a lot of red water quality complaints, which they ignored for the most part. It happened to be right in the middle of the city council election. They had red water coming out of the faucets, leaks because a lot of the pipes in the old downtown system had calcium carbonate deposits. There were a tremendous amount of leaks, and that led to a referendum in Tucson which was approved about two years ago. Seventy-eight percent of the people voted that they would never drink surface water. They built a 100 million dollar plant that sits idle today. They are slowly but surely trying to build up their confidence with the consumers there and hopefully get the bad idea of surface water taken care of.

Figure 19. Settled water pump station (left); Rapid mix inlet (right)

We obviously do not want to be doing the same thing, but yet we face the same sort of issue. The reality of it is that, once the surface water is online, our people could have four different qualities of water in a year. They could have fully surface water, a blend of groundwater and surface water, fully groundwater, and a different blend of groundwater and surface water, then back to surface water again. All of that could take place in a single year. So, we have a tremendous amount of education that we need to take care of prior to this to get people ready for that.

One of the things that we have done, and if you have been along Alameda Bridge there is a little trailer just south of there, is a pilot water treatment plant to test the water treatment process we are using at the plant. We will also be generating about 5 gallons a minute out there. We are going to be bottling the water all in an effort to get people ready for distributing this water to our customers in advance. We are also going to be working with our neighborhood associations to take tanks of that water and isolate specific neighborhoods throughout town and start feeding them the surface water next year so that we can look at the chemical compatibility issues in individual neighborhoods over the course of the next year or so. We will probably be hooking up one neighborhood every month or so, running that for a month, stopping it, going and isolating a different neighborhood and so on. All of this is an effort to look at the big picture, get people ready, and be able to understand how the surface water is going to interact with our existing system.

In bringing the surface water plant online in 2008, we are probably going to follow the Tucson example again on what not to do. We will probably end up bringing the plant online and serving it to one trunk or zone in Albuquerque for a few months, then moving to a different trunk and zone, and so on over time. The implementation process will probably take about a year. It is a tremendous challenge, and Tucson failed at that challenge. We are very glad that they did. I am sure they do not want to hear that, but we are very glad that they did so that we can avoid making the same mistakes they did.

Question: I have been trying to figure out where the plant is. Did you buy property from Vulcan, so that you basically have your own concrete making facility where you are putting in the plant?

John: We purchased 160 acres from Vulcan. Vulcan is leasing 70 acres of the property back from us, primarily so that they can finish mining the site. There were still gravel deposits that we did not want to buy mineral rights for when we bought the site. They are actively mining the site, and they are running their batch plants both there. We do not get free concrete from Vulcan if that is what you are thinking.

Question: I have to applaud you and your crew, because I think you are doing a huge project very quickly. Now with the new pipes that you are putting in, are the 96 different wells we have around the city going to be interconnected to those pipes?

John: The new pipes themselves were quite a challenge. It was not just bringing the surface water and moving that surface water to our existing reservoirs. On the east side of Albuquerque, we are going to use those large transmission lines to take groundwater from those reservoirs back to the water treatment plant to the west side so that we can meet our arsenic requirements on the west side. We do not just get the water out of the treatment plant and get it to our reservoirs. We now are moving water from our reservoirs across the river to the west side, so it was quite a challenge. We are trying to bring that online sooner than the water treatment plant comes online. We are hoping to do that sometime in late 2007 to test moving east side groundwater to the west side. Nobody will be allowed to connect onto those lines. Those will be separate transmission lines. There will not be any service connections, no extensions. They are solely for the drinking water project.

Question: With this project, will job opportunities increase? Will there be a need for more water operators for instance? Or will there be a decrease?

John: That was one of the things that Tucson told us they did right. They brought the staffing that they needed on in advance so that they could train their staff to be ready to bring the plant online when they said they would. They did. They brought the water plant online, but they just did not think about how they should do it. That is one of the things that we are working on right now. There will be a total of 20 new people for the water utility to run the drinking water project. As you can imagine, right now we pump water from the ground, we chlorinate it, sometimes we fluorinate it, and that is it. Now we are moving to a very complicated process where we are ozonating the water; we have granular activated carbon filtration. It is a whole totally new process. We have got to train our operators to do that. We are going to bring our staff online to be able to do that in advance.

__Matthew Holmes__ is the Executive Director for the New Mexico Rural Water Association, a nonprofit technical assistance provider and membership organization of water and wastewater systems. He holds an M.A. in environmental and natural resource economics from the UNM and a B.S.B.A. in business economics from the University of Arizona. Matt frequently provides testimony to the New Mexico State Legislature regarding drinking water issues and travels several times each year to Washington, D.C. to represent Rural Water. His other duties include overseeing twelve federal and state grant programs, managing the Association budget, interacting with the Board of Directors and the membership, helping rural communities, and managing fifteen employees. He currently serves on the Technical Team of the Water Infrastructure Investment Team.

REGULATORY CHALLENGES FACED BY NEW MEXICO'S SMALL COMMUNITIES

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Thank you. Good afternoon. In the rural water community, people say "Good afternoon." (Audience responds: "Good afternoon.") Sorry. I am very pleased to be here at the 51st Annual Water Conference. I was lucky enough to be able to make it to the 50th anniversary. They invited me back, which I guess is a good sign. I would like to start off by saying that the New Mexico Rural Water Association, if you are not familiar with it, is a nonprofit membership association. We have water system utility members, mostly small communities but some large communities. The City of Albuquerque has been a member. They are not a voting member, but they certainly are a supportive member. We appreciate that kind of support. We do a lot of technical assistance, outreach, and training for rural and small communities. Our mission is oriented towards public health through safe, clean drinking water. We are there to help small communities comply with the Safe Drinking Water Act, which Kim Ngo earlier gave an excellent overview of. Her talk will help my presentation go a lot quicker. I can get to some other material I want to cover at the end.

Briefly, I am going to do a quick overview of small systems and the regulatory environment that these small systems operate in, that is the existing regulations, the revised regulations, emerging drinking water regulations, and the process of how these standards are set. We will also cover the goals of drinking water regulation, which is very important and sometimes gets lost in implementation. I will talk about a few other requirements that small systems have to do and the existing tools that they have to comply with this. The meat of what I want to talk about here today is what path we are taking into the future, the future outlook for small drinking water systems, and really for all water systems, and possible alternatives.

Figure 1 is a pie chart of the sizes of the water systems in the state. Starting with the light blue chunk, there are 177 small systems. Those are systems that serve less than 100 in population. You can see here that the majority of all regulated, community water systems in the state are small systems that serve less than 3,300 people, which is the EPA's definition of a small system. In New Mexico, a small system is really one that serves less than 100 people. We have very few systems that serve more than 10,000 people and very few systems, only seven, that serve more than 50,000 in population (Figure 2). If we look at the population served by the system size, you can see the reverse of this. Of course it makes sense. Fifty-seven systems serve over 3,300 in population, and the majority of the population is actually served drinking water by large systems, by systems that serve a lot of people. That is a trend all across the country. There are a lot of small systems, but they do not serve as many people. There are 1.3 million people served in New Mexico by systems over 3,300. Small systems are still serving a significant number of people. Under that 3,300 population cutoff, we are still serving 246,000 plus people.

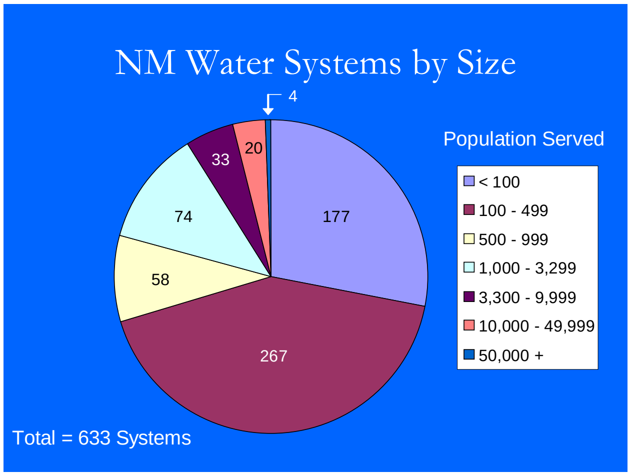

Figure 1. New Mexico water systems by size

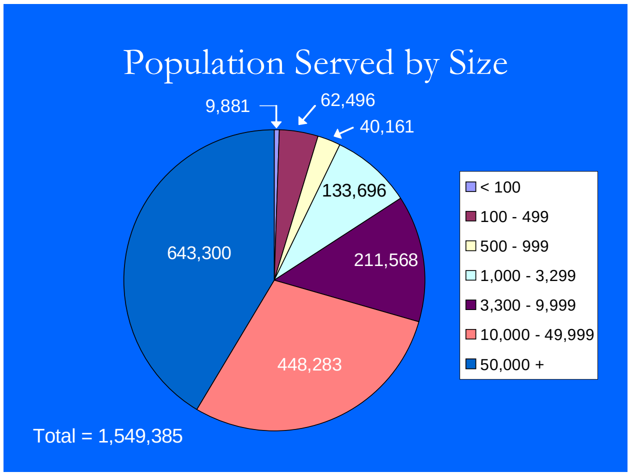

Figure 2. Population served by size

It is important that we ensure the quality of water in these systems. We are only talking about community water systems here. Kim was talking before about transient and non-transient community water systems. Community water systems are the typical systems people think about, serving towns and small unincorporated areas. They are what you typically think of when you open the tap and get a drink of water. If you take all of these other entities, campgrounds, restaurants, truck stops, there are about 1,300 of all small systems. Really anywhere you go and drink water, there is a water system of some sort. I will be able to go over this briefly, even more so because Kim already covered a lot of this stuff.

The Safe Drinking Water Act (SDWA) regulates 91 contaminants or contaminant groups. Once standards are set for a particular contaminant, that typically constitutes its own rule. It has its own document published in the Code of Federal Regulations for a particular contaminant, such as arsenic. That can be several pages long or many, many pages long just for that one contaminant. On top of that, the EPA is required by SDWA to go back every six years and consider revision of all the existing regulations. There is a no-backsliding clause in the federal law as well. EPA cannot make a regulation less stringent. That would take an act of Congress.

The arsenic rule is perhaps the most famous regulated constituent. This rule basically took effect in January 23, 2006. That started the compliance or monitoring cycle in New Mexico. I do want to briefly touch on the arsenic rule. Kim mentioned that about 60 percent of the systems know what they are going to do with the rule, whether that is to install treatment and technology or apply for variance. That really leaves 30 percent of the systems that do not know what they are going to do with the rule, which is kind of a shockingly large number. This rule is here. It is here to stay. I think everyone here in this room knows this, but a lot of times we have discussions with people in the field that somehow think this is going to go away or that the federal government is going to change it. That is not going to happen. This rule is here to stay. It will be very interesting to see what happens to these systems that do not comply. Our organization put in a lot of comments about the feasibility of this rule when that comment period was open, which was four or five years ago now. Now we are trying to help people comply with this rule, and so have a lot of entities, such as Sandia National Laboratories and the Water Resources Research Institute (WRRI). WRRI helped people determine what they were going to do with the rule, but it is still unclear how a large number of the systems are going to comply.

Kim also covered the radionuclides rule. The change in the uranium regulation that she mentioned will have a big impact on New Mexico. New Mexico does have a fair amount of naturally occurring uranium. Uranium has a whole new set of issues associated with its treatment and disposal that will have a significant impact on many of the small systems. She touched on the surface water treatment rule and the disinfection byproducts rule, which are very complicated rules. That is really my main point about those. The Safe Drinking Water Act is increasing the complexity for all systems, for all those 1,300 systems. Figure 3 is a chart that is off of the EPA webpage that shows you what the regulations and the standards look like. This is just a chunk of the chart. There are six categories that are regulated: disinfectants, things like chlorine, and disinfectant byproducts, things like trihalomethanes (TTHMs) and haloacetic acids (HAA5). When you put chlorine in water, it reacts and kills the bugs that you want it to kill, but it also interacts with leaves or any other organic material and can produce trace amounts of very toxic chemicals.

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal
OC	Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	zero
D	Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	MRDLG=4[1]
D	Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants & young children: nervous system effects	Water additive used to control microbes	MRDLG=0.8[1]
DBP	Chlorite	1.0	Anemia; infants & young children: nervous system effects	Byproduct of drinking water disinfection	0.8
OC	Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	0.1
IOC	Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	0.1
IOC	Copper	TT[7]; Action Level = 1.3	Short term exposure: Gastrointestinal distress. Long term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits	1.3
M	*Cryptosporidium*	TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
IOC	Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	0.2

Figure 3. EPA regulations and standards for selected contaminants

Those regulations are very important. You need to have enough disinfectant in water but not too much. We have inorganic chemicals, organic chemicals, radionuclides, and microorganisms. We can also think about regulated contaminants as being acute contaminants, the ones that will harm you immediately if you drink them. Obviously, E. coli and all the microbiological organisms are acute contaminants. Then we also have chronic contaminants like arsenic. Contaminants such as these cause damage over many, many years, over a lifetime of digestion.

If you look across the top of the chart, we have the maximum contaminant level (MCL). If you look across the chart you will notice the MCL for various contaminants is listed in parts per million. Chlordane is really 2 parts per billion, because it has the zeros in front. You will also notice that things like chlorine have a maximum residual disinfectant level (MRDL). Even the MCL gets very complicated in the individual rules.

Drinking water is one of the most heavily regulated commodities that we have. It is something that the government has a good regulatory handle on, so they are tempted to try to mitigate overall health risks through drinking water regulation.

There are 91 of these things, and in particular rules there are often many things you have to comply with. Obviously the common source and the public health effects are important to know for a particular contaminant. The last thing of interest on this is the public health goal, or MCLG. The MCLG is what EPA determines to be the safe level of a particular contaminant in the water. Just looking at the scientific data, the EPA determines what the safe level of a contaminant in water is. For chlordane, it is zero. That is actually less than the MCL. Almost all of them up there are actually less than the MCL. That is because the EPA has determined that that is the goal, the safe number, but we cannot feasibly treat down to that level, because the technology doesn't exist or more often that the technology exists but it is not affordable to treat down to that level.

As far as emerging regulations, which are for all systems, not just small systems, we have 51 potential contaminants that are currently on the contaminant candidate list (CCL). The following is a list that EPA is actively researching for possible inclusion as national primary drinking water regulations.

- 51 potential contaminants - CCL
  - 9 microbiological, 42 chemical
- Groundwater Rule - October 2006
- Lead & Copper Rule - late 2006
- Distribution (TC) Rule - 2007
- Radon Rule - 2007 or 2008
- MTBE, Perchlorate, Atrazine
- Endocrine Disrupters

The groundwater rule is coming in a few days. The most interesting thing about the groundwater rule is that in the old days we used to think that groundwater was relatively clean from acute contaminants, such as viruses and bacteria. People used to think that contaminants from septic tanks were filtered out in about 100 feet. Well, that is not true. Many of you are scientists in this room and know it is not true. Good science has shown that viruses and bacteria persist in groundwater, even as they travel through the aquifer. In the past, positive bacteriological results on a system were thought of as confluent growth throughout the distribution system itself. They did research on this issue and realized that a significant amount of bacteria is coming right out of the ground or the source itself. That led to the promulgation of the groundwater rule, which is going to require all systems to monitor their source and perform the various options Kim presented if they find any kind of bacteria in their source. That is going to have a big effect on New Mexico.

I do not read a lot about the groundwater rule; we read a lot about the arsenic rule as that was coming into effect, but arsenic is sort of a buzz word. Uranium should be a buzz word too. These other rules that are coming out will have just as large of an impact in New Mexico, arguably more of an impact. The lead and copper rules are currently being revised. In late 2006, there will be some minor changes to these rules. They are talking about possibly looking at a distribution system rule or modifying the total coliform rule, which would start having the systems regulate and monitor their distribution systems much more heavily. The radon rule is up in the air; no one really knows what is going on with that.

The radon rule is an interesting one, because as it was originally proposed, it required systems to either remove radon from their water down to a very low level or implement a multimedia education program to have homeowners remove airborne radon from their homes. If a system does this, they would reduce the homeowner's overall exposure to radon, so that the system could have a higher level of radon in the water. The very interesting thing about this rule is that it is putting water systems on the hook for air quality inside individual homes. That is probably why it is so controversial. Drinking water is one of the most heavily regulated commodities that we have. It is something that the government has a good regulatory handle on, so they are tempted to try to mitigate overall health risks through drinking water regulation.

Let's remember the goal of why we are talking about all of this. In 2003, EPA found that 26 percent of all public water systems received a violation, which could have been a monitoring or reporting violation. Six percent of those were actually health-based violations, something you would be truly concerned about if you were drinking water in that system. In 2004, the Drinking Water Bureau tells us that 35 percent of New Mexico's water systems received a significant violation, and 9.25 percent received a health-based violation. Clearly, we have a little bit of work to do in New Mexico compared to the rest of the country, although we are certainly not doing too bad. Our water quality in general is very, very safe in America. However, we do have issues and violations out there. It is not true that you can go anywhere in New Mexico and drink the water; it is not true of anywhere in this country. I can take you some places if you would like.

There are a few other things that water systems have to do either as best management practices or as just general planning, such as the consumer confidence report, and source water protection planning. Some of these things are required by the state. John brought up one that I did not remember, that is security planning. Security is a large issue for all systems. The Bioterrorism Act requires that water systems over 3,300 develop security plans, what is known as a vulnerability assessment and emergency response plan. The more you learn about security, the more you realize that it really is important, even though small systems usually say, "Who is going to come out to Malaga and attack my system?" Terrorist attacks are one small component of security. Water systems are required to respond to emergencies that might not have anything to do with their systems. It might be just something that happens in their town, say if an oil field blows up. Do you have a procedure to mitigate contamination of your system and to respond if there is an emergency like that? Most systems do not.

On top of all of these other things that we are required to do in small water systems, we really need to be planning and looking to the future in order to have sustainable systems. How do we get there? I think most small systems in New Mexico and a lot of small systems in the country are not really there. EPA has come out with four pillars of sustainable infrastructure, which I think are a good summary. **Better management** is right there on top. In the past, we have put a lot of money into infrastructure for systems. You heard the State Engineer talk about trying to get some better criteria on money that the state gives to systems. It makes sense. EPA learned this a long time ago. If you give people money, but they have poor management or they do not have financial controls, the money will not be spent effectively and it will not be sustainable. The next on the list is **full-cost pricing**. We do not pay enough for water. Everybody here knows that. We need to have these systems charge what it actually costs them to treat the water, to deliver it, maintain the water quality, and repair and upgrade their systems. In New Mexico, we are basically financing our small systems by neglecting them. We have often built these systems with federal money, some free money at the time, or state money and then we do not put any kind of repair and maintenance into the small systems. We have to stop doing that.

We need to have these systems charge what it actually costs them to treat the water, to deliver it, maintain the water quality, and repair and upgrade their systems. In New Mexico, we are basically financing our small systems by neglecting them.

Efficient water use is a big one on the list. If you are looking at putting in a new source, you can remove the necessity to put in that source if you can reduce your water use. There is an opportunity to significantly reduce water use in many systems in the state. Perhaps not all systems, but many systems can reduce their use, the vast majority. **Watershed sources water protection** is also on the list. Last year when I talked about source water protection, we talked about starting to integrate the environmental issues with drinking water issues. I think we are a long way from that, because right now we are still trying to deliver water that is compliant with federal and state standards. This is really the future. We have to be looking at the entire watershed to protect the quality of our source water, which leads to compliance.

The State Engineer mentioned the Water Infrastructure Investment Team (WIIT). This is an effort that the state is making largely behind the scenes. I do not know how widely known this effort is, but it is a very important thing that is going on. It is an effort by the governor's office, the executive branch, many agencies, and some stakeholders to develop rational criteria for funding that is handed out by the state. This is one version of these criteria. It has not been finalized yet. It goes along the lines of what the EPA has proposed; it expands on it a little bit.

...right now the MCLs for all systems are a little bit higher than what they would be otherwise, because small systems are an anchor in the setting of the standards.

There are a lot of tools out there to help small systems. But clearly, in order to develop sustainable systems in our state, we are going to have to do something different. What is this future going to be? We have increasing regulation and increasing costs for all water users, so certainly water rates are going to increase for everyone across the board. That is just going to happen. However, on top of that, we are looking at increasing costs putting more and more stress on small systems. This is not hypothetical. If you look at places like Texas when the 1996 safe drinking water amendments took effect and there were more sampling requirements on systems, at that time Texas did not have the same sort of water conservation fee like New Mexico has to spread the sampling costs out among all users. Many systems could collapse or consolidate. Consolidation could be good, but driving folks back to domestic wells or having the system give up the keys is not good. This is not a hypothetical situation. The state is looking at expanding its enforcement presence right now in New Mexico. There are two systems that they are looking at potentially having to take over and operate, which is not a good situation. I think we either need to realize that as these rules increase in complexity, a one size fits all approach to regulation will not work, or we are going to have to invest a substantial amount of money into our smaller infrastructure entities. We have already done that. The state has been a bit reluctant to put more money into that. Even if rate payers pay more money, I don't think it will get us to where we need to go. The other thing that we could do is start to look at the regulations and consider affordability.

This part of the talk is actually somewhat controversial. I do not know if any of you have heard of this proposal. Let me just say that my purpose here is to educate folks on this. You may or may not know about the proposed affordability policy, and there has been a lot of misinformation about it. Several months ago EPA offered a proposal to revise the methodology they use to determine if new regulations are affordable for all systems. This does not affect the arsenic rule or groundwater rule. This is only for regulations that have not been promulgated yet. This methodology already exists; it is not a new thing. However, EPA is looking to revise their implementation of the methodology. EPA proposed this policy with the support of the National Drinking Water Advisory Council and the Science Advisory Board. It is implementing existing law. This law already exists in the 1996 regulations. It says when EPA is implementing new regulations, it needs to consider the cost/benefit analysis, which is also controversial, and it has been used sporadically by EPA successfully. As a result, the EPA has never determined that a regulation is unaffordable. All regulations are affordable according to their current policy.

Basically, what the affordability policy does is allows a variance for up to three times the MCL on non-acute contaminants. In Kim's presentation, one thing I really liked was that she showed variances and exemptions as a whole category of rules. These already exist. This, however, is a broader policy. The system or the state if it chooses to do so must show that a different MCL will not pose a risk to human health. I think this slide brings up a lot of issues. Is the MCL safe or is it not safe? I think emotionally it is very easy for us to say that we do not want to be drinking water that is toxic. If that level is safe for one entity, it should be safe for all entities. But like many things in our society, this is a very technical area. It has got a lot of science behind it. There are a lot of factors that are considered in setting an MCL. The EPA has long recognized that you can deliver water above an MCL and not pose an unreasonable risk to human health, particularly if it is for a limited amount of time. These issues are very technical.

This has really caused a storm up there in Washington, D.C. EPA proposed this new policy and has said that they want this. I have a quote from here from Steven Heare. I was fortunate enough to meet with him this week. He is the director of the Source Water Protection Division. He said, "We need an affordability policy, and we need it to work. EPA has been very vocal about this need, but the devil is in the details." He told me that EPA received 12,000 comments on this policy, which is a huge number. That is the largest response they have ever had on any drinking water issue. It is clearly an issue that is very important to people. I think people that are opposed to this policy feel that small communities should have the same level of protection as large communities. You will see folks that say it sets up a dual standard for water systems, which again is not technically accurate, but it is an argument that carries a lot of weight with people. It does somewhat undermine confidence in the MCL. Again, is this level safe or not? That is something that the scientists determine, and I guess it comes down to the bottom line.

Large systems in general are against this policy. From what I can figure out, they are against it, because right now the MCLs for all systems are a little bit higher than what they would be otherwise, because small systems are an anchor in the setting of the standards. Since the small systems cannot afford to comply with as stringent an MCL as larger systems, it results in a higher MCL. If you take the small systems out of that equation and give them a separate route that they can comply with, it might actually require the larger systems to comply with a lower MCL, which costs lots of money. Clearly this is something that I understand. Virtually every other water group in Washington is against this, American Water Works Association (AWWA) and the National Resources Defense Council (NRDC). Everyone is against this, except the National Rural Water Association and EPA.

We do not necessarily want to see this go one way or the other. We are trying to elevate the debate above the level that it is now. We are trying to get people to consider whether or nor people can afford to pay for things when we promulgate regulations for them and what the potential trade-offs are. If you are in a small community trying to protect public health, and to implement a particular rule will require raising everyone's rates by $30 a month or something like that, what other trade offs does that have in public health? Does it have a trade off in nutrition or health care? What else could you do with that $30, or nation-wide hundreds of millions of dollars, to affect public health? That is my pitch for affordability.

Why I wanted to present this is because it is a cutting edge issue. It is happening right now. It is not hypothetical. The public comment period is closed for the policy; however, you can still write a letter to Ben Grumbles, the assistant administrator of EPA, to Senator Domenici, or to Senator Bingaman. It is something that folks can still have an impact on either for or against it. It does affect everyone in this room. It affects everyone who drinks water, because we are talking about the future of how these regulations are developed. That future will either include some consideration for cost/benefit analysis or it will not. Right now, it really doesn't. It is a political process, even though scientists have some input, it really is a political process, not a scientific one. I wanted to present it today because it is happening right now. It is important. If you do care about it, take the time to let someone know.

__Gary L. Esslinger__ is the Treasurer-Manager of the Elephant Butte Irrigation District. 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 and is now retired. Gary has also kept his roots in farming as well as other agricultural-based industry. After receiving a bachelor's degree in business administration from Northern Arizona University in 1973, Gary worked six years in Los Angeles for a large west coast flour milling corporation as office manager. After becoming tired of city life, Gary returned to the Mesilla Valley and began working for EBID in 1978 where he has been for the past 27 years. Gary began his District career as Purchasing Agent and has held other organizational positions of Maintenance Chief and Assistant Manager. Gary is, and has been for the past 16 years, the District's Manager and is also the District's Records Manager. Gary was appointed by Governor Richardson as the Chairman of the search committee to select the State Engineer for New Mexico. Gary lives in La Mesa on the family farm with his wife, Tina, and three daughters.

WATER QUALITY CHALLENGES OF THE IRRIGATED AGRICULTURE COMMUNITY ON THE LOWER RIO GRANDE

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My talk today is about the water quality challenges that face irrigated agriculture in the Lower Rio Grande Basin below Elephant Butte and Caballo. I want to also show you some pictures of our area that I happened to find as I am also the Records Manager and Archivist at the Elephant Butte Irrigation District (District). As I went through our archives, I found in an old cardboard box containing some canvas encased negatives—thousands of them—pictures from all over New Mexico. As I went through the file, I found a document that said that the attached photos were those of Herbert Yoe's family. Herbert Yoe was New Mexico's State Engineer (1926 to 1930) during the early years of farming after the construction of Elephant Butte Dam. I have some of his pictures here today. Some of these photos are not really clear, but at least you will have a chance to see what the river channel looked like in the late 1800s and early 1900s when these photos were taken (Fig. 1).

Figure 1. Bosque in the lower Rio Grande, 1913 photo

If you are interested in seeing these photographs, they are now a part of the historical collection at the New Mexico State University archives. Contact me, and I will prepare the necessary paperwork to get you admitted to the Rio Grande Historical Collection area of the NMSU Library.

Looking at these pictures you see what the Lower Rio Grande valleys looked like before Elephant Butte Dam was built (Fig. 2). Historians have traced farming in these valleys back to the 1500s. During these pre-Project days, diversion dams on the river were built of rock and lumber, and every year the Rio Grande would wipe them out, and every year the early farmers would once again construct the destroyed dams (Fig. 3).

This next picture is on the Las Cruces town ditch, an acequia long before the federal government started the Rio Grande Project in the late 1910s (Fig. 4).

Irrigated agriculture on the Rio Grande has long been challenged by water quality problems. From the pictures that I have shown you, it is clear that sediment was an early problem (Fig. 5). When I think back to our forefathers, I wonder what they envisioned as Elephant Butte Dam was being built. I think they must have had water quality, particularly sediment, in mind as they laid out their fields, the diversion dams, and the canal system. There is a bumper sticker that I used to have on the back of my pickup that said “Silt Happens,” and it is still happening today. Sediment problems are going to be a major problem for future

Figure 2. Rio Grande before Elephant Butte Dam, 1910 photo


Figure 3. Man-made diversion dam off the river, 1913 photo


Figure 4. Las Cruces town ditch, late 1910 photo

Figure 5. Build-up of sediment below Anthony, 1912 photo

proposed Lower Rio Grande surface water treatment plants (Fig. 6).

The salinity problems that are found throughout the Lower Rio Grande basin in both Texas and New Mexico have been with us for at least one hundred years, and salinity continues to be a challenge today. The Rio Grande Project stores and delivers water to New Mexico, Texas, and Mexico. The Project's irrigated lands are in the narrow valleys along the river running a distance of over 150 miles. There is a system of drains that parallels the canal delivery system on both sides of the river. The drain system was an afterthought built in the 1920s. Reclamation built the diversion dam and delivery canals, but they did not build the drainage system. Our forefathers' building of the drainage system is probably the most important part of salinity control, and those drains are still functional to this day. At intervals, these drains discharge into the river carrying irrigation return-flows and naturally occurring groundwaters, some of which are saline. The importance of these saline groundwaters was reported in a 1938 National Resource Committee study that found the total dissolved solids content of the drains in the lower part of the Mesilla Valley was two to four times that of a drain at the head of the valley. Similar elevated salinities were reported in the drains from the El Paso valley.

As a result, the quality of the water in the Rio Grande becomes poorer in the downstream direction. It is interesting to note that water quality is significantly different than it was shortly after the construction of Elephant Butte Dam. In the past, the conventional belief has been that irrigation return-flows were creating water quality problems. Studies done in recent years by New Mexico Tech researchers show that saline water from deep groundwater sources is discharged into the Rio Grande. Table 1 shows the sources of salinity (reported in NM Tech studies) that enter the Rio Grande from the headwater to below the narrows at El Paso. Two-thirds of the increase in the chloride content in the Rio Grande is from deep saline discharges and from discharges by municipal waste-water treatment plants.

The New Mexico Tech study identified locations where upwelling of saline groundwater occurs. They are the narrows upstream of San Acacia; the hills just west of Socorro; within the Elephant Butte Reservoir; the narrow valley in the Rincon valley just before it goes into Seldon Canyon; and also at the narrows just above El Paso.

The District has a fiduciary responsibility to care for water quality and water quantity for our members and constituents and to protect the supply for downstream users. EBID continually monitors the drain system to detect the illegal discharge of pollutants into our system. We also work with other organizations on enhancement of the riparian areas along the river. We are now working with the State Parks Department on the development of a fourth park along the river. We are working with environmental groups in the development of a safe harbor agreement should our riparian efforts attract endangered species not presently found in the area. Within EBID, outside the river levees, there are 90,000 acres of farm lands that are inhabited by wildlife and that provide cover for birds. Our future challenge is to continue to protect and enhance water quality for all users.

Source of Total Chloride Burden	Percent Contributed
Natural Tributary Inflow into River	25 %
Discharge From Waste-water Treatment Plants	26%
Dynamics of Evaporation and Bank Storage at Elephant Butte Reservoir	9%
Discharge from Deep Saline Groundwater	37%

Table 1. Sources of increase in the total chloride burden in the Rio Grande.

Figure 6. Sediment islands in the river near Rincon, 1913 photo

Jim Piatt is a native New Mexican and has worked in the environmental assessment, regulation, and management fields for many, many, many years. For the last eight years, he has been employed by the Pueblo of Isleta as director of the Environment and Natural Resource Department.

ISLETA PUEBLO'S PERSPECTIVE ON NPDES PERMITTING AND STORM WATER RUNOFF

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When it became known that I was going to give this presentation, I had a knowledgeable tribal member come in and ask how the water quality was on the Pueblo and how effective the National Pollutant Discharge Elimination System (NPDES) was in protecting that water quality. When it comes to explaining the "marriage" of science and regulation there is rarely a direct and simple answer to such a question. Moreover, in Indian country you quickly learn that you must provide a "setting" in which to discuss the question; in short, there is no simple answer to what seems to be a simple question. From the Pueblo's standpoint, there are history and long-standing sensitivities that must be addressed in my attempt to answer this question. I have to touch on some of the recent history to explain how the Pueblo really got to where it is and why we are involved in the water quality realm at all. I am also going to try to kill a couple of snakes that are still being paraded about and that continue to haunt those in Indian Country. Only then will I be able to address the elusive NPDES permit's effects on tribal water quality.

Back in 1987, Congress, in the eyes of many people, belatedly recognized the inherent regulatory authorities that tribal sovereigns have over the water resources that are in their tribal lands. The 1987 amendment allowed the tribes to attain standing in the federal water quality system, which was very beneficial, or at least the Tribe thought that it was. Hence, in 1989 the Pueblo of Isleta applied for what is called "treatment as a state." While some would argue that such language is actually a limitation of inherent authorities–essentially a step down–nonetheless, that is the language that is used statutorily. In 1992, EPA in its typical timely manner, finally issued such official recognition of the Pueblo of Isleta under the Clean Water Act. Isleta was the first Indian tribe that was so recognized.

It is important to recognize that the tribes have to jump through all of the bureaucratic hoops that the "original states" had to meet; there were no administrative shortcuts offered in the laborious process. While EPA was running around trying to determine if the tribe had met all of the necessary legal mandates to be considered a state, the tribe was moving forward to develop and adopt its first set of standards. As do all states, the Pueblo had to publish a formal legal notice that they had developed draft standards that the public was welcome to review and comment on. Two months after publishing the notice, the Pueblo had a public hearing on the proposal. I was there as an employee of the New Mexico Environment Department at the time, and I will tell you that it was a bloodbath. It was a very ugly situation. There were a number of people from outside the Pueblo who, frankly, were very confused about why the hearing was being held. The public hearing went on for some time. A significant number of entities, including several municipalities, were involved. A number of post hearings submittals were entered into the record. Six months after the public hearing, the tribal council finally had a draft that they believed answered all of the concerns that had been raised during the hearing and in the post hearing submittals. Therefore, the Pueblo finalized the amended proposal and submitted it and the entire hearing record to EPA. Ten months later on December 24, 1993, the EPA gave the tribe what could have been considered a Christmas present: they fully approved the standards. Unfortunately, a month later the City of Albuquerque turned around and sued EPA for that administrative action.

One of the primary goals of this study from the two states' standpoint was an attempt to provide an answer to the pressing question: "can we develop EPA approvable site specific standards that could replace the feds' generic criterion?"

Some time later the District Court granted EPA summary judgment on all counts raised. As you might remember the city immediately appealed to the 10th Circuit Court of Appeals. However, during the period when the appeal was going forward, negotiations were occurring behind the scenes that ultimately led to a new request by the City to the appellate court. They asked that the District Court decision [should] be mooted and the appeal thus negated, because the City had reached a negotiated agreement with the Pueblo, NMED, and EPA. The negotiated settlement was aimed specifically at implementation of a new NPDES permit. The permit was based on an agreement in which the Pueblo held implementation of a number of its newly adopted criteria in abeyance in favor of a site-specific water quality investigation. Many of you who were around at the time will remember that there were a number of claims that were made, many of them focused on arsenic, which was one of the parameters held in abeyance. The new permit finally came into effect June 1994 and was supposed to expire in 1999.

The 10th Circuit Court denied the City's request to moot the original decision and, in fact, came to the same conclusions that the District Court had. Albuquerque appealed to the U.S. Supreme Court, however, the U.S. Supreme Court refused to hear the appeal. The 10th Circuit decision was left in place that had found that EPA's review and approval methodologies, and thus the Pueblo's standards, were deemed to have been properly adopted.

In part, flowing from that lawsuit have been a series of errors that continue to reverberate through both the technical and the legal literature since that time. A number of individuals in both state and tribal government have been trying for a long time to get these erroneous proclamations corrected. I will briefly try in this venue, as I have done in others, to correct several of these errors. Hopefully we can get past these errors and work without the allegations that continue to polarize discussions of water quality.

As recently as 2003, there was still a claim being made that the standards originally adopted by the tribe should not have been approved because they were more stringent than what was required by the feds. While the Court decisions upheld EPA's contentions that the tribes have the same authority as other states to adopt standards more rigorous than those proposed by EPA (Section 510), this did not happen in this case. I ask the audience patience as I will further develop this issue shortly.

Another one of the big headaches that has been repeated *ad nauseam* is the argument that the tribe was trying to impose more rigorous water quality standards strictly to protect its own cultural or religious usages of those waters. This point is simply dealt with. If you review the water quality standards that the tribe adopted, the arsenic criterion was adopted to protect the health of people consuming fish caught in the Rio Grande or out of the tribal lakes, not to protect cultural usage. Then, as now, arsenic is not regulated under the cultural primary contact use identified in the tribal standards. Unfortunately, this erroneous claim has a life of its own. It is still being made, and it remains a problem as was recently seen in some of the arguments put forth this summer when Oklahoma tribes sought such water quality authorities. Frankly, I am using arsenic in my further discussion because I want to be able to draw some attention to this error.

I would like to address the dual-sided argument that the tribe basically pulled the criterion for arsenic out of the air and that it was much too strict. There is a 1986 criteria document the EPA put out that we laughingly call the Gold Book. It recommended criteria for several different uses of the water. This slide compares the Pueblo's original criterion (17.5 ng/L) to the EPA recommendation; their 17.5 ng/L looks awful familiar doesn't it? I emphasis yet again that this criterion was adopted to protect human health from the effects of eating fish with elevated levels of inorganic arsenic in their flesh, not to protect a cultural practice.

If someone wants to continue their use of this "argument" they need to restate it if they wish to be credibly treated. As adopted by the Pueblo, the criterion was intended to provided protection from the carcinogenic properties of this pollutant at a protection level of 10^6, hence the tribe's criterion was identical to that of EPA. The issue lies not in a difference with the federal recommendation, but it was, and is, different from the criterion adopted by the state of New Mexico. The state has historically adopted criteria for carcinogens based on a risk factor of 10^5. This means for carcinogens like arsenic, the state is willing to accept an excess cancer rate of 1 in a population of 100,000. The tribes use 10^6 or an excess cancer rate of 1 in a population of 1,000,000. That is the primary difference between the state of Isleta and the state of New Mexico's criterion for the pollutant. It does not have anything to do with it being a cultural use that is recognized by the tribe but not by the state.

One of the joys that came out of this headache, is that it led to a scientific investigation in which the City of Albuquerque, NMED, the Pueblo, and the EPA actually sat down together and developed a reasoned approach to its resolution. It funded a disinterested, competent party—the U.S. Geological Survey—to sample the river in the reach that was a concern and determine the concentrations of this pollutant including an attempt to identify "background" levels reflective of the area's geology. One of the primary goals of this study from the two states' standpoint was an attempt to provide an answer to the pressing question: "can we develop EPA approvable site specific standards that could replace the feds' generic criterion?" The majority of the funding actually came from the City of Albuquerque. NMED, the Pueblo, and the EPA also contributed. You will see that the investigation and fieldwork was done between 1994 and 1996.

Figure 1 is a summary of the ambient arsenic data. This is looking only at the dissolved phase. All of the values are in micrograms per liter. This slide is too busy, and I recognize that. I want to draw attention to three different points. The lowest line in the table is a statistical analysis looking at individual sampling points. The San Felipe Pueblo station was located well above the mouth of the Jemez, and it is also located above the main anthropogenic sources of arsenic. Its arithmetic mean concentration was statistically lowest at 1.8 ug/L. I will ask you to focus on the minimum column. At the time this investigation was conducted, it included an EPA approved Quality Assurance program where we were accurately reporting concentrations down to 1.0 ug/L. I will ask you to hold that in your memory banks for a minute, because that number will come up in a little bit. Between San Felipe and Bernalillo, the Jemez flows enter the Rio Grande. It is not significant volumetrically, but when you look at the arsenic concentrations, you can see that the mean arsenic concentration at the Rio Grande Bernalillo station, located below the Jemez, jumped up significantly. Comparing the Bernalillo station with the next two downstream, the Alameda site and the

	Maximum	Minimum	Arithmetic Mean	Standard Deviation
Rio Grande at San Felipe	2.0	1.0	1.8	0.4
Jemez River below Dam	25.0	14.0	18.2	4.1
Rio Grande near Bernalillo	3.0	2.0	2.5	0.5
Rio Grande near Alameda	3.0	2.0	2.4	0.5
Rio Grande near Rio Bravo	3.0	2.0	2.4	0.5
Rio Grande at U.S. Interstate I-25	4.0	3.0	3.1	0.4
Rio Grande at Isleta Pueblo	4.0	3.0	3.4	0.5

Comparing station mean concentrations yields the following ranking based on a generalized two-tailed T-test model in which variances are not assumed to be equal:

San Felipe **<** Bernalillo **=** Alameda **=** Rio Bravo **<<** I-25 **=** Isleta **<<<** Jemez

Figure 1. Summary of USGS ambient arsenic data (dissolved phase). All values are in micrograms per liter.

Rio Bravo site, we find that all of the concentrations are statistically equivalent. That is interesting because the two stations, respectively, receive the wastewater discharges from the town of Bernalillo and both discharges from Rio Rancho. Conversely, there is a major increase in arsenic concentrations that occurs between the Rio Bravo site and the I-25 site. That difference is significant at the 0.01 level statistically. What you are seeing there is the effect primarily of the Albuquerque wastewater treatment plant. I am going to ask you to look at those numbers closer. They will be important later on.

The maximum ambient concentration during this investigation was 4 ug/L. The mean below the plant is 3.1 ug/L. When you go below the I-25 station, located below the plant and immediately above the Pueblo, the next station is at the southern boundary of the Pueblo. The concentration at this station is statistically equal to that immediately north of the Pueblo. Let me emphasize a very important point. During this investigation, we had a safe drinking water maximum contaminant load (MCL) of 50 ug/L. The criterion has gone down to 10 ug/L now. The reason that is important is because it will come up when you consider the criteria that came out of that site-specific investigation.

As a direct result of this site specific investigation, the Pueblo in its next water quality review raised its criterion from 17.5 ng/L up over two orders of magnitude to a criterion of 4.2 ug/L. The maximum ambient concentration found below the wastewater treatment plant was 4.0 ug/L with an average of 3.1 ug/L. Simply stated the lawsuit lead to an investigation that provided data necessary to develop criteria that we could scientifically justify and was found to be protective of some level of fish consumption. Yet, in this case, the criterion have also been met by the discharge of the Albuquerque wastewater treatment plant with no additional treatment. It should also be emphasized that Albuquerque could have attained this criterion when they were not treating their drinking water to meet the new MCL. With such drinking water treatment coming online, it should be clear that arsenic is not one of the pollutants Albuquerque is likely to worry about at their wastewater treatment plant.

Let us jump to the NPDES permit issue now that I have, hopefully, set to rest some of the ongoing baseless claims. I am pleased that NMED's Marcy Leavitt went before me because she has already dealt with some of this. If you look at the Clean Water Act there are a couple of things that are really very simple. In general, if you do not have a permit, you cannot legally discharge pollutants (Section 303). Period. It is really that simple. Section 402 is the section in the Clean Water Act referring specifically to the NPDES discharge permits issued under the act. If you are a point source discharger, you better have an NPDES permit. To date in New Mexico, if you are going to get such a permit, the EPA must draft it. The state, however, has a crucial role in this. They have to review the draft, and they have to issue a certification (Section 401). They have the absolute authority to say yes, no, or maybe; that is, they can add conditions to the permit that must be included. One of the crucial points to the rest of my presentation is that when you are looking at the regulatory language dealing with that certification, a state cannot legally issue a certification of the permit if it is not adequate to fully protect its water quality standards. Section 303 deals with those standards, and it also deals with Marcy's favorite total maximum daily load (TMDL) stuff which also gets wrapped back into the permit. The more that you get involved in this the more convoluted it gets.

When we are talking about standards, the individual numeric criteria are the things that we use as a surrogate. By that I mean that Albuquerque has a discharge at a given point in the river. I am not going to go on out and test the blood of every muskrat below that discharge to see if it is healthy. I cannot do that and nobody else can either. We all work under an assumption that if a discharge results in treatment adequate to attain water quality standards, then the use, wildlife protection in this example, is going to be protected. This is the primary reason that those water quality standards are such an important issue for those of us that are out there trying to protect the designated and/or attainable and/or existing uses that are spoken of in the regulations.

As I now try to answer the question posed by the Pueblo's citizen, let's take a look at the existing permit. Remember the earlier one was supposed to expire in 1999 but was "administratively continued" until 2005. The new permit actually became effective May 1, 2005. There are a couple of real interesting things incorporated herein. What you are going to see is the fruitless end result of innumerable hours that the tribe spent trying to work with EPA on the permit specifically on their proposed effluent limits. On page 5 of part 1, if you actually look at the arsenic effluent limits that Albuquerque has to meet, and in this case this table refers directly to attainment of the tribal water quality standard, there is no numeric limit. EPA's permit only requires Albuquerque to monitor and report. That starts to look a little "interesting" when you compare that with limits on page 1 of that permit that are designed to protect the New Mexico water quality standard. In this case you have a numeric permit limit. You have both a thirty day limit and a seven day limit. The state standard is less restrictive than the tribe standard.

In either case, there is a major headache that EPA absolutely refuses to address. Earlier in this presentation I emphasized that during the 1994-1996 investigation, concentrations of 1.0 ug/L were repeatedly accepted under an EPA approved QA plan, as can be seen in this slide. EPA in its 2005 permit tells Albuquerque that if they have concentrations less than 10 ug/L, they can report 0 ug/L. The introduction of zero into averaging schemes where so few samples are collected comes close to "guaranteeing" attainment even when no such machinations are necessary to meet permit limits. Bluntly, from what we know about the treatment at the Albuquerque wastewater treatment plant, I am not particularly worried about their meeting the tribal standard. I am, however, appalled that EPA finalized a permit in which I cannot get the information to be able to make that determination, especially since ten years before this we were able to monitor concentrations an order of magnitude below that level!

Unlike the state of New Mexico where water quality standards are directly enforceable in and of themselves, the federal government seeks to regulate ambient water quality through permitting actions on effluent discharges.

Not only are your "typical" point-source discharges regulated under NPDES, but since those 1987 amendments we start to see a lot of things that are storm water derived that are now being regulated under NPDES. Apparently EPA believes that we must step into this slowly and gradually. The larger municipalities came on board first. Various industries and a number of other ground disturbing practices have also come online. Many of them are becoming a greater source of interest from a water quality standpoint.

Probably from the Pueblo of Isleta's standpoint, one of the most interesting storm water permits is the one that was issued to four different entities: the City of Albuquerque, the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), the New Mexico Highway and Transportation Department, and the University of New Mexico. Yet again, the same requirements are supposed to apply in storm water permits as for all other NPDES permits. If you look at the effluent limits written into the discharge permit, you'll see there are none. I am not beginning to imply that the City of Albuquerque or anybody else is doing anything wrong. As a matter of fact, I know that they have a very active storm water program. However, the entity who is supposed to be taking care of the permitting turns around and puts out a discharge limitation that says there are no regulatory limits. I have more than a little difficulty determining how I evaluate such language in terms that speak to the attainment of one of the tribe's water quality standards. This debacle also occurred after significant discussion with the EPA.

Let me see if I can summarize where I stand at the moment. Unlike the state of New Mexico where water quality standards are directly enforceable in and of themselves, the federal government seeks to regulate ambient water quality through permitting actions on effluent discharges. The Clean Water Act specifically requires that those permits be protective of the water quality standards that are themselves supposed to be protective of the individual water quality uses. I cannot begin to tell you what is going on at the NPDES section of the Water Management Division at EPA. What I can tell you is that after all the time that we have spent trying to get on top of these issues and trying to work with them is that, intentionally or otherwise, the water quality standards that the tribe adopted and the EPA had to fight to protect in the federal courts are simply not getting written into the permits. When effluent limits are written into the permits, we find that EPA falls back on language dealing with very archaic minimum quantification levels that basically wipe out the standards that have been adopted.

I have already said this, but I am going to say it again because it is important that this point get across. We are not accusing the City of Albuquerque, the City of Rio Rancho, or Bernalillo County or anyone else. It is just the opposite. The relationships that have developed over the course of the years have become very professional and much more beneficial than what we have seen in the past. Unfortunately, what I am saying as the representative of the Pueblo is that I cannot begin to figure out why anyone can possibly believe that those federal permits are supposed to be the end all and be all of water quality management. As they are written, I cannot tell you if they are working for us or not.

I have to go back to the person who requested this information and say that based on the best information I have, looking at the data that USGS and the NMED come up with, I do not believe that on a day to day basis that there is a problem. I cannot turn around and tell anybody with any certitude whether or not the permits EPA has put together are protective of the Pueblo's water quality.

I have covered an awful lot, and if anyone would like copies of my slides I would be happy to email them to you. I would be happy to try to answer any questions you may have.

Question: What is the current take on state NPDES primacy from the Pueblo of Isleta's perspective and from the perspective of other tribes and pueblos in the state?

Jim: I cannot speak for the Isleta Pueblo on that issue, because that decision has never been made by the governor or tribal council. I certainly cannot speak for any other tribe. Speaking only as an individual I think that the state is going to be called upon to protect the state's resources. I think EPA, even if it wanted to, has its hands tied with recent U.S. Supreme Court decisions. I think that the state is going to have to step forward and address these issues.

Question: Did Isleta do a 401 certification for those permits?

Jim: We do not have certification authority for it. The discharge is located approximately 5 miles north of the Pueblo.

Question: Did you approach the state and ask if they would deny state certification for those permits?

Jim: That is an interesting question. To be honest with you, I do not remember. EPA was pushing that language as they were trying to get it out the door. Remember it came out very late. In truth, I cannot completely respond to your question.

Marc Christensen *rejoined PNM in August 2005 as the Director of Corporate Communications after a brief "sabbatical" at a ranch in Texas and then returning to the workforce with New Mexico First in January 2005. Marc worked for the Public Service Company of New Mexico (PNM) for 13 years prior to his brief retirement and held a variety of assignments, including Senior Vice President. Marc has a long-standing interest in public policy issues. He has worked professionally in corporate communications, government relations, marketing, and customer service and has managed a variety of administrative functions. He was the executive sponsor of both PNM's Women's Professional Organization and the Forerunners, PNM's retiree organization. Marc was born and raised in San Diego County, California and is a graduate of the University of California at Davis and the Stanford Executive Program.*

INDUSTRY AND WATER QUALITY: ELECTRIC POWER

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Good afternoon. It looks like you have had a busy day, and we are the last panel. We will try to make this as interesting as we can for you.

I always like to start when we are talking about water with a reminder of what a valuable commodity it is for the state of New Mexico. The quote that I particularly like from former state engineer Tom Turney that I think puts into perspective just how little water we actually have in New Mexico is "More water flows along the Columbia River in Washington in 15 minutes than flows in all of New Mexico in a year."

Likewise, I stole Figure 1 from the state engineer's website. I have always found this chart to be particularly interesting. This is a 2000 year analysis of rainfall in New Mexico from tree rings. If you'll notice there on the left the arrow says average rainfall in New Mexico. Over toward the right side you will see a yellow dot. That is the alleged drought of the 1950s. You will notice that the drought is equal to the average rainfall in New Mexico over 2,000 years of our history. You'll notice that on the very right hand side up until 2000 was the precipitation curve that we were in, much higher than average rainfall. I think the point is that we need to continue to focus on water. The governor has declared 2007 as the Year of Water. We need to focus on how valuable this is and that our state's economic growth is entirely dependent in my view on the availability of water and, of course, using the water.

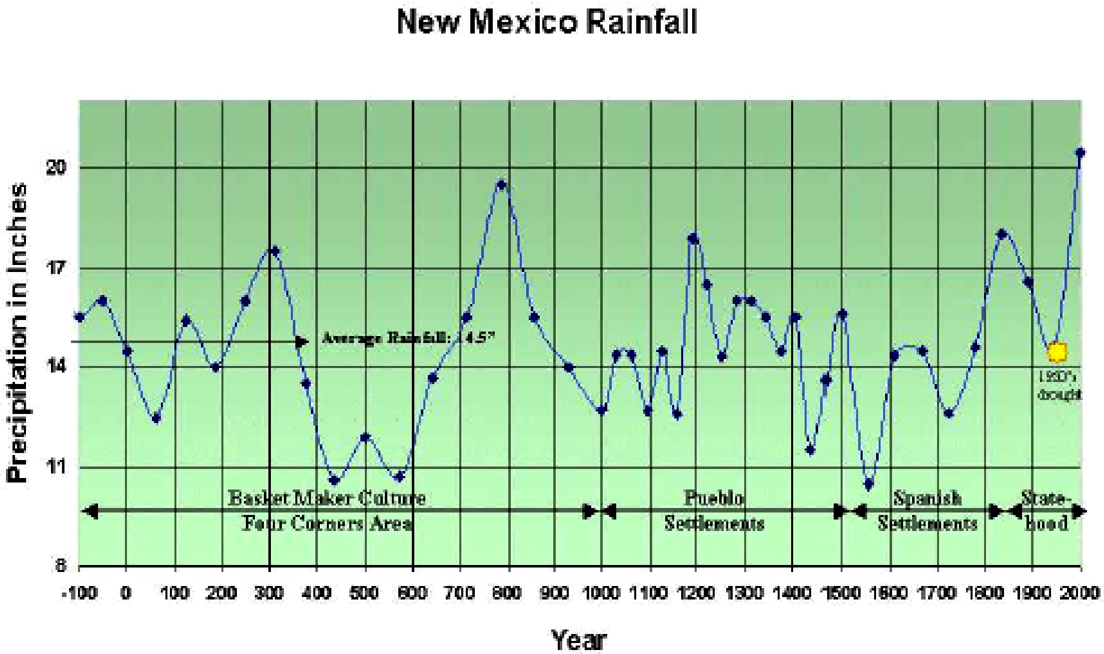


Figure 1. New Mexico rainfall over 2,000 years

Figure 2 is a picture of how water gets used in New Mexico. You'll notice that little white slice that says 2 percent is used for power production. The other 0.8 percent represents all other commercial and industrial use. In fact not a lot of water is used for industrial purposes in New Mexico right now, but it clearly is very key to supporting our industrial processes. I want to talk with you briefly about electric power generation specifically.

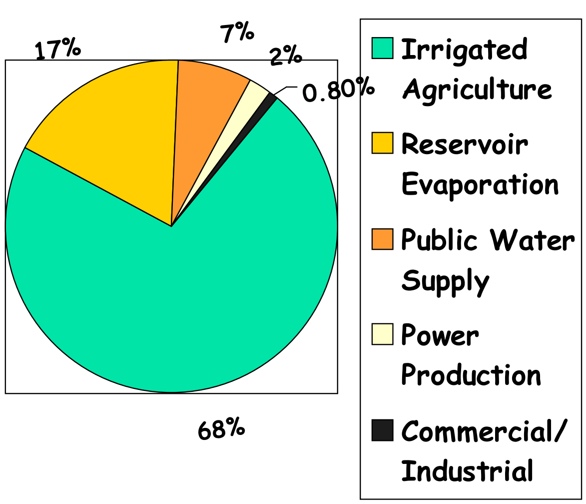


Figure 2. New Mexico's water use

Figure 3 is simply intended to show you the amount of water that is consumed at various power plants in which PPM has a stake. We do not own 100 percent of all of those. This is just our share of the water. What I want to call your attention to is the very right hand column, which is gallons divided by kilowatt hours produced. You'll notice that some of the older plants along the top, like the San Juan Generating Station up in the Four Corners area, a coal-fire plant, produces about 0.6 gallons per kilowatt hour. Afton, which is the fourth one down, is one of the new gas-fired power plants. It is much less consumptive of water. If you drop further down to the wind energy center, you see zero water consumption, which is one of the values of renewable energy.

How do we use water in a power plant? Some people say they never really knew that water use was necessary for a power plant. Without going into all the engineering details about what happens, in a steam electric plant, which includes our coal-fired plants, our nuclear plants, and some of the older natural gas-fired plants, we boil water in a boiler. You might think of it as a tea kettle. We take the steam off of the tea kettle, run it through a tube, spinning a pinwheel—we call it a turbine. That turbine in turn drives a generator, which is just a magnet that spins inside a coil of wire and that makes electricity, somehow, which we have never really been able to understand, but it works. We actually

	2005	**2005**	**2005**
	Year-To-Date	**Year-To-Date**	**Year-To-Date**
06-Mar-06		**PNM Share**	
JLR	**PNM Share Net**	**Fresh Water**	
Plant	**kWhr Generation**	**Consumed - gallons**	**Gals/kwh**
San Juan	5,727,707,300	3,423,181,630	0.598
Reeves	100,992,200	82,979,504	0.822
Las Vegas	0	0	-
Afton	53,203,000	1,803,300	0.034
Lordsburg	83,141,000	11,444,070	0.138
Four Corners	1,437,792,000	**14,672,300**	0.010
Four Corners	1,437,792,000	**695,366,952**	0.484
Four Corners	1,437,792,000	710,039,252	0.494
Palo Verde	2,634,429,000	74,544,416	0.028
Wind Farm	513,179,690	0	-
Delta Person	10,272,393	427,400	0.042
	10,560,716,583	4,304,419,572	
	2005 Gals/kwh	**0.408**	

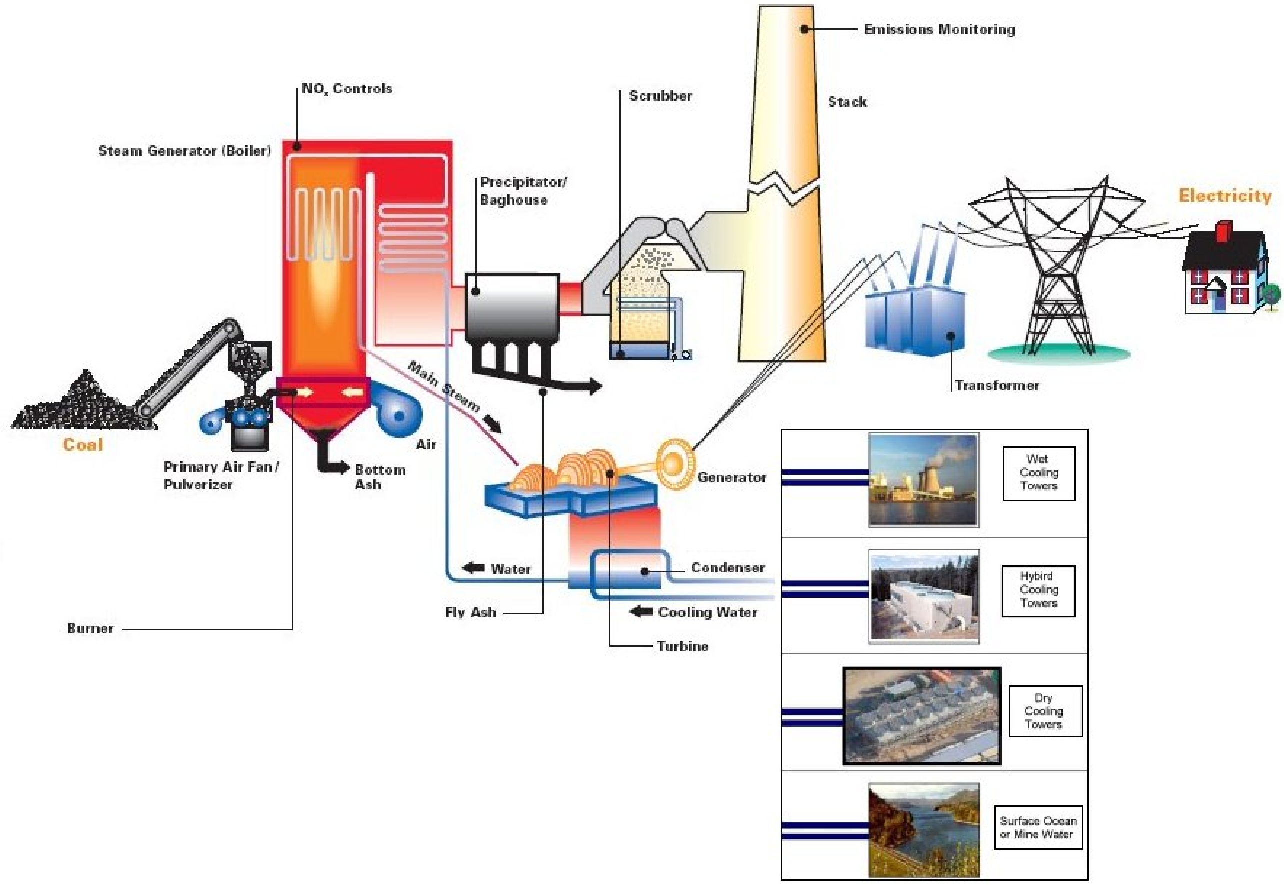
Figure 3. Water consumption - PNM NM power plants

need to use a lot of water for one particular purpose, not so much in making the steam, but in recovering that steam and cooling it down so that we can reuse that water in the boilers. This steam is super heated. You cannot put it directly back into the boiler without blowing up the boiler, which is a really unfortunate incident that we do not want to see happen. We have to take this hot steam once it has passed through the turbine out somewhere and cool it off.

Figure 4 is kind of a tough diagram to look at, but basically it depicts the different ways that you can cool that steam. In some places in the United States, if you are on the Great Lakes or on the oceans, you can simply take sea water in and run it over the coils that the steam is coming from right back out to the ocean, lake, or presumably a large river. Having neither large rivers, oceans, or lakes of any size here, we have to construct a cooling tower. At the San Juan Generating Station, for example, we draw water from the San Juan River and bring it in to a large pond or a small lake that we have constructed. We let it settle, and we then pump it into the cooling towers. The water, like in a swamp cooler, drips down from the top of the cooling towers, about a 200- or 300-feet fall, in which are the coils that contain the steam. It cools the steam. When you put cold water on those hot pipes, you evaporate a lot of water. That is how we consume most of the water, and it is just in cooling the steam coming out of the power plants. In the case of the San Juan Generating Station, in total that adds up to about 22,000 acre-feet of water per year.

Again, using San Juan as an example, we do have a water conservation plan that is in effect. Only six percent of the total water that we consume is actually discharged on site. We are a zero discharge facility, so it goes into holding ponds. The rest of it of course is reused or evaporates. We reuse it up to ten times before it ultimately evaporates. We do a lot of chemical treatment to prevent scaling.

We are looking at different alternatives to the use of water, one of which is dry cooling. Dry cooling is more akin to the radiator in your car rather than a swamp cooler, where the water is in a contained loop. When you drive down the highway and run the fan, it



Adapted from http://www.eei.org/industry_issues/environment/air/New_Source_Review/coal1.pdf

Figure 4. Water at power plants

cools off the water that goes back through your engine. Dry cooling is the same or similar in a power plant. We put the tubes that have the steam in them out in a big radiator, and we run huge fans, and blow air across those structures so that we cool the water before it goes back to the boiler. The problem is that you consume a heck of a lot of electricity running these huge fans. In the hottest times of the year, these do not cool the water very well.

The second thing that we have looked at is degraded water in various shapes and forms. Mr. Yates as I understand it is going to talk about the potential use of produced water, so I am not going to go into that in any detail. We have looked at that. The problem is the price of recovering and treating it.

I guess that it is a key message that I want to leave with you. In terms of water quality, how important is the quality in terms of the electric power industry? In a sense, it is not important. We can take very degraded water. We can treat it, clean it up, and use it in cooling towers, and we can even use it for the boilers if it is cleaned up sufficiently. The problem is cost. Those costs right now are pretty significant. If we incur those costs, it ultimately shows up in your electric rates, and that is the trade off.

Renewable energy sources of course are another really good source. We are focused significantly on the use of wind energy. The New Mexico wind energy farm, for us, is a large amount of power. It is about 200 megawatts. Our peak load is something just shy of 2,000 megawatts a year. It is something close to or a little bit over ten percent of our energy supply. That is the highest amount of wind energy that any utility in the United States has as a percentage of the power that it supplies to its customers. There are no emissions and no use of water. The problem of course is that the wind does not always blow. You have to have something to back up wind energy, and that is where we use our coal-fired and natural gas-fired plants.

We have recently announced that we will be purchasing power from the biomass power plant that is going to be constructed in the Estancia Valley. It does not have the virtue of using no water as wind energy does. It uses about the same amount of water as does any other fossil fuel power plant. However, what it does do is make use of the waste coming off of the rangelands and the forests that are going to help restore the water tables in those areas. It will improve the yield of water and groundwater recharge. In some sense, it is a benefit to water that we are using that plant. Also, from a greenhouse gas emissions point of view, it is considered to be carbon neutral, because you are releasing the carbon and the trees capture it. It is a net zero.

In conclusion, I would like to reiterate that I think that for the growth of New Mexico's economy, there could be nothing more important than water. We do need to pay top attention to it. I hope in this next legislative session that there is a lot of emphasis put on degraded water of all sorts that could be used in the state. There is a lot of that, and we are going to have to figure out eventually how we are going to use it and treat it economically in order to support the industrial needs of the state. I appreciate your time and attention, and I look forward to any questions you may have when the panel has concluded. Thank you.

Frank W. Yates Jr. *graduated from Artesia High School and received a B.S. degree in mechanical engineering from New Mexico State University in 1979. Following graduation, he worked for Lowry, Sorensen, Willcoxson Engineers, Inc. in Phoenix, AZ. He is a Registered Professional Engineer in Arizona and New Mexico. Frank returned to Artesia in 1984 to work for the Yates companies and is currently President of MYCO Industries and Executive Vice President of Yates Petroleum Corporation. He is past Director of the First National Bank of Artesia and is a board member of the Independent Petroleum Association of New Mexico, a member of the Independent Petroleum Association of America, Southeast New Mexico Playa Lake Committee, New Mexico Oil and Gas Association, People for the West and the Aircraft Owners and Pilots Association. Frank currently serves on the Board of Directors for Mountain States Legal Foundation and is a member of the First United Methodist Church in Artesia. In his spare time, Frank enjoys flying, snow skiing, water skiing, bicycling, hiking, camping, golfing, and bowling. Frank is married to Mary and has three children, Tyson, Tao, and Tevis.*

INDUSTRY AND WATER: OIL AND NATURAL GAS INDUSTRY

TURNING LEMONS INTO LEMON DROPS

Produced water treatment for the onshore oil and gas industry

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Yates Petroleum Corporation (YPC) has been looking for treatment alternatives for several years in an effort to find economically competitive alternatives to down-hole disposal. Several factors must be taken into account in order to effectively pursue these potential options. Economics, available technologies, new technologies, legal, regulatory and environmental concerns, and internal company and industry politics have had an influence on progress made in this arena.

Economics

Down-hole disposal has been the longtime acceptable method of dealing with wastewater associated with oil and natural gas production. Reinjection of produced water is expensive and can represent 50 percent of the direct operating costs of many oil and gas wells. In order to do comparative economics between down-hole disposal and treatment, we must first get our arms around what our down-hole disposal costs are. This may prove more difficult than one might think because of how the various costs of disposal are accounted for by different companies.

There are three components to reinjection costs that must be quantified: capital expenditures, direct operating costs, and gathering costs.

Initial capital expenditures are associated with drilling a disposal well, or more commonly, converting an existing dry hole to a disposal well that can be considerably less expensive. Costs vary considerably across the country. In Southeast New Mexico, a 7,000 ft Delaware dry hole can be converted to a disposal well for about $600,000. It may be capable to inject as much as 6,000 bbls/day into a well like this. This scenario calculates to $100/bbl/day of capacity, a ratio used for comparative economics. Another example in Southeast New Mexico is a Devonian disposal well in the Dagger Draw field. A typical dry hole is deepened from about 8,300 ft to about 11,000 ft and prepped for injection for about $1.4M. These wells can typically accommodate injection rates of 25,000 bbls/day initially. This equates to only $56/bbl/day of capacity.

There are three components to reinjection costs that must be quantified: capital expenditures, direct operating costs, and gathering costs.

Conversely, in Wyoming, the subsurface strata available for injection are very low in porosity and permeability. It can cost $4M to drill a disposal well that will only take 4,000 bbls/day. Now you're up to $1,000/bbl/day of capacity.

Direct operating costs for a disposal well include costs for electricity for pump operations, filters, and chemical treatments for well bore protection. These costs can add up to between $.03 and $.07/bbl for some areas, more in others.

The third component of cost is gathering or getting the produced water from the production facility to the disposal facility. This is accomplished by either pipeline gathering or trucking depending on the daily volumes of water to be transported. These costs can range from a few cents per barrel to move larger volumes through pipelines to several dollars per barrel to truck smaller volumes of water not considered to be economical to lay gathering lines to.

All of these components of costs need to be considered when doing a cost analysis of a company's produced water disposal costs. Once capital costs are amortized and gathering considered, total disposal costs can vary widely from about $.12/bbl in Souteast New Mexico to over $5.00/bbl in the Green River or Wind River Basins in Wyoming. Disposal in other parts of the country could cost even more.

Water volumes can vary widely from region to region and can have a huge impact on economics of disposal options. The New Mexico Oil Conservation Division (OCD) reports that produced water was estimated to be 653 million barrels in 2005. This includes water from East Indian basin where one well can produce 3,000 bbls/day of water, but only costs about $.17/bbl for disposal. This low disposal cost is a result of the tremendous investment in disposal infrastructure made by operators to accommodate the larger volumes of water produced per well in this region. Operators in this area are fortunate to have a highly porous and permeable Devonian formation to dispose into at approximately 11,000 ft depth level.

MYCO Industries Inc. operates five wells east of Carlsbad that only produce a total of about 120 bbl/day of water. With no disposal gathering infrastructure available, disposal costs for these wells are $2.70/bbl. This price is a combination of hourly trucking rates to haul produced water to a commercial site and a disposal fee of $0.50/barrel. Also, keep in mind that the costs for converting a dry hole are not going to change just because there is less water available for disposal. Using the $600,000 example above to dispose of only 120 bbl of water/day drives your capital expenditures up to $5,000/bbl/day of capacity.

Technical and Logistical Hurdles

Wyoming and New Mexico produce similar quantities of water, but volumes vary widely from region to region. For example, produced water volume from coal bed methane (CBM) production in the Powder River Basin (PRB) is about 1.5 million barrels per day from about 15,000 wells, or an average of 100 bbls/day/well. The gas production from the area is about 900 mmcfd. This means that for each mcf of gas produced, there is also 1 2/3 bbl of water produced. Conversely, in the Green River Basin (GRB) in Southwest Wyoming there is only an average of about 1/10th of a bbl of water produced per mcf of gas. The fact that there is 16+ times as much water produced in the PRB as in the GRB has been the source of a great deal of controversy with respect to producing gas from the PRB.

Produced water quality will present technological hurdles. Produced water qualities vary as widely as quantity from area to area and have a tremendous impact on treatment options that may be available. The following Table is a brief summary of typical produced waters encountered in the oilfield demonstrating these various challenges.

hydrocarbons and heavy metals, but does almost nothing to reduce suspended solids. New technologies such as hydrocarbon resistant micro- or ultra-filtration membranes, operating at low pressures, may offer cost effective solutions to pretreatment for R/O.

Ion exchange treatment techniques have become the application of choice in the Powder River Basin where water qualities are fairly good with the exception of elevated sodium levels.

All units Mg/l	Pecos River	Disposal well	Well 1	Well 2	Well 3	Well4	Well 5
State	NM	NM	NM	WY	WY	NM	NM
Bicarbonates	127	705	488	3,318	1,680	39	464
Hardness (CaCO3)	n/a	n/a	11,000	n/a	n/a	88,000	15,000
Arsenic	.082	.078	n/a	n/a	.036	n/a	n/a
Calcium	620	582	3,600	404	70	30,000	5,200
Chlorides	2,020	3,100	48,000	n/a	9,360	182,000	80,000
Sodium	1,064	2,010	27,261	444	6,250	78,398	45,591
Sulfates	2,040	1,160	1,800	212	4	600	400
TDS	6,350	8,070	81,629	5,977	15,700	294,167	132,135

Table 1. Variation of water quality from produced water

Treatment Technologies

Five years ago, YPC knew zero, zip, nada about water treatment technologies. After considerable time and money, we've come up that learning curve. There is still a lot to learn and a ways to go before we are treating meaningful volumes of water, but we believe that we are at the forefront of New Mexico producers who see the value to the state, our industry, and our company in pursuing produced water treatment options.

Four different types of technical solutions have evolved in the oil and gas "produced water" treatment arena: membranes, evaporative technologies, ion exchange, and thermal compression.

Thermal compression requires expensive pressure vessels, and the operator must still dispose of a concentrate stream. It does not appear to be as economic as other technologies.

It appears the key to any membrane technology will be pretreatment. Conventional R/O membranes are easily fouled by bacteria, hydrocarbons, heavy metals, and other suspended solids such as calcium sulfates. Ozone pretreatment, for example, can be effective against bacteria, marginally effective against

Evaporative technologies have evolved from simple misters dependent on ambient conditions to more sophisticated systems that recover much of the latent heat of vaporization. Altela Inc., an Albuquerque based company, is developing such a product. Their treatment tower promises to be effective at economically treating water up to 100,000 TDS. There are no metal parts so corrosion problems are practically eliminated. If waste heat is available from flash gas or a compressor, then direct operating costs go to nearly zero. An operator can produce as much as four pounds of water from 1,000 btus of heat input, or four times as much as simple boiling.

We're currently working with three proprietary variations of these technologies that appear to have promise for specific applications. We have plans to apply a membrane technology and an ion exchange technology. We currently have an operating pilot using Altela's technology to treat a few barrels per day of about 40,000 TDS produced water. There are a host of treatment companies in the marketplace experimenting with and building pilots that incorporate variations of these technologies. The key will be the economics.

Regulatory and Legal Considerations

The question has been raised several times. Who owns treated produced water? Who has jurisdiction over treated produced water?

In January of 2004, an engineering, legal, and logistical study was prepared for the Lea and Carlsbad Soil and Water Conservation Districts in New Mexico. The study's purpose was to evaluate the feasibility of treating and using produced water in that region. Luebben Johnson & Young LLP in Albuquerque did the legal research. They observed that "wastewater from oil and gas production is generally treated as part of the real property's mineral estate, which is originally owned by the landowner, conveyed to the producer in the oil and gas lease, and transferable by the producer as personal property." While there are no specific laws in NM or other states directly dealing with the "appropriation" of wastewater found in conjunction with oil and natural gas (with the exception of shallow coal bed methane water), there are indications in statutory, administrative, and appellate law that produced water is not publicly owned water, but part of the privately owned mineral estate conveyed to the oil and gas operator.

The economic treatment of produced water is right around the corner from being widely utilized throughout the oilfield.

New Mexico law is quite clear with regard to the Oil Conservation Division's jurisdiction over produced water. They have the responsibility to hold producers accountable for the proper disposition of their wastes, which include produced water. In addition, the New Mexico legislature also recognized the operator's ownership when it passed a tax credit bill of $1,000 per acre foot to operators who could deliver clean produced water to the Interstate Stream Commission at the Pecos River in Southeast New Mexico.

Conclusion

The economic treatment of produced water is right around the corner from being widely utilized throughout the oilfield. It will be a win-win situation for the oil and natural gas industry and the environment in the arid west especially. In order for this to happen, companies must overcome the current paradigm. The single-minded thinking that any time we have produced water, we have to have a disposal well, needs to be thrown out the door. Companies must also do a better job of quantifying their disposal costs. The cost of owning and operating a disposal well is not zero just because the company has sunk capital into a well. The companies that overcome these hurdles will be the companies that will develop new oil and natural gas reserves in areas formally uneconomic because the wells made too much water. This is actually a triple win scenario because it allows our country to produce more of our own domestic hydrocarbon resources.

Question: What does it cost you today to pump the produced water down in the ground to get rid of it?

Frank: That cost can vary quite considerably depending on your location. For example, in New Mexico, producer- or operator-owned produced wells in some areas down around Artesia inject into highly permeable porous zones and ammonium formations around 11,000 feet. Some of those wells can take 25 to 30 thousand barrels of water a day. Our costs, direct operating costs plus the cost of amortizing the capital cost of the well, can be as low as 15 to 17 cents a barrel. Conversely, we operate a lot of wells in Wyoming where there is not a highly porous and permeable subsurface strata that makes for good injection zones. It can cost as much as four and five dollars a barrel to get rid of produced water in those areas. It ranges everywhere in between depending on where you are, where you are putting the water. There are a lot of areas where we operate wells where we have to go to third parties to pick our water up by truck and then truck it to a disposal well. At that point, the trucking costs become the predominant cost of getting rid of that produced water. Those costs can be anywhere and as high as two to four dollars a barrel just to truck the water to an OCD approved disposal facility.

Question: Why does the oil and gas industry deserve special exemptions from the Clean Water Act that so many soil and water conservation districts have testified result in water quality impacts to surface water that interfere with and negatively impact other water interests, such as agriculture?

Frank: First of all, I would have to ask you what special privileges you are referring to.

Response: It is the exemption from storm water permits—the new exemption the current administration has added to the Clean Water Act, to put in exemptions for oil and gas.

Frank: To be perfectly honest with you, I am not that familiar with that particular EPA rule-making. I can say that typically produced oil and natural gas have an oil conservation division like the state of New Mexico and Wyoming. Wyoming has an oil and gas commission. They've developed their own very complex guidelines to regulate the oil and gas industry in those particular states. They have worked closely through the years for that exemption so that there is not overlapping jurisdiction for the regulation of oil and gas wastes. I do not know whether the storm water exemption would fall under that criteria, because I am just not that familiar with that particular rule.

Question: The oil and gas industry association has been involved with the efforts to tie the hands of the state of New Mexico and interfere with their ability to protect water quality. This topic has come up a number of times today with the definition of the waters of the state. I am wondering how local and state communities would benefit from these efforts to tie the hands of the state to protect water quality. Mr. Yates, you mentioned that you are working to benefit state and local communities. I fail to see the way that this particular effort on your behalf is benefiting them.

Frank: Again, I would have to ask you the specifics of how we are trying to tie the hands of the state government for protecting water. That sounds absolutely ridiculous to me. I am not sure where that is coming from. Certainly we are not trying to do that at all. Generally we work pretty closely with the Oil Conservation Division to improve the rules and the regulations. Certainly there are a lot of misconceptions out there with respect to things like how we address our reclamation processes and that sort of thing that might be unfortunately misconstrued by some in the public as efforts to tie the hands of the people that are trying to protect groundwater. There are a lot of situations where it is pretty apparent to us that we are focusing a lot of resources to achieve the unachievable, which is zero risk, in situations where we could potentially be putting other resources at greater risk, because of the fact that we are so obsessed with trying to maybe in one particular instance protect groundwater that is maybe one hundred or two hundred feet below the surface and there is no chance of contamination. Yet we might be required to haul drill cuttings that are benign to the environment, and we are putting people at risk on the highways because of the additional seven-tenths of the deaths per truck mile driven. We are tearing up more highways to haul all of that. We are concentrating wastes in other areas. So from an environmental perspective, it seems almost ridiculous to me in some cases that we jump on the bandwagon, because someone said we are trying to tie the hands of the state because of this new initiative to protect groundwater, when the fact is that we will work with the OCD to come up with reasonable rules that make sense from a scientific perspective.

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INDUSTRY AND WATER QUALITY: THE MINING INDUSTRY

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Good afternoon. I have a few minutes here to introduce you to the copper mining industry and talk about some of the water quality issues that we work with in our business. Today's topics include:

1. Large Scale Open Pit Mining and Water Quality
2. Where Water Quality Standards Reasonably Apply
3. Reclamation and Long-term Water Treatment

The two operating copper mines that Phelps Dodge has in New Mexico are located near Silver City in the southwest corner of the state: the Chino Mine, established in 1909 and the Tyrone Mine, established in 1967.

Figure 1 gives you a sense of the scale of these mining projects. This is an aerial view of the Tyrone mine. The mining disturbance covers about 7,400 acres. The Chino mine that is about 15 miles away covers 9,000 acres of mining disturbance. You can see that these open pit copper mines have a large impact on the landscape and on the watersheds where the mines are located.

These mines have been around for a long time. Figure 2 is an early photo of the Chino Mine when the open pit mining process was started (1910). The mining activities in this area, both open pit and underground, predate the State and certainly the development of water quality regulations.

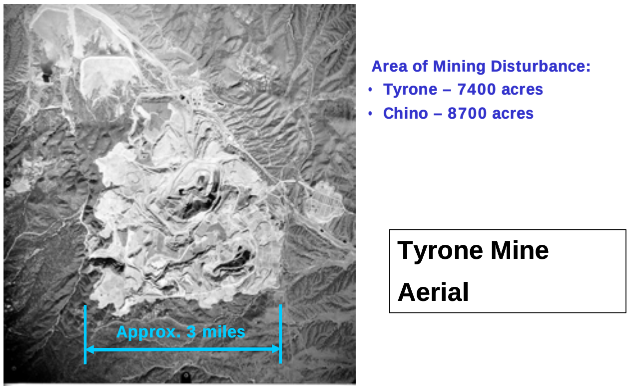

Figure 1. Large-scale hard rock mining

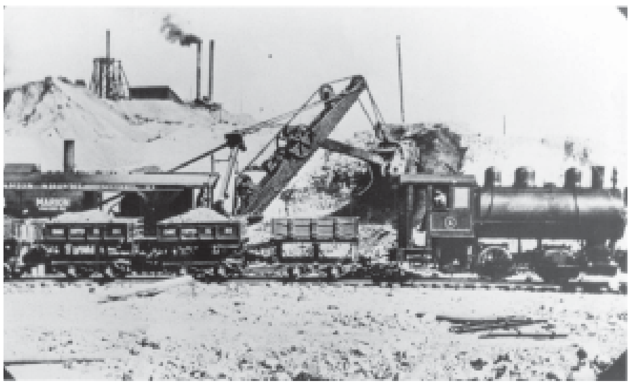

Figure 2. Early operations at Chino Mine (1910)

Figure 3. Open pit mining operations

Figure 3 shows the modern open pit mining facility at the Chino Mine, the Santa Rita open pit. To give you an idea of the scale of this operation, this open pit is about 1,600 ft. deep and about a mile and a half across rim to rim. At the Tyrone and Chino mines we are moving about 100,000 to about 400,000 tons of rock everyday. This rock that you see being loaded into this haul truck presents an environmental challenge in and of itself because the majority of the rock that we mine at these sites contains sulfide minerals. This means when it is exposed to the atmosphere and a drop of rain water hits that rock it almost immediately becomes acidic, generating sulfuric acid which will then dissolve metals. The acidity and metals will generally go wherever that drop of water goes.

Figure 4 is a schematic that describes some of the water quality issues that we face in our industry. First, this is a little cartoon model of an open pit mine. These are benches that are mined sequentially downward. At some point, both at Chino and Tyrone many years ago, we intersected the water table. You begin to dewater the open pits so that you can continue to mine. As you proceed, this acts like a large well, drawing water in from all directions. It creates a zone of influence, drawing water in from all directions. You can think of these two mines as the largest wells in New Mexico. They are not the deepest, but they are probably the largest. The material that is mined from this open pit is placed around the perimeter rim of the open pit generally. Some of it is classified as waste material, but it can still be acid generating material. Some of it is placed into heap leach stockpiles, where acidic solutions are placed on the top to extract copper from the rock. Either of these scenarios can generate seepage that then can migrate down to the water table and cause an exceedance of New Mexico's water quality standards. The open pit hydraulic sink draws all of that water in. We utilize all of this water that is collected here during mining operations. This becomes an important control feature for water quality and control of the contamination. All of this water is utilized in our mining processes. If seepage occurs outside of that zone of influence, then some other types of control technologies are needed to capture that water, like interceptor well systems (Fig. 4).

Let me describe some of the dilemmas and issues that we face as far as an industry in New Mexico. Earlier you heard from the presentations today that it is considered, by the Water Quality Control Commission and the Environment Department, that all

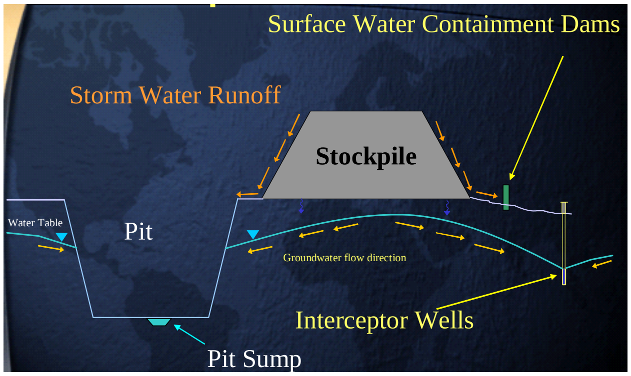

Figure 4. Water containment and point of compliance

of this water is protected under the regulation. That presents a dilemma for our business. Looking at Figure 4 again, if you want to do an open pit mine in New Mexico and you have acid generating minerals, then any water that falls on these benches will become acidic and percolate down to the water table. You would be in violation of the standards. That is a dilemma to deal with. As an industry, we do not believe it is practical or reasonable to apply groundwater standards in areas of our operations, specifically for example in the groundwater right around the vicinity of the open pit or under a stockpile. We do believe it is appropriate and reasonable to apply and enforce groundwater standards around the perimeter where we can reasonably apply control technologies. This has been a big point of discussion and debate in order to do our business, both for our operations and in reclamation.

I will move on to reclamation (Fig. 5). We have a lot of concurrent reclamation going on at these operating mines right now. These are the tailing facilities around the Tyrone mine. There are about 2,400 acres of tailing. To date since 2004, we have reclaimed about 1,000 acres. We will completely reclaim all 2,400 acres by the end of 2008. All of that equipment will then move over to the Chino mine to reclaim tailing impoundments there. At Tyrone, we are also reclaiming stock piles around the perimeter of the mine. The techniques we are using to reclaim these 7,400 acres include the following.

Earthwork

- Stockpiles - 3:1 slopes, 3 feet cover material, revegetated
- Tailing - 3:1 slopes, 2 feet cover material, revegetated
- Test plot confirmation

Water Management and Treatment

- Manage containment/pit hydraulic depression and groundwater remedial pumping
- Treat impacted water in perpetuity
- Tyrone - nanofiltration system

Figure 5. Tyrone reclamation

I want to focus on an interesting issue that is part of our overall closure plan for the mines, and that is water management and treatment. This is an area that I see as a big opportunity for innovation and optimization going forward. Certainly the maintenance of a pit capture zone that I showed you earlier is important. That is part of the closure plan. We must maintain this hydraulic depression and collect that water. It is a good control measure. Of course, we never foresee that that water will meet state water quality standards. It is going to need to be collected and treated in perpetuity.

Right now, Tyrone's financial assurance includes nanofiltration technology for water treatment. We had a WRRI conference on that about two or three years ago, which was very interesting. There is a lot of opportunity in our area for this. We are treating water that ranges from several thousand TDS to several hundred thousand TDS. We anticipate developing a better treatment methodology, so that we can do this economically and recover metals as we go as well. There is a lot of opportunity to optimize our closure plans and our operating plans now for how we manage water, so that we minimize the inventory of water that will need to be treated in the future. These are interesting projects to work on. There are lots of good problems to solve. It is an exciting time to be involved in this process.

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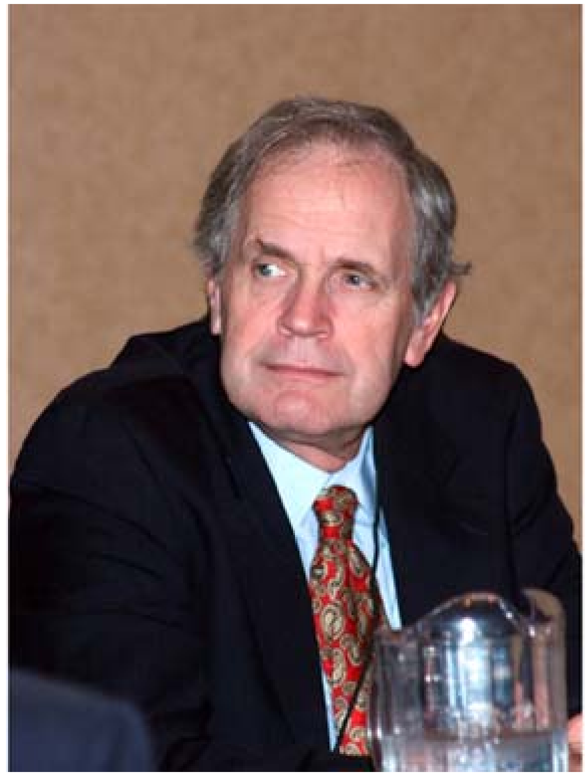

INDUSTRY AND WATER QUALITY: PRODUCED WATER

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As a representative of the New Mexico Energy, Minerals and Natural Resources Department, when I have Tom Shelley from Phelps Dodge and Frank Yates from Yates Petroleum on each side, I am in trouble. I also have only 12 minutes to speak, and that reminds me somewhat of a situation when I used to be a state district judge and I had to run for reelection. That was in Texas where the judges are publicly elected, and I went to all of these public meetings for voters. I had two minutes to explain why I should be reelected as a judge. It is about the same situation having 12 minutes to speak about the use of produced water. In those public meetings, they always put me right behind someone who was running for the school board and who got all kinds of questions. I had about the same feeling at the last water conference at which I spoke. The speaker immediately before me was a person from the Environment Department speaking on septic systems. There were a lot of questions for that speaker and not a lot for my presentation on salt water disposal wells. I would not, however, suggest that septic systems and school boards have anything in common.

I have been helped with my 12 minutes, because Frank Yates covered a lot of material I had in mind to talk about. I appreciate that. Produced water, of course, is water that is produced with oil and gas. There is a lot of it. Frank gave you the numbers, about 80,000 acre-feet per year. That seems very large because it is a whole lot more than the amount of oil produced. It is about ten times the volume of oil that is produced. It is not a huge amount of water. Most of you are accustomed to thinking in acre-feet, so I do not have to give an illustration, but I'll give it anyway, because I have often addressed produced water in venues where people were not experts on water. This is about eight times the amount of water that is used annually in the city of Santa Fe. It is a pretty large amount of water, but of course in the overall context of New Mexico, it is not a huge amount of water.

Produced water is defined by a statute. I am going to be talking a little bit about legal theory. Most of your speakers have talked about facts. Lawyers do not talk much about facts, and we do not know any facts. If we want to know what facts are, we bring in 12 people who do not know anything about the subject and let them go into a back room and talk and then tell us what the facts are. Produced water means water that is an incidental byproduct from the drilling for or production of oil and gas. That was a negotiated definition. What the Office of the State Engineer, who negotiated that with us, was most concerned with was making sure that people did not go in and drill wells where there was no real opportunity to get oil and gas just so that they could get the water without having to get a permit from the state engineer. That is where we got that definition, but it is an accurate definition. It represents what we mean by produced water.

Lawyers do not talk much about facts, and we do not know any facts. If we want to know what facts are, we bring in 12 people who do not know anything about the subject and let them go into a back room and talk and then tell us what the facts are.

How much of it is there? We have already talked about that. What is it good for? Well, it is not good for very much. It has got a lot of salt in it, and it has got a lot of hydrocarbon in it. You probably could not drink it with impunity in most cases. There are some exceptions to that. Up in the northwest in the Raton Basin for instance, we have got a fairly large amount of water that is around 3,500 TDS. That is pretty good water. It would not be very tasty to drink, but you could probably survive. Livestock are a lot less choosy than people. There is some possibility of usage for that and other water in agriculture. That is a very small amount of the total produced water.

Regionally, we have big differences. Up in the northwest, the water is from 8,000 up to about 20,000 TDS. It comes from the coal bed methane wells. Down in the southeast where Mr. Yates' company is most active, you have a lot of highly saline waters. He was talking about those very highly saline waters. As of now, there is no economic means of treating produced water. I have this information from New Mexico Tech, even though I said lawyers don't know facts. Technically, it is possible. You can extract distilled water from it if you have enough time and money, but the cost for produced water is a lot higher than water from other sources. There is a lot of research going on in this area. Apparently what is considered to be the most promising technology for treatment is reverse osmosis. Don't ask me what that means, but the problem they've encountered is that the hydrocarbon in the water tends to foul the filters that they use. They are experimenting with new kinds of filters.

Among the materials I have heard presented was a paper by my boss Mark Fesmire, the director of the Oil Conservation Division (OCD), at a water law conference. He makes the somewhat optimistic statement that by the time you read this there may be an economic means to treat produced water. It has not happened so far, and I would doubt that it is months away. It is probably years away, but probably not too many years.

I now come to my subject matter, which is the legal issues involved with produced water that might be a problem in trying to bring it to effective use. There are at least three different ways to look at who has the right to whatever economic benefit there is to produced water. Up to now, there has been no economic benefit. Someone has to drill an injection well, a deep well that is not good for any other purpose so that they can pump the water down. That costs a lot of money. Nobody is arguing at present with the oil and gas industry that is their water, because nobody else wants to have to dispose of it. There is a court decision that says about sewage that sewage is something that municipalities have on their hands. That is a graphic way of expressing it, but the same thing exists in the oil business with regard to produced water.

If produced water were to become a desirable thing, then you might have a lot of argument about it. On the one hand, one theory is that it is public water that belongs to the state, and it is subject to the right of appropriation, just as freshwater is. That is backed up by the New Mexico state constitution and by the 1907 Water Code that declares all water to be public. Of course in 1907 when they wrote the Water Code and in 1912 when the constitution was adopted, they were not thinking about water that was produced with oil and gas. Another theory is that the water down under the surface belongs to the mineral owners. There is one court decision that says something about oil and gas operators have a right to use and dispose of water incident to oil and gas operations. I do not regard that as being a conclusion that they own the water, although Mr. Fesmire thinks that maybe it is. So I may be wrong.

The legislature has taken a crack at this issue in several instances. One that I should mention is that there was a tax credit adopted for contributing produced water to our obligation under the compacts to deliver water to Texas in the Pecos valley. Of course, there are some people who think delivering dirty water to Texas is a pretty good idea. Be that as it may, whatever the reasons, whether it had to do with necessary treatment or transport—and there were problems with both—no one took advantage of that statute in its five-year history, and it sunset. The interesting thing about that statute is it makes reference to the title of the water being transferred at the point of disposition into the Pecos River. That suggests that the legislature thought that the people who produced the water had title to it. That would ring contrary to the idea of the Water Code, the idea that the water belongs to the public. If you are arguing for private ownership, the fact that the legislature used the word "title" is suggestive that the legislature may agree.

What the legislature has addressed more concretely is who has the right to control produced water. Let me first touch very briefly on the concept of artificial waters. There is a statute regarding artificial waters that says that people who develop artificial waters will be the owners of them, and the public does not have the right to appropriate them. It only applies to surface waters. It is not strictly applicable. Mr. Fesmire suggests in his paper, and I think it is a very good suggestion, that this might be applied by analogy.

The legislature has spoken somewhat more clearly on who has the right to control produced water. There are some problems there too. The first time they spoke to that was back in 1965 in the Oil and Gas Act. The Oil Conservation Division was given the power to regulate the disposition of produced water. In the context of that statute, I think that it clearly means simply how to get rid of it. That was the time in the sixties when the industry and OCD were coming to the conclusion that water quality was suffering from surface disposition of produced water and that we had to start doing something else. That is when the widespread use of deep injection became the thing for produced water.

In 1967, in order to draw a line between the Oil Conservation Division's authority and the state engineer's authority, the legislature passed an amendment to the Water Code. They did not word it very well in my opinion, because it is a little difficult to know exactly what it does. It takes out of the jurisdiction of the state engineer water produced from aquifers where the top of the aquifer is below 2,500 feet and where the aquifer contains non-potable water. There are obvious problems with that. Does the top of the aquifer at 2,500 feet mean where the well penetrates it or the highest place where that aquifer exists in New Mexico? Since the term potable water is not used anywhere else in the statutes to my knowledge, what do they mean by potable water? Does it mean under 10,000 TDS? Much water under 10,000 TDS is not very potable. Does it mean some higher standard? There really are not any answers to those questions. It is a somewhat problematic statute. But we had to learn to live with that until 2004.

There is a statute regarding artificial waters that says that people who develop artificial waters will be the owners of them, and the public does not have the right to appropriate them...this might be applied by analogy.

In 2004, in contemplation of the fact that produced water may be usable—in fact, as a result of the Public Service Company of New Mexico's (PNM) initiative—the legislature passed a statute that gave the Oil Conservation Division permitting authority over use of produced water and provided that a permit from the state engineer was not necessary. PNM did not follow through with that. There were some tax angles in that statute that the legislature decided to strip out and that made it noneconomic at that particular time for them to follow through with it, and they did not apply for a permit. The statute does specifically allow the OCD to authorize use for electric utilities and also for industrial use. The way the statute is drafted, we believe, authorizes the OCD to permit agricultural use as well. Mr. Fesmire said that, and I also said that at the water law conference that I mentioned earlier where we both spoke. The state engineer's counsel took exception to that and believes that is maybe not the case, so there may be some disagreement there. That is pretty important, because you notice that agricultural use is the leading use of water in New Mexico. Also, agricultural use can have relatively dirty water compared to municipal water systems. It is much more likely that we will have a practical agricultural use than that we will have a use for drinking water purposes.

For the regulatory approach, the OCD will be publishing rules soon on this subject. We do not have them out yet, but we have four objectives: encourage the treatment and use of produced water, maintain environmental control so that at the end of the day the water is disposed of in a way that does not cause natural water to exceed standards, to protect water rights in freshwater aquifers where they may have hydrologic communication between produced water and freshwater, and to permit use without reference to ownership or existing water rights, because that is a very complicated quagmire. If we have to get into that, it will delay and impede the use of produced water. Thank you.

Question: The first three criteria that OCD is looking at make a lot of sense. You talked about encouraging use, maintaining the environment, and protecting freshwater. The question I had is about the ability to use water without permits. Are there going to be limits or directions or time frames for use of produced water and application of it? Or are these going to be left open?

David: I did not intend to say use without regarding permits. What I was intending to say was to permit, that is, the OCD would issue permits for the use of produced water. What we would hope to do is to treat it as a license and not a water right. We would hope to avoid having to set up a regime that is dependent upon the doctrine of appropriation, which involves the ultimate possibility of adjudication. Our permits presumably will permit specific volumes of water to be used for specific purposes if it is demonstrated that it is not draining an aquifer for which other people have water rights, and if it is demonstrated that it can be done with environmental integrity.

***Linda Oyer Scheffe** has been the Acting National Nutrient Management Specialist since September 2006 for the Natural Resources Conservation Service (NRCS). She was a state water quality specialist with the NRCS since 1995 and a soil conservationist for the NRCS in Cuernavaca, Mexico from 1992 to 1995. Linda received a B.A. in ecology in 1980 from Friends World College, New York; British Columbia, Canada; Guatemala; Kenya; an M.S. in agronomy from New Mexico State University in 1982; and a Ph.D. in agronomy from Auburn University in 1988. She speaks three languages: Spanish, English, and Swahili.*

NRCS WATER QUALITY PROGRAM

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Thank you. I'm really happy to be here. I'm going to tell you a little about what we do at the Natural Resources Conservation Service (NRCS) in water quality. We provide assistance, mostly in non-point source control efforts. We concentrate a lot on sediment, animal wastes, pesticide, nutrients, and salts. We provide technical assistance and advice to landowners with planning, design, and installation of conservation practices that improve water quality. We do quite a bit of training. Over the last several years – besides NRCS, we have done a lot of training of technical service providers (TSPs) and even hired some of those technical service providers on contract. We also train landowners to plan, install, maintain, and assess what we call resource management systems that improve the soil, water, air, plant, and animal resources.

Most recently we have placed an emphasis on water and wind erosion, nutrient and pest management, and comprehensive nutrient management planning. With the animal feeding operations strategy back in 1999, which was a joint strategy between USEPA and USDA, we formed an interagency animal feeding operation workgroup that includes NMSU, NMED Surface Water and Ground Water Quality Bureaus, USGS, Cattle Growers Association, and Dairy Producers of New Mexico. We have a certification program for nutrient and pest management and comprehensive nutrient management planning (CNMPs). Each year we have an interagency workshop on CNMPs. We've trained about 100 people in each of those areas. In the past, NRCS was more focused on watershed assistance; however, we lost quite a few employees for the watershed effort. Now nationally, our agency will be reemphasizing watershed assistance. A new emphasis will be on energy and air quality as we continue with water and air quality technical assistance, technology development, technology exchange, outreach, and quality assurance.

We also provide cost-share funds for conservation practices through the Environmental Quality Incentive Program (EQIP), which is available for tribes and private landowners. We have ranking criteria and evaluate the resources with different risk assessment tools. If you rank as one of the highest as far as environmental risks, then you rank high on the list of landowners to receive money from us. Another program rewards really good producers with the Conservation Security Program (CSP) that came out several years ago. So far in New Mexico, we have enrolled producers in priority watersheds in the Clayton area, Tucumcari, Clovis, and Fort Sumner. Last year and this year we have emphasized the Deming and Lordsburg area, and there are several watersheds that will be receiving funding. Our NRCS program website that you can refer to is http://www.nm.nrcs.usda.gov/programs.

I'd like to go into what we are doing with the animal feeding operations. Some of the problems that we identified through our interagency workgroup included unlined ponds, ponds not large enough, and existing ag waste plans that were not clear. Animal feeding operation producers must have an NPDES permit from EPA and a groundwater permit from NMED, Groundwater Quality Bureau. Then we require another plan, the Comprehensive Nutrient Management Plan. Our interagency workgroup has tried to combine the three plans into one to make it more user-friendly. Other problems include not enough land on which to apply, poor commitment to apply manure, no meters or poor separation of solids, poor distribution system, applying commercial fertilizer on top of manure, poor irrigation water management, and poor record keeping. Our interagency group has developed one record set necessary to keep according to which permit the operation must maintain. Other problems include not managing pond levels to match crop growth, not valuing manure as a plant nutrient resource (an educational problem), and manure application without soil testing. Soil sampling and testing is something we are really trying to emphasize; this is the key to nutrient management.

So what is a comprehensive nutrient management plan? This is what we have been emphasizing quite a bit over the last five years. It's written for an animal feeding operation and designed to reduce runoff and leaching of animal manure into surface and groundwater. It consists of practices and management activities related to manure production, collection, storage, treatment, and transfer. That's one component. We also have a component for land treatment that looks into water and wind erosion. There is nutrient management, record keeping, and feed management. Feed management is more of a consideration. We don't try to tell the producer. In fact, we probably don't have the expertise to tell the producer, what to do concerning that. We mostly document to see if there are any problems with nitrogen. Most operations hire animal nutritionists. Other utilization activities include composting and land application. We are also starting to get into energy practices. All of this is put into a resource management plan. We use our tools and site visits to assess what is going on in the field on a field by field basis, not only on cropland, but also at headquarters. Then we determine what some of the resource concerns would be for soil, water, plant, animal, and air. Then we come up with different conservation practices that will help address those resource concerns through a resource management system.

Mostly what we do is look at the waste stream in effluents and solids all the way from production and collection to treatment and transfer, storage and utilization, including land application (Fig. 1).

There have been recent CAFO regulation changes, and the regional CAFO NPDES permit has not yet been released. If an animal feeding operation decides to have a CAFO NPDES permit, they will need to have their nutrient plan developed and implemented by July 31, 2007. We are trying to help them out with this through the CNMP.

The CNMP must satisfy nutrient management required by the EPA. It also must satisfy the NMED's groundwater permit along with federal, state, and local regulations. And again, this must be developed and approved by certified specialists per NRCS requirements.

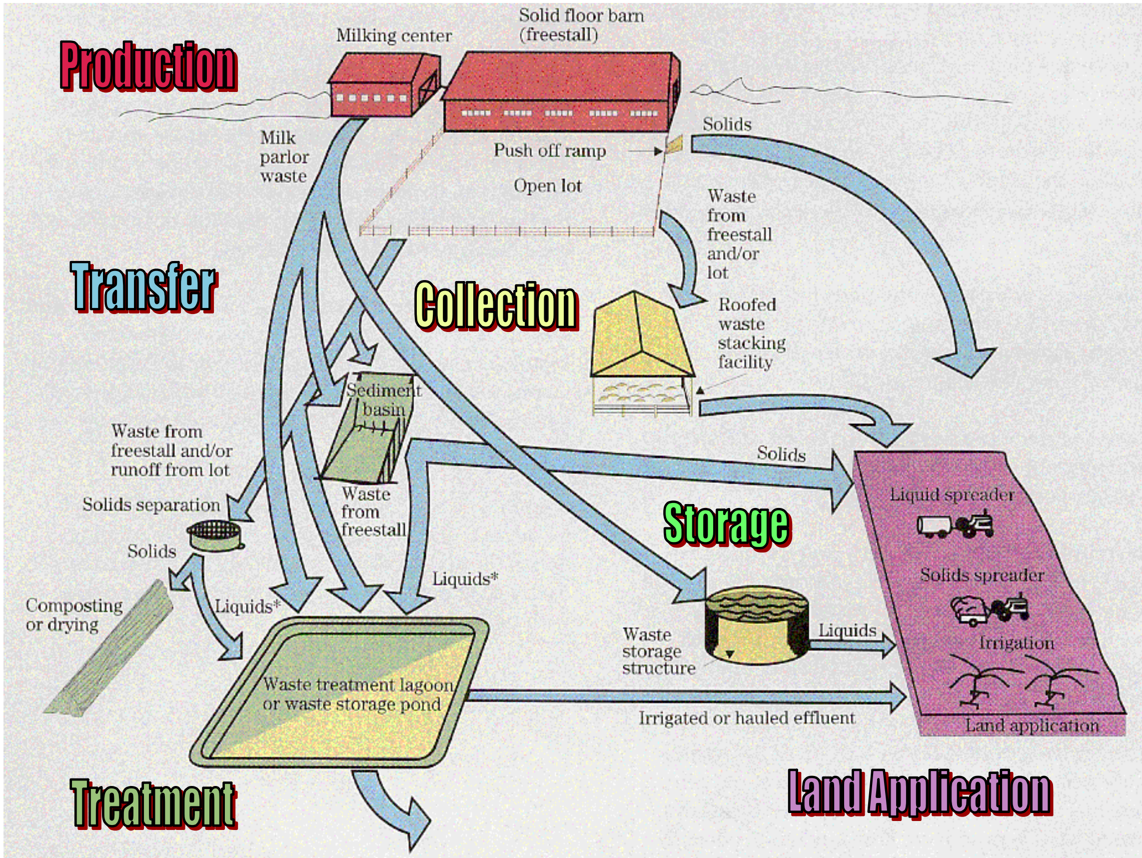

Figure 1. Manure production, collection, treatment, storage, and transfer

We have about 183 animal feeding operations that would potentially desire to have a CNMP. We have around 62 completed now. We have held producer workshops to let animal feeding operations know that technical assistance is available. I think we have accomplished quite a bit.

Now I want to go a little bit into our cost-sharing efforts. We work on all land uses, including forest land, headquarters, urban land, crop land, and range land. I'm going to describe a few practices that we have been able to accomplish this year and on different land uses like brush management.

Each of our conservation practice standards begins with a definition/purpose criteria, then goes into planning considerations, and practice specifications. Then we have job sheets that are very specific on how to implement and maintain the practices. I'm only going to go through the practices that deal with water quality. New Mexico NRCS has 188 practices currently up on our website and our national office has more than 200. The state practice standards must be at least as restrictive or protective of the environment as our national practice standards.

Brush Management - the removal, reduction, or manipulation of non-herbaceous plants. Its purpose is to restore desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality, and to enhance stream flow. This year, according to what we have described in our progress reporting system, more than 130,000 acres have been treated and our fiscal year ends in September.

Conservation Crop Rotation - the growing of crops in a recurring sequence on the same field. Its purpose is to reduce sheet and rill erosion, irrigation induced erosion, and wind erosion. It also helps to manage deficient or excess plant nutrients. It would also help manage vadose zone salinity levels and saline irrigation waters. This practice is essential on all of our crop land plans. Applications were received for more than 48,000 acres last year.

Cross wind trap strips - basically herbaceous cover resistant to wind erosion established in one or more strips across the prevailing wind erosion direction. Its purpose is to induce deposition and reduce transport of wind-borne sediment and sediment-borne contaminants downwind. Forty-seven acres were planned this year. This practice is not widely known, and we may need to do more training.

Field Border - a strip of permanent vegetation established at the edge or around the perimeter of a field. Its purpose is to protect soil and water quality. In FY 2006, 17,000 ft were applied.

Filter Strip - a strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forest land) and environmentally sensitive areas. Its purpose is to reduce sediment, particulate organics, and sediment absorbed contaminant loadings in runoff. It also reduces dissolved contaminant loadings in runoff and reduces sediment, particulate organics, and sediment adsorbed contaminate loadings in surface irrigation tailwater. We actually haven't made use of this practice very much.

Grade Stabilization Structure - a structure used to control the grade and head cutting in natural or artificial channels. Its purpose is to enhance environmental quality and reduce pollution hazards. In FY 2006, 38 structures were built.

Grassed Waterway - a natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation. On our website (http://www.nm.nrcs.usda.gov), there is a link to progress reporting systems so you can find out which counties apply this practice. Its purpose is to protect and improve water quality. In FY 2006, 411 acres applied this method.

Herbaceous Wind Barriers - herbaceous vegetation established in rows or narrow strips across the prevailing wind direction. We have not taken advantage of this practice in the last few years.

Irrigation Land Leveling - This is a big one. It entails reshaping the surface of the land to be irrigated to planned grades. In FY 2006, 15,400 acres were land leveled using this technique.

Irrigation Water Conveyance, Pipeline - a pipeline and appurtenances installed in an irrigation system. More than 240,000 ft were installed in FY 2006.

Irrigation Water Management - another essential practice for all of our crop land systems. The definition for irrigation water management is the process of determining and controlling the volume, frequency, and application rate of irrigation water in a planned, efficient manner. Its purpose is to decrease non-point source pollution of surface and groundwater resources. In FY 2006, this process was applied to 50,000 acres.

Nutrient Management - managing the amount, source, placement, form, and timing of the application of nutrients and soil amendments. The purpose is to minimize agricultural non-point source pollution of surface and groundwater resources. This type of management was used on more than 45,000 acres in FY 2006.

Pest Management - It is not our role to provide recommendations on pesticides, but to assist in the determination of the risk associated on a site specific basis. We have a tool, "Windows Pesticide Screening Tool," which helps us look at the interaction between soil and pesticide risk factors on a given field. The definition for this type of management is utilizing environmentally sensitive prevention, avoidance, monitoring, and suppression strategies to manage weeds, insects, diseases, animals, and other organisms (including invasive and non-invasive species) that directly or indirectly cause damage or annoyance. The technique was applied to nearly 60,000 acres in FY 2006.

Pond - a water impoundment made by constructing a dam, or an embankment, or by excavating a pit or dugout. In FY 2006, 28 were installed.

Pond Sealing, Flexible Membrane - We are requiring flexible liners on all of our wastewater facilities. These are manufactured hydraulic barriers consisting of a functionally continuous sheet of synthetic, or partially synthetic, flexible material. More than 20 systems were planned for in FY 2006.

Prescribed Grazing - controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specified objective. Its purpose is to maintain or improve water quality and quantity. This harvesting technique was applied to over 900,000 acres in FY 2006.

Residue Management - managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field surface is tilled prior to planting. Its purpose is to reduce sheet and rill erosion and to reduce wind erosion. This technique was applied to 120 acres in 2006.

Riparian Forest Buffer - area of trees and/or shrubs located adjacent to and up-gradient from water bodies. Its purpose is to lower water temperatures and to reduce excess amounts of sediment, organic material, nutrients, and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow groundwater. This type of buffer was applied to nearly 3,000 acres in FY 2006.

Structure for Water Control - structure in an irrigation, drainage, or other water management system that conveys water, controls the direction or rate of flow, or maintains a desired water surface elevation. It is used for water quality control such as sediment reduction or temperature regulation. In FY 2006, 720 structures were installed.

Waste Storage Facility - a waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure. In FY 2006, 13 facilities were installed.

Water Utilization - using agricultural wastes such as manure and wastewater or other organic residue. The use of these wastes helps to protect water quality. These wastes were applied to 350 acres in FY 2006.

Windbreak Establishment - linear plantings of single or multiple rows of trees or shrubs established for environmental purposes. Its purpose is to reduce wind erosion. Nearly 30,000 feet of windbreaks were installed in FY 2006.

Upcoming emphases will include more training and program assistance on water quality, riparian restoration, air quality, and energy. Remember to check out our website. We have a site on water quality with links to areas of interest. That web address is: http://www.nm.nrcs.usda.gov/technical/water/wq/html. Also, we have a website for animal feeding operations. That address is: http://www.nm.nrcs.usda.gov/technical/water/nmafo.html.

Thank you.

Dennis McQuillan *earned a B.S. degree in geology from the University of New Mexico and has more than 27 years of professional experience in the environmental field, both as a regulator for the New Mexico Environment Department and as a consultant, educator, and freelance writer. His accomplishments include more than 200 site investigations, dozens of which received corrective action such as provision of safe drinking water service and cleanup of soil and water pollution. He also initiated many new programs including new regulations for toxic pollutants, abatement of water pollution, public education and outreach, free water testing for New Mexico citizens, and research into regional environmental conditions and emerging issues such as pharmaceutical residues in ambient water. He has extensive experience in civil and criminal enforcement of environmental laws and has testified as an expert witness many times. He has worked with sites in Arizona, Colorado, New Mexico, Ireland, Nova Scotia, Scotland, and Wales.*

GROUNDWATER CONTAMINATION BY SEPTIC TANK EFFLUENTS

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I am pleased to be here. Good morning everyone. I have some good news and some bad news about septic tanks. The good news is that they do not always pollute or contaminate the groundwater in excess of the standards. When they do, the contamination levels are moderate compared to what we typically see in dairies or other areas of fertilization. The bad news is that there is a lot of contamination and a lot of wells that have been contaminated by on-site systems.

Let's talk about sewage management in the state in general. Figure 1 shows information that I got from the Census Bureau. Most of the people in New Mexico are on public sewers, as you can see by the blue piece of the pie. Septic tanks, cesspools, and outside systems account for about one-third. About two to three percent of the people in the state use privies or other systems. There is some variability around the state. In Bernalillo County, obviously most of the people are on a public sewer. In Catron County, most of the people are on septic tanks. In McKinley County, we have Gallup as a large hookup to public sewers and septic tanks. About a third of the population in Gallup is on privies. That is related to the fact that about a quarter to a third of the population does not have indoor plumbing in McKinley County. New Mexico has a high level of poverty, and that is reflected in the sewage area.

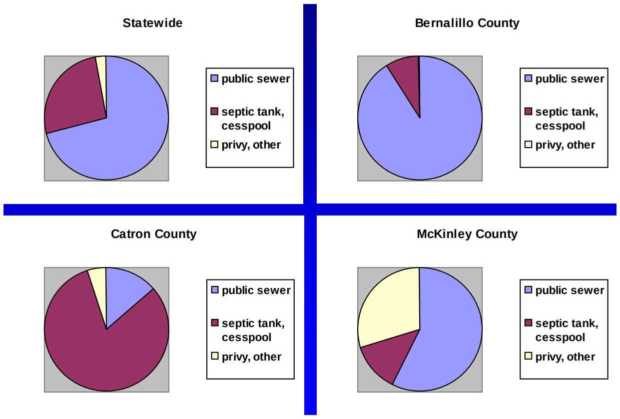

Figure 1. Sewage management in New Mexico

In New Mexico, we are approaching a quarter million on-site systems. We permit about 7,000 new systems a year. That is an increase in the past four years. We discharge about 80 million gallons per day of wastewater to the subsurface. Most of that percolates into the groundwater. Some of it is lost to evaporation. In a few areas it does not look like it gets down to the groundwater at all. What is problematic for us is that many of the areas that were developed with on-site septic systems also utilize private domestic wells.

Septic tanks are perfectly suitable as a means of on-site waste disposal if you have adequate lot size, proper soil, and if you have setbacks and clearances. John Hernandez talked about the language and statutes about reasonable degradation from beneficial use of water. The Water Quality Act and the Environment Department's regulating of on-site septics with the Environmental Improvement Act share the same principle. If you have good site conditions, septic tanks are suitable. Like I've said, most septics degrade groundwater a little bit but not in excess of standards. However, as early as 1959 the NM State Board of Health noted that septic tanks were never intended for use in closely built-up areas: "The development of fringe areas and subdivisions that do not have access to municipal water and sewage facilities is creating a continuously growing problem in proper protection of the public health in these areas. . . . Septic tanks and leaching systems were never intended for use in closely built-up areas." They were observing problems as far back as 1959. The statement written back then could just as easily have been written today about Corrales or some areas in northern New Mexico or Lake Arthur or Carlsbad; it's an ongoing problem.

Some of the regulatory problems we see with on-site wastewater systems are cesspools that have been categorically illegal since 1973, failed systems or illegal discharges that discharge on to the surface, and ground and surface water quality degradation, which can lead to the pollution of drinking water. This can not only make you sick, but stain your laundry and interfere with businesses and so on. There are public health interferences as well as public welfare and property right interferences and aesthetic issues with the water.

How many cesspools do we have in New Mexico? Cesspools have been illegal since 1973, and there is no grandfather permission available. Figure 2 is a photo of one that was being installed two years ago in Carlsbad. There were 55-gallon drums welded end-to-end; it was going to be just that with no leach field. There must be something on the Internet about putting in a cesspool with 55-gallon drums because we see these all over the place. We have done community surveys in three areas of the state assessing how many cesspools there are in these areas. San Patricio down by Ruidoso had 6 percent. Cordova, an old land grant community up by Espanola, had 96 percent. There was only one septic tank in that community. Willard had 40 percent. Figure 3 is a picture of a cesspool at a methamphetamine lab that produced a large number of bizarre chemicals we normally never see. We know cesspools are still out there, and we are working with home owners to take them offline.

Figure 2. Cesspool under construction in Carlsbad

Figure 3. Cesspool at a methamphetamine lab

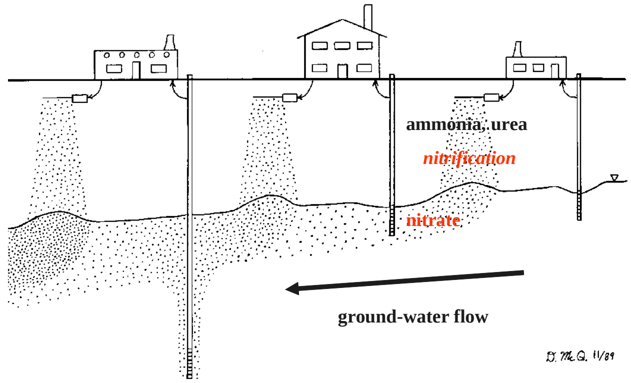

Figure 4. Drinking your neighbor's sewage

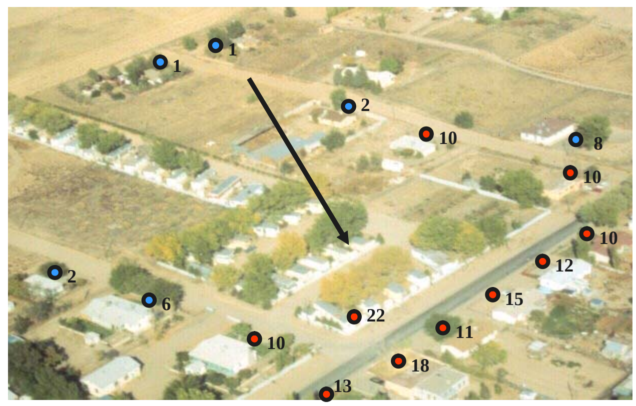

Figure 5. Barcelona NO_3-N (mg/L)

Now let's talk about groundwater contamination from on-site septic systems. The mineral pickup that occurs when you run water through a house includes chloride, nitrogen, calcium, sodium, and so on. Much of this is discharged down to the groundwater. If you have conditions where you don't get much nitrification of ammonia, the BOD, the biochemical oxygen demand, or your organic matter in wastewater can be biodegraded by the bacteria, and you generate respiration byproducts if you have anaerobic respiration. I will talk a little bit about that.

Organic chemicals can include pharmaceuticals, but we have not detected pharmaceuticals in groundwater in New Mexico. That is good, but we have found them in surface water. Also, dichlorobenzene is another household product. Those yellow or pink and white crystalline blocks for your toilet bowl that you can buy at the supermarket are dichlorobenzene. You can get them in packages as well.

Figure 4 is a diagram that shows what we see in a lot of areas in the state. The groundwater is flowing from right to left and it picks up minerals. As it cycles through wells and septic systems, the concentrations build up. There is very little nitrate in the raw sewage. It consists of mostly urea or ammonia, and if you have oxygen present in the soil, nitrification occurs from bacteria, and you end up with nitrate in the groundwater. This is exactly what we see in the Barcelona area (Fig. 5), which is on the west side of Albuquerque, as the groundwater flowed through this subdivision. The blue wells indicate nitrate levels less than ten. If red, they are greater than ten. As the water flowed through, the nitrogen built to dangerous levels. These are half-acre lots. They have wells in the front and septic systems in the back. This could also be Espanola, Carlsbad, and some areas of Santa Fe.

Figure 6 shows the relation between nitrate and chloride, and we have seen this in sewage. This is in the Barcelona area. The chloride was not above the standard of 250, but it was elevated. Chloride is a useful diagnostic tool that we use in fingerprinting nitrate sources (Fig. 7). If you look at the chloride from septic tanks (the red dots), the septic tanks generally produce moderate nitrate and moderate chloride levels, relative to what we see from most of the dairies. We have natural geologic sources, which I have indicated to be evapotranspiration. If you look at the ratio of nitrate to chloride concentrations in rainwater, you come up with the blue curve (Fig. 7), and this matches some extremely high nitrate levels that we have in groundwater with really low chloride. You can also eliminate some of the other major ions in these nitrate plumes, chloride, sodium, and draw stiff diagrams of this (Fig. 8). These are two septic tank cases. Again the contamination levels are not as high as you see in dairies; it happens mostly with fertilizer cases. These two cases we contribute to be from natural evapotranspiration.

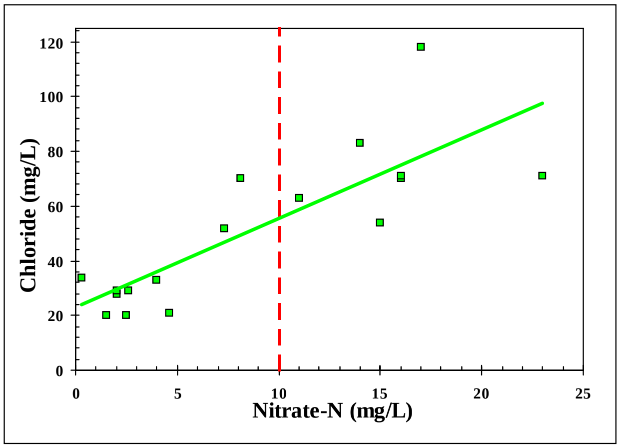

Figure 6. Barcelona nitrate and chloride

We are doing more work in fingerprinting sources of nitrate contamination. We use stable isotopes Delta and ^{15}N. It is interesting that septic tanks in the primary and secondary sewage have similar fingerprints (Fig. 9). Once you go to a tertiary sewage process—and this is groundwater contaminated by nitrate—the bacteria take a second bit out of the ^{15}N or out of the ^{14}N. They preferentially concentrate ^{15}N in the waste, because they preferentially utilize ^{14}N for cell growth. Fertilizer explosives are very light because they are made of atmospheric nitrogen, which we define as zero, our international standard. If anybody is interested, a paper is under review that goes into more detail on general groundwater.

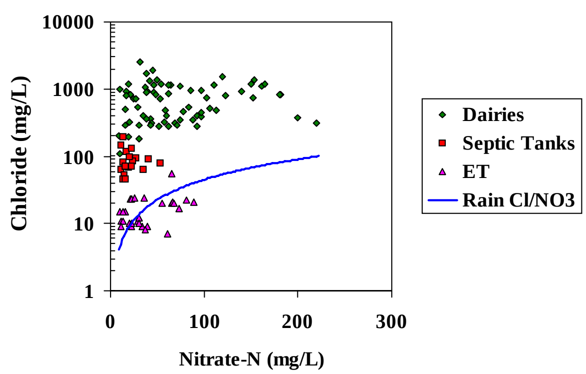

Figure 7. Nitrate source fingerprinting

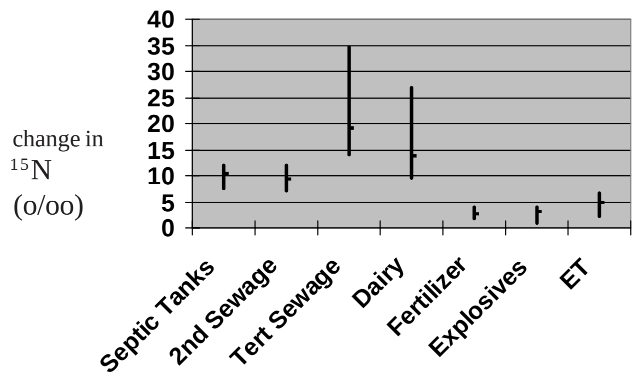

Figure 9. Nitrogen isotopes in source area groundwater

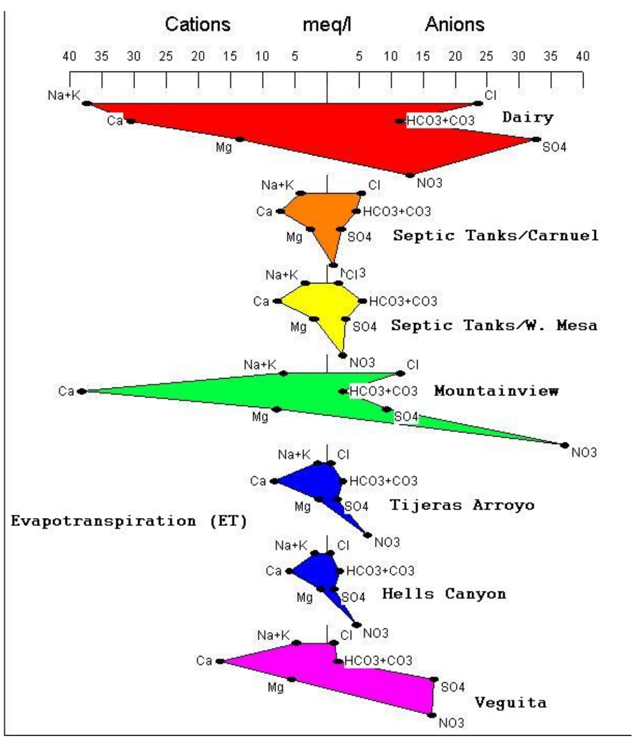

Figure 8. Nitrate source fingerprinting

We have also looked at the isotopes of hydrogen and oxygen (Fig. 10). We have found that if the water has been evaporated in a pond (see red triangles), it becomes heavier relative to meteoric water. The plumes you see from septic tanks post-collapsed the meteoric water line because there is limited potential for evapotranspiration in a leach field. It is being discharged to the subsurface.

Now let's talk about anoxic conditions. This is where the dissolved oxygen (DO) is very low or not detectable, typically less than one or less than point five. It can be caused by natural or organic deposits that you see in the Rio Grande valley, human materials, oxidation and minerals, oxidation of pyrite, for example, the mining guys know that, or biodegradation of organic matter from sewage or petroleum, any source of organic carbon. What it means for the liquid waste program is that in the anoxic areas we have decades of septic tanks and cesspools that sometimes are on really teeny, tiny lots. They have been discharging, and there is no nitrate in the groundwater. There hasn't been for decades. The ammonia and nitrate in the sewage does not nitrify. We do not find ammonia and TKN typically at detectable or certainly not in high levels in these groundwaters. We think the ammonia may be lost by cation exchange or perhaps by volatilization. If you introduce nitrate into these systems, it should denitrify, which is a process that wastewater engineers use for tertiary treatment. As you introduce organic matter, which the engineers refer to as BOD and geochemists think of in terms of organic carbon, this is a food, a carbon energy source for the bacteria. If DO is very low or not present, then the bacteria will preferentially respirate nitrate, manganese oxides, and iron oxides in soil if they are present and they usually are, or sulfate, and eventually carbon for respiration. The byproducts of this anaerobic respiration (ARBs) include soluble manganese dissolved in groundwater and hydrogen sulfite, which is the reduction product of sulfate. These cause severe aesthetic problems, and manganese has been identified as a neurotoxin.

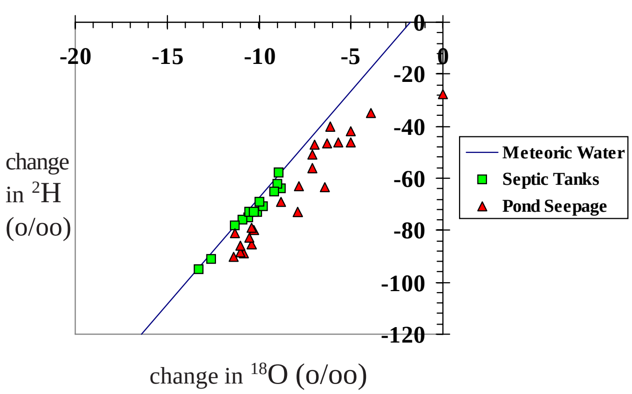

Figure 10. Evaporative fractionation

Figure 11 is the preferential sequence of anaerobic respiration. The oxygen first is smothered in bacteria, because they get more energy out of this. They use nitrate, manganese and iron oxide, sulfate, and then actually reduce carbon in the next sequence.

Thinking in a new paradigm, regulatory programs not just in New Mexico, but also in California, New York, Germany, and Israel have historically focused on nitrogen loading in nitrate. This is appropriate if nitrogen is going to be a threat, if you have nitrification

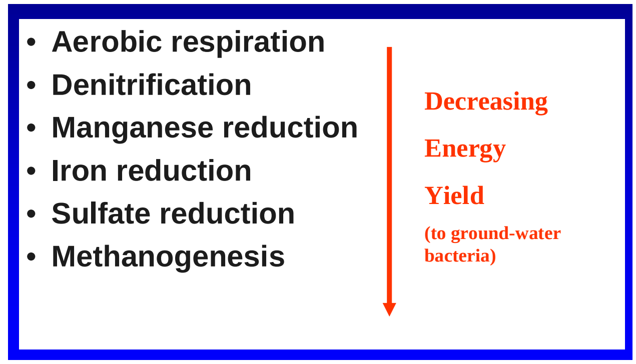

Figure 11. Respiration sequence

of ammonia, but it does not protect the groundwater from the anaerobic respiration byproducts, the manganese and iron and hydrogen sulfite. We need to protect our groundwater from this. Additionally, nitrogen reducing wastewater treatment may not be appropriate if you have widespread anoxic conditions. The liquid waste regulations now recognize that. It is a very controversial issue, and I would be more than happy to discuss that with any of you.

Let's look at some of the data from New Mexico. I borrowed Figure 12 from the USGS. This shows dissolved oxygen less than 0.5. There is an area that is shaded in the Rio Grande Valley where I think you can make a strong argument that this is largely a natural condition, where the human materials have moved in and caused depletion of oxygen and the depletion of water was introduced. If you look at dissolved oxygen and nitrate concentration, then you get a pretty good match with the areas that have high densities of septic systems and cesspools (Fig. 13). Bernalillo is right up in here. Corrales is here in our valley. We think this is good evidence that the on-site systems are contributing to the contamination of anaerobic degradation byproducts.

Look at manganese as we go down in sequence. Figure 14 shows wastewater loading in the South Valley of Albuquerque, a high density area with small lots. This also corresponds to the high levels of manganese in groundwater (Fig. 15). We have looked at iron as well. Figure 16 is Corrales based on some work we did last year. The inner valley has no nitrate to speak of. It is usually not detectable. We find lots of high iron levels. Similar, to the west we seldom see any iron but we detect nitrate greater than two. There is a pretty good redox boundary near Corrales.

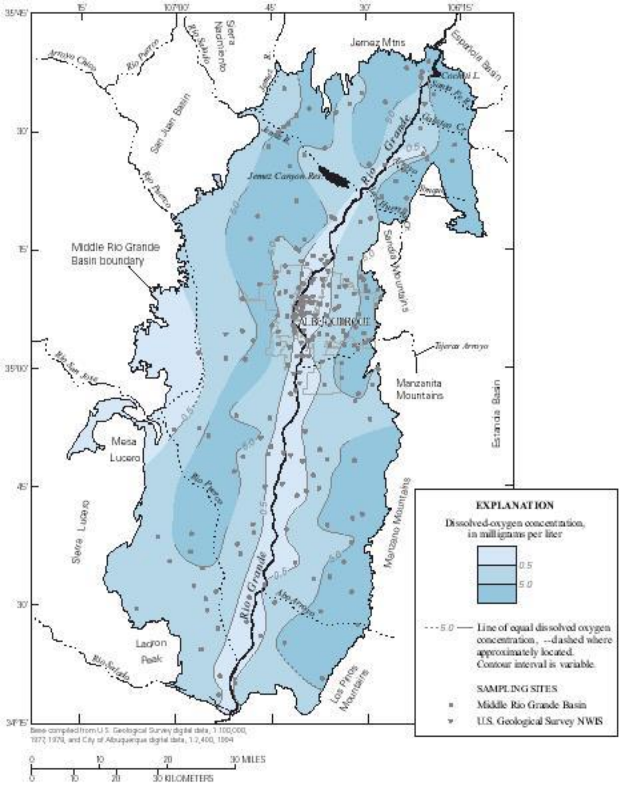

Figure. 12. Anoxic groundwater - Middle Rio Grande Valley

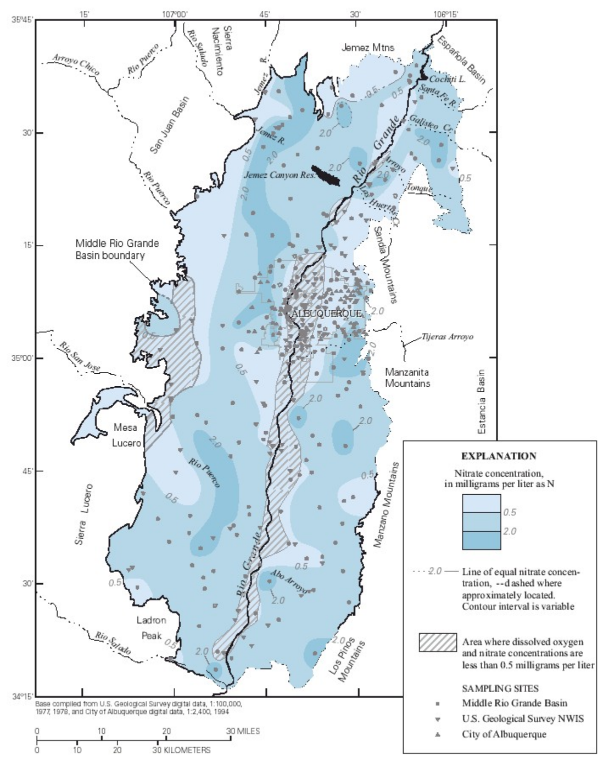

Figure 41. Nitrate concentration for ground water of the Middle Rio Grande Basin, New Mexico.

Figure 13. Anoxic and NO_3 depleted groundwater - Middle Rio Grande Valley

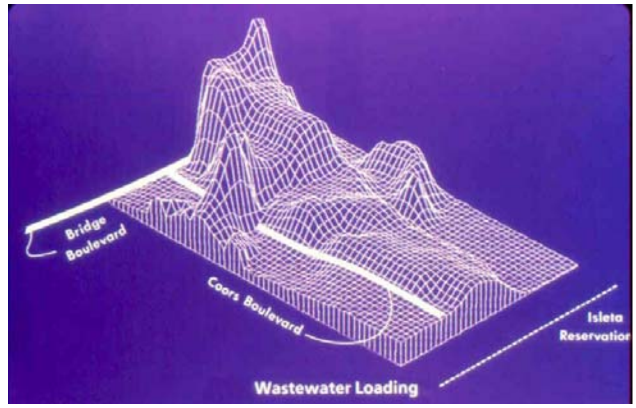

Figure 14. South Valley wastewater loading

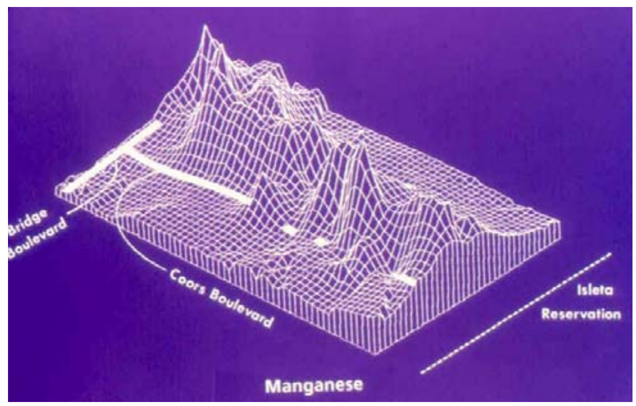

Figure 15. South Valley groundwater manganese

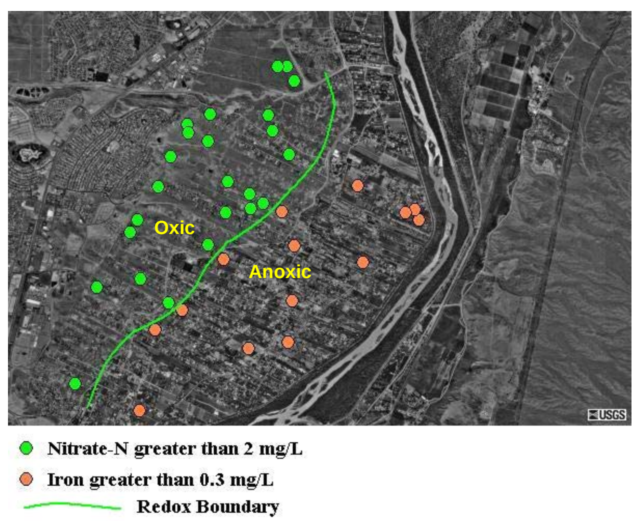

Figure 16. Corrales groundwater chemistry

The Water Quality Control Commission (WQCC) in 1989 identified, based on information we have given them, septic systems as being the largest source of groundwater contamination in the state. This is why: if you look at all the wells that have been contaminated by on-site systems, count them up, and compare them to all the wells contaminated by dairies, mines, landfills, and methamphetamine labs, the on-site systems contaminate more wells than all of the other sources combined (Fig. 17). This is based on nitrates above ten or iron and manganese in excess of the standards set by the WQCC in the public water supplies.

Figure 18 shows the distribution of groundwater contamination statewide. Again, a lot of contamination has occurred. The public drinking water systems that Kim talked about, all those 1,300, have had source water assessments. We go out and look at what potential sources are within a 1,000 foot radius. Figure 19 is Gabaldon over in San Miguel County. This well has high nitrate levels, above ten, and it is a public water supply. You can look at all the septic systems that are within 1,000 feet as well. Septic systems have been identified, based on these source water assessments, as the biggest potential threat to public water supply wells in the state (Fig. 20). Then we have grazing and farming. If you included them as a category of agriculture, then they collectively make up another third. Then we have industrial and miscellaneous uses as well. This is consistent with the data from contaminated public supply wells.

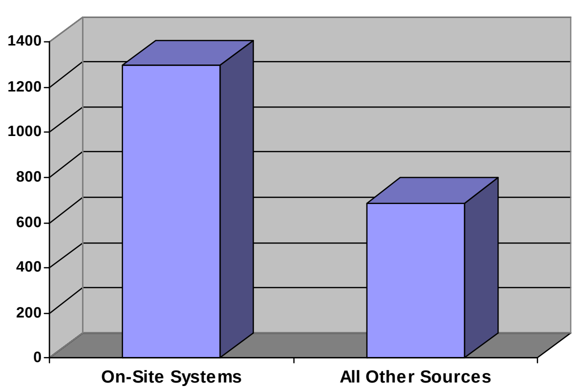

Figure 17. Contaminated wells in New Mexico

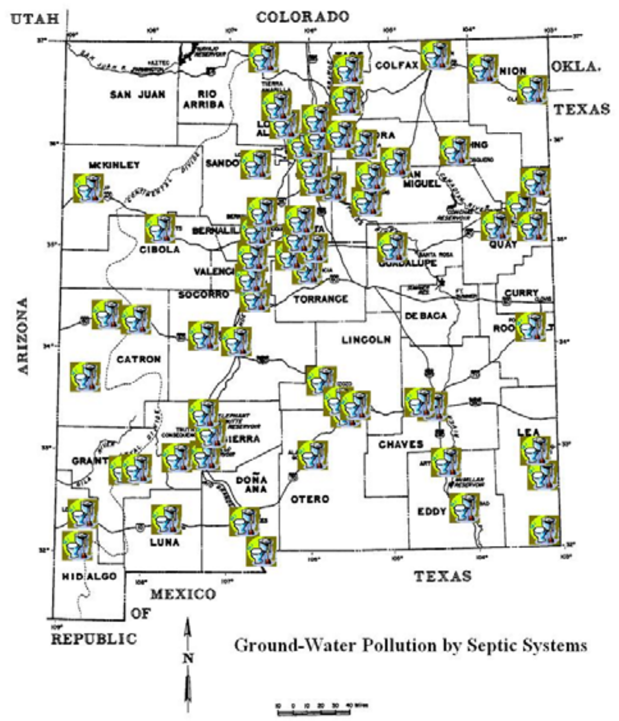

Figure 18. Groundwater contamination from onsite septic systems

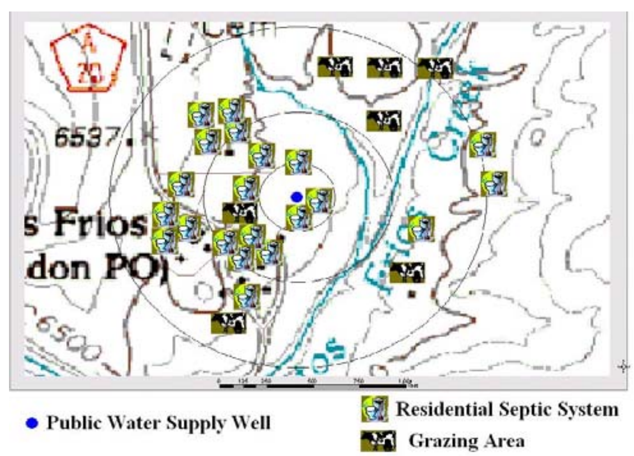

Figure 19. Gabaldon source water assessment

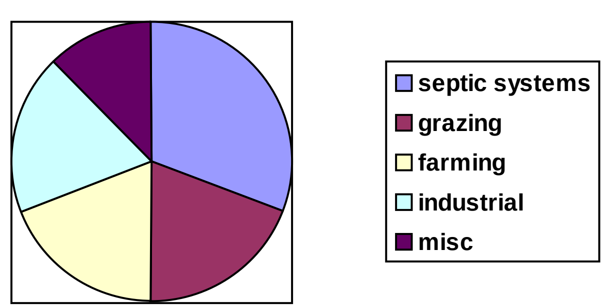

Figure 20. Risk summary for public wells

The vulnerability factors for groundwater contamination include wastewater flow, vadose-zone conditions (redox, percent saturation, hydraulic conductivity), depth to groundwater, groundwater conditions (redox, hydraulic conductivity, gradient), lot size, and nearest down-gradient supply well. I want to emphasize depth to groundwater and lot size as being important. Figure 21 is available on our geographic information system via our website. These are maps that Lee Wilson prepared for the department about 20 years ago. We have digitized them and put them up for viewing. We would like to update these maps and work with more data. Figure 21 is Sandoval County, which includes Rio Rancho and Corrales.

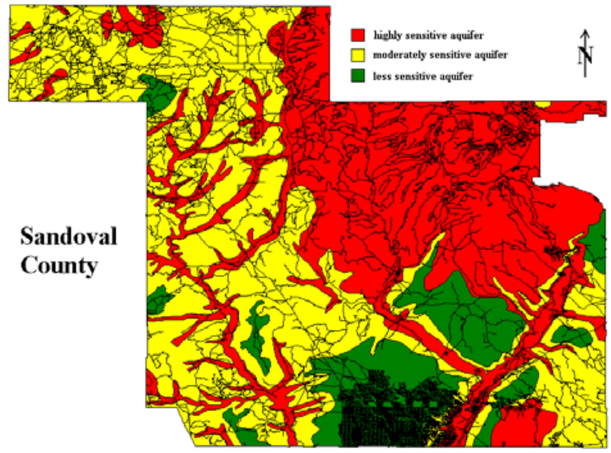

Figure 21. Aquifer vulnerability

Figure 22 is a comparison of the nitrogen loading in pounds of nitrogen per acre per year versus the nitrate increase that we have seen. Read that to mean lot size for non-point sources. This curve is what you get when you run all of the models that have been used by the USGS and by Bernalillo County. This curve shows the actual data for the New Mexico field site. We have areas where we have looked at what nitrate has been added to groundwater and the effect of lot size from all of those septic systems. In general, the model is predicting a more severe impact than we have seen in groundwater, with the exception of sites with fractured bedrock where the average lot size is more than three acres. The purple line is the allowable lot size under state regulations. You have two sites with nitrate contamination in excess of the drinking water standard of 10. That has occurred on lots larger than the minimum required by state law. This is a very important finding.

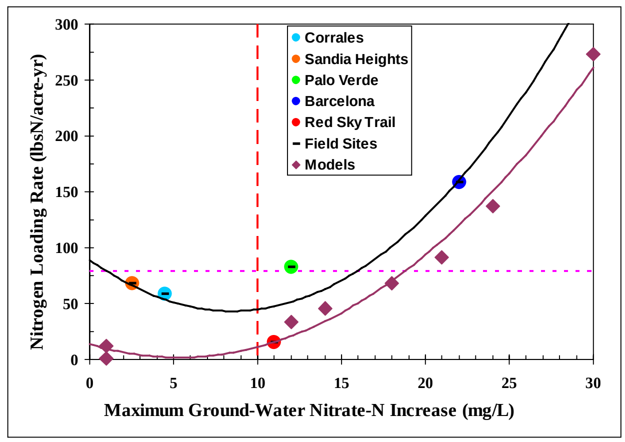

Figure 22. Lot size (nitrogen mass loading) and ground-water nitrate increase

We have some 400 miles of streams in New Mexico that have been adversely impacted by septic tank effluent, typically by elevated nutrients (Fig. 23). This is the Rio Ruidoso. It shows eutrophic algae bloom. Septic tanks are contributing to that condition. We have streams that have contamination from septic tanks, and septic tanks in the area.

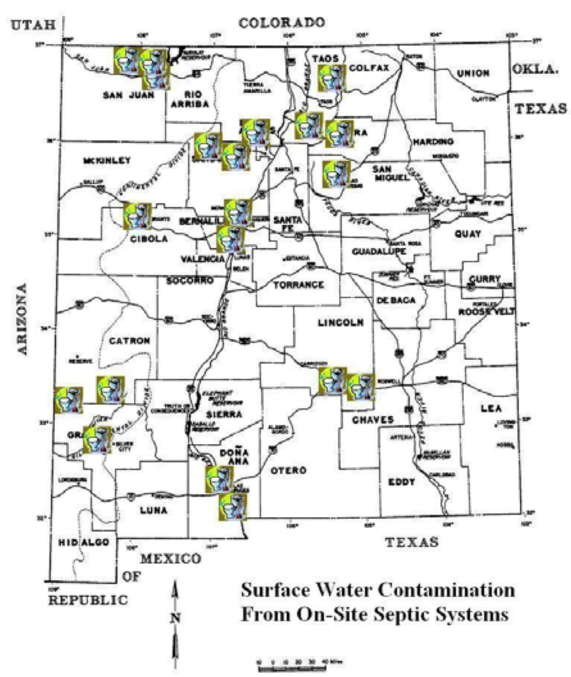

Figure 23. Contamination of gaining streams

We have seen several health hazards from the contaminants we are talking about. We have had blue babies in New Mexico. Manganese is a neurotoxin. We have also traced specific outbreaks of disease to wells contaminated by sewage. Those of you who enjoy spinach salad probably know all about E. coli. We have had the same issue with well water.

Alternatives exist to conventional septic systems including advanced wastewater treatment units, which are like mini sewage treatment plants. They can perform secondary and tertiary treatment. There are non-discharging systems and split-flow systems, where you separate the black water from the gray water. The gray water goes to a holding tank, which is about ten percent of the flow and 90 percent of the nitrogen and organic matter. Centralized management of septic tanks is another method. Clusters, where you take four, ten, or a number of houses, and hook them up to one advanced treatment system is another option. There are economic advantages to that option for the homeowners; it is not as expensive as everyone having their own advanced treatment system. Also, there is the sewer, or big pipe, solution.

Question: Septic tank legislation was talked about earlier. Do you know more about that?

Dennis: Cindy Padilla mentioned that yesterday. Bernalillo County has a program that is funded by a portion of their liquid waste permit fees. Fees go into a fund where they can use that money to hook up indigent households to a city sewer or to install a properly permitted septic tank. We are looking at legislation similar to that on a statewide basis. We have a lot of poor people in New Mexico. Some of these people have cesspools. If we could just use a portion of our fee money and some seed money from the legislature, we could greatly improve things.

Question: How does one determine which areas are sensitive and which are not?

Dennis: The criteria that Lee Wilson used for those maps was the basis of depth to groundwater and to some extent TDS. In Sandoval County where the TDS is usually pretty good, it was strictly depth to groundwater. The red areas were less than 100 feet to groundwater. The yellow areas were 100 to 300 feet to groundwater, and the green areas were greater than 300 feet to groundwater. If you look at Lee's maps in the south part of the state, then TDS became part of the equation. The vulnerability got downgraded as the TDS went up above, I think, 3,000 or 5,000.

Question: That map is from 1979, and it is fabulous work done before GIS. We need to update that. It needs to be a major priority.

Dennis: We do need to update the map. I am glad you mentioned GIS because of the governor's designation of 2007 to be the Year of Water. We have been directed to overhaul our environmental GIS. We have a GIS system online right now, and we have been directed to add a lot more data. One of the things that needs to be done is to update that map. We have a lot more information now, more wells, and so on.

David Hogge *is Program Manager of the Watershed Protection Section of the New Mexico Environment Department's Surface Water Quality Bureau in Santa Fe. He has been with the New Mexico Environment Department since 1994. David earned a bachelor's degree in community and public health in 1986 from New Mexico State University and a master's degree in health administration in 1989 also from New Mexico State University. David has 16 years experience in the environmental field including working for Lockheed Environmental Systems and Technologies Company from 1990-1994 prior to joining the New Mexico Environment Department.*

Mike Bain *is a native of Alabama where he managed commercial cattle, forestry, and wildlife resources in addition to a 27-year career training horses, specializing in reining and working cowhorses. He has an undergraduate degree in secondary education, social sciences and an MBA. Mike moved to New Mexico in 2003 as a partner in Tumbleweeds Leather Company. He has been employed by the Cimarron Watershed Alliance, Inc. since January 2005. He is currently serving the CWA, a non-profit 501(c)3 corporation, as Executive Director.*

NEW MEXICO'S 319 PROGRAM: AN OVERVIEW AND A NEW MEXICO 319 SUCCESS STORY, THE CIMARRON WATERSHED ALLIANCE, INC.

Introduction by David Hogge
Program Manager of the Watershed Protection Section
New Mexico Environment Department's Surface Water Quality Bureau
Watershed Protection Section
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Santa Fe, NM 87502

Good Morning. I see some people here who have participated in the 319 program. I'm going to be brief because I want to get Mike Bain up here to talk about real life experiences with the 319 program. I think hearing from Mike is the best way to get out information about the 319 program and its venues.

Funding for the program comes from the EPA's federal 319(h) grant. Historically the program has been funded with about $2.4 million. Right now we are waiting on a probable cut for 2007. We will see how much that cut will be as soon as Congress decides on the 2007 budget.

About three years ago we decided to change the approach for the funding of our projects in New Mexico. We decided internally that we would rather have local watershed groups be the drivers behind the 319 Program instead of us driving it out of Santa Fe. We fund watershed group formation, what we call our spark plugs. Once the watershed group is formed, a watershed restoration active strategy plan is developed. Plans deal with the implementation of ground projects for non-point source pollution abatement. We fund on-ground restoration projects. We develop dynamic programs for the progressive actions necessary to reduce pollutants for non-point sources entering surface and groundwater. Implementation of these programs will help New Mexico succeed in retaining surface water quality and implementation will hopefully protect designated uses as described in the state's Water Quality Standards and meet the goals of the federal Clean Water Act and state Water Quality Act.

Every August we advertise two RFPs for the watershed protection section. We did that this year on August 14 and they were due on October 1. We received four watershed group formation proposals and 26 on-the-ground proposals for a total of 30 proposals with a total request of about $3.4 million. We wish we had that much funding to support these projects. We will review the proposals and determine which we can fund. Every year the watershed group formation proposals get fewer and fewer because we are very close to having watershed groups in all our major watersheds. It is a very good thing to get local citizens involved in the program. They help us out tremendously with the energy that they bring to the program.

Currently the 319 program has approximately 50 open 319 projects statewide. We have on-the-ground projects that extend from 3 to 5 years, and the watershed group formation projects can go a maximum of two years.

When Cathy Ortega Klett contacted me about talking about the 319 program, I thought I could stand up here and talk about the program and how we do things, but a lot of people have heard that talk before. We decided to get somebody up here to talk who is actually involved in the 319 program and doing a great job. With that I want to get Mike Bain up here.

New Mexico's 319 Program: An Overview and a New Mexico 319 Success Story, the Cimarron Watershed Alliance, Inc.

Michael Bain
Cimarron Watershed Alliance, Inc.
PO Box 626
31094 US Highway 64
Cimarron, NM 87714

Good morning everyone. I am certainly glad to be here this morning and glad to share with you some of our experiences. The Cimarron Watershed Alliance (CWA) is primarily funded by the EPA's 319 program, as administered by the state of New Mexico.

The major reason the CWA has had success would be because of the active involvement of its stakeholders. They are a very diverse group of individuals who are very willing to work for our mission and that mission is to strive for and maintain a healthy watershed for all residents. We are glad they are there and very thankful for the energy they bring to the Alliance. We do try to take in everyone interested in water, including state, federal, and local governments; individuals; businesses; and agencies. We have ranchers, drilling interests, and we have real estate development interests in our group in northeastern New Mexico. We have a wide-ranging group of people involved. Figure 1 is a slide that shows you a map of where our watershed is located in the state.

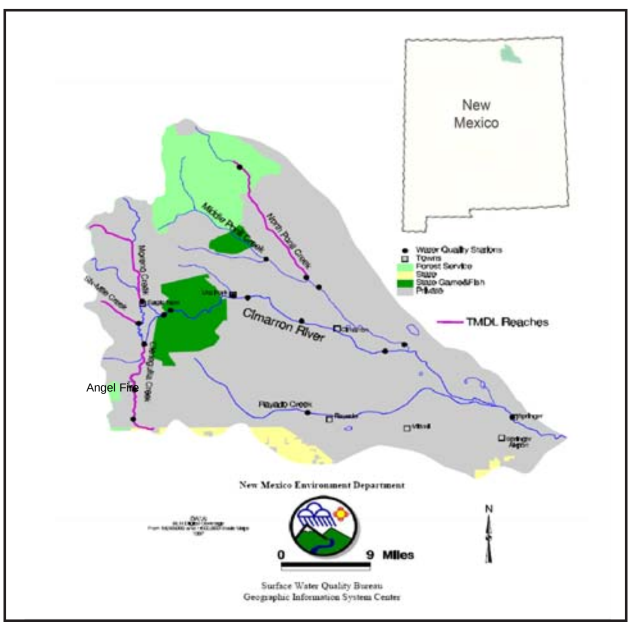

Figure 1. Location of Cimarron Watershed

Figure 2 is a portrayal of our very dynamic group of individuals. As I said, we have a diverse, wide-ranging group of people. Each person has needs, expectations, and a knowledge base of his or her own that brings he or she to the Cimarron Watershed Alliance.

Figure 2. The CWA - diverse interests coming together

Sitting here over the last day and a half I've been listening to comments and I've really thought about the interface of what you do as professionals with the needs of our stakeholders. I think a large part of my job is to try to be a liaison, if you will, for the different needs; to integrate what you are doing into our on-the-ground projects and to make sense of your work in relation to these projects for these individuals because they have a different take on the world than you do. We are just trying to bring these two realities together to work on water quality as one.

Figure 3 shows some of our natural resources. We are not only a diverse group of people but also have great diversity in our environment. We run in elevation from Mt. Wheeler at just under 13,000 ft down to the Village of Springer which is at about 5,000

Figure 3. Natural resources of the Cimarron Watershed

ft. We have a variety of ecozones that run through the watershed.

We also have other stakeholders if you want to take in consideration the natural endowment there – the wildlife (Fig. 4). Each of these species represents not only a natural endowment and intrinsic value of their own, but there is also an economic interest to the community in each of these as well. So we try to factor that in, and some of these considerations are overlapping.

There is a herd of elk in the Valle Vidal. This is a natural resource – a natural endowment, but it is also an economic resource. We try to factor these variables in thinking about projects, thinking about how we

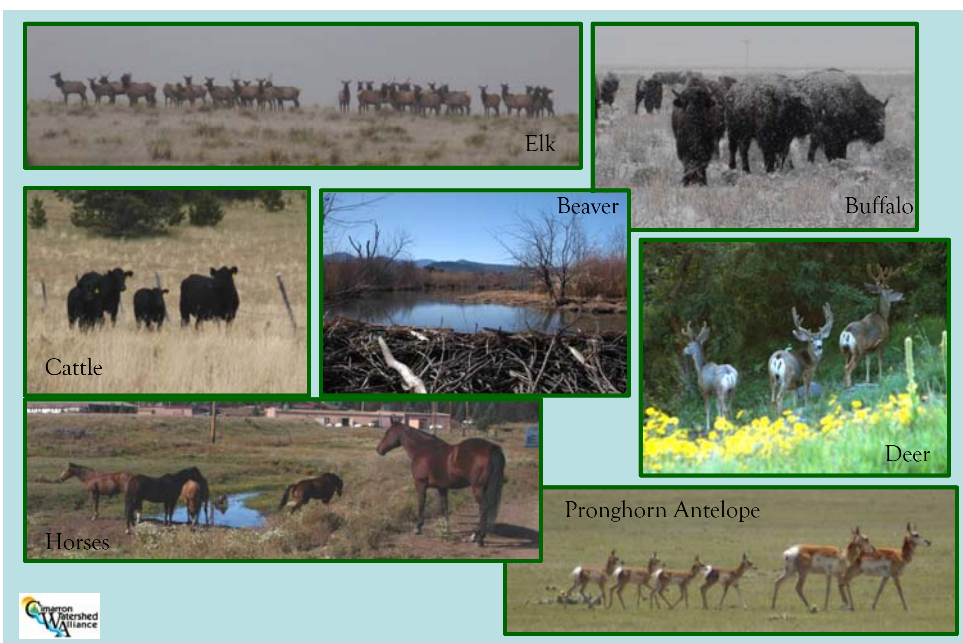

Figure 4. Animals in the Cimarron Watershed

interact with the public, private, and professional sectors, such as your own.

We feel that especially in our upper elevations, such as the Moreno Valley, one of our biggest risks is fire. Figure 5 shows the Ponil Complex Fire. We have an extremely overstocked forest situation. There are several factors lending to that situation. There has been, arguably, some resource management misuse in the past, and now we are having a hard time finding an economic solution that actually allows the harvest of this fiber in a manner that is economical for the forest industry without substantial public subsidization. So fuel has built up over the years, and if you get a fire in some of these areas it tends to be a stand placement type. This includes areas dominated by ponderosa pine, those types of ecosystems where stand replacement is not necessarily a natural fire regime. This is something that does concern us, including the resulting erosion effects through increased sediment load, which can be seen everywhere from the riparian zones down to irrigation systems. It has an effect all through our watershed.

One of the things that we have done is funded projects through the 319 program. We have worked with landowners to show them what can be done in terms of forest restoration. We have a lot of people moving in from the west coast, especially into the Moreno Valley. They are very leery to cut a tree or do anything forest-wise. They think "clear-cut," they think, "oh, wow you can't apply those practices on my land." We are trying to show them that fire hazard is the present day reality. The educational process here is incremental.

Figure 6 is the Taos Pines Ranch Subdivision, the before and after treatment. Not only is the fuel reduction treatment good for the forest health, we think it is also good for the human health. In other words, it is just a defensible space type program that is good for making the human habitation safer and also does a wonderful job of releasing the timber at the same time as enhancing and diversifying wildlife habitat.

We also have some of the ranching areas in the watershed (Fig. 7). We have Piñon/Juniper encroachment; I know there are a lot of different takes on that as far as the ebb and flow of P/J coverage over history. I know it is a natural cycle depending on fire or drought, these types of things. It does impact ranching communities just from the range health situation. We have done some work here to remove some of that fiber.

Figure 8 shows the area of the La Jara/Taos Pines Fuel Break Project. We are working with federal funds and state Water Trust Board funds to the tune of a little over $600,000 to establish a fuel break between Taos and Colfax Counties. This is also a view of our Taos Pines project, and we were able to get additional state and federal funds for this fuel break.

Also, we are very involved in promoting the "Firewise Community." We have in Colfax County a county-wide 'firewise' effort, which is one of few in the nation, and it has just expanded into an interstate

Figure 5. Cimarron Watershed's biggest risk is fire

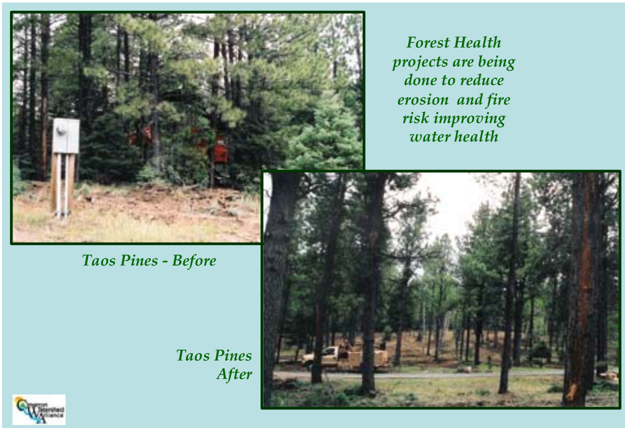

Figure 6. Forest health

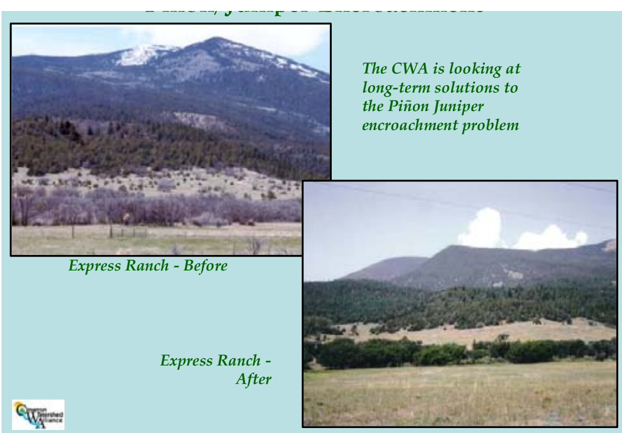

Figure 7. Pinon/Juniper encroachment

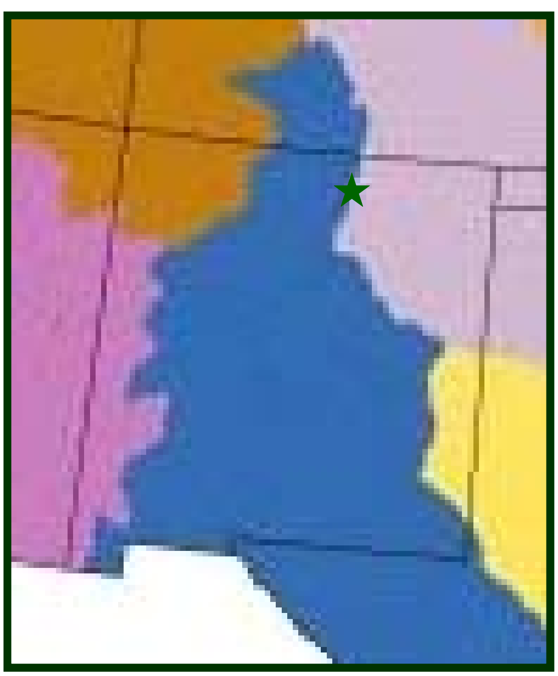

Figure 8. La Jara/Taos Pines Fuel Break

effort with Colorado communities in the Canadian watershed. We are involved with it, and it is the only interstate community 'Firewise' program that we know of.

We have an economic development program where we are trying to bring economically and environmentally sustainable solutions to the timber industry. We are trying to revitalize the timber industry to promote forest health as well as economic development. We think that being in the conversation, we can weigh in on the treatment and harvesting solutions for this industry, help bring it back, and help take some of the fiber out of our forests in a reasonable manner and a sustainable manner. We are certainly looking at that and are very heavily involved in trying to develop sustainable use, especially in the Moreno Valley area.

Regarding erosion control, we have worked with the village of Angel Fire, we have worked with Colfax County roads department, and isolated individual ranches like the Flying Horse Ranch to help them with erosion control projects (Fig. 9). The other picture you see here is of a main drainage, basically a pretty big blowout coming from floods in Angel Fire; we were able to put it in some structures to save a few buildings. It basically eroded into the main drainage.

Figure 9. Erosion control in an arid landscape

We are working with the resort in Angel Fire to look at some erosion control techniques on the ski slopes (Fig.10). I don't know if you have heard of the "poop-and-stomp" technique where cattle are involved. You move cattle in, you put out hay, you seed, and then you utilize that area for a short period of time before moving the cattle off. This technique prepares a seed bed, plants the seeds, and you get an excellent response and often a better response than some other recognized mechanical treatments.

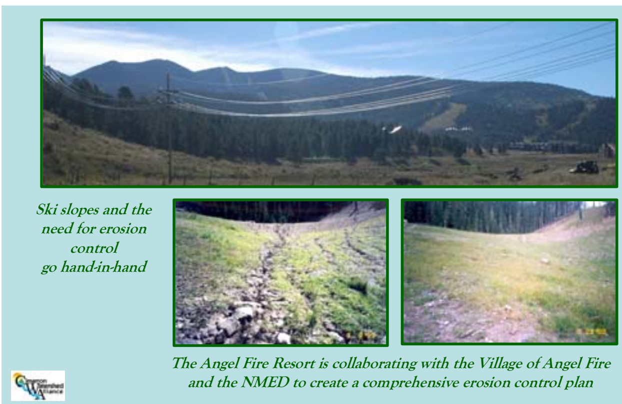

Figure 10. Ski slopes and erosion

Figure 11 shows our riparian restoration. This is located in the Village of Cimarron and is of an individual landowner with land on both sides of the Cimarron River. He let the willows come back in, just a few minor restoration techniques, but basically he got his horses off the riparian area, fenced the horses out, and over a seven-year period he had a nice response. He now has beaver ponds, waterfowl, and herrings. Everyone should see this; it's low-impact, low cost, basically a little fencing and common sense. It goes a long way.

Figure 11. Riparian restoration

Figure 12 is the Moreno Valley again. This is the headwaters that form the Cimarron River and also the Eagle Nest Lake. This slide is of some projects we are working on. The top left is of a ridge where we are going to relocate a shipping corral away from Cieneguilla Creek.

Figure 12. Moreno Valley riparian restoration project

Here, we are getting ready to work on an over-meander of the Cieneguilla Creek that is about to take out a county road. We are putting in some elk exclosures there, trying to stabilize the bank with some willow regeneration and eventually allow the reintroduction of limited dormant season grazing. These exclosures will be large enough for and allow grazing in about three to five years.

Also, these things happen over time, and we realize it takes time to mitigate what's going on. We also look upstream for the causes of riparian degradation. It's one of the things you learn talking to someone like Bill Zeedyk. It's not what's going on here that is necessarily the problem, but what's going on up the drainage, upland from streamside.

Noxious weeds are maybe not our traditional 319 target, but as a nonprofit group we are concerned about this as far as the invasion of noxious weeds into the rangelands, riparian areas, and forests (Fig. 13). So we are working actively with others that are interested in noxious weeds, whether it be the traditional noxious weed type like leafy spurge or the tamarix salt cedar type. We are working with groups interested in that and related issues.

We also have GIS needs. I was on a task force for the Chief Information Officer about how to get this going for the state. It's refreshing data, mapping data; keeping it fresh and accurate is a vital need for

Figure 13. Noxious weeds and non-native plants in our riaprian areas and watershed

Figure 14. Outreach and education

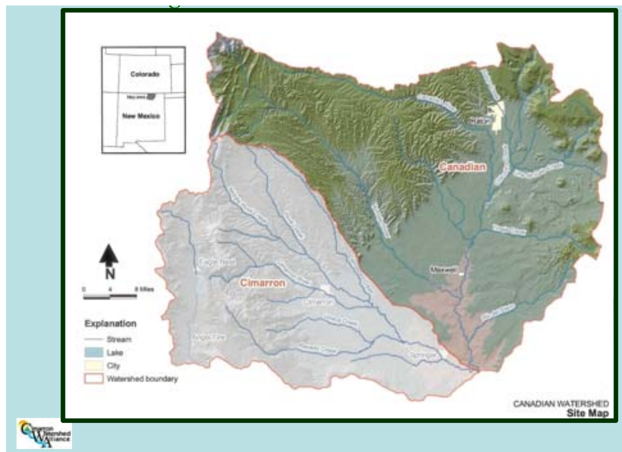

Figure. 15. Assisting the Canadian Watershed Alliance

watershed groups. We need that information on the ground.

Some monitoring things we are doing include bacterial source tracking. I know something similar has been done on the Rio Grande. We've tried it on the headwaters of the Cimarron as well. We are working with Dr. Smith at New Mexico State and we think it is a much needed project. It will take a couple of years and we are taking a lot of samples, baseline samples, then we are coming back with tracking samples and determining what kind of bacterial sources that we have.

We are also reaching out and doing projects in other areas like Sugarite Canyon State Park, which is in the Upper Canadian Watershed. We are developing some of our own monitoring capability and basic tool capabilities: wheel barrows, shovels, these types of things. We are looking forward to the results of this year's monitoring projects with the Canadian watershed as well.

We do a lot of outreach and education in each of these categories (Fig. 14). We've recently been involved in the development of proposed Oil and Gas Drilling Ordinances in Colfax County. Although it did not get passed by the County Commission, we learned a lot about the needs of industry and the needs of individuals during this process. It was a very interesting year-long process. Unfortunately, the Commission did not act on it. As you can see on this slide we are involved in a lot of different outreach and education programs.

Figure 15 shows our watershed, a sub-watershed of the Upper Canadian Watershed. We are working with the residents of the Upper Canadian to develop their own group in that region. This is just a good graph on how we work together. We have a lot of similar needs and talents across these two watersheds. We are trying to develop a relationship there and get a group going.

Figure 16 shows a little bit more about the Sugarite Canyon State Park, which is one of the head waters of the Canadian River and also the primary drinking source for the City of Raton. There are some things that concern us. There is a drilling threat there; mineral rights have been bought up by speculative interests. They say they will exploit that. So everyone is very concerned about drilling in that park. We are trying to keep everyone in the conversation on this issue.

One thing that we have as a group that we've taken a little bit of flack on is our neutral stance. We have not come out for or against a lot of issues such as drilling here or even in the Valle Vidal. The reason we remain neutral is because we have real estate developers, oil and gas exploration interests, as well

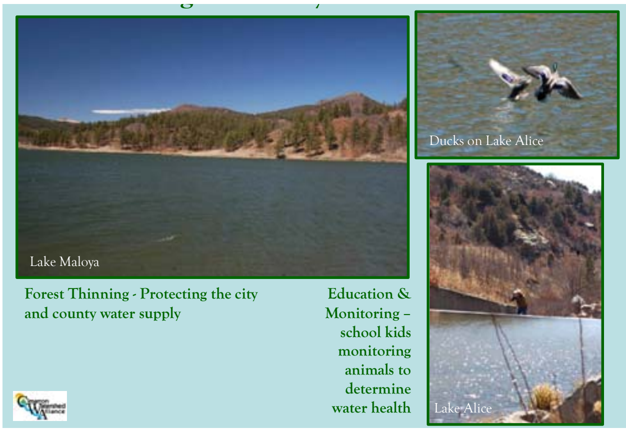

Figure 16. Sugarite Canyon State Park

as environmentalists and ranches among our stakeholders. We get together every month with members of the environmental community, the business community, ranchers, and residents. They can all come together without worrying about one take or the other. Everyone has a say in our meetings and a safe place to say it.

We try to institute best managing practices. We understand private rights are very important. We try not to violate individual private rights. By staying in the conversation we make sure that the best management practices are emphasized in anything that comes across our plate.

We work with other watersheds just sharing our experiences with them (Fig. 17). Anywhere from clerical work and paperwork to interacting with DFA on billing, all the way up to trying to find other funding sources, to personal problems, to stakeholder problems, to volunteer burnout, a whole range of things that go into a good nonprofit organization and problem solving, we are willing to share with basically anyone willing to have us.

We have had maybe some nontraditional 319 workshops trying to bring county roads crews and operators together with practitioners such as Bill Zeedyk and Steve Carson, learning that when they are out there on the motor-grader, how what they are doing interacts with the environment and what they do impacts the resultant runoff into the basin and into the drainage – things they can do to mitigate negative impacts of storm runoff from roads.

I have been on the Governor's alternative fuel task force, and the GIS task force, oil and gas task force in Colfax County. We are trying to weigh in and learn as much as we can about everything that affects our watershed.

With this I will conclude. If you have any questions or comments I'll try to answer them.

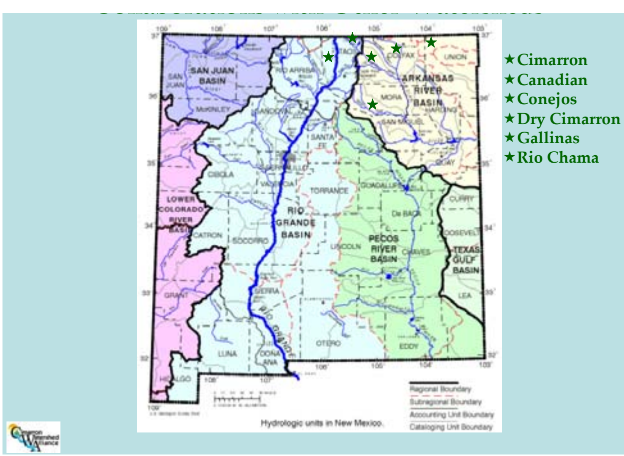

Figure 17. Collaborations with other watersheds

Marcy Leavitt *has worked for the New Mexico Environment Department for 18 years in a variety of water quality programs. Currently she is the Chief of the Surface Water Quality Bureau. Prior to her current position, Marcy was Chief of the Environment Department's Ground Water Quality Bureau for ten years.*

NEW MEXICO ENVIRONMENT DEPARTMENT'S PURSUIT OF A STATE NPDES PERMITTING PROGRAM

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Good morning. As Bobby Creel said, I am here today to discuss the state's efforts to seek primacy for the National Pollutant Discharge Elimination System program, better known as the NPDES program.

As Cindy Padilla mentioned yesterday, we have changed our plans and are not seeking NPDES legislation for the upcoming 2007 legislative session. However, the project is still moving forward. My talk today will be an overview of our efforts.

First, what is the NPDES program? It is the National Pollutant Discharge Elimination System permit program that was created by the federal Clean Water Act in the 1970s to control water pollution. Controlling water pollution is achieved by regulating the discharge of pollutants into surface waters. What this means to us in New Mexico is that the Clean Water Act and the NPDES program were intended to protect our waters from industrial chemicals, nutrients from wastewater discharges, and other contaminants from other sources including our national laboratories. It was also intended to prevent contamination from storm water and to ensure that our streams and lakes provide a healthy ecosystem for fish and other aquatic organisms. Right now in New Mexico, we rely on the federal government to protect our surface water quality by issuing NPDES permits.

In New Mexico we have approximately 120 facilities that operate under individual NPDES permits issued by the U.S. Environmental Protection Agency (EPA). This includes, among others, 52 municipal permits, 36 industrial permits, and three federal facility permits.

We also have approximately 2,000 facilities that operate under three "general" NPDES permits that have been issued by the EPA. One is the CAFO permit that regulates animal feeding operations such as dairies, feedlots, and chicken farms. There is also an industrial storm water permit and a construction storm water permit.

The Environment Department believes that it is critical for the State of New Mexico to protect and manage the quality of the state's precious surface water. The citizens of New Mexico depend on our department to protect our water quality and our environment. Many would probably be surprised to know that the EPA currently has the authority and the responsibility to issue surface water quality protection permits in New Mexico. That being said, I'd like to provide a brief overview of why the department chose to go down the path toward NPDES delegation.

New Mexico is one of only five states nationwide that does not have authority to implement the NPDES program.

First let's talk about the state's responsibilities. The New Mexico state constitution indicates that the state's beautiful and healthful environment is hereby declared to be a fundamental importance to the public interest, health, safety, and the general welfare. It specifically says that the legislature shall provide for control of pollution and control of despoilment of the air, water, and other natural resources of this state, consistent with the use and development of these resources for the maximum benefit of the people (New Mexico Constitution, Section XX21).

This is really the ultimate level of authority in New Mexico and based on it the responsibility for the protection of our environment lies with the state. In the context of today's discussion, the language is visionary. It clearly lays out our responsibility as state leaders and New Mexicans to protect our water quality.

The legislature also had the vision to declare that the state's water is a resource that belongs to the public, the people of New Mexico. Therefore, good public policy must include protection of our water quality.

Furthermore, the federal Clean Water Act states that it is the policy of Congress to recognize, preserve, and protect the primary responsibilities and rights of states to prevent, reduce, and eliminate pollution and that it is the policy of Congress that the states implement the NPDES permit program. These important documents clearly lay out our responsibility as a state to protect our water quality.

As I mentioned yesterday, recent U.S. Supreme Court cases that were decided in June of this year are shaping national water policy. EPA is relying more on the states to fill the gaps left by the federal government. If the federal government continues to limit its role in protecting the state's waters, New Mexico could be left with 90 percent of its waters unprotected. If the state is unable to fill the gap, the greatest impact of inadequate water quality protection will be felt by local governments.

As I'm sure you are aware, many of our local economies depend on clean water. Whether it's our municipal supply, water-based recreation, or sustainable agriculture, the state has the responsibility to ensure that weakened federal protections do not negatively impact our local water resources and our local economies.

Here are some fun facts for you. New Mexico is one of only five states nationwide that does not have authority to implement the NPDES program. In fact, we are soon to be one of four states because Alaska has moved ahead of New Mexico. It is close to achieving delegation for its own NPDES program.

In EPA Region 6, which is the region that New Mexico is in, New Mexico is the only state without NPDES delegation and in the entire Southwest. We are the only state not given this authority by our state legislature. This is in contrast to the fact that in the state of New Mexico, we have authority to implement all other federal environmental programs and to manage all other aspects of the state's water resources.

Beyond the clear responsibility authority for the state to protect its water quality, we believe that there are benefits to a state administered NPDES program. Draft statutes, regulations, program descriptions, enforcement management strategies, and all the other documents that would be used for the foundation of this program are available on the department's website for anyone who wants more detailed information.

First, a state program would place strong emphasis on compliance rather than enforcement. The state can seek voluntary compliance prior to initiation of costly enforcement and penalties. EPA, on the other hand, routinely uses penalties and administrative orders as a first response to violations. This concept is actually included in the proposed statute for this program. We are also committed to providing consultation services to assist municipalities and other permittees in permitting and compliance issues. Permittees can request non-enforcement facility audits, training/education, and other compliance outreach assistance so they can identify potential problems before they become enforcement issues.

State proposals also allow cities to consolidate ground water and surface water quality protection permits to reduce the administrative burden and cost of permitting that are borne by the regulating community. A key implementation strategy for the program is that this will be a joint effort between the Environment Department, the Oil Conservation Division (OCD), and the Mining and Minerals Divisions (MMD) of the Energy, Minerals and Natural Resources Department. OCD will issue NPDES permits for their surface water discharges from oil and gas facilities just as they do for groundwater discharges. MMD will issue coal mining permits just as they do for groundwater protection, and NMED will issue all other permits consistent with groundwater discharge programs. EPA would no longer issue permits in New Mexico once the state has been delegated to administer an NPDES program. Also a state program will provide permittees with global contacts. At a minimum, NPDES staff will be located in Roswell, Santa Fe, Farmington, Las Cruces, and Albuquerque, offices much closer than having to deal with regulators in Dallas, Texas.

At a minimum, NPDES staff will be located in Roswell, Santa Fe, Farmington, Las Cruces, and Albuquerque, offices much closer than having to deal with regulators in Dallas, Texas.

Finally, I will talk briefly about the process NMED has undertaken to gather input in addressing concerns of stakeholders about NPDES delegation. In 2004, we formed a workgroup to prepare a proposal for a state NPDES program. Workgroup participants include representatives from municipalities, industries, dairies, advocacy groups, and affected state and federal agencies. I believe that one of the ongoing successes of this workgroup is that participants have been able to come together, sometimes with heated debate, but mostly in open and honest discussions about issues and concerns. Most workgroup meetings are attended by 30 to 40 workgroup participants. We have received many comments over the past two years from the workgroup and most comments we have been able to address. We will continue to work on program funding over the next year.

In closing, we all know that water is one of our most precious resources. As I mentioned earlier, recent national decisions are putting some of our waters in jeopardy. The state will have to decide how it will fill the gaps left by the federal government. I expect that NPDES delegation will remain an important topic for water quality decision makers.

If you would like more information, you can check our website at: http//www.nmenv.state.nm.us/swqb/NPDES/index.html, or contact me for additional information at marcy.leavitt@state.nm.us or (505) 827-2795.

Thank you.

__Fred Phillips__ is Professor of Hydrology in the Earth and Environmental Science Department at New Mexico Tech. He received a B.A. in earth science from the University of California at Santa Cruz in 1976 and a Ph.D. degree from the University of Arizona in 1981. He has been on the faculty at New Mexico Tech since 1981. Fred's areas of research include isotopic and environmental tracers in hydrological systems, hydrogeology, hydrodynamics of arid-region vadose zones, ecohydrology of deserts, and paleohydrology. He received the F.W. Clarke Medal from the Geochemical Society in 1988, the O.E. Meinzer Award from the Hydrogeology Division of the Geological Society of America (GSA) in 2001, and the Kirk Bryan Award for Research Excellence from the Quaternary Geology and Geomorphology Division of the GSA in 2005.

NATURAL SOURCES OF SALINE WATER IN THE RIO GRANDE

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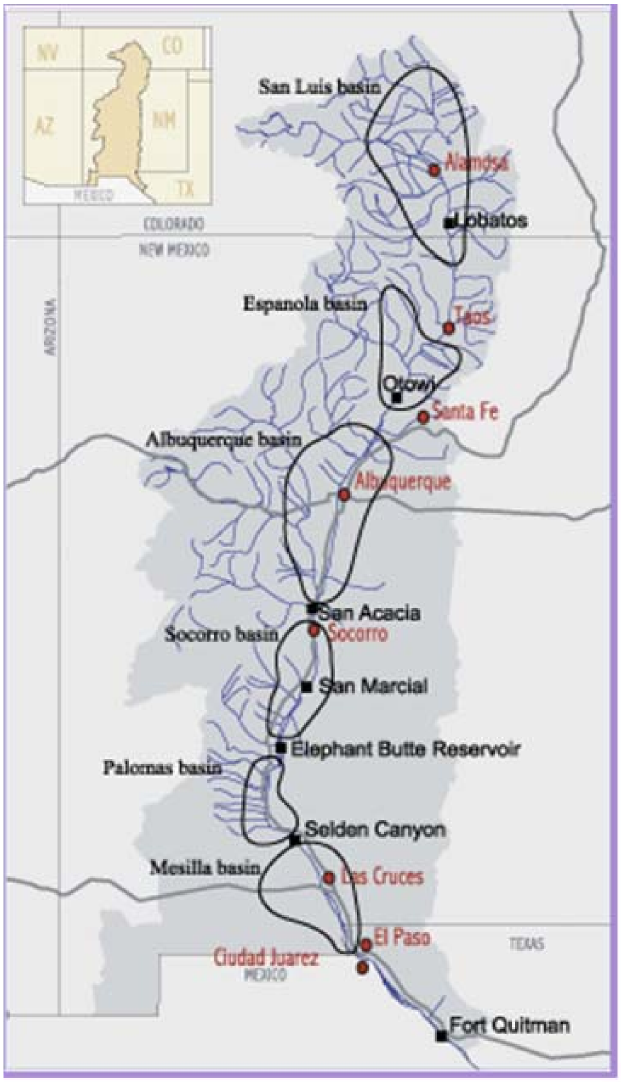
Thank you very much. First of all, I would like to acknowledge my co-authors: James Hogan who works at the University of Arizona and my graduate students Liz Bastien and Suzanne Mills. I would also like to acknowledge the funding through the Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA), which is funded by the National Science Foundation. Here is the study area that I am going to be discussing (Fig.1). It encompasses the Rio Grande from its headwaters in Colorado basically down to El Paso, really all the way down to Fort Quitman, but I will not talk about that too much. This is a geological feature that is formed by the Rio Grande Rift, a long continental rift. It is subdivided into various sedimentary basins that are outlined here. These play a role in the story that I'll talk about shortly.

What is the problem? This is the basic issue. This graph shows the total dissolved solids (TDS) from the headwaters of the Rio Grande down to below El Paso (Fig. 2). There are data from 2000 and 2001. The summer data are in red, winter 2000 data are in green, and winter 2001 data are blue. We start out with about 40 mg/L TDS at the headwaters in Colorado, and as we go down the river this progressively increases. Here is the recommended drinking water limit, denoted by the red dotted line. You can see that south of Elephant Butte Reservoir, for at least a good part of the year, the water is well above that limit. This is a tens of millions of dollars level problem for agricultural, municipalities, and industry in southern New Mexico and in Texas. I am going to address two questions today. Where is this salt coming into the river—what



Basin Area - 32,210 mi^2
Precipitation - 6 to 50 in.
Population - 1,072,000 (1990)
Irrigation - 914,000 acres

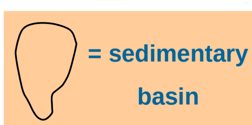


Figure 1. Rio Grande Basin

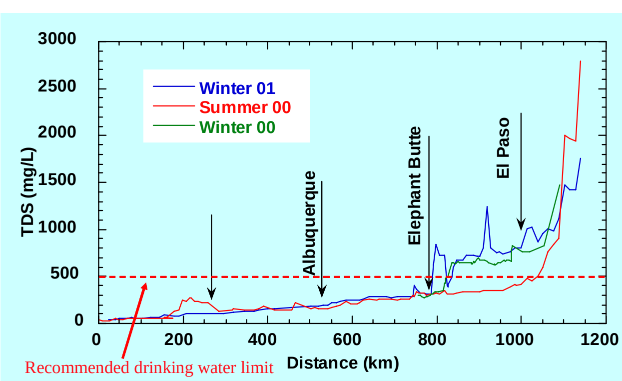


Figure 2. TDS of the Rio Grande

are its sources? Have the changes that people have made in the river system over the past hundred years acted to increase the salinization of the river?

So, where could salt be coming from? The main sources are salts that come into the river through precipitation and weathering of rocks in the source areas for the river. Another potential source is wastewater discharge into the river. Then I have a whole list of them here: riparian transpiration, consumptive use in urban areas, open water evaporation—such as from Elephant Butte, and agricultural evapotranspiration. These are not really sources of salt, but they all serve to concentrate salt that it is in the water by putting quite a bit of water into the atmosphere. The salt stays behind. Finally we have subsurface sources, such as geothermal waters and saline groundwater that we also have to consider.

This is not an easy problem. People have recognized this issue for well over 100 years. It has been studied, and various hypotheses have been put forward. J.B. Lippincott, who was one of the most noted agricultural engineers of the early 20th century, felt that he had identified the source of the problem, saying, “The increase in salinity of the waters of the Rio Grande [is] due to their use and re-use [for irrigation] in its long drainage basin...” (1939). In other words, it is due to evapotranspirative concentration. The United States Department of Agriculture restudied the problem in the 1930s through the 1950s. Wilcox who was the principal investigator in that study came to the conclusion that “There is a relatively large increase in the tonnage of both sodium and chloride from the upper to the lower stations... [that can be] attributed to the displacement of salty groundwater in the course of irrigation and drainage operations” (1957). He does not say where the salty groundwater came from. It could be due to the evapotranspiration that Lippincott mentioned, or it could be due to other sources. He was not clear on that, but both of them pretty much put the blame in the lap of agriculture. Finally, the Rio Grande was part of a larger study done by Van Denburgh and Feth in 1965. They noted that only 4.2% of the chloride burden of the Rio Grande originated from atmospheric deposition over the catchment and attributed the remainder to “continental solute erosion.” This is something different from agriculture, but it is hard to know how useful this is. What do they mean by continental solute erosion?

The traditional approach that all of these previous studies used was to measure discharge and salt concentrations at gaging stations, and they compute the salt burden based on that. We used a somewhat different approach, which was to measure environmental tracers at high spatial resolutions at the river and to interpret those results using geochemical fingerprinting and dynamic simulation modeling. This just shows our sampling points along the river. These are not all of our sample locations. For highest resolution, we tried to sample every 10 kilometers down the river.

Figure 3 depicts the geochemical fingerprinting approach, using samples taken from the river. I show two tracers here: chloride and the chloride/bromide ratio. Chloride and bromide are both halides that operate almost identically geochemically. I plotted this ratio against the concentration of chloride, going from low to high concentration. Here is the sort of fingerprinting. Meteoric waters, which mean just basically precipitation and runoff, have low values of chloride concentration. As we see, it is less than 100 mg/L certainly. It also has low values of the chloride/bromide ratio. Geothermal waters have fairly low chloride concentrations and a somewhat higher chloride/bromide ratio. We see sedimentary brines are high on both of these. The reasons why these things have these patterns are well known. I am not going to take the time to go into it today. Notice we have a star here which represents a particular sedimentary brine of which I will give you the origin in a minute.

If Lippincott's hypothesis is right and it is just evaporation that is working, we would see this meteoric ratio in the headwaters of the river stay the same, but the chloride concentrations would increase. On the other hand, we could have increases in salts through the mixing process (this is a mathematically computed mixing line), in which case we would expect the sedimentary brine concentrations to follow along this line and the geothermal concentrations to fall in between those. What do the actual data do? Here is what they do. This is going from the headwaters of the Rio Grande down through El Paso. We see that they fall quite close to this mixing line.

Figure 4 shows a somewhat different set of tracers. Again, the chloride/bromide ratio, but now we have chlorine-36 which is a radioactive isotope of chlorine, over chlorine itself. We have a double ratio type of plot here. On this type of plot, the headwaters have high chlorine-36, which is from production of this isotope in the atmosphere. Geothermal waters have much lower chlorine-36 and also a relatively low chloride/bromide ratio. Sedimentary brine waters have low chlorine-36, but a high chloride/bromide ratio. They are quite distinct on this plot. On this one, if Lippincott's hypothesis is right, all of the samples will fall over here because neither one of these ratios will be affected by evaporation. On the other hand, mixing will cause them to fall along the line like this. Mixing with the geothermal water will cause it to fall along a line like that. What do the actual data do? They fall very nicely along the mixing line from the headwaters down through El Paso. We can come to a pretty firm conclusion.

Our preliminary or interim conclusion is that a large part of salinization in the Rio Grande is due to seepage of deep brines that are basically of sedimentary origin.

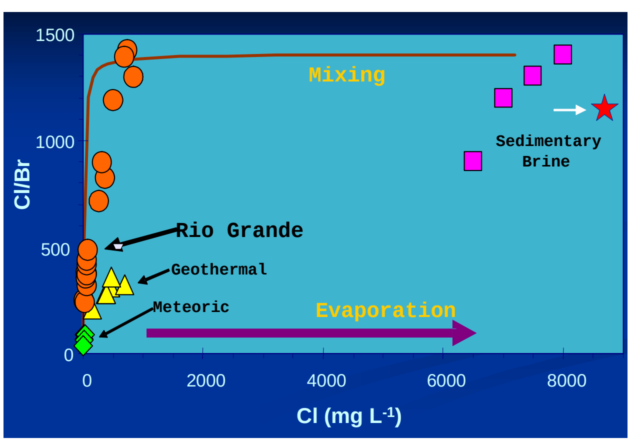


Figure 3. Geochemical fingerprinting using chloride and chloride/bromide ratio

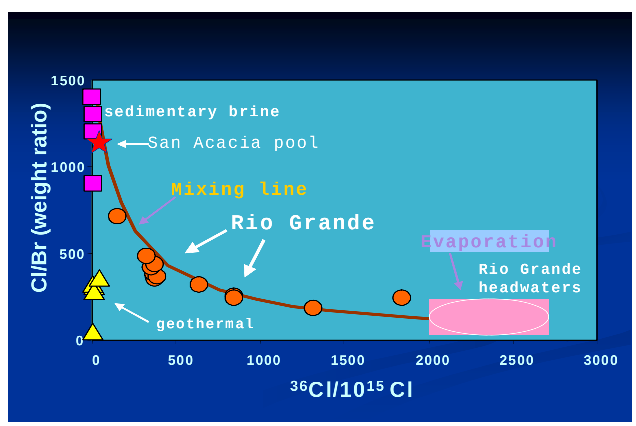


Figure 4. Geochemical fingerprinting using chlorine-36/chlorine and chloride/bromide

Where are these brines that are in the Rio Grande? Is there a pattern here? Here is a plot of the chloride/bromide ratio as a function of flow distance with various points along the Rio Grande identified. You can see a general trend and increase. Let us look a little bit more closely at this trend of increase. It looks kind of smooth if you just look at it overall. If you look at it in detail, you see that from the headwaters up to somewhere in between the state line and Albuquerque, there is a pretty constant ratio and then there is a jump upward. That jump upward is somewhere close to Albuquerque. It turns out that this particular jump is due to the Albuquerque wastewater treatment plant. Then, following Albuquerque, there is another fairly flat trend and a jump upward close to San Acacia. From San Acacia it is flat for awhile, then at Elephant Butte Reservoir it rises again. From Elephant Butte it is flat again, rises a bit at Seldon Canyon, and finally south of Seldon Canyon it is flat for awhile and jumps up at El Paso. It is really sort of a stepwise increase, not continuous input.

So where are the points of those steps? Figure 5 is a similar diagram to the last one I showed you; it has been somewhat expanded. You can see where the salt is coming in. If we look at the first place that we have a big jump in the salt concentration, it is at San Acacia. Here is that jump, and we see San Acacia identified there. Then, here is the next jump, which is down at the Elephant Butte area. Another one at the Seldon Canyon area right there, and finally El Paso itself down there. If we look at that in terms of the structural geology of the Rio Grande Rift, what we see is quite interesting. Here are the basins identified. You see that north of the Albuquerque basin you do not see those kinds of jumps, but south of the Albuquerque basin the jumps occur at the southern end of each one of these basins that form the Rio Grande Rift. Is there a logical hydrogeologic explanation? Yes, there is. Figure 6 is a cartoon of these various sedimentary basins. You see the water flows down at the north end of the basin, upward at the south end, and out, and that is where each one of those stars happens. It looks like it is the natural basin dynamics that are forcing out these saline fluids at the south ends of the basins.

Have we actually caught these brines seeping out? The answer is yes we have. First of all, we are going to look at the south end of the Albuquerque basin where you see the circled point here. We started poking around there and came up with this saline pool, which is right at the very southern end of the basin. It has

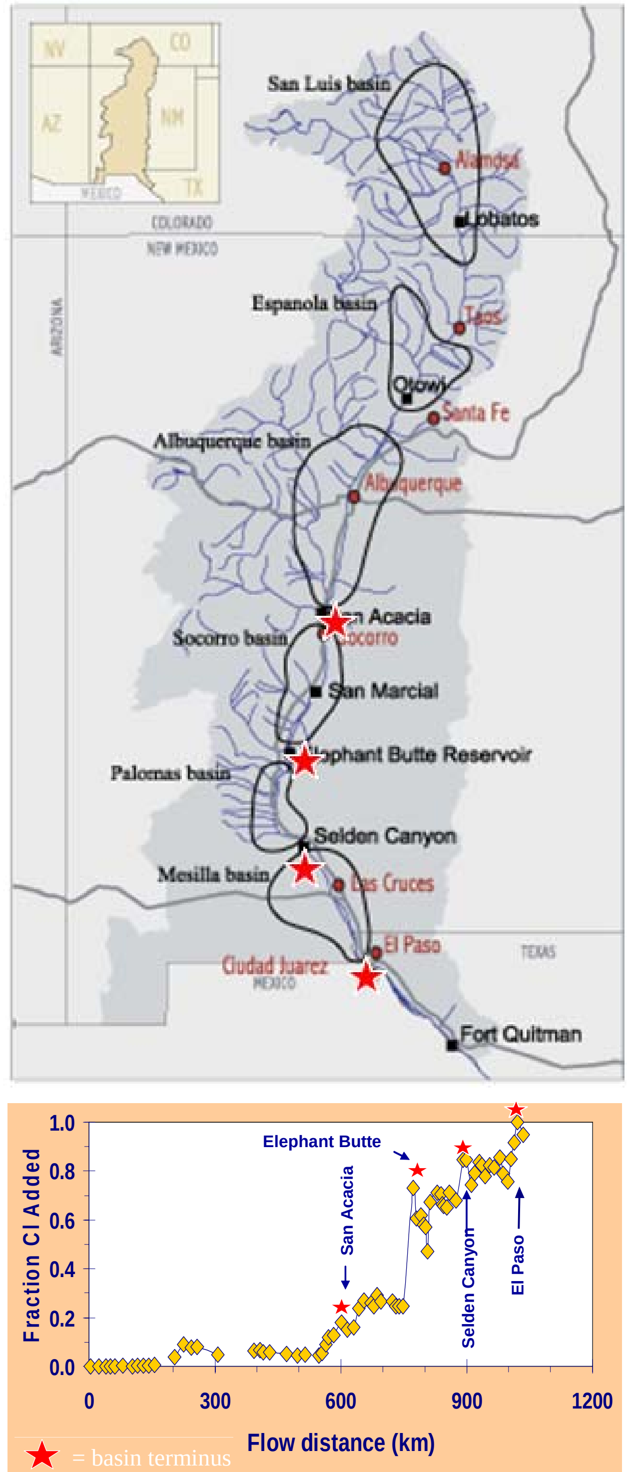


Figure 5. Points of salt addition; rraction Cl added vs flow distance

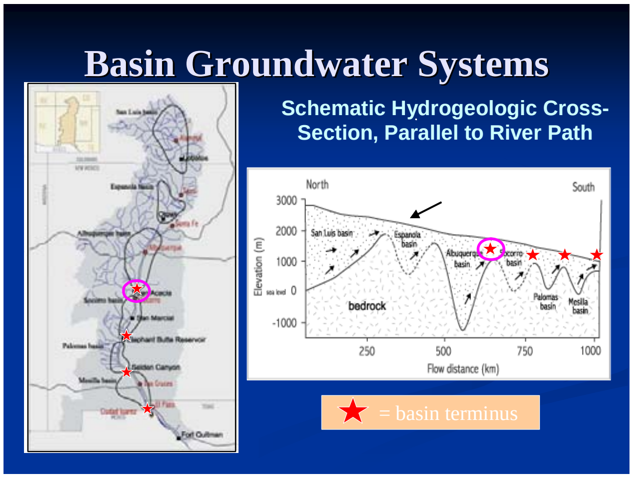


Figure 6. Basin groundwater systems

chloride at a concentration of 32,000 mg/L, which is pretty briny. It was the point that formed the star on the previous diagram. It is right in the sedimentary brine field.

Next, I am going to look at this point right here, which is at the El Paso narrows. This isn't work that we actually did. I am going to report some very interesting work done by the Interstate Stream Commission. They decided to test our hypothesis and see if these brines were going to appear where predicted. They went to the southern end of the Mesilla Basin. Figure 7 is the outline of the Mesilla Basin, and here are the El Paso narrows where the Rio Grande cuts through the structural end of the basin. Right there, they drilled a well, which they named ISC-4. This is a cross-sectional view of the same thing. This is north, and this is south. El Paso is down here. Mesilla is up here. The Rio Grande obviously flows from north to south. This is the basin discharge that we infer is happening. This is the bedrock. Here is the basin fill. It is stepping up here. They put their well right there where it would intercept that basin discharge if it were really coming out.

What did they find? Figure 8 is the same plot I showed you before, but I have expanded the scale a bit. Here is the result: they have about 18,000 mg/L of chloride and a TDS of 30,000 mg/L, which is certainly within the sedimentary brine area. It was very gratifying to see it on the first try of where someone is going to go look for the brine. It is indeed there. The sites of the brine leakage are along structurally defined pathways, and they can clearly be defined. They are not just hypothetical. You can go out and sample; you can drill; and you can find them.

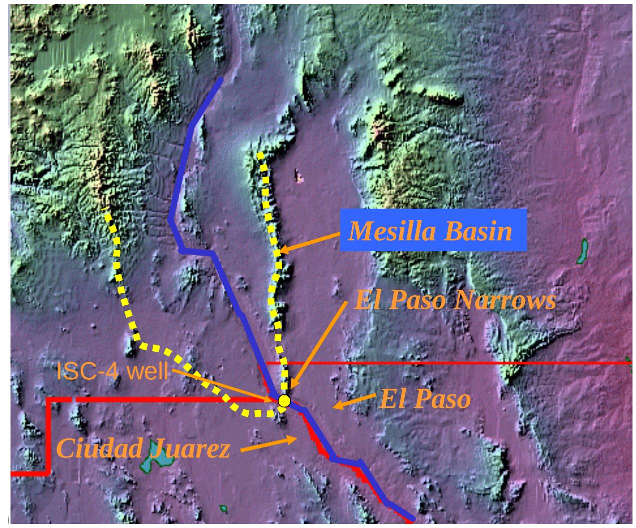


Figure 7. The Mesilla Basin

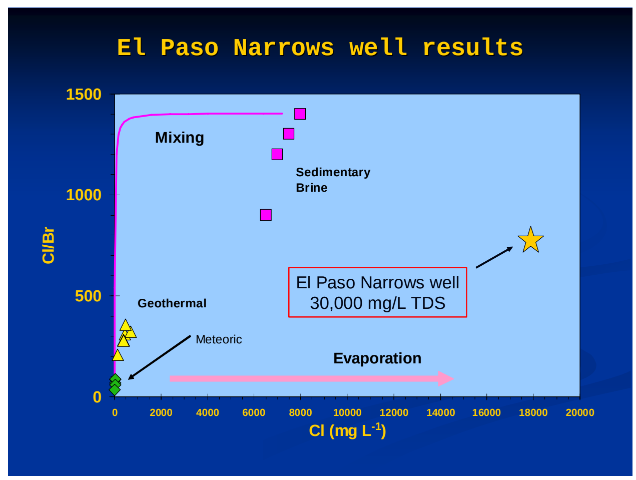


Figure 8. El Paso Narrows well results

What about the role of agriculture? Lippincott and Wilcox and all those people pointed the finger at agriculture. How big of a role does it play? This is the chloride/bromide ratio here, and this is the chloride concentration. This is the same kind of plot as earlier. In fact these are the same data points. It has just been expanded so you can see them better. They are color coded so they go from blue at the headwaters of the river to red at El Paso. The blue here is the San Louis basin. All of these here are simply analyses of the Rio Grande itself. You see this progressive increase in the chloride/bromide ratio as chloride goes up and sedimentary salt is added in. What I am going to show you now are the drains coming out of these agricultural areas in purple. First, we will look at the San Louis basin drains. Here are the drains. They are right in the field with the water. That says that the drain water is pretty much the same composition as the water that is coming in. We are not seeing a lot of added salt coming in. Next, we look at the Albuquerque basin. The drain waters are right in the river waters, no big difference there. Next is the Socorro basin in green. What we see is that most of the water from the drains is pretty much the same as the river water, with one bad apple right here. Next, we have the Palomas basin in orange. Now, we start to see something different. The waters that are coming in are considerably higher in chloride and chloride/bromide than the river. Finally, the Mesilla Basin is in red. Once again, these data points are way out here. For most of the river, the drains are simply returning water of similar quality to the river. It is only when we get to the Palomas and Mesilla basin that these drains begin to tap into the deep geological fluids that are seeping up.

Let us look at that one point for the Socorro basin that I showed you before. The green points are ones with ordinary groundwater quality. The red points are ones that are characteristic of these brines. The big one in the Socorro basin is the one that is right there near the little town of Luis Lopez. This shows a schematic of the water system in the Socorro area. Figure 9 shows the San Acacia diversion dam, the Rio Grande. Here is the Socorro main canal. It receives water from the Luis Lopez lateral drain that goes in here. The whole system drains into the Elmendorff drain. That in turn goes into the main channel. The chloride in the Rio Grande appears to be about 300 ppm. It flows down here, and it gets water from the Luis Lopez drain, and it is about 1,200 ppm. Below the junction, it goes from about 300 to 545 ppm. The conveyance channel goes from 336 ppm to 413 ppm above and below here. Above the conveyance channel, the Rio Grande has about 306 ppm and chloride 30 ppm and chloride/bromide 306 ppm. Below the conveyance channel, the Rio Grande has 386 ppm, chloride 66 ppm, and chloride/bromide 376 ppm. We see that chloride doubles, and the chloride/bromide ratio increases by about 30 percent, where this one source comes in. It is clear that relatively small, discrete sources can have a significant impact on the chloride and the salt burden of the entire river system.

Here is a summary of our results that I have discussed so far. Salt addition occurs in a stepwise pattern. Salt is added at San Acacia, Elephant Butte, Selden Canyon, and the El Paso narrows. Also the T or C hot springs plays some role. Salt is either connate fluid—that is, ones that were there when rock was

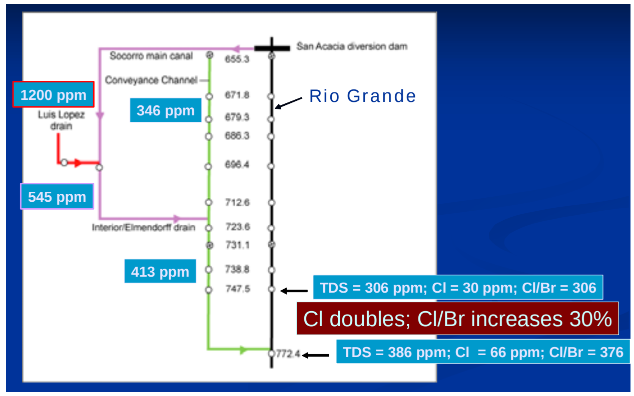


Figure 9. Drains pick up deep-basin salts

deposited in the ocean—or from long-term rock/water interaction.

I want to make a couple of quick points here. Wastewater does play an important role, especially in the Albuquerque and El Paso wastewater treatment plants. They are a significant component of the salt burden in the Rio Grande. What about the influence of long-term climate patterns? These are data from the Rio Grande from the headwaters down to El Paso. The blue points here are nondrought years. The ones that are in red and green are drought years. You see a very distinct difference between TDS concentrations of the river for those different time periods. It is clear that we have continued issues with prolonged drought. The water quality problems are going to get significantly worse.

One of the problems that we face is that chloride concentrations and loads are highly variable in time and in space. In order to overcome that, we use the dynamic modeling tool, called Powersim, to understand these budgets and variability of the solutes. This is a schematic of the model. I do not really have time to go through it. This is a water model. This is the chloride model. Figure 10 shows the output from the model. This is the chloride burden at San Acacia. The red line is the actual data. The dark blue line is the model result. It matches really very nicely. I was very pleased about the simulation. Here is the chloride budget of Elephant Butte Reservoir with the same color scheme. Again, really quite a good match over quite a long period. We feel that the model performs really well. I put Figure 11 together to summarize the results of the model. This is the average annual chloride burden in tons of chloride per month. These are various locations. Here is the mainstem input, above Lobatos when the river is coming out of Colorado. Here is the contribution to the chloride budget from tributary inflows. What we see here is basically the Rio Jemez and the Rio Puerco and the Rio Salado. Below the Rio Salado, there is not much tributary inflow, anyway. This is input from wastewater treatment plants. The big ones here are the Albuquerque wastewater treatment plant and the El Paso wastewater treatment plant. Finally, here is the input from subsurface brines. These are cumulative. Each one of these is built on the next one. Deep brines plus tributary inflows, which are basically the same kind of salt, account for about two-thirds of the chloride increase in the Rio Grande down through El Paso.

The last question here: are modern practices responsible for worsening water quality, perhaps by increasing brine inflow? In order to answer that question, I am going to look at two studies: the study by Wilcox done from 1934-1950 and a study by the USGS hydrologist Stabler from 1905-1907. He measured water quality at San Marcial and El Paso for that time period. Figure 12 is the summary of Wilcox's dataset, in comparison with modern data. This is again the average monthly chloride burden, and these are the different sites for which the monitoring was done. The 1935-1950 dataset is in blue. The modern period is in the dark color. What you see is that in all of the stages, the 1935-1950 chloride burden is higher than that for the more recent period. We could hypothesize and go on about possible explanations for this, but it is clear that the processes over the 20th century time period have not acted to increase the chloride burden of the Rio Grande.

Next I will look at the Stabler dataset. This is a really valuable dataset, because this was taken before Elephant Butte dam was constructed. I am going to show you this in terms of monthly chloride concentrations. This is at San Marcial. Here is the concentration in mg/L. Here is the modern monthly value. It is low during spring runoff in April and May, high in the winter. Here is what Stabler found. I was struck when I compared these two initially by how similar Stabler's data are to the modern data. I would have expected a lot more change. The main difference is that there are lower concentrations in spring runoff, which of course was much larger back then and higher concentrations in the fall.

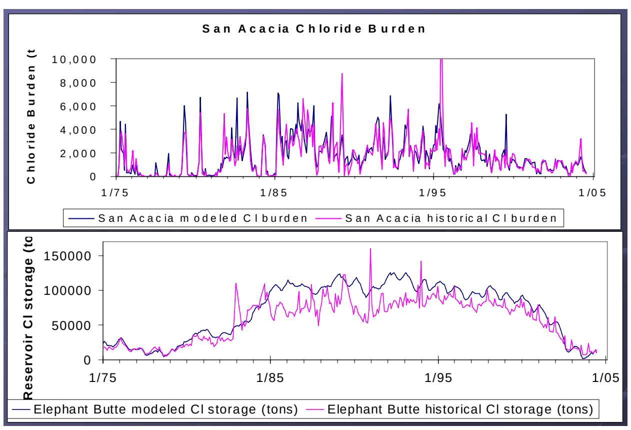


Figure 10. Model results with brine inflows: Cl burden

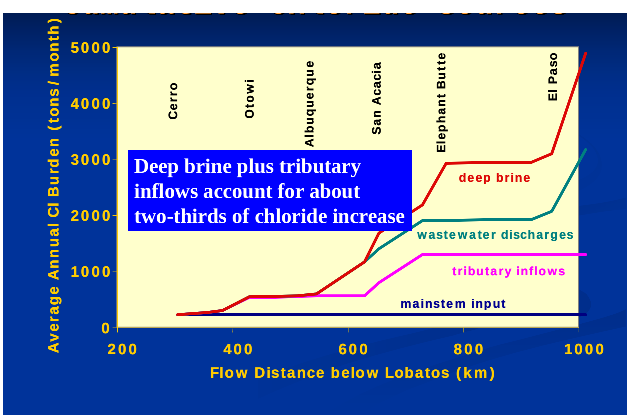


Figure 11. Cumulative chloride sources

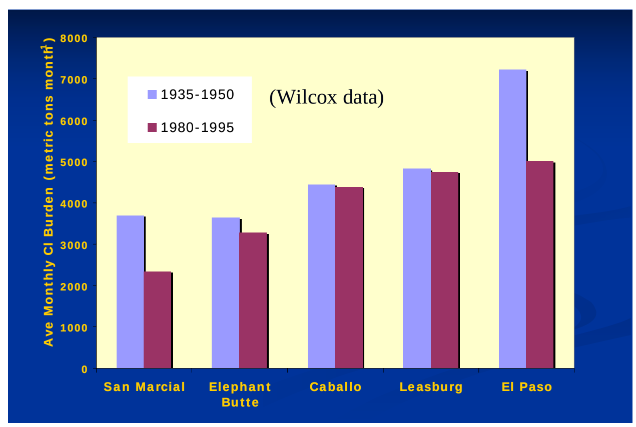


Figure 12. Monthly chloride burden

Now let's look at El Paso (Fig. 13). This is the modern pattern at El Paso. Here it is again low when the water is released from Elephant Butte Reservoir in the spring and summer and high in the winter when the gates are closed at Elephant Butte. Here is what Stabler found. Very interesting. It is lower in the spring part of the year when there was much more runoff coming through. The flows were much higher then. But during the period from July through November the concentrations were much higher. The water quality was in fact significantly worse during that time period.

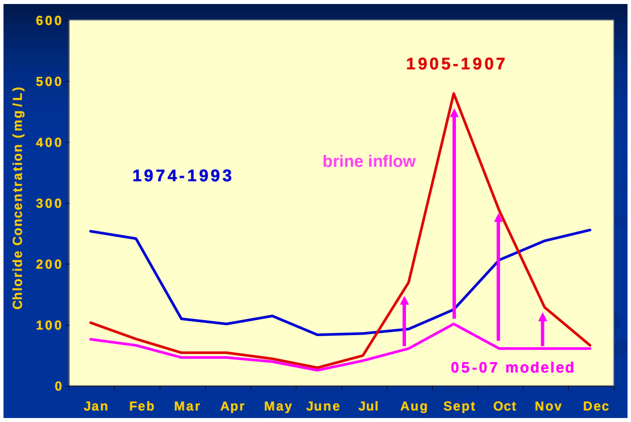


Figure 13. El Paso chloride

I had Heather, my student, run her model with Elephant Butte and all of the additional agriculture since 1960 removed. Here is what she found. This is the model. You can see that during the early part of the year, it matches beautifully. In this autumn part of the year, the match is very poor. Why is the match very poor? It is because she did not include the brine input in this model. If we add in the brine input, that is basically that difference. It is clear that this major brine inflow was happening back in 1905.

About two-thirds of the chloride in the Rio Grande is from some form of geologic salt, either brine leakage or tributaries. Brine leakage is localized along structural features, faults that are at the southern end of these basins. It is not just a diffuse seepage coming up. That means that it is possible to conceive of putting in wells and pumping that brine and disposing of it somehow, thereby improving the water quality of the Rio Grande. The brine leakage predates development of the river by people and may actually have decreased during the 20th century. Finally, although agriculture certainly does contribute to the salinization of the Rio Grande, it probably does not have a primary role in doing that, contrary to the inferences of Lippincott and Wilcox. Thank you very much.

Question: Have you looked at sulfate? It would appear that as you are going from the upper part of the Rio Grande all the way down to El Paso that you are looking at the flow of the basin from north to south rather than laterally from mouth-front recharge zones primarily in the eastern part of the basins. Can you clarify that?

Fred: In answer to the first question, we are looking at sulfate and other reactive solutes in the river system. However, it is a much more complex problem than chloride which has the simplest geochemistry. We have not analyzed all of that data and modeled it yet. In answer to the second question, the model basically looks at the solute budget by modeling all of the known and quantifiable inputs and transport of chloride and then looks at the residual that cannot be explained from the deep processes. It is not distinguishing between lateral inflow and inflow that comes in parallel to the river. It is not a spatially distributed model.

***Arvin Trujillo** is the current Executive Director for the Navajo Nation's Division of Natural Resources located in Window Rock, AZ. The Division of Natural Resources consists of eleven departments, which oversee all aspects of natural resource management and development on the Navajo Nation. Arvin has held this position since 1999 and during a six-month period, he also was the interim Chief of Staff for President Kelsey Begaye in 2001. Before joining the Navajo Nation, he worked for both Broken Hills Proprietory, Ltd (BHP) and Mobil Coal Producing, a branch of Mobil Oil, as a mining engineer. Arvin has been a past Board of Directors member for the American Indian Science and Engineering Society, and he has also been an interim Executive Director for the organization. Arvin attended Oral Roberts University for his undergraduate work and Pennsylvania State University for his post-graduate work.*

WATER QUALITY ISSUES ON THE NAVAJO NATION

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Thank you. Good morning everyone. I am the executive director for the Division of Natural Resources. The division is comprised of 11 departments within the Navajo Nation. We have about 550 to 600 employees taking care of all aspects of natural resources within the Nation, including water. Water is one of our areas of responsibility. Many of you are aware of the Navajo Nation and what it is comprised of, but I'll give you a brief introduction. The Navajo Nation is located within New Mexico, Arizona, and Utah. We have about 17 million acres of land within the three states area. We have 110 chapters, which are local communities and political entities at the local level. The last census determined that there are about 170,000 people living on the reservation. In terms of looking at water quality, what I want to do is develop a presentation that looks at water use and how use affects quality and how we want to define water quality.

There are three basic water uses on the Nation: domestic use, agricultural and livestock use, and industrial use. Two primary departments are involved with water quality: the Department of Water Resources, which is under the Department of Natural Resources; and the Navajo Nation Environmental Protection Agency, which is a division unto itself. I want to discuss the three basic areas where we utilize water and how they have developed.

In terms of domestic use, most of the water systems within the Nation are under the authority of the Navajo Tribal Utility Authority (NTUA). About 60 percent of the population has water systems under this authority. Water quality is not nearly as much of an issue as water quantity is for the authority. Most of the water that is obtained in these systems is groundwater. Because we are working through the authority, they have to meet certain federal regulations, specifications, and requirements. Again, there are other areas within the Nation that do not have adequate groundwater in order to use these systems and that is an issue that must be looked at. We have some privately owned systems. Some businesses have their own systems that are permitted through the Nation. The National Park Service has a couple of parks that have their own systems. Some church entities have their own well systems. The Department of Water Resources has about five small domestic systems that they take care of.

About 40 percent of the population does not have access to running water.

There is also another part to this. About 40 percent of the population does not have access to running water. These people haul water on almost a daily basis. There are two ways to haul water. One is to obtain water from designated water points within the Nation that are administered by NTUA through the chapter houses. But some of these homes are far from these water points. We do have livestock watering areas throughout the Nation. Many people go to those areas to pull their water from the wells. The constraining aspect of this is the cost. How much does it cost to haul that water and what distance are they hauling it? These stock wells and windmills are not monitored by any regulations or criteria, and there are issues in terms of pathogens and contaminants. About 95 percent of these systems are from groundwater; there are very few that use surface water for their domestic systems. Even there, some issues with fire and floods exist, and we have seen that in recent years. In particular the Navajo Mountain area, which is located along the Arizona/Utah border, has had some major fires and flooding that has led to contamination of surface water collection systems. In both areas for about the past six months, we have had to haul water to the residents.

What are we doing to address these quality issues? The Navajo Nation Environmental Protection Agency (NNEPA) has obtained primacy to begin developing a safe water drinking program. We do have primacy through the act that passed in 2005. We are at the beginning stages of developing a program not only regarding the necessary regulations, but also how to monitor the different systems throughout the Nation. One of our concerns that we see in terms of water quality is that there are several areas where drilling, whether it be for energy purposes or livestock use, has been abandoned but well heads are still in place. Those well heads have not been properly closed, allowing the groundwater systems to become contaminated. There is a well head protection program that the NNEPA has instituted, and they are beginning to address that issue.

The Navajo Nation has a memorandum of understanding with the Bureau of Reclamation to begin partnerships not only with the bureau but also with the Indian Health Service and the Corps of Engineers to look at how we can develop and expand water lines connected to the groundwater systems within the Nation. We have been better able to identify the sources for these systems and have developed what we call the Navajo Nation Water Strategy. This strategy has helped us identify areas that we need to look at for groundwater efforts as well as surface water aspects.

How do we develop surface water aspects? I know many of you here in New Mexico are aware of the work that the State of New Mexico and the Navajo Nation are doing in terms of the San Juan Basin area and the Water Settlement Act. We are working on the western portion of our reservation to address issues in that area and to develop surface water sources for further water development.

When you look at agriculture and livestock, you are immediately looking at rangeland water quality issues. Like any area in the West, there are four aspects to look at: sedimentation, nutrient loading, pathogens, and heat transfers. A lot of this is tied to overgrazing, the effects of erosion, and the effects of large precipitation events that occur. It is a cycle that we are beginning to see. First there is overgrazing and then we get to the monsoon season and experience flooding. The low-wash areas become flooded and sedimentation occurs. As that happens, nutrient loads and algae growth increase in our lakes and streams. As that begins to happen, the drought that we have been experiencing also comes into play as animals congregate in areas around lakes, watering holes, and low-lying streambeds. As they do gather, their waste is deposited in one area. With precipitation, all of these contaminants are flushed downstream. With reduced land cover, streams and lakes will increase in temperature and that affects the recreational capabilities of many of our stream areas.

Another factor to look at is farming. Individual farms do not have a large impact as most of the farms on the Navajo Nation are anywhere from 15 acres to much smaller plots. The only real impacts that we see are collective: if areas are laid fallow because of drought or because of an inability to get water to certain areas, then we start seeing sediment and nutrient loading from fertilizers and pesticides. In contrast to the small farms, we have the Navajo Agricultural Products Industry (NAPI) farm in Farmington. Right now, there are currently between 60,000 to 70,000 acres in production. The potential for production is about 110,000 acres. As with any commercial farming endeavor, there are issues with fertilizer and pesticide use, selenium leaching, drainage, erosion, and sedimentation. We also have a feedlot operation. The NNEPA has been working very closely with our farming operation to monitor those areas and to make sure that we address any detrimental effects from the runoff or discharge from the irrigation system.

What is the Nation doing regarding rangeland? It is an education process. We are looking at how to amend our grazing laws and how to improve our grazing practices. With the Navajo Nation, when you begin to talk about grazing, you begin to touch a very sensitive area for many of our people. When you begin to talk about changing grazing laws, you immediately hear, especially from the elderly, talk about BIA superintendent Collier at the time when livestock was being reduced without their input. A lot of these stories begin to circulate. Again, it is an education process on our part to improve grazing practices.

How do we begin to address watersheds? How do we begin to address grazing? The NNEPA has become more involved in non-point source pollution. We are now looking at the restoration of watersheds and we are working more closely with state and federal agencies. We have been working very cooperatively, and it is taking a lot of coordination to achieve some of the things we have been able to achieve, especially in the Asaayi watershed, which is along the Arizona/New Mexico border. We have had three agencies, two chapters, and three of my departments working on the Asaayi lake watershed effort. We have it completed. We not only had to coordinate efforts but also funding in order to fix the lake and the recreational areas and to reestablish the watersheds downstream so that families can begin farming in those areas. People are beginning to come back and farm those areas again. We are beginning to see good success in that effort. The NNEPA continues to work closely with our NAPI operations to monitor their operations to make sure that discharges are being maintained and that they are meeting regulations. We also are working with the Environmental Quality Incentives Program (EQIP). It is a learning process for our people. It is teaching our folks how to begin to take hold of their particular ranch, farm, or other land use area, to work on conservation efforts, and to provide labor in the cost-sharing effort so that we can improve all watersheds, improve grazing and land cover.

In contrast to the small farms, we have the Navajo Agricultural Products Industry (NAPI) farm in Farmington. Right now, there are currently between 60,000 to 70,000 acres in production. The potential for production is about 110,000 acres.

We are working very hard to establish a good relationship with the Department of Agriculture. From my experience working in this position, Indian country has not really gotten involved with the Department of Agriculture. We are learning a lot. When I first started in this position in 1999, I would go to Washington and talked about trust and responsibility. When we talked about that, most of the departments would look at me and tell me to go talk to BIA. It was a teaching process. We had been very used to working with the Department of the Interior, the BIA, the Bureau of Reclamation, and the Bureau of Land Management, and there is a culture and a way to work through the Department of the Interior that is different from the way that you work with the Department of Agriculture, which deals with producers. It is a whole different concept, but Indian country is beginning to learn how to do that. We are beginning to develop better relationships. We are learning how to work with states. We are learning how to compete, how to bring projects forward, how things work.

We are also looking at the industrial use area. Compared to domestic and agricultural use, this area is not as extensive on the reservation as we would like to see it. We must prepare ourselves to look at further development, especially power plants. We have two working power plants: the Four Corners Power Plant, which is just 30 miles outside of Farmington, and the Navajo Cogenerating Station, which is about seven or eight miles out of Paige, Arizona. Those two operations utilize about 30,000 acre-feet of water. It is a closed system. We continue to monitor them along with the Office of Surface Mining (OSM) and EPA. We have not seen real impacts in that whole aspect, but it is an issue of water quantity being utilized and not quality. We are now in the process of permitting the Desert Rock Project, also in the Farmington area. We are looking for a dry-cool system. Instead of 30,000 acre-feet, they are looking at about 4,000 acre-feet per year of usage. We are studying how we can begin to improve in that area. As I said, water quality is monitored closely and we have not seen any significant issues as far as water quality goes.

...we are trying ...to achieve a better quality of life for our people.

We are also working hard on uranium that has the effect of passing radioactivity through parts of our reservation, especially by the mining and milling activities that were active in the 1940s and 1950s. The Uranium Mill Tailings Remedial Action (UMTRA) program is under the Division of Natural Resources. We are looking at four major sites in terms of remediation: Shiprock, Tuba City, Mexican Water, and Cane Valley, which is along the Arizona/Utah border. Most of these sites were dealing with both nitrate and phosphate contamination from groundwater. There are times when we have seen some low-level radiation in some areas of the groundwater. We have not seen anything of significance. We have been going through a cleanup effort. This has been done in conjunction with the Department of Energy. We are working on different processes, some of which are pilot projects with the Department of Energy to determine the best ways to remediate these types of contaminants within the Navajo Nation.

Along with industrial uses, we are looking at mining aspects. Quantity is more of an issue than quality when we look at mining. There are discharges at times, which are being monitored. Most of the water is collected through sedimentation ponds. Most of that water is reused as dust suppression. Other water used in the plant areas is also being used for dust suppression. Manufacturing uses of water on the reservation are fairly limited at this time. We are beginning to put processes in place to begin to address this aspect.

In closing, the Nation is looking at water quality issues, just like any other community or region within the United States. We are all dealing with very similar issues and learning how to deal with those issues. We are putting the necessary programs and monitoring processes in place to address those areas. The area of most concern is domestic use. What we are trying to tackle at this point is the fact that 40 percent of our people still haul water. That is an area that we are trying to focus on in order to achieve a better quality of life for our people. As we do that, we learn from experiences outside the reservation in order to address those water quality issues inside the Nation.

Question: Is the Nation prepared to provide funding for these water systems to private enterprises?

Arvin: Yes. The Nation is looking at how we can partner with other groups and looking at cost-share development. We are looking to collaborate with the Indian Health Service and the Bureau of Reclamation and some of the other government agencies so that we can all pull funding together to get these water systems in place.

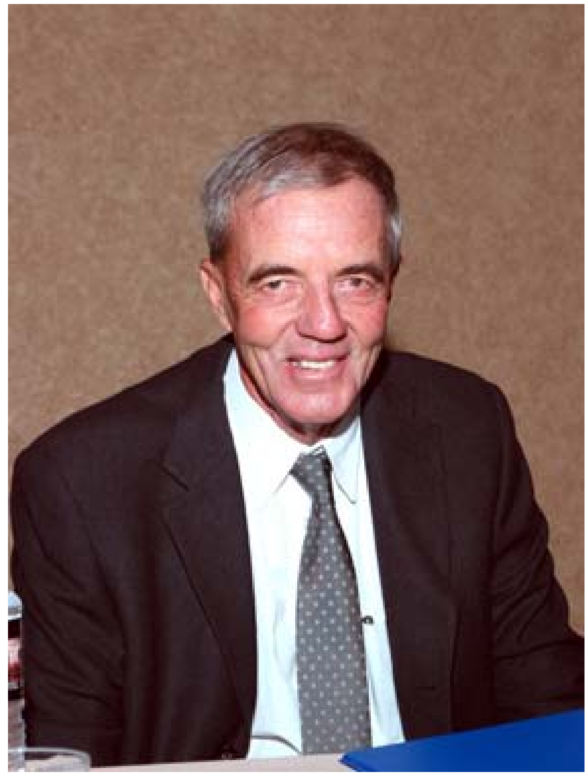
Question: You mentioned that 40 percent of tribal members are hauling water. I know that for some of your chapters it can be up to 90 percent that are hauling water from the livestock ponds that are associated with your windmills. Is the tribe looking at fill stations and closed storage tanks that tribal members could haul water from rather than taking it directly out of the livestock tanks?

Arvin: Right now we are looking at different strategies for how we can address that problem. Now that we have the EPA on board, we are beginning to tackle that. The issue comes back to how we are to develop the funding aspects to achieve that in a timely basis. That is a part of our water strategy. Now we have to figure out how to pay for it.

Question: I have been involved in groundwater hydrology and water development for about 40 years in New Mexico, and I recall about 20 to 25 years ago the director of the Central Tunisian Development went to the Navajo Nation. They were faced with developing rural water supplies for a lot of people. A lot of people were carrying water with carts behind them. The director was so impressed by the Navajo Nation's water development. He was impressed by the similarity in climate and landscape and the distribution of people and the tribal nature of people. He looked at one water system that was about 100 miles long. It was serving houses and homes all along this spine. There were a number of windmills and water sources feeding into it. He left New Mexico with the New Mexico model. He was going to replicate in central Tunisia that which he had seen in the Navajo Nation. The impression I am getting this morning is that nothing has been done. Whatever model he was looking at 25 years ago in the Navajo Nation has not continued. My question is has it continued or are we starting from scratch?

Arvin: That is a good question. Real quickly, there were a number of initiatives and a number of areas that were started in the sixties and early seventies. Water development was one. They were looking at land development. There were a number of areas that were beginning to be addressed by the Nation. We had a lot of cold winters, too. Our population had just grown. Right now, the Navajo Nation has a total population of about 300,000. For better or worse we have about a 22 percent leakage rate, meaning we see our young people leaving for college and they don't come back because there is nothing to come back to. We still have about 170,000 people that must adjust to that. The other aspect is that we have not been able to improve on the per capita income. It runs about $6,000 a year. The question is how do you begin to develop that necessary infrastructure when we missed it? The western portion of the United States really began to develop in the 1940s. We missed that. We are trying to come and filter the necessary infrastructure needs for the nation at a later date. That and the fact that the population continues to grow are issues that follow. I call it management by triage at times. We address where we are bleeding the most. This is what we need to do over here, but we are bleeding the most there, so we have to address that first. We are looking at new ways of attacking the problem. President Shirley is looking at how we can do that through capital and economic development. We are seeing some good progress. We have a larger population, but our funding levels have stayed fairly level. If you look at the reservation during the 1960s and compare it to today's reservation, you would see that the number of businesses that have come in is not that great. We are dealing with those constraints as we try to improve the quality of life on the Navajo Nation.

G. Emlen Hall *is a law professor at UNM's School of Law. He received an A.B. from Princeton University and a J.D. from Harvard University. Em is editor in chief of the Natural Resources Journal. His research and writing focus on the history of land and water in the Southwest. He has written two books on water issues: Four Leagues of Pecos: A Legal History of the Pecos Grant from 1800 to 1936 (1984) and High and Dry: The Texas-New Mexico Struggle for the Pecos River (2002). Prior to joining the UNM law faculty in 1983, he spent seven years at the Office of the State Engineer. During his time there, he wrote an administrative history of the Pecos River Compact from its inception in 1949 to 1974. This was the beginning of his research for his recent book, High and Dry. When Em first arrived in New Mexico in 1969, he wrote for and edited the New Mexico Review, a monthly investigative journal. He also practiced law in Pecos, where he lived, and served as village planner, attorney, and municipal judge for the Village of Pecos. He has worked for Northern New Mexico Legal Services and the New Mexico Land Grant Demonstration Project.*



ALBERT E. UTTON MEMORIAL WATER LECTURE

THE 1907 WATER CODE AT 100 YEARS OLD

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Over the last couple of years we've celebrated many birthdays. Last year's conference celebrated the 50th anniversary of the WRRI itself. Cathy Ortega Klett tossed a coin to select the Utton lecturer for that celebration. Chuck DuMars won last year's honor, and I drew this year's Utton slot. It wasn't such a good deal for you. You've had to suffer me two years in a row. Last year you had to listen to me on the late 19th century decentralized administration of New Mexico water and our return to it in the 21st century in the form of the Active Water Rights Management regulations. This year, in this Utton lecture, I want to get ready to celebrate with you the 100th anniversary of the venerable 1907 water code. My theme today is continuity and change, wisdom and restraint, in New Mexico's basic water law, a law that is still basically embodied in that ancient code which now applies to a water world the authors of it never could have imagined.

However, before I start down that path with you this morning, tracing the sources of the 1907 code, I'd like to recognize the source of this annual lecture, Al Utton. As many of you here know, Utton was a distinguished law professor. For almost as long as Steve Reynolds was State Engineer, Utton served as a member of the Interstate Stream Commission. He frequently spoke in public before there were Utton lectures, and he always began his lectures in a special way, by naming those members of the audience who already were leaders in the world of New Mexico water. I'm not as well connected as Al Utton was, and I'm certainly not as good at remembering names as he was. But I have been around the world of New Mexico water for 35 years now, and in Al's spirit I'd like to recognize this morning some of the great people here who also have been around this wonderful water world for a long time.

We're so used to the mythic figure of the State Engineer in our resource lives that we tend to forget who brought him and the changes that he wrought. The 1907 water code brought him in the form that we know the office today.

Today, I see in the audience Mary Utton, Al's wife, and I see their son, John, himself a Santa Fe water lawyer. I see Marilyn O'Leary, the executive director of the Utton Center established in Al's name. I see other water lawyers like John Draper and hydrologists like John Shomaker. I see some personnel from the Middle Rio Grande Conservancy District. I see a lot of past and present personnel of the Office of the State Engineer. There are many others here this morning who deserve equal recognition. All these people rarely, if ever, agree, but all of them share a devotion to this state and its most precious resource and, in Al's honor, they deserve to be named.

They also deserve to be named for another reason, closer to my topic today. The naming of these long-standing, cantankerous, devoted leaders honors the fundamental fact that water in New Mexico is equal parts law, science, policy, and history and that naming these leaders today properly emphasizes that the mix of these factors is at bottom a profoundly human enterprise and that these are the movers and shakers who do the mixing. I want to return at the end of today's lecture to the importance of naming natural things as a way, the only way, really of respecting them.

But let me begin this morning with another venerable New Mexico water institution that deserves to be named and recognized: the water code adopted by the Territorial legislature in 1907 and still basically with us today. In 1907, that "code," so-called, consisted of 73 separate sections. Like the European codes on which it was based, it aimed to be comprehensive and exclusive. The last section 73 of the 1907 code repealed "all other acts and parts of acts in conflict with this act" and thus tried to sweep away, unsuccessfully of course, more than 400 years of complex, contradictory water history in New Mexico. At least, the 1907 code clearly swept away the immediate target of its cleansing, a previous 1905 law with a similar, but much more limited, scope.

The new, broader 1907 code emphasized once again the basic principals of western prior appropriation doctrine. The 1907 code explicitly recognized beneficial use as the basis, measure, and limit of a water right. The code established priority in time as the sole explicit means of apportioning varying supplies among existing water rights. These two principles partially embodied less formal, existing water law in New Mexico. They would become the explicit centerpieces of Article XVI of the first state constitution of 1912. The really new, radical heart of the 1907 code was the creation of the office of the state engineer, a non-constitutional executive given the broad power to make fundamental water decisions for the states where they sat.

We're so used to the mythic figure of the State Engineer in our resource lives that we tend to forget who brought him and the changes that he wrought. The 1907 water code brought him in the form that we know the office today. Before he came, New Mexicans could simply take water they wanted and hope that they wouldn't get sued after the fact and as a result. After he came, New Mexicans could take water only if the State Engineer said that they could and only if the State Engineer determined in advance that the new right wouldn't impair existing claims to a common source. From this fundamental reversal of basic powers, created by the 1907 water code there emerged the mythic water engineers of the West. We in New Mexico tend to resurrect Steve Reynolds as the archetypical, all powerful State Engineer. But before him there was Elwood Mead in Wyoming and Delph Carpenter in Colorado, two predecessors who could match Reynolds, story for story, myth for myth. And after them came really substantial people like Eluid Martines, Tom Turney, and our own "John D." Men like this came because of the power conferred by basic laws like the 1907 code.

The progenitor of these icons was Morris Bean, and we are still apt to call the 1907 water code the "Bean Code." Morris Bean was an engineer, trained in the great early programs in water resources at the University of California. He was also a lawyer, trained at that other Columbia University, this one in Washington, D.C. Many years later, State Engineer Reynolds, trained as a mechanical engineer, would joke about practicing law, which he certainly did, without a license, which he certainly never had. (Reynolds' father-in-law, himself a leading New Mexican lawyer, encouraged his son-in-law to go to law school. Reynolds declined on the grounds that he didn't need to.) Governor and United States District Judge Edwin Mechem called people like Reynolds "enginoirs", hybrid creatures, part engineers and part lawyers, no matter what their formal training. The father of the 1907 water code was literally both. The great water administrators, then and now, were multidisciplinary wizards.

Ironically, the father of the state-based water laws, Morris Bean, was a federal employee of what would become the Bureau of Reclamation. Enginoir Bean led the early Bureau of Reclamation projects across the west, including the Hondo, the Carlsbad, and the Rio Grande in New Mexico. Section 8 of the 1902 Reclamation required that these federal projects proceed under state law, and Bean drew the job of guaranteeing that the state laws of the various western states would support the massive federal investments. In 1897, the International Boundary Commission's W.J. Follett surveyed New Mexico water law and found none. When in 1903 Bean and his Reclamation cohorts surveyed the field of western water, it didn't look much better. "The laws of many of the States and Territories relating to water are in a more or less chaotic condition," wrote F.H. Newell, the chief engineer in the Second Annual Report of the Reclamation Service in 1903, and Bean proceeded to straighten them out. At the Second Conference of Engineers of the Reclamation Service that met in El Paso in late 1904 and Washington in early 1905, Bean presented his proposed irrigation code. It was immediately adopted, he reported, "without material change" by the legislatures of North Dakota, South Dakota, and Oklahoma.

I've never found a draft of the Bean code itself, but you can see it in the 1905 session laws of these three territories, places that didn't have much of an existing tradition of water use and places that could easily lay down a fundamental water law because there was so little underlying it. These identical manifestations of the Bean code show its central concerns: the declaration that water was public and subject to appropriation for private use; a more formal process for the creation of new rights than the old notice by posting system used across the west; a scientific determination of the availability of water for new appropriations; and, most important, the creation of a new, powerful water czar, the state engineer to supervise all of this.

In 1905 the Territory of New Mexico joined the two Dakotas and Oklahoma, among other western states, in adopting a fundamental code, but New Mexico's 1905 version certainly was not a carbon copy of the Bean code. There were many stylistic and editorial differences. The role of the New Mexico Territorial Engineer was much diminished and less defined than his state counterparts elsewhere under true copies of the Bean code. The New Mexico Territory was divided into six hydrographic districts, and the leaders of these decentralized units had at least as important a role in water determinations as did the Territorial Engineer. Had the matter ended there New Mexico would have joined its fellow western territories as a much weaker and slightly behind prior appropriation sibling.

In 2007, we in New Mexico will have lived for 100 years under the basic system created by the 1907 code.

At the first opportunity, two years later, in the 1907 amended water code, the New Mexico Territorial Legislature made one mighty effort to catch up. The basic principles—public ownership, beneficial use, and priority—remained the same, but the power of the State Engineer was greatly increased. He wasn't subservient to regional water districts in the same way. His formal power to make fundamental determinations—the existence and amount of "unappropriated" water, for example—grew. He still served a two-year term, but he could continue "until a successor was appointed," an obscure phrase that Steve Reynolds, among others, exploited to hang on year after year. When in 1913, the now New Mexico State legislature added in one of the few early additions to the 1907 code, the requirement that private appropriators secure first a permit and then a license from the State Engineer to perfect rights to water, his considerable powers were complete.

In 2007, we in New Mexico will have lived for 100 years under the basic system created by the 1907 code. Even though the structure's the same, it's worth pointing out how the impetuses and drives have changed. For one, a hundred years ago, the basic drive to create a state water code came from federal insistence on the formalization of local New Mexico water law. These days we are used to constant claims that the federal government is infringing on state-based water systems. Ironically, the basic system that we now try to protect against the federal government was forced on New Mexico in the first place by the federal government. The ghost of Reclamation original enginioir Morris Bean still stalks the Round House halls.

In another sense, the venerable 1907 water code with which we still live is covering a water world that it never could have imagined. The drive to create the Bean code came from a world primarily fixed on agricultural uses of water. The early Reclamation projects, which the Code was designed to shore up and protect, all involved expanded agricultural acreage, at Elephant Butte, on the San Juan, on the Hondo, and at Carlsbad. These days expanded agricultural uses aren't much on the screen, unless you're talking about the other-worldly plans of the MRGCD to open the new Machenbier acreage west of the Interstate near Belen. What is more important today are the so-called M&I uses, the water needed for our growing businesses and our exploding cities. These water needs were not even in Morris Bean's ken, yet the principles of his code were broad and flexible enough to include them when the time came. Like the Rio Grande and Pecos River Compacts of the 1940s and 50s, the 1907 water code was essentially an agricultural instrument, sufficiently wise and flexible to govern a very changed world.

The point, I think, is that the fundamental concept of beneficial use as the basis, the measure, and the limit of a New Mexico water right, encased in the 1907 code, is still with us and still means something, even though beneficial use now encompasses values that couldn't have been foreseen 100 years ago when it entered our basic law.

In a parallel development, the 1907 water code focused explicitly on the need for the western water system to define "unappropriated water," partially as a way of protecting existing rights to a common supply, but, more importantly, as a way of guaranteeing that new applicants would have access to wet water from that source. That may have made sense in the Dakotas and Oklahoma where the Bean code first took root and where there hadn't been a long history of short supplies for long existing uses. But from the start of administration under the 1907 water code in New Mexico there may have been no "unappropriated water" in the State's major surface waters. Today, of course, we look almost exclusively to transfers of existing rights, rather than creation of new ones, and spend most of our time debating whether these transfers of existing rights would be "detrimental to" or "impair" existing rights. While the Bean code saw new water as its most important focus, it also recognized the transfer of existing rights as a possibility and provided for the basic machinery to accomplish these much more visible transactions today than they ever were in 1907. Although Morris Bean never would have used the terminology, the prior appropriation system that he brought with his 1907 code was the original cap and trade scheme. After all, what was a determination that a system was "fully appropriated" if not a cap? And what was dependence on water transfers to their most efficient economic uses if not a trade?

The fundamental shift over the last 100 years from new appropriations to transfers of existing ones wasn't the only fundamental shift that pushed at the edges of the 1907 water code but couldn't break its boundaries. The other fundamental change was the shift from surface to ground water. This new source of water was brought within the Bean code in a different way than was the switch from new appropriations to transfers. Instead of bringing ground water to the 1907 surface water code, New Mexico brought the surface water code to ground water.

You all know that in 1927 and then again in 1930, the New Mexico State Legislature created a parallel ground water code. With recognition for the differences between the two resources, the Legislature extended the basic principles of the 1907 code to ground water resources, and that basic scheme, for the management of both surface water and ground water, is still with us today. Among other birthdays that we ought to be celebrating, publically and noisily, is State Engineer D'Antonio's 2005 final closing of all New Mexico in one declared basin or another. His jurisdiction over ground water is now as complete as it was over surface water in 1907, and the circle of conjunctive management of all inter-related water resources finally has really closed, and we can move forward.

There's one final measure of the flexibility of the Bean code conception of things that continues today and that's one whose flexibility arises not out of a wise definition of an essential term in 1907 so much as an even wiser decision not to define it at all. I'm talking, of course, of "beneficial use" as the basis, measure, and limit of a New Mexico water right. The term had been kicking around the west before Morris Bean ever got hold of it, but Bean had the good sense to insert it in every state code he ever helped draft, and New Mexico had the good sense to make it the centerpiece of Article XVI of New Mexico's 1912 constitution.

As important as its assertion, however, Bean had the equally good sense, unlike Colorado, not to define "beneficial use" or rank "beneficial uses." Under the 1907 water code, "beneficial uses" could expand and change in importance. Sometimes the changes strained the outlines of the broad doctrine. For example, 30 years ago, mine dewatering, which from one perspective looked more like waste than it did any form of beneficial use, still was crammed into the mold. And these days, when water for instream flows for ESA purposes claims a place as a beneficial use, the term is probably still flexible enough to fit even though it takes a lot of words by a lot of lawyers to keep it so confined. The point, I think, is that the fundamental concept of beneficial use as the basis, the measure, and the limit of a New Mexico water right, encased in the 1907 code, is still with us and still means something, even though beneficial use now encompasses values that couldn't have been foreseen 100 years ago when it entered our basic law.

Napoleon threw up his hands the first time his eternal code of 1808 was amended and was supposed to have said, "Mon code, c'est perdu" because any formal change to a code contradicts its timeless elegance. Nobody has made that claim for the 1907 code. It has been supplemented, supplanted, interpreted, changed, and otherwise altered over the last 100 years but never in such a way as to really alter its fundamental design.

The courts have had some role in bringing the 1907 code into more contemporary line, although I defy any lawyer to find any catalogue of water cases, so diffused and badly indexed are they in our case logs. It takes 30 years practicing water law just to find the Court decisions, let alone figure out what they mean. Still Steve Reynolds used to say that in his time the courts had done a pretty good job helping with water law, mostly by staying the hell out of it. In more modern times, the Supreme Court has shown a very recent trend towards re-anchoring water law in the basic principles of the 1907 water code and the complex mix of history, science, and policy from which it springs. I want to return to this point at the end of this morning. For the moment, just let me say that the courts themselves have played some role in bringing the 1907 code into contemporary New Mexico.

So has the legislature. By and large, the legislature has wisely not tinkered too much with the specifics of the 1907 water code and hardly at all with its basic principles. You can count on both hands the number of provisions in the basic surface water code that don't originate in the 1907 surface water code. Instead, the basic code has been surrounded in our state law by the ground water code, by the conservancy and irrigation district laws, by the laws governing mine dewatering and community ditches. None of these laws surrounding the relatively unchanged surface water code have changed the 1907 code's basic tenets.

Instead, if amendments to the 1907 code, which are relatively infrequent, have done anything, they have amplified its terms. I think that the most amplified provisions of New Mexico's basic code have come in the area of the law of forfeiture. Some form of forfeiture—the losing of a right to use water—is an essential part of the law of prior appropriation. Otherwise, the bedrock requirement of beneficial use would lose all meaning. But over the last century the legislature has added a few pieces to the basic notion of forfeiture and subtracted a couple more until today the law of forfeiture bears the shape of the original doctrine, but not much of its content.

The 1907 surface code simply said that four years of nonuse would forfeit the underlying right, and that was something of a specification of the 1905 code that said that nonuse for an unreasonable amount of time would forfeit the right. The 2006 version of the forfeiture provision is ten times as long, the result, by my count of legislative and even constitutional changes in 1915, 1925, 1941, 1957, 1967, 1978, and 1987. That's a lot of changes. Some were minor. Some were so major that they made Steve Reynolds say that he wasn't enforcing what was left of the forfeiture statute because it had become such a joke that it made him the laughing stock of western state engineers. In any case and despite the legislative changes, the basic principle for the 1907 code remains.

The same, I think, can be said for the judicial interpretations of the basic 1907 code philosophy. New Mexico courts always have played an important role in construing and giving meaning to the basic code structure. In some areas our courts have played a more important role than others in re-shaping the contours of New Mexico's basic law. I'm thinking here of the basic role our courts have played in creating a de facto preference for municipal use of water.

You'll remember that the basic New Mexico 1907 code made beneficial use, undefined, as the basis, the measure, and limit of a New Mexico water right. Our neighbor to the north, mother of the Colorado doctrine which we are supposed to follow but don't, made the mistake of ranking beneficial uses, according to relative importance and apportioned access to water according to that ranking. For those of you who think that this is a good idea, consider that at the time Colorado determined that domestic use was the most important water use, categorically more beneficial than agriculture and mining use of water. Try telling that to west slope irrigators as Colorado Springs, Denver, Ft. Collins and the sprawling suburbs in between search for domestic supplies. Here in New Mexico, at least since the 1907 code and probably before, we avoided the problem that ranking uses created by treating them all equally and making priority the sole basis for apportioning short supplies.

The problem is that we know intuitively that all people have got to have water to drink first, and that's where the New Mexico courts have helped municipalities over the years despite the fact that the rigid contours of the 1907 code and its progeny wouldn't allow any categorical preference for drinking water. By and large the courts have done this quietly and judiciously and without a lot of fanfare. They've expanded the Mendenhall doctrine for cities, for example. They've created special rules for municipalities when it comes to rights to return flows. With the legislature, the courts have exempted municipalities from the law of forefeiture even further than the rest of us.

However, the courts have still hewed to the basic tenets of the 1907 code when it comes to municipal rights to water. Much to their chagrin, the cities still have to deal with the State Engineer. They must get their water according to the basic rules of the 1907 water code, without much special treatment and without any superior claim to water. The west, of which New Mexico is a part, is growing, changing, and urbanizing. Ten years ago, looking out across the west from the rarified air of Boulder, Colorado, law professor and resource guru Charles Wilkinson declared the law of prior appropriation dead. Clearly it hasn't died, however, proving once again the wisdom of Mark Twain's quip that notice of his death was, as usual, exaggerated. The basic system is still in place on the 100th anniversary of the 1907 water code, and we would do well to honor its roots.

Any law, like the law of prior appropriation, comes out of a basic human need to name things——beneficial use, for example—and to honor them in that naming of them. A good law simply brings language into connection with the reality that it describes. This honoring of the natural world and human interaction with it has been a part of New Mexico tradition for hundreds of years, so there's nothing new about this centennial celebration.

For centuries, the Zuni Pueblo has spoken a language all of its own, a language completely unique to itself. We all know the annual Shalako dances because the Pueblo is gracious enough to invite us. We are used to thinking that the ceremonies begin at dusk when the tall dancers on stilts approach the Pueblo plaza from the four cardinal directions. I'm told, however, the celebration really begins earlier when a religious figure approaches the Pueblo on his return from a long, isolated retreat in the Zuni mountains.

On that retreat, the Zuni mystic has spent his time learning once again the unique Zuni words for all living things: the animals, the fish, the bugs, the insects, the plants and trees, everything that is a part of the Zuni world. On his annual return to the Pueblo, the learner goes to the center of the Plaza and recites the names he has learned. This ritual has a religious meaning that is none of our business. But from a resource management point of view, it is a way of annually reaffirming their connection to the natural world by doing what is fundamentally human: naming them.

There is a parallel in the Hispanic world with which I am much more familiar. Those of you who know me or may have read one of my books know that I spend a lot of time trying to raise irrigated crops here in Albuquerque's North Valley and near a small village in northern New Mexico. In Cundiyo, that small village, I have planted perhaps a half acre of native chili for the last fifteen years. The chili is delicious, and I cherish it. But when I think of the real pleasure of that operation, I think of all that I have learned from the Cundiyosos who generously have taught me everything that they know about managing water. They know a lot. They know the seasons. They know the frosts. They know the hails. They know how to irrigate on the side of a hill. They know those "sonofagunnes", the raccoons. But when I think of them and water, I think of what they know about weeds.

Like the Zunis, the Cundiyosos have ancient Spanish names for every weed that ever invaded a northern New Mexico chili patch. Over the last twenty years I have walked those fields with people like 83-year-old Sabino Samuel Vigil asking him the name of different plants invading the chili, which can't defend itself against much. I learned what "canutillos" and "canamo" are. I know that "verdolagas" and "quelites" will squeeze chili out but can be eaten. I now know the long list of non-chilis from "aniles" to "zorgas" and everything in between. And as I yank them out of the rows of fragile chili plants and name them as I do, I remind myself that this is beneficial use and this is what it means to apply human intelligence to a chaotic natural world.

The doctrine of prior appropriation as embodied in the 1907 water code and the names and their meanings that go with it serves the same function as Sam Vigil's list of weeds or the Zuni's list of all living things. They all remind us of where we came from and what we are doing in this desert world.

I'm a lawyer and this is a conference. I guess that it's appropriate to end with a recent water law case. But I'd like to talk about the 2005 HERRINGTON case in a new way, as the modern lawyers use of legal terms to define basic natural processes in the same way that the Zunis and the Cundiyosos do. HERRINGTON represented the latest effort of the New Mexico Supreme Court to sort out the basic law of surface to ground water transfers when junior ground water development had reduced the senior surface water right source of supply. There are a lot of claims to laws that apply to the area. There is the statute that allows supplemental ground water wells. There is the CLODFELTER case that says that the right to transfer from surface to ground is part of the general power that goes with a surface water right. There is that mother of all confusion, the TEMPLETON doctrine, created by the Supreme Court in 1961 and a plague on the system of prior appropriation ever since.

In its struggle, the Court decisions had come unmoored from any real basis in the basic elements of New Mexico water law. TEMPLETON was based on questionable policy because to save senior and junior appropriators it guaranteed increased depletions on streams. It represented suspicious law because it wasn't related to all on New Mexico's basic tenets. It disregarded water history because it swept in out of nowhere. But most importantly here, TEMPLETON was based on a peculiar definition of surface-ground geophysical interrelations that hardly amounted to good science.

The original TEMPLETON case said that a water-short surface water appropriator could drill a well "clear back to the farthest reaches of the watershed" feeding his point of diversion. Subsequent cases hammered away at the reach of that right in the language of lawyers, not geologists. By 2005, the cases were completely confused about whether the TEMPLETON doctrine only applied to wells drilled into an aquifer directly feeding the surface water right and upstream of the surface water point of diversion.

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You could measure the confusion by the breadth of positions taken in briefs before the Supreme Court in HERRINGTON. Some said there was no such thing as a TEMPLETON transfer. Others said that all surface-to-ground transfers were TEMPLETON transfers. Still others said that some transfers were TEMPLETON transfers and others weren't without being able to definitively say what the difference between them was. In the face of that confusion among the state's most distinguished water lawyers, what was the New Mexico Supreme Court supposed to do?

It did what Morris Bean, the Zuni elders, and the New Mexico Hispanics had been doing for a century. It went back to the first physical principles of New Mexico water and named them accurately. Say what you will about the HERRINGTON decision, but there has never been in the annals of New Mexico's Supreme Court such a respectful, such a restrained, such an accurate description of the hydrological interrelationship between surface water and ground water. The opinion's author, Chief Justice Richard Bosson, had the benefit of a clerk who had a BS in geology and a master's degree in ground water hydrology, and Justice Bosson had the good sense to use the clerk's expertise and the opinion reflects it. The TEMPLETON doctrine may not be so important in and of itself, but the HERRINGTON decision reconnecting the esoteric doctrine to the real physical world to which it applies is a great triumph.

The 1907 Bean code, 100 years old next March 19, represents the same kind of triumph. The Code's age, its flexibility, its continuity remind me of a couple important lessons about water and life and their connection in New Mexico. One was brought home by Winston Churchill who knew nothing about the Southwest, nothing about desert rivers, nothing about prior appropriation, but who carried himself in the world exactly as a good New Mexico State Engineer should. On the subject of the passage of political man from youth to old age, Churchill remarked that "if at the age of twenty, you are not a liberal, you have no heart. And if at the age of 50, you are not a conservative, you have no brain."

On the subject of the passage of political man from youth to old age, Churchill remarked that "if at the age of twenty, you are not a liberal, you have no heart. And if at the age of 50, you are not a conservative, you have no brain."

Churchill died at 76. I'm pushing 65 and Churchill didn't tell us what to do with the later, post 50 stages of life. But I do know that the arc of my water life in New Mexico has followed the arc described by Churchill. I came here 35 years ago, long on indignation, short on wisdom, fascinated by New Mexico, and haunted by water. As every young writer and lawyer should, I began by attacking the Office of the State Engineer in print and suing the office in court. A bemused Steve Reynolds responded once at length to one of my articles because, as he said, I seemed to be "a little constrained by concern for the truth." Within 10 years I found myself working for Reynolds and the State Engineer Office, where I stayed for another ten years and learned about the wisdom and restraint of the 1907 Water Code on Saturday mornings when Reynolds would hold court. After those ten years, I went to the School of Law at the University of New Mexico and began to speak at water conferences like this. By my count, and by the number of proceeding notebooks that line my bookshelves, this is the 21st presentation I've given, and I think it must be close to my last. I'm pleased to end with the final honor of an Utton lecture and with an entirely appropriate anthem to the ancient 1907 water code.

When I think of how the Code has survived for so long, I think of old age in general. When I think of living well in old age, I think of wisdom and flexibility as central components. And when I think about other institutions that have survived for 100 years, I think of my Cundiyo neighbor, Esquipula Vigil.

At 100, Pula still rode horses and still irrigated his fields. Moderate exercise kept him going. His neighbors, mostly related Vigils, kept an eye on him as he worked. From the top of the barranca overlooking the irrigated fields where Pula worked, they would watch and make sure he was o.k. Pula would open the compuerta to his fields, let the water flow in, and then lie down on the ditch bank, shovel at his side, and let the water do its work. His cousins and nephews and great nephews would watch as he lay there, wondering whether he was alive or dead. Pula's hand would go up to waive a fly away from his face, and everyone would know everything was o.k.

I like to think of the 1907 water code in the same way. It certainly gets its exercise as the Endangered Species Act, instream flows, river restoration, water quality, and other new claims push at its boundaries. It has certainly demonstrated its continued wisdom and flexibility in its efforts to incorporate these new ideas. And, like me, the 1907 water code is still swatting away the late fall flies.

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