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MEGATRENDS IN·WATER·RESOURCES

30TH·ANNUAL
NEW·MEXICO
WATER·CONFERENCE

PROCEEDINGS

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MEGATRENDS IN WATER RESOURCES

PROCEEDINGS OF THE
30TH ANNUAL NEW MEXICO WATER CONFERENCE

Corbett Center
New Mexico State University
Las Cruces, New Mexico
October 24 & 25, 1985

New Mexico Water Resources Research Institute
New Mexico State University
Las Cruces, New Mexico

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TABLE OF CONTENTS

	<u>Page</u>
Preface	
Thomas G. Bahr, Director	
New Mexico Water Resources Research Institute	iv
Advisory Committee	v
Program	vii
Speakers	x
Speakers Preview	xi
 Water Development Trends	
Robert N. Broadbent	
Asst. Secy. for Water and Science	
U.S. Department of the Interior	1
 Future Forecasting	
Joseph F. Coates	
Futurist	
J.F. Coates, Inc.	10
 Trends in Water Planning	
Harvey O. Banks	
President, Harvey O. Banks	
Consulting Engineering, Inc.	16
 Indian Legal Trends	
Joseph Little	
Attorney	
All Indian Pueblo Council	26
 Federal Legal Trends	
George W. Sherk	
Trial Attorney	
U.S. Department of Justice	29
 Megathoughts	
Pat O'Meara	
Retired Chairman	
National Water Resources Association	41

Environmental Trends	
Ronald North	
Director	
Institute of Natural Resources	
University of Georgia	47
Research Trends	
Dennis Darnall	
Director	
Arts and Science Research Center	
New Mexico State University	64
Water Conference Participants in 1956 and 1985.....	72
Special Participants	73
First Participants' Regards	75
Participants	77
WRII Staff Participants	85

PREFACE

With this meeting, we are celebrating the 30th Annual New Mexico Water Conference--a megatrend of sorts. In recognition of the contribution of water research over the past 30 years, we decided that instead of taking a look back, we would look ahead--to the "Megatrends in Water Resources."

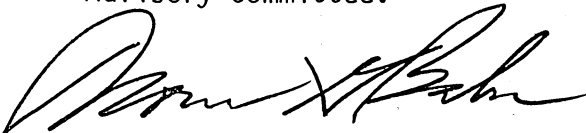
Perhaps the most intriguing speaker on this year's program was Joseph Coates, a futurist from Washington D.C., who took us "back" to 1985 from his 2033 perspective. His scenario included the dissolution of state boundaries, an earthquake restructuring the Ogallala aquifer, and Disney tours of restored cotton farms.

Interior's Robert N. Broadbent and California's Harvey Banks both addressed trends in water development and planning. In the legal segment, attorney Joe Little addressed the trend of Indian water users using arbitration and negotiation to settle disputes. Federal attorney Jerry Sherk told the group that the federal government will continue to encourage the resolution of water conflicts through compacts.

Pat O'Meara entertained those at the Water Conference banquet with his usual Irish humor. On a serious note, he admonished states to find other sources of funding outside the federal government, such as a self-imposed water tax. New Mexico State University's ShoJazz also entertained the crowd, including as special guests, those who had attended the first water conference in 1956.

The second day's program began with Norbert Dee, representing the Environmental Protection Agency, talking about ground water protection. Then, Ronald North, of the University of Georgia, gave his assessment of the nation's environmental sensitivity. Chemistry researcher Dennis Darnall spoke to the group about the value of basic research in making research a success. The conference closed with a two-hour panel discussion and question and answer session by water resources experts.

The success of this year's conference, like those before it, is due to the support and advice of the individuals on the Water Conference Advisory Committee.



Thomas G. Bahr
Director

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MEGATRENDS
IN WATER RESOURCES

30TH ANNUAL
NEW MEXICO WATER CONFERENCE
PROGRAM

THURSDAY, OCTOBER 24, 1985

8:00 - 8:45 Registration (Corbett Center, top floor)

SESSION I: The MegaPicture
(Corbett Center, West Ballroom)

Moderator: Lt. Col. David Peixotto, District Chief,
U.S. Army Corps of Engineers, Albuquerque

9:00 - 9:15 Welcome
James E. Halligan
President
New Mexico State University

9:15 - 9:40 Water Development Trends
Robert N. Broadbent
Assistant Secretary for Water and Science
U.S. Department of the Interior

9:40 - 10:05 Future Forecasting
Joseph F. Coates
Futurist, J.F. Coates, Inc.
Washington, D.C.

10:05 - 10:30 Trends in Water Planning
Harvey O. Banks
President, Harvey O. Banks
Consulting Engineering, Inc.
Belmont, CA

10:30 - 10:45 Break

10:45 - 11:45 Discussion Session

12:00 LUNCH
(Corbett Center Ballrooms)

SESSION II: The Law and the Courts
(Corbett Center West Ballroom)

Moderator: Prof. Albert E. Utton, University
of New Mexico School of Law

- 1:30 - 1:55 Indian Legal Trends
Joseph Little
Attorney, All Indian Pueblo Council
New Mexico
- 1:55 - 2:20 Federal Legal Trends
George W. Sherk
Trial Attorney, U.S. Department of Justice
Washington, D.C.
- 2:20 - 2:40 Break
- 2:40 - 3:40 Discussion Session
- 6:30 BANQUET
(Holiday Inn)
- Master of Ceremonies: Garrey Carruthers, Carruthers and
Associates, Albuquerque
- 7:00 NMSU Shojazz!
- 8:00 MegaThoughts
Pat O'Meara, Retired Chairman, National Water
Resources Association
Washington, D.C.

FRIDAY, OCTOBER 25, 1985

SESSION III: Water and the Environment
(Corbett Center, West Ballroom)

Moderator: John C. Hernandez, Civil Engineering, NMSU

- 8:30 - 8:50 Ground Water Trends
Norbert Dee
Sr. Environmental Scientist
U.S. Environmental Protection Agency

- 8:50 - 9:10 Environmental Trends
Ronald North
Director, Institute of Natural Resources
University of Georgia
Athens, GA
- 9:10 - 9:30 Research Trends
Dennis Darnall
New Mexico State University
Director, Arts and Science Research Center
- 9:30 - 9:50 Discussion Session
- 9:50 - 10:05 Break
- 10:05 - 12:00 MegaExperts Panel
Steve Reynolds, New Mexico State Engineer

Hal Brayman, U.S. Senate Committee on
Environment and Public Works, Water
Resources Subcommittee

Lt. Col. David Peixotto, District Chief,
U.S. Army Corps of Engineers

Harvey O. Banks, President Harvey O. Banks,
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SPEAKER PREVIEW

30th Annual New Mexico Water Conference

Thomas G. Bahr has been director of the New Mexico Water Resources Research Institute since 1978. In 1982-83, he was the director of the Office of Water Policy, which was established to address water issues related to Interior Department responsibilities. Before coming to New Mexico, he was director of the Institute of Water Research at Michigan State University. He holds degrees from Michigan State University and the University of Idaho.

Robert N. Broadbent is assistant secretary for Water and Science, Department of the Interior. Previously, he was commissioner of the U.S. Bureau of Reclamation. The Ely, Nevada native has held several positions dealing with planning and natural resources. As the first mayor of Boulder City, Nevada, he was instrumental in negotiating that city's transfer from a Department of the Interior responsibility to its status as a Nevada municipality. Broadbent, a businessman and licensed pharmacist, is a graduate of Idaho State College.

Harvey O. Banks is president of Harvey O. Banks, Consulting Engineering, Inc. His half century of experience in planning and resource management includes positions as the California state engineer and 10 years as director of California Water Resources. He is an honorary member of the American Society of Engineers and a member of the National Academy of Engineering. He has a B.S.C.E. from Syracuse University and a master's degree from Stanford University.

Harold H. Brayman is assistant staff director of the Senate Committee on Environment and Public Works. Brayman played a major role in the passage of the nation's first waterway user charge law, which was the focus of a book, Congressional Odyssey. Previously he was a reporter with the Detroit News and the National Observer. He is a graduate of Princeton University and the Columbia University School of Journalism.

Garrey Carruthers, president of Carruthers and Assoc., recently served four years in Washington D.C., first as Interior's assistant secretary for Land and Water Resources and then as assistant secretary for Land and Minerals Management. From 1976 to 1978, he was acting director of the New Mexico Water Resources Research Institute. Carruthers, a native of Aztec, New Mexico, was a professor of agricultural economics at New Mexico State University until April 1985 when he resigned to apply for the governorship of New Mexico.

Joseph F. Coates is president of J.F. Coates, Inc., a futurist research organization. The Washington D.C. based firm analyzes the changing patterns of the environment, the workforce and water use and distribution. His clients include the U.S. Bureau of Reclamation, Edison Electric and the Office of Technology Assessment. The industrial chemist turned futurist is an adjunct professor at George Washington University.

Dennis Darnall is the director of the Arts and Sciences Research Center at New Mexico State University. He is also dean of the College of Arts and Sciences. Darnall's research credentials include the 1978 Westhafer Award for Research, more than 64 publications and a pending patent on his research on biosorption of heavy metal ions from water. A Colorado native, Darnall is a graduate of the New Mexico Institute of Mining and Technology and Texas Tech University.

John Hernandez has wide ranging administrative and research experience including positions as dean of engineering at New Mexico State University and deputy administrator of the U.S. Environmental Protection Agency. During a recent sabbatical he worked in the Technical Division of the New Mexico State Engineer Office on studies of ground water basins and helped in planning for the 1988 Water Resources Assessment of New Mexico. He holds degrees from Harvard University, Purdue University and the University of New Mexico.

Joseph Little is an attorney for the All Indian Pueblo Council, New Mexico. From 1978 to 1984, he was general counsel to the All Indian Pueblo Council, three pueblo governments, and special counsel to one pueblo. He has administered water studies for the Rio San Jose, the Rio Jemez, and the Middle Rio Grande and established a water rights office for the All Indian Pueblo Council. He was born and raised on the Mescalero-Apache Indian Reservation. He holds a law degree from the University of New Mexico.

Ronald M. North has been the director of the Institute of Natural Resources since 1977. North, who is also a professor of agricultural economics at the University of Georgia, specializes in natural resources economics, finance, management and policy issues. The Georgia native is a Fellow of the American Water Resources Association and associate editor of Water Resources Research. He holds degrees from Clemson and Cornell universities.

Pat O'Meara's distinguished career in water resources spans nearly 30 years. He recently retired as head of the Washington D.C. office of the National Water Resources Association. He is best known for his contribution to the Office of Saline Water where as director he coordinated an in-house study on the potential of desalting water to solve the salinity problem of the Colorado River. Those who followed O'Meara's editorship of the NWRA newsletter, National Water Line, know of his commitment to water resources development.

Lt. Col. David E. Peixotto is the district engineer of the U.S. Army Corps of Engineers, Albuquerque District. The West Point graduate previously was the military assistant to the assistant secretary of the Army for Civil Works in the Pentagon. His major command assignments include company commander of the 168th Engineer Combat Battalion in Vietnam and executive officer of the 44th Engineer Battalion in Korea. He holds degrees in civil engineering from Stanford University.

Steve Reynolds is the New Mexico state engineer. He holds several state offices including secretary of the New Mexico Interstate Stream Commission, New Mexico commissioner of the Rio Grande Compact Commission and New Mexico administrator of the Water Resources Planning Program. He is a member of some 17 advisory committees mostly dealing with water issues. He has received numerous service awards including the Distinguished Public Service Award, the Conservation Service Award and the J.F. Zimmerman Award for Outstanding Achievement and Unselfish Service to the State of New Mexico and the Nation. He is a University of New Mexico graduate.

George William Sherk is a trial attorney for the U.S. Department of Justice, Washington, D.C., specializing in water law. Before taking that position in 1963, he was a special assistant in the Office of Water Policy. Previously, he was staff associate with the National Confederation of State Legislatures where he was in charge of programs in 24 states dealing with energy, science/technology and natural resources. The Missouri native holds bachelor's and master's degrees in political science and natural resources from Colorado State University.

Albert E. Utton is a professor of law at the University of New Mexico and co-director of the Natural Resources Center at UNM. He combined degrees in geology with his law degrees to build a special interest in water law. He has written numerous books and articles on the subject, including the international dimensions of resources management. The Aztec, New Mexico native is a graduate of the University of New Mexico, Oxford (England) University, and Yale Law School.

WATER DEVELOPMENT TRENDS

Robert N. Broadbent
Assistant Secretary of the Interior for Water and Science
U.S. Department of the Interior

Back when I first entered federal service as the Commissioner of Reclamation in 1981, I decided it would be a good idea for reclamation to focus its planning activities and organization on the issues that were going to be "current" five or 10 years down the road. We did a lot of work at that time, looking at water development trends. We talked to some people from high-powered think tanks. We hired Joe Coates, who is also on today's program, to take a look in his crystal ball for us. We also asked our younger, mid-level managers what they thought were going to be the water issues over the next few years. All of them basically gave us the same answers: water quality, ground water, and improved management of the supply we've already developed.

I thought those were good answers then and I think they're good answers today. When you decide 10 years from now to take a look at megatrends in water, you'll probably hear some similar things from someone else in government. In fact, many long-time employees of the Bureau of Reclamation are a little bit amused by all of the talk about new ground water recharge and conservation programs. They point out, and rightly so, that the Central Valley Project is the biggest ground water conservation project ever designed. Our ground water situation has not changed markedly over the past few years, what has changed is our way of looking at ground water. We've always known that you can't pump ground water forever. What is changing is our growing store of knowledge, which is pointing to new considerations. The same attitude is evident throughout the water field. The situation hasn't changed as much as has our definition of the problem.

From what I've seen as the mayor of a small western city, a county commissioner, and federal official, I'd say there really are few

megatrends in water. Perhaps over the past 80 years we've brought water to people instead of bringing people to water. But most water use patterns have not changed all that much over the past thousand years. Where there have been changes, they have been related to the project construction, water quality problems such as salinity, or transfers of agricultural water to other uses. The infrastructure itself only fails when there are breakdowns in political leadership.

By its nature, the task of developing water supplies is complex, time consuming, and conservative. It has to be. Building water supply systems has never been cheap or easy. Every expenditure, every change, has to be justified. Even in the days before the deficit was a national issue, taxpayers, bondholders, and water district boards were watching the books very closely. However, financial considerations are not the only reason for the continuity of water development's history. In the United States, at least, all of our water development is based on a system of law that is centuries old. The very age of such laws makes even the smallest alteration in past practice a difficult task. The fact that the water laws of each state are different compounds the difficulty of predicting what the overall result of any legal action will be nationwide. But changes do come about and it is these small changes that are pointing the way to the commonly accepted practices of tomorrow.

The proposed conservation agreement between the Metropolitan Water District of Los Angeles and the Imperial Irrigation District has been widely heralded as the opening of a new water market that will improve our management of existing supplies. The state of California told Imperial that it must implement conservation measures. Metropolitan has proposed to fund the necessary construction for a share of the water that will be saved. While I agree that this transfer agreement is an outstanding example of the kind of things transfers can do, I really don't think it's new. In some states, water trading, perhaps on a more limited basis than we see in the proposal in Southern California, has been going on for more than a century. Some states have made provisions for such transfers in their water laws. It's nothing unusual. The

attention that's being generated by this agreement is the result of the unusual combination of players. In the past, farmers usually traded water with farmers. Here, we've got farmers trading the construction of a conservation system they need, dealing with a city water supply organization that has the financial resources to back up the deal for the water they need. The fact that two California water agencies reached an agreement without a court suit also makes it unique.

We've been discussing various details of the proposed transfer with the different parties for almost five years, and I understand that proposals to do the same sort of thing have been talked about for years before that. The discussions have finally led to a draft agreement between the two parties, but it's far from finished. Water district elections must be held and approval granted by other water users in California who rely on the Colorado River for their supply.

For a number of years people have been saying that the federal government, because of its position as a kind of water master on the Colorado, was standing in the way of this agreement. That's plain wrong. Shortly after the Colorado River Compact was signed, the Department of the Interior informed the state of California that division of its share of the Colorado's waters was a matter to be settled by the state. That policy is still in force. We haven't changed our minds. That policy holds true for all reclamation projects as well. As long as a proposed water transfer does not reduce repayment to the U.S. Treasury or violate a congressional authorization, we will support the decisions made by the states.

While we are seeing more transfers of water from agricultural uses to municipal and industrial uses -- the Central Arizona Project is a good example of that -- several management changes in other areas do more than simply change the party on the receiving end of the aqueduct. We are looking seriously at the potential of improving system yields and reliability by removing restrictive or outdated constraints.

It's widely recognized that some legal and operational restrictions placed on water projects over the years have the effect of limiting yield

and reliability. This is especially true for systems where different agencies have developed a complex of storage and control facilities.

There may be limitations of effective storage capacity because the different development and operations plans in a basin haven't been fully coordinated. Now that many of the more easily developed more economical water supplies have been developed and the need for new water still exists, people are increasingly willing to look at changing institutional arrangements if they can stretch their current supplies. We've been looking at the operating rules and institutional arrangements in a few of the West's river basins on a "what if" basis and have come up with tentative plans for increasing yield without reducing anyone's supply and without new construction. If the states are interested, we will pursue our ideas with them. We've already seen the effectiveness of this approach proved in the Potomac River Basin. It has promise for arid areas as well.

While the Central Valley Project of California was not a part of this initial look at institutional problems, it is one of the classic examples of how water supplies can be augmented by reaching an agreement over man-made restrictions. We're getting close to the adoption of an operating agreement between the state of California and the Interior Department over the Central Valley and state water projects. While both of the projects were developed separately, both mix their waters in the San Francisco Bay area delta. Not only has there been a dispute over the yields of both projects, the state's water quality standards for the delta also have been a source of contention. The Interior Department has voluntarily adopted the state's water quality standards, but we need congressional authorization to do so. After virtually decades of negotiation, we've finally reached an agreement that defines the yields of both projects and provides for the water quality needs of the state. This agreement is currently before Congress for adoption. Once it has been adopted, we'll be able to contract an additional million acre-feet of water that we've already developed. That million acre-feet of water is already there. We won't have to do any new construction to obtain that yield.

In the Coordinated Operations Agreement, water quality and water quantity were closely tied. This tie-in will not be an isolated incident. While we've always been worried about salinity control in the West, we've become accustomed to thinking of water quality as industrial plants dumping pollutants into streams or waste sites leaking pollutants into aquifers. Today, much of the federal focus is turning to non-point source pollution, which includes salinity, but has much broader implications. Today we're talking about trace elements, nitrogen, phosphates and pesticides. These water quality problems are complex and widespread. They are not all related to agriculture, but much of our focus in the Interior Department is being placed on that area.

Many of you, I'm sure, have heard about the difficulties we've had at Kesterson Reservoir in California. We had planned to build a drain that carried water from the farmlands of the Central Valley to the San Francisco Bay area for disposal. We were rightly worried about the buildup of salts that would otherwise occur. However, Bay Area residents were worried about pesticides and other problems in the drain water. Congress eventually stopped the drain, midway through construction. Because drainage water was flowing into the drain, we had to have someplace to put it while the controversy was being worked out. We developed Kesterson Reservoir to handle that drainage temporarily. In the meantime, the Fish and Wildlife Service requested that they be allowed to manage the reservoir as a wildlife refuge, because of its available water supply. That request, of course, was granted. The drainage water continued to flow into Kesterson, carrying the salts with it over the years. However, until birds began to die at the refuge, no one even knew that water was also carrying a trace element that was leaching out of the earth along with the salts. High levels of selenium have collected in the environment at Kesterson. Since the discovery of dead and deformed birds at Kesterson, the situation has become intensely complicated. We have closed the reservoir and are stopping the drainage. We are in the process of cleaning up the area in cooperation with the local irrigation district. Probably a dozen different federal

and state agencies are involved in trying to find a solution to continue providing drainage service to the lands near the reservoir while still protecting the environment. One of the major problems we face is the fact that we know very little about the processes involved in selenium contamination and toxicity. Only in the last few years have we had technology capable of measuring trace elements in parts per billion. Few standards exist for human health of fish and wildlife effects. In fact, you can get bottles full of selenium at health food stores around the nation.

The Department of the Interior is involved in a major study program in an attempt to better handle the problems at Kesterson. Reclamation, the U.S. Geological Survey, and the Fish and Wildlife Service are working together in carrying out a research program. The program not only should answer some of the questions we have about dealing with the non-point source problems in the San Joaquin Valley, but should have some application in other areas of the country that might experience related problems in the future. We've asked a panel of experts from the National Academy of Sciences to provide oversight in the research program plan to ensure that the work we do will be useful in areas outside the San Joaquin Valley.

At the same time, we are looking at the U.S. Geological Survey proposal to do a national water quality assessment. Part of that assessment would specifically involve the quality of agricultural drainage. In response to congressional directives, we are looking at selenium and agricultural drainage in the West. Newspaper reports have charged that the West is laden with Kesterson-like situations. Some of the sites mentioned in the press are in New Mexico, and Congressman Richardson has expressed a keen concern about the potential for such problems in his state. While our preliminary surveys, which did not involve new water quality sampling, failed to turn up any similar situations, we do realize that we need to take a closer look. We will look first at areas that have been identified by the press as potential hotspots, but plan on conducting a more comprehensive assessment of

agricultural drainage and its effects over the long term.

The concerns over the quality of our agricultural drainage do not stop at surface water development. We have discovered that our ground water may not be as clean as we had frequently assumed it was. Quality considerations will play a larger role in both traditional surface water development and management and ground water development.

As many of you know, two years ago Congress authorized ground water recharge demonstration projects for the 17 western states, with work to be focused in the Ogallala aquifer area of the High Plains states. In recognition of the fact that it is generally more difficult and costly to clean polluted ground water than it is to deal with surface water pollution, Congress required that the U.S. Geological Survey and the Bureau of Reclamation coordinate their work on ground water with the Environmental Protection Agency (EPA). The Interior Department was already working with EPA in the organization of a ground water quality technical assistance program, so the development work was wrapped into that agreement. After several months of negotiation, we now have an agreement between the three agencies, which spells out responsibilities of each of them in ground water protection.

Now that this agreement has been worked out, we are moving ahead to get our recharge program underway. Congress has provided \$500,000 to begin planning. All of the states have expressed an interest in selecting an appropriate site for the recharge demonstration projects. Here again, the change is one of perception. Several of our conventional water projects are designed to provide conjunctive use of ground and surface water. They are, in a sense, ground water projects. The idea of artificial recharge is not new either. Recharge projects have been attempted in a number of places and the problems associated with them have been documented. It is the widely publicized depletion of the Ogallala aquifer that has focused the public's attention of ground water supply and the potential for recharge. Public awareness is usually the first step in political action.

Those of you who follow water politics will remember that the

Garrison Commission made a number of recommendations dealing with artificial recharge in its report. The state of Nebraska has proposed scrapping plans for a conventional dam and irrigation system in favor of a ground water project in the O'Neil area. The interest in recharge is definitely there, but there are a few engineering and geology issues, as well as the water quality issues I discussed earlier, that need to be addressed. We have the scientific and engineering ability not only to resolve the problems that have shown up in past recharge projects, but also to make a valuable contribution to our nation's water development expertise. Changes in the way we deal with our water problems have been the result of advances in our ability to solve engineering problems with new materials, computers and the availability of better data. These resources weren't available when we were building the Hoover Dam. Increasingly cost conscious times are ensuring that we look at projects that are not as costly. The institutional barriers to management are more likely to be breached under these circumstances. But, the basics of water remain as they have since the beginnings of civilization. People still need water and the more water they need, the more valuable limited supplies become. That is the one true megatrend in water.

There may be one other megatrend, and that's the involvement of politicians, such as myself, in the water field. We're the people who are responsible for some of the institutional barriers that have been built up over the past. It may take an engineer to show us what those barriers are and how they can be broken, but we're the ones who make the decision to act. As long as water is valuable and important to meeting the daily needs of civilization, we politicians are going to be involved. That may come as a frightening thought to some of you. If it does, might I suggest that it's time for you to think about entering politics?

Over the course of history, different people are assigned the political tasks of carrying out our engineers' plans. Sometimes it's the federal government, sometimes it's the state and local governments. Under President Reagan's direction, there is no question that we are

headed into an era of reduced federal involvement. In the long run, that's a good thing. Even more creative local leadership is going to be needed to meet the challenges in both engineering and financing that the continued need for water present. The federal government stands ready to provide the engineering and technical services it always has, but local governments will be playing a much larger role.

Much has been made of the coming water crisis. I doubt we'll see such a thing. Many areas have problems, but positive actions are being taken to address them at the local level. "New" solutions to local problems are being found all the time. Water development will continue just as it has continued and will continue into the future. It's something people can't afford to ignore for long.

FUTURE FORECASTING

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It is a great pleasure to address the 25th anniversary of the Tarizmex Provincial Water Council. The good auspices of its founding, coincident with the Second Constitution in 2010, have been fulfilled by the quarter century of steady, if not unbroken, accomplishment.

In looking over our family diaries, I note that my father spoke at one of the pre-provincial water council meetings back in '85 -- to something called the Annual New Mexico Water Conference. Both that family connection and the importance of events over the last 50 years lead me to a brief review of the high points of national water resource development and management since 1985.

Canada's joining the Union in '02 provided substantial relief to many anxieties about water supply as well as electric energy. The Canadian union not only provided for more effective integration of water resources in the eastern and western regions of the old United States, but also allowed for major civil works to carry water all the way from the severe winter regions of northern Canada into the trans-Rockies.

Perhaps an historical note on the Second Constitution would help, since some of the younger members in the audience may be unfamiliar with what is to them ancient history. The pre-constitutional convention was conducted from 2005 to 2007. The new constitution was adopted in '09 and implemented in 2010. The primary administrative consequence was to eliminate the old 50 states, the several thousand counties, and literally tens of thousands of quasi-independent special authorities, elected units controlling everything from education to water allocation. The basic new units so familiar to us, of course, are the nine provinces and the 28 administrative districts. Not only water resources, but most of the other infrastructure systems, were given a new rationally integrated base under the present constitution. Another big change under the Second Constitution was the elimination, or as they preferred to call it, the

super-succession, of all prior laws, regulations, interstate compacts, dealing with the infrastructure. Super-succession wiped the slate clean and permitted a more integrated management of all infrastructure.

Of course, the Federal Mediation Act of '92 laid the groundwork for the broad base of stakeholder participation in public policy and decisionmaking. A mere 15 years of experience under that act was crucial to the transition from the old to the new constitution and laid in place the literally hundreds of infrastructure laws and regulations required to follow the transition.

The earthquake at New Madrid, outside St. Louis, in '98 was an event of unprecedented magnitude, an earthquake of 8.4 on the old Richter scale. It wiped out 32 dams, restructured substantial portions of the Ogallala aquifer, and did some \$143 billion worth of structural damage in the four states primarily affected. One of the sights I regret not having seen directly but one we all have seen on film, is the 36 hours during which the Mississippi River ran backward. In any case, the primary effect of the New Madrid quake was to stimulate more effective long-range infrastructure and land use planning than ever before.

By 2010, atmosphere management was routine. Snow enhancement was universal through the Rocky Mountain regions from the Arctic Circle to the Mexican border. Hail control was widely practiced throughout the Midwest. Unfortunately, the management of drought has on balance been unsuccessful. Recent developments suggest that the Department of Atmospheric Management's international division, in working with the government of Tunisia in the North African Republic, is expected to make headway within the next decade.

The Mexican trouble, of course, led to the Popsicle Project, which began in '94 and was completed in 2001. It is rather amusing how ice seems to be such a focus of humor in North American politics -- you may all recall Seward's Folly, the purchase of Alaska in the 19th century. Project Popsicle involved the towing of Antarctic icebergs to North America. And the first one was moored in 2001 in Baja, California. For the last 25 years we have routinely brought two of these bergs to the

California region, and we have managed to effectively deal with the microclimate changes, which you have read about. The technology has proven so successful that 12 icebergs are routinely delivered to arid zones throughout the Northern and Southern hemispheres. Keep in mind that one of these icebergs is equivalent in fresh water to half of irrigation water in the old southern California region.

By 2015, the Total Cost Recovery Act was fully implemented, which led to the abandonment or demolition of some \$4 billion in old hydrologic, irrigation and other water works. Under the act it was shown that these were either of no value or substantial sinks for money. Under the Total Cost Recovery Act, less than one and three-quarters percent of all provincial water services throughout the United States of North America enjoy subsidies originating more than 150 miles away. Subsidies, of course, continue on a quite extensive basis on a sub-district basis, where local participation has decided that subsidization is important for local micro development.

There are some continuing, and even recurrent, sticky points in water management. Ground water pollution or contamination continues to be the nation's major environmental problem. New contamination of ground water had all but stopped by 2005, with the bulk of it already at end by '95. However, as was recognized at the time, the difficulties were only beginning, since most of the toxic, polluting or undesirable materials already in the ground had barely begun to move into the aquifers. Programs for subterranean dams, reverse flushing, chemical neutralization and numerous other underground civil hydrologic works have proven to be of little value. Today, and more precisely in the last report as of 2033, 25 percent of all potable water in the United States must go through stage 6, 7, or 8 purification processes. This, of course, has been a boon to the beverage and prepared food industries. As you all know, 19 percent of the land area of the old United States is now triple piped for direct potable, domestic use, and general use water. The plan to carry that triple piping through 26 percent of the land area should be completed over the next decade.

As early as '95, ground water contamination had begun to alter the national internal migration and resettlement patterns, both in the older northeastern and north central regions and in what was then the emerging, rapidly developing Sunbelt regions.

The global collapse of the soybean market and the total migration of cotton production and cotton textile manufacturing outside the United States have, of course, had their own effects on agricultural demands for water. I certainly urge all of you to tour the Department of History's nine restored cotton farms in the four southern provinces. They have, of course, been a smashing success, as now maintained and operated by Disney Enterprises. I particularly enjoyed the visit to the early 19th century farm called Old Alabama, which recalls the slavery days. Audio Animatronics (class A-6 robots) plant, harvest, pick, sort, gin and bale cotton in a restored pre-Civil War (1861-65) plantation.

One of the major innovations in water quality control seems in retrospect so simple it is incredible that it took a quarter of a century from its conception to its implementation. Closed loop water supply required that all industrial facilities with 25 or more workers must draw their water supply from within 50 feet downstream of their own waste-water effluent.

In summary, let me say that in looking back over the past 50 years, we must also acknowledge the previous 100 years. It has taken 150 years for water to be fully controlled and effectively managed. Water management cost per capita as revealed under the Tax Assignment Act of 2012 is \$140 per capita per year. This sharply contrasts with the experience of some 75 years ago when individual per capita subsidies in some regions ran as high as \$4,000 and direct costs in others as high as \$500 per capita.

What you have just read is one scenario of future water developments in the United States. It is only one picture, albeit a complex picture,

of how that infrastructure might evolve the next 50 years.

There is nothing in the scenario which is scientifically, technically, or public administratively bizarre. And yet it does represent in the aggregate developments which together create a future extremely different from the present.

The point of all this is to help shape our present action. By understanding the wide range of ways in which the future can evolve and seeing some hints of the significance of direct and indirect human intervention in the management of our world, we may be stimulated to create more desirable futures and act systematically to encourage the desirable and discourage the undesirable outcomes.

Let us turn briefly to the way in which the scenario was constructed, so that the reader may pick up the interest or the challenge of creating his or her own scenarios.

The scenarios were constructed by first defining a list of variables which seem critical to the evolution of the long-term future of water. These variables include quantity and stability of supply; source and reliability; qualitative factors such as health effects, salinity, and microorganisms; cost, both direct and indirect; administrative mechanisms; equity considerations in the short and long term; institutional frameworks; technological developments; social trends; political values; the users of water such as the general population; industry; the location of its users, and their special requirements; environmental factors in general; and a number of other variables. The scenario was then created by setting a value for each of those variables in a way that is coherent, that is, hangs together and is not self-contradictory. And then, with those elements in mind, one then embellishes a framework or story around them -- in this case, a presentation to a water conference in 2035. That is the scenario.

The importance of scenarios is that they permit us to deal in an intellectually satisfying way with a complex of material normally too difficult to conceptualize as a whole by concentrating merely on the individual components. As a tool for managing complexity, the scenario

has the advantage of presenting alternative images of the world, giving some interrelationship among them, and, in turn, stimulating an interest in either how to get to or how to avoid those outcomes.

Scenarios are tools of planning.

In the very sketchy scenario developed above, we did not give due weight and attention to the important role of telecommunications and computer technology, which will affect the collection of information, the modeling of patterns and the management of water facilities.

Telecommunications and computers will also open up the public policy process to more effective participation and decision-making. There are scores of sub-themes that were not used in the scenarios, such as scientific developments in water purification, in our understanding of health effects, or in biotechnology as a tool for cleanup or disposal.

TRENDS IN WATER PLANNING

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Introduction

The major thrust of water planning for the next 20 to 40 years will be devising cost effective, acceptable management strategies and operational plans to make maximum feasible use of the facilities and supplies we now have. Costs of water projects are high and continue to increase. The best projects have already been built. Funding costly new projects will be difficult, perhaps impossible.

There are many opportunities to make better use of existing projects and supplies throughout the United States. Such opportunities exist with major federal projects. In California, the Federal Central Valley Project and State Water Project are operated conjunctively under a Coordinated Operation Agreement to solve certain common problems. The costs of better management for more effective use of existing projects and supplies, singly or in combination, will generally be far less than the historic approach of building new projects to solve each new problem as it arises, often by separate agencies.

Planning for Management

To devise such management strategies will require innovative, creative thinking with, no doubt, major changes in our laws and institutions. We need new concepts of operational management and financial management, and of new institutions for joint action among agencies.

Existing agencies, federal, state and local, as well as the private sector with diverse interests will be involved. These interests must be harmonized and integrated for the greater overall good. It is difficult to harmonize separate interests by taking something from some for the benefit of others although in some cases that may be necessary. The better solution, however, is to devise a management strategy that

provides "a little candy for everyone." Those whose interests might be harmed must be compensated in some manner as part of the strategy.

An effective management strategy may impact some of our long held, deeply cherished beliefs concerning the sanctity of individual water rights. To comply with some recent court decisions, major changes in thinking and institutional structures will be required. Major changes in statutes have already occurred here in New Mexico. This evolution will require a much greater understanding of our interdependencies and interrelationships in hydrology and hydraulics as well as institutional structures and activities. Development and uses of ground water should be operationally integrated with development and uses of surface waters to maximize cost effectiveness. Often, a regional approach should be taken for maximum effectiveness.

I am led to these conclusions by observation, by my experience as the former director of Water Resources in California and as a consultant for the past 25 years to major public federal and water agencies in several states, and to some foreign governments. My conclusions also rest upon my analysis of current trends and the political realities as they exist today and as they appear to be heading in the future. Planning must take these trends and realities into account if the plans are to be implemented.

Trends

One pronounced trend is toward a greatly diminished role of federal government in funding, construction and other activities in the water resources field, except in the regulatory aspects. The federal policy now is to require major cost sharing and repayment, particularly up front funding for proposed federal projects. State and local agencies are moving to fill the vacuum created by the diminished roles of the federal agencies. But those entities also have pronounced funding difficulties and funding limitations because of the manifold demands upon the tax dollar and other sources of revenue.

The range of uses to be considered in allocating water has become much broader than just a few years ago when domestic and irrigation uses

were the principal considerations. For example, in-stream uses and environmental protection have become major considerations in the water resources allocation process. California statutes have recognized recreation and enhancement of fish and wildlife as primary functions of state water projects for nearly 30 years. Nebraska's recently adopted water policy emphasizes in-stream uses as in other states. Water rights for in-stream uses have been granted in Nevada.

There is definitely a trend toward control over the development and use of ground water at the state and local levels, possibly through a permitting process. Arizona is the outstanding example.

It appears that there may be little need for new areas to be brought under irrigation. This is due in large measure to loss of foreign markets for American agricultural products. These markets may never be regained.

A most significant trend is the increasing controversy and political dissensions concerning water. Political dissension in California has held up any significant new water projects in that state for 15 years or more, and shows little sign of abating. Controversy and dissension will increase with the ever increasing pressure on our water resources and the escalating costs of projects.

One trend of major significance is the increasing tendency to rely on the courts to resolve water resource allocation problems. Court decisions often establish new water policy. This trend is sometimes bad, sometimes good, depending on which side of the litigation one happens to be. To illustrate the point, one need only mention the Sporhase¹ decision that water is an article of interstate commerce and that state ownership of ground water is a "legal fiction." Another case, the Audubon² decision in California, broadened the scope of application of the public trust doctrine. That doctrine has been interpreted by the State Water Resources Control Board in California as giving the board the power to review any water right to see if it impacts on the public trust, and to revise or revoke the right as necessary to protect the public trust. Finally, there is a Superior Court decision in California which

would require comprehensive adjudication of all water rights in the great Central Valley. It is impossible to estimate how many water rights might be involved or how many years such an adjudication might take and at what cost. Fortunately, that case is on appeal.

Innovative Approaches

To illustrate some of the concepts in planning and management strategy, I will briefly discuss a plan in California that is in the development stage. This involves the Metropolitan Water District of Southern California (MWD), the major water service contractor under the State Water Project, and MWD's proposal to use ground water storage in the Chino Basin in Southern California to augment the yield of State Water Project. There are about 7 million acre-feet of useable underground storage in Chino Basin.

The State Water Project, as some of the audience may know, conserves water in Northern California at Lake Oroville on the Feather River about 100 miles north of Sacramento. The conserved water is released from Oroville to flow down the Feather River to the Sacramento River and on into the Sacramento-San Joaquin Delta, generating hydroelectric energy and serving in-stream uses and irrigation on the way. The released water is rediverted and unregulated flow is diverted from the delta to serve irrigation and cities in the Central Valley, and the urban areas in the San Francisco Bay region and in Southern California. Major offstream storage downstream from the Delta filled by pumping is provided to conserve excess unregulated flows in the Delta not needed for immediate use. The offstream storage reservoir, San Luis, and about 100 miles of the aqueduct system were financed and are used jointly by the state and the U.S. Bureau of Reclamation.

MWD is the primary water importing agency for the urban areas in Los Angeles, Orange, and San Diego counties, and major areas in San Bernadino, Riverside and Ventura counties. All told, MWD serves some 9 million people, selling water wholesale to its member agencies through an extensive distribution system.

MWD's water supply contract with the state calls for a full delivery of slightly more than 2 million-acre feet of water annually on a firm basis. But, because of the political controversies between Northern and Southern California, the state has not been able to build the additional conservation works in Northern California that were contemplated at the time the contract was negotiated, and with the present facilities, will not be able to fulfill that contractual commitment to MWD on schedule. So, MWD is taking steps to make use of surplus state water that is available from time to time in wet years. MWD will develop and utilize underground storage in Chino Basin for storage of the surplus water available to it not immediately needed for direct use. The surplus water will be added or recharged directly to underground storage by surface spending and injection, and indirectly by supplying municipal agencies now pumping ground water with treated surface water in lieu of pumping at times of surplus availability.

MWD will extract the stored water as needed in dry periods for the benefit of MWD's member agencies when the State Water Project is short. That sounds simple, but the institutional, financial and legal arrangements with the local Chino Basin agencies are complicated. For example, water rights in Chino Basin have been adjudicated and must be recognized and protected in the agreements. There are other complications but all are being worked out.

The indirect storage aspects of this MWD program need a bit more explanation. The Chino Basin underlies an urban area with a number of municipal water purveyors including the cities of Chino, Upland and Ontario. As noted above, the ground water rights in Chino Basin have been adjudicated under a stipulated judgement administered by the Chino Basin watermaster. The cities now pump ground water under their adjudicated rights and pump additional water to meet their demands, which is replenished by Chino Basin Municipal Water Agency, a member agency of MWD, with MWD water under its entitlement. Under the indirect storage concept, it is proposed that when surplus State Water Project water is available in wet years, the urban water supply agencies cease pumping

from ground water and be supplied with treated surface water directly into their distribution systems. The proposal includes building a pipeline from MWD's Weymouth treatment plant to the area. When a period of deficiency occurs, these entities will again pump ground water, while MWD uses the water it has stored. They will not lose their basic ground water rights, even though they may not pump for 10 or more years. The complexities of negotiating mutually acceptable contractual arrangements, including financial, with the multiplicity of agencies involved, are obvious.

The cost of the increase in yield to MWD, which may aggregate up to 100,000 acre-feet per year, will be much less than from a new water project in Northern California, perhaps half as expensive. Those agencies that enter into exchange agreements with MWD will benefit from higher ground water levels as well as being supplied directly with treated surface water much of the time. There will be financial advantages to all concerned from this regional approach.

This is, in my opinion, an outstanding example of cost effective management of ground water in conjunction with limited surface supplies, not just for the benefit of the area overlying Chino Basin but for all the member agencies of MWD in Southern California. The water extracted from that previously stored will be part of MWD's total supply.

This multi-agency, regional approach to the solution of common water problem is, I believe, an outstanding example of the concept of conjunctive management of limited surface supplies with ground water to serve an extended area. The investment required for new facilities will be relatively minor compared to the cost of a new dam and reservoir in Northern California to develop the same amount of new yield for the same area. This isn't to say that new conservation works in Northern California will not be required at some future time. However, new works are now politically infeasible and may remain so for some years. Even with additional dams and reservoirs, conjunctive use of surface and ground water as envisioned will continue to be an essential and cost effective component of the regional supply.

The well publicized arrangements being worked out between MWD and Imperial Irrigation District (IID) are an example of an innovative approach to making more effective use of existing supplies and facilities on a regional basis. It is proposed that MWD pay IID \$10 million per year for which IID will improve its irrigation systems by lining irrigation canals, by collecting and reusing tail water and other measures, to make efficient use of its supply and reduce the amount of water now flowing to the Salton Sea from the irrigation system. The amount of initial reduction is estimated at 100,000 acre-feet per year and could increase to as much as 250,000 acre-feet annually. The conserved water will not be diverted by IID from the Colorado River in which IID has prior rights dating back many years. Rather it will be diverted upstream by MWD and conveyed to Southern California for municipal and industrial uses through its existing aqueduct system.

There will be no transfer of water rights. Imperial Irrigation District will continue to have its full rights in and to the water of the Colorado River available if and when needed.

An interesting aspect is the impact on third-party interests. The level of Salton Sea has been rising for many years, adversely affecting properties and developments around the periphery of the sea. Reduction in the inflow will slow the rate of rise and hasten the time when the water level will stabilize. Stability will have a beneficial effect. Conversely, the reduction in inflow of relatively fresh water will increase the rate of salinity buildup in the waters of the Salton Sea, which is already more saline than ocean water. This buildup will shorten the time before the salinity becomes so concentrated that it is no longer tolerable by the currently important sport fishing industry.

Other examples of transfers of water rights and water supplies to different types of use at different locations that have already been consummated or are being considered could be cited. Transfers appear to be a definite trend. However, before such transfers are approved, full consideration must be given to the hydrologic, environmental and social impacts of the proposed transfer and to the third-party interests in the

water involved. In most, if not all transfers, there will be such impacts and third-party interests. It cannot be considered as a single transaction between a "willing seller and a willing buyer" as some of the more ardent proponents of transfer are prone to think. Transfers should be carefully controlled by the state after a full investigation as to the possible effects and a public hearing. Water must not be considered as a "free good" to be used and abused at will. It is important to all and should be administered with full regard to the public interest.

The Future

To summarize, future water resources planning must:

- o Give careful consideration to means of achieving more effective use of existing facilities and supplies;
- o Provide better management and protection of ground water. Conjunctive use of ground and surface supplies will be increasingly important;
- o Propose measures that will provide incentives for more efficient uses of water;
- o Consider multi-agency, regional approaches;
- o Develop new management concepts, for example management agreements or compacts among all those interested in a particular water resource;
- o Devise new approaches to funding management activities. In this regard, thought should be given to levying assessments on existing and future economic uses of water, both surface and ground, to provide the monies necessary for management and for construction of needed new projects;
- o Provide for transfers of water rights and supplies with full regard to hydrologic, environmental and social impacts, and protection of third party interests, sometimes termed externalities;
- o Give full consideration to in-stream uses and environmental impact; and
- o Consider the broad public interest or public welfare in the allocation of water resources.

And finally, I want to submit a controversial thought for possible consideration by future New Mexico Annual Water Conferences. I believe that water rights should be reviewed periodically, say at not greater than ten-year intervals, to determine the reasonableness of current use under each right and to take advantage of new developments and technological improvements for more efficient use. This review is essential to make the most effective use of increasingly scarce and costly water supplies.

We must accept the fact that all projections of future supplies and demand and plans made based on such projections are fraught with uncertainty. We must be willing to accept some degree of risk unless we want to pay exorbitantly to minimize the risk of future shortage. The future question will be -- how much are we willing to pay to avoid shortage?

END NOTES

- 1 Sporhase v. Nebraska; 458 U.S. 941 (1982)
- 2 National Audubon Society v. Superior Court; 658 P 2d 709 (Cal.),
cert. denied, 104 S. Ct. 413 (1983).

INDIAN LEGAL TRENDS

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"In the 1908 case of Winter v. U.S., the court gave its classic statement on Indian water rights. ...and found that State law did not control Indian water rights. Rather, it was held that the United States, when it recognized the Indian reservation through Congressional action, implicitly reserved sufficient water with the land in order to fulfill the very purpose for which the reservation had been created, namely, to help the Indians establish a new way of life based on the arts of non-Indian civilization, including agriculture." (What Indian Water Means to the West by Western Network, Inc.)

The Winters Doctrine II decision has been the standard bearer that tribes have taken into courts for over half a century in attempts to defend their rights to the use of their waters. Under the so called "Winters Doctrine", a tribe's right to water has been seen as an expanding right, one that would expand with the tribe's growth and needs. However, in the arid Southwest, water as a physical resource does not necessarily expand as easily as the court decreed on paper.

The physical limitations caught up with the decision in 1963, when the U.S. Supreme Court in Arizona v. California held that a tribe's apparent open-ended reserved rights could indeed be quantified through a formula based on the amount of "practically irrigable acreage" within the confines of the reservation. Like the U.S. Supreme Court's definition of tribal governments as "quasi sovereigns", the yard stick of "practically irrigable acreage" has been subject to problems of interpretation. Courts, in attempting to define "practically irrigable acreage" have attempted to tie it to the economic feasibility of irrigating Indian lands, applying parameters to a once open-ended decision.

In New Mexico, the Mescalero and Jicarilla Apache tribes and the Navajo tribe are currently in litigation attempting to define their rights to water based on the principles of reserved rights enunciated in

Winters v. U.S. and Arizona v. California. In the meantime, the Pueblo Indians of New Mexico are apparently re-defining what may be a new Indian water right. The U.S. District Court in New Mexico v. Aamodt has recently held that those portions of the Pueblos created by Executive Order (and presumably similar types of federal action) could claim Winters Doctrine rights to their waters, while those Pueblo lands aboriginally retained would be subject to prior appropriation guidelines.

The court found that:

"The Pueblos have the prior right to use all of the water of the stream system necessary for their domestic uses and that necessary to irrigate their lands, saving and excepting the land ownership and appurtenant water rights terminated by the operation of the 1924 Pueblo Lands Act...acreage under irrigation of 1846 was protected by Federal laws including the Treaty of Guadalupe Hidalgo, supra, and the 1851 Trade and Intercourse Act, supra." (N.M. v. Aamodt, Memorandum Opinion and Order, 1985)

The decision is being appealed, the Pueblos contending a "Winters Right" for all lands. At the very least, the parties still face a long period of court activity that will likely end in another U.S. Supreme Court decision as to the water rights of the Pueblos.

As all these cases of both Pueblo and Treaty tribes began winding their way through the federal courts and the state courts (under the McCarren Act), the physical parameters of water are beginning to exert a different kind of pressure. As New Mexico's population grows, and water needs expand, the luxury of extended court battles concerning paper water rights are becoming viewed as a stumbling block to development. Threats of relatively quicker solutions through the legislative route continue to rise and fall seemly in rhythm to dry and wet seasons. But, legislation is the Sword of Damocles that continues to hang over Indian water rights and consideration of future Indian water uses.

The pressures of expanding water uses and congressional whims have moved some Southwest tribes to consider the once forbidden areas of negotiation and arbitration. The former method for resolving water disputes is still viewed very cautiously by tribal groups. This need for

caution rests partially on the contention that negotiation presupposes knowing the extent of the commodity that can be negotiated, but this cannot be done until the full extent of the tribe or Pueblo's rights have been defined; and partially because of the history of Indians coming out on the short end of the stick in most negotiation proceedings. Tribes and Pueblos have usually fared better through the court system.

Arbitration carries with it more of the fairness of a court proceeding. However, there is some difficulty in selecting an arbitrator that might be considered fair by both Indian and non-Indian water users.

Some tribes outside of New Mexico have felt the physical pressures of water usage more acutely and have actually entered into or attempted negotiated settlements. In doing this, tribes have found how important it is to have a good knowledge of the technical use of water and not simply a strong legal principle. This growing awareness of how water usage is changing in a growing society that is shifting away from an agrarian lifestyle is the latest ripple on the old problem of Indian water rights.

There is a growing awareness that they, as Indian communities, are being pressured to develop limited resources in direct competition with rapidly growing non-Indian communities. At the same time, tribal communities are growing, not dwindling, as more and more Indians remain on the reservations. With such internal and external pressures, Indian communities are looking much more closely at how their legal paper rights will translate into actual useable water. This issue more than anything will cause many tribes to look not only to the court system for a resolution, but has and will begin opening up other areas of resolution to the very emotional and volatile issue of water rights.

FEDERAL LEGAL TRENDS

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THE OPINIONS EXPRESSED HEREIN ARE STRICTLY THOSE OF THE
AUTHOR AND MAY NOT REFLECT THE OFFICIAL POSITION EITHER
OF THE UNITED STATES OR OF THE DEPARTMENT OF JUSTICE

If there is any single area of American law in which there will be substantial development during the next 50 years, it is water law. As demands increase, and the supplies of quality water decrease, the resulting conflicts will require the continued development of laws and regulations governing the use of water.

Many of these laws and regulations will develop at the state level throughout the 50 states. The practice of water law will no longer be limited primarily to those states lying west of the hundredth meridian. For example, 16 of the 26 historically riparian states lying east of the Mississippi River now have water laws of some kind. The need for revision of state laws and regulations governing water use is being studied (or has been studied within the past five years) in all of the 26 eastern states.¹

Substantial activity also will continue at the federal level. These comments address likely developments in federal water law during the next 50 years in three areas: (1) resolving water conflicts, (2) types of federal water rights, and (3) water conservation. After these areas have been reviewed, a number of additional areas in which there will also be federal water law development will be mentioned.

Resolving Water Conflicts

Traditionally, disputes over water have been resolved through litigation, legislation or the development of interstate compacts. Though each of these dispute resolution mechanisms will continue to be used, each has certain limitations that inhibit its effectiveness.

Litigation concerning federal water rights can occur in state courts (under the McCarran Amendment),² in U.S. District courts (if there

exists a federal question or diversity of citizenship) or in the U.S. Supreme Court (if a case is appealed or if one state sues another). Regardless of the forum in which it occurs, litigation is both expensive and time-consuming.

In addition, the U.S. Supreme Court established a burden of proof requirement in the Vermejo decisions³ which will eliminate equitable apportionment litigation as a mechanism by which interstate water conflicts will be resolved. In Vermejo, the Supreme Court ruled that a state bringing an equitable apportionment action must be able to prove by clear and convincing evidence (i.e., to a high probability) that it has suffered real or substantial injury or harm. No state will be able to allow an interstate water conflict to continue to the point that the state can meet this burden of proof requirement.

Litigation, however, will continue. States will return to the Supreme Court, but under different theories. South Dakota recently asked the Supreme Court to be allowed to file a complaint concerning the use of Missouri River waters. In its complaint, which the court has yet to accept, South Dakota argues that Congress intended to allocate the waters of the Missouri River when it enacted the Flood Control Act of 1944. South Dakota wants the Supreme Court to enjoin the states of Nebraska, Iowa and Missouri from interfering with the exercise of South Dakota's water rights.⁴ It is interesting to note that South Dakota is specifically arguing that this action is not an equitable apportionment action, probably because South Dakota cannot meet the burden of proof requirements that the Supreme Court established in Vermejo.

Resolving interstate water conflicts through legislation also will continue, though there are many problems with this approach. Legislative solutions are also time-consuming and may be motivated by purely political reasoning. Unfortunately, many legislative solutions result in litigation when they are implemented.

Legislation has been introduced that would restrict the diversion of water resources which are shared by a number of states unless all of the states sharing the resource consent to the diversion.⁵ Coal slurry

pipeline legislation contained numerous provisions regarding the use of water in the interstate shipment of coal.⁶ The legislative approach to resolving interstate water conflicts is certain to continue.

Development of new interstate compacts is also time-consuming and also requires congressional consent. Compacts frequently fail to address specific contingencies and may contain errors or ambiguities that emerge over time. (Regarding errors in compacts, the Colorado River Compact is an excellent example.)

Regardless of the difficulties in resolving water conflicts through compacts, development of new compacts will continue. Montana recently entered into a compact with the tribes of the Ft. Peck Indian Reservation (the Assiniboine and the Sioux tribes) regarding Indian water rights. North Carolina and Virginia are considering the development of a compact to resolve water use conflicts in the Tidewater area.

The difficulties of using any of these three methods to resolve water conflicts will result in the emergence of a fourth method focusing on mediation and arbitration. This mechanism will be established by an Act of Congress and will be fashioned after the Federal Mediation and Conciliation Service. Congressional willingness to encourage the use of mediation to resolve conflicts can be seen in the Dispute Resolution Act of 1980.⁷

In essence, the mediation mechanism will be a sitting special master, a "neutral corner" in which water conflicts may be resolved. This approach to resolving conflicts will be comprehensive, quick, relatively inexpensive and informal. When it enacts legislation establishing the mediation mechanism, Congress will also limit access to the courts by requiring an attempt at mediation before litigation may commence. Within the next 50 years, many (if not most) water conflicts will be resolved through mediation or arbitration.

Types of Federal Water Rights

Historically, the federal government has held two types of water rights. The first, appropriative water rights, are those rights that have been acquired pursuant to state water laws. Many federal agencies

are required to obtain state water rights when water is needed for a federal purpose.⁸ In granting a water right, a state may impose whatever terms and conditions it chooses so long as the terms and conditions are not inconsistent with express congressional directives.⁹

The second, reserved water rights, are those water rights that the federal government has acquired by implication when land is withdrawn from the public domain for a specific purpose. The quantity of water reserved is the minimum quantity needed to fulfill the primary purpose of the reservation. Reserved water rights are limited to the quantity of water that was unappropriated at the time of the reservation.¹⁰

The federal government will continue to hold both appropriative and reserved water rights. In addition, over the next 50 years, a third type of federal water right will emerge: A preemptive water right.

What will happen if water is needed for a federal purpose and it can be acquired neither pursuant to state law nor through the exercise of a reserved water right? If it is the express intent of Congress, then state laws restricting the availability of water for the federal purpose will be preempted. Such a preemption is based on Article VI, section 2 of the U.S. Constitution (the Supremacy Clause). For example, in Missouri v. Holland, 252 U.S. 416 (1920), state laws asserting title to migratory birds, which were protected under federal law, were preempted. A similar result would have occurred if the state laws had restricted the availability of water for such waterfowl. When water is needed for a congressionally mandated purpose, state laws restricting availability will be preempted.¹¹

Water Conservation

The states will continue to have primary responsibility over water conservation. Many states will follow the examples of California and Arizona in establishing stringent water conservation requirements.¹² Despite the ongoing role of the states, there will emerge numerous federal laws and regulations focusing on water conservation.

Future federal policies will reflect the approaches that were taken toward energy during the energy crisis of the early 1970s.

Specifically, federal policies will address both a reduction in demand for water and development of alternative supplies of water. It is certain, for example, that federal tax incentives will be offered for investments in water conservation just as such incentives have been offered for investments in energy conservation.

Water from federal projects flows primarily into irrigation. Much of this water is used inefficiently due to outdated distribution facilities and conveyance systems. An Interagency Task Force on Irrigation Efficiency determined in 1978 that water conservation in irrigated agriculture could save as much as 24 million acre-feet of water per year.¹³

In terms of reducing demand for water from federal projects, operational criteria for existing projects will be changed to improve project efficiency. Future federal projects, if any, will be designed for maximum water use efficiency. For example, it is certain that existing contracting entities receiving water from federal projects will be required to demonstrate an ongoing water conservation program as a condition precedent to contract renewal. Such water conservation program requirements will become a standard provision in all new contracts for federal project water.

Federal cost-sharing requirements will also result in improved water use efficiency, basically because the water resource will cost too much to waste. As subsidies in all forms are eliminated, and as water consumers are required to pay the true costs of their water supplies, it will be in their best interests to minimize their demands on those supplies.

In terms of increasing water supplies, future federal policies will focus on mandatory water reuse and on federal weather modification programs. Where feasible, water will be delivered from federal projects only to those contracting entities that have ongoing water reuse programs. This may result in litigation regarding existing federal projects because of the likelihood that downstream water users are relying on existing waste as a source of supply. Future federal

projects, however, will require reuse whenever feasible. These requirements will be imposed on contracting entities immediately upon construction of the project before downstream water users can come to rely on the waste of federal project water as a supply source.

Within the next 50 years, operational federal weather modification programs will be implemented in numerous watersheds throughout the western United States. These programs will focus on the wintertime seeding of orographic clouds to increase the efficiency of such weather systems. The increased efficiency will result in increased precipitation, snowpack and runoff. The proposed CREST (Colorado River Enhanced Snowpak Test) Program of the Bureau of Reclamation is an example of such a federal initiative.

One aspect of any federal weather modification program is a certainty. If weather modification programs are federally funded, then the increased water supplies produced by such programs will be claimed by the federal government irrespective of state ownership claims. Water produced by federal weather modification programs is water that would not have naturally occurred in a stream system. As such, it will be seen as the property of the developer, that is the federal government.

Despite the predictions contained in the previous section, if there ever is another successful equitable apportionment action in the Supreme Court, the outcome may turn on the success of state water conservation programs. The Supreme Court made it very clear in the Vermejo decisions that a state's efforts to conserve a shared water resource would be a major factor to be considered in any equitable apportionment action.¹⁵

Additional Trends

Future litigation in federal courts will establish that Indian water rights must be treated the same as all other water rights existing within a state water rights system. In quantifying Indian reserved water rights, the same beneficial use requirements and waste restrictions that apply to other water right holders will be applied to Indian claims. To do otherwise will be seen as an impermissible racial classification. For example, if a state requires water efficient irrigation systems in an

effort to conserve state water supplies, Indian water rights will not be quantified on the basis on preexisting inefficient irrigation systems.¹⁶ It must be remembered that all reserved water rights are for the minimum quantity of water needed for the primary purpose of the reservation.

Numerous developments will affect the use of water from federal projects. Restrictions on use to specific service areas will be eliminated once water augmentation plans are developed. These plans will provide for a supply of water to service areas so that existing service area supplies may be used for other purposes. As federal projects are paid-out by project sponsors, the restrictions on use to specific service areas will be eliminated.

Also to be eliminated as federal projects are paid-out will be any further involvement of the federal government in the operation and maintenance of a project. The sponsoring entities will be expected to assume full responsibility. Unless there is an ongoing national purpose to be served, continued federal involvement following pay-out will be seen as an unacceptable subsidy. Once project sponsors have assumed responsibility for specific projects, they will be subject to federal health and safety regulations. This will become the maximum extent of federal involvement.

Future litigation will clarify the second subsentence of the McCarran Amendment.¹⁷ The first subsentence has been subject to substantial judicial scrutiny.¹⁸ The rulings have been clear: State courts have jurisdiction over federal water claims in general adjudications. When presented with the issue in future litigation, the courts will rule that the second subsentence of the McCarran Amendment subjects the federal government to state administrative requirements once a general adjudication has occurred. Administration of water rights decrees will become exclusively the responsibility of the states.

Perhaps the most important development that is likely to emerge during the next 50 years may be the decline of both federal and state governments as having responsibility over water resources planning and

management. New institutions will emerge that will manage water resources on the basis of hydrologic reality, not on the basis of historic but irrelevant political subdivisions. The new management districts will transcend political boundaries, both interstate and international.

These new management districts will be areawide or basinwide. They will allocate and manage both surface water and groundwater based on a principle of multiple use maximization. Such maximization will become feasible as hydrologic and geologic information expands and as computer systems develop to make use of the information. Specific area or basin models will be developed. Telemetry and remote sensing systems will feed enormous amounts of data into these models on a real-time basis.

Maximum multiple use efficiency will be possible because all of the impacts of all water uses or requirements can be determined. Water uses will be allowed when and where such uses can be of maximum benefit. Existing water rights holders will receive the same benefits of water use that they are now receiving, but based on a complete understanding of how their water uses relate to all other water uses in the area or basin, not on the antediluvian concept of temporal priority.¹⁹

Conclusions

Cheif Justice Warren Berger, in his Annual Report to the American Bar Association on February 12, 1984, spoke of the need for innovation in the legal system.

The story of justice, like the story of freedom, is a story that never ends. What seems unrealistic, visionary and unreachable today must be the target even if we cannot reach it soon or even in our time. If we ever begin to think we have achieved our goals, that will mean our sights were set too low or that we had lost concern for our profession or the public interest.

What will occur within the next 50 years? How many of the projections which were made 50 years ago were accurate?

The accuracy of a projection is relatively unimportant. What is important is the commitment to resolving issues before they become crises, rather than reacting to crises with ill-conceived laws and policies. The future will occur. The only real question is whether it will be by accident or by intent.

END NOTES

- 1 Sherk, "Water Rights: Eastern Water Law," 1 Natural Resources and Environment _____ (1985) (forthcoming).
- 2 The McCarran Amendment provides, in part, that:

Consent is hereby given to join the United States as a defendant in any suit (1) for the adjudication of rights to the use of water of a river system or other source, or (2) for the administration of such rights, where it appears that the United States is the owner of or is in the process of acquiring water rights by appropriation under State law, by purchase, by exchange, or otherwise, and the United States is a necessary party to such suit. The United States, when a party to any such suit, shall (1) be deemed to have waived any right to plead that the State laws are inapplicable or that the United States is not amendable thereto by reason of its sovereignty, and (2) shall be subject to the judgments, orders, and decrees of the court having jurisdiction, and may obtain review thereof, in the same manner and to the same extent as a private individual under like circumstances: Provided, That no judgment for costs shall be entered against the United States in any such suit.

43 U.S.C. 666 (1984).

- 3 New Mexico v. Colorado, 459 U.S. 176 (1982) (Vermejo I) and _____ U.S. _____, 104 S. Ct. 2433 (1984) (Vermejo II) rehearing denied _____ U.S. _____, 105 S. Ct. 19 (1984).
- 4 State of South Dakota v. States of Nebraska, Iowa and Missouri, Motion for Leave to File Complaint (August 15, 1985). The Supreme Court applied a similar legislative intent history in Arizona v. California, 373 U.S. 546 (1963), regarding the Boulder Canyon Project Act and the appropriation of the lower Colorado River.
- 5 See, for example, H.R. 1749 which was introduced by Representative Badell on March 1, 1983. Section 2 of the bill provided that:

No state shall sell or otherwise transfer or permit the sale or transfer, for use outside of such State, water which is taken from any river or other body or surface water which is located in or which passes through more than one State or from any aquifer or other body of ground water underlies more than one State unless -

(1) there is in effect an interstate compact (A) among the States under which

such aquifer or other body of ground water lies, which governs such sale or transfer, and

(2) all the States which are parties to such compact consent to such sale or transfer.

The bill was not enacted.

- 6 See, for example, H.R. 1010 (the "Coal Pipeline Act of 1983") as reported by the House Committee on Interior and Insular Affairs on April 15, 1983. Section 207 of the bill as reported provided that:

Pursuant to the commerce clause in Article I, section 8 of the United States Constitution, the Congress hereby expressly delegates to the States the power to establish and exercise in State law, whether now in existence or hereafter enacted, terms or conditions (including terms or conditions denying or terminating use) for the reservation, appropriation, use, export, or diversion of or other claim to, or exercise of any right in, water for a coal pipeline, notwithstanding any otherwise impermissible burden which may thereby be imposed on interstate commerce.

Coal slurry pipeline legislation containing this language was defeated in the House of Representatives on September 27, 1983.

- 7 28 U.S.C. App. 1-10 (1982).

- 8 For example, section 8 of the Reclamation Act of 1902, codified at 43 U.S.C. 383 (1964), provides that:

Nothing in this act shall be construed as affecting or intended to affect or to in any way interfere with the [sic] laws of any State or Territory relating to the control, appropriation, use, or distribution of water used in irrigation, or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this act, shall proceed in conformity with such laws, and nothing herein shall in any way affect any right of any State or of the Federal Government or any landowners, appropriator, or user of water in, to, or from any interstate stream or the waters thereof: Provided, That the right to the use of water acquired under the provisions of this act shall be appurtenant to the land irrigated and beneficial use shall be the basis, the measure, and the limit of the right.

- 9 California v. United States, 438 U.S. 645 (1978) (the New Melones decision).
- 10 Winters v. United States, 207 U.S. 564 (1908). See also Cappaert v. United States, 426 U.S. 128 (1976) and United States v. New Mexico, 438 U.S. 696 (1978).
- 11 See also First Iowa Hydro-Electric Co-op. v. Federal Power Commission, 328 U.S. 152 (1946), and Federal Power Commission v. Oregon, 349 U.S. 435 (1955) (the Pelton Dam decision).
- 12 See Shupe, "Wasted Water: The Problems and Promise of Improving Efficiency under Western Water Law," paper presented at Colorado Water Issues and Options: The 90's and Beyond (Denver, Colorado, October 8-9, 1985).
- 13 Cited in Shupe, id. at 10.
- 14 The operational characteristics of an orographic weather modification program and the basis for claiming the water produced as "developed water" are discussed in Danielson, Sherk and Grant, "Legal System Requirements to Control and Facilitate Water Augmentation in the Western United States," 6 Denver Journal of International Law and Policy 511 (1976). Also appears at Water Needs for the Future 289 (1977) (V. Nanda, ed.).
- 15 In Vermejo II, for example, the Court disagreed with the Special Master over the issue of water conservation: "[W]e cannot agree that Colorado has met its burden of identifying, by clear and convincing evidence, conservation efforts that would preserve any of the Vermejo River water supply." Supra note 3, 104 S. Ct. at 2439.
- 16 In terms of future trends, a major decision was recently handed down by the Colorado Supreme Court. In Alamosa-LaJara Water Users Protection Association v. Gould, 674 P.2d 914 (Colo. 1984), the Court ruled that existing senior water rights holders who were receiving surface waters could be required to satisfy their rights through the pumping of groundwater. Not to do so would have precluded the development of substantial quantities of groundwater in the Rio Grande basin. In essence, historic water use practices are not protected merely by the seniority of the appropriation. Changes may be required in order for limited water supplies to be put to their maximum beneficial use.
- 17 The McCarran Amendment is quoted at footnote 2, supra.
- 18 Most recently, see Arizona v. San Carlos Apache Tribe, 463 U.S. 545 (1983).

- 19 Studies of how such an approach might be applied to the South Platte River Basin in Colorado have been ongoing. See Grigg, "Voluntary Approaches to Basinwide Water Management," paper presented at Colorado Water Issues and Options: The 90's and Beyond (Denver, Colorado, October 8-9, 1985).

MEGATHOUGHTS

Pat O'Meara
Retired Chairman
National Water Resources Association
Washington, D.C.

Our program today is centered on megatrends. It seems odd to me, but all day we have been talking about megatrends without anyone ever mentioning megabucks. I think that is really what we came to talk about, megabucks and not megatrends. Unfortunately the megabucks don't seem to be there like we would like them to be. And they're no going to be there.

On the archives building in Washington D. C., carved in stone are the words "The Past is Prologue." If you think about it, that's true. While we're thinking about the future, the past is prologue. There was a visitor to Washington one time who was going down Pennsylvania Avenue in a taxi and he asked the taxi driver what "The Past is Prologue" meant. The cab driver said "That means you ain't seen nothing yet." And I think that is true.

I went to Washington to work when Eisenhower was president and at that time Fred Seaton was the Secretary of the Interior. They had a policy at Interior at that time called "No New Starts." That was in 1957, and this year the policy at the Bureau of Reclamation is "No New Starts." Everything stays the same.

Earlier this month we celebrated the 50th anniversary of the great Hoover Dam, one of the proudest achievements of the Bureau of Reclamation and the engineering community. I shudder to think of what would happen today if we proposed to build a Hoover Dam. The chances of getting it accomplished would be slim.

Next month, Colorado River water will flow into Phoenix as part of the great Central Arizona Project, a multibillion dollar project that's bringing much needed water to the people of Arizona. That project wouldn't be there if it hadn't been for Sen. Hayden. I remember Sen. Clinton P. Anderson telling me one time that while he was battling to get

the Hoover Dam authorized, senators came to him on the floor of the Senate and said, "Clint, you're trying to fool the Senate by telling it you've got a market for all that power from the dam. You know that out in that part of country you have no market for that kind of power." Well we're upgrading Hoover Dam because we desperately need more of that kind of power today.

There's a little story that goes along with Hoover Dam. In World War II the U.S. aircraft industry in Southern California was mustered to build the Air Force that defeated the axis. It was there in Southern California that the power to operate that industry was available, power that came from Hoover Dam. So Clint wasn't fooling. But we couldn't meet that challenge today, I'm sorry to say. Perhaps it's fair to say the Golden Age of Reclamation may be behind us. I hope not. I think the challenge of water resources development is still there. It may not be in the same form as Hoover Dam, but the challenge is there, and the water need is still real. We still have to address those needs. What goes on in the 80s and 90s will be evaluated by future generations. Let us do what we can today to assure that those future generations will give us a passing grade for our efforts.

Here in the Sun Belt is where the United States is going to grow. The biggest problems you have in the Sun Belt are growth, development and the availability of water. You know the problems you have here and you know the problems they're having in the High Plains of Texas. Texas has searched to Canada, to the Mississippi and to the Missouri River trying to find a water supply they could pipe to the High Plains.

Now we're developing some new approaches besides pipelines. We're talking about cost sharing, we're talking about financial partnerships, and we're talking about reduced federal involvement. Garry Carruthers' favorite saying was "We've got to have innovative financing." I finally figured out what he meant. It means somebody other than the federal government is going to pay. That's innovative financing.

We're not giving new authorizations for projects and we're not getting the cooperation we once had. It's a matter of fact that the Army

Corp of Engineers is spending more money on operation and maintenance than they are on construction. And the National Water Resources Association is today struggling to get a bill through Congress that would extend the very successful Small Reclamation Project Act. That program has been successful and has paid back the government. Yet we're having trouble. Any why are we having trouble? Farmers in Iowa, and Indiana and Illinois don't get any participation out of the Reclamation Act.

When you stop to think that this year the American farmer will produce about 8 1/2 billion bushels of corn, that's more than we know where to store, or where to sell, or even give away. So when we try to convince Congress that we need more irrigation projects, and most of those irrigation projects would raise some corn to add to the surplus, it is a difficult job to sell. What are we going to do with all the corn that's depressing the market? Think about feeding the starving people of the world. We know those people demand more food. We know we'll have droughts, as Ethiopia is having now. When those droughts come, this country is going to rely very, very heavily on its irrigated agriculture. We know that we're losing 6 acres of land every minute in this country -- 6 acres of agricultural land to urban developments, to factories and to highways. That lost land needs to be replaced with agricultural production and the best way to replace it is through irrigation.

Our work is not finished, it has just begun. We need to start at the grass roots. It shouldn't be just the farmers and ranchers who irrigate and the city officials who have water problems, it should also be businessmen, labor leaders, politicians and students. I was very pleased at the meetings today to see the number of women who were attending. I'm glad to see that women are making a dedicated effort to help solve New Mexico's water problems.

Tom Bahr quoted from statements made at the first water conference 30 years ago. It's interesting to note that there was no mention in that first conference of infrastructure. When we start talking infrastructure, it includes water resources development, highways, ports,

and waterways. The cost to bring highways up to speed, to maintain water resources and other developments in this country is estimated at up to \$100 billion over the next few years. We need to maintain what we have today and at the same time work on management and conservation. That's going to be an enormous task. It's a challenge for you.

Hal Brayman is here from the Senate Environment and Public Works Committee. Hal will speak to you tomorrow. Go ask Hal about the coalition of senators working to develop a new water policy and bring forward new authorizations out of the Senate for water development. It wouldn't take Hal long to answer. There isn't such a coalition. Water is not the big priority with your senator or my senator anymore.

Colorado is a dry state, as are many of the western states. Sen. Armstrong of Colorado told me, "I know what water means to Colorado, I know what it means to the development of the West, but its not the main issue in Colorado. There are issues that transcend water, so I have to give my attention to other matters."

Your Sen. Pete Dominici has the awesome responsibility of working on the tremendous deficit in the federal government. It's pretty hard for people to try and cut back on everything and then on the other hand say I want water resources money. Sen. Domenici said that 52 percent of all the tax revenues received by the federal government today goes to pay the interest on the national debt. Then 32 percent of that money goes to operate the military. If my figures are right, that leaves only 16 percent for all the other functions of government. So I might say as a water lobbyist working for appropriations, I've been an abysmal failure, because our share of that federal budget is a small part of 1 percent. I think it's going to become smaller. Projects are going down the tube instead of being authorized. I think if I have any kind of solution to suggest, it's that now is the time for states to say to the federal government, "We appreciate the help you've given us for the past 80 years, but now we're going to dissolve this partnership and we're going to march on our own."

The Natural Water Resources Association has stressed over the years that water belongs to the state, not to the federal government. When the federal government starts talking partnership, they're talking in favor of the rich states that are going to do well. But the poor states are going to suffer more than they've suffered up to this time.

Look at Wyoming for example. It has a severance tax on its coal and it's digging coal by the train loads every day. That money is pouring into the state engineer's coffers because a large part of that money has been set aside for water resources development in Wyoming. So when it came to matching a partnership, Wyoming can step right up and say "We're ready. We've got money in the bank, we'll match you 3 to 1." Have you got that kind of an opportunity in New Mexico? Nebraska is trying to get an addition to the state sales tax designated for water resources development only in Nebraska. To fund water development, other states have had increase in their labor tax, some have increased their tobacco tax. I think that's all foolhardy. We're operating the finest industry in the United States and we refuse to tax ourselves.

What's wrong with a New Mexico water tax? People need your product. They tax every other utility you've got. You pay taxes on your telephone bill, you pay taxes on your electric bill, you pay taxes on your sewage bill, but you don't want to tax water.

It could be a miniscule tax per thousand gallons. I think we would have the richest man in New Mexico if we taxed water 1 cent per thousand gallons and sent that money to (state engineer) Mr. Reynolds.

The average person wouldn't even see it in his water bill after the first bill. That's the smallest utility bill you get. So I'm pleading with you, take the product that we need and everyone is going to buy and put a tax on it. You'll have big revenues.

You're fooling yourselves if you sit around and think you're going to get that money out of the federal government anymore. So stand up. Say we want to tax our product. Once we do, we're in business.

I want you to keep one eye on the future. If we do our job right, the golden age of water and water development may still be ahead of us.

We know the population in this great country will grow, and as I mentioned earlier, so will our challenge. Let us make sure that in 60 years when they look back at us, they judge us well.

ENVIRONMENTAL TRENDS
IMPLICATIONS FOR WATER RESOURCES

Ronald North
Director, Institute of Natural Resources
University of Georgia

Introduction

My charge is to "identify environmental issues" that will shape the future of water resources development and management and the consequences of society adopting various courses of action. Specifically I will look at the impact of environmental laws on water resources development. We all know how the National Environmental Policy Act (NEPA) of 1969, and Earth Day 1970, the Fish and Wildlife Coordination Act, the Endangered Species Act, the Water Resources Council Principles and Standards and other policies put an end to water development projects. Can you imagine being able to design and build a water project with so many environmental laws and attitudes? It is not possible that the day of federal water projects is already finished! By 1972 we had been building projects at a rapid rate for some 70 years. How many more projects could be built on the Tennessee, the Rio Grande, the Colorado, the Savannah, the Chattahoochee? I propose that a contrarian view is more accurate.

In economics we deal with choices, how they are made and by whom. Our objectives are optimization -- maximize net returns, maximize benefits, minimize costs, maximize GNP, maximize personal income. Kenneth Boulding, taking a cue from A. Marshall, has said that we, as a society, more likely engage in suboptimization: maximize the irrelevant, achieve efficiency in undesirable outputs, and develop least cost methods of doing the unnecessary. But this accusation does not apply to water resources? I propose that achieving efficiency in water projects, and the failure to recognize that point, was a major "reason for," or incentive for environmental laws.

Attempted overinvestment in water projects contributed to development of environmental laws. Building too many water projects too fast helped create the environmental movement that we are quite proud of today. Now that we have disposed of the question of the impact of environmental laws, let's look at some other aspects of environmental trends and water resources.

I find it hard to separate environmental trends from the age in which we live. It is a complex age -- one of massive amounts of information and data that can be used either to support or discredit an idea or an issue. With these general thoughts in mind I want to review briefly three kinds of environmental trends:

1. General and technical trends
2. Commodity trends, and
3. Issue trends

General Trends

We are, as a nation and within the water resources community, moving rather swiftly to an era beyond that perceived as industrial maturity. The era is often described as a high technology era. These times have also been described in terms such as "post-industrial era," "service era," "communications-information era," "environmental era," "computer era," and the "era of limits." There are numerous other subsets of these descriptions of our times but they all point to a major shift in the way society conducts its business, orders its priorities, and views itself vis-a-vis other social eras. It is a new era, as clearly evident as the era that it replaces, i.e., the industrial revolution and its two centuries or so of social structure.

Our interests as professionals are focused on water -- a most elementary, age-old, but ageless resource. How do we resolve our work with this resource with the environmental issues in the high technology era? First, we must recognize the changing social structure and use its attributes as well in this era as our forebearers did in earlier eras. Second, we must not be shy about suggesting innovations and changes in both technologies and institutions that will keep the core of our

discipline, i.e. hydrology, competitive with other disciplines. We must keep ourselves abreast of the latest operating modes and needs of our society. We must recognize that in a span of one or two decades, we in the water business have made the transition from the industrial era, characterized by fabrication and development of durable goods, to an environmentally sensitive, high technology era, characterized by recycling resources and management of tertiary services. These services include community utilities, resource allocation, waste management, health, research, education and recreation. Who would imagine, in 1961, that a Corps of Engineers reservoir in Georgia (Lake Lanier) would accommodate more visitors than our largest national park? We are, in this era, more concerned with water services such as reuse, conservation, quality protection, and delivery of pluralistic water services than we are with methods such as levies, dams and locks.

What are the symptoms of environmental concern and high technology, that is, the signs of transition from development to management that are evident everywhere? We indulge in instant coffee, instant stock market quotes, instant news of catastrophies, instant governmental policies and near instant movement from coast to coast or continent to continent. We are admonished by futurists to accept the potentials of a new state of society while we are yet unable to comprehend much of the existing state of affairs. We know that certain forms of technology and behavior described by Aldous Huxley's Brave New World in 1931 and by George Orwell's 1984 in 1949 are, sometimes painfully, becoming more evident. It is easy to recognize the a, b and c vocabularies of "newspeak" described by Orwell. What else but "newspeak" uses terms such as "cad-cam," "word processors" and "user-friendly" as also inferred in Huxley's scented disk, a.f.632?

We are in an age of environmental sensitivity that is also in transition from water resources development to water resources management. For example, the federal government's withdrawal from its significant role in water resource financing resulted in pressures from a large segment of the population to look at environmental issues and consequences -- to look at new methods of developing and managing the

nation's water resources. These conditions lead directly to more pressure on state and local governments to assume additional responsibilities for managing the nation's water resources. These interrelated developments were coincident with significant developments of technology and significant changes in the structure of North American society. They force us, at least, to ask questions about the ways we have been doing business with water resources. I shall point out a few indicators that point decidedly to changes in environmental and economic trends that have implications for water resources and related industries. These changes have implications for the way we do business, the way we conduct research, the kind of students we train and the quality of public service activities we provide our sponsoring citizens.

One of the least understood interrelationships that is about us today is that between privatization and environmental interests. Privatization is a major trend of this decade. It seeks to shift more of the costs and responsibilities of society from government toward the private sector. I think we have accepted many aspects of this trend without being fully conscious of its implications or where it comes from. For example, we now have, some major corporations and many small ones in the waste management business charging users directly or contracting with municipalities and other governments for such services. (The signal companies, now Allied Corp., are heavily involved.) Some states, such as a Tennessee, are contracting with the private sector to operate its prison system. The armed forces started contracting for food services from the private sector in the late 1950s and early 60s.

George F. Will's premise in his book on Statecraft as Soulcraft is enlightening on this issue. He says government has a role in making society work well for its individuals and small groups -- not necessarily for self-appointed public interest groups (or their elitist leadership). "Statecraft is a successful management of the state with equal concern for maintaining the highest level of individual and civic responsibility. We have, because of the foresight, the prevailing interests and the compromises of the founding fathers, the world's finest

set of institutions to manage the state of the tone that encourages, even stimulates creativity and innovation. Capitalism is dynamic -- it creates economic and social transformations, it dissolves "old" micro-institutions (organizations and alliances), it diminishes generations of skills and jobs and industries, it creates new industries and organizations and new modes of operations, new communities and new alliances." One of the most active manifestations of these privatization dynamics are the interests in environmental values; that is, a good environment now and in the future. We have created, mostly with volunteers, the new institutions to look after our environmental interests.

We must recognize and join in these innovations if we are to continue on the course of being a society of free persons. We must create and innovate in our fields, we must teach our children and our students to do this if we are to grow. We must perform. We cannot shirk our civic responsibilities in the small (our discipline) or in the large (our society). We are seeing such changes today. An environmental group is actively promoting a market system for reallocating water in the lower Colorado. This concept would have been heresy to an environmental organization a decade ago.

We are engaged, or should be, in a debate on public policy about our water resources that will effect the continuity and health of our field and our society in proportion to how well we resolve the changes that are imminent. Our roles as professionals and citizens should be that of seeking larger outcomes and solutions that do more than just remake the waters of the nation to our limited concerns. We should dispel the idea that changes in the operation and management of our waters do not involve real financial and social costs. We should identify and publicize the true costs and benefits of new public policies to our discipline, to the economy, to the environment and to society.

What are some of the indicators of our environmental era and environmental trends that affect water resources? We can look at table 1, Non-Agricultural Employment, and see what is happening to our basic

Table 1. Non-Agricultural Employment By Sectors, 1957-84.

Year	Total Non-Agricultural Employment	Goods Related				Services Related					
		Total		Manufacturing		Total		Services		Government	
	Million	Mil.	%	Mil.	%	Mil.	%	Mil.	%	Mil.	%
1957	52.9	21.0	40	17.2	32	31.9	60	6.7	13	7.6	14
1958	51.3	19.5	38	16.0	31	31.8	62	6.8	13	7.8	15
1959	53.3	20.4	38	16.7	31	32.9	62	7.1	13	8.1	15
1960	54.2	20.4	38	16.8	31	33.8	62	7.4	14	8.4	15
1961	54.1	20.0	37	16.3	30	34.1	63	7.6	14	8.6	16
1962	55.5	20.5	37	17.0	31	35.1	63	8.0	14	9.0	16
1963	56.7	21.0	37	17.0	30	36.0	63	8.3	15	9.2	16
1964	58.3	21.0	36	17.3	30	37.3	64	8.7	15	9.6	16
1965	60.8	22.0	36	18.1	30	38.8	64	9.0	15	10.1	17
1966	64.0	23.2	36	19.2	30	41.0	64	9.5	15	11.0	17
1967	66.0	23.3	35	19.4	29	42.5	64	10.0	15	11.4	17
1968	68.0	24.0	35	20.0	29	44.2	65	11.0	16	12.0	18
1969	70.4	24.4	35	20.2	29	46.0	65	11.2	16	12.2	17
1970	71.0	24.0	34	19.4	27	47.3	67	11.5	16	12.6	18
1971	71.2	23.0	32	18.6	26	48.3	68	12.0	17	13.0	18
1972	74.0	24.0	32	19.2	26	50.0	68	12.3	17	13.3	18
1973	77.0	25.0	32	20.2	26	52.0	68	13.0	17	14.0	18
1974	78.3	25.0	32	20.1	26	53.5	68	13.4	17	14.2	18
1975	77.0	23.0	30	18.3	24	54.3	71	14.0	18	15.0	19
1976	79.4	23.4	29	19.0	24	56.0	71	15.0	19	15.0	19
1977	82.5	24.3	29	20.0	24	58.1	70	15.3	19	15.1	18
1978	87.0	26.0	30	21.0	24	61.1	70	16.3	19	16.0	18
1979	90.0	26.5	29	21.0	23	63.4	70	17.1	19	16.0	18
1980	90.4	26.0	29	20.3	22	65.0	72	18.0	20	16.2	18
1981	91.1	25.5	28	20.2	22	66.0	72	19.0	21	16.0	18
1982	90.0	24.0	27	18.8	21	66.0	73	19.0	21	16.0	18
1983	90.1	23.4	26	18.5	21	66.7	74	19.7	22	15.9	18
1984, June ¹	94.0	25.0	27	19.6	21	69.0	73	20.7	22	15.8	17
1957-71 %	135	110	--	108	--	151	--	179	--	171	--
1970-84 %	132	104	--	97	--	146	--	180	--	125	--

¹ Preliminary. Seasonally adjusted for payroll period including the 12th month.

Source: U.S. Statistical Abstract 1985.

way of doing business. For example, total employment increased 35 percent over the 15-year period from 1957 to 1971. During the 15-year period from 1970 to 1984, this rate of growth of employment was 32 percent, practically no change in the two 15-year periods. However, if we look at the goods producing sector of the economy, total employment in goods related sectors was 40 percent of the labor force in 1957 and only 27 percent in 1984. This decline represents a growth rate of employment in goods related sectors of 10 percent from 1957 through 1971 but only 4 percent during the 15-year period of 1970 through 1984. The decline in manufacturing was even more severe, decreasing from 32 percent of the total in 1957 to 21 percent of the total employment in 1984. The growth rate during the first 15-year period was 8 percent while employment declined by 3 percent over the last 15-year period (1970-1984).

Let's look now at the service producing area and the employment therein. Total employment in services was 60 percent in 1957, increasing to 73 percent in 1984. If we look at services alone, excluding governments, employment was 13 percent in 1957. Service employment increased to 22 percent in 1984. The growth rate in services related employment during the first 15-year period (1957-1971) was 51 percent, decreasing to 46 percent during the next 15-year period (1970-1985). Services, exclusive of government, grew by 79 percent and by 80 percent over the two 15-year periods. As an aside, we can see that total government employment increased from about 14 percent in 1957 to about 18 percent in 1967. However, government employment has remained relatively constant as a proportion of total non-agricultural employment since that time.

What does this mean to our environmental interests as they relate to water resources? It indicates that people will have more leisure time, that they will be engaged in largely inside occupations, that they will require more outdoor area and recreational opportunities away from home. These are all trends that will be of concern for environmental interests and for water resources.

I will summarize the general indicators of environmental trends by looking at two categories of legislation with respect to U.S.

congressional interest. These two categories of laws -- preservation legislation and pollution control legislation -- are by no means all inclusive. First, the data in table 2 show the concentration of preservation legislation passed in the 1970s. Certainly there have been other preservation acts, but nothing like the activity in major new directions such as in wilderness, clean water, fisheries, endangered species. Second, the data in table 3 are focused on federal pollution control legislation and its heyday in the decade of the 1970s. The heavy activities were in water pollution, air pollution, noise, pesticides and "toxics."

Commodity Trends *

Environmental commodities may sound a bit crass but the term helps make a point. Environmental commodities are the water we drink, the air we breathe, the wildlife we enjoy, the wilderness areas we visit, the rivers we float, the lakes we fish and all of the other natural amenities we consume. These environmental amenities are also environmental services in a service dominated era. A park is no less an environmental service than are public schools or insurance. Let's look briefly at the trends involving environmental amenities (commodities, services, resources).

Air Quality. Since 1975, air quality appears to be improving in terms of the five measured pollutants as they occur in the air and in terms of emissions. Carbon monoxide and sulfur oxide emissions and ambient air levels have shown more improvement than other pollutants. Even though carbon dioxide ambient levels and emissions have increased dramatically since 1945,

* The most authoritative and comprehensive source of data on environmental trends is found in State of the Environment, published by The Conservation Foundation, Washington, D.C. 1984. All notes refer to figures in this publication. These data in Environmental Trends are available in tabular form in the annual reports of the Council on Environmental Quality (Environmental Quality ----) and the Environmental Protection Agency (annual reports and special reports).

Table 2. Preservation Legislation Enacted by the U.S. Congress

Law	Year enacted	Main preservation provision(s)
Yellowstone Park Act	1872	Created first national park.
Antiquities Act	1906	Created system of national monuments.
National Parks Act	1916	Created National Park System.
Wilderness Act	1964	Created national wilderness system.
National Historic Preservation Act	1966,1980 amend.	Expands scope of historic preservation, directs federal agencies to examine impacts on historic properties.
Wild and Scenic Rivers Act	1968	Created national wild and scenic rivers system.
National Trails System Act	1968	Created national trail system.
Bald Eagle Protection Act	1969,1972 amend.	Forbids killing of bald and golden eagles and protects habitat.
National Environmental Policy Act	1969	Requires study of environmental impacts associated with major federal actions.
Wild and Free-Roaming Horse and Burro Act	1971	Provides for federal management and protection of wild horses and burros.
Clean Water Act	1972 amend.	Sets national standards for clean waters.
Endangered Species Act	1973	Bars federal actions that would jeopardize an endangered or threatened species.
Eastern Wilderness Act	1975	Extended wilderness system into East, creating first eastern wilderness areas.
Fisheries Conservation and Management Act (FCMA)	1976	U.S. right to manage fisheries within 200nm.
Federal Land Policy and Management Act	1976	Requires wilderness review of BLM lands.
Surface Mining Control and Reclamation Act	1977	Requires restoration of mined land to original condition.
Endangered American Wilderness Act	1978	Added 1.3 million acres of new wilderness.
National Parks and Recreation Act	1978	Made important additions to the wild and scenic rivers system, and national wilderness system.
Public Rangelands Improvement Act	1978	Sets goal to restore rangelands to earlier productivity.
Archeological Resources Protection Act	1979	Requires permits for site excavations and artifact removal, provides other protections for archeological resources on federal lands.
Alaska National Interest Lands Conservation Act	1980	Establishes large new national parks, wildlife refuges, wilderness areas, and other "conservation system units" in Alaska.

Source: Adapted from Robert H. Nelson. "The Public Lands" in Current Issue in Natural Resource Policy. Resources for the Future, Incorporated. Washington, 1982.

Table 3. Federal Pollution-Control Statutes

Statute	Year Passed
<u>Statutes Focusing on "Conventional" Pollutants</u>	
Rivers and Harbors Act (Navigable Waters)	1899
Clean Air Act Amendments	1970
Resource Recovery Act (Amendments to the Solid Waste Disposal Act)	1970
Water Pollution Control Act Amendments	1972
Noise Control Act (Amendments to the Federal Aviation Act)	1972
Ocean Dumping Act (A title of the Marine Protection Research and Sanctuaries Act)	1972
Noise Control Act Amendments	1976 1978
<u>Statutes Focusing on "Toxics"</u>	
Federal Environmental Pesticide Control Act (Amendments to the Federal Insecticide, Fungicide and Rodenticide Act)	1972
Safe Drinking Water Act (Amendments to the Public Health Service Act)	1974
Resource Conservation and Recovery Act (Amendments to the Resource Recovery Act focusing on hazardous wastes)	1976
Toxic Substances Control Act	1976
Clean Air Act Amendments	1977
Clean Water Act (Amendments to the Water Pollution Control Act)	1977
Federal Insecticide, Fungicide and Rodenticide Act Amendments	1978
Comprehensive Environmental Response, Compensation and Liability Act (more commonly, Superfund)	1980

Source: Adapted from State of the Environment, The Conservation Foundation. Washington, D.C. 1984. p. 38.

it is unclear whether the warming is CO₂ related or natural part of the secular interglacial cycle. The overall measure of air quality is the Pollution Standards Index (PSI) that measures number of days per year with unhealthful conditions in 23 metropolitan areas. Since 1974 such days have declined from 91 per year to only 41 days per year in 1981. These are good signs for air quality.

Wildlife. One of the best indicators of environmental quality trends is the health and vitality of our flora and fauna. As measured by the U.S. Fish and Wildlife Service, on U.S. Forest Service lands, large animals such as moose, elk, peccary, sheep, mountain lion and antelope have increased their population over the last 20 years. Wild turkey populations have more than doubled, due largely to effective stocking programs. However, wolf, grizzly and black bears and mule deer populations have declined. White-tailed deer and duck populations are relatively unchanged. Here, with large animals and waterfowl, the successes are attributable partly to habitat improvements, to better hunting management and to restocking.

Recreation and Recreational Resources. Participation in outdoor recreation, much of which is water related, has remained relatively steady over the past eight years. The most participation is on Forest Service lands with second place going to U.S. Army Corps of Engineers reservoir projects and the third level of visitation to national parks. Most of the added visits to national parks since 1972 have been to new areas, relieving pressure on the older parks. For example, Golden Gate Natural Recreation Area did not exist in 1960 but it recorded 20 million visitor days in 1982, far exceeding such parks as Great Smokey Mountains (9 million) or Yosemite and Yellowstone (about 3 million each). There are good signs for better utilization and conservation of national parks and other public access lands and waters.

Substantial increases have been made in adding natural recreation areas, even excluding Alaska, since 1960. There have been about 5 million acres added to state and national parks; about 12-13 million acres to wildlife areas; 26 million acres to the wilderness preservation systems

(all since 1965); and more than 1,000 river miles to the Wild and Scenic River systems (all since 1968).

On the negative side, we have lost about 11 million acres of valuable fresh water wetlands, much of which was used for waterfowl and wildlife sanctuaries.

Pollution Control Investments. Pollution abatement and control expenditures by both the public and private sectors (in 1972 dollars) peaked out in 1979 with declines underway for air, water and solid waste pollution abatement. However, investments in pollution control, as a percent of GNP, peaked at 1.9 percent in 1976 but declined to 1.7 percent in 1982. This decline is not a good trend for environmental quality for the future unless we have in fact changed our life styles, business operations and attitudes sufficiently to have reduced permanently our waste emissions.

The best quantitative indicator of overall interest in environmental affairs is the willingness to pay. This evidence is clear with the substantial increases in dues paying members of environment organizations. The larger (more than 100,000 members) organizations (National Wildlife Federation, National Audubon Society, Sierra Club and Wilderness Society have more than doubled their membership since the early 1970s). Substantial gains have been shown by all of the "big four" since 1980, in tune with the privatization theme. Most of the smaller organizations (less than 75,000 members) did not exist in 1970. The largest growth rates have occurred in the Environmental Defense Fund, Natural Resources Defense Council and Defenders of Wildlife.

The more subjective indicators of environmental interests have been provided by Public Opinion and Roper Polls. There has, since 1980, been an increase in those who think environmental laws and regulations have "not gone far enough" and a decline in those who think we are "about right." There also has been a decline in those who think environmental laws and regulations have "gone too far," especially since 1980. These opinions indicate a continuing strong interest in public support (about 0

percent think we have "not gone far enough") for environmental programs. These environmental programs and attitudes toward them substantially affect how we develop, use and manage our water resources. I think we will have fewer projects and we will spend relatively more for environmental enhancement such as mitigation. We will spend more on managing our waters to protect in-stream flow needs, riparian habitats and other amenities.

Environmental Issue Trends

There are several ways to look at environmental trends. We have looked at the commodity aspects of environment, that is, how pure is the air, how clean is the water, and how many species are we saving. Perhaps a more interesting aspect is to look at environmental trends in terms of how well we live. That is, we should look at environmental trends in terms of the ideology or the philosophy that comprises the environmental movement. One of the most interesting aspects of the current environmental trend is what I would describe as the enclosure period. All we need to do is to look about us and see the manner in which communities are being planned, developed and constructed today. From hotels to residential living areas, we are enclosing ourselves with an artificially constructed environment. Communities are planned with walls surrounding them, with security gates, with enclosed gardens, and with all of the natural resource amenities (golf courses and riding trails) within a single community. This means we are tending to look more inward for environmental amenities than in the past two decades.

In the past several decades, because of the manner in which we lived in isolated residences, we depended on public parks and other publically supported recreational areas. We tended to be outward looking. This time we are clearly inward looking in a large segment of society, providing within our communities a large supply of environmental amenities. I am not sure how long this trend will continue but, if Europe is an indicator, it will continue for several centuries. This is especially true in older inner cities where one seeks the closeness of a major city and its amenities while not giving up a higher quality of

life. The only way we could do this in major cities with today's inner city decline is to turn inward, that is, to enclose ourselves about a created environment. This does not mean that we will be able, in the short run, to reduce our support of publicly provided environmental amenities. I believe we must continue for some time to spend large amounts of private and public money to expand and maintain public access, open space, parks and other environmental amenities. What this does is to privatize more of the environmental amenities according to the current, widely held attitudes.

We can think also of environmentalism and environmental trends in terms of the ideologies. In earlier decades the main ideology for environmentalism was conservation and preservation. We looked at policy in terms of science. We are now looking more carefully at science driven by policy. We also looked at ownership of natural resources that benefit our environment as a legitimate public investment. We do not see this changing quickly. However, it may erode gradually over time as outside pressures force retrenchment in public expenditures for environmental, water and related resources.

The trend I see now is somewhat opposite or contradictory to earlier decades when the ideology was conservation. The new ideologies now include such terms as multiple use, sustained yield (evenflow harvest), primary productivity, and natural diversity. I will leave it to your imagination to name the specific descriptive term that will prevail historically. My own idea is that multiple use will prevail. Difficulty with multiple use is that it is in some ways contradictory to conservation. With the multiple use concept we advocate "use" up front rather than conservation. We are also looking for multiple services that can be provided by our environmental resources. In conservation ideology of the last 80 years, we could structure a doctrine that provided for free access to all public parks, lands, wildlife refuges, hunting and fishing, etc. We could offer what we had in abundance for free admission. However, the current concept of multiple use offers no clear decision making framework. There is no acceptable way to time harvests

or investments when we openly promote optimum uses that conflict. When and how should we harvest timber in a national forest or wildlife refuge to protect recreation and wildlife? The consequences of multiple use are opposite that intended. That is, we are favoring current consumption as opposed to future consumption implied so strongly in the conservation ideology.

However, there were some drawbacks to the conservation ideology in that it ignored distributional issues by cliches that were only vague statements about "the greatest good for the greatest number." This carryover of conservation ideology will force us to recognize certain "environmental entitlements" for natural resources. Some of these include grazing rights, timber cutting, fishing and hunting, and access to wilderness areas. These entitlements, although not tested legally at this point, will most likely have a political strength that is at least equivalent to welfare entitlements today. There is not likely to be sufficient political pressure for a long time to successfully attack these entitlements. What this means for the environmental trends is that we will have a combination of inward turning or enclosing for a large segment of the population while we continue to recognize the entitlements through the public lands such as parks, reservoirs, and wildlife refuges. Entitlements also will mean a larger interest in using wilderness areas even though they are ostensibly well protected from overuse.

The interface of economics to environment in this instance must take place in terms of allocation to these publicly provided environmental entitlements. We will see most certainly large increases in user fees and other restrictions such as quotas that we now use in many natural resource entitlement areas. For example, the number of boat trips on the Colorado River are limited by quota to avoid overuse of this resource. Now that we have a precedent for more efficient allocation, we will tend to view the use of environmental amenities more in terms of user fees. The next step is to convert these user fees into funds that will expand the system or improve the existing amenity in order to provide more

access without destruction. That is, we must seek to develop and recognize the concept of a sustained yield for all environmental commodities -- water, air, land, wildlife, wetlands, etc.

Another important issue concerns the way we have chosen to manage environmental affairs. This issue is a book unto itself so I will only touch it, leaving the rest to your independent thinking. Traditionally, in the water resources business, the federal government exercised a direct role by providing funding, planning and constructing projects and by owning and managing these projects thereafter, collecting revenues from vendible services and exercising considerable direct control. In the environmental area the federal government reversed its role, giving grants and shunning ownership, but, and this is important, delegating responsibility for environmentally related issues to the states. The data in table 4 show eight environmental programs that have been (or can be) delegated to states for implementation and management. This process offers some flexibility to the states but it also offers substantial costs with few to zero opportunities for vendible services (cost recovery) such as electricity sales or municipal water supply services. If I were a state, I would prefer to be delegated a multiple purpose water project to manage than a National Pollutant Discharge Elimination System Permitting program. Enough said!

Summary

We have been making measurable progress in improving most parameters of environmental quality, especially at what I have described as the commodity aspects. Much needs to be done, especially in the areas of defining what are truly substantive improvements to the environment. For example, what constitutes a viable riparian habitat and how should stream flows be managed to insure this condition? However, I fear some of the environmental gains have been made at the expense of water resource development. Our job now is to recognize the need for environmental concern and busy ourselves figuring out better ways to manage our water resources so as to enhance environmental amenities. Perhaps this can be done at your 31st Annual New Mexico Water Conference.

Table 4. Delegation of Selected Environmental Programs
to State and Territorial Governments, 1984

Program	Number of Delegations	
	Full	Partial ¹
<u>Clean Air Act</u>		
PSD permits - for new and modified sources in areas classified for prevention of significant deterioration	36	10
NSPS permits - for sources required to meet new source performance standards	34	18
NESHAPS permits - for hazardous air pollutants	37	11
<u>Clean Water Act</u>		
NPDES permits - for point-source dischargers	15	21
Construction-grants management	4	51
404 permits - dredge-and-fill	0	--
<u>Safe Drinking Water Act</u>		
Drinking-water-standards enforcement	52	--
Underground-injection-wells control program	22	8
<u>Coastal Zone Management Act</u>		
Coastal-zone-management programs	28	--
<u>Federal Insecticide, Fungicide and Rodenticide Act</u>		
Applicator certification training	48	--
Restricted pesticide uses	48	0
<u>Occupational Safety and Health Act</u>		
Occupational safety and health programs	2	--
<u>Resource Conservation and Recovery Act</u>		
Interim program	1	--
Phase I	45	--
Phase II	12	11
Final Program	1	--
<u>Surface Mining Control and Reclamation Act</u>		
Regulatory programs	25 ²	--

¹"Partial" has different meanings in different programs. See figure references for full explanation.

²Two states may soon have their approvals revoked. See figure references.

Source: State of the Environment. The Conservation Foundation. Washington D.C. 1984. p. 457.

RESEARCH TRENDS

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Humanity's preoccupation with, attraction to, and study of water resources are as old as civilization. Ancient cities were built within easy reach of water, Roman aqueducts channeled water to Rome, the Chinese culture developed along with their efforts to intensify agricultural production by the use of irrigation, and modern cities have flourished or declined in direct relationship with the availability and management of water resources.

Yet, even today, we are still grappling with many of the same issues that have plagued humanity for thousands of years. Floods, droughts, hurricanes, energy intensive irrigation practices, waste water management, and pollution control are items that have dominated our water management specialists in the past and continue to be at the forefront of research efforts today.

What are the future trends in research efforts aimed at successfully managing our water resources? Before I answer that question, I would like to briefly discuss the difference between applied research and basic research. In order to do that I am going to describe four examples of how basic research led to solutions of practical problems dealing with water.

Research on the Shapes of Raindrops

In the 1960s Hans Pruppacher, a physicist at UCLA, asked the questions, "What is the shape of a raindrop?" Up to this point, scientists had had difficulty observing the fast-falling raindrops. They knew that contrary to popular opinion, raindrops were not shaped like teardrops, but the actual shapes remained uncertain. Pruppacher was able to gain support from the National Science Foundation (NSF), which resulted in the formulation of a theory that enabled him to predict the shape of a raindrop from its size, considering the forces that act upon

the drop while it is falling freely in the atmosphere. In 1970 and 1971, Pruppacher was able to test and verify his theory by suspending raindrops in the vertical air stream of a wind tunnel. In the wind tunnel, Pruppacher could observe raindrops closely.

There was no immediate application of Pruppacher's resultant findings relating the height and width ratio of the raindrop to its specific size. It was almost a decade later, in 1979, that Thomas A. Seliga, an electrical engineer at Ohio State University, developed a new rainfall-observing radar technique based upon Pruppacher's work at UCLA on the basic geometry of raindrops.

Seliga arrived at his technique after two years of experiments. It takes advantage of the difference in signal power scattered by raindrops when the radar beam is aligned along two different planes of polarization. Although standard radar equipment that senses raindrops along the radar beam gives an incomplete picture, Seliga's radar reveals both the size and density of raindrops. This improves the estimates of rainfall and now enables meteorologists to predict floods sooner and with greater accuracy.

Salt Tolerant Plants

In the early 1960s, NSF supported research at several universities on how plants selectively absorb chemically similar minerals. By tracing the movements of radioactively "tagged" elements in the root zone, the scientists hoped to learn more about the mechanism that regulates movement, or exclusion, of metal ions across plant membranes. The plants used in such experiments normally grow in salty water. They included mangroves, which form dense masses of vegetation and tangled roots in tropical coastal lowlands.

Researchers hoped to discover what properties of root membranes permit plants to absorb potassium (an essential plant nutrient, required in large amounts) and at the same time reject sodium (one of the elements of common table salt, usually harmful to plants), even in soils with high sodium content. They also explored genetic aspects of the varying salt-tolerance of different species of plants.

By the end of the decade, research had shown that even closely related plants may differ in their tolerance of high concentrations of sodium. It was also demonstrated that these differences are directly related to the plants' absorption or exclusion of sodium.

It is this connection that a practical application of the research entered the picture. Many soils in the western United States, including New Mexico, and in other arid or semi-arid regions throughout the world are saline, that is, they contain so much salt that crops are adversely affected. On the basis of their research experience in plant physiology, some investigators, especially Emanuel Epstein at the University of California, Davis, reasoned that it might be possible to select and breed crops that would be tolerant of much higher concentrations of salt than present day varieties.

Recognizing the possible applications that could result from this line of research, the Commerce Department began supporting further experiments to test the crop irrigation potential of saline water. Initially, Epstein and his colleagues produced strains of barley irrigated only with seawater. Later they were able to produce a strain of tomatoes irrigated with 70 percent seawater. Epstein has also produced strains of wheat that grew to maturity even though irrigated with undiluted seawater. If scientists can create salt tolerant crops--and the prospects are promising--much of the world's saline, marginal land and brackish waters could be used in a much more productive manner.

Recombinant DNA

In the early 1950s, Max Delbruch, a physicist at Cal Tech, began to study mechanisms underlying genetic recombination in bacteria. This research helped set off an explosion that may well lead to the most important gains in medicine, agriculture, energy, and indeed, water management in this century. Delbruch's research group concentrated their efforts on phages--viruses that live in bacteria. A phage can attach itself to a simple bacterium cell, shuck off its own protein coat, and infiltrate the host cell somewhat like the material in a syringe entering a vein. Once inside a cell, a phage takes charge of the cell's

chemical activity and reproduces itself exactly. In less than half an hour, one phase produces many descendants and ruptures the bacterium, freeing the new phages to repeat the process. This led to more advanced studies that showed if two similar but different phages infect a bacterium, their progeny contain a high proportion of phages that have exchanged genetic material, DNA.

From these rudimentary beginnings came remarkable advances in the knowledge of the structure and function of the units of heredity and contributed to the rise of molecular genetics. In the late 1960s and 1970s, the expansion of knowledge in molecular genetics proceeded by quantum leaps. Aided by modern instruments, studies in the field of recombinant DNA have brought us to the threshold of applications undreamed of in the early 1950s.

Recombinant DNA work has implications for converting agricultural wastes and other wastes into low cost fuel. Already several human protein hormones have been produced by inserting human genetic material into bacteria. World food production stands to increase dramatically when crops can be genetically engineered to fix their own nitrogen from air and when plants can be engineered to live in arid climates using brackish water. The potential of genetic engineering is what led to the establishment of the Plant Genetic Engineering Laboratory at New Mexico State University and similar laboratories around the country.

Removal of Toxic Metal Ions From Water

The final example I would like to share with you comes from research in my own laboratory. More than 20 years ago my colleagues and I began studying how metal ions were involved in biological systems. It was known that many of the so called heavy metal ions such as iron, zinc, and copper, are necessary nutrients for living systems. Many of these metal ions were known to be associated with proteins, but the actual manner in which they were bound and the way they functioned in enzyme action was unknown. Through our work, as well as the work of many others, we now know much of the chemistry involved when different metal ions interact with proteins or other biological molecules.

Two or three years ago it was brought to our attention that heavy metal ions seem to have a high affinity for the cell walls of algae. Further investigation revealed that the binding of metal ions to algal cells is not dependent upon a living organism and that metal ions are bound with different affinities to the algal cell depending upon the acidity of the medium. From an understanding of how metal ions interact with other biological materials and with financial support from the New Mexico Water Resources Research Institute and the U.S. Department of the Interior, we have now been able to devise schemes by which different metal ions can be selectively absorbed and recovered from waters contaminated with heavy metal ions. Very recently, we have been able to immobilize algal cells by encapsulating them in a silica gel polymer. This material constitutes what we call an algae filter. We hope that these filters can be used on a commercial basis to remove and selectively recover a variety of toxic metal ions that may be found in industrial waste waters. It is also possible that the process will be used in the mining industry.

The Common Thread

The common thread running through all four examples is that very basic research preceded the practical application by 20-30 years, and at the time the basic research was being done, there was no practical application for it. In fact, "Studying the Shape of a Raindrop" sounds very much like the type of research that would earn Senator Proxmire's "Golden Fleece" award.

The fundamental difference between applied research and basic research is that applied research can be channeled whereas basic research cannot. Wernher von Braun once defined basic research as "What I'm doing when I don't know what I'm doing." Basic research generally begins with a single investigator or a small group of investigators setting out to attempt to understand the unknown. The plans of investigation remain flexible and the work proceeds in an atmosphere of high uncertainty. The basic facts at hand can only be suggestive enough to allow for imagining and guessing. Hypotheses must be set up for testing, but it is

understood that many of these will be proved wrong. Sometimes an idea emerges from what can only be called intuition; and when the mind producing the idea is imaginative and very lucky, the whole field moves forward with a quantum jump. Applied research then results from using basic research to solve an immediate problem. However, without basic research there can be no applied research.

Unfortunately, public opinion about long-range problems rarely crystallizes into a sense of urgency. The average American, like his political representative, has a high discount rate concerning the future. The problem is typified by comments made by John Sawhill, formerly the Federal Energy administrator, when discussing the energy problem: "The president can't introduce a program until people are ready to support it, and the people won't be ready until they are in a crisis situation. Once we are in a crisis, we can shape a crash program to deal with it." He continues, "I believe in the efficacy of crash programs. It's only when you marshal all your talents and resources on a crash basis that you get good hard results."

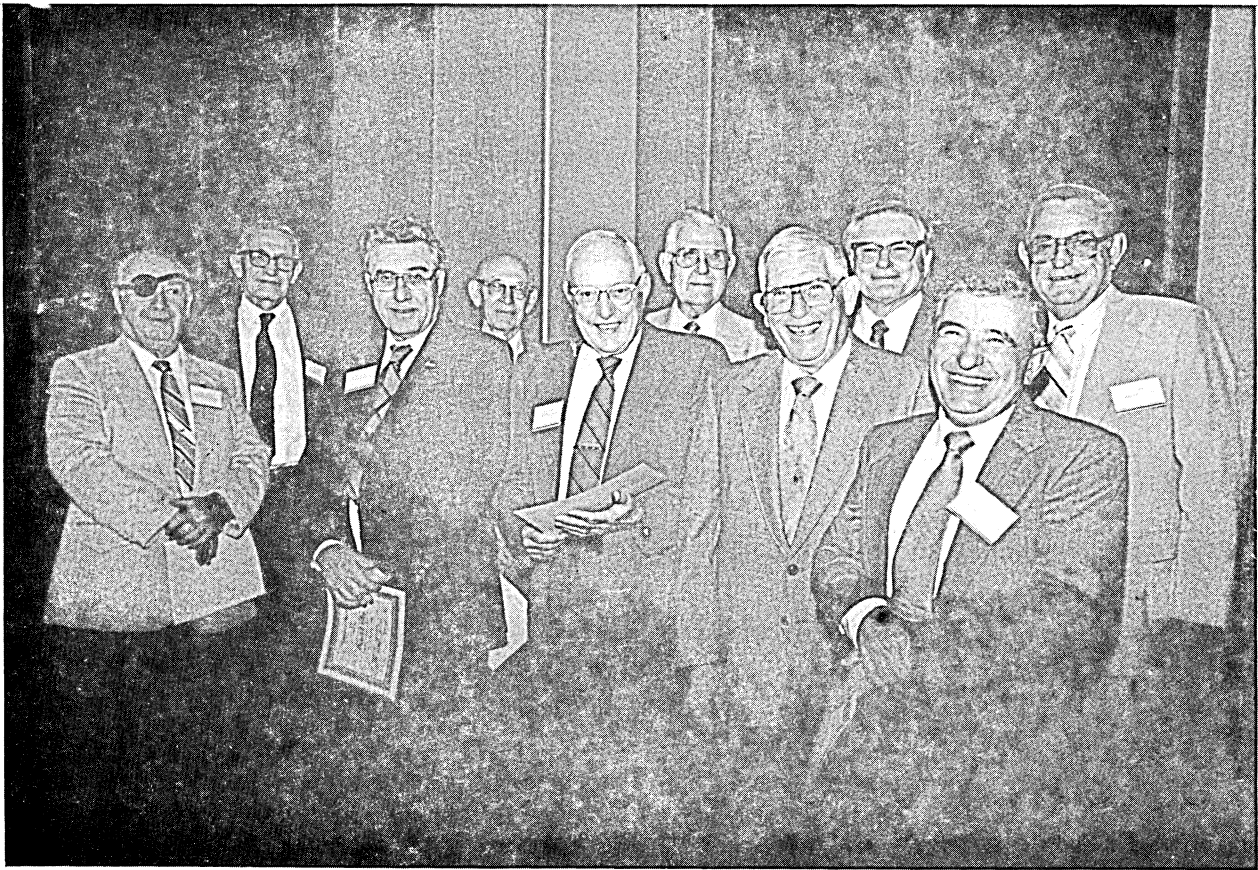
He is right if the prerequisite basic research has been done, and all that is needed is to marshal technological forces. This was basically what happened in NASA's manned moon landing program. The basic research had been done previous to the decision to land a man on the moon. However, I submit that in dealing with the energy problems, our water problems, or our toxic waste cleanup problems, this attitude is extremely short sighted. And in view of the progress that has been made in the last few years in some of these areas, this approach can be most charitably described as trying to produce a baby in one month by putting nine men on the job.

Now let me come back to the question I first posed, "What are the future trends in research efforts aimed at successfully managing our water resources?" Successfully is the key word here. I believe support of fundamental basic research is imperative to endure the successful management of water resources in the future. As many governmental agencies are pressured to "target-direct" their resources, we must not

forget that without basic research, then applied research founders, and without applied research, the society we know cannot grow. Water pollution problems, water management problems, water conservation problems will not be solved.

There is no question that fundamental science pays for itself, and returns to society both cultural enrichments and continued resources for enhancing the quality of life. Moreover, given the stresses on our water resources and on the environment that the future appears to hold, an adequate base of fundamental knowledge on which to build a technological response becomes a matter of survival. One can safely assume that for all these reasons, the ideas of fundamental basic research as a national trust is both sound and profitable.

ANNUAL NEW MEXICO WATER CONFERENCE PARTICIPANTS
WHO ALSO ATTENDED FIRST WATER CONFERENCE



The 30th Annual Water Conference was pleased to have as special guests, 10 people who attended the first Water Conference in 1956. Joining the reunion are (back row, l. to r.) Steve Reynolds, Ira G. Clark, Eldon Hanson, Stuart Meerscheidt, and Lewis T. Putnam. Those on the front row are Phillip E. Crystal, Claude Pilley, Ralph Stucky, Jacob Tejada and O. F. Baca.

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SPECIAL PARTICIPANTS

The following persons attended the very first New Mexico Water Conference in 1956 and because of their long support of water research in New Mexico, they are our special guests at the 30th Annual New Mexico Water Conference.

Odelio F. Baca a rancher from Las Vegas, New Mexico, attended the 1956 conference representing the Storrie Project Water Users Assn. He now lives in Los Lunas.

Ira G. Clark, who in 1956 was a professor of history, is a history professor emeritus at New Mexico State University. His book, Water in New Mexico: A History of its Management and Uses, will be published in early 1986.

Philip E. Crystal, the Curry County extension agent in 1956, is now retired and living in Clovis, New Mexico.

Eldon Hanson, in 1956 was department head of New Mexico State University's agricultural engineering department, ended his university tenure with a three-year assignment to Egypt. He lives in Las Cruces.

Stuart Meerscheidt in 1956 attended the conference representing his company, Butte Pump and Machinery. Today he owns the Jornada Water Co. and farms in Las Cruces.

Claude A.L. Pilley was a civil engineering student participant in the 1956 conference. Today he is the chief engineer for the city of Alamogordo.

Lewis T. Putnam in 1956 was the State Engineer Office district engineer for the Deming area. He still holds that position.

Steve Reynolds in 1956 was in his first year as the New Mexico state engineer. He is now celebrating 30 years in that position.

H. Ralph Stucky, organizer for the first New Mexico Water Conference, went on to help establish the New Mexico Water Resources Research Institute in 1963, and retired as its director in 1971. After retirement, he went on to become a founder of the Good Samaritan Retirement Village in Las Cruces.

Jacob Tejada in 1956 was the associate county extension leader. He is now retired from the Extension Service and lives in Las Cruces.

FIRST PARTICIPANTS SENDING THEIR REGARDS

The following persons also participated in the 1956 conference but were unable to attend this conference. We thought you would also like to know some of their thoughts about the first conference.

Charles A. Brink was an engineer with W.S.P.G. in 1956. In sending his regrets, he writes: "(Water) is a most important subject and should be of utmost concern to all of our citizens. I'm sure you will have an interesting program and I hope it will be a very successful conference."

Robert Emmet Clark in 1956 was professor of law at the University of New Mexico. He is now professor emeritus at the University of Arizona College of Law. He writes: "I will not attend but I would ask you to give Professor Stucky my best wishes as we both remember very well the first conference thirty years ago."

Evan Carroon in 1956 was the area engineer for the Soil Conservation Service. He is retired and writes: "I did attend the first water conference and I also attended most of the later conferences until I retired in 1964. I am now 91 years old. If I was living in Las Cruces, I would surely attend the banquet. Give any old survivors my regards."

Walter O'Brien attended the conference in 1956 as a civil engineering student. He is now with the Dallas engineering firm, Black and Veatch. He writes: "Time flies, the first conference doesn't seem that long ago. Best wishes for an outstanding meeting. I have very warm regards for the water resources program at NMSU and sincerely wish you and the program continued success."

William P. Stephens attended the 1956 conference representing the NMSU Agricultural Experiment Station. Today he is director of the New Mexico Department of Agriculture and sends regrets that business prevents him from attending the conference.

K.A. Valentine attended the 1956 conference from NMSU's Agricultural Experiment Station. He called to say he will be unable to attend the conference.

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