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Proceedings

31st Annual
New Mexico Water Conference

New Mexico Water Resources Research Institute

New Mexico State University ● Telephone (505) 646-4337 ● Box 3167, Las Cruces, New Mexico 88003

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PREFACE

In the past year New Mexico has been faced with the problem of record flows in the Rio Grande. While that might not be considered a problem in a semiarid state like New Mexico, it does complicate a river management system designed to deal with water scarcity, not water surplus. In July 1985, and for only the second time since Elephant Butte Reservoir was built, the Rio Grande flowed over the reservoir spillway. High water also taxed the storage capacities of reservoirs upstream. With those events as a backdrop, the 31st Annual New Mexico Water Conference explored the topic of "Managing the River."

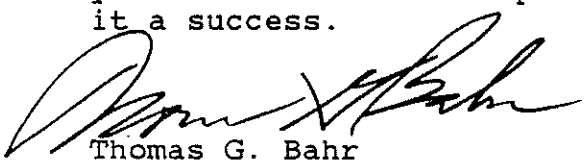
The first speaker, Albuquerque Journal reporter Nolan Hester set the tone for the conference with his speech, "Who are the Outsiders?" The "outsiders", he said, emerged during the water surplus to challenge the laws and the institutions created by the "insiders". The rest of the speakers then gave the participants an insider/outsider overview of the problems surrounding the water surplus.

Those talks, presented here, provide insight not only about the problems of managing the river, but also about the cooperation between the agencies and groups solving those problems.

The second day of the conference was devoted to a Roundtable Discussion magnificently led by Jerry Sherk of the Department of Justice. The roundtable consisted of a dozen of the region's top water leaders engaged in lively debate as they answered questions submitted by the audience. The transcript of that part of the discussion is printed here. Following the question and answer session, Sherk then posed additional questions to the panelists based on real and hypothetical water management situations.

This year's water conference accomplished two things. It confirmed the complexities of managing the river that serves many uses and many users, and it gave those users a better understanding of each other's special interests.

Special thanks should go to the Water Conference Advisory Committee, which suggested the theme for this year's conference and provided the support necessary to make it a success.



Thomas G. Bahr
Director

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NEW MEXICO STATEWIDE
ADVISORY COMMITTEE

Ms. Katharine D. Adam
League of Women Voters
416 Apodaca Hill
Santa Fe, NM 87501

Ms. Lynn Brandvold
N.M. Bureau of Mines
N.M. Institute of Mining
and Technology
Socorro, NM 87801

Mr. Ralph Charles
Middle Rio Grande Flood Control
Association
510 Second St., NW - Rm. 215
Albuquerque, NM 87101

Mr. Quincy C. Cornelius
San Juan County Rural Domestic
Water Users Association
112 S. Mesa Verde
Aztec, NM 87410

Dr. Ronald G. Cummings
The University of New Mexico
Economics Department
1915 Roma, NE - #110
Albuquerque, NM 87131

Mr. Wayne Cunningham
N.M. Dept. of Agriculture
New Mexico State University
Box 5702
Las Cruces, NM 88003

Dr. Stanley D. Farlin
Assistant Director
Agricultural and Resources
Development
Cooperative Extension Service
New Mexico State University
Box 3AE
Las Cruces, NM 88003

Mr. Herbert Garn
Subdistrict Chief
U.S. Geological Survey
308 Cathedral Place
Federal Bldg. - Rm. 115
Santa Fe, NM 87501

Ms. Helen Gram
Los Alamos Tech. Assoc.
Inc.
P.O. Box 410
1650 Trinity Drive
Los Alamos, NM 87544

Mr. Michael Hatch
N.M. Department of Game
and Fish
Villagra Building
Santa Fe, NM 87503

Mr. William McIlhaney
N.M. Farm and Livestock
Bureau
520 El Paraiso, NW
Albuquerque, NM 87103

Lt. Col. David E. Peixotto
District Engineer
U.S. Army Corps of
Engineers
P.O. Box 1580
Albuquerque, NM 87103-1580

Mr. Steve Reynolds
State Engineer
N.M. State Engineer Office
101 Bataan Memorial Bldg.
Santa Fe, NM 87503

Dr. Doug Schneider
Environmental Program
Manager
Environmental Improvement
Division
P.O. Box 968
Santa Fe, NM 87503

Dr. William P. Stephens
Director
N.M. Department of Agriculture
New Mexico State University
Box 3189
Las Cruces, NM 88003

Dr. William J. Stone
N.M. Bureau of Mines
N.M. Institute of Mining
and Technology
Socorro, NM 87801

Mr. Albert E. Utton
The University of New Mexico
School of Law
1125 Bratton Hall
Albuquerque, NM 87107

Mr. Ronald L. Ward
Soil Conservation Service
U.S. Department of Agriculture
517 Gold Avenue, SW
Albuquerque, NM 87102-3157

Mr. Gerald Wright
Regional Planning Officer
U.S. Bureau of Reclamation
714 S. Tyler
Amarillo, TX 79101

1986 PROGRAM DEVELOPMENT AND REVIEW BOARD

Dr. Ronald Cummings
Economics Department
University of New Mexico
1915 Roma NE - #110
Albuquerque, NM 87131

Dr. Gerardo W. Gross
Department of Geosciences
N.M. Institute of Mining
and Technology
Socorro, NM 87801

Dr. John Hawley
Senior Environmental Geologist
Bureau of Mines and Mineral
Resources
N.M. Institute of Mining
and Technology
Socorro, NM 87801

Dr. Koert Lessman
Professor
Crop and Soil Sciences
New Mexico State University
Box 3Q
Las Cruces, NM 88003

Dr. Sam Maggard
Civil Engineering Department
New Mexico State University
Box 3CE
Las Cruces, NM 88003

Ms. Kathy Sisneros
Chief of the Surface Water
Quality Bureau
Environmental Improvement Division
P.O. Box 968
Santa Fe, NM 87503

Mr. Bill Fleming
Bataan Memorial Building, Rm. 101
State Capitol
Santa Fe, NM 87503

Mr. Bob Knutilla
District Chief
U.S. Geological Survey
Western Bank Bldg, Rm 720

Mr. Al Utton
Professor of Law
University of New Mexico
School Of Law
Albuquerque, NM 87131

31st Annual New Mexico Water Conference

MANAGING THE RIVER

Hilton Hotel
Santa Fe, New Mexico

THURSDAY, OCTOBER 23, 1986

Morning Sessions Moderator:
Thomas G. Bahr, Director, New Mexico
Water Resources Research Institute

SESSION I: MANAGEMENT OVERVIEW

8:00 - 8:35 Welcome
Thomas G. Bahr, Director
N.M. Water Resources Research Institute

8:35 - 8:55 Who Are the Outsiders?
Nolan Hester, Staff Reporter,
"Impact" Magazine,
Albuquerque Journal

8:55 - 9:15 Surface Water Resources: Milestones in the Rio Grande Basin
Philip B. Mutz
Interstate Stream Engineer
N.M. Interstate Stream Commission

9:15 - 9:35 Water Management Responsibilities for the Rio Grande Basin
John J. Cunico
Chief of Planning Branch
Albuquerque District
U.S. Army Corps of Engineers

9:35 - 9:50 Operations on the Upper Rio Grande, 1985-86
Charles Calhoun
Project Superintendent
Upper Rio Grande Basin Projects
U.S. Bureau of Reclamation

9:50 - 10:05 You Can't Put Too Much Water in Elephant Butte
David P. Overvold
Chief
Water and Land Division
Rio Grande Project
U.S. Bureau of Reclamation

10:05 - 10:20 Session Discussion

10:20 - 10:45 Break

SESSION II: DIVERSIONS

10:45 - 11:00 Albuquerque and the Rio Grande
Gary Daves
Policy Planner
Public Works Department
City of Albuquerque

11:00 - 11:15 The Evolution of the Middle Rio Grande Conservancy District
Ray Shollenbarger Jr.
Attorney
Middle Rio Grande Conservancy District

11:15 - 11:30 Managing Under a Surplus
William J. Saad
Treasurer-Manager
Elephant Butte Irrigation District

11:30 - 11:45 Session Discussion

11:45 - 1:15 Lunch: On the town!

Afternoon Sessions Moderator:
Frank A. DuBois III, Assistant Director
New Mexico Department of Agriculture

SESSION III: RECREATION

1:15 - 1:35 Recreation and Water -- Pools and Flows
Robert M. Findling
Deputy Director
New Mexico Department of Natural Resources

1:35 - 1:55 The Effects of Water Management on Fish and Wildlife
Charles J. Ault
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service

1:55 - 2:15 Rio Grande Management: The View from Upstream
Phillip Wallin
Southwest Regional Manager
Trust for Public Land, Santa Fe

2:15 - 2:35 Federal Reserved Water Rights for a Wild and Scenic River
Herbert S. Garn
Subdistrict Chief
U.S. Geological Survey/Water Resources Division

2:35 - 2:55 Management Impacts on Fishery and Recreation in the Rio Grande
Michael Hatch
Fisheries Management Project Leader
New Mexico Department of Game and Fish

2:55 - 3:10 Session Discussion

3:10 - 3:30 Break

3:30 - 3:50 Snowmelt Runoff, 1985, and Trends in the Upper Rio Grande
Scott D. Waltemeyer
Hydrologist
Santa Fe Subdistrict Office
U.S. Geological Survey

3:50 - 4:10 Hydrogeology in River Management Rio Grande Valley, New Mexico
William J. Stone
Senior Hydrogeologist
N.M. Bureau of Mines and Mineral Resources
N.M. Institute of Mining and Technology
W.K. Summers
President and Senior Geologist
W.K. Summers and Associates, Inc.

4:10 - 4:30 Water Systems Analysis for Sport Fishing Management
Richard Allen Cole
Associate Professor
Fishery and Wildlife Sciences
New Mexico State University

4:30 - 4:50 The Need for Dialogue in Basinwide Management
Steven J. Shupe
Program Consultant
Western Network

4:50 - 5:10 Session Discussion

5:10 - 6:30 Further Discussion:
Promenade (outside the Mesa Ballroom)

FRIDAY, OCTOBER 24, 1986

SESSION V: POLICIES AND PRACTICALITIES

9:00 - Noon Managing the River:
A Roundtable Discussion

Roundtable Leader:

- George William Sherk
  Attorney
  Land and Natural Resources Division
  U.S. Department of Justice

Roundtable Participants:

- Jeris Danielson
  State Engineer
  Colorado Division of Water Resources

- Robert M. Findling
  Deputy Director
  N.M. Department of Natural Resources

- Jesse B. Gilmer
  Texas Compact Commissioner
  Rio Grande Compact Commission

- Narendra N. Gunaji
  U.S. Commissioner Designate
  International Water and Boundary Commission

- Eugene Hinds
  Regional Director
  Southwest Region
  U.S. Bureau of Reclamation

- Monte G. Jordan
  Acting State Director
  U.S. Bureau of Land Management

- Robert L. Knutilla
  District Chief
  U.S. Geological Survey/Water Resources Division

- Lt. Col. David E. Peixotto
  District Engineer
  U.S. Army Corps of Engineers

- Steve Reynolds
  State Engineer
  N.M. State Engineer Office

- Michael J. Spear
  Regional Director
  U.S. Fish and Wildlife Service

- William P. Stephens
  Secretary
  N.M. Department of Agriculture

- Phillip Wallin
  Southwest Regional Manager
  Trust for Public Land

WATER CONFERENCE SPEAKERS

Mr. Charles J. Ault
Fish & Wildlife Biologist
U.S. Fish & Wildlife Service
3530 Pan Am Highway, NE
Suite C and D
Albuquerque, NM 87107

Dr. Thomas G. Bahr, Director
Water Resources Research Institute
New Mexico State University
Box 3167
Las Cruces, NM 88003

Mr. Charles Calhoun, Projects Superintendent
Upper Rio Grande Basin Projects
Bureau of Reclamation
P.O. Box 252
Albuquerque, NM 87103

Dr. Richard Cole, Associate Professor
New Mexico State University
Fishery & Wildlife Sciences
P.O. Box 4901
Las Cruces, NM 88003

Dr. John Cunico, Chief of Planning Branch
Albuquerque District Corps of Engineers
P.O. Box 1580
Albuquerque, NM 87103

Mr. Gary Daves, Policy Planner
City of Albuquerque
Public Works Department
P.O. Box 1293
Albuquerque, NM 87103

Mr. Frank DuBois, Assistant Director
NM Department of Agriculture
New Mexico State University
Box 3189
Las Cruces, NM 88003

Mr. Robert Findling, Deputy Director
New Mexico Department of Natural Resources
408 Villagra Building
Santa Fe, NM 87503

Mr. Herbert Garn, Subdistrict Chief
U.S. Geological Survey/WRD
Federal Building - Room 115
308 Cathedral Place
Santa Fe, NM 87501

Mr. Mike Hatch
Fisheries Research Project Leader
N.M. Department of Game and Fish
State Capitol
Santa Fe, NM 87503

Mr. Nolan Hester, Reporter
Albuquerque Journal
P.O. Drawer J
7777 Jefferson, NE
Albuquerque, NM 87103

Mr. Phillip B. Mutz, Interstate Stream Engineer
N.M. Interstate Stream Commission
Bataan Memorial Building - Room 101
State Capitol
Santa Fe, NM 87503

Mr. David Overvold
Acting Project Supertintendent
Rio Grande Project
Bureau of Reclamation
700 E. San Antonio - Room 335
El Paso, TX 79902

Mr. William Saad, Treasurer-Manager
Elephant Butte Irrigation District
530 S. Melendres
Las Cruces, NM 88001

Mr. Ray Shollenbarger, Attorney
Middle Rio Grande Conservancy District
500 Copper, NW - #300
Albuquerque, NM 87103

Mr. Steven J. Shupe
Program Consultant
Western Network
1215 Paseo de Peralta
Santa Fe, NM 87501

Dr. William J. Stone, Senior Hydrogeologist
New Mexico Bureau of Mines
N.M. Institute of Mining & Technology
Socorro, NM 87801

W.K. Summers, President and Senior Geologist
W.K. Summers and Associates, Inc.
P.O. Box 684
Socorro, NM 87801

Mr. Phillip Wallin, Southwest Regional Manager
Trust for Public Land
P.O. Box 2383
Santa Fe, NM 87504

Mr. Scott D. Waltemeyer, Hydrologist
U.S. Geological Survey
Federal Building - Room 115
308 Cathedral Place
Santa Fe, NM 87501

SPEAKER PREVIEW

31st Annual New Mexico Water Conference

Charles J. Ault is a fish and wildlife biologist with the U.S. Fish and Wildlife Service. His responsibilities with the service include determining the effects of water development projects on fish and wildlife resources and finding ways to avoid or mitigate those effects. The Indiana native came to New Mexico by way of the military. He holds a B.S. in Fishery and Wildlife Sciences from New Mexico State University.

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.

Charles Calhoun is projects superintendent for the U.S. Bureau of Reclamation's Upper Rio Grande Basin Projects Office in Albuquerque. The Mississippi native received a B.S. in engineering from the University of Mississippi. He is a registered professional engineer and a member of the American Society of Civil Engineers. He has been with the bureau since 1961. Recently, he was regional supervisor of Water, Land and Power in the Southwest Region, Amarillo.

Richard Allen Cole is an associate professor in New Mexico State University's department of fishery and wildlife sciences. His research includes interdisciplinary modeling of large watersheds, trophic dynamics of reservoirs and interaction of ungulates with stream fisheries. He holds a Ph.D. in zoology from Pennsylvania State University and is a member of the American Society of Limnology and Oceanography, the American Fishery Society and the North American Benthological Society.

John J. Cunico is chief of planning, U.S. Army Corps of Engineers, Albuquerque District. He has been with the corps since 1960. His work now is primarily concentrated in the hydrology-hydraulics area and in water resource planning. He was born in Raton, New Mexico, and grew up on the family ranch there. He is a civil engineering graduate of New Mexico State University.

Jeris Danielson is the state engineer for Colorado, Division of Water Resources. He has held that position since 1969. The Colorado native holds a Ph.D. in civil engineering from Colorado State University.

Gary Daves is the policy planner for the City of Albuquerque Public Works Department where his duties include managing City San Juan-Chama Project water. He grew up in

rural New Mexico and graduated with a B.S. in chemistry from Arizona State University. Following graduation he taught chemistry and English in Ethopia with the Peace Corps. While serving with the International Voluntary Services in Vietnam, he was taken prisoner of war during the 1968 Tet offensive. Following his release in 1973, he obtained a law degree from the University of New Mexico. Before taking his present position, he was an attorney for the Albuquerque City Council.

Frank A. DuBois III is the assistant director of the New Mexico Department of Agriculture with responsibility for the administration of 33 different laws, which are agricultural and consumer service oriented. He also has responsibility for the department's agricultural programs and resources, marketing and development, agricultural and environmental services, and standards and consumer services. From 1981 to 1983 he was the deputy assistant secretary for Land and Water Resources, Department of the Interior.

Robert M. Findling is the director of planning for the New Mexico Department of Natural Resources where he supervises design, construction and planning activities. He also serves as deputy director of the department's resource management and development division. He holds a bachelor's degree in environmental design and architecture from the University of Colorado. He has worked for the Washington, D.C. office of Skidmore, Owings, and Merrill and the Southern Rio Grande Council of Governments in Las Cruces.

Herbert S. Garn is the subdistrict chief, U.S. Geological Survey/Water Resources Division, Santa Fe. Previously he was a forest hydrologist with the U.S. Forest Service and a state office hydrologist with the U.S. Bureau of Land Management. He holds an M.S. in watershed management/hydrology from the University of Arizona and is president of the newly formed New Mexico section of the American Water Resources Association.

Jesse B. Gilmer has been the Rio Grande Compact commissioner for Texas since 1969. The civil engineer began his career with the U.S. Department of Agriculture in 1934. At the USDA, he eventually became administrator of the Production and Marketing Administration and was president of the Commodity Credit Corporation. In 1974 he was named Distinguished Alumus of New Mexico State University's College of Engineering. He is a registered professional engineer.

Narendra N. Gunaji is the U.S. commissioner designate of the International Water and Boundary Commission. He recently retired after 26 years with New Mexico State University's civil engineering department. He is recognized in the fields of environmental control, hydraulics, hydrology, water resources, pollution control, and energy conservation and utilization. He holds degrees from the University of Poona (India) and the University of Wisconsin.

Michael Hatch is the fisheries management project leader at the New Mexico Department of Game and Fish. In his 13 years with the department he has worked in the area of rare and endangered species of fish and in game fish management. The nearly native New Mexican received a B.S. in Fishery and Wildlife Sciences from New Mexico State University and an M.S. in biology from Eastern New Mexico University.

Nolan Hester is a staff reporter for the Albuquerque Journal's "Impact" magazine. Although he has been interested in environmental issues since high school, his experience in water resources dates from 1980 when he covered the drafting of Arizona's new ground water code for the Prescott Courier (Arizona). He holds a bachelor's degree in journalism from the University of Illinois.

Eugene Hinds is the regional director of the Southwest Region of the U.S. Bureau of Reclamation, Amarillo. In his 26 years with the bureau he has served as an agricultural economist, regional director in the Lower Missouri Region, regional director in the Lower Colorado Region and assistant commissioner for planning and operations. The Oklahoma native grew up in northwestern New Mexico.

Monte G. Jordan is the acting state director of the U.S. Bureau of Land Management. His 24 years of experience with the bureau include the Outer Continental Shelf Leasing Program, program development in the Office of Coal Management, and division chief for Coal, Tar Sands and Oil Shale, Washington, D.C. He was born in Dora, New Mexico, and received a B.S. in geology from the University of New Mexico.

Robert L. Knutilla is the district chief of the U.S. Geological Survey/Water Resources Division, Albuquerque. His 35 years with the survey include tours in Michigan, Florida and New Mexico. He graduated with honors from Michigan Technology University with a B.S. in civil engineering. He has 35 technical reports to his credit and received the Blue Pencil Award from the Federal Editors Association for his report "Water for a Rapidly Growing Urban Community--Oakland County, Michigan".

Philip B. Mutz is the interstate stream engineer, New Mexico Interstate Stream Commission, a position he has held since 1956. He directs the commission's staff in activities that include water resources investigation, litigations, apportionment, authorizing legislation and funding of water resource projects. Previously he was with the Colorado Water Conservation Board and U.S. Bureau of Reclamation. He was born in Colorado but grew up on the family ranch in Eagle Nest, New Mexico. He holds a B.S. in civil engineering from the University of New Mexico.

David P. Overvold has been chief of the water and land division of the Rio Grande Project, U.S. Bureau of Reclamation, El Paso, Texas, since June 1983. Prior to coming to El Paso, he spent 10 years in the Lower Colorado regional office in Boulder City, Nevada. He grew up in North Dakota, received a bachelor's degree in civil engineering from North Dakota State University and began his career with the bureau on the Fryingpan-Arkansas project in Salida, Colorado.

Lt. Col. David E. Peixotto is the commander of the Albuquerque District of the U.S. Army Corps of Engineers. 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 Batallion in Vietnam and executive officer of the 44th Engineer Batallion in Korea. He holds degrees in civil engineering from Stanford University and an MBA from Long Island 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, which mostly deal 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.

William J. Saad is the treasurer-manager of the Elephant Butte Irrigation District. He was controller of the district before being named to his present position in 1980. Previously he was the corporate controller of Billy the Kid, an apparel manufacturer in El Paso, Texas. He holds a degree in accounting from West Virginia University.

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 1983, 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 a B.S. and an M.S. in political science and natural resources from Colorado State University.

Ray Shollenbarger, Jr. is a private practice lawyer and the attorney for the Middle Rio Grande Conservancy District. He holds a J.D. degree from the University of San Diego.

Steven J. Shupe is a program consultant at Western Network and is a mediator and president of Watershed West, an interdisciplinary consulting network of water resource professionals. After receiving his M.S. in environmental engineering from Stanford University, he worked in the Water and Land Resources Department of Batelle Northwest. He also is a graduate of the University of Oregon School of Law. In 1983 he was the assistant attorney general for Colorado, representing the state in various areas of water law.

Michael J. Spear is the regional director of the Southwest Region, U.S. Fish and Wildlife Service, encompassing Texas, Oklahoma, New Mexico and Arizona. He has been with the service since 1973 and has held positions as assistant director-planning and budget and as the associate director--environment in Washington, D.C. The San Francisco native received a B.S. from the U.S. Naval Academy and served six years in the Navy's nuclear submarine program before receiving a M.B.A. from Stanford University.

William P. Stephens became New Mexico's first cabinet-level secretary of agriculture in 1978, a position he still holds. That appointment culminated a career that includes positions as a professor in New Mexico State University's agricultural economics and agricultural business department, assistant director of the Agricultural Experiment Station and coordinator of environmental research. He received a B.S. and an M.S. in agricultural economics from the University of Tennessee and a Ph.D. from the University of Minnesota.

William J. Stone is a senior hydrogeologist with the New Mexico Bureau of Mines and Mineral Resources and is an adjunct associate professor in the geoscience department at the New Mexico Institute of Mining and Technology. His research interests include geologic controls of hydrologic phenomena and various aspects of the water budget in arid lands. He holds a B.S., M.S. and Ph.D. in geology. Previously, he worked with the petroleum industry, in the army's atmospheric research lab and as a university teacher.

Phillip Wallin is the southwest regional manager and vice president of the Trust for Public Land. He is a board member of the Rio Chama Preservation Trust, the Adobe Whitewater Club of New Mexico and the New Mexico Conservation Voters Alliance. He also has served as the field representative of the Nature Conservancy. The California native holds a B.A. in political science from Stanford University and a law degree from the University of Chicago Law School.

Scott D. Waltmeyer has been with the U.S. Geological Survey as a hydrologist since 1974. He has worked in Utah and Montana and has been in New Mexico at the Santa Fe subdistrict office for the past four years. He holds a B.S. in forest hydrology from Colorado State University.

ROUNDTABLE PARTICIPANTS

Mr. Sam Arquero, Governor
Cochiti Pueblo
P.O. Box 70
Cochiti, NM 87041

Dr. Jeris Danielson, State Engineer
Colorado Division of Water Resources
1313 Sherman Street - Room 818
Denver, CO 80203

Mr. Robert Findling, Deputy Director
New Mexico Department of Natural Resources
408 Villagra Building
Santa Fe, NM 87503

Mr. Jesse Gilmer, Commissioner
Rio Grande Compact Commission
P.O. Box 12785
El Paso, TX 79913

Dr. Narendra N. Gunaji
U.S. Commissioner Designate
Internatinal Water & Boundary Commission
4171 N. Mesa - Building C, Suite 310
El Paso, TX 79901

Mr. Eugene Hinds, Regional Director
U.S. Department of the Interior
Bureau of Reclamation - Southwest Region
Commerce Building - 714 S. Tyler, Suite 201
Amarillo, TX 79101-2386

Mr. Monte Jordan, Acting State Director
U.S. Bureau of Land Management
P.O. Box 1449
Santa Fe, NM 87501

Mr. Robert L. Knutilla, District Chief
U.S. Geological Survey/WRD
505 Marquette Avenue, NW - Room 720
Albuquerque, NM 87102

Lt. Col. David E. Peixotto
District Engineer
U.S. Army Corps of Engineers
P.O. Box 1580
Albuquerque, NM 87103-1580

Mr. Steve Reynolds, State Engineer
New Mexico State Engineer Office
101 Bataan Memorial Building
Santa Fe, NM 87503

Mr. George William Sherk, Attorney
U.S. Department of Justice
Land and Natural Resources Division
Benjamin Franklin Station
P.O. Box 7415
Washington, D.C. 20044-7415

Mr. Michael Spear, Regional Director
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, NM 87103

Dr. William P. Stephens, Director
N.M. Department of Agriculture
New Mexico State University
Box 3189
Las Cruces, NM 88003

Mr. Phillip Wallin, Southwest Regional Manager
Trust for Public Land
P.O. Box 2383
Santa Fe, NM 87504

WHO ARE THE OUTSIDERS?

Nolan Hester

Reporter

Albuquerque Journal

Who are the outsiders? I've picked that title because while it sometimes seems that we are surrounded increasingly by outsiders, demanding scarce New Mexico water, the designation as outsider also seems a matter of perspective. How well we solve the current problem of surplus on the Rio Grande, as well as how well we solve the larger water issues hanging about the periphery, may turn on how we view this matter of outsiders and insiders.

In a normal year, this conference would be on some other topic and we would not be here. New Mexico is seldom wet. Our problems began in 1985 with a heavy snow pack and, then, high rainfall right through the summer. Last winter seemed better at first but southern Colorado got high snowfall and then unseen tectonic motion apparently moved New Mexico into an equatorial rain forest zone. Have you ever seen such rain? The range has been green all summer. Of course 1985`s water didn't just disappear, much of it still sits in reservoirs along the Rio Grande system. What will the winter of 1986-87 bring? Well, this hasn't exactly been a dry October.

For a moment, let's review some of the events and issues that got us here. When the water came in 1985, downstream farmers felt great. Not only did the reservoirs from Elephant Butte to El Vado swell, but most got extra rainfall directly on their fields. With reduced irrigation demand, the bonus proved even bigger. Many, however, worried about letting go of any of that God-given bounty. Seize the opportunity, said farmers.

Of course, opportunity cuts many ways. The Bureau of Reclamation, for example, had its own problems, mainly not enough capacity in the Rio Grande channel below Elephant Butte Reservoir. Unable to release even an amount of water equal to the reservoir's inflow, the bureau let the whole river system back up. Last winter's dredging eased the problem somewhat by boosting channel capacity to 5,000 cubic feet per second. But that does nothing for the extra water already being held in the system.

Upstream in 1985, the surplus was seen as less than a blessing. Lakeside residents watched land go underwater, boaters saw favorite rapids drowned, perch trees used by wintering bald eagles were killed and the state scrambled to save its small recreational pool at Elephant Butte. That water, being last reserved, would be the first lost if a spill had been required. To save the pool, the water was traded through water accounting to Abiquiu and later Cochiti

reservoirs upstream. That, of course, simply sharpened the debate between upstream and downstream interests over how to manage the surplus. (Since then, the recreational pool has been spilled and lost.)

The surplus had other effects. The most important was the cancelling of all debts under the Rio Grande Compact for Colorado, New Mexico and Texas in 1985 and 1986. And while that gave Colorado farmers relief, it also aggravated the management debate. Non-farming interests along the Rio Grande accused the Compact Commission, the Bureau of Reclamation and the Army Corps of Engineers of engaging in an unspoken conspiracy to zero out compact debts -- regardless of the effects on other riverside uses, such as wildlife and whitewater boating.

Who was right remains a lingering question. The most interesting aspect of the water surplus, however, was the nature of the debate. Water, as we all know, is for fighting and the surplus had a way of setting off battles better than cannons. Much of the debate was not about problems and how to solve them, but over who was right. A lot of energy went to convincing the media that logic, if not God, was on one side or the other. Of course, if logic was not enough, both sides found other methods useful as well. Recreationists, eager to stop upstream flooding, predicted a disastrous flood at Truth or Consequences, which

sits just below Elephant Butte Dam, if surplus water was not released quickly. The last time I checked, T or C is still on the map. The corps, on the other hand, gave media tours of swollen Cochiti Reservoir and pretended that very few eagle-perch trees were killed by the rising water. An on-sight count showed otherwise, at which point corps officials countered that related wildlife damage would be insignificant. Such blustering by both sides did nothing to further the debate.

In fact, the debate quickly hardened into a battle of upstream versus downstream, recreationists versus farmers, Texas versus New Mexico. Most of all, the lines were cast as insiders versus outsiders. You know who the insiders are -- if it isn't you, it is surely the guy sitting next to you.

Most of our water law and institutions were created by insiders, people who needed the water long before Albuquerque ever had an interstate highway, let alone more exit ramps than you can count. Farmers, miners, the State Engineer Office, the Bureau of Reclamation, the Corps of Engineers -- all had a hand in shaping those laws and customs. But the surplus brought into the largely self-contained water world a raftload of outsiders -- city slickers, environmentalists and even the larger public. To them, all this hubbub seemed strange. The water laws

driving the agenda seemed even odder.

The seemingly intrusive introduction of outsiders into such issues, reflects larger changes going on in western water. The El Paso suit, for example, is only perhaps the most well known example of these changes. Recent court rulings have created a brave new world for once stable western water law. At the same time, water projects have faced tougher scrutiny. Driven by concerns over the federal deficit, Congress has grown ever more reluctant to foot the full bill for project construction. And, of course, still hanging in the background as a huge and unsolved issue is the question of quantifying Indian water rights.

These outside forces are not going away. Already other states have changed some of their water laws in response or anticipation of the changes these issues will bring. They raise even more troubling issues than the already confounding issue of surplus. And, it seems to me, these outside forces show that sticking to the insider-outsider labels of water may prove a hindrance. Farmers in Arizona, for example, stuck to their us-versus-them guns when that state's ground water code was overhauled in 1980. For their stubbornness farmers were rewarded with a law that clearly gave them the short end of the stick in the future division of dwindling water supplies. Insiders versus outsiders

stands just next to winners versus losers, which is fine -- if you win. So, how well we deal with the surplus issue may presage how we deal with these other issues as well.

There are hopeful signs that neither the surplus issue nor these larger questions need slip into blood and guts battles. The U.S. Fish and Wildlife Service, for example, worked with the Bureau of Reclamation for timed water releases below El Vado Reservoir to protect downstream fish hatcheries on the Rio Chama. Also on the Chama, an agreement in principle between the bureau, the Middle Rio Grande Conservancy District, the state of New Mexico and the city of Albuquerque will enable Chama boaters to enjoy a longer season. This agreement still has some problems, mainly because of continued excess rainfall and related storage questions. Still, both cases offer clear lessons on how dropping the insider-outsider approach and working together can produce results that please everyone.

Outsiders versus insiders. Think about it as you read the conference proceedings on the issue of surplus water on the Rio Grande.

SURFACE WATER RESOURCES DEVELOPMENT, APPORTIONMENT, ADMINISTRATION AND MANAGEMENT MILESTONES

Philip B. Mutz
Interstate Stream Engineer
N.M. Interstate Stream Commission

Tom Bahr asked me to sketch the legislative history of developments on the river. Apparently he had in mind that this presentation could possibly give some perspective to the presentations that follow. Accordingly, I have thrown in several other bits of history, and some of the appendage documents and events, which make up the story of the development, apportionment, administration, and management of the surface water supply of the Rio Grande Basin above Ft. Quitman, Texas.

The Rio Grande Basin above Ft. Quitman contains about 32,000 square miles if the closed drainage basins which do not contribute significant amounts of water to the stream system are not included.

The theme of this conference is managing the Rio Grande during recent "water surplus" years. A measure of the "water surplus" can be taken by comparing the 1984, 1985 and 1986 flows, the latter year being partially estimated, with

average flows at three locations on the river:

	Del Norte, CO	Otowi Bridge	Below Caballo Res
1984	762,000AF/117%	1,380,000AF/125%	655,000AF/106%
1985	1,010,400AF/154%	1,993,000AF/181%	677,000AF/109%
1986	940,000AF/150%	1,650,000AF/150%	1,020,000AF/164%

Development of the water resources of this river system almost antedates the history. The Chamita ditch on Rio Chama in New Mexico has a documented priority date of 1724. In Colorado the earliest documented water right in the state, 1852, is the San Luis Peoples Ditch in the Rio Grande Basin. The water law of the New Mexico Territory was initiated by Stephen Kearny in 1846. The Kearny Code provided that the laws theretofore enforced concerning water courses would continue in force except that such regulation as was required was transferred from officials of the villages to those of the counties.

The New Mexico Territorial Supreme Court, in 1898, said that the doctrine of prior appropriation is and always has been the settled law of this territory by legislation, custom and judicial decision. It said further, in effect, that the public interest required that that be the settled law of the territory.

The Colorado law dates from 1872 and embraces the appropriation doctrine.

Jumping out of chronological order for the purpose of

enhancing comity on the river, the Texas Code, which does not embrace the appropriation doctrine to the extent that the Colorado and New Mexico Codes do, originated in 1913.

In the 1700s and the 1800s, Spanish Colonization in the Espanola and Middle valleys and in the Elephant Butte-Ft. Quitman section was accompanied by the expansion of irrigation. In the 1880s, extensive irrigation development began in Colorado. In the early 1890s, water shortages began to occur in the Mesilla and El Paso valleys and the people near Juarez complained to their government. The Mexican government filed a claim for damages against the United States. As a result, the United States Department of State instituted an investigation through its International Boundary Commission. The report of this investigation, best known as the Follett Report, covers comprehensively and in detail the stream flow, irrigated areas, canal systems and diversions for every section of the basin from the San Luis Valley to El Paso and is published in United States Senate Document 229, 55th Congrsss, 2nd Session.

An outcome of the Follett investigation was the "embargo" of 1896, which was an order by the Secretary of the Interior preventing further irrigation development of any magnitude in Colorado and New Mexico through suspension of all applications for rights-of-way across public lands for use of Rio Grande water. With some modification in

1907, this embargo remained in effect until May, 1925, when it was lifted.

In 1902, the United States Congress enacted legislation providing for the construction of irrigation works for the reclamation of arid lands to be known as the Reclamation Act. The legislation also provides that all monies received from the sale and disposal of the public lands in 16 western states is to be reserved and appropriated in a special fund to be known as the Reclamation Fund. Subsequently, the state of Texas became the "seventeenth state" under the Reclamation Act. That act, as supplemented and amended, constitutes the federal reclamation and related laws, the authority for the authorization and construction of federal reclamation projects in the 17 western states.

In 1905, Congress enacted legislation relating to the construction of a dam on the Rio Grande, providing for a reclamation project in New Mexico and Texas to be supplied from the reservoir and extending the provisions of the Reclamation Act to that portion of the state of Texas which can be irrigated from the reservoir. Elephant Butte Dam was completed in 1916 with a New Mexico water right initiated by the Secretary of the Interior carrying a priority date of 1906. Its priority antedates that of any of the major and most of the small reservoirs constructed in the Rio Grande system in New Mexico and Colorado.

In 1906, the United States and Mexico entered a treaty, another outgrowth of the 1896 Follett Report, which provides that the United States shall deliver on a schedule at the International Dam on the Rio Grande at Juarez, Mexico, 60,000 acre-feet of water per year. The multi-purpose functions of Elephant Butte Reservoir include the delivery of water to meet the Mexican Treaty.

New Mexico's Surface Water Code, as amended, was enacted in substantially its present form in 1907. The code recognized all rights initiated prior to March 19, 1907, its effective date.

In the period from 1900 to 1935, a number of investigations of the water supply and potential works for its development were conducted on various segments of the river basin.

Meanwhile, Colorado was striving to secure permission to build reservoirs under the embargo. Permission was finally obtained to build several reservoirs in Colorado, and during the period 1909-1978, nine reservoirs were built on the Rio Grande and its tributaries having an aggregate capacity of about 280,000 acre-feet. Costilla Reservoir, capacity 15,000 acre-feet, was built in New Mexico in 1917 for irrigation of lands in Colorado and New Mexico. These reservoirs, built by local organizations, were the product of the 1907 modification of the "embargo."

In 1918, the Elephant Butte Irrigation District, which distributes water from the Rio Grande Project in New Mexico and the El Paso County Water Improvement District No. 1, which performs the same function in Texas, signed contracts with the Department of the Interior for the repayment to the federal government of the project costs allocated to them. Those contracts provide that the New Mexico portion of the Rio Grande Project constitutes 57 percent, of the total project and the Texas portion constitutes 43 percent. Subsequent amendatory contracts have all retained these same percentages.

About 1918, active interest developed in reclamation in the Middle Valley of New Mexico, extending from Cochiti to San Marcial. Much of the irrigated area had become badly seeped, the area irrigated had declined and the acreage that was irrigated failed to produce.

With the interstate situation becoming increasingly aggravated, and competition increasing for use of the river among users from Texas to Colorado, some were in favor of attempting to negotiate an interstate compact which would apportion the river's flow. In 1923, the legislatures of Colorado and New Mexico enacted statutes authorizing the appointment of representatives; Texas followed suit. Congress consented to the formation of the Rio Grande Compact Commission, and the president designated a

representative of the United States. The hydrographic studies previously undertaken, principally by the states of Colorado and New Mexico, were still in progress and compact negotiations moved slowly. In 1929, an agreement was reached, temporary in nature and which did not attempt to apportion the river's water; the purpose of the 1929 Rio Grande Compact was to establish a "status quo" on development of the river until a permanent compact could be negotiated.

During the same period of negotiation of the 1929 Compact, under cooperative agreement between the Middle Rio Grande Conservancy District and the Bureau of Reclamation, an extensive investigation of the Middle Valley was conducted. The primary purpose being to determine the probable effect on the water supply for the Rio Grande Project by the construction and operation of the proposed works of the Middle Rio Grande Conservancy District. The District was created in 1925, and issued its final plan for flood control, drainage and irrigation in 1929.

The irrigation and drainage works of the Middle Rio Grande Conservancy District were undertaken and completed by 1935 along with El Vado Dam and Reservoir on the Rio Chama to regulate the water supply to the district. With construction of the works of the district, the available water resources of the Rio Grande above Ft. Quitman were

apparently fully appropriated and conflicts of interest among federal agencies were indicated as was potential violation of the Rio Grande Compact. As a result, the president, in 1935, issued a memorandum to the federal agencies concerned to not approve any application for projects involving large allotments of Rio Grande water above El Paso without securing from the Natural Resources Committee an opinion on all relevant points of view. Also in 1935, the Rio Grande Compact Commission, meeting with the Natural Resources Committee, adopted a resolution requesting the committee to arrange immediately for: 1) a comprehensive investigation of the water resources of the Rio Grande Basin above Ft. Quitman, 2) the past, present and prospective uses and consumption of water in the basin, and 3) opportunities for conserving and augmenting the Water resources by all feasible means; all to assist the Rio Grande Compact Commission in reaching a satisfactory basis for equitable apportionment of the waters or the Rio Grande. The resulting Rio Grande Joint Investigation, completed in 1937, was, and still is, one of the most comprehensive reports on regional planning.

Also, in the banner year of 1935, Texas sued New Mexico in the United States Supreme Court alleging violation of the Rio Grande Compact through construction and operation of El Vado Reservoir. The suit was dismissed in 1939 following

negotiation of the Rio Grande Compact.

Following construction of Elephant Butte Dam, the river channel downstream progressively decreased in capacity to carry flood flows. Also, the river channel always had been unstable and shifting. In 1933, a convention between the United States and Mexico was concluded which proposed: 1) construction of Caballo Reservoir, 2) canalization of the channel of the Rio Grande from Caballo Dam to El Paso, and 3) construction of the American Diversion Dam and Canal to deliver Rio Grande Project water to the El Paso Valley. Caballo Reservoir was completed in 1939 with a total capacity of about 350,000 acre-feet of which 100,000 acre-feet is reserved for control of floods originating downstream from Elephant Butte Dam. The Caballo-El Paso canalization project was also completed as was the American Dam.

Using results of the studies of the Rio Grande Joint Investigation, negotiations in 1937 and early 1938 resulted in the Rio Grande Compact as we know it today. The compact as ratified by the respective state legislatures and the United States Congress and became effective May 31, 1939.

Platoro Reservoir was completed in 1951 on the Conejos River in Colorado by the Bureau of Reclamation pursuant to a congressional authorization in 1940. Platoro Reservoir has multi-purpose functions and the entire capacity of the

reservoir may be used for flood control if necessary.

Two flood and sediment control reservoirs, Jemez Canyon, completed in 1954, and Abiquiu, completed in 1963, were authorized by Congress in 1948 as a part of the Middle Rio Grande Project. That authorization also included channel rectification, involving a low-flow channel extending some 75 miles south of San Acacia into the upper reaches of Elephant Butte Reservoir; a floodway from Cochiti to Elephant Butte Reservoir and a floodway through the city of Truth or Consequences. The legislation also authorizes the U.S. Bureau of Reclamation to maintain the channel of the Rio Grande from Velarde to San Acacia to accommodate flows of about 5,000 cubic feet per second. Under the legislation, the U.S. Army Corps of Engineers constructed flood control levees along sections of the river in the Middle Valley, which are maintained by the Middle Rio Grande Conservancy District.

In 1960, Congress authorized the construction of Cochiti and Galisteo reservoirs, completed in 1975, for flood and sediment control. The 1960 authorization includes operating criteria governing the operation of all four of the Middle Rio Grande Project reservoirs: Jemez Canyon, Abiquiu, Cochiti and Galisteo. The U.S. Army Corps of Engineers operates and maintains the four flood control reservoirs and the authorization also provides that the

corps' operation may depart from the specified criteria with the advice and consent of the Rio Grande Compact Commission.

In 1963, Congress authorized construction of the San Juan-Chama Project to import San Juan River water to the Rio Grande. Heron Reservoir completed in 1970 in the Rio Grande Basin is used solely to store and regulate the imported San Juan-Chama Project water.

Pursuant to the authorizing legislation, a complex accounting procedure has been developed to account for the imported San Juan-Chama Project water, its storage, losses and use in the Rio Grande Basin. The accounting is also necessary for the determination of New Mexico's scheduled and actual delivery of water under the Rio Grande Compact and, therefore, must be approved by the Rio Grande Compact Commission.

In 1964, Congress authorized the establishment and maintenance of a permanent pool of 1200 surface acres in Cochiti Reservoir for fish and wildlife resources and for recreation, the pool to be established and maintained with San Juan-Chama Project water. The pool was established in the winter of 1975-76 and continues to date.

The Closed Basin Division, Colorado, was authorized by Congress in 1972 to provide for the delivery of water to the Rio Grande from the Closed Basin at the northern end of the San Luis Valley. This project was investigated from the

early 1900s, was contemplated in the 1929 Compact, and was dedicated and delivered its first water (a very modest amount) to the Rio Grande in 1985.

The United States Congress in 1974 authorized the establishment of a recreation pool at Elephant Butte Reservoir and its maintenance for a period of 10 years using excess San Juan-Chama Project water. The authorized 50,000 acre-foot recreation pool was established in 1975-76. The authorizing legislation provided that in the event of spill from Elephant Butte Reservoir, the pool would spill first. When it became apparent that spill would occur in 1985, the Rio Grande Compact Commission arranged to transfer, by exchange, the pool to Abiquiu Reservoir with the agreement of the U.S. Army Corps of Engineers. Later the corps could not maintain the pool in Abiquiu Reservoir because of the lack of rights-of-way and the Rio Grande Compact Commission requested, and the corps agreed, to move it to Cochiti Reservoir.

In 1986, there remained no viable option to store the Elephant Butte recreation pool, including the possibility to store at least a part of it in Platoro Reservoir in Colorado. As a result, the pool spilled in August 1986.

The diversion and terminal storage elements of the San Juan-Chama Project were completed in 1971. The city of Albuquerque has a contract for 48,000 acre-feet of water,

about one-half of the project yield. Albuquerque has not had the need to use all of its contracted water to date, which is also true for a number of the other contractors. Congress enacted legislation in 1981 authorizing storage of San Juan-Chama Project water in Abiquiu and Elephant Butte reservoirs. Albuquerque stored some water in Elephant Butte, but that amount was exchanged to Abiquiu in 1985 when the Elephant Butte recreation pool was moved. Otherwise it would have spilled. The 200,000 acre-feet of authorized storage in Abiquiu Reservoir was filled in 1985 and remains full.

The Middle Rio Grande Conservancy District stores its excess San Juan-Chama Project water in El Vado and Abiquiu reservoirs, which is also the case for most of the contractors. By contract, by exchange, by sub-contract and by congressional authorization, San Juan-Chama Project water has been stored in most of the major and some of the minor reservoirs in the Rio Grande system in New Mexico.

The Hudspeth County District in Texas has a contract extending only to return flow as it occurs from operation of the Rio Grande Project which it distributes to water users in Hudspeth County. The contract puts no obligation on the Rio Grande Project for delivery of a specific amount of water.

Numerous ditches located upstream from the Middle Rio

Grande Conservancy District divert water from the Rio Grande and its tributaries and most of those in New Mexico are organized as community ditches, which are political subdivisions of the state of New Mexico.

Thus, a multitude of interests can be affected and a plentitude of agencies can be involved in the operation and management of the Rio Grande reservoir and river system.

Operation under the Rio Grande Compact has historically resulted in both Colorado and New Mexico being in a debit status more of the time than otherwise. Operation under the compact also resulted in two United States Supreme Court cases alleging violations of the compact.

The first case, Texas v. New Mexico, was dismissed in 1957 because of the absence of the United States as an indispensable party.

The last case, Texas and New Mexico v. Colorado, was carried under a continuance of the court from 1968 to 1985, provided that each and every year Colorado met its annual delivery obligation of the Rio Grande Compact. The record shows that Colorado each year met that annual obligation.

Because of the need to provide protection to the city of Truth or Consequences from spills from Elephant Butte Reservoir, the Rio Grande Compact Commission agreed to an operation in 1985 that would allow storage of water in the upstream flood control reservoirs, thus allowing Elephant

Butte Reservoir to maintain some empty space to control floods originating downstream from Cochiti Reservoir. Under that agreement, a procedure to credit upstream storage to Elephant Butte Reservoir was devised. Pursuant to the accounting procedure, Elephant Butte Reservoir would have actually spilled on June 13, 1985, had not upstream storage been made to provide flood protection below Elephant Butte Dam. This was the first spill of water from Elephant Butte Reservoir since the actual spill in 1947.

At a special meeting held July 2, 1985, the Rio Grande Compact Commission found that actual spill had occurred and that the spill had wiped out the debits of Colorado and New Mexico. The commission also adopted a resolution requesting the attorneys general of the states to petition the United States Supreme Court for dismissal of the case, New Mexico and Texas v. Colorado, which was done.

Operation of the upstream flood control reservoirs in 1985 and 1986 to prevent flood damage resulted in the maximum amount of water ever stored in Abiquiu and Cochiti reservoirs with unavoidable environmental consequences which were of deep concern to some citizens.

Those concerns included impacts on the fishing and perching opportunities for bald eagles, portions of Bandelier National Monument and white water rafting on Rio Chama above Abiquiu Reservoir. As a result of the latter, a

suit styled State of New Mexico v. the Bureau of Reclamation and the U.S. Army Corps of Engineers was filed by the district attorney for the First Judicial District in Santa Fe. The suit alleged, among other things, improper operation of the reservoirs and violation of the Rio Chama Scenic and Pastoral Act, which is legislation enacted by the New Mexico Legislature in 1977. The suit was dismissed by the District Court but has been appealed by the plaintiff in the Tenth Circuit Court of Appeals.

WATER MANAGEMENT RESPONSIBILITIES FOR THE RIO GRANDE BASIN

John J. Cunico
Chief of Planning Branch
U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers has been actively involved in water resource development in the Rio Grande Basin since the early 1940s and in a cursory way before then. Our active involvement followed the floods of 1941 in the Rio Grande Basin. The U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation (USBR) conducted joint studies during the mid 1940s, which resulted in companion reports by the two agencies (Corps of Engineers - House Document 243, and USBR House Document 653, 81st Congress, 2nd session). At the conclusion of these studies in 1947, the two agencies reached a joint agreement on a comprehensive, federal program for flood control and reclamation in the Rio Grande Basin in New Mexico. The agreement stated each agency's responsibility. The corps' was to construct three dams and reservoirs, the Bluewater Floodway, and rehabilitate the Rio Grande floodway levees. The USBR would have responsibility for Rio Grande channel rectification and rehabilitation of existing drainage and irrigation facilities within the middle valley.

The Flood Control Act of 1948 authorized the elements of the comprehensive plan of improvement for the Rio Grande with the exception of Chiflo Dam and Reservoir. From this authorization, the Jemez Canyon Dam was constructed and went into operation in 1954. The Abiquiu Dam project was substituted as a preferred alternative to the high and low Chamita projects on the Rio Chama and construction of this project was completed in 1963. A subsequent study and report lead to the authorization of the Cochiti Lake and Galisteo Dam projects. The construction of these projects was completed in 1975 and 1970 respectively.

The 1960 authorization legislation (Public Law 86-645) for the Cochiti and Galisteo projects contained the specific operating criteria for the Middle Rio Grande Flood Control projects. The federally mandated operating criteria is very specific on operational requirements with little latitude in the operation. The legislation does however, provide flexibility in the operation of the projects with advice and consent of the Rio Grande Compact Commission.

The operating criteria as set forth in PL 86-645 generally limits the operation of the Middle Rio Grande Reservoir projects to flood and sediment control. The only exception would be that storage may be allocated to permanent pools for recreation and fish and wildlife

purposes provided that water to establish and maintain such pools is obtained from sources outside the Rio Grande Basin (San Juan-Chama imported water). The operating criteria for the Middle Rio Grande projects are also very specific on how stored flood waters are withdrawn from storage. Generally the principles of flood control dictate that stored flood waters are released as rapidly as downstream conditions will permit. This principle allows for flood storage capacity to be available as soon as possible for subsequent events. However, the operating criteria for the Middle Rio Grande projects provides that during the months of July, August, September, and October when the natural inflow to Cochiti Lake at the Otowi gage is less than 1500 cubic feet per second (cfs), no water will be withdrawn from Cochiti Lake as long as the project has 212,000 acre-feet of available storage. Due to other language in the legislation, no flood waters are released from the other flood control projects during this period. However, if flood waters are released from the upstream projects, these waters will be retained in the Cochiti Lake project. Flood water "carried over" during this period is released from November 1 through March 31. The basis of this operational criteria was established by the three Rio Grande Compact states during the formulation of the Cochiti Lake project to ensure that water belonging to the users below Elephant

Butte Dam would actually be delivered to Elephant Butte.

The flood control operation of the past two years has been a real challenge, not only for the corps, but for all the federal and state agencies with water management responsibilities. There are several reasons for the challenge. Foremost, is that most all relevant laws, regulations and policy, and history are geared to water deficiencies rather than water excess. Similarly the laws, regulation and policies were formulated around the use of water for maximum beneficial economic return based on conditions and projections made 30 to 50 years ago. Today's increased interest in environmental, aesthetic, and special interest concerns, such as white water rafting and endangered species, were not integrated into the concepts for design and operation of these projects. Thus, no matter how noble the need or desire, the laws governing our actions generally preclude the corps from accommodating these needs and desires.

A couple of examples of these later-day needs and desires are the bald eagle population at Cochiti Lake, and the state of New Mexico statute known as "El Rio Chama Scenic and Pastoral River Act" enacted in 1977 (codified as Chapter 16, Article 4, NMSA, 1978).

The record does not reflect a wintering population of bald eagles in the vicinity of Cochiti Lake prior to the

construction of the project. Thus neither the authorization of the project, nor the original Environmental Impact Statement addressed the bald eagle habitat. Subsequent to initiation of storage, a significant wintering population of bald eagles has been attracted to the lake area due to the permanent pool. The Endangered Species Act placed the bald eagle in a category that indicates special attention be directed to the eagles. The corps has very little flexibility to enhance the eagle habitat since the project operation is spelled out in federal legislation, and the corps has little control of project lands except for flowage easements. The majority of the lands are controlled by either the U.S. Forest Service, the National Park Service or the Cochiti Pueblo. We are nevertheless under considerable pressure by a concerned public, whose interests are the bald eagles to protect and enhance the eagles' habitat by manipulating reservoir levels and releases.

The New Mexico El Rio Chama Scenic and Pastoral River Act of 1977 was enacted for the preservation, protection and maintenance of the natural and scenic beauty of designated portions of the Chama River. The authorization of a federal dam on the Rio Chama predates the state statute by 30 years and the construction of the Abiquiu Dam project predates the statute by 13 years. Section 16-4-6.E. of the statute states: "Nothing in El Rio Chama Scenic and Pastoral Act

shall be construed as being incompatible with existing state property laws. Nothing shall be construed to be incompatible with regulation of river flow for flood control or beneficial uses of water." To an engineer, it would seem reasonably clear that the act recognized the Abiquiu project and the operation of the project. Nevertheless the district attorney of Santa Fe has filed suit against the United States and the secretaries of the Army and Interior, essentially claiming the operation of the Abiquiu project and the Middle Rio Grande reservoirs are in violation of the New Mexico statute. A final decision in the case is still pending.

The 1985 operation of the Middle Rio Grande flood control projects was viewed by many as a conservation operation in lieu of a flood control operation since it involved integrating the Elephant Butte and Caballo projects into the overall flood control operation of the Rio Grande. As indicated previously, the normal water shortage in the basin had allowed certain conditions to develop that are not acceptable under conditions of high reservoir pools and reservoir spills. As examples, the Rio Grande channel through Truth or Consequences needed to be improved from about a 2,500 cfs capacity to 5,000 cfs capacity to reduce the risk of damage from potential spills from Elephant Butte. The earth dike at Elephant Butte showed signs of

distress in the fall of 1985 due to pool stages in Elephant Butte that had not been experienced for more than 40 years. These potentially hazardous items demanded remedial measures that required the upstream flood control dams be operated to minimize the risk and provide river conditions that allowed the remedial work.

The 1986 snowmelt runoff brought some new problems and challenges. With the conservation pools in most of the reservoirs full and basin conditions which produced larger than expected runoff, the flood from the runoff and reservoir releases extended into the Rio Grande below El Paso. This brought an additional interest into focus. The Rio Grande below El Paso is under the jurisdiction of the International Boundary and Water Commission and forms the boundary between the United States and Mexico. Because water reaches below Fort Quitman, Texas, farmers on both sides of the border have developed lands adjacent to the river. However, with the releases exceeding demand from Elephant Butte and Caballo reservoirs, large areas of the lands were flooded, and requests were received to operate the Middle Rio Grande flood control projects to achieve flood reduction in this area of the Rio Grande. Because the original authorization did not limit the reaches where flood control would be provided, the projects were operated to give limited relief to property owners in these lower

reaches of the Rio Grande.

In summary, I believe that the U.S. Army Corps of Engineers' Middle Rio Grande flood control projects have been a good investment for the taxpayers and to the water resource interest in the three Rio Grande Compact states. I believe the future potential benefits of these projects when operated in conjunction with the other federal projects in the basin, will be extensive. However, to maximize the benefits of the projects will require a comprehensive, unified approach by all interests to achieve a balance in use, with all interests gaining in the process.

OPERATIONS ON THE UPPER RIO GRANDE

Charles A. Calhoun

Project Superintendent

U.S. Bureau of Reclamation

Introduction/Background

U.S. Bureau of Reclamation operations on the Upper Rio Grande in 1985 and 1986 have been very challenging and stimulating. This has resulted from an abundant water supply and new requirements coming into play. Each of these years featured far above normal runoffs and water supplies. Further, they have followed a sequence of almost unprecedented years of abundant water supply. Beginning in 1979, with the exception of 1981, each year has furnished an above-normal water supply.

Authorizations

Three projects are managed by the reclamation's Albuquerque office. These are the Middle Rio Grande Project, the San Juan-Chama Project, the Platoro Dam, and part of the San Luis Valley Project. The Middle Rio Grande Project was authorized by Congress through the Flood Control Acts of 1950 and 1960.

El Vado Dam and Reservoir, a feature of the Middle Rio Grande Project, was built by the Middle Rio Grande Conservancy District in the middle 1930s. Recently, it

celebrated its 50th birthday, and was recognized by the American Society of Civil Engineers as a civil engineering landmark because of the unique characteristics of its construction, which featured a large amount of steel face plate on the upstream face of the dam and in the spillway chute.

Other features of the Middle Rio Grande Project include the three diversion dams at Angustora, Isleta, and San Acacia. At these three locations, and also at Cochiti Dam, water is diverted from the main stem of the Rio Grande into the conveyance and distribution system of the Middle Rio Grande Conservancy District. The Middle Rio Grande Project is a partnership arrangement between the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, and the Middle Rio Grande Conservancy District. The U.S. Bureau of Reclamation at Albuquerque has retained operation and maintenance responsibility for the river channel between Velarde, New Mexico, in the north, and the headwaters of Caballo Reservoir in the south, excluding Elephant Butte Reservoir. Also, water salvage projects of up to about $1 million each year are executed by reclamation for the New Mexico Interstate Stream Commission. This maintenance responsibility and work of reclamation in the channel will be the subject of most of this paper.

The San Juan-Chama Project diverts water from three

locations in southern Colorado. The water flows through some 26 miles of tunnel, passes under the Continental Divide and discharges at Azotea Creek. The water then flows downstream into Heron Dam and Reservoir, which has a capacity of about 400,000 acre-feet. Here the water is stored for release for use by contractors downstream in the state of New Mexico.

The authorization for the San Juan-Chama Project requires very close accounting of this transbasin water, which is brought into the Rio Grande system. As a result, the reclamation office in Albuquerque does most of the water accounting for the Upper Rio Grande. The San Juan-Chama Project was authorized with the Navajo Indian irrigation project in June of 1962.

A participating project within the San Juan-Chama Project is Nambe Falls Dam. This is located approximately 30 miles north of Santa Fe. This facility provides supplemental irrigation water to the Pojoaque Valley Irrigation District, which serves non-Indian lands and the pueblos of Nambe, Pojoaque, and San Ildefonso.

Platoro Dam was authorized as part of the San Luis Valley project under Secretary of the Interior authorization pursuant to the Reclamation Act of 1939 with a reauthorization in 1949. Platoro is located at approximately 10,000 feet elevation, about 35 miles

southwest of Alamosa, Colorado. While this 60,000 acre-foot reservoir is not large in comparison with other features in the system, it has been the subject of many interesting discussions, particularly relating to the storage of water for flood control and the release of water as a result of the Rio Grande Compact requirements.

Dry Period, 1950 - 1978

Next, let us examine what has transpired over the period of historical record on the Rio Grande system. Two gaging stations, the Otowi gage to the north and the San Marcial gage to the south, are very important because of the delivery requirements contained in the Rio Grande Compact. Figure 1 is entitled "Rio Grande at Otowi Recorded Flow" and shows the annual discharge at that location. The wide range of annual discharge is further emphasized by the lack of lengthy unbroken periods of below or above average discharge. With few exceptions, one or two high or low years have been followed by opposing low or high years. Thus, the sawtooth pattern results which appears to have a strong random component. The recorded flow data at the Otowi station on the Rio Grande can be compiled into a ten-year moving average as shown on figure 2, entitled similarly to the previous with "Ten Year Moving Average." This figure demonstrates quite vividly the abundance of water before 1950, the dry period, beginning in 1950 and extending nearly for three decades.

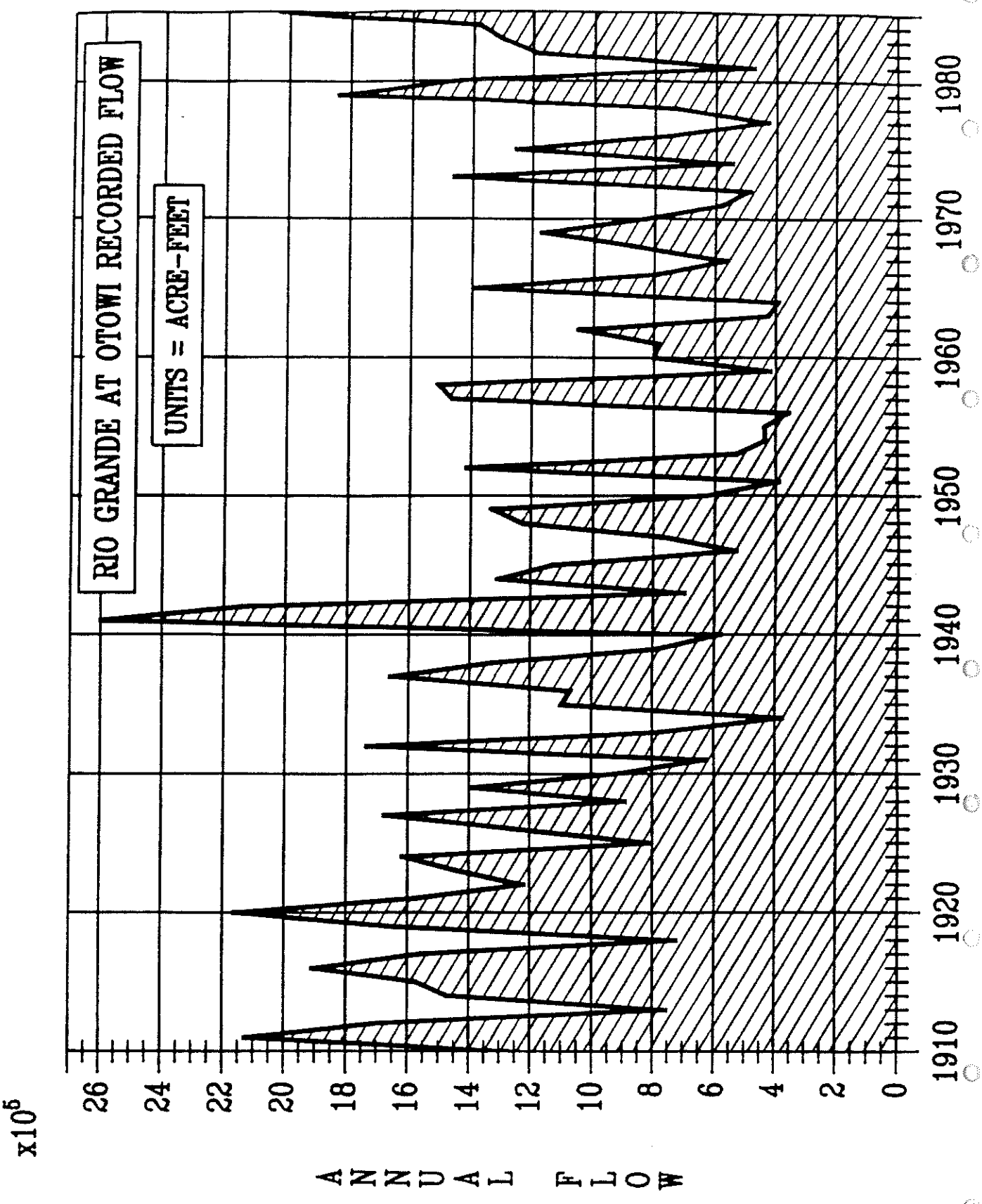

Figure 1. Rio Grande at Otowi. Recorded flow.

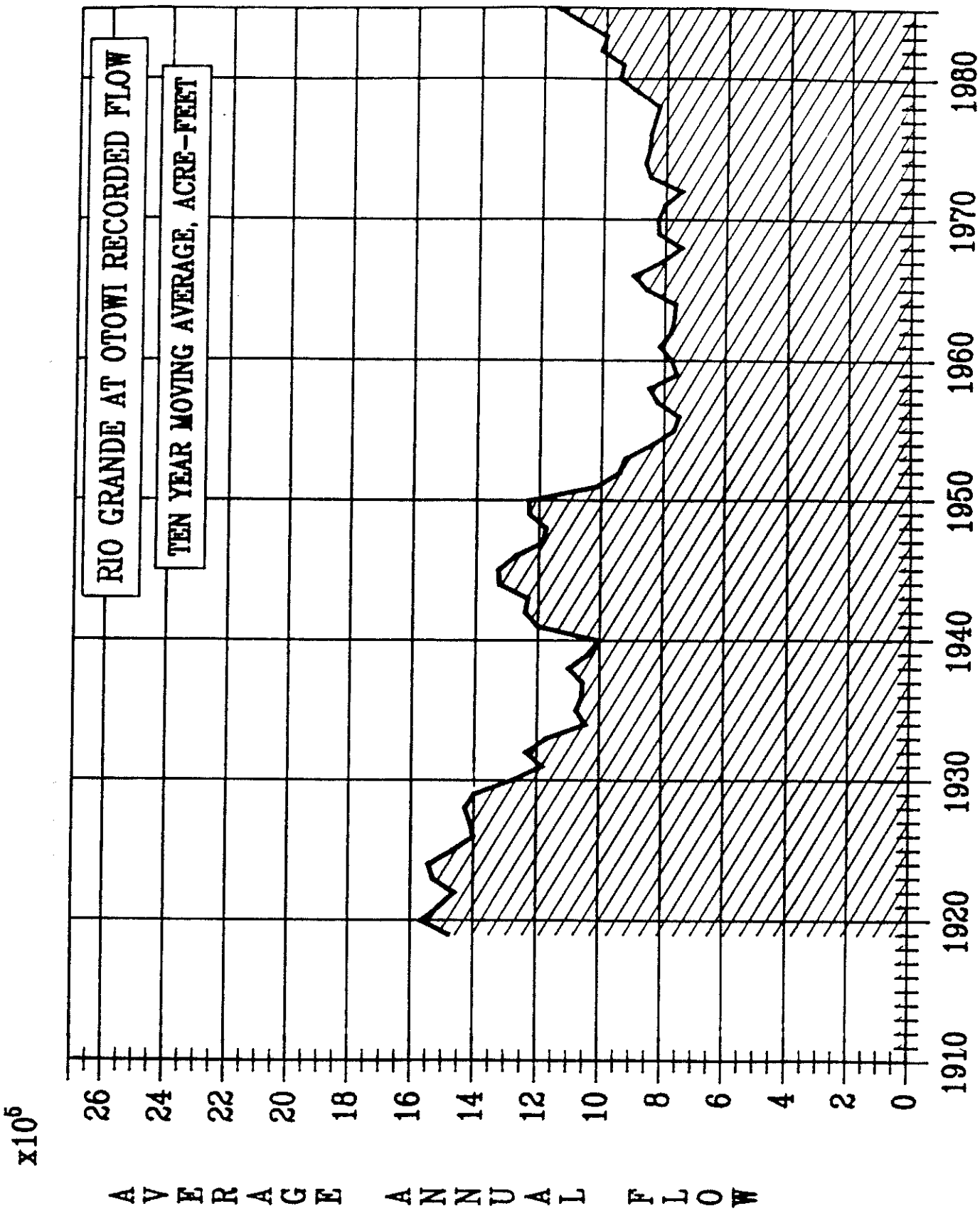

Figure 2. Rio Grande at Otowi. Recorded flow. Ten-year moving average.

A comparison of both annual and ten-year moving average data at San Marcial as shown on figure 3 shows a similar conclusion at that location. The San Marcial gage is just upstream of Elephant Butte Reservoir and reflects depletions of the Middle Rio Grande Valley not shown on the Otowi figure.

Wet Period, 1979 to Present

Further study of these hydrographs shows a reversal of the dry period of the 1950s, '60s, and '70s beginning in 1978. Good runoff was reported in 1979 and 1980 but 1981 was a very low year. Since then, however, an unbroken string of wet years have followed. You can conclude that we are in a wet period but that we are overdue for a low runoff year.

CRITICAL PROBLEMS IDENTIFIED

River Maintenance Responsibility

Several critical problems were identified during this wet period. Before the filling of Elephant Butte Reservoir, a severe channel restriction problem was recognized downstream of Elephant Butte through the city of Truth or Consequences, New Mexico. This reach of the river had an authorized capacity of 5,000 cfs. However, as a result of arroyo inflows, sediment plugs, and other factors, only a little more than 2,000 cfs could pass through this reach. So it became imperative that this reach be restored and

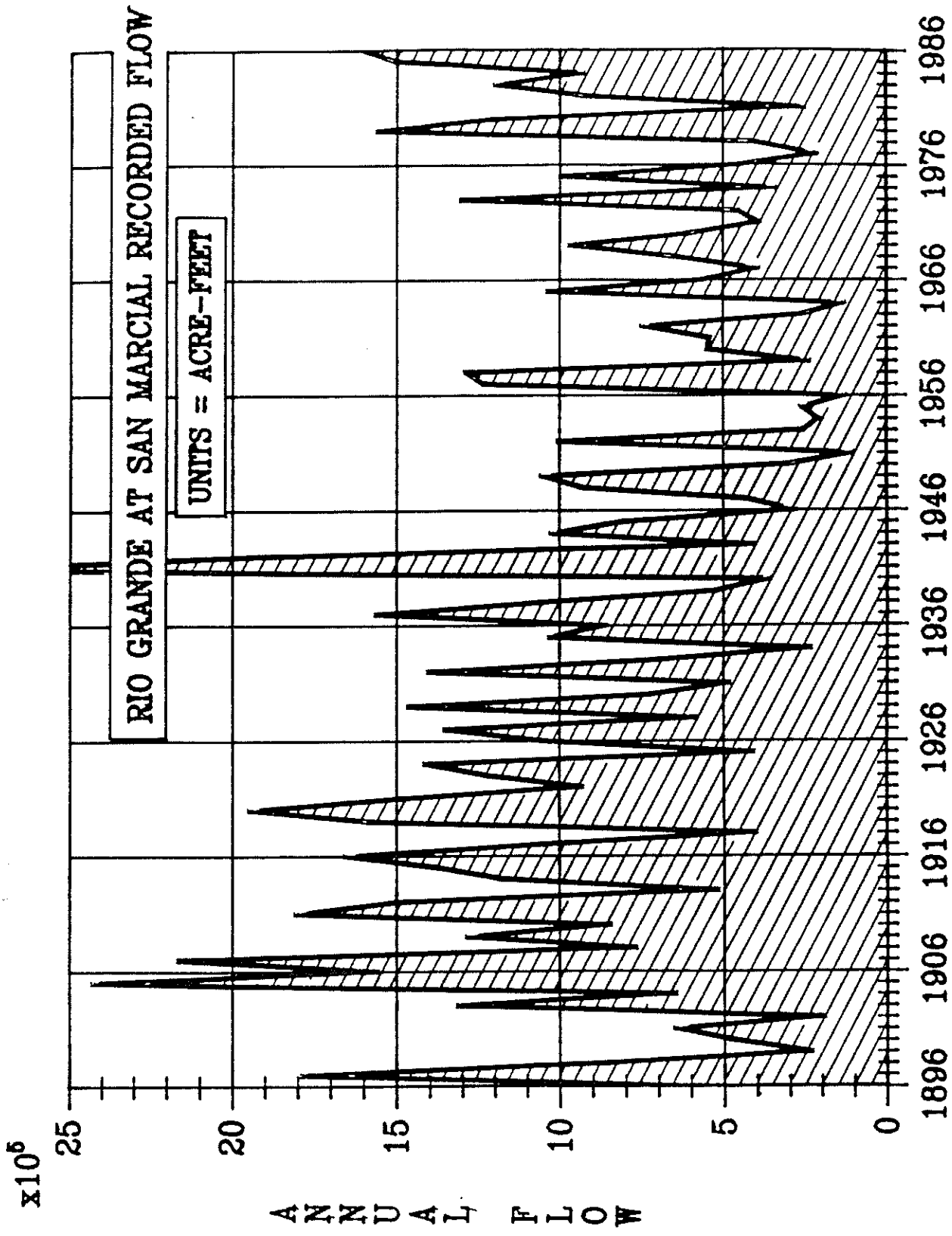

Figure 3. Rio Grande at San Marcial. Recorded flow.

maintained to make large discharges, up to 5,000 cfs, possible from Elephant Butte Dam.

Other problem areas recognized include the reach immediately upstream of Elephant Butte. Here, a meandering river with sediment deposition is taking place. A well-defined, deep, narrow channel is now filled with sediment, plugged over, and the river is spreading out and more or less going off cross country with some velocity of water against the spoil levee. Near the San Marcial railroad bridge the river was seeking to establish a new channel by flowing back to the north and northwest. That situation was watched with a great deal of concern earlier this summer. Fortunately, the river does not seem to be pursuing that track now. Nevertheless, the entire reach upstream of Elephant Butte does provide some very serious challenges, both from the standpoint of management of the river and sediment depositions.

Further upstream in the vicinity of the Santa Domingo Pueblo, the river is attacking the levee. Erosion has been limited with the installation of a line of jetty jacks and dumped rip-rap. This area is upstream of Albuquerque and downstream of Cochiti Dam.

Another problem encountered is the sediment plug that occurs when arroyos, such as Tonque Arroyo at San Felipe Pueblo, flow. Arroyos tend to drop large amounts of

sediment into the river, and then this sediment must be removed or transported further downstream.

Water Accounting

The complexity of the water accounting was made a part of the San Juan-Chama Project Authorization. The inflow into El Vado Reservoir for 1983-1985 included both the Rio Chama natural flows and the imported San Juan-Chama flows. Basically, this reflects the natural runoff with the added discharges from Heron into El Vado, which is now at capacity.

Reservoir Operations

The reservoir operations associated with these wet years have changed from what was experienced during the dry years. For the most part, storage reservoirs are full, and new problems of trying to account for water and to accommodate the requirements of the full reservoir system have resulted. One particular case in point was the transfer of the Elephant Butte recreation pool from Elephant Butte upstream to Abiquiu and then to Cochiti, and finally the loss of this recreation pool for lack of a location for further storage.

Possible Solutions

Let's consider solutions. Certainly, one of the solutions that has been used extensively along the Rio Grande system is the installation of steel jacks. An

installation within the city limits of Albuquerque is protecting the east bank of the Rio Grande from further erosion. Jetties have been and continue to be effective at a number of locations. They do have limitations in that they require a high sediment concentration and trash or debris to be caught in the wires to form an effective barrier to erosion and removal of material.

The necessity of restoration of the channel from Elephant Butte to Caballo was described earlier. This was accomplished from September 1985 to February 1986, under a $2 million construction contract with Ed Logan Contracting Company from Arizona. The Logan Company was able to get in the river channel with double-engine scrapers and the river bed was removed to restore the channel capacity to the 5,000 cfs authorized discharge.

Not all the excavation went smoothly. An example of one of the incidents is when the equipment became stuck. When a scraper was submerged it usually ruined the transmission at a cost of more than $12,000. Nevertheless, the contract went quite well, and the contractor was able to perform this excavation with the scrapers, whereas before the contract it was assumed by many that drag lines would be required to remove a great deal of this material.

The area at Truth or Consequences is environmentally and politically sensitive. Many people live adjacent to the

river. They were concerned about the work that was going on in their back yards. They wanted to be assured that not only would the channel restoration take place, but it would be done in a manner that protected their environment and protected their property. As part of the channelization, two grade control structures were installed.

Certainly, many problems and challenges lie ahead for us. One of the biggest is at the headwaters of Elephant Butte Reservoir with the very difficult problem of sediment deposition and high discharges during a high reservoir state. Other problems include the erosion and other difficulties in the Cochiti Division, and similar problems in the Espanola Valley.

Conclusions

Water accounting remains a day-to-day activity and concern, as does reservoir operations. We work very closely with the U.S. Bureau of Reclamation office in El Paso, the U.S. Army Corps of Engineers office in Albuquerque, the three state commissioners to the Rio Grande Compact, and with a number of other entities.

There are gray areas and a number of serious limitations to project management. Certainly, one problem at many locations is that the public feels we should not only maintain the river but that we should protect their private property from erosion. To the extent that this work

can be accomplished within our authorizations, we try to accommodate it. However, many times it just comes down to the fact that work cannot be accomplished outside the authorization, and it would be improper for any agency to do so.

Priorities for river maintenance work are addressed to a large degree through the river assessment, which is performed each year. All of the work that needs to be done on the river is prioritized into three broad categories. Priority one is the most urgent and work that has to be done in the near future. It's very difficult to accomplish some of this work with the high flows and the large amount of water recently experienced. We do have to be flexible. There are many other entities that we share our concerns and priorities with.

The projects are working well to serve the public. The public's needs and priorities change and our operations change within the authorized limits to meet those needs.

In closing, please consider the flooding at Albuquerque at the time of the disastrous 1941 floods. Certainly, we all want to prevent this sort of thing from happening in our valley again. We're working together towards the goal of assuring that it does not.

YOU CAN'T PUT TOO MUCH WATER IN ELEPHANT BUTTE

David P. Overvold

Chief, Water and Land Division

Rio Grande Project, U.S. Bureau of Reclamation

You can take the title of my talk -- "You Can't Put Too Much Water in Elephant Butte" -- two ways. You can't put to much water in Elephant Butte or you can't put too much water in Elephant Butte.

It reminds me of a sketch on "Saturday Night Live" where Ed Asner played the part of a nuclear powerplant operator back east who retired. At his going-away dinner he told his successors, "There's only one thing you have to remember about this powerplant. You can't use too much cooling water." The next day the new operators were sitting there scratching their heads wondering - does that mean keep pouring it on or don't use very much? The next scene shows Ed Asner on a beach in Bermuda, watching the sunset, sipping a margarita. He gets an emergency phone page from the United States just as he sees this big bright glow on the horizon from a nuclear explosion.

That's now my favorite expression. "You can't put too much water in Elephant Butte." If we get it too full we'll be sorry and if we keep on sending it down the river we'll always have room for more.

The statutory authority and purposes of the U.S. Bureau of Reclamation are spelled out by Congress starting with the Reclamation Act of 1902. The Rio Grande Project was authorized in 1905. Elephant Butte Dam was completed in 1916. The irrigation facilities were constructed by 1929 to serve roughly 160,000 acres in the Elephant Butte Irrigation District and in the El Paso County Water Improvement District.

Caballo Dam was added in 1938 for flood control. The International Boundary and Water Commission (IBWC) contributed $1 million for 100,000 acre-feet of flood space, which they control.

Our primary objective is to deliver water to the two irrigation districts. The districts place water orders twice a week, Tuesdays and Fridays. We consolidate the orders of the two districts and Mexico and determine the release needed from Caballo Dam to meet the orders.

Our office has the responsibility of determining the water allotment at the beginning of each year for the districts and Mexico based on the amount of water in storage. The past eight years have been a full supply, but prior to that there were shortages declared in 15 of the previous 30 years. Because of this fact we have always concentrated on water conservation.

We also measure and account for all water deliveries to

the districts. We must ensure that each district's use does not exceed its allotment. Not that they would, mind you, but just for the record.

The Power and Storage Division at our Elephant Butte office operates and maintains the 23-megawatt powerplant. There are three units that generate up to nine megawatts each. A release of 2,100 cubic feet per second (cfs) is needed to generate at maximum capacity. In 1985 and 1986 we have been operating the power plant at 115 percent of rated capacity.

To the extent we have space, we operate Elephant Butte and Caballo reservoirs to provide flood protection. However, there is no flood space allocation in Elephant Butte. During the 1942 flood, we had a target elevation of 4396 by mid-February. This provided about 500,000 acre-feet of space. In 1985, we operated in cooperation with the U.S. Army Corps of Engineers to provide 100,000 acre-feet of flood space in Elephant Butte. Cochiti Dam has been constructed since 1942 upstream of Elephant Butte, which provides 450,000 acre-feet of flood space.

We are not authorized to regulate releases for power generation or recreation. A 1938 law states that "... the use of Elephant Butte Dam, project works, and water supply for power purposes shall not deplete or interfere with the use thereof for irrigation purposes..." A 1962 law

specifically states "... the construction of recreation facilities at Elephant Butte and Caballo Reservoirs shall not provide in any manner whatsoever a basis for allocation of water for recreation use or for the allocation of reservoir capacity for recreation use..."

Our basic management priority during the last two years has been simply, "You can't put too much water in Elephant Butte."

I'll never forget a meeting we had in January 1985 at Gary Rowe's house (because he was recovering from his back injury) where we argued about whether or not we should allow Elephant Butte to exceed 1.6 million acre-feet, because we would lose the capability of using the low flow channel. I was worried about the increased evaporation of storage in Caballo over Elephant Butte. Then two months later we were filling Caballo to the top of the conservation pool and the low flow channel hasn't been used since.

Another priority we have, especially this year, is limiting excess releases to minimize flood damage downstream. We have had difficulties with determining which is better -- a higher release for a shorter time period, or a lower release for a longer time.

We have been releasing 2,500 cfs from Caballo Dam since October 8, 1986, with no demand for water. We expect to dump about 120,000 acre-feet in October alone. This amount

is about as much water as the city of El Paso uses in an entire year.

One of the gray areas we encountered this year was encroachment into the flood space in Caballo Reservoir. For example, last summer when we were trying to keep a steady flow at Fort Quitman, it rained, and the districts' orders dropped off. Elephant Butte was within less than 50,000 acre-feet from being full, so what do we do? Do we encroach into the flood space at Caballo or do we keep releases the same and suffer flood damage downstream? What we did was made use of the flood space in Caballo, called the corps and asked for a cut in releases from Cochiti, cut the release from Caballo and Elephant Butte, and waited for the demand to pick up again. The IBWC was tolerant of this operation, and I thank them for that.

Another gray area is the amount of flood space needed in Elephant Butte Reservoir. In 1985 we operated with 100,000 acre-feet of flood space. In 1986 we had a goal of maintaining 50,000 acre-feet of flood space. In reality, we operated in the 30,000 acre-feet range. The flood space got as low as 17,000 acre-feet at one point in May.

A third gray area we encountered was whether to use the coordinated forecast to operate our reservoirs or not. There was one point in 1985 when we had more water in hand in the reservoirs than what the runoff forecast indicated.

We handled this by preparing several operating plans, one with the published forecast and another with a higher runoff to reflect a reasonable range.

A fourth gray area surfaced at the last Rio Grande Compact meeting in March 1986. There was not a clear definition of what constituted a spill at Elephant Butte. There were also accusations that we in the Rio Grande Project were manipulating releases to try to prevent a spill in 1986. I believe there are some people who are still suspicious of us this year too. As a result of these concerns, we intend to fill Elephant Butte to the top on the first of January and have a physical spill before we start evacuating for the 1987 runoff.

During these past years we have set some records:

1. Record for power generation in one month--July 1986;
2. Record for annual net power generation in 1985;
3. Highest release from Caballo since 1942 (7/17/86 3,640 cfs);
4. Highest storage in Caballo since 1947 (3/29/86 4,177.13 feet, 277,900 acre-feet);
5. Highest storage in Elephant Butte since 1942 (5/5/86 4,406.53 feet 2,093,000 acre-feet);
6. Most release from Elephant Butte for a year since 1942 (1,232,000 acre-feet in 1986), third highest on record (1,830,000 in 1942 and 1,270,000 in 1917), (1,232,000 acre-feet in 1986);

7. Flow at Ft. Quitman in 1986 will be over 600,000 acre-feet, 1912 was 1,070,400 acre-feet, 1942 was 1,270,400 acre feet; and
8. Expect 410,000 acre-feet excess release in 1986. Expect 360,000 acre-feet spillway flows in 1986. A total of 880,000 acre-feet was released for flood control in 1942.

It appears that some of my predecessors did not expect the reservoirs to get this high again. The Caballo boat launching and parking area was built below the high water mark; the pipeline for the sewage treatment facilities at the damsite marina is under water and filling with water; and many cabin lease lots at Elephant Butte are at the water's edge, some relocated. Even our office at Elephant Butte was built directly across from the spillway and had to be protected last year.

One of the priorities for 1987 will be to try to move water out through the lower end of the Rio Grande below El Paso. After 40 years of no flow, we seem to be a bit constipated.

Looking back, I think we did an excellent job of managing the river. A potentially dangerous operation is the carryover of all this water to next year to ensure a spill for Rio Grande Compact purposes. A more prudent operation might be to continue to evacuate excess water

during the winter to provide more flood protection.

Regarding the flexibility of operating rules to accommodate the desires of additional water users, I would say that we have tried to accommodate all the water users. We have achieved water conservation flood protection for T or C and Hudspeth. Recreation has been great this year, and fish spawning at Caballo was greatly enhanced.

In summary we need to work together, make our concerns known, and look at the problems from others' perspective, and try to work out the best solution.

ALBUQUERQUE AND THE RIO GRANDE

Gary Daves

Policy Planner

Public Works Department

City of Albuquerque

This talk will be broken into two general areas. The first will be a short discussion of Albuquerque's legal and physical relation with the Rio Grande given by the city water and wastewater systems and also Albuquerque's physical and aesthetic relation to the river as it passes through here. The legal relation has created the imperative that Albuquerque acquired San Juan-Chama water which creates the basis for the city's involvement in the river upstream and down, as will be discussed in the second part. The second part will be more directly to the point of this conference; the ongoing management of the river, particularly in this era (characterized by the conference brochure) of "water surplus." I might note that throughout this presentation, the use of the word "river" includes the Rio Grande and its tributaries.

City Water and Wastewater Systems

In a 1980 Albuquerque Tribune article, Steve Reynolds, New Mexico state engineer, wrote in a column regarding the city of Albuquerque's water supply that the "well-known

intimate relationship between the aquifers of the Rio Grande depression and the surface flow of the Rio Grande is at the same time a blessing and a constraint." The blessing is from God the creator. The constraint is from God the water manager, Steve Reynolds. The creation is recorded in Genesis 1:1. The constraint is found in the scripture of City of Albuquerque v. Reynolds, recorded in 71 NM 428, 379 P2d 73 (1962).

The New Mexico Supreme Court's ruling in City v. Reynolds to uphold the state engineer provides the essential legal link between the city and the Rio Grande. Because of water law in New Mexico, as exemplified by this case, and the fact of the hydrologic relation between groundwater pumping and fully appropriated surface flows in the Rio Grande basin, the city's consumption of water (which has historically been exclusively from wells) is strictly controlled and regulated based on the river. The city's water rights, vested before declaration of the Rio Grande Underground Water Basin in 1956, translate into the right to diminish the surface flows in the river by the amount of the rights. This amount was originally determined by measuring the city's total annual pumpage at the time of declaration of the basin less the 50 percent return flow to the river by way of the city wastewater system. The effect on the river from wells some distance from the river lag behind the time

of pumpage. This lag can be many years, depending upon distance of the pumping from the river and the transmissivity of the material containing the groundwater.

The state engineer determined the city's vested rights based upon its consumption (total pumpage minus return flow) but has allowed the city to increase its consumption in excess of its water rights because the consumption lags behind the effects on the river as I also understand it because the city may acquire water rights by eminent domain. He will require the city to have acquired and to retire additional water rights (or augment river flow as with the city's San Juan-Chama water) as the effects of city pumping in the river exceed its rights.

A few numbers might be of interest as they relate to the city water and wastewater systems' historic, present, and projected effects on the surface flows in the Rio Grande. In 1956, when the basin was declared, total city annual pumpage was about 36,000 acre-feet with half of that returning to the river by way of the wastewater system. Thus the city was granted some 18,000 acre-feet of vested rights. However, because of the lag between pumping and the effect on the river, the net effect of the city on the flow in the river was positive at that time (i.e. return flow from the city exceeded the drawdown on the river caused by the pumping) and has been until the last few years. Since

about 1976, the effect of the city's activities have depleted surface flows. In 1979, depletion was 2,900 acre-feet and in 1985 about 11,000 acre-feet. This last number compares to pumpage of 101,692 acre-feet by the city in 1985 and return flow into the river of one-half of that.

Several obvious points can be made from this. First from the 1950s until about 1976, the city has actually been augmenting rather than depleting flows on the river downstream. Augmentation is the result of the city's rapid growth away from the river and placement of wells further from the river and the quick return of half the water pumped by way of wastewater outfall into the river. Second, net effect of the city on the river does not yet equal its right to affect the river and will not until sometime in the 90s. This means there will have been about a 40-year lag between the river having been debited by the amount of the city's vested rights and the maturation of that debit as reflected by actual flows on the river. Third, notwithstanding this ultimate net drawdown on the river, the city by way of return of treated wastewater to the river provides a fairly constant minimum flow to the river downstream from the wastewater plant outfall. For example, the city now treats and returns to the river about 44 mgd, which translates to a 68 cfs flow, or about 50,000 acre-feet per year. This steady flow will increase with increased

pumpage of water by the city. Finally, the city's effects on the river are increasing very rapidly. Projections are that the city's net annual drawdown on the river will be about 30,000 acre-feet in the year 2000. That brings us to the city's San Juan-Chama water.

The city in its wisdom, and in a series of decisions and commitments in the 50s and 60s culminating in a contract with the U.S. Bureau of Reclamation in 1963, has the rights to a share of water diverted from the San Juan Basin to the Rio Grande by way of the Rio Chama. This wisdom was undoubtedly in large part promoted by Steve Reynolds' declaration of the basin and the definitive affirmation by the Supreme Court in 1962 that the city could no longer freely appropriate water for its increasing consumption. Under the contract, the city receives an annual allotment of 48,200 acre-feet of San Juan-Chama water.

The ultimate use of this water by the city will be to offset the city's effects on the river in excess of the city's rights. Thus, sometime in the 90s when effects exceed city rights, the state engineer will require the city to begin running amounts of San Juan-Chama water down the river to offset the deficit. City projections indicate that this deficit will increase at a rate such that by around 2030, the full 48,200 acre-feet will be needed on an annual basis. Following that, the city will have the task of

acquiring and retiring additional water rights at an awesome pace. It's a scary prospect, if it's possible to be scared about something some 40 years in the future. Accordingly, the city, upon the admonition of Mr. Reynolds, actively purchases existing surface and groundwater water rights in the basin. Mr. Reynolds has estimated that non-Indian irrigators in the mid Rio Grande Valley (between Cochiti and Elephant Butte) have consumptive rights of about 128,000 acre-feet, acquisition of which he sees as the way to accommodate increased domestic use and industrial growth in the basin.

A resource management program is being implemented to develop several strategies including conservation, and postponement of water usage, groundwater recharge with San Juan-Chama water, development of new water sources if possible, and ways to acquire existing rights. In the interim, the city has the mixed blessing of 48,200 acre-feet of water it's trying to find some place to put in storage and to beneficial use. During this time, and with this water, the city is a participant in the water in the river.

What is the river's physical and aesthetic relation to the city? We hope it is, on the whole, and will increasingly be, a mutually beneficial co-existence. The river, its valley, and the Sandias are the key geographical determinants of the city. The city exists here because the

railroad was built between the river and the mountains. The river in Albuquerque and its environs is a ribbon of bosque and semi-rural green belt of agriculture and gentlemen farmers. It is more than just a place to argue interminably over where or whether to put in a bridge. Hopefully, its bosque will become less and less a place for clandestine dumping of trash and junk and other destructive activities. Existing facilities in the city made possible by or enhanced by proximity to the river include the beautiful Albuquerque Zoo, the state operated Rio Grande Nature Center, Tingley Beach and numerous other parks and recreation facilities. At the instigation of, and with the support of the city, the 1983 State Legislature authorized creation of the Rio Grande Valley State Park, which consists essentially of Middle Rio Grande Conservancy District (MRGCD) land contiguous to the river in Bernalillo County. The park now legally exists with the city as the operating party. With the development, adoption and implementation of a Park Management Plan, realization and preservation of the aesthetic, wildlife, wetland, and recreational values of this area can be achieved, in a manner consistent with the interests of the MRGCD and the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation.

To conclude this point, the city tries to be a good neighbor to the river, which over millenia has created the

bountiful aquifer that is the city's lifeline. The river is more than just plumbing. The river, its bosque and its valley define the city and its character; the city in turn must preserve this magnificient resource as well as be sustained by it.

Management of the River: City Role and Perspective

The city is a marginal actor in the river drama and has particularly been so during these years of wet weather and high flows, which are perhaps best characterized by noting the unprecedented spills in Elephant Butte Reservoir that we are experiencing.

That the city is a marginal actor on the river is two-faceted. First the chunk of San Juan-Chama water it receives annually (48,200 acre-feet) is a relatively small amount of the flows on the Rio Grande and its tributaries. This is particularly true in comparison with the high spring and summer runoff from snowpack and the extensive runoff from thunderstorms that we've experienced these last years.

Second, the city must take care of its water under the law of the river -- the Byzantine web of Interstate Stream Compact, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers' rules that govern river management -- and the river sheriffs: Mr. Reynolds, Mr. Gilmer, and Mr. Danielson, and their not totally compliant deputies, Mr. Charlie Calhoun, Mr. David Overvold and Col. Peixotto. In

this far from definable hierarchy of control, the city is not a manager but rather more a client among many on the river.

But as a minor actor, the city and we who manage its San Juan-Chama water, are in a position to observe some of what's going on in river management. And we not infrequently have either placed ourselves (for example, requesting the resumption of the Abiquiu Storage Study), or been placed by others, as a factor of more or less importance in decisions or policies on the river. I think, however, that any perception of a particularly key role for the city on the river is mostly illusory. The back of the city cannot by itself support a decision to authorize increased conservation storage in Abiquiu. If such ought be done, it must make sense from a state and a Rio Grande Basin (including all three Rio Grande States) perspective, as will be discussed. And the city's actions cannot assure that the Adobe Ruins take out point on Abiquiu is high and dry each spring. A little more on this later, also.

Before I go into a few specifics of my impression of the management of the river and some comments regarding beneficial niches the city might fill or assist in its management, let me give you my philosophical perspective for the comments. As the Rio Grande and its tributaries flow from the New Mexico and Colorado mountains south through the

length of New Mexico, and through the Texas/Mexico border to the gulf, it shares and grants its benefits of water and beauty to the land it passes. It passes no islands, and the city of Albuquerque is no island of interests to be placed ahead of and in derogation of others. The city does not view the river as a battleground of interests, but rather a community of interests that should be shared with equity. Thus, we are not interested in adversaries, particularly an adversary chosen for us by others. We are not interested in advantages gained at the expense of others. And we don't make decisions affecting the river just because citizens (and voters) of Albuquerque are narrowly benefitted, but hopefully because the decisions make sense to both us and the river community at large, upstream and down.

With that testament to city sainthood out of the way, let me temper what I've just said with the imperative that what the city does with its customers' San Juan-Chama water must be consistent with their interests. I might note that up through today, the city has paid about $10 million for the San Juan-Chama project. The city's costs this year are $1.7 million, which translates to a charge of about $15 per year per city customer or account for water. Not a drop of this water has been used for the city system.

To my mind, the wet years themselves and the massive amounts of water that the river has had to accommodate have

been the major determinant in the management of the river. To that extent, institutional/jurisdictional prerogatives and niceties have of necessity had to take a back seat. During this time much water has gone downstream. However, it has been controlled such that all but minor flood damage to communities in the river has been prevented and the reservoirs filled as never before. And so far as I am able to determine, this control has been exercised with due regard for the multitude of concerns and constituencies of the river. Certainly the city has no complaints regarding the fate of its San Juan-Chama water through this time. For example, by the stroke of a pen the commissioners moved city water in Elephant Butte upstream to Abiquiu to prevent it being spilled during the paper spill of '85.

There has been excitement, drama, and controversy during this time. Of the controversy, I think it has been on the one hand the natural inclination to blame men and institutions for events forced by nature. On the other hand, those decisions have received more attention than the impacts of those decisions deserved.

There are two major complaints and concerns: 1) Too much flood water was retained in upstream reservoirs (notably Cochiti and Abiquiu) far too long, leading to damage to land and the river upstream, and related to this; 2) the accounting transfer of the 50,000 acre-feet State

Recreational Pool and the city San Juan-Chama pool in Elephant Butte to Abuquiu to prevent their loss by spill. This paper transfer added that increment of impact of flood waters in Abiquiu.

I must tread carefully here, for I have not studied the ins and outs of these actions as much as the managers and the opponents of these actions have. I do believe the essential fact of this situation was that these reservoirs have had to, in this wet era, be used for the reasons they were built, and were raised to unprecedented levels. This resulted in some unfortunate, but not devastating, effects to land or the river.

By specific act, Congress provided for the pool and its maintenance for 10 years. The compact commissioners and the U.S. Army Corps of Engineers creatively sought to maintain what Congress created. I'm not so sure but that it didn't make sense at the time. Creative, but illegal. I would only note that the corps says it was legal, and that I am sure there are many lawyers who could persuasively argue either position. At any rate, I would say that the increment of negative impact of this arguably meritorious action has not deserved the heat and noise and recriminations of the opposition to it. Nature has conspired with this opposition and the recreational pool has been lost. Nature again has been the ultimate determinant.

I alluded earlier to the ongoing study regarding the possibility of allowing increased conservation storage in Abiquiu. The city's position is open and has been disseminated to both opponents and proponents of the proposal, so I will not go into detail here. I will highlight three points. First, those who wish the additional storage, including the city, should be willing to and be able to justify paying the real costs of such storage. It remains to be seen whether the city by itself can meet this criteria. Second, the benefits (economic and aesthetic) of such storage should outweigh the detriments (economic and aesthetic) -- (aesthetic meaning here all tangible and intangible things of value that are not quantifiable in dollars). Neither the corps nor Congress should be asked to make this kind of local decision without direction from those affected. Finally, as I understand it, the largest impediment to the value of increased storage in Abiquiu for holders of Rio Grande water is restrictions under the compact. Surely, those, who by the stroke of a pen, can move water hundreds of miles upstream, should be able to creatively obviate this obstacle and do so without great harm to this bible of the river.

Whatever the city might have done prior to and in the spring of '85, the Adobe Ruins rafting takeout would still have been flooded that year. In subsequent years,

assuming a possibility for city action to realize this goal, we will remain willing to cooperate, even to the extent of enduring some losses by transfer or transport of city water, given the water glut situation. But as a general proposition, we think that any losses of water that would not otherwise be lost immediately or ultimately ought be borne by the state (with the proportionate city contribution by its citizens' taxes to any state money) through direct compensation to the city, and not exclusively by the city water rate payer. If drawing down Abiquiu for this reason is of overriding value, those deriving the value (meaning the state and its citizens) ought to be willing to pay for it.

There is another niche the city with its San Juan-Chama water might fill. I understand that there have been occasions where minimum flows on the Rio Chama have not been maintained for short periods of a few hours or a day or two. Maintaining minimum flows is certainly not a problem during this wet era. Assuming that there would be legal destinations for the water, the city would consider arrangements to allow some of its water to be used for creating minimum flow. Again, to the extent this would create real losses of water, compensation by the entity benefitted (the state) would be appropriate.

What are we doing with our San Juan-Chama water, while

we don't need it directly? I would hope we use it with some common sense and in the spirit of a river we all share. During these years the water is available for more than just offsetting city depletion of the river. This water is a state resource -- a basin resource and should be used as such.

As a matter of policy, the city holds this water available for beneficial use within the state in the basin. Any income derived from this is dedicated to acquiring additional water rights, but income is not our only goal.

One prime example of putting this water to use and from which the city got a hefty chunk of income is the permanent recreational pool. The state agreed to maintain the permanent recreational pool in Elephant Butte Reservoir by making up evaporation losses on the pool through the year 2020. In addition the city agreed to accommodate summer weekend rafting by releasing city water to raise flows in the Rio Chama between El Vado and Abiquiu reservoirs to raftable levels. In return for this agreement the city received some $2.3 million the state had available for maintaining the recreational pool. As it has turned out, the unprecedented three years of spill of Elephant Butte Reservoir have resulted in the loss of the full State Parks Recreation pool. Consistent with, and in the spirit of the agreement, the city will make all efforts to assist the

state in reconstituting the pool as it becomes needed. The extraordinary wet cycle we are now in has also frustrated the city's ability to make the rafting releases. As we enter a more normal precipitation regime and room appears in Elephant Butte, the city also will have flexibility to accommodate this interest. Several other instances illustrate the city's cooperation with other agencies on the use of San Juan-Chama water. For several years the city has had some of its water in the MRGCD's El Vado Reservoir and has made some of this water available to the district for its use. This cooperation continues.

With a touch of city generosity (and little choice), and a little bit of Steve Reynolds/Phil Mutz hornswoggling, the city agreed to allow its water to be used by the Interstate Stream Commission to fill the sediment retention pool in Jemez Canyon Reservoir. As fair warning to Mr. Reynolds and Mr. Mutz, the city considers this transaction to have been a loss leader financially and hopes to wangle money out of the situation by making up evaporation and seepage losses on this water in the future.

The city has, at no sacrifice, routinely and gladly consented, with other San Juan-Chama contractors, to postpone delivery of its San Juan-Chama water from Heron Reservoir to minimize disruption of spawning on the Rio Chama fishery. City water, as many of you may know, has

allowed the development of vineyards and wineries east of Elephant Butte at Engle. Europa Vintner, one of the wine growers, won the overall wine championship at this year's state fair with a sparkling wine (champagne). Vinter has produced more than 50,000 bottles of this marvelous champagne. In addition, the city has agreements with other water purchasers, (nurseries, mobile home parks, small developments, small industrial operations) who buy water in bits and driblets. These sales allow them to meet their water needs without having to buy expensive water rights.

The wet cycle has limited the city's ability to manage and even take delivery of all its San Juan-Chama water. However, speaking as one who has been a New Mexican for 40 some years, I know that New Mexico is still essentially a desert and that water is valuable. On the other hand, I should note that the city has no policy of taking delivery of its water against all reason, economic and otherwise. I anticipate that the Albuquerque Public Works Department will shortly initiate a marketing study to see if it is feasible to market or otherwise put to use more of the city San Juan-Chama water that is not now needed, given the many limitations on its use. Without some success in this effort, there may be years when we and the state lose this water.

To conclude, I hope and think the city is not totally

self interested, narrow-minded, and that it can and does look past the end of its nose, to the extent city decisions affect the river. The city must look out for its citizens' interests, but with regard to the river, these interests must be shared with the whole community up and down the river, just as the river is shared. We are trying to treat the river as it deserves and as our citizens deserve.

THE EVOLUTION OF THE MIDDLE RIO GRANDE CONSERVANCY DISTRICT

Ray Shollenbarger Jr.
Attorney
Middle Rio Grande Conservancy District

The original Conservancy Act of New Mexico was enacted by the Legislature in 1923. The Conservancy Act made possible the formation of districts with the ability to make assessments for drainage, flood control, and irrigation. The Middle Rio Grande Conservancy District was formed by a small group of businessmen who desired to improve land values and stimulate the economy in the Middle Rio Grande Valley. Over a period of four decades, the irrigated land in the Valley had decreased by approximately 68 percent. Rising ground water caused water logged soil, alkaline and seeped areas. With the creation of the Middle Rio Grande Conservancy District and the construction of the drainage system in 1930s, the lowering of the water table was generally accomplished.

By 1936 the district has completed construction of El Vado Dam in northern New Mexico in order to have facilities to store water from early spring runoff for use by the irrigators in later summer when the flows of the Rio Grande diminished. The district also constructed four major

diversion dams, 190 miles of levees, 350 miles of drains and 250 miles of canals. This construction and the construction of the drainage system provided better control of the river and nearly doubled the irrigable land in the Middle Valley.

With the construction of Elephant Butte Dam in 1917, and the filling of this dam, the district faced new problems. The river channel above the lake filled with silt and no water would pass into Elephant Butte. Under the terms of the Rio Grande Compact, New Mexico was required to deliver to Elephant Butte approximately 58 percent of the Rio Grande water that passed through Otowi. If these deliveries were not made, there was a water debt owed to the state of Texas. In a debt situation, the district could not use the storage facilities at El Vado, or any other dam that it might construct. The district was destined to rely on the natural flows of the Rio Grande River. The district was not able to use the storage facilities of El Vado from the 1940s until recently. In the dry years the district contracted for water from the transbasin diversion of the San Juan River and borrowed water from other San Juan Chama contractors who had no present use for their water. The district used this water as supplemental water for its irrigators as best it could. However, many years there was not adequate water available.

When the district began the construction of its

facilities, it issued approximately $8 million in bonds. By the mid-1940s, refinancing was required because all of the bonds were in default. The financial problems and the silt build up at Elephant Butte lead the district to enter into a contract with the U.S. Bureau of Reclamation in 1951. The ultimate benefits of this contract were: the channelization of the Rio Grande River for approximately 45 miles north of Elephant Butte to increase water deliveries to Elephant Butte; the payment of the outstanding bonds and a new loan from the federal government without interest; an upgrading and modification of its works; and an upgrading of the assessment procedures in the district.

The U.S. Bureau of Reclamation operated the Middle Rio Grande Conservancy District from the mid-1950s until 1975, when the operation and maintenance of the district was turned back to the district.

The last few years of the high flows in the Rio Grande have discharged the water debt owed to Texas and allowed the district to store Rio Grande water, but it has not needed to make use of this stored water because of the high flows in the river. If the recent high river flows cease, the district will again be relying on San Juan-Chama waters to provide waters to its irrigators.

MANAGING AN IRRIGATION DISTRICT

William J. Saad

Treasurer-Manager

Elephant Butte Irrigation District

I would like to thank Dr. Bahr for saving the Elephant Butte Irrigation District for the last presentation of the morning. It is understandable to save the best for last and I am only cooperating with his wishes. We are the largest, most prosperous and successful irrigation district in New Mexico and West Texas. We have the greatest agricultural yields and profits in the state. We are the stronghold of agriculture. The green belt that runs south of Elephant Butte Dam to the Texas state line is proof of our successes and accomplishments.

INTRODUCTION

The Elephant Butte Irrigation District (EBID) is a quasi-municipal corporation organized in August 1917. The EBID has succeeded to all the rights, powers, privileges, liabilities and assets of the Elephant Butte Water Users' Association. That association was the corporation that made the original contract for the construction of the Rio Grande Project under the U.S. Reclamation Law.

An irrigation district is a public corporation, functioning for the purpose of public improvements rather

than for governmental purposes. It is organized under a state law and is, therefore, a political sub-division of the state and possesses most of the powers and privileges of county or city governments. The powers and duties of its officers and directors are strictly defined by statute.

RELATIONSHIP BETWEEN THE RECLAMATION SERVICE AND THE DISTRICT

The U.S. Reclamation Service now has complete control of the storage, drainage and distributing system of this district with title to all canals, rights-of-way, structures, reservoirs, etc., vested in the United States and held for the benefit of the water users and land owners of the district. The United States is proceeding with the construction and completion of such drainage and irrigation works under contract with the EBID. The contract calls for the expenditure of $6,530,000, of which nearly $5,000,000 has been spent. The U.S. Reclamation Service also is operating and maintaining the works under annual water rental contracts.

The chief function of the district in the past (as a Water Users' Association) has been, and in the future will be, representing the landowners as a legal entity in negotiating with the United States. A second function now growing rapidly in importance is the levy and assessment of administration, operation, maintenance and construction

charges. Ultimately, of course, the district will take over the control, operation and maintenance of the completed works.

RESPONSIBILITY OF ELEPHANT BUTTE IRRIGATION DISTRICT

The EBID is part of the Rio Grande Project, which is responsible for the surface waters of the Rio Grande, commencing 4 miles south of Caballo Dam and diverted by the three major diversion dams within the boundaries of the EBID. The actual size in the district is 133,000 acres but federal law currently allows the EBID to irrigate from surface water rights, 90,640 acres. The district has 90,639.48 acres on the tax rolls. Our tax assessor has already guaranteed us that we will have 90,640 acres next year. We now have a waiting list for 700 acres from people wanting to receive EBID irrigation water. However, we are at our maximum acreage. When we receive suspensions, we resolve the names on a first come, first serve basis.

The philosophy of the district and its elected officials is to encourage agriculture and its benefits in our community. We do not insist on immediate urbanization but rather on a planned progressive movement to balance the urban/rural need of the constituents. The agriculture demand for irrigation water is apparent from the long list of those waiting to get into agriculture. The profitability of our farm products also speaks for the

success of agriculture. For example, in 1985 the yields and the per acre revenue for the EBID were $1,403 per acre compared with $700 for the El Paso County Water Improvement District and $588 for the Hudspeth County Water Resources District.

STRUCTURE OF ELEPHANT BUTTE IRRIGATION DISTRICT

We service 328 miles of laterals and canals and more than 200 miles of drains. To accomplish the tasks of servicing the farming community in the EBID, we employ from 96 to 106 people at the peak time of irrigation. During the 33-week irrigation season we are on duty 24 hours a day, seven days a week in 11 geographic areas. In addition, our dispatchers work alongside our operations personnel, receiving orders, contacting ditch riders and logging others into the computer.

During the irrigation season, the accumulated water orders are placed with the Bureau of Reclamation. The farmer is then alerted to the time the water will be ready and when and where to expect the ditch rider. He will also be told the amount of water he is to receive, the beginning and ending delivery times, and the amount of water used. Monthly during the season, the EBID furnishes the farmer with a bank statement. The statement shows his beginning allotment, amount used, ending balance, and the year-to-date data by crop and water usage. Disputed charges are metered

and upon request, any farmer can receive an individual or permanent metering request. Our contact with the farming community and our ability to deliver services satisfactorily has led to a minimum of metering requests.

At the completion of the irrigation season (or upon request), a constituent can receive a complete owners' history, giving him the entire water season at a glance. The computerized history tells the farmer the day and time he placed the order, how much he received, when he received the order and when delivery was complete. This computer program answers any questions concerning services.

The cost to the farming community is based on a formula that has been followed successfully in the past. In a full allotment year, the taxpayer is billed a fixed amount per acre for the first two acre-feet of water. After that amount is consumed, the constituent can purchase an additional amount at an additional charge per acre-foot. For example, the 1987 irrigation season will provide the farmer with 2 acre-feet at $25; an additional 2 acre-feet for $5 each, or $10; or 4 acre-feet for $35. The total cost runs $8.75 per acre-foot. The EBID has been able to hold the basic $25 rate since 1982.

Annual reports were a regular occurrence at the district in previous years. The reporting process was stopped in the 70s but was re-initiated in 1979 when the

District took over operations and maintenance responsibility from the Bureau of Reclamation.

In an annual report to the farmers the following was presented:

-- the best water supply in America.
-- the best climate in the Southwest.
-- the best soil in the Southwest.
-- the most successfully drained lands.
-- the lowest water rates in the Southwest.
-- the cheapest farm labor in the West.
-- the most miles of concrete paving and graveled roads in the state.
-- the best educational facilities in the Southwest.
-- the best railroad facilities in the Southwest.
-- the best markets in the Southwest.
-- one of the greatest irrigation, drainage and storage systems in the world.
-- the strongest farm organizations in the Southwest.

These Facts to Remember were printed in an annual report and are still in existence today. The only interesting facet of these facts is that they occurred in 1920 in the Report to Farmers. At that time it was a dream

and not a reality as it is today. We have grown through this dream into an irrigation district unsurpassed in our area in revenues, profits and overall efficiency.

RECREATION AND WATER - POOLS AND FLOWS

Robert M. Findling

Deputy Director

New Mexico Department of Natural Resources

I would like to preface my remarks by referring to Nolan Hester's talk regarding the conflict between the water management insiders and outsiders by saying that if Gary Daves of the Albuquerque Water Resources Department thinks of himself as an outsider then the people on this panel must be extraterrestrials. I also would like to say that the inclusion of a panel of this type with representation from natural resource agencies at New Mexico's Annual Water Conference represents real progress.

The recreation industry in New Mexico is a huge, rapidly growing, but largely unrecognized part of the state's economy. Colorado's recreation industry which, like New Mexico's, is largely water dependent, is estimated at $4.5 billion dollars. New Mexico's travel, tourism and recreation industry is in the $1.9 billion dollar range. The recreation and tourism industry in New Mexico is alive and healthy while the state's mining, oil/gas and agricultural industries are depressed.

Recreational water uses are almost totally overlooked and unprotected under New Mexico's present system of water

law and policy.

The water needs of the recreation industry, which are often non-consumptive, are in many instances not in conflict with the requirements of the state's irrigation districts or municipalities. The rafting industry, interestingly could be in better shape as a result of dams, if the release patterns from those dams could be modified to better enhance recreational water needs.

It has become clear that although the recreation industry must piggyback on other water uses, (rafting, skiing, fishing, hunting, hiking, and sightseeing) those uses generate income in the same ballpark as agriculture, logging or mining. However, recreational uses depend upon water - water in streams, reservoirs and shallow aquifers to maintain wetlands and marshes.

It is interesting to note that Colorado's eleventh annual water workshop this year chose the theme, "Water and Colorado's Recreation Industry: Beauty, Bucks and Beneficial Use." I think it's clear that New Mexico's priorities relative to water management have yet to evolve in the same fashion as our neighbor to the north. More importantly, it has not evolved in the same fashion that our economy has. The doctrines of prior appropriation and beneficial use have not served to protect New Mexico's recreational industry or its environment.

How can New Mexico maximize the economic benefits attained from its water resources? I believe the solution does not lie in an abandonment of the doctrine of prior appropriation. However, we must recognize that the water originated in a stream or river before it was impounded or diverted. While some real progress has been made in negotiating releases for recreational boating and to reduce fishery impacts, these programs need to be broadened and made a component of the water management equation in New Mexico. If the same level of ingenuity and imagination that has been placed on capturing and using New Mexico's water surpluses the past few years was brought to bear on the equally important issues of recreational water use, New Mexico's economic woes might not be as serious as they now are. Many of the major water projects in the Rio Grande system were developed prior to enactment of the National Environmental Policy Act (NEPA). In some cases the management of these projects could be significantly improved by a thorough analysis of their impacts with an eye toward improved operation.

The importance of recognizing instream flow water rights has in many respects diverted, no pun intended, attention from what I feel is a more realistic and practical means of addressing this issue.

In the case of the San Juan River, Navajo Dam created a

blue ribbon fishery which has become an important part of the management equation for that river because of its popularity and importance both as an economic and natural resource. Unfortunately while the same potential exists on the Rio Chama, it has gone largely unrealized. However, if the river's fishery potential were developed, I don't doubt that it would receive the same degree of "administrative protection" as the San Juan.

The challenge for the water management community is that once the resource has been developed it has to be managed and protected. Management of recreational use can complicate management for more traditional agricultural and municipal uses which now receive 99 percent of the "managerial discretion" available under current water law and in the state's water management system. What is now needed is a change of thinking and management practices so that recreational uses can be fostered and developed. I believe that sufficient "managerial discretion" exists to accomplish this goal without major changes in the state's water law.

The solution does not lie in transferring water rights from irrigated farmland in order to create a recreational pool in a reservoir, (thereby sacrificing one economy for another) with financing provided by the state's severance tax bond fund. I believe water rights transfer is an

expensive substitute for improved management, when by modifying our management strategies we can improve both sectors of the state's economy. However, I would be remiss if I did not point out that there are many streams in New Mexico whose recreational uses are impacted by agricultural diversions and poor quality agricultural return flows that may only be protected by the transfer of water rights to preserve instream flows. Whether this is either practical or possible will have to be the subject of someone else's presentation at a future water conference.

Several other important facts have become clear as a result of the surplus flows in the Rio Grande system this year. First, flood control in one location means flooding in another. This fact became graphically clear when additional water held at Abiquiu Reservoir inundated the lower section of the state's only scenic and pastoral river.

Second, more water doesn't necessarily improve recreational opportunities, even in dry New Mexico. The primary interest of the water management hierarchy was to convert flood water storage to conservation storage. However, little consideration was given to improving recreational flows that most likely could have been achieved. Also, the filling of Elephant Butte Reservoir to its spillway elevation has caused the loss or destruction of many of Elephant Butte Lake State Park's recreational

facilities.

Third, water, even inexpensive water, isn't always marketable. This fact was illustrated not only by the surplus in the Rio Grande system but also by the earlier surplus that occurred in the Colorado system. Albuquerque continues to be frustrated in its attempts to sell it's surplus San Juan-Chama water even at bargain prices.

People who use water recreationally are willing to pay reasonable user fees for the privilege. Whether the fee covers the total cost of this nonconsumptive usage will depend upon the number of users and how the costs are defined. This year's first recreational releases on the Chama were reasonably successful but would have been more so if the releases were more predictable and if the U.S. Bureau of Reclamation would have initiated Sunday releases three hours earlier in order to compensate for downstream flow delays. If costs are involved, users are willing to pay reasonable fees.

The U.S. Army Corps of Engineers has adapted well to Gramm-Rudman-Hollings by biting the cost-sharing bullet. The Abiquiu Reservoir expansion project will go a long way toward determining how much cost-sharing it will take to kill what many view as a boondoggle. If the users won't pay, then the benefit of this publicly financed dam should be focused on the public with river based recreation being

recognized as one of those benefits. Recreational benefits are almost always a part of the cost-benefit justification for the construction of a new project. Somehow though, recreational benefits never seem to become a part the project's management framework after it's been constructed.

And finally, the relative importance of a minimum pool to recreational benefits can be determined only by the surface/capacity characteristics of the reservoir and the aesthetic impacts that low reservoir elevations have on recreational use.

In keeping with the long held axiom of western water law that "Water is for fighting, liquor is for drinking," I thought it would be timely, although potentially self-destructive, to discuss some of my views relative to a real "sacred cow" of New Mexico water management -- the Elephant Butte minimum pool. I think it's an appropriate time to put the minimum pool into perspective. You may have noticed that I didn't say the Elephant Butte "recreational" pool because the pool at Elephant Butte has very little to do with recreation. However, it does have a lot to do with agriculture and potentially public health. The Elephant Butte Irrigation District (EBID) is placed in an extremely difficult position without the minimum pool in Elephant Butte Reservoir. Because if they drain the reservoir in order to save their crops they potentially cause a

significant fish kill with all of its associated public health and economic implications.

While some 400,000 acre-feet of flood water has flowed past Fort Quitman, Texas, this year, only the 50,000 acre-foot pool from Elephant Butte was accompanied by hand wringing and mourning. The New Mexico Department of Natural Resources, the State Engineer Office and various federal agencies have primarily, through sleight of hand, mirrors and some extraordinarily innovative maneuvering, shuffled the Elephant Butte minimum pool to Abiquiu and Cochiti reservoirs the past two years. However, this year the burden of surplus water in the Rio Grande system was simply too great and the pool has been temporarily lost. Ultimately it will be recovered under the terms of the Department of Natural Resources's contract with the city of Albuquerque, which provides evaporative loss protection for the pool through the year 2010. This recovery is due to the fact that because the pool is gone, it can no longer suffer evaporative losses. Therefore, the approximately 6,000 acre-feet that would normally evaporate from the pool in Elephant Butte Reservoir can be used to recover the pool in continuously decreasing amounts until the pool is restored. Unfortunately, as a result of this year's high water there is no storage point where that recovery process can begin, for as soon as the 6,000 acre-feet is delivered, it will

also spill as well.

The Elephant Butte pool has an interesting history. It was originally authorized in Public Law 93-493 in 1974. However, it's authorization was subordinated to any other San Juan-Chama water use and also to the recreational pool in Cochiti Reservoir. Also its protection from evaporation and transport losses was only for 10 years with an expiration date of 1986. In addition, the Elephant Butte pool was required to spill from Elephant Butte Reservoir before the spill of "native waters." Thus, its existence while hard fought was tenuous at best. In 1978 and 1979 the New Mexico State Legislature appropriated $2.5 million dollars for the acquisition of water rights to provide continued protection for the minimum pool. Sounds reasonable doesn't it, maybe a bit expensive, but let me fill in some of the blanks.

Although 6,000 acre-feet are required to offset evaporation from a 50,000 acre-foot minimum pool, approximately 8,600 acre-feet of pre-1907 water rights (4.5 square miles) would have to be purchased "as is, where is" in order to deliver 6,000 acre-feet to Elephant Butte after transport and ground water recharge losses are deducted. This translates into 2,866 acres, or 4.5 square miles, which clearly is a lot of irrigated agriculture in a state like New Mexico.

Land ownership patterns are such that the acquisition of 8,600 acre-feet would require 200-300 separate real estate transactions at what would most likely be an incredibly high administrative cost.

Elephant Butte Reservoir since constructed in 1916 or 1917 has only dropped below the 50,000 acre-foot recreation pool level six times during the normal recreational season (April to December). These events occurred in 1951, 1954, 1956, 1964, 1971 (one month), and 1972 (one week).

The 50,000 acre-foot recreational pool is far too small to offer any real recreational benefits in a reservoir the size of Elephant Butte because at that size the boat ramps will not be operative nor will the fishery be a productive or viable one.

The current cost of pre-1907 water rights, which are the only type that can be transferred with any reasonable chance of success, is approximately $1,200 per acre foot. Thus, the full acquisition program would cost in excess of $10,300,000. This figure assumes that water rights would not increase in price during the term of the purchase program, which obviously is not likely.

Also at the time the Legislature appropriated the funds for the water right acquisition program they did so with the understanding that the water rights would be acquired from lands that were no longer under production as a result of

urbanization in the middle valley. However, these urbanizing lands rarely coincide with lands holding pre-1907 rights. Thus, the Natural Resources Department was placed in the position of purchasing water rights and retiring what were often prime agricultural lands from production. The EBID fortunately was protected by language in the bill that required that all acquisitions be made from above Elephant Butte Dam. However the Middle Rio Grande Conservancy District enjoyed no such protection. It initiated protests relative to any transfer that did not pre-date the establishment of the district. Thus, the importance of the pre-1907 rights. It is interesting to note that had the EBID not been exempted by law, the Elephant Butte minimum pool water rights acquisition program could have become involved in the pending litigation regarding the El Paso case as well as the dispute between the EBID and the city of Las Cruces regarding the dedication of water rights on annexed lands.

Each purchase and transfer that we submitted required more than four months of administrative processing time within the New Mexico State Engineer Office. Each transfer is subject to protest and potential litigation by other water users in addition to lengthy legal advertisement procedures.

In view of the aforementioned facts and recognition that public health considerations may preclude any drawdown below a 50,000 acre-foot level, it did not appear financially responsible to pursue this multi-million dollar purchase program.

In addition, once Elephant Butte Reservoir is again in a position to store San Juan-Chama water, it is likely that given the extremely soft market for Albuquerque's surplus San Juan-Chama water and the lack of available storage elsewhere, that the city will be storing at least 50,000 acre-feet in Elephant Butte Reservoir. That storage is in addition to the minimum pool that will be recovered under the Natural Resources Department contract. Also, the city could amend its storage contract to permit even more San Juan-Chama water storage.

In recognition of these important facts, the New Mexico Legislature in Chapter 287 of the 1983 laws, amended the appropriation language of the 1978 and 1979 laws to permit the acquisition of water in lieu of water rights. The contract with the city of Albuquerque, which I previously mentioned was a result of this change and currently protects the minimum pool from evaporative losses. However, nothing protects the pool from a spill. Given the current water surplus in the Rio Grande system and the lack of buyers or users for Albuquerque's surplus San Juan-Chama water, it

does not appear likely that the minimum pool will play an important role in the forseeable future. However, it will undoubtedly continue to influence water management decisions.

The important message I would like to leave with you is that as New Mexico's economy changes from its heavy dependency on extractive industries and agriculture, our attitudes toward water management must evolve as well. We have to place the same importance and emphasis on recreational uses of water as we have traditionally placed on agricultural and municipal uses. The same type of innovative thinking and imaginative management techniques must be brought into play if New Mexico is to maximize the benefits it receives from its scant water resources. Ultimately that should be every water manager's bottom line.

WATER MANAGEMENT'S EFFECTS ON FISH AND WILDLIFE MANAGEMENT ALONG THE RIO GRANDE IN NEW MEXICO

Charles J. Ault
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service

In order to appreciate the present and properly plan for the future, we need to look to the past. Geese, cranes, turkeys and other native fowl were abundant along the banks of the Rio Grande. Many saline seeps on both sides of the river suggested poorly drained conditions. These were some of the findings of early explorers like Coronado and Espejo along the Rio Grande in the 1500s. In 1844 Joseph Gregg found the Rio Grande near Santa Fe to be several hundred yards wide but quite shallow, often less than knee-deep, with cottonwoods scattered along it banks. In 1846 and 1847, J.W. Abert recorded seeing mallards, brant, snow geese, "blue" cranes, sparrow hawks, quail, western meadowlarks and many muskrats along the Rio Grande between Socorro and Santa Fe. He described the river as a magnificent winding stream, its continuity broken by meanders and islands. It looked like chain of silver lakes.

The Rio Grande of the past was a magnificent river surrounded by desert and mountains, flowing unimpeded out of its deep gorge, onto a broad floodplain. A very precise and synchronous association evolved between this river and the

plant and animal communities living within its waters and on its floodplain. Today, since 1900, things have changed considerably. Elephant Butte Dam was constructed in 1916 and Caballo Dam in 1938. Cochiti Dam was completed in 1975. The Rio Grande channelization project from below Caballo Dam to the Texas border was authorized in 1936. Several miles of low flow conveyance channels, levees, and several diversion dams were constructed within a 300-mile reach of the Rio Grande from Velarde to Elephant Butte Dam during the 1930s, 1940s and 1950s.

These activities and others, have resulted in the loss of at least 10,000 acres of wetlands. They have also rendered fish habitat unsuitable along 60 percent, or 290 miles, of the Rio Grande's natural floodway in New Mexico. Levee construction and channelization have confined the once dynamic Rio Grande within a very small portion of its broad floodplain. This confinement, coupled with strict controls placed on stream flows, have brought about the additional loss of hundreds, perhaps thousands, of acres of riparian and wetland habitats.

Effects

These activities have had several effects on the Rio Grande's fishery. For example, dams and their operation modify instream flows and impede migration within the system. Instream flow modifications affect the availability

of required habitats of fishes during their various life stages. For example, if exceedingly large flows are released during the spring, they may kill young fry that have just hatched from eggs laid the previous fall. Likewise, if fish are not allowed to migrate to and from feeding, spawning, rearing and resting areas, they will not survive.

The modifications to the Rio Grande have also introduced a new aquatic environment to the system -- reservoirs. Many new exotic species of fish have been introduced to the Rio Grande as a result. Largemouth bass, crappie, northern pike, striped bass, bluegill and walleye are some examples. These fish are popular as sport fish, as are the rainbow and brown trout, which also have been introduced to the river. These fishes require fairly dependable and constant water storage levels in the reservoirs or instream flows in order to survive.

The annual and/or seasonal fluctuation of reservoir storage levels and resultant downstream releases often conflict with the needs of the fish fauna. Thus, management becomes difficult. These problems can become magnified during periods of water abundance due to the need for evacuation of reservoirs to accommodate extraordinary runoff and the obligation to meet the seasonal irrigation needs of agriculture.

The effects on the birds, mammals, reptiles and amphibians and their habitat are not dissimilar from the fishes. Construction and channelization also change several aspects of life along the Rio Grande. Operation and maintenance activities associated with water projects on the Rio Grande affect 73,000 acres of riverine, riparian, and wetland habitats along the Rio Grande from Velarde to Elephant Butte. The reservoirs created by the dams, inundate and destroy thousands of acres of riparian, wetland, and upland habitats that support hundreds of species of animals and millions of individuals.

Modification of instream flow affect seasonal flooding events that are necessary for the regeneration of cottonwood communities that support hundreds of species of birds. In addition, extended periods of water abundance and inevitable drought cycles create severe problems in management of riverine habitats for migratory waterfowl.

The Fish and Wildlife Service is responsible for protecting the Rio Grande's valuable fish and wildlife resources under the authorities of the Fish and Wildlife Coordination Act, Endangered Species Act, National Environmental Policy Act, Clean Water Act, Migratory Bird Treaty Act and other pieces of federal legislation as well as some executive orders. We do not take the responsibility lightly. Today the Rio Grande remains, in spite of the

pressures placed upon it, a productive ecosystem. It supports approximately 60 percent of the 444 bird species known to occur in the state. The bald eagle, whooping crane and peregrine falcon, three of our nation's endangered species, occupy the skies above it and rest on its shores. Two federal and three state wildlife refuges are located in its floodplain. We must, and we shall, keep trying to find the median ground between water management for the people and water management for the wildlife along the Rio Grande.

RIO GRANDE MANAGEMENT: THE VIEW FROM UPSTREAM

Phillip Wallin
Southwest Regional Manager
Trust for Public Land

Just before World War I, a Frenchman names Clemenceu said, "War is too important a matter to be left to the Generals." In the last two years, in the Rio Grande Basin, we have learned that water management is too important to be left to the managers.

The Rio Grande is managed by a fraternity of professional water managers in the U.S. Corps of Engineers, the U.S. Bureau of Reclamation and the State Engineer Office, together with the Rio Grande Compact commissioners. They manage the river on behalf of the consumptive users, like the Albuquerque Water Resources Department, the Elephant Butte Irrigation District (EBID) and the Middle Rio Grande Conservancy District (MRGCD). These people <u>are</u> the system of Rio Grande management. Together, they determine how the water will flow, where and how long it will be held, what will happen to rivers and facilities and what initiatives will go to Congress. They are constrained by law and compact, but they exercise a great deal of discretion.

The last two water years have seen extremely high runoff in the Rio Grande Basin, with spills at Elephant Butte and one yet to come in March. Nevertheless, the fraternity has managed the Rio Grande as if we were in the clutches of a drought. They have clung to flood-water at Abiquiu and Cochiti in May through September only to spill it the next March. Whether this was truly flood control, or whether water was being held at Abiquiu and Cochiti for the benefit of the Elephant Butte irrigators, is the subject of litigation in New Mexico v. Hodel, et al., currently on appeal to the 10th Circuit Court of Appeals on the issue of federal jurisdiction.

Viewed from outside the fraternity, the Rio Grande appears to be managed strictly for the benefit of consumptive users. Other considerations, such as recreation, fish and wildlife, national monuments, archeological sites, and so forth, are honored in the breach if at all.

Let me give an example of single-purpose management. In June 1985, immediately after a "paper spill" occurred and New Mexico's debt to Texas was eliminated, the U.S. Bureau of Reclamation shut the gates at El Vado Dam, at the request of the Middle Rio Grande Conservancy District. On June 12, the natural flow went from 1,400 cubic feet per second (cfs) to a trickle of less than 100 cfs. The motivation, of

course, was to maximize storage at El Vado for the district. The basis, I would expect, was little more than a telephone conversation between representatives of the bureau and the district. Of course, 50 cfs provides very little support either for a trout or for a boat. The flow was increased somewhat after objections were made. As usual, however, considerations of wildlife or recreation were honored only in the breach.

Let me give a second example which is the normal mode of management. On April 4, 1986, immediately after floodwaters finally had been evacuated from Abiquiu Dam by the U.S. Corps of Engineers, the U.S. Bureau of Reclamation opened the gates at El Vado Dam. The flow in the Rio Chama then jumped to 4,500 cfs during a sensitive time for trout fry when radical fluctuations in the river need to be avoided. The motivation? Albuquerque Water Resources wanted to take delivery of 30,000 acre-feet of San Juan-Chama water. Because Albuquerque had no beneficial use for the water, and had already stored to the legal capacity at Abiquiu Dam, Albuquerque arranged wtih the Middle Rio Grande Conservancy District to store the surplus water at El Vado. Because El Vado was already full, the district asked the bureau to dump 30,000 acre-feet of district water, to make room for the Albuquerque water. If this were done before April 1, the water would have to flow on down to

Texas, under the requirements of the Flood Control Act of 1960. If it were done after April 1, it could be captured at Abiquiu by the corps and held there, under authority of flood control. That's what was done, and the water is still there, at Abiquiu, in October.

For the fraternity of water managers, and their consumer clients, both these events were causes for rejoicing. They had successfully manipulated flows so as to maximize the water storage that was retained in Rio Grande reservoirs after the spring runoff in 1985 and 1986. They could pat each other on the back and congratulate each other for a job well done.

Meanwhile, on Labor Day of 1986, 200 people, including Congressman Manuel Lujan, boated the Rio Chama. They ended their trip at the take-out, which used to be on the Rio Chama but for the last two years has been encroached on by the rising waters of Abiquiu Reservoir. As Lujan and the others tried to unload gear off their boats, they stumbled and slid through two feet of silt in the river and mud on the bank, courtesy of the extra storage at Abiquiu Dam.

Meanwhile also, the Ghost Ranch, which owns private lands surrounding Abiquiu Reservoir, watched as their lands were inundated for a second year. Farmers in the Chama Valley below Abiquiu Dam, and residents of Espanola, watched with misgiving as a dam within a major regional fault zone,

originally intended to protect them, accumulated more and more water storage.

Examples could be multiplied of management on the Rio Chama and Rio Grande which is oriented strictly to downstream benefits. Those of us who are interested in upstream values -- recreation, riparian habitat, private lands, fishing, wilderness, acequia farming, archeological and paleontological sites, and cultural values -- must simply recognize that we are not part of the system for managing the Rio Grande. We are on the outside looking in. We can complain, we can write to our congressmen, we can attend hearings, we can even sue, but we are not part of the system. We are referred to collectively by Steve Reynolds as "the rafters" and "the environmentalists."

Bob Findling of the New Mexico Department of Natural Resources has described very well the growing importance of recreation and tourism in New Mexico's economy. Frank Ward of the agricultural economics department at New Mexico State University has estimated that an acre-foot of water in the Rio Chama can be worth up to $1,100 for recreational purposes, far more than its agricultural value. Recreation is a growth industry in New Mexico, particularly in northern New Mexico, and one that depends greatly on protecting river environments. If New Mexico were to sacrifice the scenic areas that make it the "Land of Enchantment," we would have

little to build on in the north. Nevertheless, the only way that recreationalists or environmentalists or residents of Rio Arriba County can have any impact on river management is to band together in a coalition, like the Rio Chama Preservation Trust, and oppose the bureau, the corps and the state engineer through litigation, legislation and community organization.

The fraternity of water managers has a set of beliefs that govern water management in the Rio Grande (and indeed throughout the arid West). These beliefs are so obvious to the fraternity that they are not even considered beliefs. They are simply truth.

A few of these obvious truths that appear to dominate Rio Grande water management are:

1. The purpose of water management is to maximize supply, because water is good, and more water is better. What could be more obvious?
2. The more storage the better. How could you possibly have too much (or even enough) water storage?
3. Consumption of water in New Mexico is bound to increase.
4. The cheaper the water the better.
5. Water conservation is only for droughts.
6. Water that is not diverted and consumed is wasted.

7. Recreation, wildlife and tourism are mere luxuries.

8. Upstreamers must divert their water or lose their rights.

9. Water management is a technical matter that should be kept out of "politics".

10. Nature serves no particular purpose, and needs to be re-engineered.

And so on. The power of these propositions is obvious--so long as they are not looked at with a critical eye.

The philosophy of the Rio Grande managers comes out of the past. It emphasizes supply, storage, consumption, and engineering. It conceives of rivers as little more than plumbing. It harkens back to the old reclamation ideal of government projects providing cheap water that would make the desert bloom. It is not a philosophy that looks to our realistic future. It pays no heed to recreation, to tourism, to the design of nature, to traditional cultural values, or to public participation. It boils water policy down to a simple matter of maximizing supply for unlimited consumptive use.

Basic to this concept of maximizing supply is the assumption that wanting more water or storage is the same as needing it. The fraternity wants water projects to be as

cheap as possible so that the question of real economic need never arises.

The controversy regarding Abiquiu Dam is a good example of this assumption. There is a lot of surplus water in the Rio Grande system right now, San Juan-Chama water as well as native water. This creates a desire for more storage at Abiquiu, so that water will not escape beyond Fort Quitman. Last summer, the Albuquerque District of the U.S. Corps of Engineers accommodated this desire by pointing out that space at Abiquiu could be converted from flood control to permanent storage. Great interest was forthcoming from those burdened with a water surplus, specifically the Albuquerque Water Resources Department and the EBID. The fraternity of water managers encouraged this interest.

Unfortunately, cost has reared its ugly head. To begin with, it would cost some $40 million to condemn private lands, relocate roads, "mitigate" destruction of archeological sites and wildlife habitat, and so forth. Furthermore, the Water Supply Act of 1958 and U.S. Army Corps of Engineers policy require that water users who wish to take over flood control space reimburse the United States for the original cost of that space, updated to current prices. This would bring the total price for 467,000 acre-feet of new storage at Abiquiu to about $85 million, or about $20 per acre-foot per year.

This price tag has been very effective in distinguishing want from need. For water that is needed and can be devoted to a beneficial use, $20 per acre-foot might be an attractive price (about half the price Albuquerque is paying for San Juan-Chama water). But for storage that is merely wanted to prevent water from going downstream, that use produces no reasonably foreseeable economic benefit, not even $10 is an attractive price. (Albuquerque has come to that conclusion and has so informed the U.S. Army Corps of Engineers.)

The response by the fraternity has been to promote the possibility of lowering the price. The attitude is that storage is a good thing, so more storage is better, and if cost stands in the way of storage, then we must find a way to lower the cost. This action will present a dilemma for Sen. Domenici, who has been the chief proponent in Congress of requiring local interests to bear the cost of federal water projects to ensure that a real economic interest is being served. Sen. Domenici appears to understand that the purpose of an economic price is to distinguish between what someone wants and what they actually need.

In this debate over Abiquiu Dam, the only interest that appears to matter to the fraternity is that of the downstream users. It is a curious phenomenon that in water management, by and large, the benefits are downstream and

the impacts are upstream. Traditionally, it requires very little in the way of downstream benefits to override any amount of upstream impact. If an impoundment or structure or flow regime will benefit a municipality or irrigation district, then the fraternity will seek a way to do it. Upstream impacts on farmers, landowners, fishermen, businessmen, boaters, local taxpayers and so forth are not part of the equation. They may have to be dealt with in some manner if the outcry is great and persistent. They may present a political or a legal problem to be overcome. They may be the subject of an Environmental Impact Statement (EIS), or a hearing, or mitigation, or a study, or a reassuring letter to a congressman. They are not, however, an ingredient in the original decision whether the initiative should proceed.

Bob Findling described very well the dedicated effort of the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers and the State Engineer Office to preserve the "Elephant Butte minimum recreation pool," as it was sometimes styled. Findling suggests that the purpose of that body of water was not in fact recreation, but rather protection of the EBID from legal liability in years when they might be forced to draw down the reservoir to the point of a fish kill and a public health problem. That reasoning would explain the persistence with which the fraternity

worked to protect that pool from spilling last summer, moving the pool from Elephant Butte to Abiquiu (without authority) and then to Cochiti (without authority). If the pool were indeed for recreation, it would hardly have been the object of such attention and ingenuity.

It doesn't seem likely to me that the attitudes of the fraternity will change. They come out of the past, out of traditional alliances and strategies that have produced water projects.

How, then, will it be possible to put upstream impacts on a par with downstream desires in the formulation of water policy? How can we give an effective voice to those whose environment and way of life would bear the brunt of a water project or management policy? How can we preserve the recreation, the fisheries, the scenic values that are essential to New Mexico's economic future, when these things mean little to the technicians who control our rivers?

This, I believe, is the big issue in Rio Grande management: how to get away from the simplistic obsession with "developing our water resources" and move to a system that accommodates a wider range of economic, social and ecological needs.

I would suggest the following measures:

First, make the EIS into a real planning tool, rather than just a whitewash and a target for litigation. It

would, I suppose, be unrealistic to try to remove the EIS process from the corps or the bureau and lodge it with an impartial agency. At the least, though, the EIS should be reviewed for minimum standards by the federal Council on Environmental Quality, and reviewed for substance by the governor or appropriate state agency.

Second, impose a more rigorous pricing system in which a price is placed on all the upstream impacts and the beneficiaries of the project are required to pay the cost. This is the only way to ensure that the benefit really justifies the cost. If, for example, people downstream from a dam have misgivings about the safety of the site, then the beneficiaries of water storage should pay for a thorough and independent analysis of the site and the structure that will reassure local people. If the water storage will take away or damage a recreational resource, or grazing lands, then let the beneficiaries pay a price that truly reflects the value that is being taken from others.

Third, give the "county of impact" the right to say "no" to the project. This option would require the beneficiaries to negotiate with those who bear the burden. It would allow the Rio Arriba County commissioners to calculate the cost of impact and to recover that cost from the beneficiaries. It would make the county of impact a necessary co-sponsor of the project.

Fourth, obtain state legislation to make instream flow for recreation and for fish and wildlife a beneficial use of water in New Mexico. This designation would enable Albuquerque, for example, to make beneficial use of its surplus San Juan-Chama water for the recreational benefit of its citizens.

Fifth, develop a true water policy-making body for the state of New Mexico that is responsible to the governor. The present anomaly, in which the state engineer operates unilaterally to speak for the state of New Mexico on all issues of water management and development, is attributable to the personal characteristics of Steve Reynolds, but it is also attributable to the lack of any appropriate institution to play that role. One would hope to see the new governor establish a Division of Water Resources within the Department of Natural Resources that could develop a state-wide plan and prepare options for the governor.

Sixth, re-examine the role of the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers. Now that the cost/effective projects are built, should we maintain federal agencies that will continue to generate new projects? Shouldn't the water resources job be done at the state level? The era of re-engineering natural systems is over. The era of subsidized water for agriculture is drawing to a close. We are entering the phase of repairing

the damage done in the past, of desalting rivers and detoxifying drainage basins. The state of Florida is about to spend $100 million to undo what the corps did to the Kissimmee River and the Everglades. The state of California is beginning the task of restoring the salmon fishery that was wiped out by the damming of the Trinity River. As Governor Lamm of Colorado said recently:

"Ours is not a shortage of water but a shortage of imagination. We must take that same determination and intelligence that built Hoover Dam and other magnificent reservoirs and complex irrigation systems throughout the West and apply them to reshaping our laws and institutions to cope with an era of better management and to living within our limits".

ESTABLISHMENT OF A FEDERAL RESERVED WATER RIGHT FOR A NEW MEXICO WILD AND SCENIC RIVER

Herbert S. Garn
Hydrologist
U.S. Geological Survey, Water Resources Division
(formerly State Office Hydrologist,
Bureau of Land Management)

The lower four miles of the Red River in New Mexico as well as 48 miles of the Rio Grande downstream from the Colorado state line were designated as one of the "instant" components of the National Wild and Scenic River system by the Wild and Scenic Rivers Act of 1968. The major purpose of the act is to preserve these rivers in their free-flowing condition. The Bureau of Land Management (BLM), as the managing agency of the wild and scenic river, was a participant in a general water rights adjudication of the Red River stream system.

The Red River stream system adjudication was filed by the state of New Mexico in November 1972. The BLM sought a federal reserved water right and asserted a claim to the necessary instream flows to protect and maintain the particular scenic, recreational, fish, and wildlife values unique to this river. The matter of whether the United States had a right to a minimum instream flow was referred

to trial in 1978.

Instream flows are not considered a beneficial use of water under state law, and the other parties strongly resisted a federal reserved right for that purpose. In planning the case, a major problem we faced was how to quantify and prove the instream flow requirements of the river. The BLM conducted studies from 1979 to 1980 to quantify the instream flow needs of the lower Red River. Negotiations with the involved parties began in 1980 to settle and terminate the matter without the necessity of further lengthy and costly litigation.

DESCRIPTION OF STUDY AREA

The Red River is located in Taos County in north-central New Mexico about 20 miles north of Taos (figure 1). The Red River originates in the rugged Sangre de Cristo Mountain Range. The Rio Grande is entrenched in a gorge that begins about six miles north of the Colorado state line and gradually deepens to a maximum depth of 860 feet. The lower portion of the Red River is also entrenched in a similar gorge.

The Red River component of the wild river is unique from other wild rivers in that it is downstream from all developments and effects of man within its drainage basin. Developments along the Red River, in downstream order, include the town of Red River and a ski area, a molybdenum

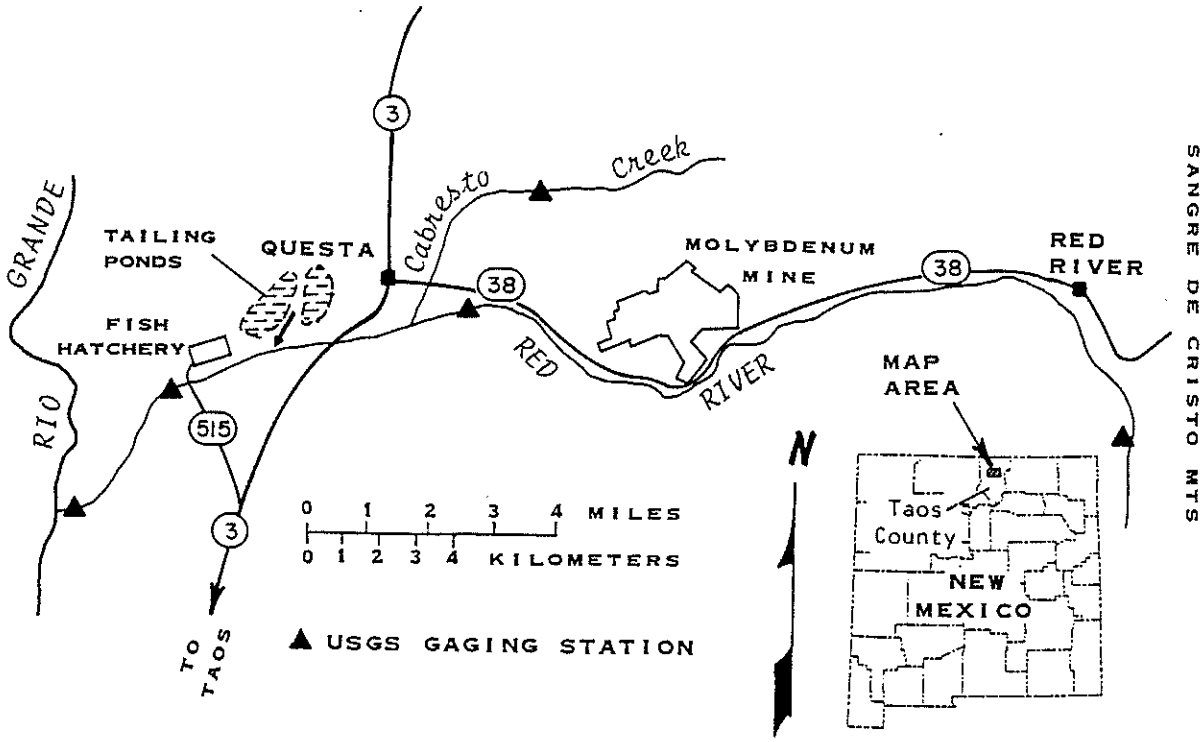

Figure 1. Vicinity map and major features within the Red River Stream System.

mine and mill, the town of Questa, scattered rural homes and recreation facilities, molybdenum mill tailings ponds, and a state fish hatchery at the upper end of the wild river segment. The majority of the basin is undeveloped national forest land.

The major uses of water in the basin are for irrigation, mining, municipal water supply, and fish culture purposes. All water rights have a priority date prior to October, 1968 (New Mexico State Engineer Office 1974). No diversions occur below the fish hatchery, and the wild river portion is downstream from all return flows.

The lower Red River and the Rio Grande are renowned for their high-quality rainbow and brown trout fisheries, and represent one of the top trout fishing areas in the state. Recreational activities in the wild river portion of the Red River consist primarily of fishing followed by camping, picnicking, hiking, sightseeing, and nature study. These are, therefore, the major instream water uses of the lower Red River.

Water quality of the Red River is generally suitable for most uses, although some short-term degradation of water quality does occur due to both natural and artificial causes (Garn 1985). The toxic elements zinc, cyanide, copper, and cadmium approach or exceed water quality criteria. This is due to leaching of natural ore bodies and discharge from the

mill tailings ponds. Water quality is an important factor because it is related to the scenic, recreational, and fish and wildlife values of the river.

METHODS

An interdisciplinary team approach including hydrologists, fisheries biologists, and landscape architects, was used in the quantification process. We determined that fish and wildlife, scenery, and recreation are the major purposes for which instream flows would be quantified. Instream flows for waste transport and maintenance of water quality were also determined because of the upstream waste discharges and the relationship of water quality to these values.

A state-of-the art methodology was required for quantification in this case. The instream flow incremental methodology (IFIM), developed by the Cooperative Instream Flow Group of the Fish and Wildlife Service, was selected (Bovee 1982). The incremental methodology predicts the amount of potential fish habitat available for each life stage of a species as a function of stream flow. It is based on the premise that the suitability of a species' habitat can be described by measuring selected physical variables in the stream, such as water depth, velocity, and substrate or cover type. A more detailed discussion of the methodologies used in this study is given by Garn (1986).

As a part of the IFIM, the physical habitat simulation computer program (PHABSIM) was used for data analysis (Milhous et al. 1981). This program consists of several sub-programs: IFG2 or IFG4, FISHFIL, and HABTAT. IFG2 or IFG4 are two different hydraulic simulation programs (only one is used) that predict the depth, velocity and flow in the reach. IFG4 was used for the Red River because of its complexity and large roughness components. FISHFIL contains the habitat preference criteria for the particular species and life stages of fish. The criteria curves relate fish occurrence to the physical habitat variables. Brown trout and rainbow trout are the management species of interest in the Red River. The HABTAT program combines hydraulic data with the biological criteria to predict potential available habitat (Weighted Usable Area, WUA) in the given reach for the life stages of the target species at various flows.

Sound is an important aesthetic value associated with running water. Quantification of instream flows to maintain the sounds of falling, splashing, trickling water were attempted with the use of a sound level meter. Sound measuring points were established within each of the study reaches and sound levels were measured, in decibels, for a wide variety of flows encountered during the study.

Instream flow requirements for the preservation and protection of water quality were determined based on the

maintenance of safe levels of toxic elements in water. Flow requirements for waste transport and dilution of upstream discharges were determined by using mass balance equations to maintain concentrations at acceptable instream values based on water quality criteria for trout.

RESULTS AND DISCUSSION

Application of the Fish and Wildlife Service's incremental methodology results in a computer printout of potential available habitat area versus streamflow for each target species, life stage and study reach. Runs were made for three fish species: rainbow trout, brown trout, and white sucker. Such a curve for adult trout is given in figure 2.

To analyze these curves, it was necessary to determine the times at which the various life stages of the fish occur in the stream. By comparing the habitat area vs. flow curves for each life stage of a species with the time of year that each life stage occurs, monthly instream flows to maintain a desired level of habitat was determined (table 1). Instream flows were selected from the curves near the point where habitat area decreases sharply with decreasing flows. The monthly flow requirements for the various life stages of the management species were then compared and a single monthly flow requirement for fish habitat that best satisfies all life stages of all species was selected. This

process also considered the adverse effects of non-game species such as the white sucker.

Instream flow requirements for aesthetics were close to those determined for fish habitat. Instream flows needed for waste transport and water quality maintenance were also found to be in the general range of those for the other purposes. Sound measurements showed a promising relationship to streamflow that further helped to quantify instream flow needs for aesthetic purposes (figure 3).

The final instream flow recommendation was made from an evaluation of the individual instream flow requirements in table 1 for fish and wildlife, aesthetics, and water quality. This recommendation is the water requirement to maintain all of these uses at an acceptable level. This instream flow recommendation was also compared to the monthly available flow to meet the test of reasonableness. Daily flow duration curves for each month were used to make this comparison. Lastly, the flow recommendation is checked to see that it does not adversely affect watershed conditions and food and other relations in the stream that have not been accounted for. The final instream flow recommendation was adjusted to best accommodate all of these variables.

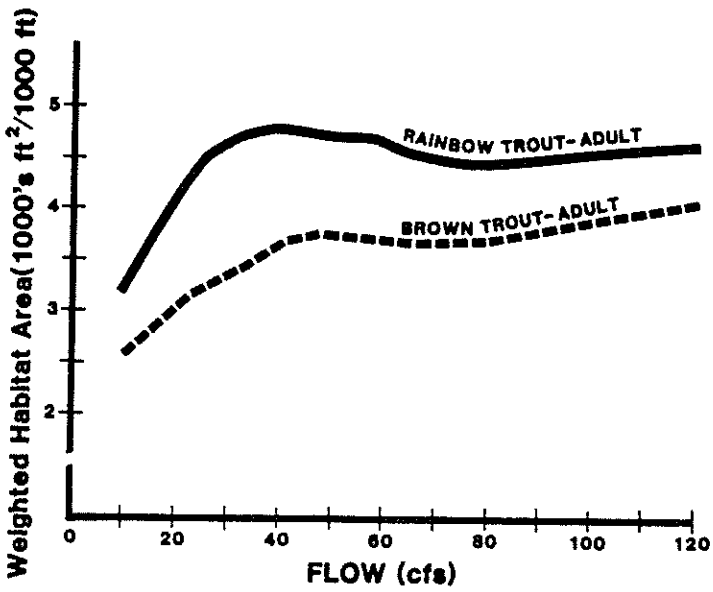

Figure 2. Weighted Available Habitat Area (from two Study Reaches) for Adult Brown and Rainbow Trout Versus Flow in the Lower Red River.

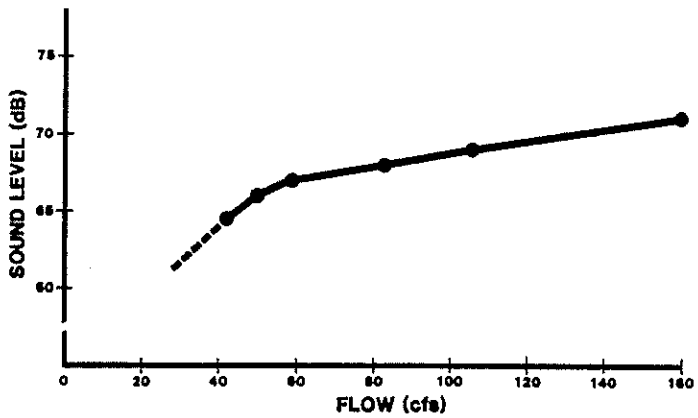

Figure 3. Sound Level Versus Flow in the Lower Red River.

Table 1. Comparison of Individual Instream Flow Requirements with Available Streamflow and the Final Federal Reserved Water Right.

Characteristic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TYPE OF USE												
Brown Trout												
Adult	40	40	40	40	40	40	40	40	40	40	40	40
Spawning										45	45	
Incubation	35	35										35
Fry			40									
Juvenile				45	45	45	45	45	45	45	45	45
Aesthetics	50	50	50	50	50	50	50	50	50	50	50	50
Water Quality	38	38	38	38	38	38	38	38	38	38	38	38
AVAILABLE FLOW												
Q50*	34	35	35	42	110	115	63	54	43	41	39	34
Q80*	30	31	32	35	55	63	42	41	34	34	33	28
Q90*	27	29	30	32	45	48	37	36	30	30	30	26
RESERVED RIGHT	30	30	30	35	45	45	40	40	35	35	30	30

*Percentile flows from flow-duration curves for each month.

This methodology held up well under cross-examination during depositions. The IFIM and other supporting methods used in this study to quantify the reserved water right provided a strong position for entering into negotiations. On February 23, 1984, the parties involved in this case entered a precedental stipulation recognizing a federal reserved right to instream flows for the Red River component of the Wild and Scenic River System. The quantity of the reserved right was that arrived at through the IFIM. The average monthly instream flows agreed to in the stipulation ranged from 30 to 45 cfs (table 1, bottom). On March 2, 1984, the court approved the stipulation.

This case is believed to be the first of its kind to be settled in the nation, and sets a precedent for other wild and scenic rivers. It also set a precedent in negotiation and cooperation among the federal, state, and private parties in order to settle the federal reserved water right issue quickly and at least cost. The constructive negotiation by the parties resulted in a stipulation in four short years, compared to many other water rights cases involving federal reserved rights that have not been settled yet after 15 to 20 years.

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MANAGEMENT IMPACTS ON FISHERY AND RECREATION IN THE RIO GRANDE

Michael D. Hatch
Management Project Leader
N.M. Department of Game and Fish

The New Mexico Department of Game and Fish is charged with protecting and managing game mammals, game birds, raptors, song birds, game fish, and select nongame species including some mammals, birds, fish, reptiles, amphibians, mollusks, and crustaceans. This responsibility is shared with the U. S. Fish and Wildlife Service, especially as regards migratory waterfowl, raptors, and federal endangered species.

Chapter 17 of the State's Statutes establishes the department's general powers to protect and manage the state's wildlife and fishery resources and embodies most of the state laws protecting these resources. Most broad reaching habitat protection laws are administered by other agencies; however, habitat issues are commented on routinely by my agency as provided by the National Environmental Policy Act, the 404 Dredge and Fill permitting procedure, the Endangered Species Act, etc.

Water management decisions affect all animal groups over which the New Mexico Department of Game and Fish has

jurisdiction. However, my comments will be restricted to fishes as they are most immediately affected by water management decisions. Emphasis will be placed on watershed conditions and how these influence water management decisions; and finally, how the interplay of these factors affect fish and water-based recreational activities in general.

New Mexico is an inhospitable place for fishes. Averaging only 13 inches of rainfall each year, it is the third most arid state in the nation. In spite of this, New Mexico supports one of the most diverse ichthyofaunas of any of the interior southwestern states. Some 69 species of native fish are known to have occurred in New Mexico's waters and approximately 40 species of exotic fish have been successfully introduced here by man. The diverse native ichthyofauna exists because six of the seven life zones exist in New Mexico and six biogeographic provinces converge in the state. As such, New Mexico represents a series of ecotones with many species of fish existing here peripherally and many are sensitive to environmental change.

Within the Rio Grande, 27 species of native fish (representing 12 families) are known to have occurred here, many of which are obligate or facultative big river fishes, including: shovelnose sturgeon, blue sucker, gray redhorse, longnose gar, freshwater drum, phantom shiner, and bluntnose

shiner. All of these and many others are presently extirpated in the Rio Grande of New Mexico; however, their former presence is evidence of more prosperous times. Testimony to this effect is provided by Spaniards as they entered the Mesilla Valley during the 1550s. At that time, they found the Rio Grande to be a perennial system composed of a series of large lagoons and marshes flanked by gallery forests of cottonwoods, willows, and shrubby phreatophytes - all in stark contrast to today's ephemeral condition.

After the Civil War, immigration by Anglo-Europeans into the Rio Grande Valley of New Mexico accelerated. Irrigation activities intensified and the grazing industry emerged - all of which brought about dramatic changes in hydrologic conditions. By 1880, every piece of available irrigable land was under development and people began to complain of water shortages. The river is known to have gone dry during 1879, 1891, 1894, and 1896. Keep in mind that this desiccation of the river occurred nearly 40 years before the construction of any large reservoir on the river. Degradation of the watershed continued and by 1907, army engineers described the Rio Grande as a storm water system subject to large oscillations in flow.

The effects of overgrazing are graphically represented in the Rio Puerco Valley where seeps and occasional storm waters flow through a 30-foot deep, vertically walled

arroyo. But before 1885, this incised arroyo did not exist. The period of its cutting coincides with the maximum grazing of livestock in the valley. The increased sediment load of the Rio Puerco was deposited in the Rio Grande within a section of the river that is naturally aggrading, which in turn increased the incidence of flooding and required more and elaborate water projects to compensate.

Most ranchers cut back stocking allotments by the 1920s, adopting modern grazing practices. However, the impacts of those early days remain with us. Over the years, 11 of the 27 native species of fish in the Rio Grande have become extirpated; and only 11 others can be classified as stable. Likewise, of 41 species of exotic fish that fisheries managers attempted to establish in the Rio Grande, only 13 have become established and an additional 11 are localized.

Obviously, many factors have contributed to the degraded condition of the Rio Grande. However, the same factors of a degraded watershed that work to endanger native forms are often the same factors that frustrate the efforts of fishery managers to establish a desirable sport fishery. These factors include: increased erosion and sedimentation rates (New Mexico is the only state in the nation with total erosion rates from rangeland exceeding five tons per acre per year), altered nutrient loading, altered temperature

regimes, decrease of cover, alteration of stream morphology, alteration of food base, and reduced primary productivity. Impacts within watersheds have also affected decisions and actions in water management as these impacts often directly affect man and his livelihood. For example, the deteriorated condition of rangeland in the Rio Puerco Valley led to the abandonment of six towns and numerous ranches there and increased the incidence of flooding. Efforts to remedy these and similar problems elsewhere in the Rio Grande drainage have often been directed at treating the symptoms rather than the causes. As a result, we build dams to alleviate water shortages and we construct levees to contain flood waters, both of which can be but are not necessarily detrimental to a fishery. Dams will change a natural flowing stream into a ponded water system, a condition that cannot be tolerated by all fishes. In addition, the periodicity and volume of flows are altered, predicated upon the needs of agriculturalists. Finally, dams block the migration of fishes and they alter water temperatures and sediment loads.

Dams also serve as a nutrient trap. Although New Mexico reservoirs are among the most productive in the nation, a high fraction of this production is diverted to rough fish. High annual fluctuations of runoff contribute vast quantities of organic detritus to reservoirs, which in

turn allows for rapid growth of those species of fish which feed on the detritus, i.e., detritivors such as carp and shad. The detritivors quickly grow to such large sizes which are unavailable to predation by piscivores, such as bass and walleye; and with their larger size, they are often very fecund. The result is that populations of fish soon become dominated by detritivors with a net low production of game fish.

However, there are many good points about dams. If located correctly, they do not have to infringe upon rare or otherwise sensitive fish; and as mentioned earlier, they are very productive - as are their tailwaters. A case in point is the San Juan River where rainbow trout readily grow to 20 inches in length, supporting one of the most prized trout fisheries in the entire nation. In addition, dams provide for diverse recreational opportunities, including: boating sports, swimming, camping, and fishing. In New Mexico, there are approximately 250,000 licensed anglers who contribute between $100 and $130 million annually to the state's gross receipts revenue. Roughly 65 to 70 percent of this comes from reservoir anglers. This may seem like an infinitesimal amount when compared to the $850+ million in gross revenues from the livestock industry and $273+ million from crop receipts. However, when you consider that the income from sport fishing is ancillary to other water uses

and that it is produced with no subsidy, its contribution suddenly appears very significant.

A leisure audit conducted in 1985 by the Gallup Poll indicated that the second most popular leisure activity in the nation was angling, and that angling was shown to be the number one activity among adult males. However, in New Mexico, it appears that the percent of people who fish is less than the national average and the total days fished per angler per year is also less. This, of course, means that New Mexico realizes far less revenues from sport fishing than do most other states. There are many reasons for this, among them is the possibility that it is too far to travel to preferred fishing sites or because of poor recreational facilities. The latter scenario is aptly illustrated by Abiquiu Reservoir where anglers are denied access to much of the shoreline.

The history of man's occupation in New Mexico is characterized by exploitation of natural resources. Impacts by man and his animals in the watershed have been devastating and lethal to fishes and have influenced or forced decisions in water management that are also deleterious to fishes. All of this occurs at considerable cost to the public, including the cost of water projects and the cost of tourist dollars lost. There is a need to implement management practices to increase perennial

sustained yield of surface and ground water supplies. If the national forests within the Rio Grande were managed to maximize sustained yield of water, there could be an increase of 16 to 18 percent to the base flow of the Rio Grande. This could reduce, by 60 percent, the 450,000 acre-foot deficit projected for the Rio Grande basin by 2025.

To appreciate the need for a more equitable allocation of resources, one needs to contemplate the future with a 28 percent increase in New Mexico's population each decade. These people will compete at increasing rates for the limited water resources. The demand for surface water is likely to increase most in the Rio Grande basin where 63 percent of the population now lives. Eventually, water will go to the highest bidder and perhaps may be sold to out-of-state users. Without provisions for instream rights, we may lose even ancillary uses of water as it is piped out of state.

Water-use practices will change as municipalities are forced to procure more water and as industry is willing to pay more and more for water. Increasingly, instream flows will become predicated on uses other than agricultural; and as this occurs, it is hoped that concessions will be extended to fishery and other water-based recreational uses. Generally, water-based recreation, including fishing, can be

compatible with other uses and will contribute to the long-term economic and environmental health of the state.

TRENDS IN STREAMFLOW AND RESERVOIR CONTENTS IN THE RIO GRANDE BASIN, NEW MEXICO

Scott D. Waltmeyer

Hydrologist

U.S. Geological Survey, WRD

Introduction

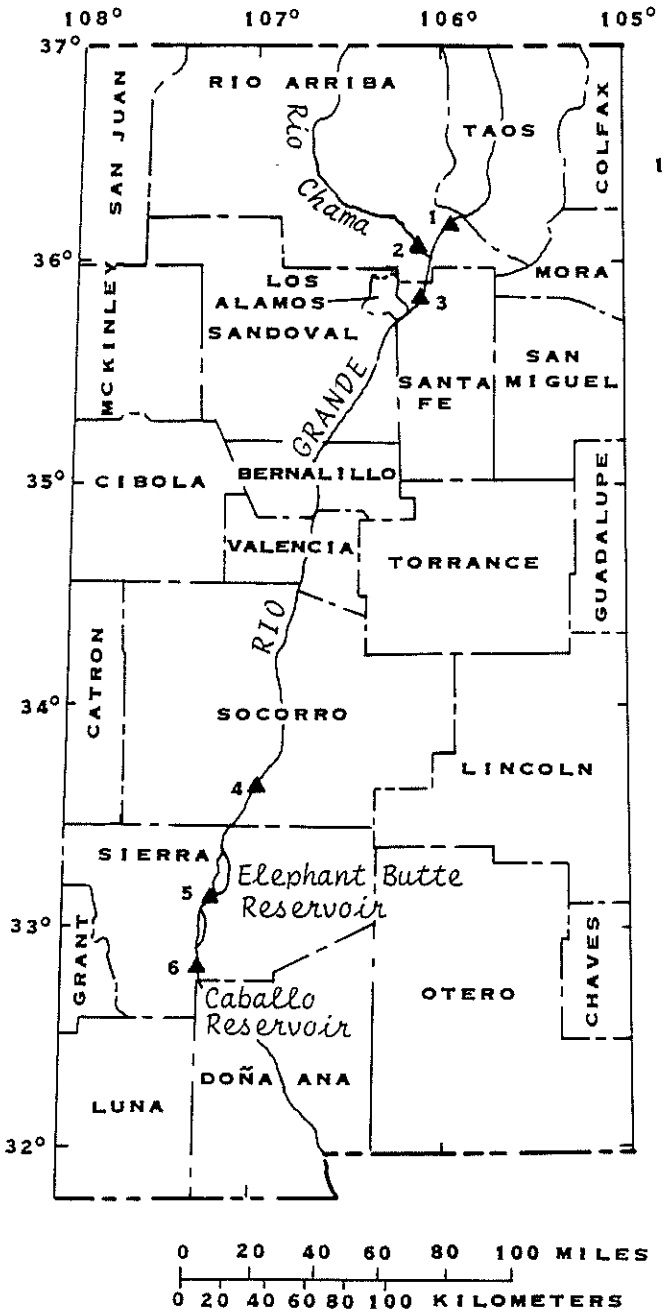
Streamflow data have been collected in the Rio Grande basin since 1888 when the site of the gaging station near Embudo was chosen as the training center for the first hydrographers of the U.S. Geological Survey. Continuous records of discharge have been collected there since January 1889. Since then, numerous additional stations have been added to the network in order to gage the discharge the Rio Grande and its tributaries. In the New Mexico part of the Rio Grande Basin upstream from the gaging station below Caballo Dam, there are 18 streamflow-gaging stations on the Rio Grande and 60 stations on its tributaries (1984 figures). In addition, there are 12 stations on reservoirs where reservoir-stage and contents data are obtained. However, some data are collected by the U.S. Army Corps of Engineers and the U.S. Geological Survey.

Records collected at the gaging stations provide a continuous record of streamflow and reservoir contents from which long-term trends and changes can be evaluated and from which short-term water-management decisions can be made. This paper graphically presents the data for selected

long-term stations in the basin from which fluctuations in streamflow and water levels may be seen and trends may be inferred. No attempt has been made to evaluate the causes for any changes that might be indicated by the record.

Although more than 70 gaging stations are operated in the Rio Grande Basin, many of the stations have a relatively short period of record, the records have not been collected continuously over the years, or the records have not been collected during winter months. This evaluation of records was limited to stations that had a long continuous record, that provided a representative sample of conditions in the basin as a whole, and that provided as broad an areal coverage as possible. Location of the stations selected is shown in figure 1.

Streamflow varies greatly from year to year. For example, figure 2 shows the variations in annual mean discharge for the period 1913-1985 for the Rio Grande at Embudo. As shown, large changes occur with discharges going from well above the long-term average discharge to well below the average from one year to the next. These wide variations in discharge make the record difficult to analyze visually. For this reason, the five year moving average of the annual mean discharges was used to present streamflow trends. The five year moving average is the average of five years of data plotted at the midyear. For example, the average of the annual mean discharges for the five water years 1950-54 is plotted at 1952. Similarly, the average



EXPLANATION

1▲ GAGING STATION AND MAP NUMBER

Map number	Gaging-station name
1	Rio Grande at Embudo
2	Rio Chama near Chamita
3	Rio Grande at Otowi Bridge
4	Rio Grande at San Marcial
5	Elephant Butte Reservoir
6	Rio Grande below Caballo Dam

Figure 1. Location of gaging stations.

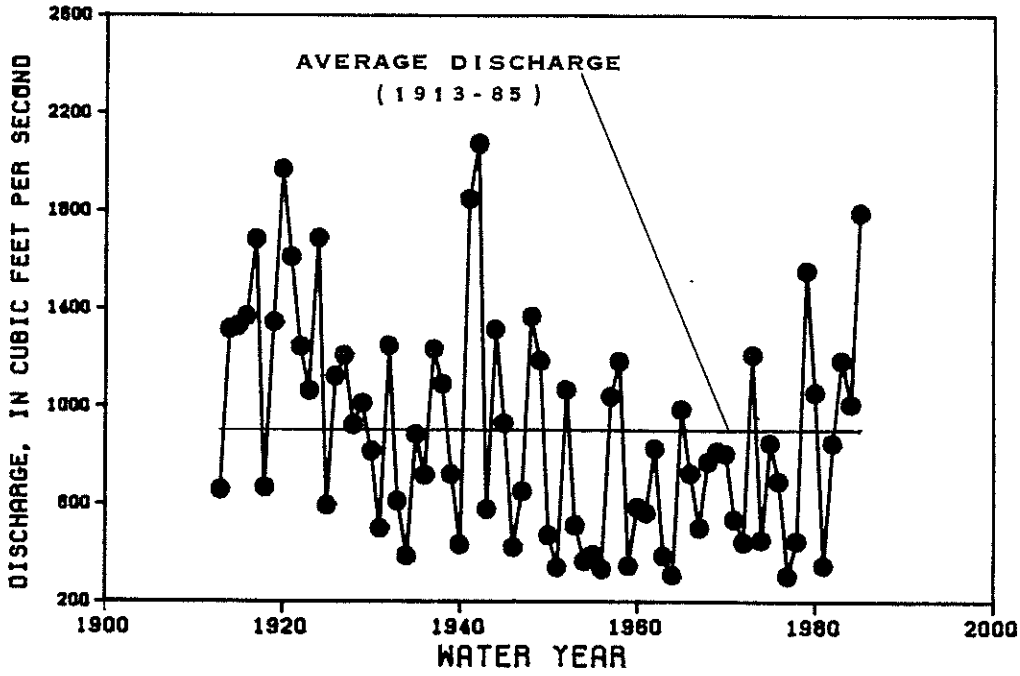


Figure 2. Annual mean discharge of Rio Grande at Embudo, 1913-85.

for 1951-55 period is plotted at 1953. For each successive year, a new five year average is determined and plotted at the midyear of the five year period. The five year moving average does not show the discharge for any given year, but is a smoothing technique for illustrating streamflow patterns and for detecting trends in streamflow.

The five year moving average of annual mean discharges for the Rio Grande at Embudo is shown in figure 3. Comparison of figure 3 and figure 2 illustrates the application of the five year moving average. As shown in figure 3, the earlier years of record (around 1920) and those around 1940 were higher than the long-term average. Discharges during recent years that have been above average (figure 2) are not reflected in figure 3 except as a rising trend since about 1980. Here, the averaging technique dampens the impact of the high discharge of 1985 (figure 2). If the above-average discharge pattern continues, the weight of additional years of high discharge will be reflected in a continued upward trend in the five year moving average (figure 3). It will be noted for example that the mean discharge for 1985 was about 1,800 cubic feet per second. This is higher than any peak shown in the five year moving average.

The hydrograph of the five year moving average for the Rio Chama near Chamita, a tributary of the Rio Grande, is

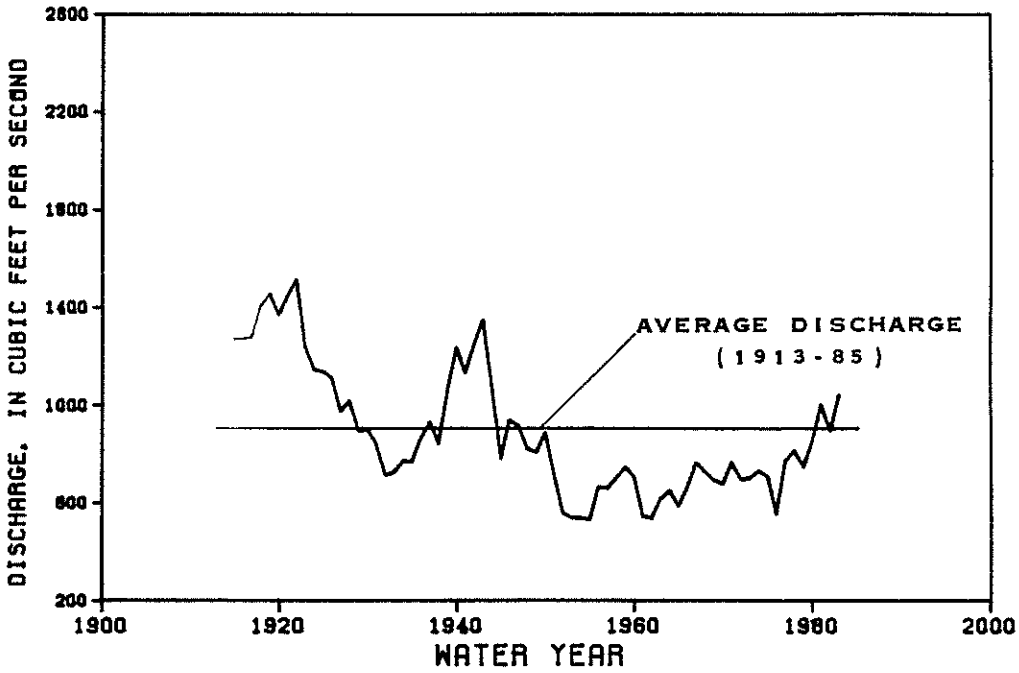


Figure 3. Five year moving average of annual mean discharge of Rio Grande at Embudo.

shown in figure 4. Hydrographs of the five year moving average for the Rio Grande at Otowi Bridge and Rio Grande at San Marcial are shown in figures 5 and 6, respectively. Although the periods of record for each gaging station are not the same, the patterns for concurrent periods reflect similar trends. In general, the hydrographs indicate high discharge around 1920 and 1940 and a somewhat lower discharge during the intervening years. From about 1945 to 1978, annual mean discharge generally was low; as reflected by the hydrographs, discharge was less than the long-term average (figures 4 - 6). Since 1978, streamflow has generally been increasing to well above average discharge.

The five year moving average of annual change in contents in Elephant Butte Reservoir is shown in figure 7. In general, the trends shown are similar to those for the streamflow-gaging stations with increases to decreases in contents following above and below average streamflow. The pattern, however, is somewhat more irregular probably due to releases or gains in storage.

The five year moving average for the Rio Grande below Caballo Dam, the most downstream streamflow-gaging station summarized, is shown in figure 8. The hydrograph does not show as much above-average streamflow after about 1980 as noted for the other streamflow-gaging stations. Some of this is primarily due to patterns of release from Elephant Butte and Caballo Reservoirs.

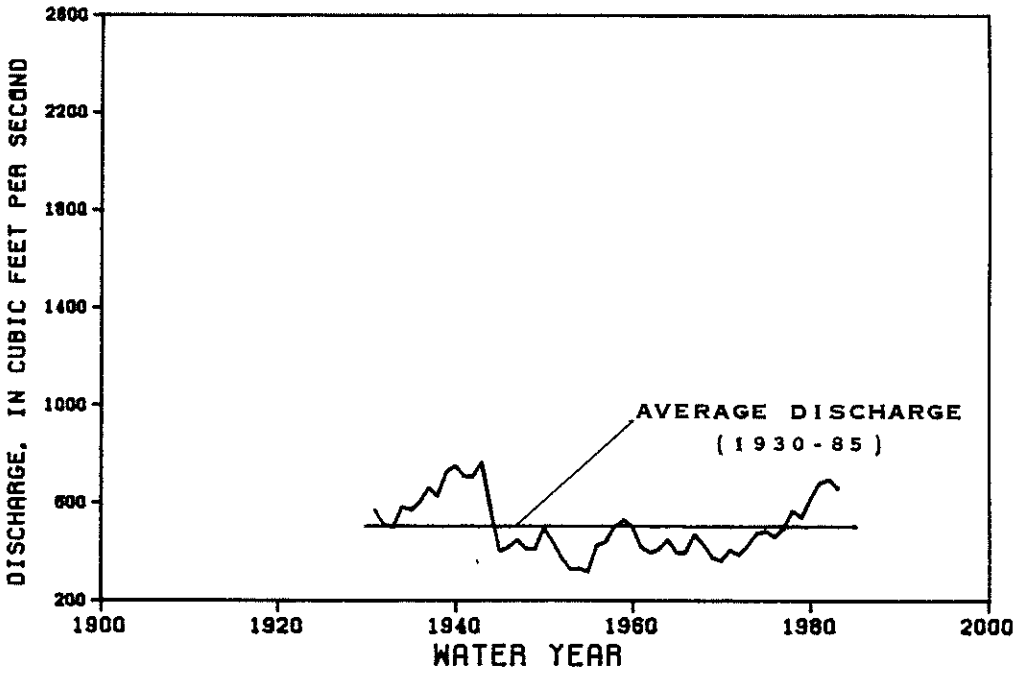


Figure 4. Five year moving average of annual mean discharge of Rio Chama near Chamita.

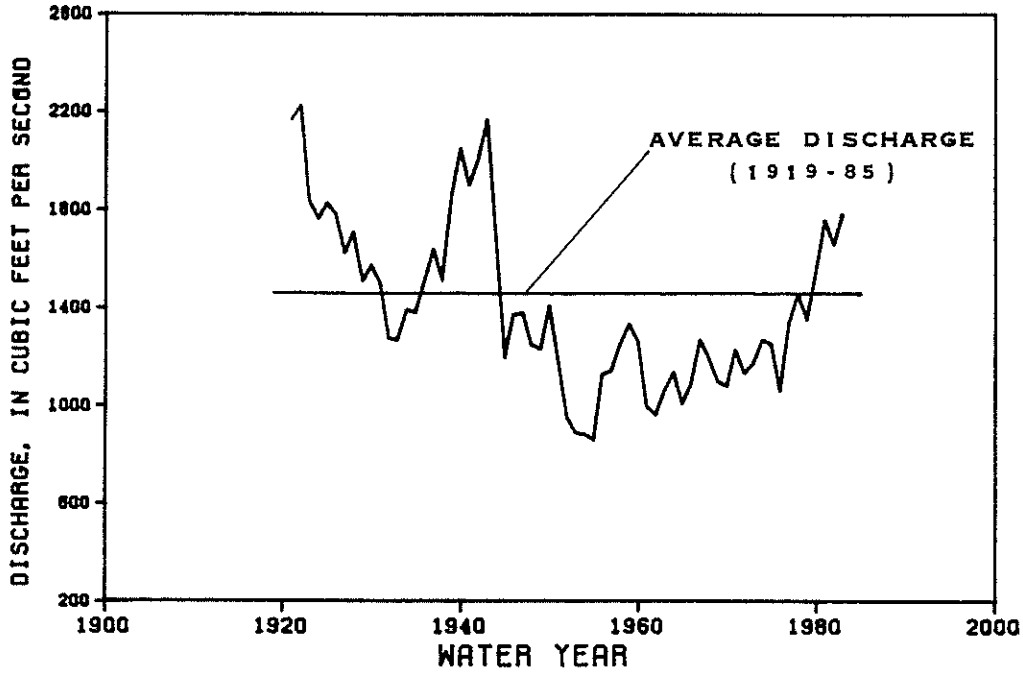


Figure 5. Five year moving average of annual mean discharge of Rio Grande at Otowi Bridge.

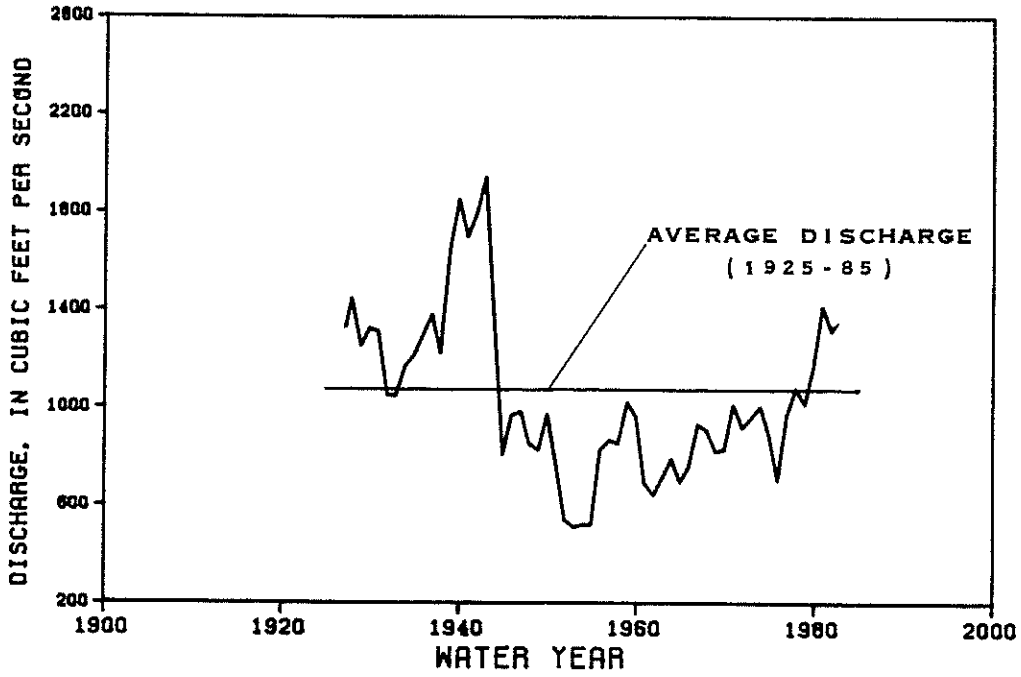


Figure 6. Five year moving average of the annual mean discharge of Rio Grande at San Marcial.

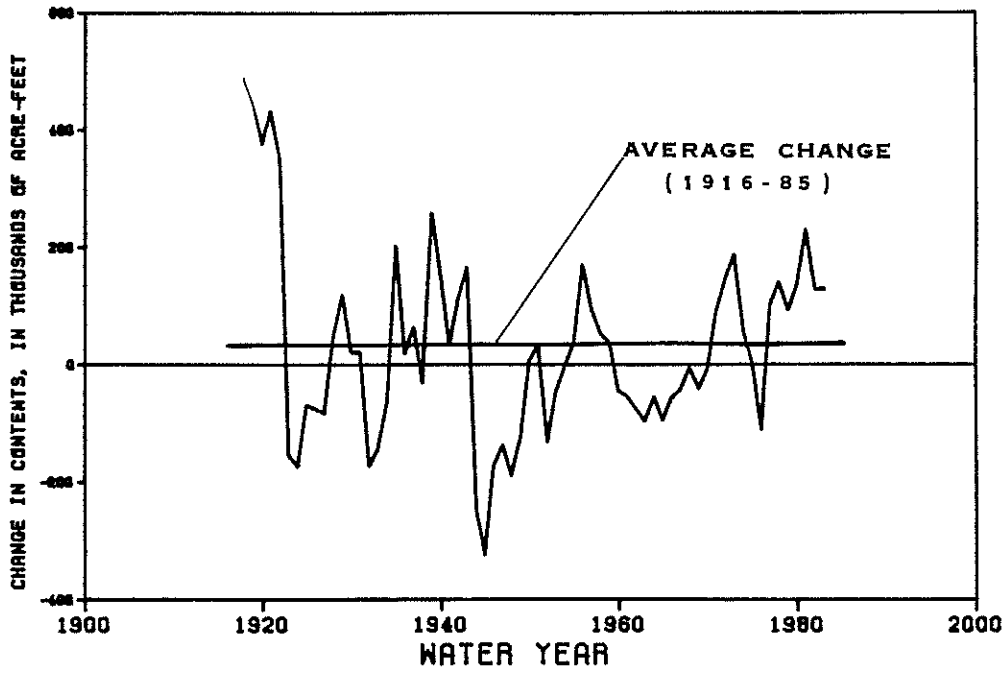


Figure 7. Five year moving average of annual change in contents of Elephant Butte Reservoir.

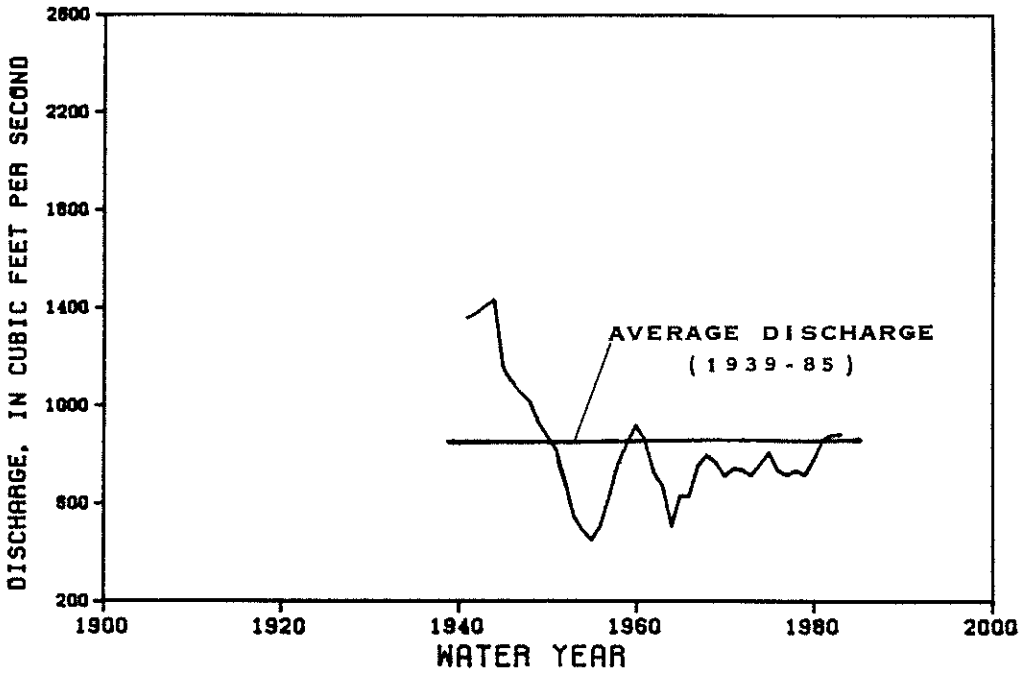


Figure 8. Five year moving average of the annual mean discharge of Rio Grande below Caballo Dam.

HYDROGEOLOGY IN RIVER MANAGEMENT

RIO GRANDE VALLEY, NEW MEXICO

William J. Stone

Senior Hydrogeologist

New Mexico Bureau of Mines and Mineral Resources

W.K. Summers

President and Senior Geologist

W.K. Summers and Associates, Inc.

INTRODUCTION

Problem

In addition to the legal, political, and socioeconomic aspects discussed elsewhere in this volume, river management also involves many technical considerations. Rivers seldom exist as hydraulically isolated phenomena, but are dominant features in larger, complex ground water/surface water systems. Effective administrators recognize and appreciate the significance of the geologic and hydrologic factors that control a river's behavior. Thus, efficacious management of the Rio Grande depends upon the administrators' capacity to conceptualize the ground water/surface water system, of which it is the dominant feature.

Purpose

We have three purposes in this paper. One is to call attention to some of the geologic, hydrologic, and

hydrochemical concepts that have been advanced to explain ground water phenomena observed in the Rio Grande Valley. Another is to examine how these concepts fit into models of the system. The third is to discuss the implications of these conceptual models for management, especially in water-deficit or water-surplus years.

MODELS

Scientists and engineers use "models" to help themselves understand water-resource conditions. Models range from simple mental images, that can be expressed as "cartoons", to complex numerical simulations, that rely on advanced computer technology.

For discussion purposes we classify models as: (1) conceptual, (2) scale, (3) analog, (4) analytical, and (5) numerical. A conceptual model is a mental image. It is invoked through words and diagrams. A scale model is a small physical representation of reality. It may be a simple paper-mache replica of a basin or a small dynamic version built in a sandbox.

Analog models may be maps and cross sections that depict appropriate features of the basin: or they may simulate conditions in one physical/chemical domain using another physical/chemical domain with similar equations but different properties. (For example, hydrologists have simulated ground water flow which obeys Darcy's Law using

the flow of electricity, which obeys Ohm's law.) An analytical model is an equation or set of equations that gives exact solutions, when appropriate values are substituted for specific parameters. An analytic model is usually expressed by a simple diagram, an equation, and a list of parameters; it produces a unique answer for each set of parameters used.

A numerical model makes use of equations that are solved by approximation methods. Usually these models require a grid, parameters for the grid, and a solution scheme. The user specifies the size of the grid and the basis of successive approximations. The most useful numerical models have been validated and calibrated. Usually validation means that the model reproduces an analytical solution. Calibration means that the model generates solutions that match data. However, even calibrated models may not be unique. Other validated/calibrated models, based on different assumptions, may give different answers.

Model types overlap, because they have some common features. They start with some expressed or implicit (but not necessarily the same) basic assumptions, they attempt to represent the salient features of an observed phenomenon, and they invoke logical responses to change.

Models have two uses. First, scientists and engineers

use models to identify areas where more data may be needed. Second, they use models to predict the effects of changes in the system.

Models and data are intimately connected. The relation between models and data ranges from specific and direct to vague and dubious. Even though files contain years of records, the data they contain may be neither appropriate nor adequate, because scientists and engineers collect data for three different purposes:

(1) To quantify a system or art of a system they understand (e.g. the flow of water into and out of a reservoir),

(2) In the hope that the data will contribute to their understanding of the system, and

(3) To check a model's ability to predict.

A sound conceptual model can reduce the data required to create a useful numerical model.

Although a model may seem adequate, we should not assume that it is the only one that will serve. Other models may be just as adequate. Simple models may be easy to understand and use, but may not give acceptable results. Complex models may be capable of providing acceptable predictions, but the data they require may never be available. Even when models and data blend to give good

predictions, political or economic factors may force managers to ignore them.

DATA SOURCES

Modelers need both geologic and hydrologic data. Models are only as good as the data used. The most effective models are those based on adequate geologic and hydrologic data.

Geologic data include the location, size, extent, and character of major structural features (folds, faults, basins, uplifts, and volcanic cauldrons), as well as the thickness, structure, extent, and lithology of major rock units. Raw data include outcrop observations, descriptions of samples, cuttings or core, and well logs. Interpretations of these data include geologic maps, subsurface (structure, depth, and thickness) maps, and cross sections.

The two major sources of geologic information in the state are the New Mexico Bureau of Mines and Mineral Resources and the New Mexico Geological Society. The bureau prepares and distributes separate lists for open-file and more formal report series. The New Mexico Geological Society also provides current lists of its publications. Both sources distribute material through the publications office of the bureau on the New Mexico Tech campus in

Socorro. The bureau is also a retail outlet for selected U.S. Geological Survey reports and maps.

Hydrologic data include climatological data, stream-flow and reservoir-capacity data, and ground-water data. Climatologic data are available for precipitation, snow pack, precipitation chemistry, air and ground temperature, evaporation, humidity, and wind. Stream-flow data include gaging-station records, results of seepage runs, as well as chemical and sediment loads. Ground-water data include records of existing wells, test holes, and piezometers; results of pumping tests; water-level-fluctuation histories; and chemical analyses of water.

Various government agencies routinely collect and, in some cases, publish water-resource data in New Mexico. State agencies include the New Mexico Bureau of Mines and Mineral Resources, New Mexico Environmental Improvement Division, and the New Mexico State Engineer Office. Federal agencies include the National Oceanographic and Atmospheric Administration, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the U.S. Geological Survey-Water Resources Division, the U.S. Bureau of Land Management, the U.S. Bureau of Reclamation, and the U.S. Soil Conservation Service. The New Mexico Water Resources Research Institute has published a directory of

sources, which gives the kinds of information available from each agency (Harris 1986).

Some data compiled by these agencies may be easily searched and recovered by computer. For example, the U.S. Geological Survey has access to several national data-bases. The Bureau of Mines has put its well records and chemical analyses of water for DeBaca, Lea, Quay, and Union Counties, the San Juan Basin, Estancia Valley, and Nations Draw Area into computer files (Stone 1980). At present, these files contain only data published by the Bureau.

GENERAL SETTING OF THE RIO GRANDE VALLEY

The valley of the Rio Grande and its tributaries extends from the Colorado border on the north to the Texas border on the south (figure 1). Major tributaries include the Red River, Rio Pueblo de Taos, Rio Chama, Santa Fe River, Galisteo Creek, Jemez River, Rio Puerco, Rio Salado, and Costilla Creek. Along its path the Rio Grande drops 3,674 ft, entering at 7,410 ft at the Colorado border and exiting at 3,736 ft near El Paso (Smeltertown).

The valley traverses portions of two physiographic provinces (New Mexico Geological Society 1982). In the area north of Santa Fe County the river flows through the Southern Rocky Mountain Province. The rest of its course lies within the Basin and Range Province. Some western tributaries drain part of the Colorado Plateau province.

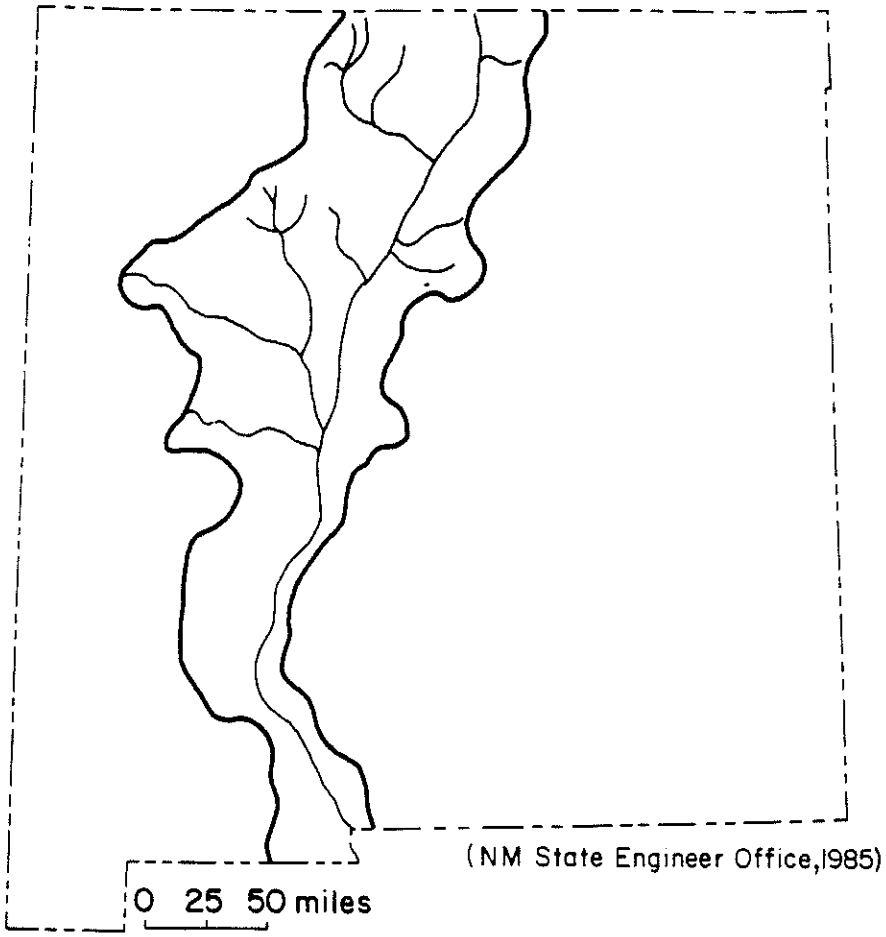


Figure 1. Location and extent of Rio Grande drainage.

GEOLOGIC CONCEPTS

Structure

The Rio Grande Valley occupies a structural depression known as the Rio Grande Rift or Trough. Geophysical investigations have shown that the valley consists of 13 basins separated by faults or bedrock highs (figure 2a). Crystalline and sedimentary rock units of Precambrian through Tertiary age crop out on both sides of the valley and alluvial and bolson deposits of Tertiary-Quaternary age underlie the valley floor (figure 2b). Fault-bounded uplifts and basins as well as volcanic features ranging from simple cones to extensive cauldrons with long histories complete the geologic setting.

Stratigraphy

In the past, geologists distinguished separate rock units in the basin-margin uplifts, but paid little attention to sedimentary units of the valley fill. Outcrops in the uplifts are easy to see and convenient to map; whereas outcrops and deep wells in the valley fill are rare. The data disparity led geologists to portray and conceptualize the uplifts as stratigraphically complex, and to treat the valley fill as a homogeneous mass (figure 3a). However, by integrating available subsurface data and geomorphic models, geologists now recognize distinct lithologic units in the valley fill as well (figure 3b). The improved

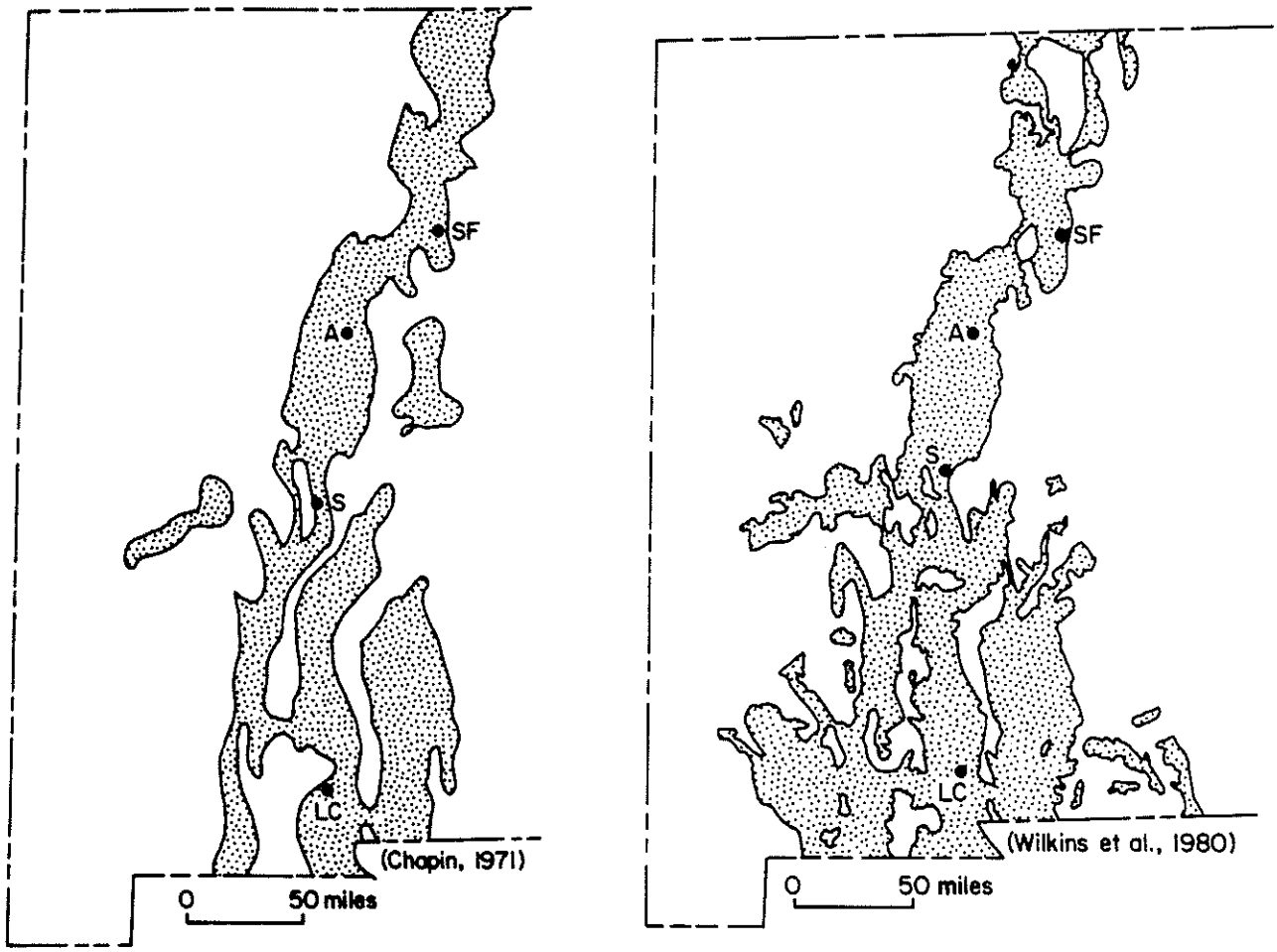


Figure 2. Distribution of basins within Rio Grande valley: a) based on structure, b) based on fill. Towns shown for reference include Santa Fe (SF), Albuquerque (A), Socorro (S), and Las Cruces (LC).

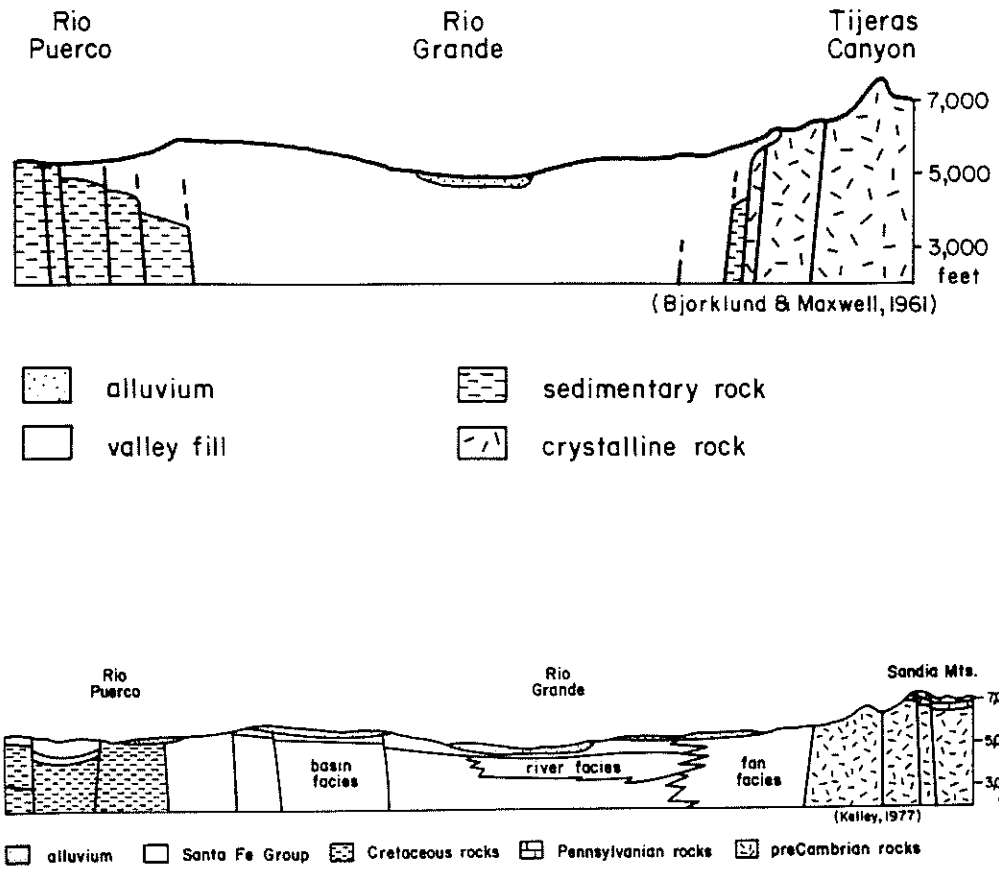


Figure 3. Geologic cross sections of the Rio Grande valley at Albuquerque: a) assuming valley fill is homogeneous, b) distinguishing various facies of the fill.

conceptualization of the geologic history and character of the fill leads to a revised conceptualization of the ground-water/river system.

HYDROLOGIC CONCEPTS

Groundwater Basins

The geologic concepts outlined above limit the ways in which one may conceptualize the hydrology. Dinwiddie (1967) characterized the Rio Grande valley as an impermeable "bath tub" filled with permeable material; whereas, Bryan (1937) recognized fault or bedrock boundaries between subbasins and characterized it as a chain of "bath tubs".

Study of the configuration of the water table or potentiometric surface reveals that the valley margins are not impermeable boundaries (Purtyman and Johansen 1974; Stone 1977). Although there are differences in the hydraulic properties of the uplifts and valley fill, they are hydraulically connected. Titus (1961) recognized this difference and described the "trough" in the water table associated with the central part of the Rio Grande Valley at Albuquerque as a lineal ground water drain and argued that it exists because the material in the valley center has a much higher average hydraulic conductivity than the rocks on either side.

Coons and Kelly (1984) recognized a trough or constriction between Taos and Espanola where volcanic rocks

take the place of sediments. They suggested that the groundwater velocity in this trough is greater because the cross sectional area through which flow occurs has been decreased.

Water Budget

If an administrator knows the water budget of a basin, he can manage it more effectively. For maximum benefit, he must quantify both the ground water and surface water parts of the system. Available water-budget data are summarized in table 1 and are shown schematically in figure 4.

West and Broadhurst (1975) provided the estimates of runoff and evapotranspiration in water-use areas of the Rio Grande Basin. We estimated recharge using their basinwide precipitation value of 12 inches/yr and the empirical relationship (Summers 1981).

$$\frac{R}{P} \times 100 = i\ (p-j)/100$$

where R/P x 100 is recharge (R) expressed as a percent of precipitation (P), i is a terrain factor ranging from 0.5 to 1.5, and j is the precipitation that must be exceeded for recharge to occur (6 inches). Our minimum estimated recharge assumes i = 0.5; our maximum assumes i = 1.5.

Hydrologists can readily obtain precipitation records and stream-flow histories. But, recharge, evapotranspiration (ET), and ground water underflow must be

Table 1. Water-budget summary (in part from West and Broadhurst, 1975).

Parameter	Low Recharge Estimate (ac-ft x 106)		High Recharge Estimate (ac-ft x 106)
Input			
Precipitation	20.6		20.6
Total	20.6	Total	20.6
Output			
Runoff	0.7		0.7
Recharge			
discharge to Rio Grande	0.7		0.7
underflow	0.0		1.4
Evapotranspiration			
use areas	2.7		2.7
elsewhere	16.5		15.1
Total	20.6	Total	20.6

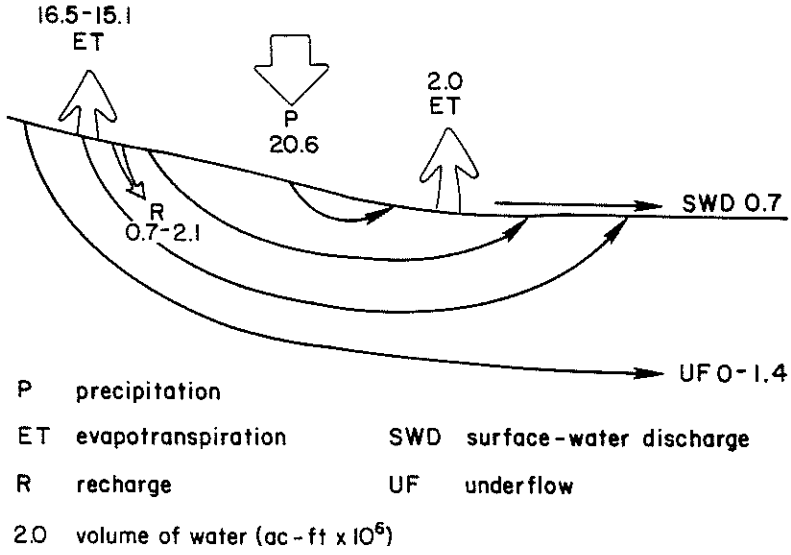


Figure 4. Schematic diagram of the water budget for the Rio Grande valley based on data in Table 1.

estimated. ET estimates from irrigated areas are probably pretty good, because agronomists have studied water use by crops extensively. But estimates of ET elsewhere in the basin and recharge are difficult to defend. ET is usually assumed to be the difference between precipitation and other water-budget parameters. Hydrologists have made only a few measurements of recharge (Phillips et al. 1984; Stone 1984a, b), and ideas about the validity and representativeness of these measurements vary. We know recharge occurs through direct infiltration and percolation of precipitation and through seepage along mountain-front streams. The volume of water that becomes recharge is moot.

We also know that not all ground water discharges to the river or to wells in New Mexico. Some moves to Texas as ground water underflow.

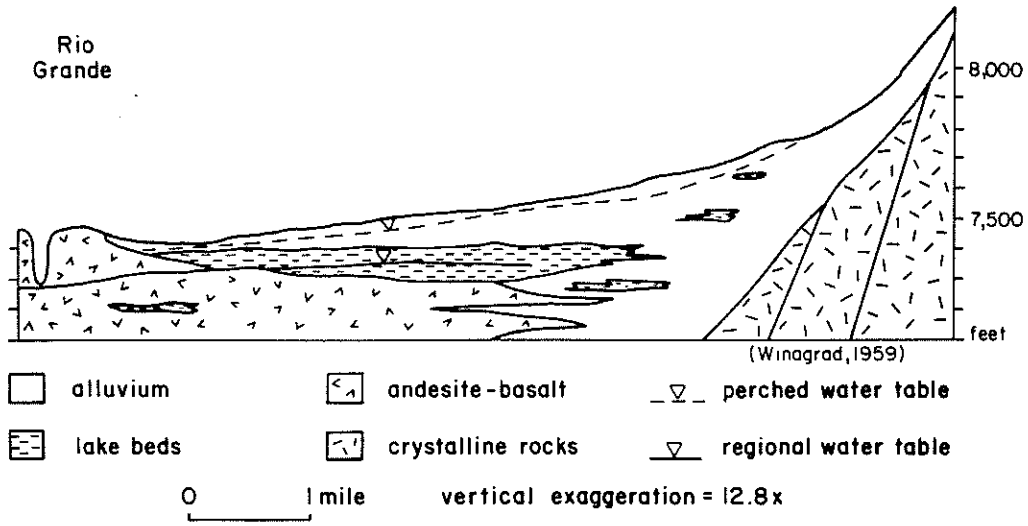
In some places within the Rio Grande trough in New Mexico the river is a gaining stream; in others it is a losing stream, that is, the Rio Grande gains water from the ground water part of the system in some reaches and gives water up to the ground water reservoir in others. Thus, the distinction between surface water and ground water becomes blurred. Wilson et al. (1981) found, for example, that in the Rincon/Mesilla valleys, both gaining and losing reaches occur. Tributary streams crossing the mountain front lose water to the ground-water reservoir. Heath

(1983) concluded that average seepage rates along a 48-mile reach of the Rio Puerco, where it flows over valley fill, average approximately 5 cfs in the winter and 10 cfs in the summer. Water diverted to acequias from streams in northern New Mexico lose as much as 5 percent of their water per mile (Lee Wilson, Personal communication 1984).

Flow nets and Discharge

Conceptualization of flow nets and discharge depend on both availability of data and interpretation of those data. Different interpretations have been made from essentially the same data (figure 5; Winograd 1959; Summers and Hargis 1984; Winograd 1985).

Figure 6 shows the flow paths in a cross section from the San Andres Mountains to the Rio Grande obtained by a numerical model (Bedinger et al. 1984). It shows that although the ground water circulates to depths of more than 2,000 m (6,000 ft), most of the flow occurs above 1,000 m and must have its origin at the mountain front. The model also shows that discharge occurs to a zone that is perhaps as wide as 200 m. Because the conditions imposed on the model allow no other solution, and because it is two dimensional, the model cannot show underflow and must show that all ground water in the plane of the section discharges to the river.



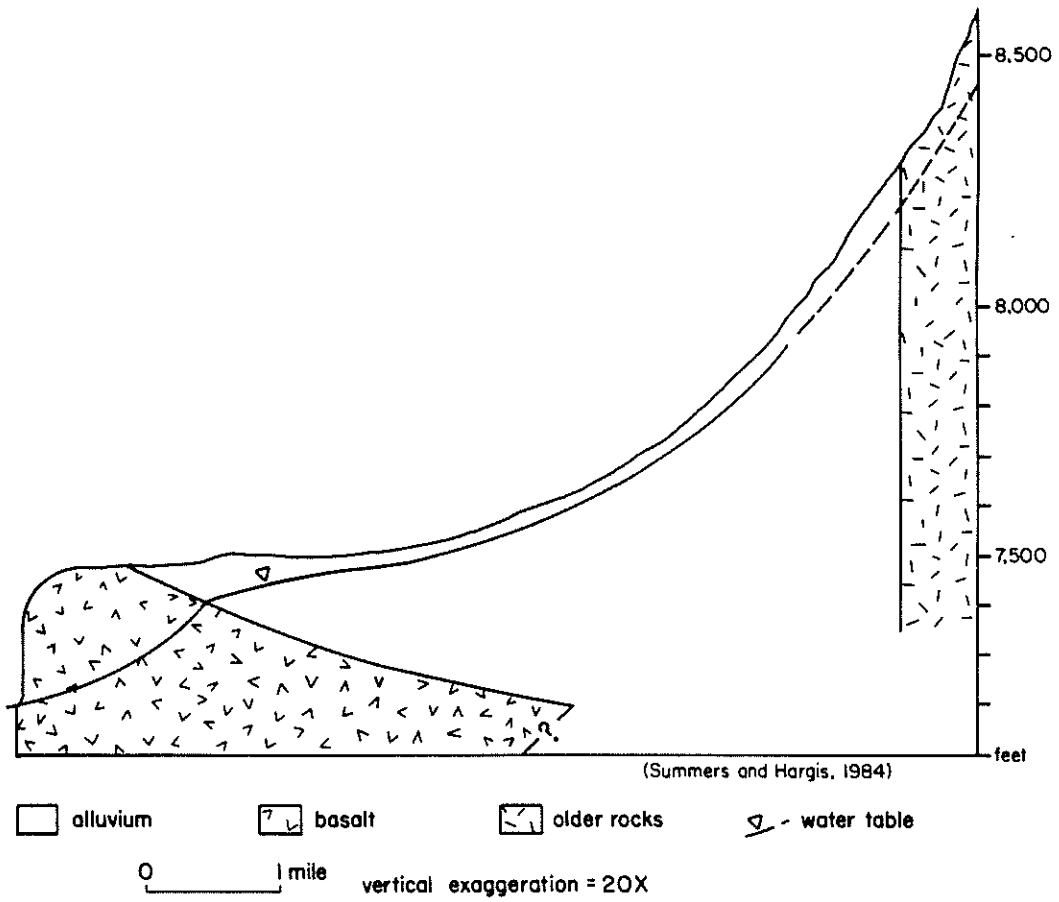


Figure 5. Cross sections showing different interpretations of the hydrogeology of Sunshine Valley: a) with a perched and regional water table, b) with just a regional water table.

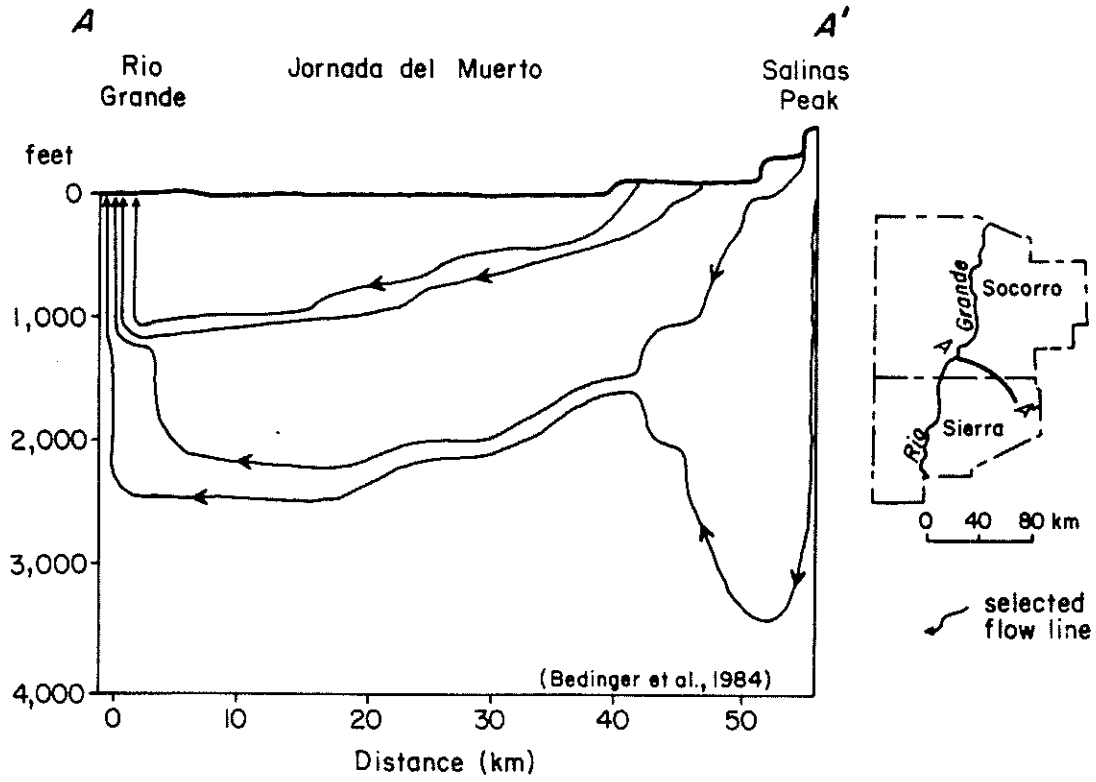


Figure 6. Cross section of a portion of the Rio Grande valley showing flow lines as generated by a two-dimensional, vertical model.

Pumping Wells Near the River

The predicted effect of pumping wells on the river depends upon the model one uses. One analytical method (Glover and Balmer 1954) that engineers have used for years to predict pumping effects assumes that the river and the well fully penetrate the ground water reservoir and that initially the water table is flat, therefore excluding recharge. This model predicts that eventually 100 percent of the water pumped comes from the river. Other methods, that assume the river only partially penetrates the reservoir and allow for recharge, show that less than 10 percent of the water discharged by well comes from the river (Emery 1966; Wright 1958). In Albuquerque, the city's south valley wells and the drains installed by the Middle Rio Grande Conservancy District to prevent water logging of irrigated land have created a situation where the river is a recharge source. As a consequence, the ground water for approximately 1/4 mi on either side of the river is in fact river water that has moved into the ground (Dennis McQuillan, EID, personal communication Oct. 2, 1986).

HYDROCHEMICAL CONCEPTS

Salinity Layers

One prevailing water-chemistry concept is that more or less continuous layers of differing salinity exist within the valley fill. Kelly (1974) applied this concept to the

entire Rio Grande basin in the United States. In his model, fresh ground water lies at or very near the water table. Beneath the fresh water are layers of increasingly higher salinity, ranging from slightly saline to brine (figure 7).

Other hydrogeologists (Bushman 19G3, Cliett 1969, and McQuillan 1984) working in the valley have noted and employed a slightly different layered model. In this case, they reason that shallowest water is of poorer quality than somewhat deeper water, because irrigation return flow, evapotranspiration, and pollution from septic-tank effluent increase the salinity of the shallow ground water.

Fresh Water Tongues

Hiss and others (1975) showed that the chemical characteristics of ground water in the northern part of the Albuquerque/Belen Basin could be correlated with those of probable source areas on both sides of the basin.

Work in the Socorro area has produced more specific conceptual hydrochemical models. Stone and Foster (1977) and Stone (1984c) found that ground water along the western margin of the Rio Grande valley was much fresher than that underlying the valley proper because of leakage of fresh ground water from an elevated side basin through the mountain front. This fresh water occurs in tongues associated with the more conductive fracture zones in the mountain (figure 8a). Such tongues no doubt occur in other

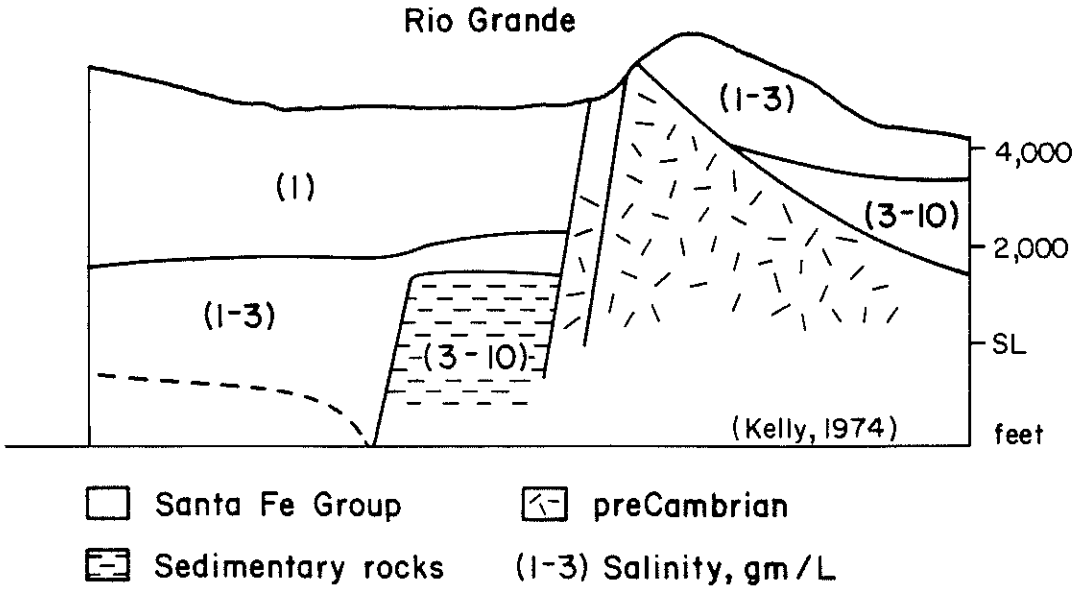


Figure 7. Cross section in northern Socorro County showing salinity layers in ground water.

favorable settings along the valley, such as the Nutt-Hockett Basin, southwest of Hatch. Summers and others (1981) also recognized tongues of differing quality in the Socorro area. They attributed this to infiltration from mountain-front recharge (figure 8b). Depending on relative salinities, these tongues may freshen or degrade valley ground water.

Pollution

Based on the prevailing conceptual hydrogeologic model of the valley, pollutants from solitary sources, such as landfills, septic tanks, or gasoline storage tanks, ultimately wind up in the river through natural flow/discharge processes (figure 8). The river dilutes the contaminanted discharge and effectively eliminates the problem. But, if levels of pollutants are high, the river becomes a source of contamination.

Pumping water from wells reverses the process and high-salinity river water or contaminated river water moves into the ground water body and flows towards wells. Gallaher and others (1986) have identified pollutants in the Albuquerque south valley at depths of 220 ft that could only have come from the surface. Presumably pumping the city's wells has reversed hydraulic gradients and water now moves downward from the water table (and from the river). Pumping may also short circuit the natural flow of polluted water toward the

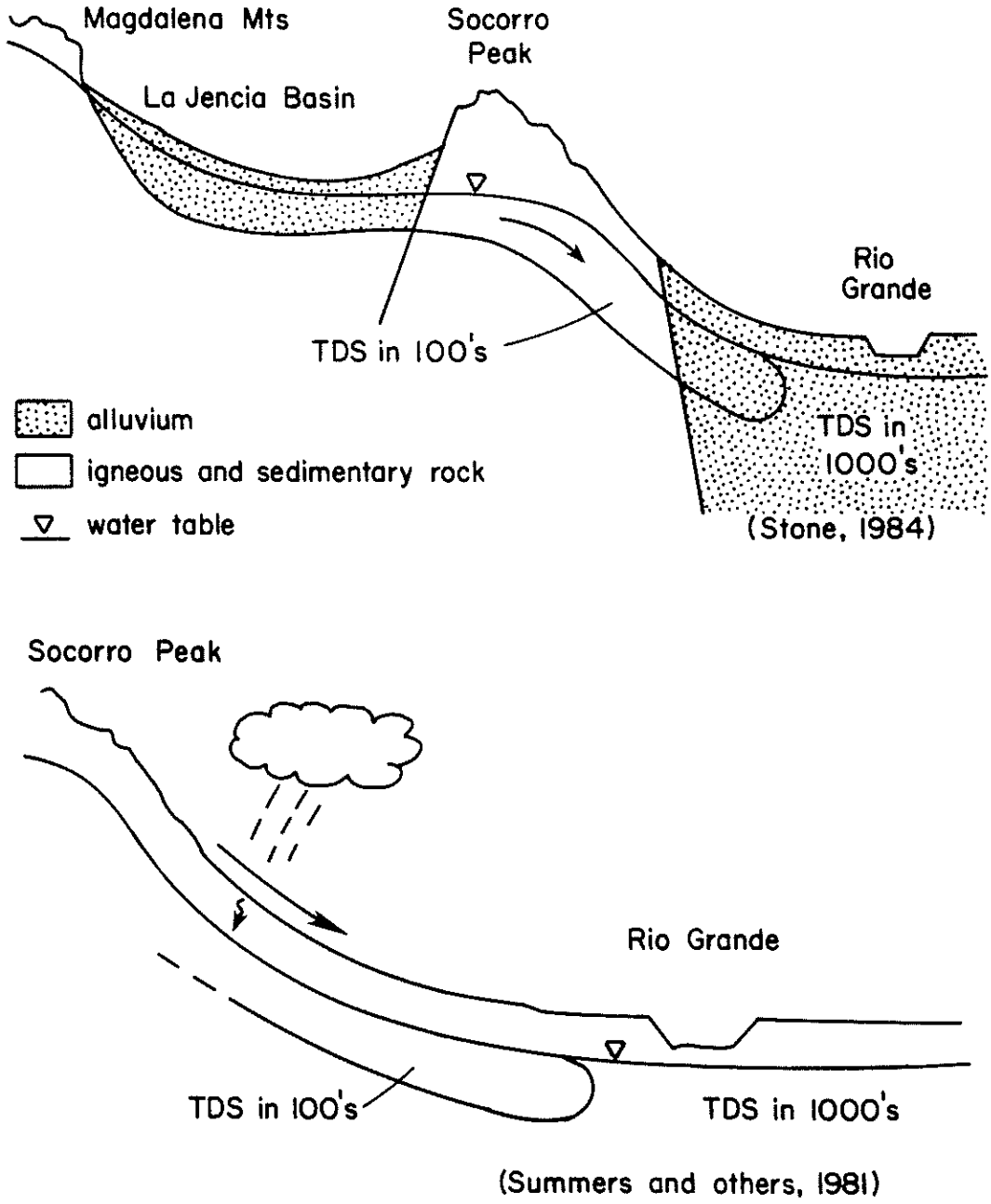


Figure 8. Schematic cross sections in Socorro area showing salinity tongues in ground water: a) due to elevated-side-basin discharge, b) due to mountain-front recharge.

river and divert it to wells. In Santa Fe County, Gallaher and McQuillan (1986) identified 17 locations at which one or more wells were polluted.

IMPLICATIONS FOR MANAGEMENT

Water Quantity

During periods of low flow, when reservoirs are low, surface runoff consists primarily of ground water discharge. If river flow remains low for an extended period, water levels in wells near the river may decline at abnormal rates and well yields may decline in response to reduced recharge from the river.

During periods of high flow, the ground water component of river flow is small. If river flow remains high over a long period, ground water levels may rise. This is not a problem except near dams and reservoirs where areas with a shallow water table may become water logged or actually flooded. This has become a problem around Cochiti Lake.

Presumably these areas could be protected by installing dikes to prevent direct flooding and high-capacity wells (discharging directly to the river) to prevent water-logging or indirect flooding. Protection of these areas demands long-term planning and installation of the dikes and wells during low reservoir periods.

Water Quality

A major problem that looms on the horizon is an increase in the total-dissolved-solids content of water pumped by wells. Seepage from the river may not be fast enough to sustain the chemical integrity of the ground water. In reaches where the river and ground-water reservoir receive a substantial volume of water with large dissolved solids concentrations from tributary systems, the location and pumping rates of wells will be especially critical.

Conflicts

We recognize two conflicts facing managers of river systems. One is water use. The other is the managers' objectives or responsibilities.

Changing water uses bring about changes in points of diversion from surface to ground water. As agricultural uses of water give way to municipal and industrial uses, wells divert an increasing volume of the total water used. In those areas where the water supply depends upon wells (as well as a surface-water diversion system), river management involves not only the controlling of the flow of water through the reservoir system to farmlands, but also the location of wells and the volume of water they pump.

Managers concerned with water quantity are not necessarily those responsible for water quality and vice versa. Although water may be allocated to a specific use

without impairing the water supply, such use may ultimately impair water quality. More specifically, diversion of river water or pumping of ground water for an irrigation scheme may not significantly impact water levels in the area, but subsequent flushing of salts from the unsaturated zone beneath the irrigated lands (in response to enhanced recharge) may elevate salinity of ground water.

Feasibility studies of water diversions often focus solely on water quantity. For example, Hearne (1980) reported that 37.5 cfs could be pumped to irrigate new farmlands in the Pojoaque River Basin. Of this amount, 26 percent was expected to become return flow. Although Hearne carefully simulated the impact of development on quantitative aspects of the water resources, he did not address the impact on chemical aspects in his report. Investigators should devote as much effort to the chemical aspects of stressing hydrogeologic systems as they do the quantitative aspects.

In conclusion, managers of the Rio Grande must cope with concepts, strategies, and models advanced by a variety of specialists. The successful manager will discriminate among these. He will recognize their shortcomings and set into motion a data-collection program to reduce their data deficiencies. He will use their short-range predictions and compare these predictions with the eventualities. But most

of all, he will be continually alert to our universal predicament: We live in a world of infinite variety, but must manage it with finite concepts and limited data.

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USING SYSTEMS ANALYSIS FOR FISHERY MANAGEMENT IN RIVER BASINS

Richard A. Cole, Associate Professor
Fishery & Wildlife Sciences
Timothy Ward, Professor
Civil Engineering
Frank Ward, Associate Professor
Agricultural Economics & Agricultural Business
New Mexico State University

Several themes have emerged from this conference: (1) underlying all of the discussion is an awareness of a manageable physical system in the Rio Grande Basin; (2) the system's water is valued in diverse ways; (3) opinions differ about how the system's water would best be distributed for the greatest social benefit; (4) improved planning for future water management and use is imperative; (5) desire to communicate and resolve differences in perceived values is earnest; (6) resolution of differences sometimes appears overwhelmingly difficult and; (7) better management tools are needed to define values in commonly understood terms, to logically sort out alternatives, and to analyze for optimal solutions to water-use problems.

I will briefly describe recent development of one management tool, which is specifically designed for managing

sport fisheries in the New Mexico Rio Grande. Fishery managers have long recognized a need for improved fishery management of river basins managed primarily for irrigation and flood control. Fish habitats in the Rio Grande and elsewhere in New Mexico fluctuate greatly in response to watershed supply and downstream user demand. Different reservoir and connecting-water habitats form a system of physically and economically linked parts. Management applied to any one of those parts usually has ramifications elsewhere in the system, many of which are difficult, if not impossible to predict without the organizational capability of computers. One current example is the impact of site-specific instream flow alterations on other parts of the river system. In large, complex river basins, like the Rio Grande, an array of tradeoffs can be expected with any proposed alteration of flows.

The need for a fishery management tool has grown more acute with growing awareness of the trends in fishery-resource supply and demand. Per capita angler expenditures (1980 dollars) have increased about 60 percent over the past three decades, reflecting growth in leisure time and disposable income (figure 1). The percentage of people who fish and the mean time each spent fishing has steadily increased. Also, the population of New Mexico nearly doubled between 1955 and 1985. Extrapolations of

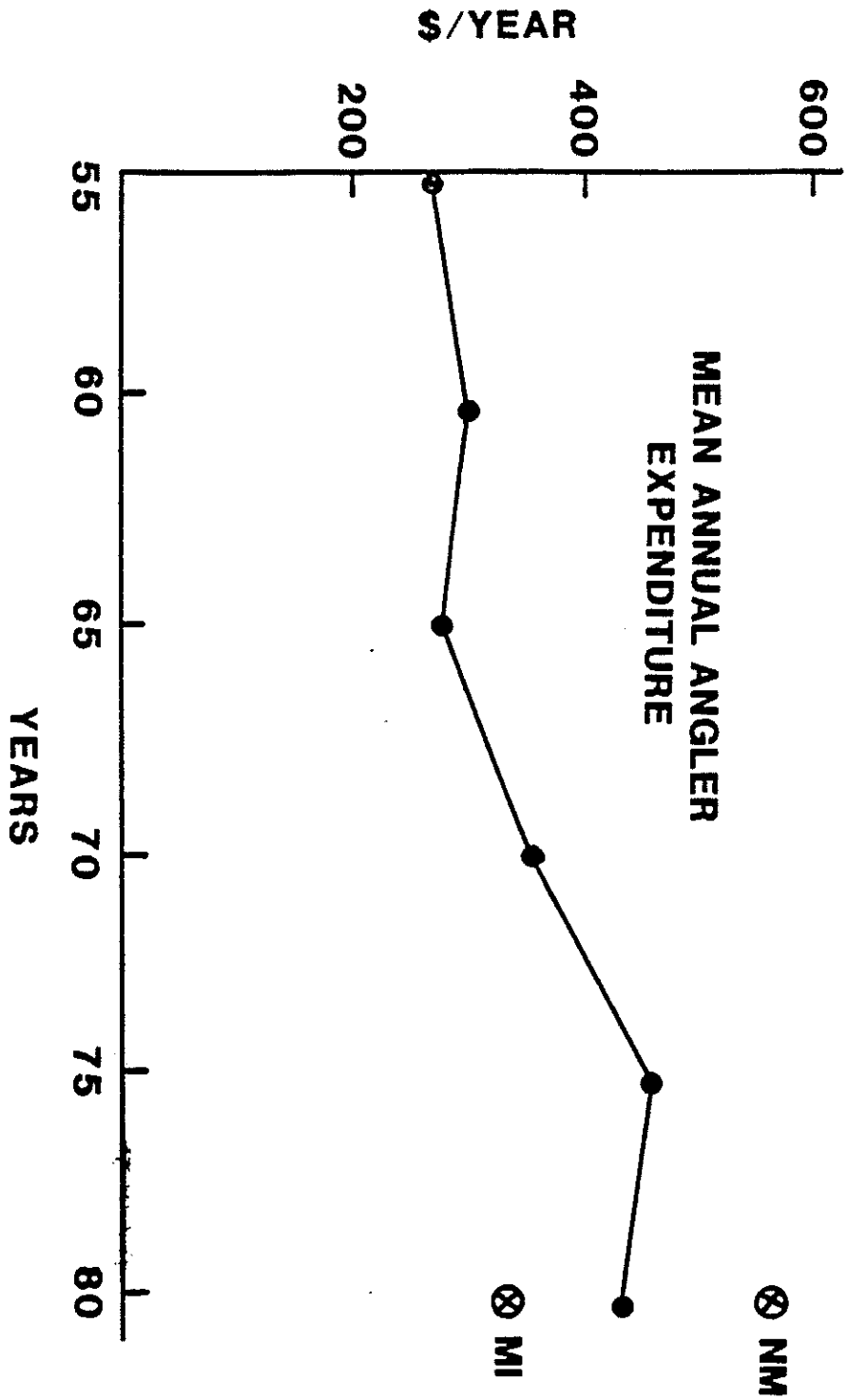

Figure 1. Per capita angler expenditure in the United States from 1955 to 1980 (corrected for inflation with 1980 dollars) and expenditures in New Mexico and Michigan in 1980.

past trends indicate that the fishing demand will increase by three to four times over the next 30 years. A challenge for fishery managers is to provide for increased demand in spite of limitations imposed by habitat availability and traditional aquacultural approaches.

Another challenge for fishery managers is to provide a better benefit-cost ratio for New Mexico anglers, who presently incur higher than average sportfishing costs. New Mexico residents spent nearly $600 each in 1980 for fishing experiences that cost the average U.S. angler about $450 (figure 1). Fishing costs more in New Mexico mostly because the average angler in New Mexico has to travel about twice as far as the average U.S. angler. Because anglers pay most of the bills for managing fisheries, the management agencies owe it to the anglers to provide more cost-effective angling, whenever possible.

Estimates of fish production and stocking in high- and low-water years illustrate the management challenges. Because total habitat and the mean fish productivity per unit habitat both decrease as waters fall from high-to low-water years, the total supply of fish varies from a high of about 21 million pounds to a low of about 4 million pounds with onset of drought (table 1). Because 1985 and 1986 were record high water years, recent natural production of fish has been nearly 20 million lbs per year, while the

Table 1. Estimates of natural production and stocked weight of fish (thousands of pounds) in high and low water years (based on mean estimates of production for state waters) and estimated demand for fish sampled in 1980 and 2010.

ESTIMATED SUPPLY AND DEMAND
FOR FISHERIES (THOUSANDS OF LBS)

	HIGH WATER	LOW WATER
SUPPLY (1985)		
STOCKING	1,100	1,100
"NATURAL"		
FLOWING WATER	3,000	400
MAIN RESERVOIR	13,500	1,900
SMALL RESERVOIRS	4,000	500
TOTAL SUPPLY	21,600	3,900
TOTAL DEMAND		
1980	3,400	3,400
2010	11,000	11,000

annual angler demand has been about 3.5 million lbs (10 lbs per angler). If 1985 had been a drought year the demand would have been at best equal to the total supply, and probably would have exceeded the available supply. Not all of the total supply is available to anglers because fish production in large water bodies is substantially inaccessible to the average angler. While small water bodies often yield 85 percent or more of fish stocked or naturally produced in them, large water bodies are likely to yield less than 25 percent of their potential. Because more than half the natural fish production in New Mexico occurs in large water bodies, the available supply is substantially lower than the total calculated fish production. If a drought occurs in the near future, the fishery demand will exceed the available supply. In thirty years, demand could exceed available supply even in high-water years. Thus alternative management approaches need to be considered.

A basic management strategy for analyzing alternatives was initiated in 1980 to develop a comprehensive planning tool -- a fishery management model for the Rio Grande. That model, completed in 1985, has served as a prototype for more comprehensive versions to be completed about 1990 for most of the the fishable waters in New Mexico. Model development has been financially supported by the N.M. Department of Game and Fish, the Water Resources Research Institute at New

Mexico State University, the Agricultural Experiment Station at NMSU, the N.M. Interstate Stream Commission, the U.S. Bureau of Reclamation and N.M. State Parks. An interdisciplinary research team was organized at NMSU in 1980 to develop the model, which simulates real-world linkages between hydrologic, biologic and economic elements for Rio Grande reservoirs and connecting waters (figure 2). The hydrologic component mathematically recreates flows of water, nutrients, and other materials over a nine-year period from 1975 to 1984. The biologic component estimates fish production through simulations of ecological processes that originate with water and nutrient flows, other material flows and solar energy influx. From the estimated fish production and various other social considerations (distance travelled, access, environmental considerations), the economic component estimates total angler benefits and county income generated. A model user applies a management alteration to the simulation of the historical (status quo) condition in the river and observes the affect on various hydrologic, biologic and economic outputs.

A sequence of management changes is applied at different intensities to develop an optimization curve through reiterative use of the model. Model users can alter water distributions, water flows, nutrient flows, suspended solids, fish stocked, fishing regulations, fishing access

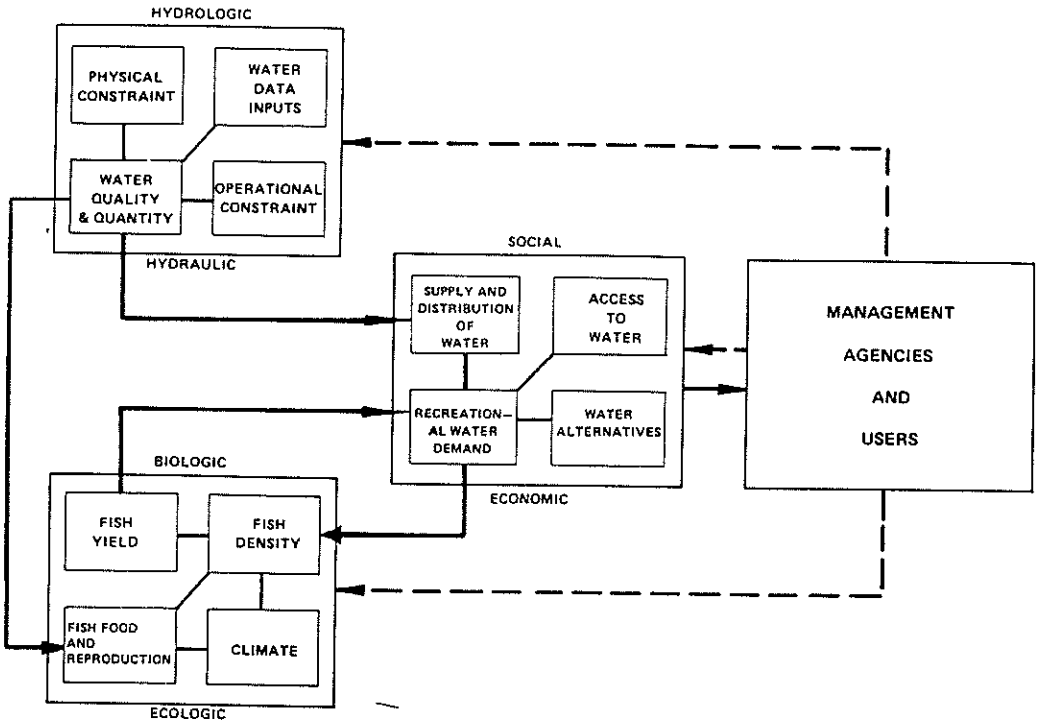

Figure 2. A schematic representation of the main components in the fishery management model RIO FISH, which simulates hydrologic, biologic and economic processes on the Rio Grande Basin.

and other policy related aspects. They can observe management impacts on water quantity and quality, fish population dynamics, fish food production, economic benefits and local income generated. The model has been made user-friendly so that managers with no computer experience can use it.

One example of model use is the analysis of instream flow considerations in the lower Rio Grande. One possible way to develop greater available fish supply is to improve connection-water habitat by maintaining year-round flows. Year-round flows would be desirable also because the connecting waters run past the most populated areas in New Mexico, thus anglers would have closer fishing and greater benefits. However, analyses with the model reveal some problems.

The primary problem is the potential impact on reservoir fish production. Under present water management policies, reservoir water levels fluctuate close to a desirable scenario for fishery management in many years (figure 3). Optimum natural sportfish production, without stocking, occurs when water levels rise before spawning occurs (usually about early March) and are held high until early life history is complete when the water is dropped back to low cool-season levels. The major difference between desired and realized water fluctuations occurs about

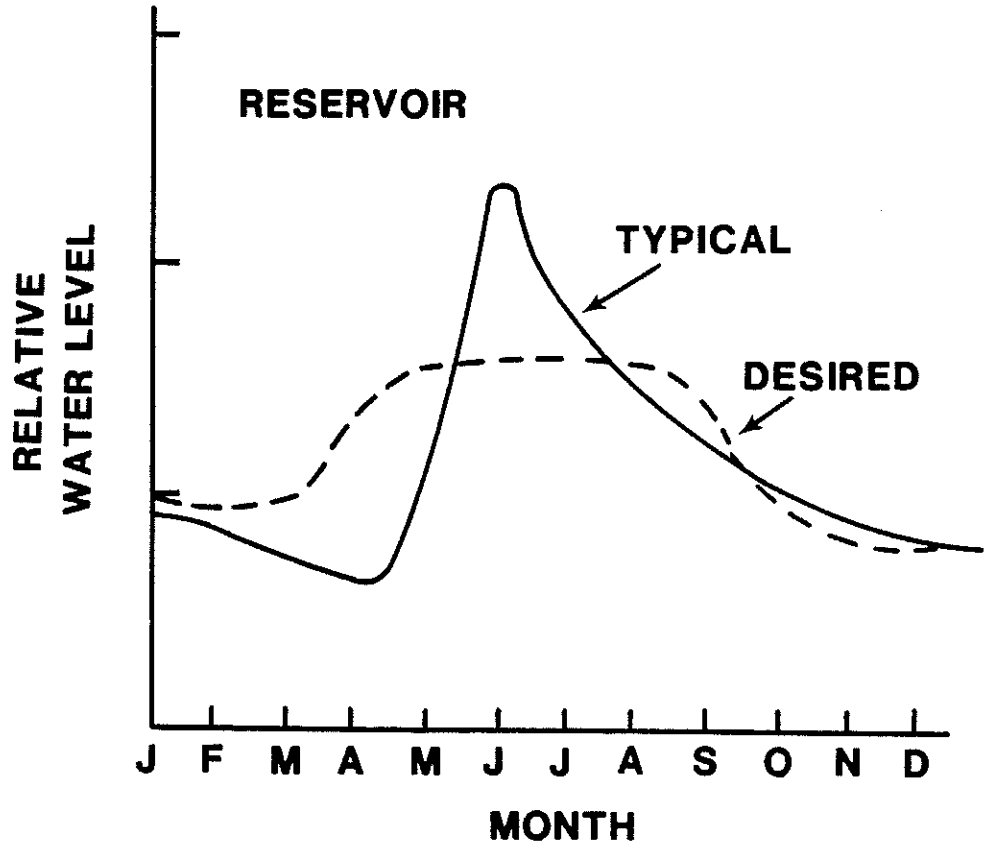

Figure 3. A "typical" high-water pattern of water-level fluctuation in New Mexico irrigation reservoirs contrasted with a desirable fluctuation for optimal fish production.

March through May when irrigation demands can cause water levels to drop sharply during early spawning before snowmelt runoff counter balances drawdown. A little later in the season, rapid snowmelt runoff can far exceed irrigation demand and sharply rising waters can inhibit other spawning. The lower the initial reservoir water level, the greater the relative impact on fish reproduction. The model quantifies these impacts and, in a future version, will enable the fishery manager to mitigate impacts through appropriate stocking or harvest regulations, or, possibly, through some modification of reservoir release rates.

In contrast with reservoir fluctuations, the flow through connecting waters in the lower Rio Grande usually varies greatly from a desirable flow for most sportfish (figure 4). Desirable flows vary depending on species, but a flow approaching constant with short periods of higher discharge to remove fine sediment from spawning sites, is a commonly encountered scenario. The desired flows differ greatly from the status quo conditions and would require large river-management modifications to develop. However, because connecting waters are strategically placed, such scenarios are worthy of consideration among model analyses of management alternatives.

Such a scenario is represented in a simplified schematic shown in figure 5. In a scenario established to

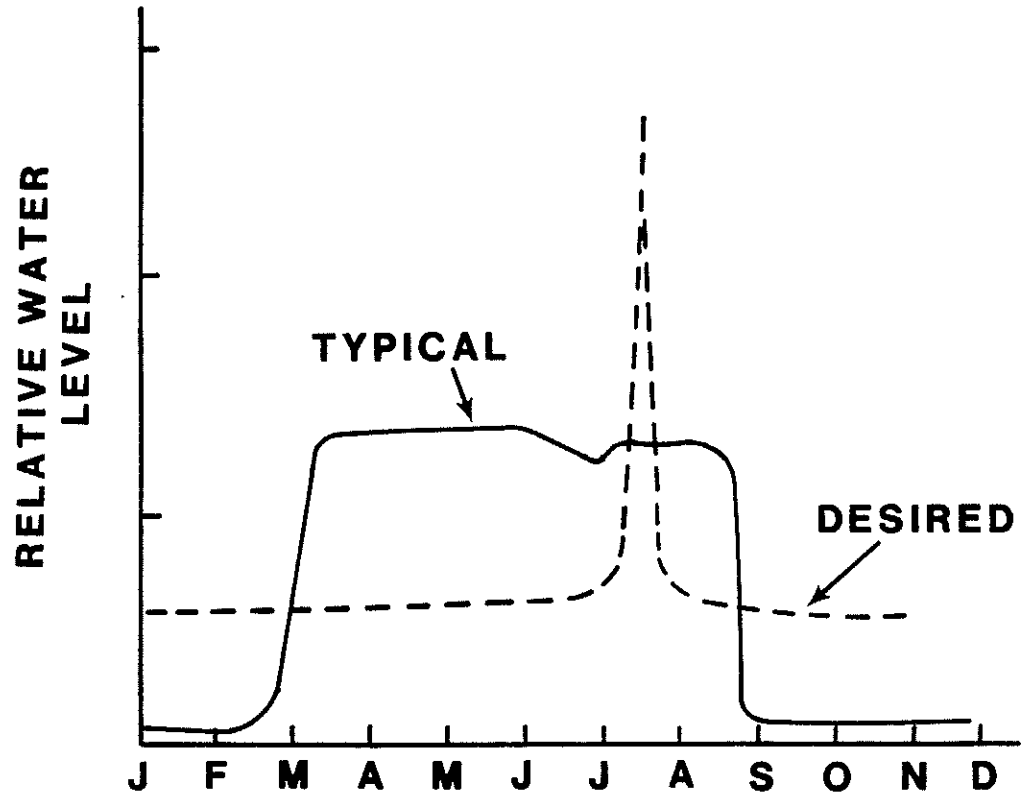

Figure 4. A "typical" pattern of water discharge fluctuation in connecting waters between irrigation reservoirs contrasted with one possible alternative flow for optimal fish production.

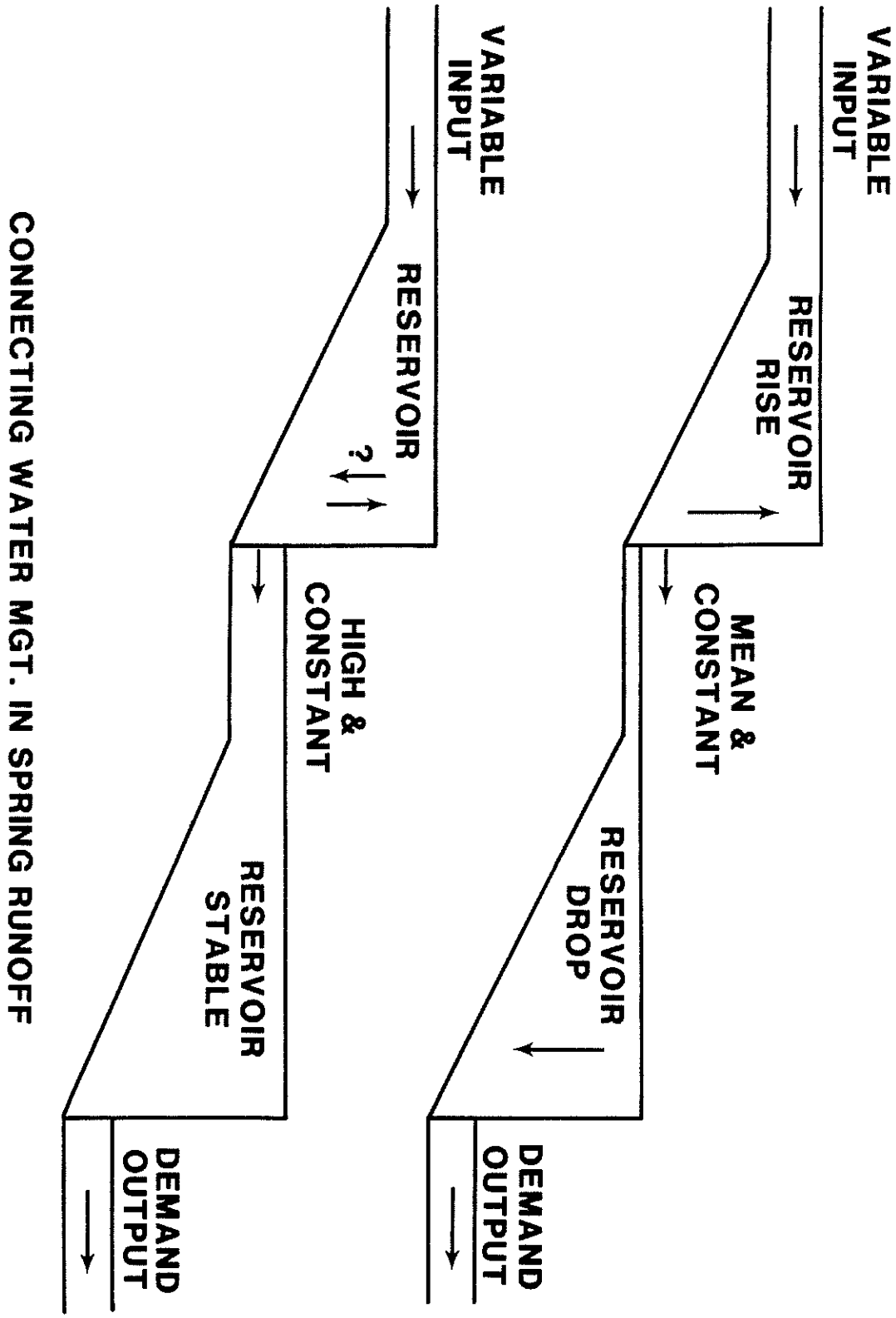

Figure 5. Two scenarios exemplifying the relative impact of different instream flow maintenance on reservoir water levels during the spring runoff and time of most reservoir fish spawning. In the upper example, connecting water flows held at an average annual discharge causes high elevational fluctuation in upper and lower reservoirs. In the lower example, connecting water flows held at the irrigation demand flow cause more stable water levels in both reservoirs.

maximize production in a connecting water by maintaining a constant mean annual flow between two reservoirs, dramatic ramifications occur in the reservoirs during the spawning period. At that time irrigation demands exceed mean annual river flows and water level in the lower reservoir drops. Simultaneously in most years, the snowmelt discharge into the upper reservoir increases water levels. Levels in both reservoirs shift rapidly in low-water years, causing large, if not total, reproductive losses of many game species. In such a situation, benefits gained in the connecting-water fishery would be countered by losses in the reservoirs; possibly to the extent that overall reservoir and connecting-water fish yield decreased. Thus, such a scenario would not be the most desirable for managing fisheries.

An alternative scenario, managing the flow of connecting water so that it closely matches the irrigation demand and the upstream inputs, would result in better reservoir conditions. This scenario would sacrifice high productivity in the connecting water but result in a greater combined fish productivity, yield and economic benefit in reservoirs and connecting water. Of course some intermediate operational state between the two presented in figure 5 may be the best scenario for fishery management.

A more complicated analysis could be conducted with

incorporation of other water uses such as, for example, boating on the reservoirs and rafting on the connecting waters. As long as economic values were available for boating and rafting under various hydrologic regimes, scenarios could be developed that optimized for their use as well as for fishing. An expanded model could calculate water-based recreational values directly, but this one does not now do so.

Important model limitations are now being investigated to increase model utility. For example, because of the greater inherent fish production in reservoirs, more attention has been paid to reservoirs than to the connecting waters. The model is being expanded to allow analyses of the fishery economic consequences of diverting flows from the connecting waters into ponds and small streams managed specifically for fisheries before the water is returned to the river.

Preliminary analyses (ballpark figures) have indicated that half the fishery demand for Albuquerque in 30 years could be provided with intense management of about 3,000 surface acres in small lakes constructed on the river floodplain. The annual cost in consumed water would be about 20,000 acre-foot/year. At $60/acre-foot, the water used would cost $12 per angler annually. It would also cost $100 million to dredge the lakes (20 feet deep) and maintain

them over the 30-year period. Prorated annually, a yearly cost of $3 million would add another $24 per year per angler to the management bill. Stocking would cost another $5 per angler per year. The cost for the urban fishery would be about $40 per angler each year for half of his or her fishing. In the process, the angler's travel bills would be reduced to about $400 per year and the total cost would be reduced from $600 to $450, close to the mean annual value for the United States as a whole. Thus, the expected demand in 30 years could in theory be met by redistributing water of certain connecting waters into intensively managed urban fisheries. The expanded model should allow more precise examination of costs and benefits.

The existing model is limited to the mainstream river and does not include small waters in the peripheral watershed. Because many of these small reservoirs are intrinsically more manageable than the larger water bodies, they provide at least half of the total stocked and natural fish yielded in New Mexico. Therefore, watershed modeling is being incorporated with the existing model to enable fisheries management in waters outside the mainstream river. A watershed approach will also allow direct analysis of various watershed management scenarios on water quantity and quality. The present model relies entirely on U.S. Geological Survey gauges for information on water flow.

Substantial water enters reservoirs without being gauged, thus a watershed approach ultimately will provide a more accurate model.

The model is also being extended to the river basins of the Pecos, Canadian, San Juan and Gila rivers over the next several years. In its final form, the model will allow economic impact analyses of management in one watershed, on water used in other watersheds, and it will include roughly 85 percent of the state fisheries. Model validation is underway and will continue as the model is developed.

THE NEED FOR DIALOGUE IN BASINWIDE MANAGEMENT

Steven J. Shupe

Program Consultant

Western Network

Many of you have been contacted regarding a project in which Western Network is putting together a handbook about how the Rio Grande Basin is managed. The handbook turns out to be a springboard in helping groups come together to discuss various issues around water management in the Rio Grande Basin. It turns out that our work at Western Network and the Annual New Mexico Water Conference are plowing common ground.

Rather than trying to be reasonable and rational about research, which is the topic of this session, let me shake things up a little bit and take a look at the way we're going in western water resources.

We are in a transition in New Mexico as well as throughout the West regarding water resources and water management. While I think the presentations today were excellent, I think we are looking backward. We see river management as control, as ways of harnessing the river, as building levies and rehabilitating habitat. But if you look forward, you will see throughout the West that there are a whole lot of water management elements we can't control.

I used to be the assistant attorney general in Colorado and as a former state official, I can say that in some ways water will manage and control us unless we become prepared to deal with these forces. Not all the forces are negative, however.

I'd like to discuss four of the forces I think haven't been addressed at this river management conference. I think they need to be addressed in a meaningful way so that we may prepare for the future.

The first of those forces is water marketing. We hear that term water marketing used, and it is very subtly and effectively shaping water management decisions in many areas of the West. The water market has been operating in Colorado for many years. For example, when the city of Fullerton, a Denver suburb, announced it had secretly borrowed $13 million worth of agricultural water rights from north of Denver, it also announced it was pulling out of the Newport Reservoir project. Several Colorado cities had planned to contribute to the costs of that project, but Fullerton found it cheaper to go out and buy agricultural rights.

In Arizona, speculators and investors are buying up ground water rights that were created and grandparented by the 1980 Arizona Ground Water Management Act. Using eastern capital, those speculators are wheeling and dealing with $35

million in western water rights. Here in New Mexico we see the water market in operation to a lesser extent. Albuquerque is a big actor in this picture and when you are buying and selling water the way they are, the long term implications on river management are very important.

Another force that we really haven't touched upon during this conference is the role of local Indian tribes in water management. You can't go anywhere in the West these days without reckoning with tribal rights to water. For 100 years these rights have been sitting dormant, but now the tribes aren't sitting there watching that water flow down the river and letting the non-Indian world use them without paying.

The tribes' paper entitlements to these massive quantities of water are both causing conflict and requiring cooperation as the tribes attempt to translate their paper entitlements into "wet" water. It's not only the water rights per say that the tribes are trying to control, they're also exerting tremendous control over the management of the water resources. They seek control over the water resources that flow from one jurisdiction to another while crossing tribal boundaries.

This year under the Clean Water Act and the Safe Drinking Water Act, Congress gave the tribes the same status as states to get federal funding to control pollution

discharges and to manage water quality control. You can't just talk water management on any river system where there are Indian reservations without talking about the rights of the tribes both to their water needs and to their jurisdiction. I hope the round table discussion tomorrow accommodates that perspective.

We have touched on the third force a little today through the question and answer sessions--public interest. In New Mexico we see that feelings are stronger than elsewhere concerning the public interest in water resources, at least we see that sentiment in the courts. The public right to instream flows is a component that is gaining importance throughout the West, and not just because of the aesthetic and spritual qualities of water that we heard discussed here today.

It is an absolute necessity to protect instream uses in western states where recreation accounts in great part for the stable economic base. Mining, energy and agriculture all fluctuate, but the recreation component is very strong. I see the results of that strength in states such as Wyoming and Utah--not just among the "hot tubbers" in California--that are passing instream flow protection laws. I think any state that does not pass such laws is hurting itself in the long run and not just because of the economic and aesthetic values.

Instream flows are becoming a big part of the western water picture. States like Wyoming and Utah, for example, realize that they also want a say in how the federal government controls claims to instream flows on Wild and Scenic Rivers, and now the national forests and wilderness areas are established and administered.

Another reason states are wanting to get in on instream flow decisions is the Public Trust Doctrine. The Public Trust Doctrine is creating the possibility of the courts requiring that the state protect its instream flow values even to the extent of jumping ahead of senior irrigation users to protect the stream. So states are saying let's get our instream flow program established so that we can control it.

I think the public interest certainly has to be part of managing the river in the years ahead. Twenty years from now it will be incredible for anyone in this field to think that in the 1980s the state legislature didn't consider instream flow as an integral part of water management.

The other problem with the public interest, which we know well here in New Mexico, is the protection of rural communities. In the Sleeper ruling, which involved water rights in a rural ski basin community, the court said that although there was a willing seller and a willing buyer, the

sale would not be allowed because it was not in the public interest.

What will the public interest mean to us in the future? How will it impact river management? We need to look ahead at these questions and decide where we want to go.

The fourth force I see affecting water management is "maximum utilization." The legislatures are using that term, and the courts are shoving it down the throats of state engineers. The courts are trying to encourage efficient use of the resource. Nineteenth century mentality is giving way to a recognition of the need to manage water resources in such a way that it maximizes its benefits.

However, there is certainly controversy and differences of opinion over what "maximum utilization" means. Maximum utilization, conservation and efficiency are forces that need to be reckoned with in managing the river.

We are seeing these new forces--water markets, Indian water rights, public interest and minimum utilization--emerge in the western water picture. We are seeing coalitions of environmentalists and entrepreneurs cooperating to promote the water market. And we are seeing coalitions of Indian tribes, energy companies and municipalities banding together to create new uses of water.

These new partnerships are making some groups nervous about the water market and what it is doing to instream

flows and community values. They are saying let's get together and talk about it and see where we're going. It's going to take thought, cooperation and dialogue to learn how we can all benefit from this valuable and precious resource.

MANAGING THE RIVER: A ROUNDTABLE DISCUSSION

The Roundtable Discussion of the water conference consisted of questions and answers based upon written questions submitted by the audience and two hypothetical water management scenarios. The scenarios were patterned after the successful Public Broadcasting series, "The Constitution". In this instance, each panelist, as the spokesperson for his agency or interest, made decisions relevant to the water management scenario. The videotape of the scenario segment of the Roundtable Discussion is available on loan from the New Mexico Water Resources Research Institute. The following has been transcribed and edited from the question and answer segment of the Roundtable Discussion.

ROUNDTABLE LEADER:

- George William Sherk, Attorney, Land and Natural Resources Division, U.S. Department of Justice

ROUNDTABLE PARTICIPANTS:

- Sam Arquero, Governor, Cochiti Pueblo
- Jeris Danielson, State Engineer, Colorado Division of Water Resources
- Robert M. Findling, Deputy Director, New Mexico Department of Natural Resources

- Jesse B. Gilmer, Texas Compact Commissioner, Rio Grande Compact Commission
- Narendra N. Gunaji, U.S. Commioner Designate, International Water and Boundary Commission
- Eugene Hinds, Regional Director, Southwest Region, U.S. Bureau of Reclamation
- Monte G. Jordan, Acting State Director, U.S. Bureau of Land Management
- Robert L. Knutilla, District Chief, U.S. Geological Survey/Water Resources Division
- Lt. Col. David E. Peixotto, District Engineer, U.S. Army Corps of Engineers
- Steve Reynolds, State Engineer, New Mexico State Engineer Office
- Michael J. Spear, Regional Director, U.S. Fish and Wildlife Service
- William P. Stephens, Secretary, New Mexico Department of Agriculture
- Phillip Wallin, Southwest Regional Manager, Trust for Public Land, Santa Fe.

Sherk Assuming no change can be made in the basic water law of New Mexico, would transfers of existing water rights from irrigation purposes to recreation or instream purposes be contrary to

water conservation in the state or detrimental to the public welfare of the citizens of the state?

Wallin I consider water conservation to mean the highest and best use of water for the public welfare. And instream flow fits that definition in the sense that it's a nonconsumptive use. It's an opportunity to use water twice. I enjoy being a skier and a boater and drinker. It gives me that feeling of righteousness about multiple use of water. It's compatible with water conservation. In fact, it enhances water conservation. We need to recognize that New Mexico is urbanizing. The people in Albuquerque are certainly as interested in recreation and wildlife as they are in eating vegetables and drinking water. There are those for whom recreation is not a luxury, it's a necessity. I count myself as one of those. I wouldn't be in New Mexico if I didn't have the opportunity for water based recreation. I feel that changes in the the law--you would have to change the law as I understand it--should make instream flow, without diversion, a benefieial use. I feel it would enhance the public welfare for the citizens of New Mexico.

Sherk Mr. Reynolds, would it be necessary to change the law to protect instream uses?

Reynolds Yes.

Sherk Would or could the instream flow advocates be willing to bear the burden of proof of nonimpairment of existing water rights as well as bear the costs of water rights acquisitions and the necessary litigation to protect that water right? If you were representing the Public Land Trust, how would you respond?

Reynolds It would be very expensive. I doubt that Public Trust members themselves would be willing to pick up the extra cost. The administration that would be required to protect an instream right would be quite expensive and probably should be paid by whatever state agency was in charge of acquiring diversion rights and converting them to instream flow rights. It would only be fair for the state to pay that cost rather than charge it to the water users in general.

Sherk Mr. Spear, the Fish and Wildlife Service clearly

has an interest in instream flows. To what extent do you think the service might be able to assist on the acquisition of instream flows, which is a polite way of saying "Can you pay for it?".

Spear Under certain circumstances that might be a possibility. For instance, if it were for the protection of endangered species and certain water rights were critical I can see the service perhaps agreeing to pay for instream flow rights for an endangered species in an emergency when something had to be done quickly. I think the tide is moving in the direction of maintenance of instream flows for the public trust. Most state and federal wildlife agencies are not going to be anxious to step up and say they will pay for the water necessary to maintain fisheries. In many cases adjustments can be made to do a good job for both. Are agencies willing to pay for instream flow rights? In extraordinary situations, yes. On a more routine basis, probably not.

Sherk Mr. Stephens, you are involved with agriculture. The questioner asks how you prioritize beneficial uses? Are public health, safety and welfare of

water uses more important to public welfare and economics than instream flow uses. How do you come up with a priority? How much water should still go into agriculture? How much should stay instream for tourism? How do you balance the necessary uses of water?

Stephens I am involved in agriculture. We do use a main portion of the water in this state. We have to recognize the essential things. You have to have water for drinking. But when we go to other uses, such as fishing and saving an endangered species, then it becomes a little less distinct. We have to protect the people who have the water rights at the present time. Someone has to pay if that farmer gives it up. I was interested in the comment yesterday from the attorney from Colorado who said if we do not go to instream flow its like shooting ourselves in the foot. As I look at it, if you do go that way, it might be like shooting the farmer in the head.

Findling I'd like to respond to all three questions. First, there are a lot of different ways to look at instream flows. From a pragmatic standpoint

you need to identify those streams that are worthy of instream flow protection. In many instances in New Mexico those streams are located on public land in many of the state's wilderness areas and on Forest Service and BLM lands. In many cases those streams are wild and scenic rivers. I don't think there's a lot of interest in establishing instream flows in stream channels such as the lower Rio Grande that are unstable and have silted bottoms. In many instances the streams that need protection or that are desirable for instream flows are not streams that represent an impairment to agriculture. What the instream flow would do would be to establish protection for the stream in its present state. It wouldn't impound water because the water would still flow downstream. Only in some instances would there be consumptive use. If consumptive use means increased evaporation or some increase in transport losses, there are public entities that are willing to compensate for that impairment. Certainly in the case of the 6,000 acre-feet delivered for the Elephant Butte minimum pool, there is 300 acre-feet of instream flow losses. We pay to offset that 300 acre-feet of transport losses.

The key is to exercise managerial discretion in establishing goals that the water management community can all focus on and work toward achieving. Relative to the question of litigation, if we focus on managerial discretion when identifying what reasonable losses and consumptive uses are accrued to instream flow as defined under the present water law, then we can work toward compensating for those impairments. Another point is that the state of New Mexico cannot afford to trade one economy for another. Certainly we can't afford to retire water rights from agricultural land on a large scale in order to re-establish instream flows. We have to identify means and management techniques that provide a joint use for that water so we can have our cake and eat it too. It's very cheap. It's a very reasonable goal to reach. It's one that we can work toward in making these uses a success. Relative to the questions of public welfare and economics, it's clear that as the state's economy shifts from the traditional emphasis on extractive industries and agriculture toward tourism and recreation, instream flows will become a rea_ity. It exists in Colorado. If the state is going to

work toward improving its economy it's essential that we not think of ways to preclude the possibility of improving the state's water use for recreational purposes. We must work toward achieving that goal and minimizing the impact it has on existing water uses.

Wallin To give a good example of that, I want to thank Ray Shollenbarger, attorney for the Middle Rio Grande Conservancy District (MRGCD) who did a wonderful thing this summer in working with Bob Findling and state parks by providing late summer weekend releases on the Rio Chama for recreation. There was no gain and no loss as far as I know to the MRCD in coming up with a plan whereby their irrigation release from El Vado came down on the weekends to provide instream flow of 1,000 cfs for recreation. That was a terrific example of cooperation for the public benefit. It was common sense multi-use management. I also want to thank Gary Daves and the Albuquerque Water Resources Department, which did something similar this summer.

Sherk Mr. Danielson, you and I are alone here to uphold

the honor of the great state of Colorado. Colorado has an instream flow law. If you were an adviser to Mr. Reynolds, how would you advise him regarding protection of instream flows in New Mexico?

Danielson It's difficult to say how I would advise Mr. Reynolds on an instream flow program for New Mexico because I think such a program cuts far beyond what the State Engineer or any state agency does. Perhaps if I describe the Colorado program it might give Mr. Reynolds and other members of agencies here in New Mexico some ideas. Our water laws are similar to those in New Mexico. We're also a prior appropriation state. About 10 years ago Colorado became very concerned about two things. First, environmental groups were extremely concerned about instream flows. Second, the agricultural interest became very concerned because the environmentalists were concerned. Agriculture consumes about 94 percent of our water. We foresaw a lot of environmental groups coming in because of the broad definition of beneficial use in our state. We perceived being faced with all kinds of instream flow applications

and nobody was willing to bet on what the Supreme Court would do about the question. So we identified one agency in the state that was granted the authority to obtain instream flows. That was the Colorado Water Conservation Board, which is something akin to the Interstate Stream Commission in New Mexico. To date that agency has filed for instream flows on approximately 7,000 miles of streams in Colorado. The rights for those instream flows fit into our priority system. Many of them are recent applications in late 1970s, late 1980s, which generally are not of much value in terms of consumptive use. But when you look at the location of most of those streams, you'll find they're in wilderness areas and on forest lands. So they do preserve those flows in those recreational and forest areas from any future degradation. There have been instances where on our critical streams the state has put up money to go out and purchase a senior water right and dedicate that consumptive use to an instream flow. Instream flow is not something to be feared. Without major law changes, you can have a program that meets that environmental need and still preserves those water rights that are critical to the state's economy.

Sherk When water laws were formulated many of today's interests--aesthetics, fish and wildlife resource protection, and recreation--were not integrated into the process. How can the agencies and organizations represented on the panel ensure that these interests are represented in the future?

Peixotto The future is much easier than the past. Most of the laws that affect our flood control projects are fairly old laws, going back into the 60s and earlier, back before the days of the National Environmental Protection Agency (NEPA), before the days where we had an environmental conscience to the extent we have now. To modify the way we operate our projects is going to take changes in the law as we look to the future and future projects. We do have in place the mechanisms of NEPA, the mechanisms of the Endangered Species Act and the whole host of laws from the environmental 60s and 70s. In the future, the stage is set for not having the kind of challenges we now have.

Sherk Mr. Hinds, Bureau of Reclamation projects operate with fairly strict criteria regarding their congressionally authorized purposes. How do you

expand your management role or change it to address things like instream flows?

Hinds Like the Corp of Engineers, we are mandated by a number of laws going back to 1902. I'll have to concur with the colonel that since NEPA there's very little that we do in the way of river management that doesn't get the scrutiny of the public, even on river maintenance. We have to prepare an environmental assessment, an opportunity for comment from the public on what we're doing. We have cooperated to the best we can, at the same time meeting our obligation to the people who are paying for the water to implement instream flow uses. We work with Mike Spear's office very closely on fisheries and hopefully if it's within our ability and existing law and policy we can cooperate with all the entities on all uses of water. But laws are laws and that's what the colonel and I operate under. Congress mandates what we do and if there's going to be any changes required, that will require changes in the law.

Sherk Yesterday we heard Mr. Wallin suggest a number of

changes which might be made to protect instream flows. Rather than asking him to repeat those, I'm going to ask Mr. Spear if he were sitting in the chair occupied by Col. Peixotto or Mr. Hinds, what would he do?

Spear The question asked if the fish and wildlife, aesthetics and recreation interests are represented. I think the fish and wildlife interests are very well represented. I have no problem at all working with the Corp of Engineers and the Bureau of Reclamation. We don't always like what they decide because the law generally gives the construction agency the final decision. You really can't have it any other way. Sometimes I would like to have the final decision but in fact they're the ones building the project so they get to make the final decision. However, the law is good in making them take fish and wildlife interests seriously. I represent the national interests, but we also bring in the state interests. What it really boils down to in many of these cases is that the interests that I represent and their constituency are growing in strength. It's a differential strength depending

on where you work. In some parts of the country it's a lot stronger than others. In some cases the more traditional water interests are still strong and the decisions tend to go that way. So the final decision still comes down to what the public opinion is to a great extent. If I were sitting in their shoes, the only thing I would do differently is perhaps bring a little different consciousness. But we would still work under the same laws. The public interest is key. They simply have to get more involved. At times they just don't seem to be as interested as those people who are trying to build the projects. I don't have any doubts that Col. Peixotto and Mr. Hinds take those interests very seriously. I feel very well represented. The question is that sometimes I feel our point of view isn't seen as important. Sometimes you hear those comments about whether endangered species and fish and wildlife are as important. I think they're increasingly more important and will get considered that way.

Reynolds I think those interests alluded to in the question are protected. For example, we have one of the

first if not the first wild and scenic rivers in New Mexico. It takes up a long reach of the Rio Grande and a very important part of Red River. We've got at least three federal reservoirs that require minimum releases. They're not protectable once they're released, but nonetheless they are required. Perhaps most important is that the geography as well as the land ownership patterns in New Mexico protect what are some of our best streams. There's no real opportunity for reservoirs in these high mountain streams or even agriculture, so it seems to me those interests are protected. We should not denigrate what we do have. There are some excellent fishing streams in New Mexico and the several reservoirs we have also provide considerable recreation opportunity not only for fisherman but boaters and others that enjoy water recreation. So let's not put down what we do have.

Sherk Mr. Jordan, Mr. Reynolds mentioned this Wild and Scenic rivers designation of the Rio Grande and part of the Red River. Yesterday we had a discussion on how the process came about by which those two river segments were protected. Is that

the kind of procedure you would like to go through every time a wild and scenic river is protected or is there another approach, perhaps based on instream flow laws, that might be preferrable?

Jordan Let me say first that BLM does not have a general authority for acquiring or adjudicating instream flows. We have adjudicated only the Red River. We have not adjudicated any instream flows on the mainstem of the Rio Grande. My staff tells me we only have one real authority and that is the Wild and Scenic Rivers Act, which we can use to obtain instream flows. The process we followed in the Red River is a good one because it brought everybody into the picture. We don't like to short cut that process. We find it helps to have the full involvement of the state and federal agencies and local government. When we get to the end of that process then we have something that everybody will live with and we can manage.

Sherk Mr. Wallin, in light of what you've heard this morning, do you think those are still appropriate suggestions? Are there others you would like to make? If you were sitting in Col. Peixotto's or

Mr. Hinds' chair, how would you protect multiple resource values from projects that have a limited statutory authority?

Wallin One phenomena I noticed is that people who have the power of a public agency behind them continually say they're obliged to operate in a certain way by statute. They say their hands are tied and this is the only way they can act. I've had enough debates with the colonel and Steve Reynolds and others that I know there is a range of discretion on how you read the laws and how you apply the laws. For example, flood control management of the Rio Grande is not an open and shut case. There is a lot of discretion about how much water to let out and when to let it out. We need to have better communication, but right now the environmental community is in one water tight compartment and the water management agencies are in another. We need to break down the walls between the departments and have some sort of roundtable discussion here in New Mexico. It might have to be a very big table, or maybe it would be better to have a very small table, but we've got to have some kind of ongoing

structure--informal or formal--whereby various water management people and various environmental people can stay in communication on a continuing basis. We in the environmental community must become part of the constituency for the Corp of Engineers, for the Bureau of Reclamation, and for the state engineer rather than be like minute men sniping at them from behind bushes as is our want. It is vital to have the kind of talking relationship that is structured and happens on a regular basis where we get to know each other on a first name basis and become familiar with each other's Organic Acts, operating requirements, vocabulary and concerns.

Sherk Governor Arquero, I'll move on to you now. I knew you had been invited to be on the panel but I wasn't sure you would be here. I was concerned that I would have a panel talking about the waters of the Rio Grande without representation from the pueblos. That would be like having a car running on three wheels. What is your interest in instream flows and how do you best go about defending them?

Arquero Let me just interject something here. I agree with the gentleman's comments relative to communication. There is a big lack of communication with the Corp of Engineers and with all the agencies within this state. I'm not here as an expert on the complexity of water management but I'm here as a concerned citizen representing the Pueblo Cochiti. Cochiti has faced a drastic problem on the reservation with seepage below Cochiti Dam. I mentioned that yesterday. The council and I as a governor were willing to cooperate with whatever agency we could deal with to correct the problem. We've had many sessions with Steve Reynolds, with the colonel, and with others of my good friends. And it appears to me that they all have a sincere concern to correct the situation at that level. However, I don't know where the delay is and who has the final authority to correct it. The authority is so complex and it's awfully difficult to understand just who has the authority to allow our water storage in the lake, and who has the authority to release the water. But I think by sitting down and communicating that we can understand one another and perhaps help one another in this

situation. As I indicated yesterday, I was disappointed and frustrated because the slides showing damages all the way down to Elephant Butte Dam made no mention of Cochiti. Today I hope you'll take the time to see the film we brought, which shows the damages that are occurring below the dam. Our farmland is under water today. Somewhere someone is responsible for the damages that have occurred. I don't know if that answers your question sir, but those are the circumstances.

Sherk That's fine. Would anyone like to own up? I will ask one more instream question because it's a specific question for Mr. Reynolds. Senate Bill 426, which was passed in September, required that fish, wildlife and other environmental issues be given equal consideration in the granting of hydropower licenses. Will that bill have an effect on New Mexico water management?

Reynolds I can see no important effect at this time. Hydropower is not a thing that's of great importance in New Mexico. We do have the elevation in many places. But there are efforts,

particularly by Los Alamos, to develop hydropower both at El Vado and Abiquiu reservoirs. But these will be simply "run of the river" power plants so I can predict no substantial effect on the environmental or instream flows, or on any of the environmental issues we have discussed here today.

Spear I'd like to add something to that and give an example of what's happened after this law was passed. The Fish and Wildlife Service made instream flow recommendations below two dams in Texas that were going back to the Federal Energy Regulatory Commission (FERC) for relicensing. In other words, their regular license of 40 or 50 years had run out. We are making recommendations to increase the flow below those dams. Of course this is being resisted by the hydropower authorities, which are basically the river authorities in Texas. But I'm pleased to say that the FERC is taking it very seriously and next Wednesday there'll be a meeting in Washington over one of the dams. In essence, not only are any new hydropower projects required to get a license from the FERC, but any license that needs to be reissued will be looked at. The license possibly

will require more appropriate flows below the dam so the fisheries and recreation interests can be better served. The new Electric Consumers Protection Act will have an effect on the situations that come up. But as Mr. Reynolds has said, there won't be many cases in New Mexico.

Sherk Mr. Reynolds, why should state law permit people who have access to a good public water supply drill their own wells?

Reynolds The fundamental reason is for administrative convenience. But, one has to review the history a bit. Back in the 30s as I recall it, maybe early 40s, there was a great oil boom and people needed water. It was hard to get because in Hobbs the growth of the population was so great the state engineer in effect turned them loose and said go ahead for a domestic well. I guess the legislature recognized the wisdom of that and for administrative convenience provided that by filing an application and a fee of $1, the state engineer would be required to grant a domestic well permit without concern as to whether or not that well would impair existing water rights. Those wells

are still subject to the doctrine of prior appropriation and could be enjoined if in fact it turned out they were impairing senior water rights. I think administrative convenience is correct in that if a community gets large enough to have enough domestic wells to impair existing rights they fairly quickly see that their own economic advantage dictates a community well for which they must acquire water rights pursuant to the regular procedure. Also, we have a number of applications for domestic wells right here in Santa Fe where there is a public water utility. And more often than not the permit is never exercised because by the time one looks into the costs of drilling, operating and maintaining his own water system, bearing in mind that the well will probably go out on Monday, a private water supply is not worth it. There isn't too much of that that goes on.

Sherk I'm going to make a wholesale leap then to the Sleeper decision. I might ask if you would like to summarize that very briefly for the audience. In your opinion, Mr. Reynolds, does the Sleeper decision represent an appropriate application of

the public interest standard to proposed transfers of water rights? And if not, why not?

Reynolds We don't have a Supreme Court decision on that yet and there remains considerable uncertainty in New Mexico as to what the term public welfare means. I'll not try to tell you, I'll refer you to Black's Dictionary. But if that opinion is extended, I can briefly say that the problem with the Sleeper decision is that the irrigation water rights could not be transferred to develop a ski resort. As I recall, it was for the reason that it would be detrimental to the traditional community ditch management and economy in that area. Now then, as I say if that is extended, it will certainly deprive the irrigation water right owners of a substantial value of their water rights and that might not be consistent with the public welfare.

Sherk One of the members of the audience submitted a question which relates to your comment yesterday, Mr. Reynolds, that you served at the will of the governor. It seems you have served at the will of

a number of governors. The questioner was worried about there being continuity in water management in New Mexico. Although you may have been here for more than one term, many others haven't. There is a different management strategy with every election and with every flip of the coin. Are you concerned about continuity in New Mexico's water management and water policy? Conversly, is continuity all that important in a time when values are changing from expanded agriculture to recreation and instream flows?

Reynolds You put that very graciously. The state engineer, in my opinion, has not dominated water policy, he has administered it. The legislature sets the policy. We're fortunate that that original 1907 legislation has not been substantially modified. And I think that is in the public interest. That sort of stability is important. If in fact, continuity is not desirable, there's a sure and easy way to remedy that. The state engineer serves a two-year term. Let me add that it's not uncharacteristic for positions on New Mexico's Interstate Stream Commission, an important water agency, to be inherited. We have people on the

commission whose fathers served before them. In fact, there are at least three members, out of nine, whose fathers have served on the commission. And I think it has worked.

Sherk I have this image of the probate court judge sitting there looking at someone's last will and testament and seeing whether or not the grant of the position on the Interstate Stream Commission was within the person's testamentary capacity. Col. Peixotto, one of the members of the audience asked how you could justify ignoring the Endangered Species Act vis a vis bald eagles just because it was enacted after the authorization of construction of Abiquiu and Cochiti reservoirs?

Peixotto I would contend that we do not ignore the Endangered Species Act vis a vis, the bald eagle. If you look at the historical record, you'll find that before our projects were built the bald eagles weren't overwintering on the portion of the Rio Grande and Chama where we have our projects. Last year in times of peak water storage, we also had peak bald eagles overwintering. Every winter Army helicopter comes up from Ft. Bliss and we fly

up the Rio Grande between Cochiti Lake and Abiquiu Dam and count the bald eagles. As memory serves me, the count was 26 between Cochiti and Abiquiu, which was a record. So we do have great concern for the bald eagle. Those of you who know a little bit about bald eagles, and I admit to knowing just a little bit, know that their first choice in food is fish and the best place to get fish is out of flat water. Therefore, they tend to congregate around the flat water areas. So I disagree that we haven't considered endangered species. We take them into account very gravely in all of our actions.

Sherk The helicopter isn't an Huey Air-Cobra gunship is it?

Wallin That reminds me of the guy who wrote a letter to the editor last summer about Abiquiu and Cochiti saying, "I don't know what all the concern is about. It's a beautiful reservoir. I have a power boat and I went up to Bandolier National Monument. Golly, it's great. I finally got access to the monument. I don't see how anybody could object to this." I'd like to write back to

the guy about now as the waters go down and ask him how it looks now as a mud hole with a lot of denuded land and silt several feet deep and archeological sites you can't see anymore. As far as eagles using Cochiti, I think any biologist will tell you that the eagles do flock to a rising reservoir. However, they tend to fall off precipitously after the waters come back down. It has the effect of destroying perching trees and so forth. So I think its kind of a half-truth to say we've reached record numbers of eagles while the reservoir was at maximum. The question is what is sustainable?

Reynolds I think with regard to this particular issue, it is important to know that at the March 1986 meeting of the Rio Grande Compact Commission, it was reported that the operation of the flood control reservoir on the Rio Grande had prevented $120 million of damages in 1985.

Sherk Does anyone else on the panel care to address endangered species?

Findling I would like to comment on Steve's response about

the $120 million. An important issue in that report is that it did not mention what other management techniques also could have provided equal flood protection while enhancing recreation and environmental values and benefits. There are a lot of different ways to manage and achieve like goals.

Spear We administer the Endangered Species Act. Col. Peixotto has to come and ask our opinion on things like management of Abiquiu as it affects bald eagles. Its only fair to comment on how we saw that question. The Endangered Species Act does not say that you can't affect an eagle or even 20 eagles. It does have a say in how you affect the continued existence of a population or a species or a subspecies. In this case, our opinion was easily that the continued existence would be affected, even though all 20 might move somewhere else. Had this been a breeding population our opinion might have been different. We would have looked at it as a southwestern desert breeding population, which does exist in Arizona. But here we're dealing with wintering populations. We told that to Col. Peixotto. We may find that when the

water goes back down there may not be as many of them hanging around. The plain fact is the Endangered Species Act doesn't come into play and prevent something simply because it may be an impact on one or two animals or a great number. We are talking about a rather large wintering bald eagle population coming from the north and wintering in the south. That population extends over a wide range of states to the south and so its very hard to find how it may affect a particular lake. So I have to agree with the colonel. He did not ignore the act as it relates to that incident.

Sherk Mr. Jordan, is the increased cutting of trees by the Forest Service a concern to fish and game management agencies regarding runoff?

Jordan I think the most foolish person in the world would not try to answer a question for the Forest Service. However, let me turn it around a little. In the BLM, we have a close working relationship with the state Game and Fish, hopefully also with Mike Spear, on any of our activities. I'm sure that that relationship exists with the Forest

Service. If they see anything that we're doing that might impact the resources that they're charged to protect, they'll tell us and we work with them. I think that answers the question.

Knutilla The U.S. Geological Survey is working for the Forest Service on some proposed studies in the Las Vegas area where there may be some logging. We plan on monitoring stream flow, water quality and sediment load to find out the impacts on runoff. The Forest Service is indeed concerned about the runoff and quality of water as a result of logging practices.

Sherk Excellent, especially since I have to defend the Forest Service. I love to hear things like that. Dr. Gunaji, one of the participants raised a question about whether future development in Mexico is going to increase demands on the Rio Grande, which might require an amendment to the existing compact or an additional mechanism by which water could be supplied to Mexico. I'd appreciate your comments.

Gunaji Before I answer the question I should make some

observations. I'm still a commissioner-designate, so my answer is going to last 50 minutes because I'm coming from academia. The second thing I want to say is that I've observed the operations of the agency from outside this department, so I want you to decide the entanglement of any answer I give. I have Mr. Joe Valdez, the principal engineer for the commission, who will assist me with the technical part of the question. I will answer the question as follows, keeping in mind that I have a right to change my answer after I take office.

Sherk Everyone else does, why should you be any different?

Gunaji The division of waters between the two republics is a little more complex than as is done under the treaty. Under the 1906 treaty we are committed to deliver 60,000 acre-feet of water at the international border just north of El Paso. That particular item cannot be changed under whatever circumstances the development occurred in Mexico and the United States. Until such time we are obligated to operate under that agreement. If any development occurs in Mexico or the United States

that would change this, we are going to require another treaty convention to change those figures.

Sherk Under that agreement though, coming to Mr. Gilmer now, would increased flow into Mexico require an amendment or renegotiation of the Rio Grande Compact?

Gilmer No. The Rio Grande Compact recognizes the treaty with Mexico and the states that require delivery of 60,000 acre-feet of water a year by the International Boundary and Water Commission at El Paso. Bear in mind that the Rio Grande Compact is the law of Colorado, New Mexico, Texas and the United States. But an international treaty, approved by the senate and signed by the president, takes precedence over any domestic law in this country. Should the international treaty be changed, it would be incumbent upon the commissioners of the Rio Grande Compact to give due consideration to any changes in the compact.

Reynolds One needs to look at Article 14 of the Rio Grande Compact for the answer. It says, "The schedules herein contain the quantities of water herein

allocated shall never be increased nor diminished by reason of any increase or diminishment in delivery or loss of water to Mexico."

Sherk How would the compact commissioners respond to an issue raised by someone in the audience? Should the compact require renegotiation to protect environmental values because when the compact was negotiated those values were not nearly as important as they are now?

Gilmer I would reply this way to attract Mr. Phil Wallin to my answer: We have today white water running in the Rio Grande downstream from El Paso where we put the river through a thing we call the "little box" where white water is going at least 25 ft. in the air from time to time. I appreciate Phil being here today instead so he won't have trouble on the Rio Grande with white water rafting. Phil, that's a joke.

Wallin To refer to that as white water is a joke!

Sherk How does the water stored in the reservoirs above Santa Fe affect the compact?

Gilmer The laws authorizing the construction of the flood control reservoirs upstream from Santa Fe must respect the Rio Grande Compact as being the law of the three states and the United States. The compact also respects the rights of any Indian tribe on the river. I don't see any conflict between the Rio Grande Compact and the Flood Control Act because the act is built around the Rio Grande Compact. There are only certain circumstances under which water can be stored and released--possible danger, loss of life and danger to major structures. The law is compatible enough, I think it's the administration of the law that gives us trouble.

Sherk There is one area that is near and dear to my heart, growing up as I did overlooking the Missouri River, fondly known as the Big Muddy. That's the area of silt. I've always liked silt. There were two questions submitted about silt. So panel you may turn your thoughts to silt. Land erosion is a very serious problem. Is anyone presently studying silting problems?

Knutilla We have initiated two activities that address

silting, one with the Bureau of Reclamation and one with the Corps of Engineers whereby we are doing some cross sections on the Rio Grande. These two agencies are concerned about the impacts of silting on some structures.

Sherk In a related question, does any of the silt that's flowing into Elephant Butte contain toxic elements?

Knutilla We have not investigated that specifically yet but we've done a lot of water sampling on the Rio Grande. We have also looked at such things as water quality in the Bosque del Apache. But the work to date has been data collection as part of other activities or the kind of work at the Bosque del Apache that may be done in perhaps FY 88.

Hinds Because we have the responsibility to keep the water moving down the river, when we identify areas that need corrected we work with the USGS to look at the silt depositions in the river. We also maintain a close surveillance on our reservoirs to see what the silt aggregation is. When we design reservoirs, and I'm sure the

colonel works the same way, we build into that reservoir capacity for sediment deposition. We've found that it really isn't economical to go into a reservoir and remove silt. We don't plan it that way. We usually use another reservoir to replace the one built up. In that manner we feel we are doing as good a job as we can.

Reynolds The Soil Conservation Service under the Department of Agriculture has done a great deal to undertake sediment control in New Mexico. There is also a Soil Conservation Division of the state's Natural Resources Department which addresses that problem. The Environmental Improvement Division, under the general provisions of our Water Quality Act, has on occasion recommended best management practices in forestry in the harvesting of timber. Appropriate procedures are followed to minimize erosion. It has been demonstrated by the Department of Agriculture that the harvesting of timber improves water flow. At the same time, unless good practices are followed, it also greatly increased the sediment that will go into the reservoirs.

Gilmer You might mention that according to engineering literature in existence when Elephant Butte reservoir was designed early this century, the dam was predicted to be completely filled with sediment by now. The facts are that last night at midnight we had stored in the dam, 2,370,000 acre-feet of wet water.

Jordan Proper management of the public lands has always had an underlying mission of reducing erosion as much as possible. We adjust this with proper land management practices related to grazing, to the construction of small retention dams to catch the silt to keep it out of the mainstream of the Rio Grande, and ongoing studies. For years we've been involved in a study with the Forest Service in the Rio Puerco drainage and we're hoping that that's going to add to the knowledge that we all need to control it. We're actively involved in this on a continuing basis.

Wallin I had the privilege of going out to the Rio Grande drainage with Paul Applegate of the BLM and looking around. I was astounded at the degradation out there. In my idealistic way, I

wondered if there wasn't something interagency that could be done to reduce the silt runoff there. I went on one of my pilgrimages to see John Cunico at the corps. We locked ourselves in a room as an experiment to see if we could agree on something. We allocated half an hour and tried to come up with something we could agree on as a way the environmental community could work together. So I put forward this possibility on the Rio Puerco: Couldn't the Corp. of Engineers be the lead agency in devising structural or nonstructural ways of impeding the soil erosion and the sediment load up there? And I think John basically said they looked at it and it wouldn't work. Anyway I wonder who could look at it again? There's got to be a way we can deal creatively with that running sore in the Rio Puerco drainage.

Sherk I'd like to allow one more response. We all know that it all comes from Colorado anyway--I mean the silt. Mr. Danielson, you're upstream.

Danielson Silt or water all measures the same at the interstate gage. I don't want to berate the issue of silt in forest management, but I'm convinced

that the U.S. Forest Service and their forest management program to increase runoff comes to us from the People's Republic of California. And its a ploy to steal more Colorado River water. Seriously though, we've looked at it in great detail in Colorado, both the U.S. Forest Service and our own state forest service. It's great to keep chip board plants going, but we found that it makes the streams more flashy, the hydrographs peak higher, the runoff occurs at a shorter period and there are major contributions of silt. We do everything we can to subvert you client there, chopping down all the aspen.

Sherk Thank you all for your comments.

WATER CONFERENCE PARTICIPANTS

Katharine Adams
League of Women Voters
416 Apodaca Hill
Santa Fe, NM 87503

Martin W. Aguilar
San Ildefonso Ave.
Rt. 5 Box 315A
Santa Fe, NM 87501

Fred Allen
Plains Electric Coop.
P.O. Box 6551
Albuquerque, NM 87197

Fred Ambrogi
Ameriwest Corp.
P.O. Box 25625
Albuquerque, NM 87125

Elmer Aragon
No. N.M. Legal Services
P.O. Box 1454
Las Vegas, NM 87701

Sam Arquero
Cochiti Governor
P.O. Box 59
Cochiti, NM 87041

Ames Atencio
Siete del Norte
P.O. Drawer B
Embudo, NM 87531

Frank J. Bailey
Sangre de Cristo Water Co.
P.O. Box 1268
Santa Fe, NM 87501

Ken Balizer
City of Albuquerque
City Council
1 Civic Plaza, NW
Albuquerque, NM 87103

W. Peter Balleau
Leggette, Brashears & Graham
Inc.
423 Sixth St., NW
Albuquerque, NM 87102

Clare Bernero
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Jim Blizzard
San Juan County
305 S. Oliver Dr.
Aztec, NM 87410

Karen A. Bova
American Indian Law Center
P.O. Box 4456 Station A
Albuquerque, NM 87196

Dorothy Boynton
Rt. 9, Box 387
Santa Fe, NM 87505

Eric Briggs
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

F. Lee Brown
University of New Mexico
1915 Roma, NE
Albuquerque, NM 87131

John R. Brown
State of New Mexico
State Capitol
Santa Fe, NM 87503

Martin A. Brown
City of Albuquerque
P.O. Box 1293
Albuquerque, NM 87103

Lee Case
U.S. Geological Survey
505 Marquette, NW
Room 720
Albuquerque, NM 87102

Elaine Catanach
New Mexico State University
Student
Box 3782
Las Cruces, NM 88003

Sanford Caudill
Arch Hurley Consv. Dist.
P.O. Box 1167
Tucumcari, NM 88401

John Cawley
BIA - Albuquerque Area Office
P.O. Box 26567
Albuquerque, NM 87125-6567

Arthur Chan
New Mexico State University
Department of Economics
Box 3CQ
Las Cruces, NM 88003

Calvin Chavez
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Vincent Chavez
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Jay Chester
Ameriwest Corp.
P.O. Box 25625
Albuquerque, NM 87125

Peter Chestnut
Lawyer
620 Roma NW, Suite D
Albuquerque, NM 87102

Raymond P. Churan
Dept. of the Interior
P.O. Box 2088
Albuquerque, NM 87103

Robert Clark
4317 Rio Grande Blvd. NW
Albuquerque, NM 87107

John Cochran
State Engineer Office
4949 San Pedro NE, #25
Albuquerque, NM 87109

M. Bradley Compton
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Quincy Cornelius
San Juan County
1229 N. Mesa Verde
Farmington, NM 87401

John Couzens
State Engineer Office
909 E. Second St.
Roswell, NM

Wayne Cunningham
N.M. Dept. of Agriculture
Box 3189
Las Cruces, NM 88003

Martha Dabney
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Tom Davis
Carlsbad Irrigation District
201 S. Canal
Carlsbad, NM 88220

Robert Deitner
New Mexico State University
Box 4901
Las Cruces, NM 88003

Frank DiLuzio
Santa Fe Metro Water Board
Box 276
Santa Fe, NM 87504

Quentin Drunzer
City of T or C
Box 209
Williamsburg, NM 87942

Frank A. DuBois
N.M. Dept. of Agriculture
P.O. Box 3189
Las Cruces, NM 88003

Richard Earl
New Mexico State University
Department of Earth Sciences
Box 3AB
Las Cruces, NM 88003

Henry Edgar
U.S. Fish & Wildlife
P.O. Box 1306
Albuquerque, NM 87103

Phillip Enis
New Mexico State University
Department of Agricultural Economics
P.O. Box 3169
Las Cruces, NM 88003

Jim Everheart
State Engineer Office
3502 Kathryn SE
Albuquerque, NM 87106

Larry Ferns
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Edd Fifer
El Paso County Water Imp. Dist.
294 Candelaria
El Paso, TX 79907

William Fleming
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Diane Flock
Lee Wilson & Associates
P.O. Box 931
Santa Fe, NM 87504

Randy Foltz
New Mexico State University
Student
Box 3CE
Las Cruces, NM 88003

Roger Ford
SCS - USDA
517 Gold Ave. SW, Rm. 3301
Albuquerque, NM 87102-3157

Dennis Fordham
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Robert S. Freeburg
New Mexico State University
Dept. of Civil Engineering
Box 3CE
Las Cruces, NM 88003

Janet Garcia
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Jeff Gardner
Sunwest Bank
P.O. Box 25500
Albuquerque, NM 87125-5500

W.O. Gary
Elephant Butte Irrigation Dist.
Star Route 35
Hatch, NM 87937

Aileen Gatterman
League of Women Voters
12215 Casa Grande NE
Albuquerque, NM 87112

Phillip Gavurnik
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Robin Gelston-Walls
U.S. EPA
1201 Elm St.
Dallas, TX 75228

R. LeRoy Givens
Boyle Engineering
3939 San Pedro NE, Suite D
Albuquerque, NM 87110

Maxine Goad
N.M. Environmental Improvement
Division
P.O. Box 2502
Santa Fe, NM 87504

Barry Goldstein
N.M. Solar Energy Institute
Box 3SOL
Las Cruces, NM 88003

Ed Gonzales
San Ildefonso Pueblo
Rt. 5 Box 318AB
Santa Fe, NM 87501

John Goodfellow
Bureau of Indian Affairs
P.O. Box 1060
Gallup, NM 87301

James L. Goodrich
N.M. Research Institute
1105 Gardner
Las Cruces, NM 88001

David Gottlieb
891 16th St.
Boulder, CO 80302

Jay Groseclose
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Alice Grisham
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Raymond Gurule
Bloomfield Irrigation District
P.O. Box 606
Bloomfield, NM 87413

Samuel J. Hall
City of Albuquerque
P.O. Box 473
Estancia, NM 87016

Steve Hamp
BIA - Albuquerque Area Office
P.O. Box 26567
Albuquerque, NM 87125-6567

David Hanna
N.M. Environmental Improvement
Division
P.O. Box 968
Santa Fe, NM 87501

James Harder
L.A. County Utility Sept.
P.O. Box 30
Los Alamos, NM 87544

Deborah Hathaway
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87501

David Henderson
National Audubon Society
P.O. Box 9314
Santa Fe, NM 87504

Steven L. Hernandez
Martin Law Firm
P.O. Drawer W
Las Cruces, NM 88004

Lucy Hilgendorf
Western Network
1215 Paseo de Peralta
Santa Fe, NM 87501

Richard Hirsch
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Rita S. Horton
Entranosa Water
NSR Box 150
Edgewood, NM 87015

Richard Hughes
Luebben, Hughes, Tomita &
Borg
201 Broadway SE
Albuquerque, NM 87102

Larry Icerman
N.M. R&D Institute
1220 S. St. Francis
Santa Fe, NM 87501

Peter Jacobsen
6151 Indian School
Albuquerque, NM 87110

Henry Jenkins
EPCDG - Water Resources Committee
Rt. 1 Box 71
Clovis, NM 88101

Terrell Johnson
P.O. Box 327
Los Alamos, NM 87544

Conrad Keyes, Jr.
New Mexico State University
Dept. of Civil Engineering
Las Cruces, NM 88003

Thomas R. Kincheloe
Army Corps of Engineers
1114 Commerce St.
Dallas, TX 75242

Stephanie Kruse
N.M. Environmental Improvement
Division
P.O. Box 968
Santa Fe, NM 87504-0968

Noel Larson
Forest Service USDA
795 Trammel NE
Albuquerque, NM 87122

Edwardo Lavadie
S.W. Research & Information
Center
Box 4388, Trujillo Lane
Taos, NM 87571

Gene Leyendecker
City of Albuquerque
P.O. Box 1293
Albuquerque, NM 87103

Andrew Lieuwen
University of Arizona
Student
8080 E. Speedway #202
Tucson, AZ 85710

John Lissoway
National Park Service
Bandelier National Monument
Los Alamos, NM 87544

Charles Liston
Bureau of Reclamation
Denver Federal Center, Bldg. 56
Denver, CO 80225

Don Lopez
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Jose N. Lucero
Soil & Water Conservation
Division
Villagra Bldg.
Santa Fe, NM 87503

J. Roger Madalena
Jemez Pueblo
P.O. Box 255
Jemez Pueblo, NM 87024

Peter Magdalena
Jemez Pueblo
P.O. Box 78
Jemez Pueblo, NM 87024

Craig Mapel
New Mexico State University
Department of Agricultural Economics
Box 3169
Las Cruces, NM 88003

Charles Martinez
Rio Grande Conservation District
P.O. Box 581
Albuquerque, NM 87103

Manuel Martinez
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Sherman Martinez
San Ildefonso Pueblo
Rt. 5 Box 315A
Santa Fe, NM 87501

Barbara Mattingly
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Karen S. McAda
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Thomas McGuckin
New Mexico State University
Department of Agricultural Economics
Box 3169
Las Cruces, NM 88003

Mary Miello
Camp Dresser & McKee
5301 Central NE, Suite 1204
Albuquerque, NM 87108

William Miller
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Harold Morgan
Sunwest Bank
P.O. Box 25500
Albuquerque, NM 87125-5500

Clair R. Morris
Designwrights
407 East Palace Ave.
Santa Fe, NM 87501

Dan Murray
Soil Conservation Service
517 Gold Ave. SW
Albuquerque, NM 87102

Sharon Murray
N.M. Environmental Improvement
Division
P.O. Box 968
Santa Fe, NM 87504-0968

Allen Nakaidinae
New Mexico State University
814 Poe
Las Cruces, NM 88001

James B. Nixon
State Engineer Office
530 S. Melendres
Las Cruces, NM 88005

Paul G. Novotny
Chino Mines Co.
P.O. Box 234
Bayard, NM 88023

Edwin Nyirendra
New Mexico State University
Student
P.O. Box 4577
Las Cruces, NM 88003

Gordon Odell
Soil Conservation Service
517 Gold Ave SW
Albuquerque, NM 87102

Lou O`Dell
Plains Electric Coop.
P.O. Box 6551
Albuquerque, NM 87197

Aubrey Owen
Ghost Ranch Conference Center
Abiquiu, NM 87510

Dan Page
Bureau of Reclamation
700 E. San Antonio, Rm. B318
El Paso, TX 79901

Steve Palmer
Mining & Minerals Division
525 Camino de los Marquez
Santa Fe, NM 87501

Lee E. Peters
State Land Office - Legal Div.
P.O. Box 1148
Santa Fe, NM 87504-1148

Chuck Pettee
Bureau of Land Management
P.O. Box 1449
Santa Fe, NM 87501

James Pratt
N.M. Environmental Improvement
Division
P.O. Box 968
Santa Fe, NM 87504

Edith Pierpont
League of Women Voters
Route 9 Box 72-4
Santa Fe, NM 87505

Sandra Lee Pinel
Pueblo de Cochiti
Box 70
Cochiti Pueblo, NM 87011

Paul Powers
2712 Coors SW
Albuquerque, NM 87105

Margaret Prince
1808 Dartmouth NE
Albuquerque, NM 87106

Alex A. Puglisi
N.M. Environmental Improvement
Division
P.O. Box 968
Santa Fe, NM 87504

Lewis T. Putnam
State Engineer Office
216 S. Silver
Deming, NM

Carmen Quintana
La Herencia en Santa Fe
P.O. Box 8553
Santa Fe, NM 87504-8553

David O. Quintana
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Joseph Quintana
Cochiti Pueblo
P.O. Box 70
Cochiti Pueblo, NM 87041

Bob Ray
Plains Electric Coop.
P.O. Box 6551
Albuquerque, NM 87197

Jose A. Rivera
University of New Mexico
1829 Sigma Chi NE
Albuquerque, NM 87131

Sidney Rollinson
U.S. Air Force
27CES/DEMM-WW
Canon AFB, NM 88101

Sammy J. Salazar
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Blane M. Sanchez
BIA Southern Pueblos Agency
P.O. Box 1667
Albuquerque, NM 87103

Todd Sargent
Watershed West
Santa Fe, NM

Steve Schwebke
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Thomas R. Shelley
Chino Mines Co.
P.O. Box 7
Hurley, NM 88043

Peter Shoenfeld
P.O. Box 2421
Santa Fe, NM 87504-2421

James T. Smith
State Engineer Office
2340 Menaul NE, Suite 206
Albuquerque, NM 87107

Phil Soice
Sangre de Cristo Water Co.
P.O. Box 1268
Santa Fe, NM 87504

Pat Soule
U.S. Geological Survey
505 Marquette
Albuquerque, NM 87102

Cecil Stark Jr.
The University of New Mexico
Student
121 Sicomoro St.
Santa Fe, NM 87501

Neil C. Stillinger
Attorney at Law
P.O. Box 8378
Santa Fe, NM 87504

Gail Stockton
U.S. Army Corps of Engineers
P.O. Box 1580
Albuquerque, NM 87103-1580

David Stone
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

L.C. Strawn
Arch Hurley Consv. Dist.
P.O. Box 1167
Tucumcari, NM 88401

Ben Tafoya
Canon Domestic Water Assoc.
P.O. Box 123
Taos, NM 87571

Rita Loy Thomas
Entranosa Water
NSR Box 150
Edgewood, NM 87015

Jan F. Thompson
N.M. Environmental Improvement
Division
P.O. Box 968
Santa Fe, NM 87501

Sherry Tippett
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

James Tolisano
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Luis Torres
S.W. Research & Information
Center
3051 S. Riverside Dr.
Espanola, NM 87532

Paul Tosa
Jemez Pueblo
P.O. Box 117
Jemez Pueblo, NM 87024

Eddie Trujillo
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

John Tysseling
N.M. State Land Office
Box 1148
Santa Fe, NM 87504

Chrys Uhlig
City of Gallup
P.O. Box 1270
Gallup, NM 87301

Steven E. Vandiver
State of Colorado
P.O. Box 269
Alamosa, CO 81101

Scott Van Pelt
New Mexico State University
Department of Agronomy
Box 3Q
Las Cruces, NM 88003

Steven Van Vactor
New Mexico State University
Student
Box 3AF
Las Cruces, NM 88003

Charles Vigil
Tularosa Community Ditch Corp.
P.O. Box 145
Tularosa, NM 88352

Larry Vigil
State Engineer Office
Bataan Memorial Bldg.
Santa Fe, NM 87503

Fred Vigil
Rio Chama Acequia Assoc.
243 Los Alamos Highway
Espanola, NM 87532

Louhannah Walker
State Land Office - Legal Div.
P.O. Box 1148
Santa Fe, NM 87504-1148

Fred J. Waltz
No. N.M. Legal Service
P.O. Box 948
Taos, NM 87571

Frank Ward
New Mexico State University
Department of Agricultural Economics
Las Cruces, NM 88003

Ronald L. Ward
Soil Conservation Service
517 Gold SW
Albuquerque, NM 87102

Robert M. Whitenton
Rio Grande Compact Commission
for Texas
2403 Bliffara View
Austin, TX 78704

Jean Witherspoon
City of Albuquerque
Box 1293
Albuquerque, NM 87110

Jim Wright
403 S. Sycamore
Roswell, NM 88201

Keith A. Yarborough
National Parks Service
P.O. Box 728
Santa Fe, NM 87504-0728

WRRI STAFF PARTICIPANTS

Thomas G. Bahr
Director

Bobby Creel
Program Advisor

Linda G. Harris
Information Coordinator

Darlene Reeves
Project Coordinator

Peter Herman
Specialist

Ellie Khodaie
Administrative Secretary

Janice M. Apodaca
Reports Layout Typist

Toni Martinez
Accounting Clerk

Lucy Gaines
Student Aide

Sam Ojinaga
Student Aide