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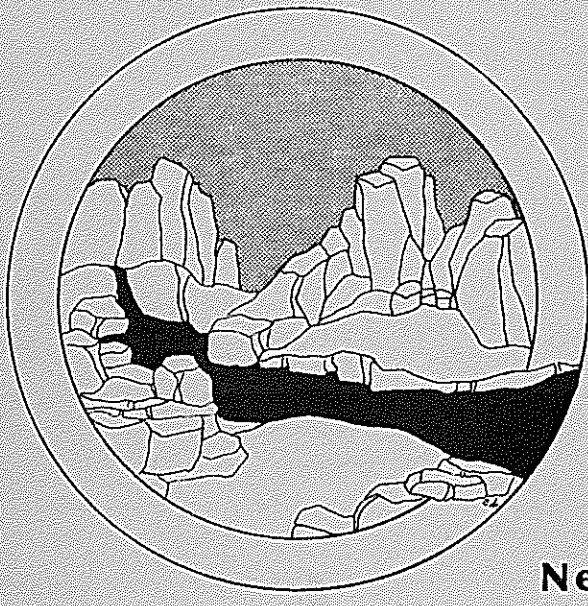

Proceedings of
Twenty-eighth Annual
New Mexico Water Conference

Water Quality in New Mexico

New Mexico Water Resources Research Institute

New Mexico State University • Box 3167, Las Cruces, New Mexico 88003

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WATER QUALITY IN NEW MEXICO

PROCEEDINGS OF THE TWENTY-EIGHTH

ANNUAL NEW MEXICO WATER CONFERENCE

New Mexico Water Resources Research Institute

New Mexico State University

Las Cruces, New Mexico

April 5-6, 1983

PREFACE

The dominant water issue in the past has been one of quantity--conserving the scarce supply. Knowledgeable people, however, realize that protecting the quality of our available water is just as important as conserving water quantity. To protect the state's water quality, we must have the necessary information for making management decisions regarding water quality.

Information exchange about water quality, then, was the primary goal of the 28th Annual New Mexico Water Conference entitled "Water Quality in New Mexico." The conference program was designed to make more New Mexicans, including agency people, aware of the scope of water quality research and information gathering being done in the state.

For the first time, the New Mexico Environmental Improvement Division (EID) and the U.S. Geological Survey (USGS) joined the New Mexico Water Resources Research Institute in sponsoring the conference. Through our combined efforts, we hoped to encourage more interaction among the groups involved in water quality issues.

Each of the three sponsoring agencies conducted a half day session that included an overview of its role in managing the state's water resources. Each agency also presented examples of its functions specific to water quality.

Brad Cates, former New Mexico State legislator and now the intergovernmental liaison for the Environmental Protection Agency (EPA), spoke to the conference about the EPA's role in water quality. Cates said the EPA recognized the state's primary role in ground water protection and urged states to develop protection strategies that consider both current and future water uses.

A group of high school students, ending a year-long study on water as part of a Contemporary Issues in Science program, also attended the conference. Their participation was in preparation for a student-run seminar on water which was presented a few weeks later.

The joint conference could not have been as successful if it were not for the careful coordination with the EID and the USGS. Special thanks for their efforts should go to Douglas Schneider, program manager of the Water Pollution Control Section, EID, and Lee Case III, chief of Hydrologic Investigations, USGS. This cooperation sets the stage for closer cooperation among all the agencies, state and federal, that are concerned with water quality in New Mexico.

George A. O'Connor

George A. O'Connor
Acting Director

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Russell Rhoades
David Tague
Timothy J. Ward
Donald B. Wilson

PROGRAM

Albuquerque Convention Center
Albuquerque, New Mexico
April 5-6, 1983

TUESDAY, APRIL 5
WATER QUALITY CONCERNS IN NEW MEXICO
Ballroom A

8:00 - 9:00	REGISTRATION Convention Center, ground floor
9:00 - 9:05	WELCOME George A. O'Connor, Acting Director NM Water Resources Research Institute
9:05 - 9:15	THE ENVIRONMENTAL IMPROVEMENT DIVISION'S ROLE IN WATER POLLUTION CONTROL Russell Rhoades, Director NM Environmental Improvement Division
9:15 - 10:15	PROTECTION OF WATER QUALITY IN MOUNTAIN STREAMS Panel Moderator: Russell Rhoades Panel Members: Charles Nylander, Chief NM Environmental Improvement Division David Tague, Program Manager NM Environmental Improvement Division Maxine Goad, Program Manager NM Environmental Improvement Division Anthony Drypolcher, Program Manager NM Environmental Improvement Division
10:15 - 10:45	BREAK
10:45 - 11:10	HYDROCARBON FUELS IN GROUND WATER--INCREASED AWARENESS AND CONCERN IN NEW MEXICO Devon Jercinovic, Water Resource Specialist NM Environmental Improvement Division
11:10 - 11:35	GROUND WATER QUALITY IN THE SOUTH VALLEY OF ALBUQUERQUE Dennis McQuillan, Water Resource Specialist NM Environmental Improvement Division

11:35 - 12:00 RIO PUERCO DEL OESTE: MUDDY ISSUES RAISED BY A MINEWATER-DOMINATED EPHEMERAL STREAM
Bruce Gallaher, Water Resource Specialist
NM Environmental Improvement Division

LUNCH
Ballroom B

12:15 - 1:30 THE ENVIRONMENTAL PROTECTION AGENCY AND THE STATES: A SPIRIT OF COOPERATION
Brad Cates, Director
Office of Intergovernmental Liaison
U.S. Environmental Protection Agency

INFORMATION NEEDS EXCHANGE
Ballroom A

1:30 - 1:35 INTRODUCTION TO SESSION
James F. Daniel, District Chief
Water Resources Division
U.S. Geological Survey

1:35 - 2:00 FIVE-YEAR PLAN FOR HYDROLOGIC INVESTIGATIONS IN NEW MEXICO
H. L. Case III, Chief, Hydrologic Investigations
Water Resources Division
U.S. Geological Survey

2:00 - 2:20 WATER QUALITY NEEDS OF THE INTERSTATE STREAM COMMISSION AND STATE ENGINEER OFFICE
Philip B. Mutz, Interstate Stream Engineer
NM Interstate Stream Commission

2:20 - 3:10 FEDERAL WATER QUALITY INFORMATION RESPONSIBILITIES, ACTIVITIES AND NEEDS
Panel Moderator: Frank Jones, Head
U.S. Bureau of Indian Affairs

Panel Members: Eugene Hinds, Regional Director
Southwest Region
U.S. Bureau of Reclamation

Lt. Col. Julian Pylant, District Engineer
U.S. Army Corps of Engineers

Monte Jordan, Associate State Director
U.S. Bureau of Land Management

Kenton Kirkpatrick, Deputy Director
U.S. Environmental Protection Agency

3:10 - 3:40 BREAK

3:40 - 4:05 INDIAN WATER QUALITY INFORMATION NEEDS
Delfin Lovato, Chairman
All Indian Pueblo Council

4:05 - 4:55 MUNICIPAL WATER QUALITY PROBLEMS AND INFORMATION NEEDS
Panel Moderator: T. E. Kelly, President
Geohydrology Associates, Inc.

Panel Members: Gustavo Cordova, Health Program Manager
NM Environmental Improvement Division

Frank DiLuzio, Director
Santa Fe Metropolitan Water Board

Paul Noland, Director
Water Resources Department
City of Albuquerque

Don Patterson, Director
Community Development
City of Carlsbad

WEDNESDAY, APRIL 6
WATER QUALITY RESEARCH EFFORTS
Ballroom A

9:00 - 9:15 WATER RESOURCES RESEARCH INSTITUTE RESEARCH AND INFORMATION RESOURCES
George A. O'Connor, Acting Director
NM Water Resources Research Institute

9:15 - 9:40 ANALYSIS OF WATER SAMPLES FOR TOXIC VOLATILE ORGANIC COMPOUNDS: STATE OF THE ART METHODS AND STRATEGIES FOR SAMPLING
Gary Eiceman, Assistant Professor, Chemistry
New Mexico State University

9:40 - 10:05 RAINFALL SIMULATORS AND SEDIMENT YIELD ESTIMATES
Timothy Ward, Associate Professor, Civil Engineering
New Mexico State University

10:05 - 10:30 ADVANCED WATER TREATMENT--ION EXCHANGE: APPLICATION FOR URANIUM REMOVAL
Donald B. Wilson, Professor, Chemical Engineering
New Mexico State University

10:30 - 11:00 BREAK

11:00 - 11:25 WATER QUALITY TECHNIQUES
Robert C. Averett, Regional Research Hydrologist
U.S. Geological Survey

11:25 - 12:00 CONFERENCE WRAP-UP
James F. Daniel, District Chief
Water Resources Division
U.S. Geological Survey

Proceedings Editor: Linda G. Harris

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NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE BACKGROUND

New Mexico's Water Resources Research Institute (WRRI), founded in 1963, was the first such organization in the United States. It also was among the first 14 in the United States financed under the 1964 Water Research Act.

The original purpose of the WRRI was to coordinate existing water research at New Mexico State University. When the institute was founded, 32 water research projects were in progress, scattered among 10 university departments.

Since then, the WRRI's goal has broadened to encourage water resources research throughout the state. The WRRI now works with all the state universities, state agencies, federal agencies and private firms which sponsor water research activities.

Unlike some of the other 52 water research agencies funded under the 1964 law, the New Mexico WRRI does no in-house research. Instead, the institute serves to help researchers obtain the means to do their projects and assists granting agencies in determining where research money should be spent.

Projects sponsored by the institute and its companion agencies also provide the means for students to do research leading to undergraduate and advanced degrees.

Projects selected for funding are first screened by a nine-member Program Development and Review Board which is made up of water authorities from universities and state agencies. Those selected by the board are then submitted to the funding agencies for final approval.

The WRRI assists in administering funds for approved projects while they are in progress and publishes the researchers' interim and final reports as appropriate. The WRRI distributes these reports to educational institutions, libraries, sponsoring agencies and other interested researchers.

Beginning in 1964, federal funding made up the bulk of the WRRI's budget. In 1970, the state legislature appropriated the first state funds, $104,000, to support water research through the institute. In

1982, federal funds made up about 43 percent of the WRRI budget at $560,000 with various state and private funds accounting for about 57 percent or $740,000.

The Annual New Mexico Water Conference, which dates back to 1956, was one of the earliest organized efforts to broaden the study of state water problems. About 150 persons attended the first conference and before it ended, they voted to make it an annual event. Each year since, the conference has been a public forum for federal and state decision makers, representatives of the water users in industry, recreation and agriculture, university researchers and state residents to discuss New Mexico's water problems.

A statewide advisory committee also advises the institute on New Mexico's water research needs and on the overall institute program.

UNITED STATES GEOLOGICAL SURVEY BACKGROUND

The Water Resources Division of the U.S. Geological Survey (USGS) is the principal federal water data agency in the state. The division collects and disseminates about 70 percent of the water information now being used by several state, local, private and federal agencies to develop and manage water resources.

In New Mexico, the USGS, in cooperation with the State Engineer and others, collects data and makes hydrologic and hydraulic studies relating to streamflow, reservoir content, ground water, physical and chemical character of water, and water use. Information resulting from scientific investigations and research efforts is available to the public through reports, maps and computerized information services.

A current USGS study of the Rio Grande drainage system in parts of New Mexico, Colorado and Texas will provide information about the quantity and quality of the ground water resources and their relationship to surface water supplies. Examples of other current USGS studies include water resources assessments in Cibola, Socorro and Catron counties, the Jemez geothermal area and the Zuni Reservation. These assessments will result in tables, graphs and maps which will provide a general description of the water resources in the study area.

The USGS is also conducting basin assessments in the Pecos River and Tularosa basins. Basin assessments are studies of hydrology in areas that are bound by topographic drainage divides. These studies provide information, such as precipitation-runoff relationships, stream gains and losses, effects of ground water pumping on streams and land use effects on stream flow.

Because energy development in New Mexico has a major impact on water resources, the USGS is collecting information on the effects of present and potential mining of coal and uranium. The USGS has conducted detailed hydrologic studies for analysis of the transport of nuclear and hazardous wastes by ground water at nuclear or hazardous waste disposal sites.

The USGS also provides hydrologic, scientific and technical assistance to other federal, state and local agencies. This assistance is also available to licensees of the Federal Energy Regulatory Commission and to international agencies on behalf of the State Department. The USGS Water Resources Division district office in New Mexico is in Albuquerque with other offices in Santa Fe, Las Cruces, Carlsbad and Farmington.

NEW MEXICO ENVIRONMENTAL IMPROVEMENT DIVISION BACKGROUND

New Mexico law charges the Environmental Improvement Division (EID) of the New Mexico Health and Environment Department with responsibility for environmental management and consumer protection in order to promote the health, safety, comfort and well-being of the citizens of New Mexico. The EID is further charged with protecting the current inhabitants of the state, as well as those yet unborn, from health threats posed by the environment.

In order to fulfill these responsibilities, the state legislature has mandated that the EID develop and enforce regulations in areas including:

1. Food production
2. Water supply
3. Water pollution control
4. Wastewater disposal by individual septic tanks and alternative systems
5. Air quality
6. Solid waste sanitation and refuse disposal
7. Radiation control and radioactive material disposal
8. Occupational health and safety
9. Sanitation of public swimming pools and public baths

Regulations in all areas, except water pollution control, are adopted and issued after a public hearing by the Environmental Improvement Board which is appointed by the governor. Water pollution control regulations are adopted and issued by the Water Quality Control Commission. The EID is a constituent agency of the commission, which is composed of the directors or designated representatives of eight agencies and a representative of the public appointed by the governor.

The EID does more than just enforce regulations, however. It offers consultation services to citizens, local governments and industry; per-forms field research; publishes findings in special reports and professional journals; and helps communities obtain funding for various projects. The division also operates emergency response teams to deal with food poisonings, plague incidents, hazardous waste exposures and other incidents.

The EID carries out its environmental programs through bureaus located in Santa Fe responsible for air quality management, occupational health and safety, radiation protection, water pollution control and community support services. In addition, the EID maintains district offices in Albuquerque, Las Cruces, Roswell, Santa Fe and 18 field offices located throughout the state to implement a variety of environmental health programs at the community level.

ON THE PROGRAM

Robert C. Averett is a regional research hydrologist, U.S. Geological Survey, Water Resources Division, Central Region, Denver, Colorado. He is responsible for the management and program development of 47 research projects. Averett has a bachelor's degree, a master's degree and a doctorate in aquatic physiology.

H. L. Case III is chief of hydrologic investigations, U.S. Geological Survey (USGS), Water Resources Division, in Albuquerque where he supervises water resources investigations in New Mexico. He has been with the USGS since 1973 and has had assignments as a hydrologist in Baton Rouge, Louisiana, and as a project chief in Rapid City, South Dakota. He has a B.S. in geological sciences from the University of Texas and an M.S. in geology from Oklahoma State University.

Brad Cates is director of the Office of Intergovernmental Liaison and special counsel to the administrator, Environmental Protection Agency, in Washington, D.C. Cates served four terms in the New Mexico legislature before resigning to accept his present postion. While in the legislature, he was vice chairman of the House Judiciary Committee, Minority Caucus chairman, and a member of the Transportation and Education committees. He received a law degree from the University of New Mexico and a degree in business management from New Mexico State University.

Gustavo Cordova is health program manager, N.M. Environmental Improvement Division, where he is responsible for the implementation and management of several projects, including the Safe Drinking Water Act and the Water Supply Construction Grants Program. He oversees the compliance and water quality reporting of more than 1,200 public water systems in the state. He holds a B.S. and an M.S. in biology from New Mexico Highlands University. He is the author of scientific publications on lead and mercury toxicity.

James F. Daniel is the district chief, Water Resources Division, U.S. Geological Survey (USGS), in Albuquerque. He directs the survey's $4.3 million annual water investigation and data collection program in the state. Before coming to New Mexico in 1979, he was regional ground water specialist for the Southeastern Region. Daniel, a 24-year USGS veteran, holds a bachelor's degree in civil engineering from California State University at Sacramento.

Frank C. DiLuzio is the director of the Santa Fe Metropolitan Water Board. His 40 years' experience in the field include serving as assistant secretary for Desalting and Water Pollution Control, Department of the Interior; special assistant to Sen. Clinton P. Anderson on natural resource problems; and presidential appointee on the National Water Commission. He has a B.S. and an M.S. in civil engineering from Fenn College in Ohio.

Anthony F. Drypolcher is the program manager of New Mexico's National Pollution Discharge Elimination System program for industrial surface water discharges, N.M. Environmental Improvement Division (EID). He has been with the EID since 1972 and has participated in drafting state regulations for effluent and water quality standards. He studied environmental and civil engineering on an Environmental Protection Agency water pollution control fellowship and has a degree in biology from Northland College in Wisconsin.

Gary Eiceman, an assistant professor of chemistry at New Mexico State University, has more than 25 research publications to his credit. Most of his research is concentrated in the area of organic compounds in wastewater and in studies of fly ash from municipal incinerators. Eiceman, a Pennsylvania native, has a doctorate in chemistry from the University of Colorado.

Bruce Gallaher is a water resource specialist with the N.M. Environmental Improvement Division. He has been involved in a wide range of ground water quality investigations and is now completing a five-year study of the uranium industry. He has a bachelor's degree in mathematics from Eastern New Mexico University and a master's degree in hydrology from the University of Arizona. Gallaher is a native New Mexican.

Maxine Goad is a program manager, Water Pollution Control Bureau, N.M. Environmental Improvement Division. She was the principal designer and developer of the New Mexico regulations to protect ground water quality and has been responsible for the implementation of these regulations since their adoption in 1977. Previously, she worked for Los Alamos National Laboratory. She is a native of California and holds a B.S and an M.S. in physics from Stanford University.

Eugene Hinds is the regional director for the Southwest Region of the Bureau of Reclamation in Amarillo, Texas. The region encompasses Texas, Oklahoma, most of New Mexico, and portions of Colorado and Kansas. Hinds first worked for the bureau in 1961 in Phoenix, Arizona, before moving to posts in San Bernardino, California; Boulder City, Colorado; Washington, D.C.; and Denver, Colorado. Hinds grew up in New Mexico and earned a degree in agronomy from New Mexico State University.

Richard Holland is a program manager, Construction Grants Section, N.M. Environmental Improvement Division (EID). The Kansas native received a B.A. from Catholic University of America in Washington, D.C., and has done graduate work in regional planning at the University of Wisconsin, Madison. He has been with the EID eight years.

Devon E. Jercinovic is a water resource specialist in the Ground Water Section of the Water Pollution Control Bureau, N.M. Environmental Improvement Division. She is completing her master's degree in geology at the University of New Mexico where she is writing her thesis on the geomorphic stability of small watersheds affected by coal surface mining in New Mexico. She has a bachelor's degree in geology from the University of Cincinnati.

Frank Jones is head of the Water Rights Protection Group, Bureau of Indian Affairs (BIA), Albuquerque. The purpose of the group is to secure and protect Indian water rights and resources. The group also is involved in water right adjudications and assists tribes in long-range water development planning. Jones, who has an M.S. in civil engineering from New Mexico State University, has been with the BIA since 1977. He also has worked as a construction engineer with the U.S. Fish and Wildlife Service.

Monte G. Jordan is associate state director for the U.S. Bureau of Land Management (BLM). The 16-year BLM veteran has been involved primarily with land and minerals management programs. He was previously the chief of the Division of Coal, Tar Sands and Oil Shale at the BLM headquarters in Washington, D.C. The Dora, New Mexico, native received a B.S. in geology from the University of New Mexico.

T. E. (Tim) Kelly is president of Geohydrology Associates, Inc., Albuquerque. The firm has conducted projects throughout the nation including the Tombigbee Project, the Tellico and Cochiti dams and the Waste Isolation Pilot Project. Before forming his consulting firm, Kelly was a hydrologist with the USGS and a subsurface geologist with the Kansas Geological Survey. The Kansas native received a B.S. from the University of Dayton and an M.S. from the University of Kansas, both in geology.

Kenton Kirkpatrick, deputy director of the Water Management Division of the Environmental Protection Agency, Region IV, shares responsibility with the director for the development, coordination, implementation and evaluation of the regional water programs and water supply programs. He develops the division's program strategy, including fiscal year planning. He also sets priorities for work completion and directs evaluation of proposed water programs, regulations and policy changes. He holds a B.S. from Colorado State University and an M.S. from Oregon State University. Both degrees are in civil engineering.

Delfin J. Lovato is chairman of the All Indian Pueblo Council. The organization, which was founded in 1598, is comprised of 19 Pueblo Indian tribes in New Mexico. As chairman, Lovato's responsibilities include representing the tribes in their interactions with federal, state and municipal governments; planning long- and short-range economic development; and overseeing resource management. He is an officer or board member of some 14 Indian organizations.

Dennis M. McQuillan is a water resource specialist with the Water Pollution Control Bureau, Environmental Improvement Division (EID). He has been with the EID four years, serving first as an environmental scientist compiling data for the Surface Impoundment Assessment Study and then as a water resource specialist studying the San Jose area of Albuquerque's South Valley. He has a B.S. in geology from the University of New Mexico.

Philip B. Mutz is the interstate stream engineer with the New Mexico Interstate Stream Commission. His work encompasses a wide range of responsibilities including water resources investigations and development. He is advisor to the New Mexico Compact Commissioners on several interstate water compacts, including the Rio Grande Compact. Mutz grew up on his parents' ranch near Eagle Nest, New Mexico. He holds a B.S. in civil engineering from the University of New Mexico.

Paul Noland is the director of Water Resources for the city of Albuquerque which has about 107,000 water and liquid waste customers. Noland, a Kentucky native, received a B.A. in history and political science from Berea College, Ky., and a master's degree in public administration from the University of New Mexico. In 1973, the governor of New Mexico awarded Noland the New Mexico Distinguished Public Service Award.

Charles. L. Nylander is chief of the Water Pollution Control Bureau, N.M. Environmental Improvement Division (EID). At the EID, he has worked on both surface and ground water program areas and in technical and administrative capacities. Previously, he worked for the New Mexico Department of Game and Fish and the U.S. National Park Service. The Santa Fe native holds a B.S. in fisheries management from New Mexico State University and an M.S. in water resource management from the University of Wisconsin at Madison.

George O'Connor is acting director of the New Mexico Water Resources Research Institute. O'Connor, an agronomist at New Mexico State University (NMSU), received the Distinguished Research Award from NMSU's College of Agriculture in 1981. He also has administrative responsibility for a multimillion dollar, interdisciplinary research study on the uses of irradiated sewage sludge. He holds a bachelor's degree from the University of Massachusetts and an M.S. and Ph.D. from Colorado State University.

Don R. Patterson, as director of Community Development for the city of Carlsbad, New Mexico, is responsible for environmental services, engineering, federal and state grant programs, and water and wastewater laboratory services. He has also held positions as an environmentalist for the New Mexico State Health Department and as a surveyor for the E. V. McCollum Corporation. Patterson has a B.S. in geology and chemistry from the University of Texas at El Paso.

Lt. Col. Julian E. Pylant is district engineer of the U.S. Army Corps of Engineers, Albuquerque District. Previously he was in the Force Planning and Programming Division of the Office of the Joint Chiefs of Staff, Washington, D.C. He also has served as executive officer and assistant division engineer of the 7th Engineer Battalion, Fort Polk, Louisiana. He holds a B.S. from the U.S. Military Academy at West Point and an M.S. in civil engineering from Stanford University.

Russell F. Rhoades, as director of the N.M. Environmental Improvement Division (EID), is responsible for the overall direction of the division's regulatory programs, including planning, organization and implementation of policy, regulations and statutes. Before coming to the EID in 1972, he was the public health sanitarian at the University of Minnesota at Minneapolis. He holds a bachelor's degree from the University of New Mexico and an M.S. in public health from the University of Minnesota.

David Tague, program manager of the Surveillance and Standards Section of the Water Pollution Control Bureau, N.M. Environmental Improvement Division (EID), has been with the EID since 1975. He has a B.S. in biology and chemistry from Western Michigan State University and an M.S. in chemical limnology and aquatic sciences from Michigan State University. While at Michigan State, he worked on a research project investigating lake eutrophication, a project supported by the Office of Water Research and Technology.

Timothy J. Ward is an associate professor of civil engineering at New Mexico State University. His previous experience includes four years as an assistant professor of civil engineering at Colorado State University and three years at the Center for Water Resources Research at the Desert Research Institute, University of Nevada. He holds a B.S. and an M.S. in geological engineering from the University of Nevada and a doctorate in civil engineering from Colorado State University.

G. E. Welder has been a hydrologist with the U.S. Geological Survey since 1961. He is currently managing a project in San Juan County and a new project at Brantley Dam. Previously he worked for Exxon and the Texas State Board of Water Engineering. He holds a B.S. from the University of Texas an an M.S. from the University of Colorado, both in geology.

Donald B. Wilson is a professor of chemical engineering at New Mexico State University (NMSU). In addition to his 19 years at NMSU, Wilson also has worked as a consultant to state agencies and private industry and as a project engineer for Phillips Petroleum Company. Wilson, who has 71 publications and presentations to his credit, has worked on several water resources research projects. He holds a B.S. from the University of New Mexico and an M.S. and Ph.D. from Princeton University.

THE ENVIRONMENTAL IMPROVEMENT DIVISION'S ROLE IN WATER POLLUTION CONTROL

Russell Rhoades
Director

New Mexico Environmental Improvement Division

On behalf of the Environmental Improvement Division (EID), we are delighted to have the opportunity to address the Annual New Mexico Water Conference on "Water Quality in New Mexico." As background for this morning's session on water quality concerns in New Mexico, I will provide an overview of the role of the EID in water quality protection and water pollution control.

The Environmental Improvement Act mandates that the EID of the New Mexico Health and Environment Department serve the citizens of New Mexico in areas of environmental management and consumer protection in such a way as to optimize health, safety, comfort and well-being. To fulfill this mission, the division has a broad range of environmental protection and public health programs that deal with such areas as food protection, water supply, refuse disposal, hazardous waste disposal, subdivision control, air quality management, radiation control, and occupational health and safety.

In all program areas, except water pollution control, regulations are adopted and issued after adversarial-type public hearings by the Environmental Improvement Board (EIB) which is appointed by the governor. Water pollution control regulations on the other hand, are promulgated by the Water Quality Control Commission. The division is a constituent agency of the commission, and the division director is one of the eight agency directors, or their designated representatives, who are members of the commission. The ninth member is a representative of the public appointed by the governor.

The Water Pollution Control Program, one of the division's major programs, is administered by the Water Pollution Control Bureau. The purpose of the Water Pollution Control Bureau is to prevent and abate water pollution in New Mexico. While consultation and training are key ingredients, the bureau's primary emphasis is on the development and enforcement of regulations. The bureau fulfills its responsibilities through five program areas. I will highlight each of these areas briefly.

I will begin with regulation of discharges to surface waters. The bureau enforces state regulations for discharges to surface waters. These regulations are Part 2 of the Water Quality Control Commission regulations. One area given high priority in this enforcement effort has been the protection of New Mexico's mountain streams. These streams provide high quality trout fisheries and may serve as a source of domestic water supply. To protect these streams, enforcement action has been taken against certain towns and sanitation districts.

Enforcement action has been taken against several other municipal and industrial discharges over the past two years.

The bureau also promotes compliance with state regulations and improved operation of wastewater treatment plants through on-the-job training offered through a contract with the Dona Ana Branch of New Mexico State University, and through a regulatory program requiring certification of operators. Under New Mexico law, wastewater treatment facilities, as well as water supply facilities serving 2,500 people or more, must be operated by, or be under the supevision of, a certified operator.

The second area of bureau responsibilities is regulation of discharges to ground water. The bureau enforces state ground water quality regulations, which are Part 3 of the Water Quality Control Commission regulations; except as they apply to certain aspects of the oil and gas industry, geothermal installations and carbon dioxide facilities. These exceptions are regulated by another constituent agency of the commission, the Oil Conservation Division of the New Mexico Energy and Minerals Department.

Under commission regulations, an approved discharge plan is required for any new or newly modified discharge since 1977 and for older discharges upon request of the division. This discharge plan is, in effect, a permit to discharge to ground water. Emphasis is on the prevention of ground water pollution because such pollution is very difficult to correct once it has occurred. Of the 279 discharge plans submitted by April 1, 210 have been approved. Many of these have required extensive modification to ensure protection of ground water quality before they could be approved. Despite the many new or newly modified discharges initiated since the 1977 adoption of the ground water quality protection regulations, only a single case of noncompliance with the regulations has been reported for a discharger operating under an approved discharge plan.

The third area of our responsibilities concerns monitoring and surveillance of surface and ground water quality. The information gained through these activities is used to help direct the bureau's programs. The bureau is in the final stages of completing a regional water quality assessment of the Grants Mineral Belt. A study of ground water contamination by toxic organic compounds in the South Valley of Albuquerque is leading to a "superfund" state contract with the U.S. Environmental Protection Agency for a remedial investigation and feasibility study that may result in site cleanup. A recent assessment of the scope and extent of ground water contamination by hydrocarbon fuels indicates that this problem is more serious than previously realized. A similar evaluation of toxic substances should be completed this month.

Ongoing surface water monitoring has identified significant standards violations in an estimated 200 miles of the approximately 3,500 miles of perennial streams in New Mexico. These violations are distributed among six stream reaches.

One of the more widely known programs of the bureau is assistance to local communities in planning and construction of wastewater treatment facilities. State grants totalling over $4 million were awarded to 14 municipalities and one sanitation district between October 1, 1981, and December 31, 1982. The state grants serve as state match for the more than $28 million awarded in federal grants under the wastewater treatment construction grants program of the Federal Clean Water Act. As of January 1983, projects for three large municipalities, four smaller cities and one sanitation district remain on the state's priority list for wastewater construction grants funding.

The fifth area of bureau responsibilities is planning for program direction and evaluation of effectiveness. A notable, though still ongoing achievement, is the development and updating of the state's water quality management plans which set forth strategies for water pollution control in New Mexico. A major accomplishment in 1982 was the completion of the biennial report to the U.S. Congress required under the Federal Clean Water Act. This report summarized surface and ground water quality in New Mexico, described state water pollution control programs, and made recommendations to both the U.S. Congress and the U.S. Environmental Protection Agency. Copies of this report and information on materials on water quality and water pollution control are available.

Additionally, the division is responsible for administering EIB regulations addressing domestic waste discharges up to 2,000 gallons per day to assure adequate protection from individual, on site, liquid waste disposal systems. Also, the division is pursuing authority from the federal government in the areas of underground injection control and hazardous waste management under the Resource Conservation and Recovery Act.

Now that I have provided an overview of the bureau's activities, I would like to initiate the presentation on water quality concerns by asking members of the panel on "Protection of Water Quality in Mountain Streams" to come forward.

PROTECTION OF WATER QUALITY IN MOUNTAIN STREAMS: OVERVIEW

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The purpose of this panel discussion is to describe how the water quality of New Mexico's high mountain streams is protected. By summarizing the variety of multidisciplinary activities undertaken by the Water Pollution Control Bureau with respect to one particular river, both the complexity of the problems involved and the various policies, regulations and programs employed will be presented.

The Red River in northern New Mexico was selected for discussion because there are both municipal and industrial discharges to the river and because it is a typical high mountain stream. The Red River's headwaters lie in the Sangre de Cristo Mountains in Taos County (figure 1). The river flows for some 27 miles, from an elevation above 9,500 feet to an elevation of 6,500 feet at its confluence with the Rio Grande. The river's total drainage area is 190 square miles, much of which is in the Carson National Forest.

The upper mountain watershed of the Red River is forested by aspen, spruce and fir. Reproducing populations of cutthroat, brook and brown trout inhabit its upper reaches. Rainbow trout are annually stocked in the river by the town of Red River and the New Mexico Game and Fish Department.

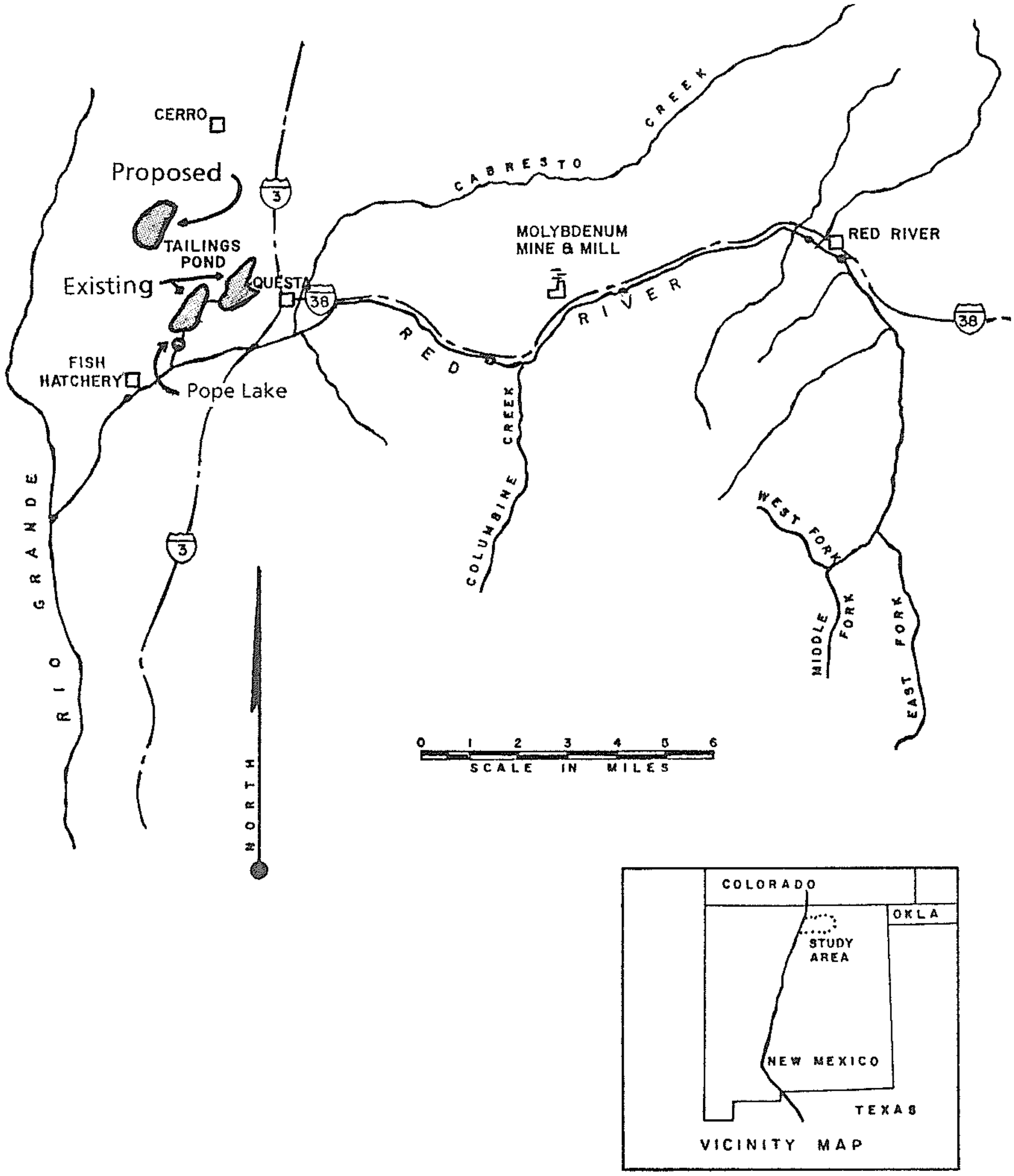

Fig. 1. Location Map

There is an intensive development of private lands for summer homes along a six mile reach of the river above the town of Red River. The lower piedmont valley, in the vicinity of the village of Questa, supports traditional family agriculture. Between the towns of Red River and Questa is located the Molybdenum Corporation of America, or Molycorp, mine and mill. The mill's tailings slurry is conveyed by pipelines along the Red River Fish Hatchery, operated by the New Mexico Game and Fish Department.

In order to protect the water quality of New Mexico's rivers, the State Water Quality Control Commission, which is by state law the official water pollution control agency in New Mexico, first determines the designated uses to be protected for a specified stream reach. Then the commission establishes numeric and narrative criteria to protect these uses. As one of the constituent agencies of the commission, the Environmental Improvement Division (EID) has been delegated by the commission to implement several specific programs aimed at ensuring that stream standards are maintained and that the water quality of each stream is protected for these designated uses. These programs are effectuated by the Water Pollution Control Bureau.

Because of its natural conditions, the Red River has been divided into two segments for the purpose of protecting its water quality. The first segment extends from the river's confluence with the Rio Grande to about 1-1/2 miles above the fish hatchery; the second extends from that point, upstream to its headwaters. The upstream reach of the Red River includes designated uses of irrigation, domestic water supply and high quality coldwater fishery. For these reasons, the numeric water quality standards that apply to this upstream reach are more extensive and more stringent than those for the downstream segment.

By monitoring stream water quality and by using these stream standards as a guide, the bureau establishes both limitations on discharges of wastes into the Red River and monitoring and enforcement procedures to make sure these limits are not exceeded. One method used to impose these discharge limitations is the federal National Pollutant Discharge Elimination System permit program, commonly referred to as NPDES permits. To illustrate how the discharge of contaminants is controlled, this panel will briefly review the history of bureau activities affecting two discharges to the Red River. The town of Red River and the Molycorp discharges are used as examples of the multiprogram process of bureau water pollution control activities.

One of these programs, the Engineering and Construction Grants Program, assists in reviewing and funding publicly owned treatment works. For example, the town of Red River received a 30 percent federal grant to assist in constructing a $235,000 wastewater treatment system in 1968. The town finished construction of stabilization ponds with supplementary surface aeration in late 1972. The effluent from the treatment plant was discharged to the Red River. However, major amendments to the Federal Clean Water Act adopted in 1972 included more stringent requirements for municipal wastewater discharges than the just completed Red River plant was designed to meet. So the town began the process of obtaining a new construction grant.

The purpose of the federal and state wastewater treatment construction grant program is to assist communities in meeting water pollution control responsibilities. The federal government, through the U.S. Environmental Protection Agency (EPA), presently provides 75 percent of the total eligible project costs. For 10 years now, the state has provided an additional 12-1/2 percent of the project costs and these funds are administered by the EID. The city must provide the remaining 12-1/2 percent of the project costs. Along with the federal dollars, as usual, come numerous regulations and detailed planning and design requirements which make the grant process complex and time-consuming.

These requirements, however, are designed to ensure that the grant recipient has the ability to finance, operate and maintain the system once it is built, and to ensure that by analyzing various alternative treatment systems in the detailed planning phase, the most cost effective, appropriate technology for the specific municipality's wastewater treatment needs is selected.

The town of Red River is a good example of how this process, even though it can take many years, can also result in a less expensive and more efficient wastewater treatment system. The town received a grant for planning a new treatment plant in 1974. After the planning phase, a new plant was designed; but, because in 1977 all the bids for construction exceeded available grant monies, construction was delayed. Bureau engineering staff questioned the treatment efficiency of the proposed plant and after intensive engineering review by the bureau, the EPA and a team of independent consulting engineers, the plant was redesigned.

In 1981, the town was awarded a $4 million federal grant and a $680,000 state grant to construct the first advanced wastewater treatment plant in New Mexico. The new plant, now 90 percent complete, provides for normal secondary treatment for about nine months of the year. During periods of high plant flow and low streamflow, about three months of the year, the stream standards for ammonia and phosphorus would be exceeded without the additional, advanced treatment provided by the new plant.

In designing this treatment plant, the most critical consideration was determining appropriate effluent quality limitations which would preserve stream quality and protect designated uses while minimizing construction and operation costs.

POINT SOURCE WASTE LOAD ALLOCATION FOR THE TOWN OF RED RIVER

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The Federal Clean Water Act requires that every municipality must at least provide secondary treatment of its wastewater before discharging it to a surface watercourse. The application of secondary treatment is usually sufficient to improve the water quality of the receiving stream. In high mountain headwater streams like the Red River, however, advanced wastewater treatment, often called tertiary treatment, must be provided to ensure that violations of water quality do not occur.

When the water quality standards cannot be met by secondary treatment, the state must develop a point source waste load allocation (WLA) for the municipal discharge. The allocation will specify the quantity of a pollutant that may be discharged during a period of time. The purpose of waste load allocation is to preserve and enhance the water quality of the receiving stream and to protect its designated uses.

The process of developing a waste load allocation for the town of Red River began with a consideration of the water quality standards of the Red River. A water quality standard consists of two principal elements:

1. A "designated use" (such as high quality coldwater fishery).
2. "Numeric or narrative criteria" sufficient to preserve the designated use. We should keep in mind that the designated use is the most important element of the water quality standard.

The designated uses of the upper Red River are given in figure 1. The most vulnerable of these, and hence the most critical, is high quality coldwater fishery. The numeric criteria or "standards", as they are usually called, are shown in figure 2. All of these numeric standards are necessary to protect the designated use, high quality coldwater fishery. A point source waste load allocation may be calculated for any water contaminant that could potentially impair a designated use.

STREAM SEGMENT	DESIGNATED USES
The Red River from its confluence with the Rio Grande upstream to a point 1-1/2 miles above the bridge at the Red River Fish Hatchery.	Coldwater Fishery Fish Culture Livestock and Wildlife Watering Secondary Contact Recreation
The Red River from a point 1-1/2 miles above the bridge at the Red River Fish Hatchery upstream to its headwaters, including all tributaries thereto.	Domestic Water Supply Fish Culture High Quality Coldwater Fishery Irrigation Livestock and Wildlife Watering Secondary Contact Recreation

Fig. 1. Stream Segments and Designated Uses

The intent of the numeric standards for inorganic nitrogen and phosphorus is to control the growth of algae and other aquatic plants in order to preserve the aesthetic and ecologic qualities that originally provided the basis for designating the stream as a high quality coldwater fishery. Excessive accumulations of biomass and changes in the kinds of algae can lead to the deterioration of the quality of the fishery habitat.

PARAMETER	HOW APPLIED	STANDARD	UNITS
	Shall...		
Un-ionized Ammonia	Not exceed	.02	mg/l
Conductivity	Be less than	400	μmho
Dissolved Oxygen	Be greater than	6.0	mg/l
Total Inorganic Nitrogen	Be less than	1.0	mg/l
pH	Be within range	6.6 to 8.8	--
Temperature	Be less than	20	°C
Total Chlorine Residual	Be less than	.002	mg/l
Total Organic Carbon	Be less than	7	mg/l
Total Phosphorus	Be less than	0.1	mg/l
Turbidity	Be less than	25	ftu
Fecal Coliform Bacteria	Be less than	100/100	cells/ml*

*Based on monthly log mean

Fig. 2. Numeric Standards

One or both of these plant nutrients are often in short supply in aquatic environments. The nutrient in short supply will limit algal growth, providing that all other growth requirements are being met. This phenomenon is known as the limiting nutrient concept.

Control of the limiting nutrient only can result in a significant reduction in cost of constructing and, in particular, operating advanced wastewater treatment systems while ensuring that designated uses are protected. Recognizing the economic importance of this, the Water Quality Control Commission adopted a provision to the water quality standards (1) that allows for the control of the limiting nutrient only. Therefore, waste load allocations will be developed for nitrogen or phosphorus, but not both.

To provide a current data base, the bureau conducted a yearlong stream and effluent sampling program on the Red River above and below the town (figure 3). The purposes of the study were to:

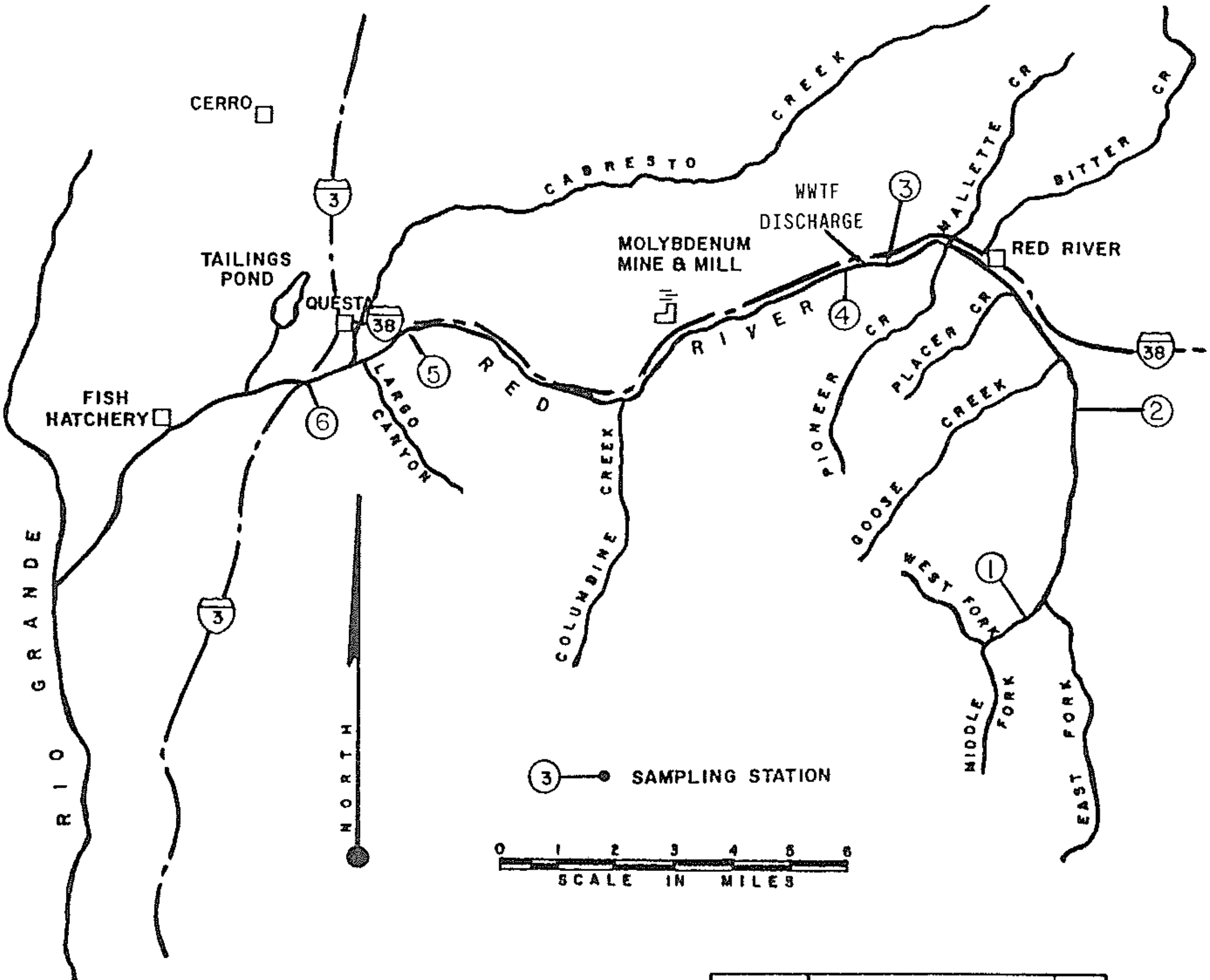
1. Determine which stream standards were being violated (if any)
2. Characterize the natural background (or ambient) quality of the river
3. Determine the limiting nutrient
4. Quantify the nonpoint source loading to the river

The results of the study were as follows:

A series of 11 algal assay tests demonstrated that the Red River is a phosphorus-limited aquatic environment. Consequently, the river is exempt from the total inorganic nitrogen standard and a waste load allocation is not required for that constituent.

The stream standard for total phosphorus was exceeded on 15 of 21 sampling dates at the station below the treatment works. No other violations of stream standards were observed at this station.

The mean and range of total phosphorus concentrations observed at several Red River stations during winter low flows is shown in table 1. The natural quality of the river is represented at Station HRG-21, six miles above the town. The average P concentration here is 0.006 mg/liter. Cultural nonpoint sources in and above the town of Red River add phosphorus sufficient to raise the river concentration to 0.022 mg/liter, increasing it 3.67 times.



LEGEND

STATION	STORET NUMBER
1	HRG21
2	HRG22
3	HRG23.1
4	HRG23.3
5	HRG24
6	HRG25

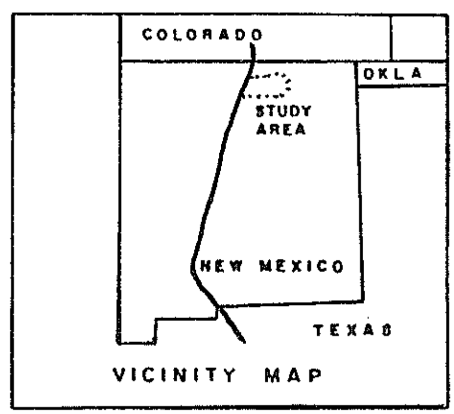


Fig. 3. Location Map

TABLE 1
Total Phosphorus Concentrations in the Red River
During Winter Low Flow 1979-1981
(mg/liter--November through March)

STATION	NO. OF SAMPLES	MEAN	MINIMUM	MAXIMUM
HRG-21 (Middle Fork)	11	.006	.001	.01
HRG-22 (Two miles above town)	13	.021	.001	.059
HRG-23.1 (Above lift station)	10	.022	.009	.042
HRG-23.3 (Below WWTF)	13	.154	.03	.37

Effluent flow from Red River's new wastewater treatment works will vary seasonally. Critical low streamflow varies monthly. These data are shown in table 2.

Early on in Red River's WLA process, the bureau recognized that plant operating costs could be substantially reduced while ensuring that designated uses were protected if seasonal variations of flow were considered. Accordingly, monthly phosphorus limitations were developed that take into account monthly low streamflow and seasonal variations in wastewater flow.

TABLE 2
Seasonal Variation of Effluent and Streamflow at the Outfall of the Red River Treatment Works

MONTH	CUBIC FEET PER SECOND 7Q10*	EFFLUENT
January	6.1	0.60
February	5.9	0.60
March	5.9	0.60
April	8.4	0.15
May	16.3	0.15
June	18.0	0.75
July	12.3	0.75
August	11.3	0.75
September	10.7	0.15
October	9.4	0.15
November	5.6	0.60
December	5.6	0.60

*7 consecutive-10 year recurring low flow

Un-ionized or undisassociated ammonia is potentially highly toxic to trout. However, the concentration of un-ionized ammonia that results from a given concentration of total ammonia varies greatly as a function of pH and temperature. The relationship is illustrated in figure 4. We used this relation together with stream and effluent flow variation to develop effluent limitations for un-ionized ammonia while not requiring unnecessarily stringent ammonia removal.

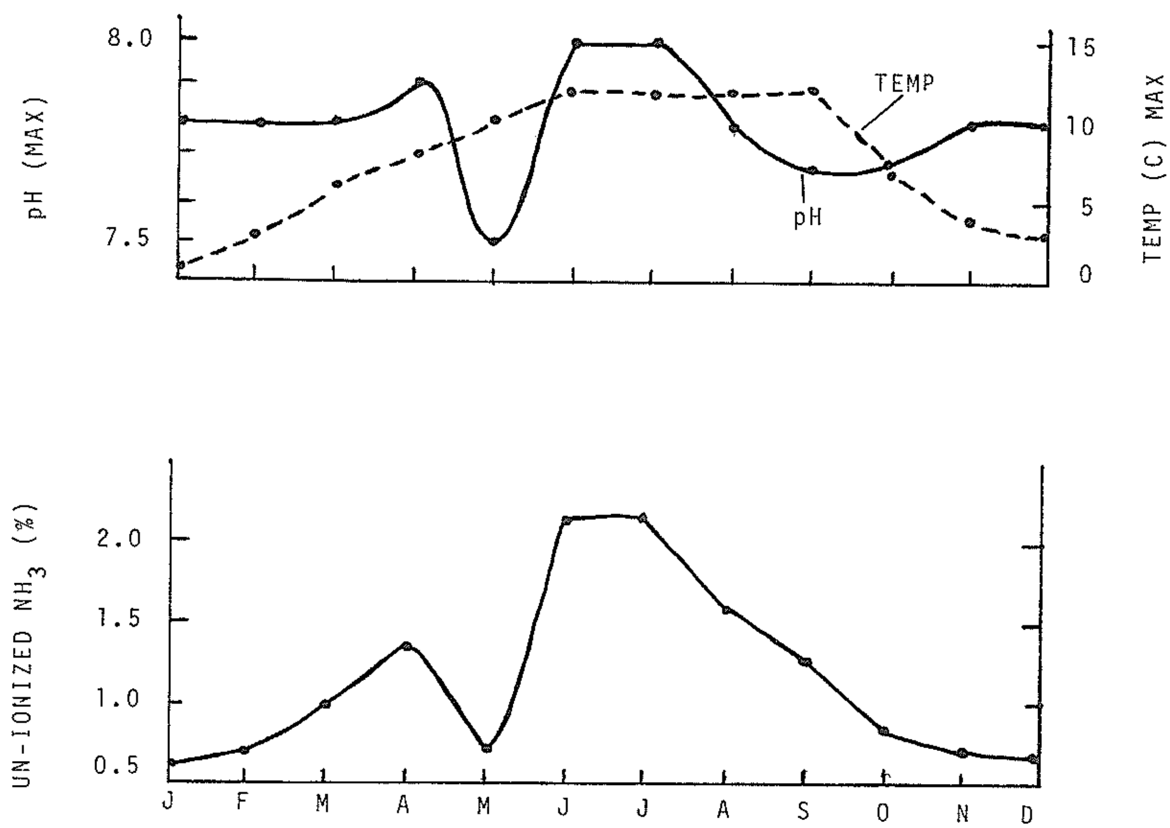


Fig. 4. Relation of Temperature and pH to Un-ionized Ammonia

The savings in costs of operation to the town of Red River that will result from wastewater treatment requirements for phosphorus and ammonia developed on a seasonal schedule was estimated at more than $200,000 per year. This is a substantial savings to a town of some 5,000 people.

The monthly waste load allocations for phosphorus and ammonia are summarized in table 3. These allocations were recommended to the U.S. Environmental Protection Agency for inclusion as effluent limitations in the town's NPDES permit.

TABLE 3
Final Effluent Limitations for the Red River

MONTH	TOTAL PHOSPHORUS	TOTAL AMMONIA
January	1.0	30
February	1.0	30
March	1.0	20
April	1.0	20
May	7.5	30
June	1.7	20
July	1.2	14
August	1.2	18
September	5.0	30
October	4.0	30
November	1.0	30
December	1.0	30

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MOLYCORP, AN INDUSTRIAL DISCHARGER

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Molycorp, now a division of Union Oil, operates a molybdenum mine and mill upstream on the Red River from the village of Questa (see map, figure 1; photograph, figure 2). At the mill, the ore is ground and processed to remove molybdenum. The waste materials from the mill form a slurry (approximately 60 percent water, 40 percent solids; by weight) known as tailings. These are transported through a pipeline system approximately nine miles long to a tailings disposal area downstream from Questa. Liquid overflow from the tailings pond is discharged to a small decant pond called Pope Lake and thence to the Red River. The discharge to the Red River is regulated by a National Pollutant Discharge Elimination System (NPDES) permit.

Effluent limitations can be imposed through NPDES permits. There are nationwide NPDES effluent limitations that must be met by all dischargers in a given category (in this case, molybdenum mining and milling). In addition, the state can, through the permit certification process, impose more stringent limitations if they are to meet the stream standards adopted by the New Mexico Water Quality Control Commission (1), including the general standard for hazardous substances. When Molycorp's permit was being negotiated in the mid 1970s, two major concerns were under discussion:

1. The quality of the discharge from Pope Lake to the Red River

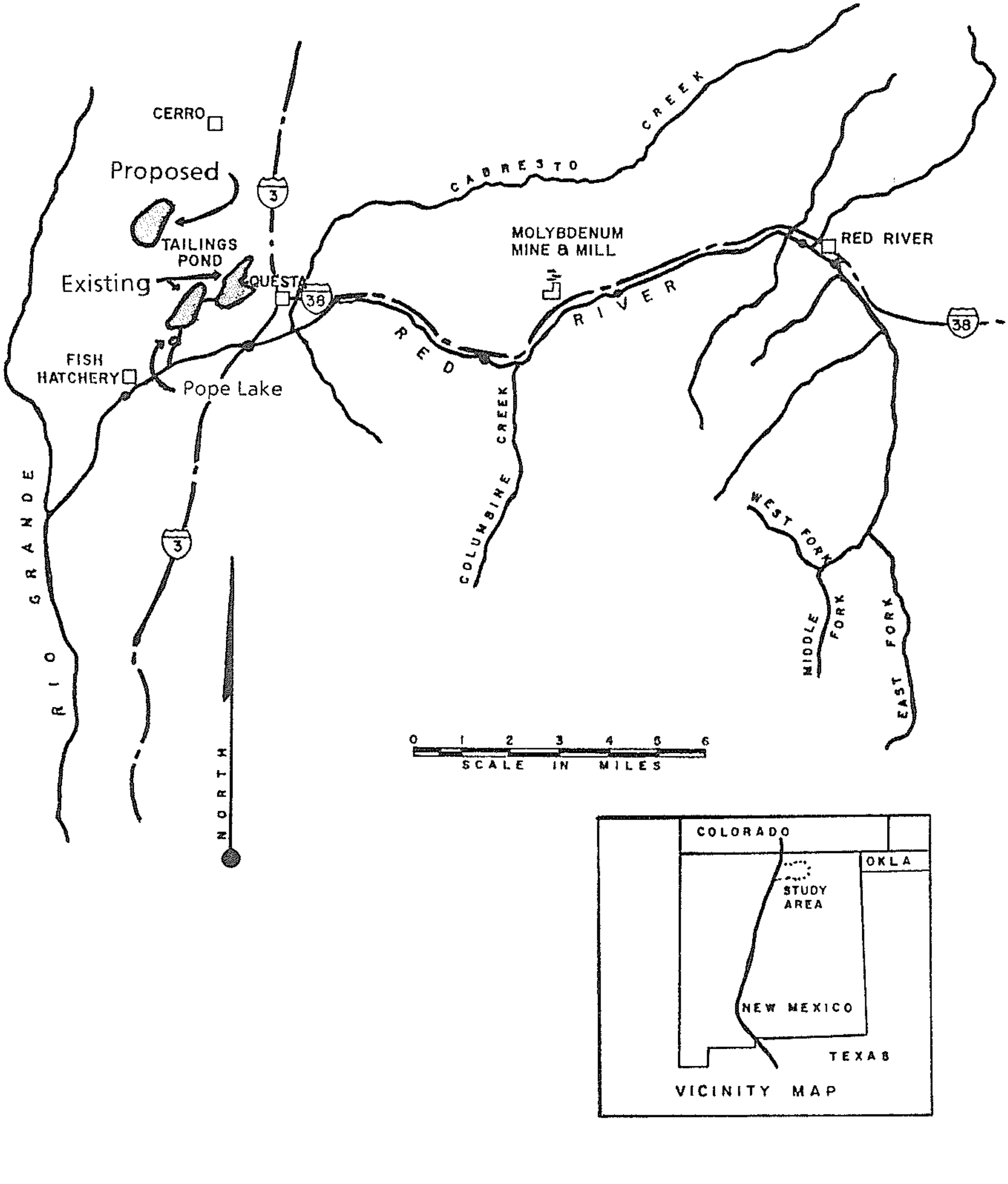

Fig. 1. Location Map

Fig. 2. Molycorp Mill and Open Pit Mine

2. The numerous breaks in the tailings pipeline which had been occurring since it was put in use in 1966, and the resulting spills of tailings into the Red River

With respect to the permitted discharge from Pope Lake, the Water Pollution Control Bureau of the New Mexico Environmental Improvement Division (EID) took the position that restricting the molybdenum level to prevent vegetation from accumulating molybdenum levels toxic to animals and restricting the levels of cyanide, cadmium and zinc to protect fish life were necessary to meet New Mexico stream standards. With respect to the tailings line breaks, the division took the position that an effective spill prevention plan was necessary.

There was considerable public interest in Molycorp's permit. A public hearing (2) was held on the permit application by the U.S. Environmental Protection Agency (EPA), the permit issuing entity. Subsequent adjudication resulted in a stipulated agreement (3) among the parties which were, in addition to the EPA, the EID and Molycorp, the U.S. Bureau of Land Management, the U.S. Forest Service, the New Mexico Citizens for Clean Air and Water, and the Rio Grande Chapter of the Sierra Club. The permit, issued in June 1977 (4), incorporated all of the provisions requested by the EID to protect stream standards. Requirements included a strict design and construction development program to result in a decrease in molybdenum discharge in 1983, and development and implementation of a spill prevention plan.

The Molycorp mill is not operating at the present time while mining operations are changed from the old open pit mine to the new underground mine. The present tailings area is being expanded to accommodate initial tailings from the underground operation which is expected to begin in mid-1983. At the same time, a new 1,320 acre tailings area on Guadalupe

Mountain about three miles west-northwest of Questa is being proposed to accommodate future tailings until the year 2018 (5, 6). The surface discharge from the new tailings area would be transported back to the existing tailings facility near Pope Lake where it would be treated in the new ion exchange plant to remove molybdenum and then discharged back to the Red River through the exisitng NPDES outfall. See figure 3 for an aerial photograph of the existing and proposed tailings areas.

Under the New Mexico Water Quality Control Commission (WQCC) regulations (7), the new tailings pond is (in addition to its NPDES permit) required to have an approved discharge plan which is, in effect, a permit to discharge to ground water. The discharge plan will address discharges by seepage through the pond bottom, which are predicted to be substantial. Molycorp was notified in January 1983 by the EID that a discharge plan was required for the proposed new tailings pond. In order to obtain discharge plan approval from the EID, Molycorp must demonstrate that the discharge to ground water will not cause the ground water quality standards in the New Mexico Water Quality Control Commission Regulations to be violated at any place of present or foreseeable future use. Molycorp must also demonstrate that the discharge to ground water will not cause any stream standard (1) to be violated. This latter requirement for discharge plan approval is particularly relevant in the case of the proposed Guadalupe Mountain tailings disposal site for the following reasons.

Guadalupe Mountain is a volcanic cone and presently available data indicate high permeability and rapid movement of ground water through the basalt under and around it (6, 8). The proposed tailings site is between the Red River and the Rio Grande on public land administered by the U.S.

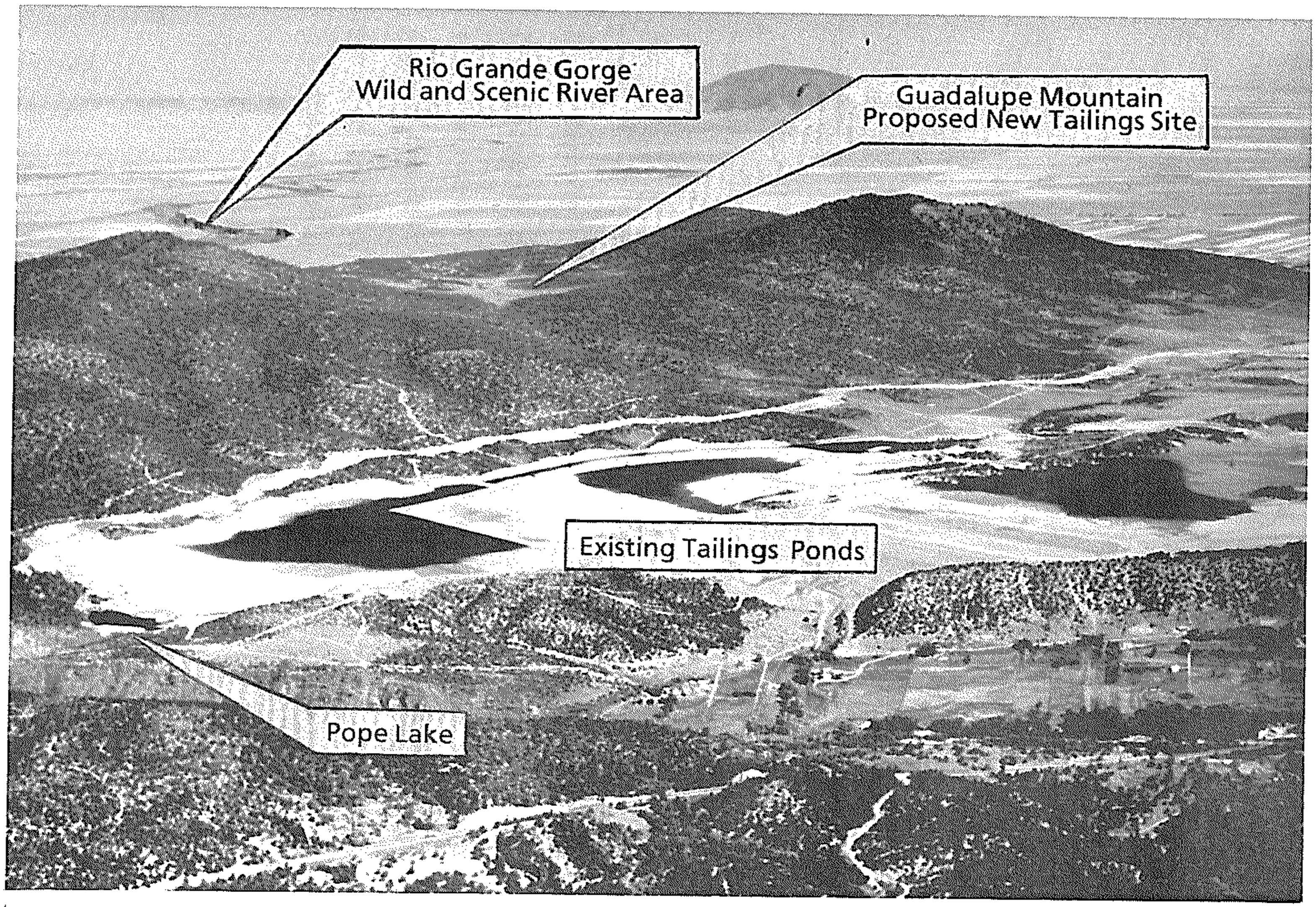

Fig. 3. Molycorp Tailings Area Near Questa, New Mexico

Bureau of Land Management and adjacent to the Rio Grande Wild and Scenic River Recreation Area. This segment of the Rio Grande and the first four miles of the Red River above the confluence, were designated by Congress in 1968 for inclusion in the Wild and Scenic Rivers Act. There are natural springs along both the Red River and the Rio Grande in this area. The springs presently have extremely good quality water although Big Arsenic and Little Arsenic springs have misleading names. Legend has it that in the 1920s, a hermit who lived by Big Arsenic Spring gave these springs names to discourage others from coming there. The various springs in this area support diverse aquatic communities, serve as a water supply for visitors to the recreation area, and contribute substantially to the flow of both rivers.

Before discharge plan approval can be obtained under state regulations, Molycorp will be required to submit adequate information to demonstrate that the proposed Guadalupe Mountain tailings disposal will not cause stream standards to be violated, either in the stream channels of the springs which constitute tributaries to the Red River and the Rio Grande, or in the main stems of the rivers themselves. To date, Molycorp has not yet submitted the discharge plan for the Guadalupe Mountain site.

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STATE COMPLIANCE ACTIVITY RELATED TO THE RED RIVER IN TAOS COUNTY, NEW MEXICO

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Wastewater discharges to surface waters in New Mexico fall into two broad classifications: municipal treated wastewater and nonmunicipal treated wastewater. Alternative terms used to classify dischargers, although not as accurate, are: publicly owned and privately owned, or simply, municipal and industrial.

The Red River in Taos County has a discharge in each of these two categories. Municipal treated wastewater runs from the town of Red River and consists almost entirely of domestic sewage. The other discharges of treated wastewater come from the molybdenum mine and mill that Molycorp, a division of Union Oil, owns and operates.

Discharges containing pollutants that go to surface waters are regulated nationwide under the Federal Clean Water Act through the National Pollutant Discharge Elimination System (NPDES, [1]) permit program administered by the U.S. Environmental Protection Agency (EPA). Under this program, a permit is issued by the EPA to a discharger that specifies effluent limitations, sampling frequencies, sample types and other technical and administrative conditions that have to be met in order to comply with state and federal regulations. Through the process of state certification of an NPDES permit, effluent limitations can be made more stringent than national technology based effluent guidelines in order to protect the receiving waters, such as the Red River, which is a high quality coldwater fishery.

Due to federal manpower constraints, the New Mexico Environmental Improvement Division's (EID) Water Pollution Control Bureau conducts many of the inspections, sampling and analysis of the effluent and tracking of the discharger's self-monitoring reports for the EPA on a contractual basis. Recently, the state has had to take the lead in enforcement activities through the use of state water quality regulations (2). Under certain prescribed conditions, the bureau can enforce applicable parts of the Water Quality Control Commission regulations against a discharger that continually remains out of compliance with its federal NPDES permit.

Both the discharges that I mentioned earlier, Molycorp and the town of Red River, have repeatedly violated their federal NPDES permits. I will discuss each of these to show how the EPA, through the NPDES permit program, and the New Mexico Water Quality Control Commission through the bureau, work toward obtaining compliance with their individual regulations to achieve effluent quality required of each discharger by law.

The first discharger, Molycorp, has actual discharge points to the Red River from a large tailings pond and a small decant pond called Pope Lake below the village of Questa. In addition, for many years a serious water pollution problem came from unpermitted discharges, that is, breaks in a seven-mile portion of tailings lines that run alongside the Red River. The tailings lines carry mill tailings in a slurry from the mine down to the mill tailings disposal area below Questa. Breaks have resulted in tailings spilling into the Red River, causing the EPA, the state EID and other interested parties, to enter into a Stipulated

Agreement (3) with Molycorp in 1977. This agreement addressed the many tailings line breaks and also set the molybdenum effluent limitation at levels that would become part of Molycorp's NPDES permit in 1983. Molycorp has constructed an ion exchange plant in order to obtain the molybdenum levels required in their soon to be reissued permit.

Due to continuing tailings line breaks over the two and one half years after the 1977 agreement, a stronger, court approved document called a Judgement by Consent (4), was negotiated in 1981. The Judgement by Consent provided for a penalty payment of $60,000 for past violations and $8,500 for each future violation, until October 1, 1984. The penalties, in part, are paid to a tax-exempt organization that administers the money for environmentally beneficial research purposes in northern New Mexico. The rest of the money went to the state of New Mexico general fund and the United States government.

Molycorp is now undertaking a major construction project to initiate a new underground mining operation and they have asked for delays in these two legal agreements until they restart mining and milling operations. Completion of the new ion exchange unit and newly redesigned pipeline are expected to improve the water quality in the Red River.

The second discharger, the town of Red River, has had a lagoon system since 1972 to treat its wastewater. The lagoon system has proved to be inadequate to protect the Red River, as shown by repeated violations of effluent limitations in the NPDES permit and in-stream monitoring of biological and chemical quality, especially during the ski season. The New Mexico Water Quality Control Commission entered a legal agreement called An Assurance of Discontinuance with the town of Red River for the purpose of obtaining and maintaining full compliance. This assurance gives the town a schedule for constructing and putting into operation a new advanced wastewater treatment plant to replace the existing lagoon system. As mentioned in earlier talks, the state and federal governments provided the major share of the funding for the new plant. The new wastewater treatment plant is to come on line in early April 1983, followed by a start-up period of several months.

The Water Pollution Control Bureau always tries to obtain voluntary compliance from a discharger prior to investigating legal options afforded to us by the Water Quality Control Commission regulations. Faster and more permanent abatement of water pollution can often be realized through a cooperative effort between the bureau and the discharger. Legal remedies have been used in the past and have achieved the desired results. They will continue to be used if voluntary methods do not achieve compliance with state regulations.

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HYDROCARBON FUELS IN GROUND WATER--INCREASED AWARENESS AND CONCERN IN NEW MEXICO

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Introduction

The New Mexico Environmental Improvement Division (EID) has become increasingly aware of the water contamination problems associated with the leakage and surface disposal of hydrocarbon fuels. The hydrocarbon fuels of concern include refined petroleum products such as gasoline, kerosene, gas oil (diesel fuel), fuel oils and lubricating oils. While there have been a number of contamination incidents involving discharges of hydrocarbon fuels to surface streams, this discussion will focus its attention on ground water contamination from hydrocarbon fuels. The following accounts are only two of many situations involving hydrocarbon fuels being brought to the attention of the EID.

The first example is:

> Following large inventory losses in May, June and July of 1981, an old gasoline storage tank at a newly rebuilt gasoline station was excavated. Gross contamination of the soil was encountered during the excavation and a large hole was discovered in the storage tank upon removal. A new underground tank was quickly installed. In October 1981, a resident of a home 60 meters west of the gasoline station complained of headaches and of smelling gasoline fumes. Explosive concentrations of gasoline vapors were detected underneath the house and the soil less than one meter below the ground surface. Backhoe excavations, aimed at reducing the amount of gasoline vapors in the soil, intercepted gasoline floating on the ground water. Company records indicated a loss of approximately 162,157 liters of unleaded gasoline from the old tank. Ground water sampled in the area contained benzene concentrations of 23.0 milligrams per liter (mg/l), 1,000 times higher than the New Mexico Water Quality Control Commission (NMWQCC) regulations ground water standard for benzene (Section

> 3-103). Legal negotiations for the cleanup of the gasoline and restoration of the aquifer have been underway since July 1982. Explosive concentrations of gasoline vapors, measured as recently as March 1983, have continued to collect in telephone manholes surrounding the station, attesting to the need for a prompt resolution to the problem.

A second example is:

> Diesel fuel contamination of ground water has been found in shallow domestic wells in the alluvium of the Rio Grande Valley near a railroad refueling facility. Diesel fuel has been spilled at the site for more than 30 years during refueling operations. The diesel fuel contamination has migrated more than 300 meters down gradient from the site due to the high permeability of the alluvium and the shallow water table (three meters). Present mitigation measures include catchment basins beneath the tracks, collection drains and a skimmer pump to remove the diesel fuel from atop the water table. Cleanup efforts were impeded, however, by a January 1983 spill of 190,000 liters of diesel fuel. The spill occurred when a railroad car derailed into an aboveground fuel storage tank. The storage tank ruptured, spilling the 190,000 liters of diesel fuel onto the ground.

These situations are not unusual. Week after week, the EID continues to receive information on leakages, spills and disposals of hydrocarbon fuels which have polluted ground or surface waters or which have the potential to impact these waters. As a result of having invested considerable time and money in situations like those described above, the EID is beginning a prevention and mitigation strategy to combat these contamination problems. This strategy involved answering four very important questions.

1. Why is hydrocarbon fuel contamination of ground water a problem?
2. What are the major sources of hydrocarbon fuel contamination?
3. How widespread is the problem of hydrocarbon fuel contamination in New Mexico?
4. What are some possible solutions to the problem?

Hydrocarbon Fuel Contamination of Ground Water Health and Environmental Concerns

The contamination of ground water by hydrocarbon fuels can cause serious environmental and health concerns. The importance of ground water in New Mexico cannot be overemphasized. Approximately 95 percent of the water supplied by public systems is from ground water sources and three-fourths of the state's population is supplied drinking water by these systems (NMWQCC 1982). It is imperative that ground water for present or potential future use be protected from contamination.

When a hydrocarbon fuel reaches ground water, it may be present as both a free-floating phase and as a dissolved or emulsified phase. The free-floating phase may be intercepted by subsurface features such as building foundations, sewer and water lines, and telephone and electric cables. The interception and subsequent collection of fuels at these features causes potentially explosive concentrations of vapors to collect in the subsurface (Yaniga 1982). This is the case in the first situation described above involving the leaking underground storage tank.

In the dissolved or emulsified phase, hydrocarbon fuels may cause objectionable odors and tastes in the water. Of greater concern, however, may be the health hazards resulting from long-term exposure to ground water contaminated with hydrocarbon fuels. Hydrocarbon fuels, such as gasoline, are a mixture of four basic types of hydrocarbon compounds--paraffins, olefins, naphthenes and aromatics (Bland and Davidson 1967). The aromatic hydrocarbons commonly found in gasoline include compounds such as benzene, toluene and xylenes, all of which are extremely soluble in ground water. Although the human toxicological data for toluene and xylenes are not good, benzene has been causally linked to leukemia, aplastic anemia and other conditions affecting the blood and bone marrow in humans (McQuillan 1982). Ethylbenzene, which may constitute as much as 20 percent of some gasoline blends, may result in chronic respiratory disease and skin disease (U.S. Environmental Protection Agency 1980). In addition, gasoline may contain a variety of additives such as tetraethyl lead which may cause lead poisoning and 1,2-dichlorethane which may result in cancer of the liver. From the standpoint of preserving both health and safety, expedient removal of hydrocarbon fuels from ground water is necessary.

Major Sources of Hydrocarbon Fuel Contamination

There are five aspects of the petroleum industry to review when considering sources of potential contamination. These aspects are production, refinement, transportation, storage and handling, and disposal. This discussion will be confined to those aspects dealing with the refined petroleum products or hydrocarbon fuels. The protection of ground water from crude petroleum production is the responsibility of the Oil Conservation Division of the Energy and Minerals Department. It should be noted, however, that there are a large variety of potential ground water contamination problems associated with the production of large amounts of crude oil in New Mexico. These contamination problems are the result of leakages from surface impoundments and improperly completed or plugged production wells. At least 20 cases of ground water contamination from crude petroleum production have been documented in New Mexico (Boyer et al. 1980).

Refinement. There are currently six active gasoline refineries in New Mexico and numerous gas plants (which produce gasoline as a by-product of natural gas). Ground water contamination has been documented at two of the gasoline refineries and is suspected at the remaining four. Contamination at the gas plants has not been evaluated at this time. The ground water problems associated with these facilities are a result of improper surface disposal, spills and leakages. Additionally, there are several abandoned facilities in New Mexico. One abandoned refinery in particular has gasoline floating on the water table and is suspected of contaminating one nearby private well and potentially may contaminate many others. Benzene levels in the well have reached concentrations as high as 0.28 mg/l, 28 times higher than the NMWQCC ground water standard.

Transportation. The transportation of hydrocarbon fuels by pipeline, railroad and highway may potentially contaminate ground water as a result of leaks and accidental spills. The hydrocarbon fuels commonly released are gasoline and diesel fuel and may involve quantities as large as 40,000 liters.

Storage and Handling. Facilities which store and handle hydrocarbon fuels include bulk terminals, railroad refueling facilities, and private and commercial distribution outlets (e.g., gasoline stations). Surface spillage and disposal, combined with underground leakage, are responsible for ground water contamination in many areas of the state. There are 762 bulk fuel teminals distributed around the state, only one of which has been investigated in detail. Shallow ground water at this terminal is contaminated with hydrocarbon fuel constituents, including benzene and lead concentrations of 45 mg/l and 0.08 mg/l, respectively. Surface discharges of tank bottom water, hydrostatic test water and spillage at this terminal are suspected to have caused the contamination of the subsoils and shallow alluvial aquifer. As the discharges of tank bottom water and hydrostatic test water have long been accepted bulk terminal practices, it is likely that some degree of water and/or soil contamination exists at all bulk terminals. There are five railroad refueling facilities in New Mexico. Two of the five facilities have been investigated and diesel fuel has been discovered floating on the water table at both. There are 2,750 commercial distribution outlets in New Mexico and an unknown number of private distribution outlets. Of main concern at these facilities are gasoline losses due to a failure, in part, of an underground tank and line system. Underground storage tanks may leak due to corrosion or, in the case of fiberglass tanks, as a result of improper installation (figure 1). Product losses aboveground may be due to leakage of aboveground storage tanks or negligent refueling practices. These fuel loss problems are also shared by private facilities which store fuel for their own use rather than retail. These facilities include airports, truck stops, trucking companies, construction companies, rental car agencies, bus companies, and car and truck dealerships.

Disposal. The disposal of "spent" hydrocarbon fuels occurs throughout the state both legally and illegally. Waste lubricating oils, kerosene and fuel oil are often disposed of at recycling facilities, at landfills and in septic tank systems where the water table is shallow and hydrocarbon fuel contamination is possible.

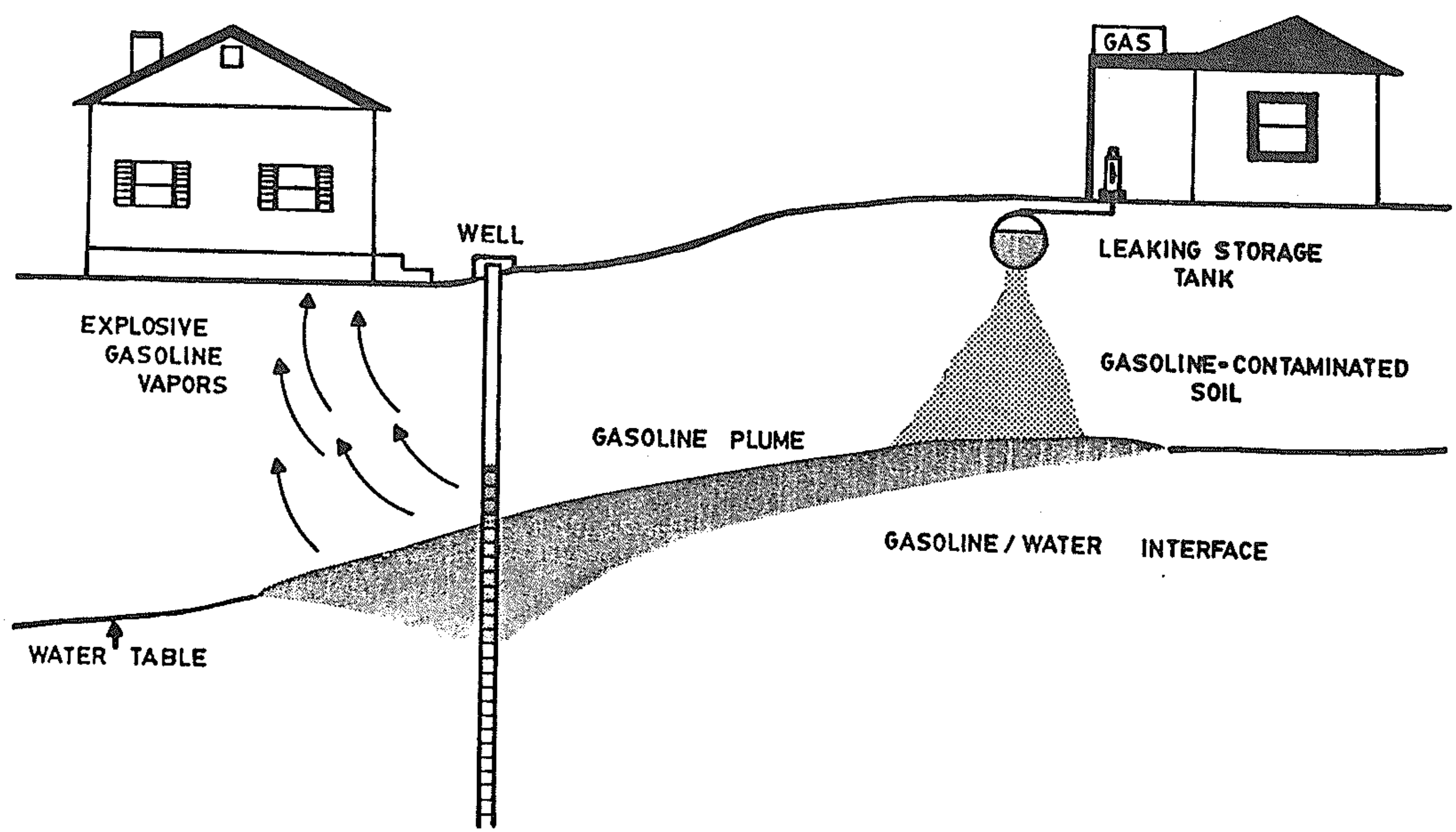

Fig. 1. Overview of Underground Gasoline Leakage and Subsurface Impacts to Soil and Ground Water

Hydrocarbon Fuel Contamination in New Mexico--Extent and Magnitude

In order to evaluate the extent and magnitude of hydrocarbon fuel contamination in New Mexico, it is necessary to consider the number and location of potential sites, the nature and amount of hydrocarbon fuels involved in the discharges, subsurface characteristics of the sites and the depth to ground water. In June of 1982, the EID began to inventory all known or suspected cases of hydrocarbon fuel contamination of ground water as a first step in evaluating statewide impacts. The EID Surface Impoundment Assessment (Boyer et al. 1980) provided a baseline for many contamination incidents. Additional information was obtained through EID drinking water files, ground water files, spill reports and telephone surveys. Of the 78 incidents recorded in the 1982 inventory, more than 32 percent were associated with underground leakage of hydrocarbon fuels from commercial retail outlets (table 1). Commercial retail outlets, such as gasoline stations, may be one of the major sources of concern for the following reasons:

1. Sheer numbers--2,750 operating facilities as of November 1982
2. Many storage tanks put into the ground in the lush service station growth days of the 1950s and 1960s are now 20 to 30 years old and pose a high leakage risk
3. Storage tanks are usually below ground so that leakages are not visually apparent
4. Small leaks, on the order of one or two gallons per day, are not detected by current facility operating practices
5. Largest concentrations of facilities occur in population centers located in the river valleys of the Rio Grande and Pecos River areas characterized by permeable, unconsolidated sediments and shallow water tables
6. The installation of used storage tanks which pose even a higher leakage risk

TABLE 1
Summary of Documented Incidents of Known or Suspected Ground Water Contamination by Hydrocarbon Fuels

FACILITY	UNDER-GROUND LEAKAGE	SURFACE SPILLAGE	SURFACE DISPOSAL
AIRPORTS	0	0	1
BULK-FUEL TERMINALS	0	0	1
RAILROAD FACILITIES	0	1	3
RECYCLING FACILITIES	0	0	2
RETAIL OUTLETS	25	1	2
TRANSFORMERS	0	1	3
TRANSMISSION PIPELINES	2	0	0
TRUCK STOPS	1	0	3
TRUCKING COMPANIES	0	5	5
WASTE SITES	0	0	13
TOTAL	28	8	33

UNKNOWN SOURCES	9
TOTAL INCIDENTS	78

7. An unknown number of abandoned facilities, the majority of which have fuel storage tanks left in the ground

The abandoned gasoline stations may prove to be of as much concern as the active gasoline stations. Four weeks ago, while replacing a floor in a television warehouse, three abandoned underground storage tanks were discovered and upon opening the tanks, the building quickly filled with explosive concentrations of gasoline fumes. The building was closed down by fire officials and tank removing experts were called in. A gasoline station had occupied the site 11 years earlier and the tanks had been filled with sand and abandoned, as required by fire codes. One of the three tanks, however, had been left with approximately 20 centimeters of leaded fuel in the bottom. The portion of sand in contact with the fuel contained 574 parts per million (ppm) organic lead, thus legally qualifying it as a hazardous waste. Approximately 20 barrels of the fuel-contaminated sand had to be shipped out of state to a hazardous waste site at great expense. The remainder of the sand, containing less than two ppm organic lead, was disposed of in a landfill and the tanks were subsequently filled with a concrete slurry. In the past, when fuel prices were lower, large quantities of fuel may have been left in abandoned tanks. Eventually, corrosion of the abandoned tank allows hydrocarbon fuels to escape, potentially impacting ground water. It is clear that the potential health and environmental problems do not necessarily cease when a gasoline station is abandoned.

Compounding this problem of leaking underground tanks from active and abandoned gasoline stations is the fact that there is no agency in the state of New Mexico which knows how many tanks are currently in use.

There are no inventories of underground tanks at abandoned stations or even an inventory of where these abandoned stations are located. Furthermore, there is no used tank tracking at this time. Several of the large United States oil companies have implemented tank integrity programs at those stations for which they have ultimate liability. At each of the stations, all tanks and lines are tested. If the testing reveals any leaks in the tank or line systems, say for instance, one leaking tank out of four tested, then all four tanks are removed and replaced. The companies reason that if the tanks are of similar age and material and are in place in similar soil conditions, then it is only a matter of time before the other three tanks fail. Those three tanks, although each has a high failure risk, are available for resale and reuse. Where do those tanks go? Consequently, the EID cannot predict how many tanks may have leaked or are presently leaking.

Hydrocarbon Fuel Contamination of Ground Water--Possible Solutions

For the past few years, the EID's role in hydrocarbon fuel contamination of ground water has primarily been one of response to contamination incidents. For efficiency and effectiveness, this role must become one of mitigation and prevention. Regardless of the source of contamination, whether it be a bulk fuel terminal, a large refinery or a "mom and pop" gasoline station, responsible parties must be made aware of the environmental and financial liabilities they assume when handling hydrocarbon fuels. Property damages and aquifer restoration costs have climbed as high as $10 million from a single leaking underground gasoline tank. Prevention of losses is in the best interest of all parties.

The EID is currently developing some possible solutions to the problems of ground water contamination by hydrocarbon fuels. The following are some preliminary suggestions:

1. Hydrocarbon fuels or hydrocarbon fuel contaminated water from refineries, bulk terminals or other facilities should be discharged to lined evaporation ponds unless depths to ground water are sufficient to ensure no potential impact
2. Prompt reporting of all losses to local or central EID offices and expedient cleanup of any escaped hydrocarbon fuels
3. Accurate daily inventories of all hydrocarbon fuels stored at a facility and possibly the implementation of leak detection systems at these facilities
4. Development of a statewide inventory of all underground tanks, both active and abandoned; including numbers, sizes, locations, age and contents
5. Development of guidelines restricting the resale and installation of used storage tanks
6. Periodic tank testing of all underground fuel storage tanks, the period to be determined by the age of the tank and type of tank material (steel, fiberglass, etc.)
7. Perhaps most importantly, a more active role by the EID and other regulatory agencies in increasing the public awareness of the significance of ground water contamination by hydrocarbon fuels

These suggestions will involve the cooperation of the state and local fire prevention agencies, the New Mexico Department of Agriculture, and most importantly, the petroleum industry. However, only through such a cooperative effort will it be possible to protect ground water from hydrocarbon fuel contamination in New Mexico.

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GROUND WATER QUALITY IN THE SOUTH VALLEY OF ALBUQUERQUE

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The Albuquerque South Valley is underlain by a fresh water aquifer with a saturated thickness of approximately 3,000 feet (1). Water-bearing valley fill materials include permeable units of the Santa Fe group and of the Rio Grande alluvium (2).

Ground water quality problems in the Albuquerque valley date back to at least 1927. Water from shallow (less than 100 feet deep) wells in the valley was so hard that the city, in response to agitation by water consumers, constructed an iron removal and lime softening plant. The plant was operated only until 1933 because water of better quality was discovered deeper within the aquifer (3). In 1932-33, four "soft water deep wells" were drilled to depths of approximately 425 to 715 feet. Waters from the shallow and deep wells were mixed for the city supply (4).

Since 1927, further documentation of the relatively poor quality of shallow (less than 100 feet) alluvial ground water was provided by Bjorklund and Maxwell (2), Clayton (5), Wilson et al. (6), Heggen et al. (7) and by studies of the New Mexico Environmental Improvement Division (EID). The EID, however, found an exception to this phenomenon (table 1). Possible causes of this regional ground water quality problem include evapotranspiration, contaminant discharges and naturally occurring, water-souluble materials.

TABLE 1
"Pristine" Water Quality
(milligrams/liter)

	Rio Grande	21 Foot Well East of River
Calcium	53.	55.3
Sulfate	100.	70.8
Total Dissolved Solids	306.	280.

The Rio Grande station is at the downstream side of Old Town Bridge on old U.S. Highway 66. The 21 foot deep well is approximately 2.5 miles downstream of the Rio Grande station.

The river water data in this table were generated by the United States Geological Survey (USGS) and published in the USGS's annual Water Resources Data for New Mexico for 1981.

Evapotranspiration

Irrigation canals have diverted water from the Rio Grande for hundreds of years. Percolating irrigation water caused ground water levels in many valley areas to rise and be more vulnerable to evapotranspiration. The degree to which riverbed aggradation may have worsened this condition is not quantified.

The high water table killed orchards, ruined adobe houses and laid once productive alfalfa land idle. In 1919, about 28 percent of the valley floor area was covered by salt grass and alkali or was swampland (8). Such features are located on topographic maps of the U.S. Reclamation Service dated June 1922.

The Middle Rio Grande Conservancy District designed and constructed drains in the early 1930s to control the waterlogging of irrigated lands.

The drains lowered the water table and, as croplands were reclaimed, much of the alkali was leached from the soil surface.

Contaminant Discharges

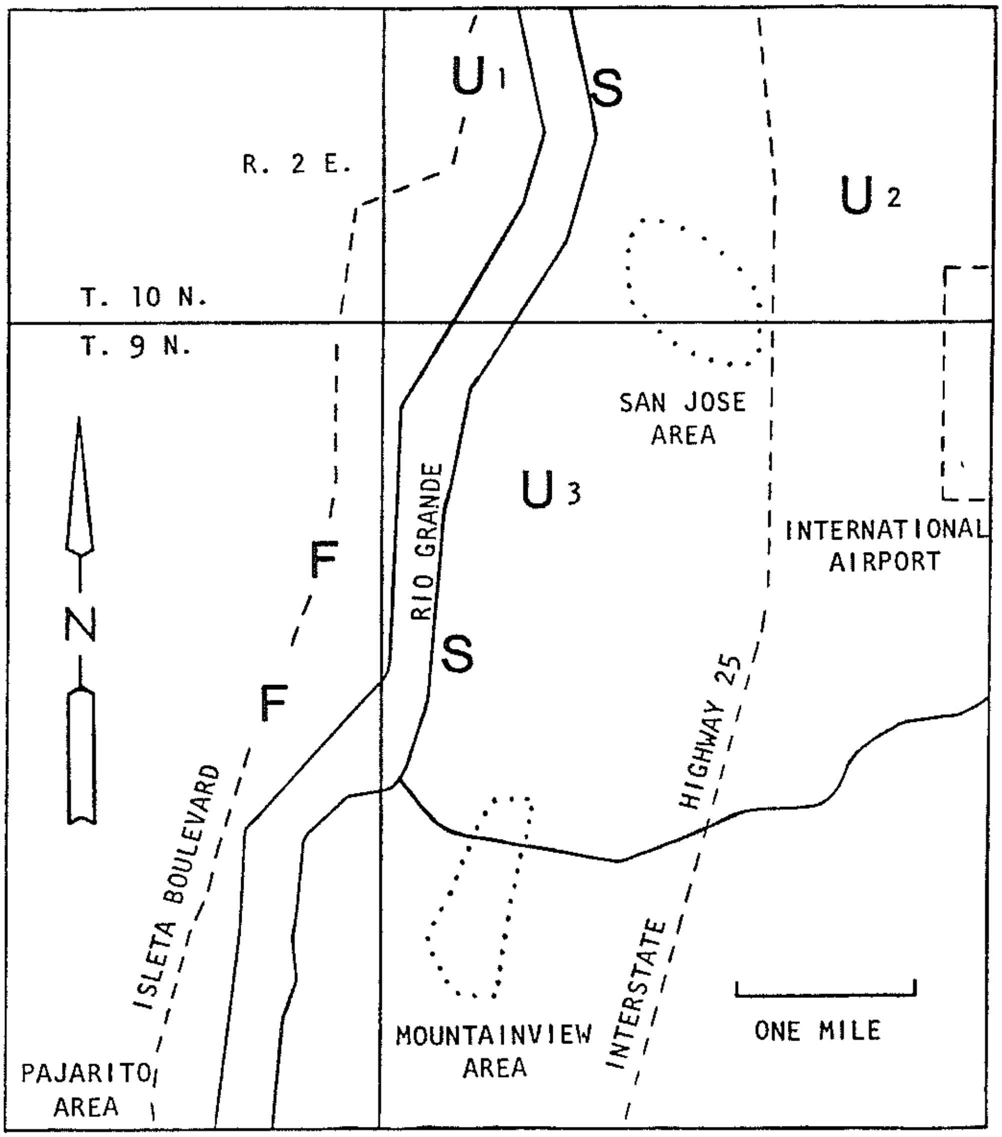
As the population grew from 2,315 in 1880 when the railroad reached Albuquerque, so did the quantity of waste generated by human activity. In 1919, a sewage treatment plant consisting of large Imhoff tanks was built on south Second Street (9). In the late 1930s, with a 10-year-old ground water quality problem at its northern boundary, the South Valley acquired a "new" sewage treatment plant and a petroleum refinery.

Since the 1930s, and especially after World War II, Albuquerque grew at an unprecedented rate. Several residential or industrial areas in the South Valley, originally developed with on site waste disposal, were later connected to the municipal sewage system which received numerous federally assisted improvements, including the construction of a second plant.

Today, potential sources of water contaminants in the South Valley include private and municipal wastewater systems, dumps, animal confinement facilities and packing plants. Other potential sources include agricultural chemicals, petroleum product handling facilities (pipelines, bulk terminals, tank truck firms, retail outlets and domestic sources) and numerous other industrial facilities, many of which have had some degree of on site waste disposal. Industrial wastes also have been discharged to several landfills and to the municipal sewage system.

Specific Instances of Ground Water Pollution or Anomalous Water Quality

There are several specific instances of ground water pollution or anomalous water quality (figure 1) in addition to the regional problem



Explanation

- F — Hydrocarbon fuel contamination of ground water
- S — Municipal sewage treatment plant
- U — Anomalous water quality occurrence, cause unknown
- – – – Roadway or airport boundary
- ——— Watercourse or boundary of township or range
- ····· Area of ground water quality concern

Fig. 1. The Albuquerque South Valley. All cases on this map are discussed in the text except for U3, where unusually mineralized ground water was recently found. The Five Points Area discussed in the Isleta Blvd. section is U1. The city well, Miles #1, discussed in the San Jose section is U2. The Pajarito area extends off the map to the south and west.

discussed above. Water chemistry data for several of these cases are listed in tables 2, 3 and 4.

San Jose Area. Inorganic water quality data, from most San Jose area wells located on the floodplain (table 2), reflect the regional problem of poor quality, shallow, alluvial ground water discussed above. However, ground water produced from a 21-foot-deep well located less than 1,000 feet east of the Riverside Drain in the South Valley is of very good quality. With regard to inorganic solutes, water from this well closely resembles river water (table 1).

Organic contaminants were detected in water from a supply well at a chemical handling facility in 1978. Reports of tastes and odors in well water elsewhere in the San Jose area date back to at least the mid 1960s.

Several organics, including halogenated two and three carbon compounds, were detected in water samples in 1979 from municipal supply wells San Jose 3 and 6. These two wells and Miles 1, another city well, were shut down in late 1980 when "priority pollutant" compounds were detected in their waters. (These compounds are on the list of 114 organic chemicals designated as "priority pollutants" by the U.S. Environmental Protection Agency [EPA].) Subsequent analyses did not detect volatile organics in Miles 1 which was put back to use in 1981.

With financial support from the EPA, the New Mexico Environmental Improvement Division (EID) conducted an investigation of the source(s) and extent of organic contamination. The EID study found at least three sources of organic ground water contaminants: at least two sources of chorinated two carbon compounds and at least one source of refined petroleum oil (e.g., diesel). Potential sources of the organic compounds in-

TABLE 2
San Jose Area
(milligrams/liter)

	Well Depth		
	19 Feet	66 Feet	912 Feet
Calcium	165.	93.	34.
Sulfate	307.9	194.1	65.
Total Dissolved Solids	874.	576.	329.
Volatiles	0.059	0.085	0.064

These three wells, located on the floodplain, reflect the regional problem of poor quality, shallow alluvial ground water discussed in the text. Ground waters with total dissolved solids levels higher than 874 mg/l exist in the shallowest (approximately 20 feet deep) zone. These three wells were selected because they were each contaminated with low part per billion levels of volatile organics, as shown.

The term "volatiles" in this table refers to volatile organic contaminants, including the benzenes and halogens mentioned in table 3. The term "benzenes" includes the sum of the concentrations of benzene, toluene, ethylbenzene and isomers of xylene.

All data were generated by the EID except for the inorganic data for the 912 foot deep well which was generated by the U.S. Geological Survey (USGS) and published in 1980 in the USGS's annual Water Resources Data for New Mexico.

clude chemical and petroleum product handling facilities, manufacturing or processing establishments, sewer lines, dumps and domestic products such as septic tank and cesspool cleaning solvents.

The San Jose well in table 3 is heavily contaminated with industrial chemicals such as calcium chloride and halogenated organic solvents. Table 4 compares the highest levels of organic halogens detected in San Jose area ground water with New Mexico Water Quality Control Commission

TABLE 3
South Valley Worst Case Examples
(milligrams/liter)

	Mountainview	San Jose	Isleta Blvd.
Calcium	765.	1,023.	120.
Nitrate-Nitrogen	501.	7.9	0.23
Total Dissolved Solids	4,776.	7,066.	1,383.
Benzenes	Not Detected	1.6	43.
Halogens	Not Detected	80.	Not Detected

Volatile organics, including the benzenes and halogens, were not detected in the excessively mineralized Mountainview ground water. This particular Mountainview well at one time was a private source of drinking water.

The San Jose case is a monitor well heavily contaminated with industrial chemicals. In addition to the benzenes and halogens, other classes of volatile organics (e.g., ketones) were detected in water from the well at levels up to 100 mg/l).

The Isleta Blvd. case is a monitor well heavily contaminated with unleaded gasoline. The levels of calcium and total dissolved solids probably reflect the regional mineralization problem; the well is only 25 feet deep.

The halogens mentioned in this table should not be confused with inorganic halogens such as chloride.

health standards. No such standards exist for other contaminants such as 1,1-dichloroethane.

No organic contaminants, other than low part per billion levels of trihalomethanes (only in chlorinated samples), have been confirmed in the product waters from other city wells or reservoirs that were sampled; in the South Valley, this includes reservoirs of the San Jose and Atrisco

TABLE 4
Organic Halogens
(milligrams/liter)

Contaminant	New Mexico Water Quality Control Commission Ground Water Standard	South Valley Ground Water
Carbon Tetrachloride	0.01	0.001
1,2-Dichloroethane	0.02	0.36
1,1-Dichloroethene	0.005	9.
Trichloroethene	0.1	6.
Tetrachloroethene	0.02	20.

All of the New Mexico Water Quality Control Commission ground water standards listed are based upon human health considerations rather than aesthetics. The ground water concentrations are worst case examples.

The halogens mentioned in this table should not be confused with inorganic halogens such as chloride.

well fields. San Jose wells 3 and 6 remain shut down. However, organic contaminants have been detected in several private water supply wells in the San Jose area.

The San Jose area has been designated as the state's top priority "superfund" site pursuant to the federal Comprehensive Environmental Response Compensation and Liability Act. Application for funding has been made for additional investigation and a feasibility study to determine what remedial action, if any, should be taken.

Mountainview

Excessively mineralized ground water has caused water supply problems in the Mountainview area at least since 1961. The worst cases historically show several hundred mg/l of nitrate-nitrogen (NO_3-N) and calcium, with most other major ions also at high concentrations, such that there are several thousand mg/l total dissolved solids (TDS [table 3]). Bicarbonate levels, however, are relatively low (e.g., 151 mg/l). Recently sampled well waters also contained anomalously high levels of selenium (e.g., 10.024 mg/l), strontium (e.g., 2.6 mg/l), uranium (e.g., 10.018 mg/l), vanadium (e.g., 0.084 mg/l) and chemical oxygen demand (e.g., 113 mg/l).

Interestingly, water collected in 1936 from test wells located immediately northwest of what is now the Mountainview community was found to be excessively mineralized with TDS concentrations on the order of 9,000 mg/l (10). These were the highest TDS levels found anywhere in the Albuquerque area during the 1936 study. In fact, the next highest level was an order of magnitude less.

In 1980, a six-month-old infant residing in Mountainview developed methemoglobinemia after ingesting food prepared with well water containing more than 200 mg/l NO_3-N (the health standard is 10 mg/l). The child recovered after being treated at a local hospital.

After 22 years of monitoring and investigation involving federal, state, county, city and private parties, numerous hypotheses have been produced, but the cause(s) of the Mountainview problem remain a mystery. In 1982, the state and city governments appropriated funds to help provide

Mountainview residents with drinking water from the Albuquerque municipal system.

Isleta Boulevard

Isleta Boulevard (U.S. Highway 85) was a major north-south highway before the construction of Interstate Highway 25. According to Bjorklund and Maxwell (2, Plate 2a) the depth to ground water along Isleta Boulevard in the South Valley area is very shallow (approximately 10 feet or less).

Many old, and sometimes abandoned, petroleum product retail outlets (i.e., filling stations) with underground steel storage tanks are located along Isleta Boulevard. Gasoline has been found floating on ground water at two locations near Isleta Boulevard (figure 1). The northern case is described as the "first example" by Jercinovic (1983, this publication). The Isleta Boulevard well in table 3 is heavily contaminated with unleaded gasoline. In the southern case, gasoline floating on the water table was encountered in a construction related excavation in 1980.

Additionally, hydrocarbon of unknown origin(s) was detected in two different well waters in the Five Points area (figure 1) in the early 1970s. Just recently (early 1982), a family in the Los Padillas area (located south of the Pajarito area shown in figure 1) has complained of a fuel like odor in water from their 50-foot-deep domestic well. This case is now under investigation by the EID.

Pajarito Area

Elevated nitrate levels (greater than 1 mg/l, but usually less than 10 mg/l NO_3-N) also have been reported in the Pajarito area (11). Wilson et al. (6, p. D-74) believed that septic tanks and cesspools to the north of Pajarito may be at least partly responsible for the problem, but that other possibilities could not be ruled out.

Municipal Sewage Treatment Plants

The city's monitoring program indicates localized nitrate contamination at both plants (figure 1). Concentrations of NO_3-N were on the order of several hundreds of mg/l and several tens of mg/l at plants 1 and 2, respectively.

Sludge drying beds appear to be the source of contamination at plant 2 (the newer and southernmost facility). Sources at the site of the older plant, where sewage treatment activity dates back to at least 1919, are not defined.

Discussion and Conclusions

A long history of human activity in a zone of shallow ground water has created a regional ground water quality problem in the Albuquerque South Valley. The problem appears to be limited to ground waters less than 100 feet deep, but its areal extent and chemical nature(s) is poorly defined.

Additionally, there are numerous cases of ground water pollution that are less extensive in geographic area. Most of these cases undoubtedly are the result of contaminant discharges.

Contaminants of health concern include nitrate, aromatic hydrocarbons and chlorinated one or two carbon organics. Other parameters reduce the amenities of water supplies derived from shallow valley ground water.

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THE PUERCO RIVER: MUDDY ISSUES RAISED BY A MINE WATER DOMINATED EPHEMERAL STREAM

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Streams and rivers have long been receptacles for the disposal of industrial and domestic wastewaters. These streams generally offer immediate dilution of contaminants carried in the waste stream. With travel downstream, the contaminant load is further reduced by chemical and biological assimilative processing in the stream. Unless the natural assimilative capacity of the stream is exceeded, the wastewater may be discharged to a perennial stream with minimal effects on the environment.

With increased urbanization and industrialization, disposal of wastewater in ephemeral watercourses has increased correspondingly. Due to the naturally dry character of the channels, there is little, if any, recreation or naturally occurring aquatic life to be affected. On the other hand, because there is minimal in-stream dilution of the wastewater, the impacts on ground water may be more severe than from a discharge to a perennial stream.

I will discuss some of the environmental and regulatory problems associated with ongoing uranium mine wastewater discharges to a major ephemeral watercourse in northwestern New Mexico. Specifically, I will focus on discharges from the Church Rock Uranium Mining District to the Puerco River.

The Church Rock Uranium Mining District

The Church Rock Mining District represents one of three major active uranium mining locations in the Grants Mineral Belt--the predominant uranium production area in the United States. The Church Rock Mining District is located approximately 15 miles northeast of Gallup, New Mexico (figure 1). The district has been a significant producer of uranium ore since 1969.

Associated with, production of ore is production of water. Because the principal ore-bearing zone (Morrison Formation) is also a regional aquifer, areas to be mined must first be dewatered. Much of the water thus removed is utilized to meet water needs in mines and mills. Excess water is disposed of in the channels of a formerly ephemeral stream--the Puerco River.

The Puerco River Watershed

The Puerco River, at an altitude of 6,000-7,000 feet, drains the southern Colorado Plateau in New Mexico and Arizona. Alternating mesas and broad alluvial valleys dominate the landscape. Upland areas are capped by resistant strata such as sandstone; river valleys have been excavated from less resistant formations such as shale.

Climate is temperate and semiarid. Owing to the aridity, lowland areas can only support a sparse ground cover of grasses and drought-resistant shrubs. At Gallup, annual precipitation is usually less than 15 inches. Most of this falls during the summer thunderstorm season of July through September. Winter frontal storms from December through March produce lesser amounts of precipitation.

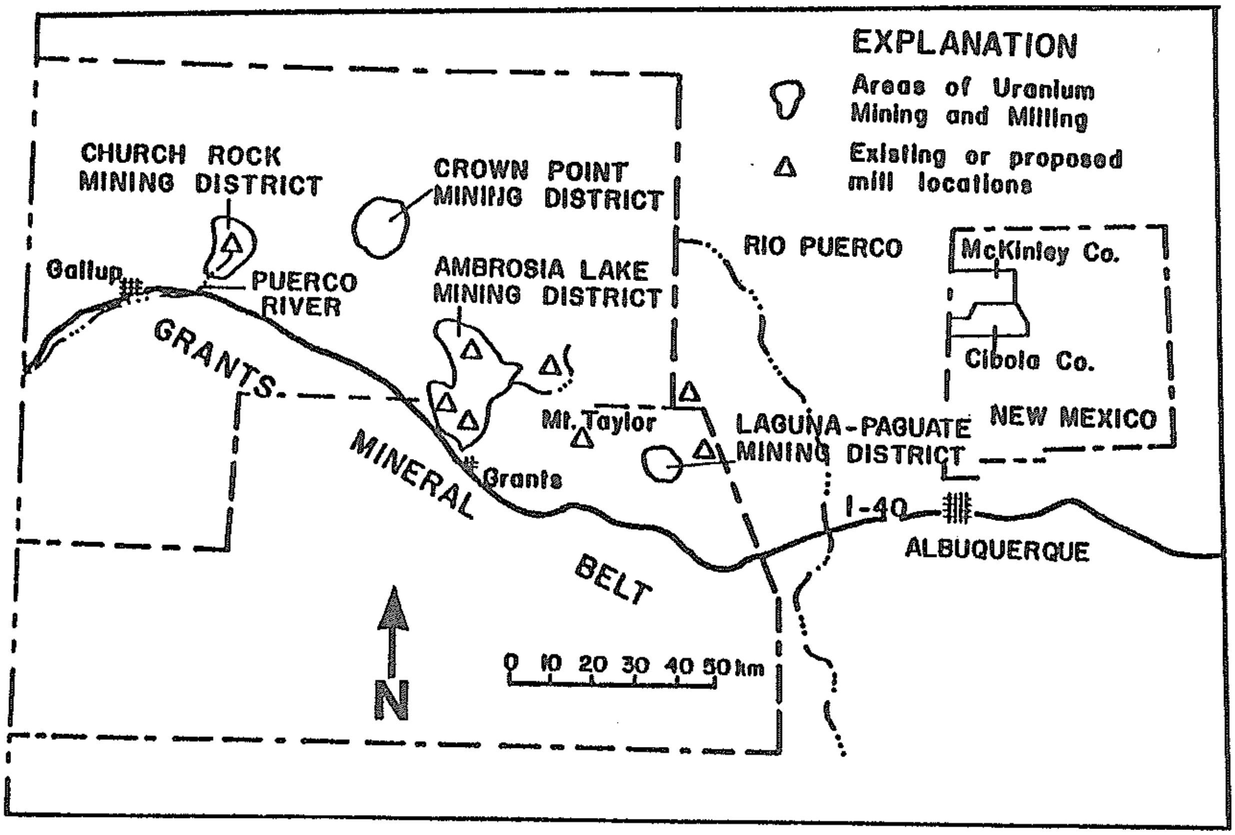

Fig. 1. Map of Grants Mineral Belt

Except for a few isolated springs and mountain streams, the Puerco River Watershed has no naturally perennial surface waters. Available records indicate that prior to uranium mine dewatering, the Puerco River was dry more than 70 percent of the time, flowing only during spring snowmelt and major summer thunderstorms. Since 1968, dewatering of underground uranium mines has caused perennial flow in the Puerco River.

Perennial conditions now exist from above Church Rock to about 15 miles beyond the Arizona border.

Water for livestock use comes from the now perennial Puerco River and from shallow alluvial wells. Prior to dewatering, livestock utilized water pumped from the wells and occasional surface water flows.

Regulatory Control of Uranium Mine Discharges

During 1982, Church Rock mines continuously discharged nearly 5,000 gallons per minute of mine dewatering effluent to the Puerco River. Prior to discharge, the mine water flowed through a series of ponds wherein most of the contaminants settled. Elevated levels of uranium or radium were subsequently reduced by ion exchange treatment.

Before the mid-1970s, none of the mine discharges in Church Rock were effectively regulated. Since 1979 however, all discharges to the Puerco River have been under the regulatory control of the federal National Pollutant Discharge Elimination System (NPDES) administered by the U.S. Environmental Potection Agency. (See discussion of NPDES program in the panel "Protection of Water Quality in Mountain Streams.") The NPDES permit sets concentration limits for some contaminants normally associated with a particular type of discharge. For uranium mine effluents, the concentrations of uranium, radium, total suspended solids and pH are controlled by NPDES. Overall, the mines are in compliance with their NPDES permits.

Although the quality of water discharged from the mines is regulated, the quality of water in the Puerco River itself is subject to little regulatory control in New Mexico. Because of its ephemeral nature, the Puerco River has no designated uses. Therefore, there are no specific stream standards applicable to that channel except the narrative general standards applicable to all surface waters of the state (1).

Arizona, to the contrary, has determined that the Puerco River in Arizona should be protected for aquatic life, wildlife, irrigation and livestock (2). Eighteen numerical standards have been developed for metals, radionuclides and nutrients. While these are not effluent limits per se, they could be used as such. All in all, the NPDES permit system represents the primary method for regulating the quality of uranium mine discharges. It is of particular importance to note the following points regarding NPDES:

1. NPDES permit limits are adopted based on treatment technoloy considerations rather than on health and water quality considerations. This can cause a situation in which a mine discharge is in compliance with all permit limits, but is not suitable for livestock watering, which routinely occurs along the Puerco River.

2. Only a few of the many radionuclides and metals present in untreated mine waters are regulated under the NPDES permit.

Mine dewatering effluents now constitute the entire flow of the Puerco River during dry weather. However, the contaminants in the flow need not be derived exclusively from the discharges. This is due to the geochemical and geomorphic processes operating within the Puerco River system.

Sediment in the Puerco River Valley is largely comprised of silt and clay sized particles. Due to the lack of vegetation in the valley, these materials are readily eroded and available for transport by streamflow. Silts and clays preferentially attract contaminants such as metals or radionuclides; the quality of whole water in the Puerco River, therefore, may worsen with increased amounts of suspended sediment.

Figure 2 compares ranges of contaminant concentrations in (1) natural runoff (high suspended sediment load) in areas within the Puerco River Watershed unaffected by industrial activities with (2) mine water dominated flow in the Puerco River during dry weather. The following points deserve highlighting:

1. Lead concentrations in natural runoff usually greatly exceed limits and guidelines established for livestock (3) or drinking waters (4). These concentrations are directly related to the concentrations of sediment carried with the water. In periods of low flow, the amount of lead in the Puerco River is at an acceptable level. Lead levels during low flow, however, are still 10 times greater than levels found in mine waters.

2. The gross alpha radioactivity concentration is a general indicator of the total amount of alpha radioactive emissions from a material. The gross alpha concentrations in natural runoff, while less than in the mine water dominated flow are likewise far greater than some established guidelines. Uranium (represented by crosshatching) is largely absent in natural runoff, but dominates gross alpha radioactivity levels during low flow conditions. The remaining amount of activity is probably derived from natural material present in the Puerco River channel.

Issues

A recent Environmental Improvement Division (EID) report (5) noted that the Puerco River contains levels of radioactivity and certain toxic metals that approach or exceed standards or guidelines designed to protect the health of people, livestock and agricultural crops. Parameters that routinely exceeded one or more criteria were barium, manganese, molybdenum, lead, selenium, radium, and gross alpha and beta radioactivity. As a result, the EID recommended that the Puerco River not be used

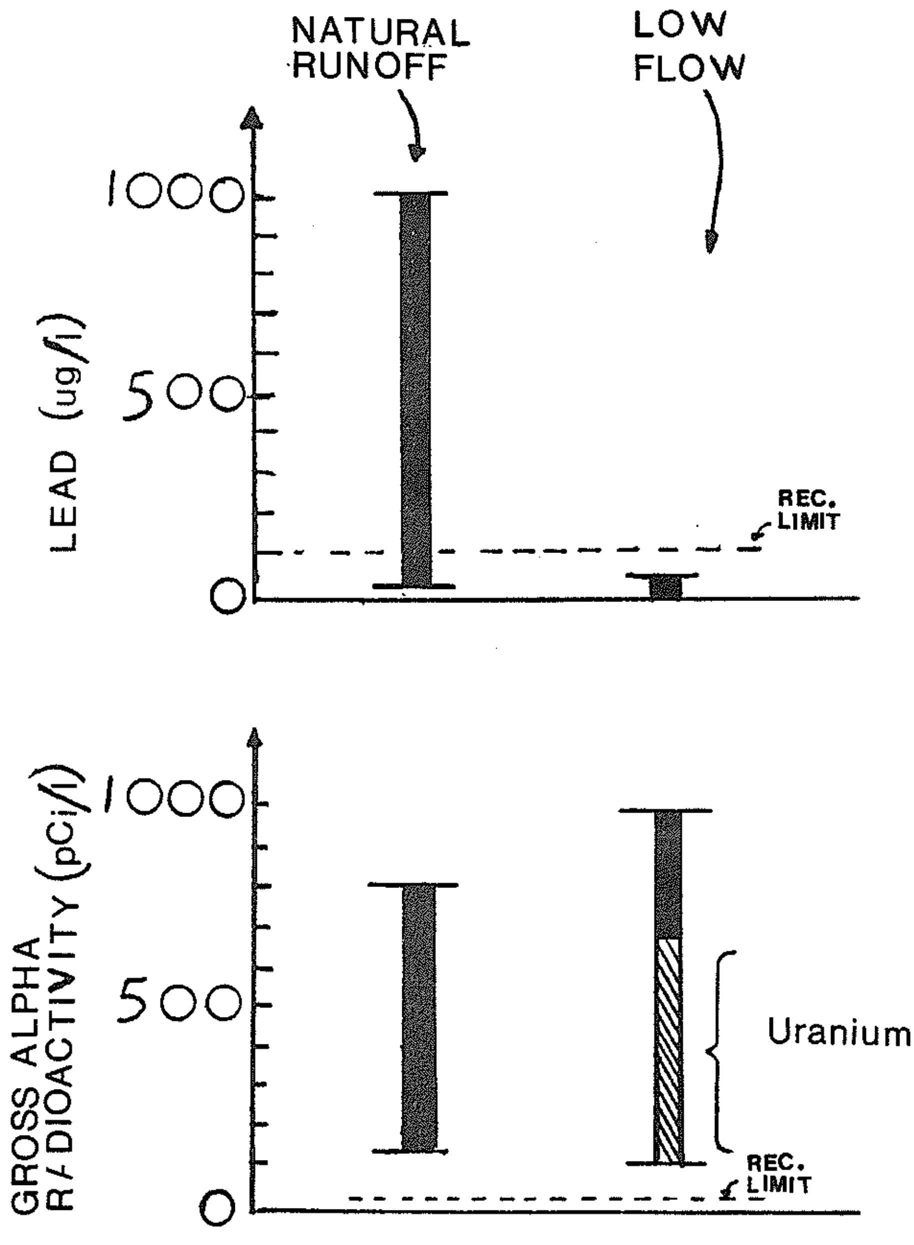

Fig. 2. Ranges in contaminant concentrations within the Puerco River Watershed versus recommended limits (3, 4). Natural runoff in areas unaffected by mining activities; low flow in Puerco River during dry weather mine water dominated condition. Crosshatching represents the range directly attributable to the mine water discharges.

as a primary source of water for human consumption, livestock watering or irrigation.

A conventional approach to rendering a stream suitable for use might be to impose stricter effluent limits on discharges to that stream. However, that approach may have limited value on the Puerco River.

Data collected within the Puerco River Watershed suggest that no level of improvement in effluent quality would render the river totally suitable for livestock watering, the predominant use of the river. In short, the uranium mines could be discharging distilled grade water but the Puerco River still may be unsuitable for livestock watering due to the natural pickup of the contaminant-laden sediment with travel downstream. Livestock drink water directly from the channel and inadvertently ingest these contaminants.

The above factors indicate that water pollution control of effluent dominated ephemeral streams presents unique problems. Perhaps the best that we can hope for in these settings is that the effluent at the point of release is suitable for the predominant downstream use. It may prove more difficult to convince local residents that the water downstream of the discharge point is not suitable as the primary source for livestock watering.

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THE ENVIRONMENTAL PROTECTION AGENCY AND THE STATES: A SPIRIT OF COOPERATION

Brad Cates, Director

Office of Intergovernmental Liaison
United States Environmental Protection Agency

I appreciate the opportunity to be here with you today. A few weeks ago, the Washington Post published a cartoon on its editorial page. The drawing depicted three people speaking at a cocktail party, a woman introducing two men to each other saying, "This is Mr. Smith. He hasn't heard from his office in the last half hour, but he reportedly works for EPA."

Over the past two months, some of us haven't found a great deal of humor in such cartoons. We have the impression that Doonesbury went on vacation, leaving us stranded on the ledge.

We have now been entrusted to the capable hands of Mr. William D. Ruckelshaus and as soon as people at the U.S. Environmental Protection Agency (EPA) learn to spell his name, they can continue the work of environmental protection.

In truth, the agency has carried on a great deal of essential environmental work despite the headlines of the past few months. However, as you know better than I can explain to you, the essential work of environmental protection can succeed in Washington only as long as it has the effective support of interested groups and institutions--such as this one--around the country.

I have often marvelled at President Reagan's abilty to find a suitable quotation from Alexis de Tocqueville every time he has a major national address. In reality, it's not that hard to do since Tocqueville wrote on nearly every aspect of democratic life. For instance, his opening chapter of <u>Democracy in America</u> discusses the profound effect that the Mississippi River had on life in our early frontier. Tocqueville wrote:

> The valley which is watered by the Mississippi seems formed to be the bed of this mighty river, which, like a god of antiquity, dispenses both good and evil in its course. On the shores of the stream, nature displays an inexhaustible fertility; in proportion as you recede from its banks, the powers of vegetation languish, the soil becomes poor, and the plants that survive have a sickly growth...the whole aspect of the country shows the powerful effects of water, by both its fertility and its barrenness.

Here in New Mexico, we don't require reminders from the great thinkers of western civilization to discern the importance of water for our way of life. What we sometimes wonder, however, is whether policies of the national government help or hinder the water resources of our people. At the EPA, we are primarily concerned with the effects that environmental policies have on the quality of water available to the American people.

The past year has been one of the busiest in the history of the EPA as far as productive activity affecting water is concerned. Given the relative scarcity of surface water in New Mexico, we don't have extensive evidence of these accomplishments in our state, but those of you who travel a bit can see cleaner rivers and lakes in virtually every state in the union.

The Federal Water Pollution Control Act--more commonly known as the Clean Water Act--was adopted in 1972. The law attacked the nation's water pollution problems on two main fronts. First, it established a

Construction Grants Program to enable municipalities to develop adequate systems for the treatment of their wastewaters. Through the assistance of the Construction Grants Program, nearly 85 percent of the affected cities and towns in the United States have come into compliance with the technology based pollution control requirements of the Clean Water Act.

The effort to improve municipal wastewater treatment is continuing under this administration. In late 1981, Congress enacted amendments to the Clean Water Act to stabilize this program, providing $2.4 billion in annual funding to complete this work on a national level by the end of this decade. These amendments also reduced parts of the planning and paperwork that contributed to the expense of the program.

While Congress has been assisting the development of these municipal wastewater treatment facilities, private industries in the United States also have been required to comply with their own technological methods of wastewater treatment. In 1977, EPA issued a set of regulations known as BPT guidelines, or "Best Practicable Technology", for the treatment of industrial effluents. Under the requirements of the law--and a series of court decisions--EPA was also expected to issue a series of BAT--that's "Best Available Technology Economically Achievable"--guidelines to provide more sophisticated treatment for toxic effluents in industrial waste streams.

This turned into one of those "they said it couldn't be done" projects. The initial Clean Water Act had called for these BAT regulations within a year; however, by November 1982, we were well on the way. Today, half of those regulations are on the books and the rest have been proposed. For the first time in its history, The EPA issued the guidelines in keeping with a court schedule with these regulations.

Industries have been very successful in their efforts to comply with the earlier BPT regulations. Fully 96 percent of the regulated facilities have installed the required equipment. This substantial investment on the part of our industries has complemented the efforts of American municipalities to reduce the discharge of wastes into the nation's lakes and streams, thereby improving the quality of waters for a wide variety of uses.

Improving the quality of surface waters is only half of the water quality concern of the American people. Fully half of all Americans depend on ground waters for their drinking water, irrigation of croplands, industrial uses and other forms of water consumption. As each of you is intensely aware, we in New Mexico have far greater reliance on ground waters than people in other sections of the country where surface waters are more abundant.

The quality of our underground water resources has been the leading concern of two pieces of legislation beyond the Clean Water Act and the Safe Drinking Water Act--although these laws have played a role in shaping our developing national ground water policy. The Resource Conservation and Recovery Act (RCRA), which regulates facilities engaged in the treatment, storage and/or disposal of solid wastes; and the Comprehensive Environmental Response, Compensation and Liability Act, better known as "superfund", also make ground water quality central issues of current environmental policy.

Under RCRA, ground water quality considerations have been central to all regulations governing land disposal facilities, surface impoundments and land treatment facilities. Under regulations issued last July, anyone operating a land disposal facility must install sealed double liners to prevent any liquid within the landfill from leaching into surrounding ground waters. These regulations merely complement the requirements that had been issued with the original RCRA regulations in November 1980 for monitoring surrounding ground water.

Strict limits on the liquid content going into land disposal facilities and monitoring requirements to assess the quality of surrounding ground waters, along with liners, go a long way toward ensuring that we will be able to prevent the worst nightmares of ground water quality that concern many people.

Such nightmares, as is common with other areas of human uncertainty, thrive in the absence of adequate information. We know that when people talk of movement in waters on the surface, we are talking in terms of miles per day. Under the ground, we might be talking in terms of inches per year. Better understanding of ground water movements must be one of our leading research concerns.

Some people are under the impression that once a plume of some pollutant enters an underground aquifer, the entire aquifer is unsuitable for human use. This is not accurate in many respects, but we are not sure how many. We know, for example, that even in large bodies of surface water we can have wide variations in water quality from one shore to another. With water moving so much more slowly under the ground, it makes sense that pollutants moving within that water would move correspondingly slower.

We know, too, that different grains of sands and other substances beneath the soil frequently filter many surface pollutants out of water moving through the earth. We don't always know what might come out, or how quickly, or with what variations in conditions.

Further, we know that different qualities of water are suitable for different kinds of uses. Some water might contain residues of pesticides, or fertilizers, or other material that would make that water useless for direct human drinking. That would not mean, however, that the same water could not be used to irrigate fields or for some other very valuable, noningestion purpose. We could use more research into the quality of water appropriate for different uses.

Where RCRA covers the regulation of currently operating waste disposal facilities, superfund covers abandoned or inactive facilities and attempts to guide national efforts to clean up those sites, remedying the damage that has occurred and preventing future damage as the task is completed. People here in New Mexico's Environmental Improvement Division are thoroughly familiar with the ground water concerns of superfund. They are deeply involved in ground water assessments that will shape the course of future responses to each of the four superfund sites in the state.

While we at EPA move vigorously to address some of the water quality concerns of the American people, we remain aware of the ways in which these quality concerns can affect water supply decisions. We make a conscious effort to separate these concerns and leave questions about the development of new water resources in the hands of state and local governments where they have been throughout American history.

Last year, EPA began the development of a national ground water policy. Given the scope of the subject and the variety of interests concerned about the final shape of the policy, you might expect that the final policy will involve more than one agency and more than one year's preparation. The EPA is now awaiting comments and further Cabinet Council action. However, let me outline the five guiding principles that have shaped EPA's approach to the policy so far.

First, our policy must recognize the primary role of states in ground water protection.

Second, we should encourage voluntary state strategies for the protection of ground water resources and foster coordination among the various state institutions in protecting ground water policy.

Third, the level of ground water protection should consider projected future uses as well as current usage.

Fourth, EPA's role should emphasize coordination of our own existing authorities.

And fifth, EPA will not become involved in the important state responsibility of allocating ground water rights. Our duties center on the water quality concerns of the American people.

These are the major issues of water quality, both on the surface of the earth and under the ground, that the American people will confront in the coming years. We know that working through the New Mexico Water Resources Research Institute, you can make valuable contributions to the developing national discussions of these policies.

Talking about your continued work is somewhat easier than talking about how work will continue at EPA these days. We know that the work of environmental protection will go on but I know that many of you share reservations about whether the efforts of regulatory reform, increased reliance on our federal system, and considerations of balancing environmental regulation and economic growth can continue.

The overriding concerns of environmental protection are not partisan issues, and the environmental concerns that inspired the formation of EPA are not the same environmental concerns that the American people face in 1983. I would, however, like to share with you a few of the thoughts that our new administrator expressed to EPA employees the day after his nomination was announced.

Explaining why he decided to come back to EPA--after noting that his wife thinks he ought to be committed for doing so--Mr. Ruckelshaus told us:

> ...I have come to believe that over the years since leaving EPA, that how free societies deal with chronic problems of modern life like pollution, resource depletion and population pressures, will very much dictate whether free societies will remain free.
>
> These chronic problems that persist, that are difficult to manage, the mangement of risk itself, is a very divisive, very emotional thing for a free society to face and what we need to do is get better at it. And we need to do all of these things in the context of freedom.

He added:

> EPA should be in the forefront of preserving human health and the environment and at the same time never losing sight of our central focus on freedom.

That central message was woven throughout Mr. Ruckelshaus' text. He also reminded those of us who work with him at EPA:

> The debate over whether we are going to protect human health and the environment ended 15 years ago...The issue today isn't whether we are going to clean up, but how...In discharging our responsibilities, we must never, never forget that we are public servants. Our job is to serve the people, not condemn them, not bully them.

I have enjoyed the opportunity to be with you today and I hope that I have helped a bit in indicating some of the directions of our national environmental concerns at EPA.

LONG-RANGE PLANS FOR HYDROLOGIC INVESTIGATIONS

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ABSTRACT

Solutions to future water resources problems in New Mexico will require water information users to have accurate hydrologic data and interpretations available during the decision process. The purpose of this report is to briefly describe projects that will address and assist in providing solutions to these problems.

Objectives of the eight hydrologic data collection projects presented in this report include continuing to identify future data needs, conducting an analysis of the water quality, ground and surface water observation networks, and entering all available current and historical hydrologic data into the U.S. Geological Survey (USGS) Data Storage and Retrieval System (WATSTORE). Objectives of areal appraisal studies include evaluating the water resources in the Gallup-Grants-Zuni-Acoma sag area and on the eastern flank of the Sandia and Manzano mountains in Bernalillo County. Potential projects for basin assessments include quantifying the ground water/surface water relationships on rivers with flows governed by compacts, and an investigation of the water resources of the Estancia Basin. Projects that will assist in the evaluation of energy-related activities include describing the effects of resaturation of coal mines and of milling operations on the quality and quantity of ground and surface waters.

Activities that need to be undertaken to assist in addressing waste disposal problems include the evaluation of the hydrologic factors influencing the feasibility of cleanup at the Albuquerque South Valley "superfund" site and the establishment of a monitoring network at the Waste Isolation Pilot Plant (WIPP) project near Carlsbad. Scientific methods that need to be developed include: (1) the testing of analytical techniques for estimating site-specific conditions with the results of digital hydrologic models, and (2) the determination of the influence of recharge from ephemeral streams on alluvial aquifers. Quantified surface water/ground water interaction information is needed by water managers charged with comprehensive water management of the Rio Grande system. Information services that need to be accomplished include conducting question-answer sessions on hydrology at local levels and preparing a nontechnical report describing the hydrology of the southern Mesilla Basin for the lay reader.

INTRODUCTION

The need for water resources information in New Mexico is constantly changing as the availability, use and management of water changes. Urban and industrial development, new water management practices, depletion of existing supplies and innovative water resources technology all change the type and frequency of information required by water resources planners. Local and federal budget constraints require program planners to ensure that limited funding and human resources are directed toward solving the most critical water problems and obtaining the maximum results possible for the effort expended. This can be referred to as getting the "biggest bang for the buck."

The purpose of this plan is to describe the studies that the USGS believes are needed to help answer future questions by water resources planners in New Mexico, and that are consistent with priorities of the Department of the Interior and local needs. By identifying potential problems and studies, this plan also provides a mechanism for other federal, state and local agencies to contribute their expertise, advice and resources toward developing a comprehensive and efficient approach for solving the problems.

Active projects in the New Mexico district are funded in cooperation with the New Mexico State Engineer Office (SEO), the New Mexico Highway Department, the New Mexico Bureau of Mines and Mineral Resources, the Pecos River Commission, the Rio Grande Compact Commission, the Albuquerque Metropolitan Arroyo and Flood Control Authority, the city of Albuquerque, the city of Alamogordo, the city of Las Cruces, the New Mexico Environmental Improvement Division (EID), the Santa Fe Metropolitan Water Board, the Zuni Pueblo and the Alamo Band Navajo tribe. Federal cooperators are the Bureau of Reclamation, the National Park Service, the Bureau of Land Management (BLM), the Bureau of Indian Affairs, White Sands Missile Range, the Department of Energy, the U.S. Army Corps of Engineers, and Holloman Air Force Base.

Potential investigators for the programs outlined in this report are not limited to the personnel of the USGS. By identifying a project need, we are saying that we believe: (1) the information needs to be obtained, (2) the objectives of the study are consistent with the mission of the Water Resources Division, and (3) the personnel and technical capabilities to meet the objectives are, or can be, available within the New Mexico district.

The ideas and subsequent studies (program steps) discussed in this plan are products of special and ongoing program review sessions with state cooperators and internal identification by New Mexico district personnel. The steps were grouped into broad categories of need and scientific discipline that are referred to as program elements. Many active and planned projects (program steps) may need to be successfully completed to achieve the long-range goals identified for the program elements.

Many of the program steps (projects) identified logically could be placed in other program elements than those shown. In fact, all steps do contribute to overall knowledge and, hence, to all program elements. The placement is subjective according to our view, but we hope that capriciousness has been avoided.

In addition, this listing reflects the "best guess" of needs based on today's problems. As water problems change, so will the emphasis on individual steps and elements within this plan. Therefore, we do not view this plan as a binding project-by-project priority commitment for future studies. Rather, it is a guide for development of programs in a logical sequence. As such, it is intended to be periodically reviewed, changed and restructured as problems change and as the general level of water knowledge increases. Indeed, this document represents the revision of a plan developed by the New Mexico district in 1980 that covered the timeframe 1980-84. By viewing the program and water information needs as a whole, however, we have attempted to identify those activities that should endure in spite of changing emphases.

The authors wish to thank the personnel of the SEO and the EID for their perspective and input during the formulation of the ideas that are included in this plan. In addition, their review of the plan and the review by personnel of the New Mexico Bureau of Mines and Mineral Resources are greatly appreciated.

PROGRAM ELEMENTS

Hydrologic Data Collection and Processing

The accuracy of interpretive studies is dependent on the type and quality of hydrologic data available or collected. Water level, water quality and water use data provide the cornerstone for hydrologic investigations. The need for collection of specific hydrologic data often is indicated during the first phase of a study. Such data collection is the logical next step toward a better understanding of a hydrologic system. The proper type of data can be invaluable in narrowing the range of uncertainty in results of hydrologic investigations.

In the future, all phases of hydrologic data collection must continue to reflect the need for efficient use of personnel, travel and other resources. To meet high priority changing needs, existing and future data collection programs will have to be reviewed frequently and coordinated with other data collection and investigative agencies.

Current surface water data collection activities in New Mexico include measuring stream discharge at approximately 227 gauging stations, stage and contents for 25 lakes and reservoirs, and gauge height at 135 crest stage, partial record stations. Water levels are recorded at 91 federal network observation wells. Water quality data are collected at 89 gauging stations, six partial-record stations, one reservoir, 44 springs and 293 wells (USGS, 1982). Water levels are measured periodically in approximately 5,000 wells as part of a cooperative program with the SEO. Water use data are collected for every county in New Mexico and are available in a publication by Sorensen (1982).

Goal. Continue to collect and disseminate information on the water resources of New Mexico through the most efficient use of available money and manpower.

Program Steps. Planned or needed new projects (table 1) to:

1. Identify data needs and coordinate data collection. The USGS views this step as a continuing process. The 1983 Annual New Mexico Water Conference (April 5-6, 1983) provided a forum for the exchange of data needs for local, state and federal agencies. The identification and collection of hydrologic data must continue to be flexible and responsive to changing needs, but must also provide a consistent baseline for monitoring long-term trends and changes.

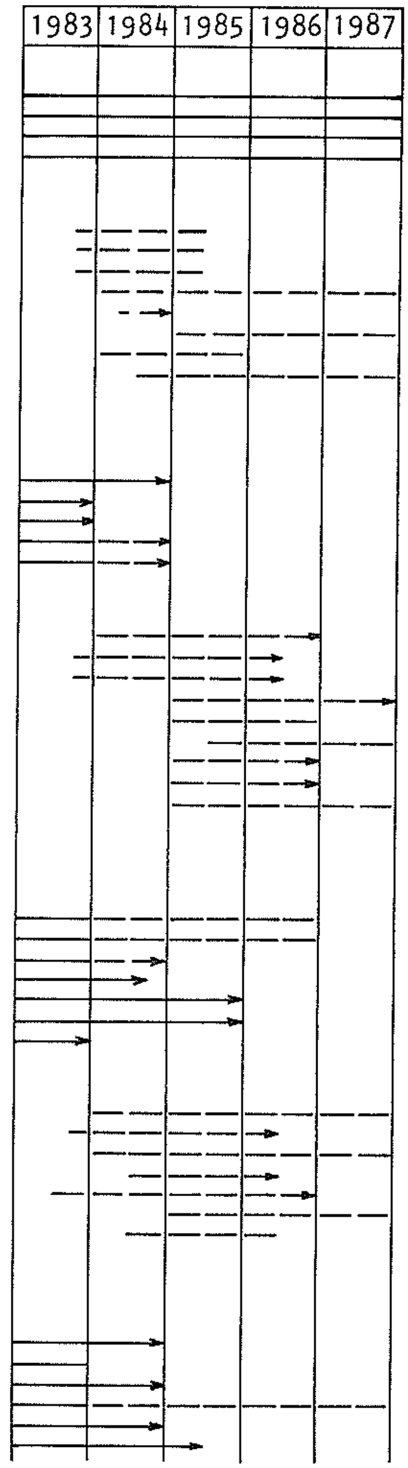
2. Conduct a network analysis for the collection of surface water, ground water and water quality data. A scientific, statistically valid analysis of frequency and areal distribution of data collected is needed to ensure that meaningful data are collected and personnel and limited monetary resources are efficiently utilized.

3. Enter historic, current and future hydrologic data in WATSTORE. This step reflects a commitment to organize and centralize hydrologic data in the New Mexico district. Specific activities in this step include evaluating the district's technical files, entering historic water quality data and continuing the conversion and entry of water well records into the ground water site inventory (GWSI) data base. The processing of data in OMNIANA, the former New Mexico district in-house ground water data storage system, into GWSI is also part of this step.

4. Collect borehole-geophysical log information. This step includes collecting existing logs and using the New Mexico District logger to obtain additional borehole-geophysical logs

TABLE 1

Time Frames for Active and Planned or Suggested Studies in the New Mexico (A solid line indicates an active project. A dashed line indicates a planned or suggested project or the extension of an active project. An arrowhead indicates the end of a project; no arrowhead indicates that the project might continue.)



I. HYDROLOGIC DATA COLLECTION AND PROCESSING

A. ACTIVE PROJECTS

1. SURFACE WATER
2. GROUND WATER
3. WATER QUALITY (CHEMICAL, SEDIMENT, BIOLOGICAL)
4. WATER USE

B. PLANNED OR SUGGESTED NEW PROJECTS

1. DATA NEEDS IDENTIFICATION AND DATA COLLECTION COORDINATION
2. NETWORK ANALYSIS OF SW, GW, AND QW
3. PROCESSING OF HYDROLOGIC DATA
4. GEOPHYSICAL LOGGING OF KEY WELLS
5. COMPILATION OF AQUIFER TEST DATA
6. MUNICIPAL WATER-QUALITY SURVEY
7. INVENTORY OF ORGANICS IN VADOSE ZONE
8. PRECIPITATION QUALITY NETWORK

II. AREAL APPRAISALS

A. ACTIVE PROJECTS

1. ZUNI TRIBAL LANDS
2. SAN AGUSTIN PLAINS
3. CIBOLA COUNTY
4. SOCORRO COUNTY
5. CATRON COUNTY

B. PLANNED OR SUGGESTED NEW PROJECTS

1. (a) SAN ANDRES - GLORIETA AQUIFER OF ZUNI UPLIFT
   (b) SAN ANDRES - GLORIETA AQUIFER OF ACOMA SAG
2. SANDIA - MANZANO MOUNTAIN HOME SUPPLIES
3. TAOS AND RIO ARRIBA COUNTIES
4. WATER QUALITY IN AQUIFERS ABOVE MINERAL DEPOSITS
5. HYDROLOGIC EFFECTS OF NAVAJO INDIAN IRRIGATION PROJECT
6. CURRY AND QUAY COUNTIES, OGALLALA AQUIFER
7. SANDOVAL COUNTY
8. SALTWATER ENCROACHMENT, TULAROSA BASIN

III. BASIN ASSESSMENTS

A. ACTIVE PROJECTS

1. PARTS OF PECOS RIVER BASIN
2. PARTS OF RIO GRANDE BASIN
3. SWAB
4. TULAROSA BASIN, GEOPHYSICAL STUDIES
5. SOUTHERN MESILLA BASIN
6. SAN JUAN BASIN GROUND WATER
7. MIMBRES BASIN GROUND WATER

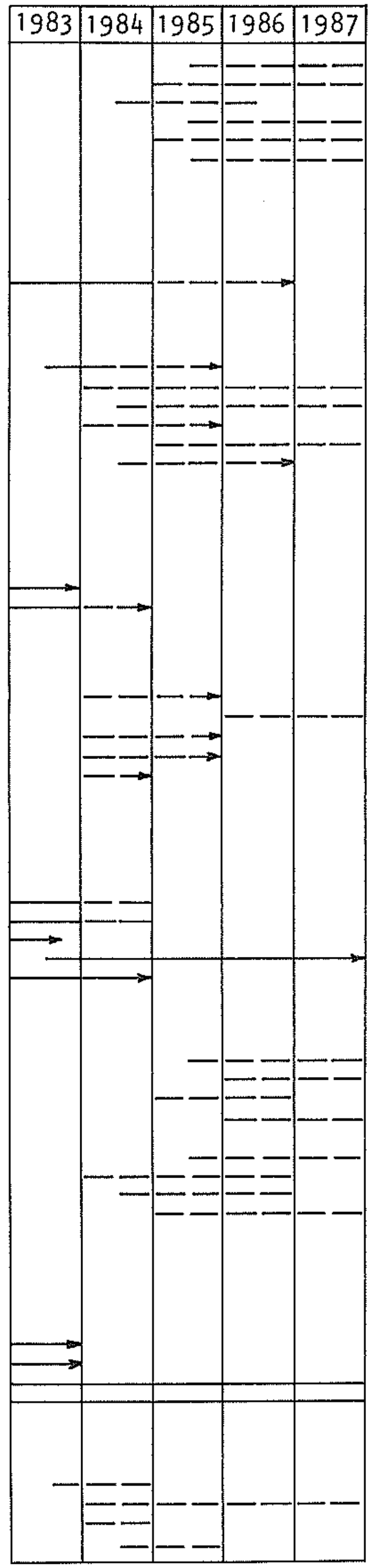
B. PLANNED OR SUGGESTED NEW PROJECTS

1. GROUND WATER/SURFACE WATER INTERACTION
2. ESTANCIA BASIN
3. MIDDLE RIO GRANDE WATER QUALITY
4. GILA RIVER BASIN
5. PECOS RIVER STUDIES: ROSWELL, BRANTLEY, MALAGA
6. ALBUQUERQUE-BELEN, ROSWELL BASIN FRESHWATER/SALT WATER
7. PUERCO RIVER WATER QUALITY

IV. FOSSIL FUEL AND MINERAL EXTRACTION

A. ACTIVE PROJECTS

1. RF/RO MODEL COAL LEASES, SAN JUAN BASIN
2. EFFECTS OF COAL DEVELOPMENT ON SAN JUAN RIVER
3. RESATURATION OF MARIANO LAKE URANIUM MINE
4. EFFECTS OF MINE DEWATERING ON KIM-ME-NI-OLI WASH
5. HYDROLOGY OF IN SITU URANIUM-LEACHING MINING
6. JEMEZ GEOTHERMAL STUDIES



B. PLANNED OR SUGGESTED NEW PROJECTS

1. RESATURATION OF COAL MINES
2. EFFECTS OF MILL TAILINGS
3. QUALITY OF WATER IN GRANTS MINERAL BELT
4. QUALITY OF WATER IN SILVER CITY AREA
5. ACID RAIN, FOUR CORNERS AREA
6. QUALITY OF WATER NEAR QUESTA

V. WASTE DISPOSAL

A. ACTIVE PROJECTS

1. WASTE ISOLATION PILOT PLANT (WIPP)

B. PLANNED OR SUGGESTED NEW PROJECTS

1. ALBUQUERQUE SOUTH VALLEY "SUPERFUND" HYDROLOGIC STUDY
2. LONG-TERM MONITORING NETWORK AT WIPP
3. TIME-OF-TRAVEL FOR HAZARDOUS-WASTE SPILLS
4. EXTENT OF HYDROCARBON CONTAMINATION
5. EFFECTS OF LANDFILL AND FEEDLOT SITES
6. DENITRIFICATION POTENTIAL OF SOILS

VI. SCIENTIFIC METHODS DEVELOPMENT

A. ACTIVE PROJECTS

1. TREND-ANALYSIS TECHNIQUES, EFFECTS OF COAL DEVELOPMENT
2. MONITORING CRITERIA FOR IN SITU MINING

B. PLANNED OR SUGGESTED NEW PROJECTS

1. DIGITAL MODEL ANALYTICAL TECHNIQUES
2. ESTIMATION OF RECHARGE FROM EPHEMERAL STREAMS
3. EFFECTS OF GASES IN AQUIFERS
4. SENSITIVITY ANALYSES OF DIGITAL MODELS
5. SOLID-STATE RECORDERS FOR RAPID WATER-LEVEL CHANGES

VII. WATER MANAGEMENT

A. ACTIVE PROJECTS

1. ALBUQUERQUE FLOOD AND WATER-QUALITY RUNOFF
2. EFFECT OF WITHDRAWALS NEAR ALAMOGORDO
3. SANTA ROSA RESERVOIR EFFECTS
4. ALBUQUERQUE URBANIZATION EFFECTS ON GROUND AND SURFACE WATER
5. SANTA FE MODEL STUDY

B. PLANNED OR SUGGESTED NEW PROJECTS

1. RIO GRANDE BASIN COMPREHENSIVE HYDROLOGIC MODEL
2. EFFECTS OF SANTA FE URBANIZATION ON RETURN FLOW TO RIO GRANDE
3. WATER QUALITY CHANGES NEAR SMALL COMMUNITIES
4. EFFECTS OF RECREATIONAL DEVELOPMENT NEAR ELEPHANT BUTTE RESERVOIR
5. MIDDLE RIO GRANDE RESERVOIRS EFFECTS
6. REMOTE SENSING AND WATER USE
7. SOURCE OF NITRATES IN ALBUQUERQUE SOUTH VALLEY
8. ARTIFICIAL RECHARGE ALBUQUERQUE WEST MESA AND ALAMOGORDO

VIII. INFORMATION SERVICES

A. ACTIVE PROJECTS

1. WATER RESOURCES OF SAN JUAN BASIN
2. COAL AREAL 62 WATER INFORMATION
3. ANNUAL PROGRAM REPORTS
4. PROJECT REPORTS

B. PLANNED OR SUGGESTED NEW PROJECTS

1. DEFINITION OF NEW WATER PROGRAM NEEDS
2. PUBLIC QUESTION AND ANSWER SESSIONS
3. LAYMAN'S REPORT ON MESILLA BASIN
4. LAYMAN'S REPORT ON SCARCITY OF WATER IN PARTS OF NEW MEXICO

from key new and existing wells. Logging existing holes provides a relatively inexpensive method for determining the lithology and geometry of aquifers and confining beds. Borehole-geophysical logs supply valuable information on the "third dimension" of hydrologic investigations which often must be estimated because of a lack of data.

5. Obtain aquifer test data. Numerous aquifer tests have been conducted in New Mexico. These data need to be gathered, evaluated and placed in one location. A bibliography of existing aquifer tests may be prepared. With a first generation of digital models having been developed for selected areas of New Mexico, a need for vertical hydraulic head data has been identified. In addition, new aquifer tests are needed to provide data about the hydraulic properties of most aquifers and confining beds in New Mexico. Aquifer tests need to be conducted whenever the resources and potential for obtaining interpretable data exist.

6. Conduct a statewide municipal water quality survey. The purpose of this step is to ensure that water quality data for aquifers providing water to municipal systems are available for informed management. Organic, toxic and trace element concentrations in water from these aquifers need to be determined. Periodic comprehensive sampling of municipal water supplies also provides a quantitative basis for evaluating natural or man-induced changes in water quality.

7. Test for organics in the vadose zone. This step is critical for areas such as the South Valley of Albuquerque where surface sources of organic pollution are postulated. The organics may be trapped by clay and silt lenses above the water table.

8. Expand the precipitation quality observation network. As industrial and municipal developments in the Southwest increase, changes in the quality of precipitation (including snowfall) might occur. One factor influencing the quality of surface and ground water is the initial quality of the water before it contacts the earth's surface. A program is needed to monitor selected ions in precipitation for background information in several areas of the state.

Areal Appraisals. Areal appraisals may provide reconnaissance or detailed pictures of the state's water resources and are useful precursors to more detailed modeling and problem solving efforts. They may include first cut models of large areas in order to reduce the range of uncertainty in parts of the water budget. Study areas may include parts of a county, a county, or several counties. Because the natural flow of water is not governed by political boundaries, areal appraisals provide a mechanism for studying a complete hydrologic system .

Current areal studies being conducted by the New Mexico district (figure 1) include studies of the water resources of the Zuni tribal lands and the plains of San Agustin. Water resources investigations for Cibola, Socorro and Catron counties are also underway.

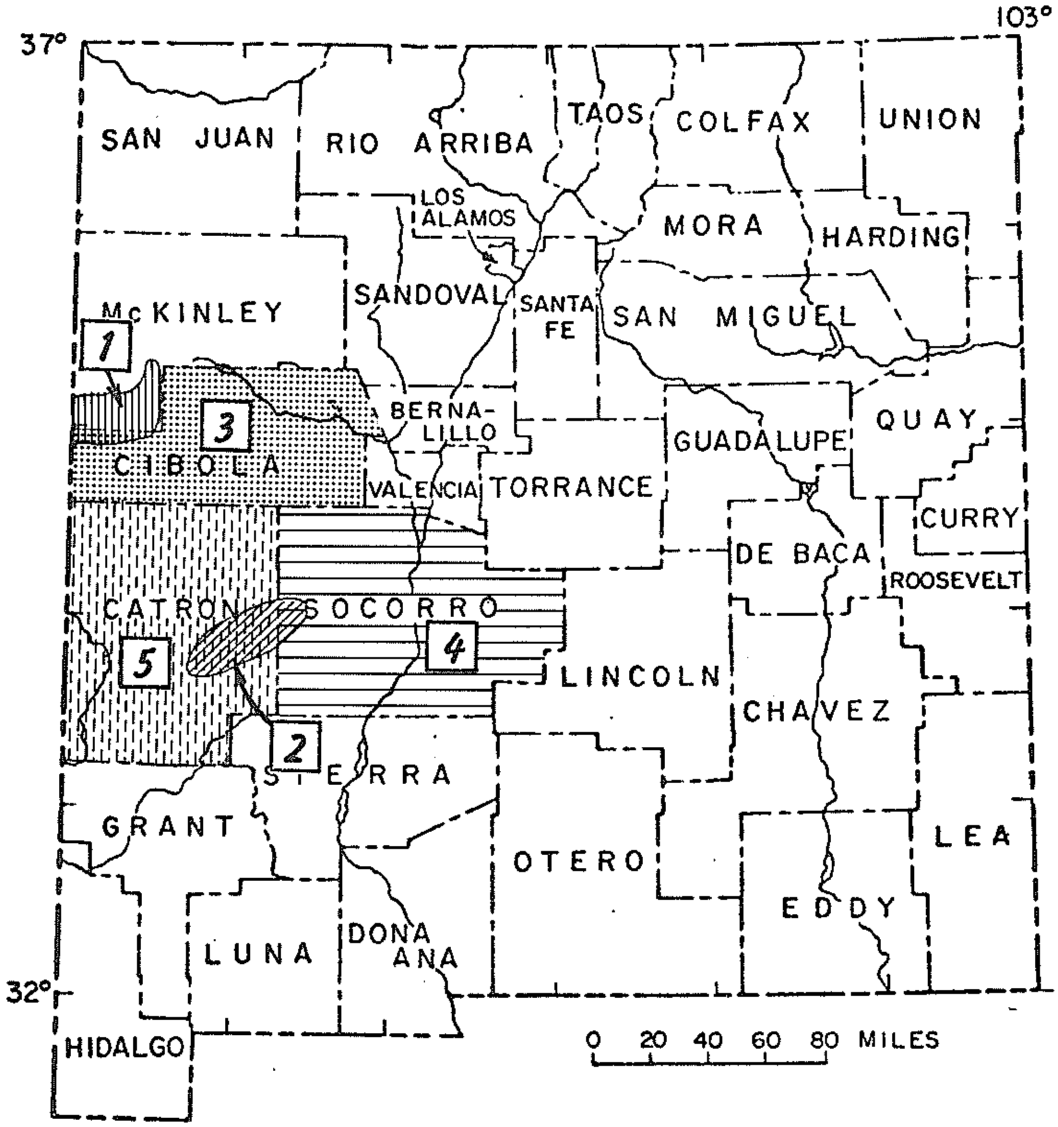
Goal. Identify geographic areas requiring water resources investigations and conduct studies in these areas emphasizing hydrologic rather than political boundaries.

Program Steps: Planned or needed new projects (figure 2) to:

1. Evaluate water resources of the Glorieta-San Andres aquifer system in the Gallup-Grants-Zuni-Acoma Sag area. Development by municipal, domestic and industrial water users in this area is increasing. The effects of increased withdrawals on the quality and quantity of existing supplies need to be investigated. Hydrological data, including water levels, aquifer and confining bed hydraulic properties and thicknesses, and vertical hydraulic gradients are needed to better conceptualize the hydrologic system and quantify the effects of its development.

2. Evaluate water resources of the area on the eastern flank of the Sandia and Manzano mountains in Bernalillo County. Development in this area is expected to continue. The effect of increased demand on the quality and quantity of water in the area needs to be quantified to provide county planners with information for evaluating requests for development.

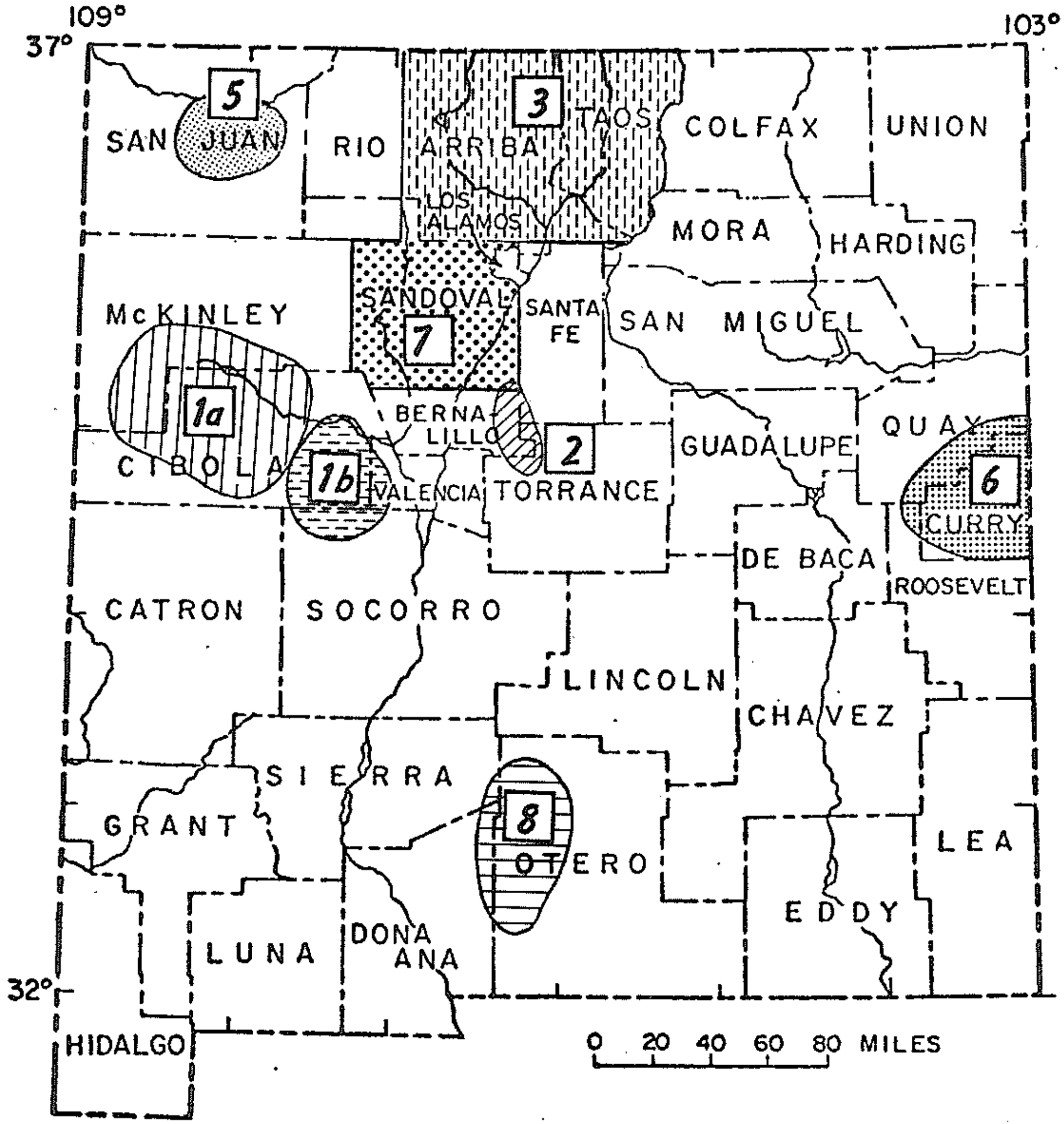
3. Evaluate water resources of Taos and Rio Arriba counties. The recreational activities of this area are placing increased stress on the quality and quantity of the water supply. A reconnaissance of the water resources is needed and the effects of development in high use recreation areas (Taos, Rio Costilla, Red River) need to be identified.



EXPLANATION

1. Zuni Tribal Lands
2. San Agustin Plains
3. Cibola County
4. Socorro County
5. Catron County

Fig. 1. Locations of Areal-Appraisal Study Areas, Active Projects 1983



EXPLANATION

1. (a) San Andres-Glorieta Aquifer of Zuni Uplift
2. (b) San Andres-Glorieta Aquifer of Acoma Sag
3. Sandia-Manzano Mountain Home Supplies
4. Water Quality in Aquifers Above Mineral Deposits (Statewide)
5. Hydrologic Effects of Navajo Indian Irrigation Project
6. Curry and Quay Counties, Ogallala Aquifer
7. Sandoval County
8. Saltwater Encroachment, Tularosa Basin

Fig. 2. Locations of Areal-Appraisal Study Areas, Planned or Suggested Projects

4. Determine the quality of water in aquifers overlying mineral production zones in areas of intense energy development. Current state regulations require "casing off" of selected water-bearing units in oil and gas production areas. An updated evaluation of the quality of water in these units could be used by the regulating agencies and industrial users in determining the effect of current and planned "casing off" practices.

5. Evaluate the effect of the Navajo Indian Irrigation Project on water resources. The irrigation project is currently applying large amounts of San Juan River water to sediments in an area of the San Juan Basin. The effects on the quantity and quality of water in the shallow water system need to be studied. The potential for salt loading in the soils also needs to be monitored and evaluated.

6. Determine effects of water withdrawals in Curry and Quay counties (northern High Plains). Water level declines in the Ogallala aquifer in this area continue. The geographic distribution and rates of declines based upon large-scale management practices need to be determined.

7. Evaluate the water resources of Sandoval County. Existing hydrologic conditions, particularly in the Santo Domingo area and in the eastern part of the San Juan Basin, need to be defined.

8. Locate the fresh water, salt water interface in the southern Tularosa Basin. Continued demand on the limited fresh water resource of the area creates the potential for encroachment of saline water into wells that currently produce fresh water. Application of solute transport models can assist in the evaluation of potential movement (laterally and vertically) of dissolved constituents in the subsurface.

BASIN ASSESSMENTS

Basin assessments are studies of the hydrology of areas that are bounded by topographic drainage divides. They may include an entire major river basin, a smaller tributary basin, or an interior basin (bolson). These studies can yield qualitative or quantitative information on surface and ground water resources, depending on the scope of the investigation. Precipitation-runoff relations, stream gains and losses, effects of ground water withdrawals on streams, land-use effects on streamflow, changes in sediment load, and quality of water are subjects that may be evaluated in basin assessments.

Basin assessments are needed to:

1. Describe the water resources and availability of water in a river basin

2. Provide information for determining the amount of water that can be utilized for agricultural and other uses at a particular time

3. Provide information for determining the effects of industrial, agricultural and energy-related development on the quality of ground water and surface water

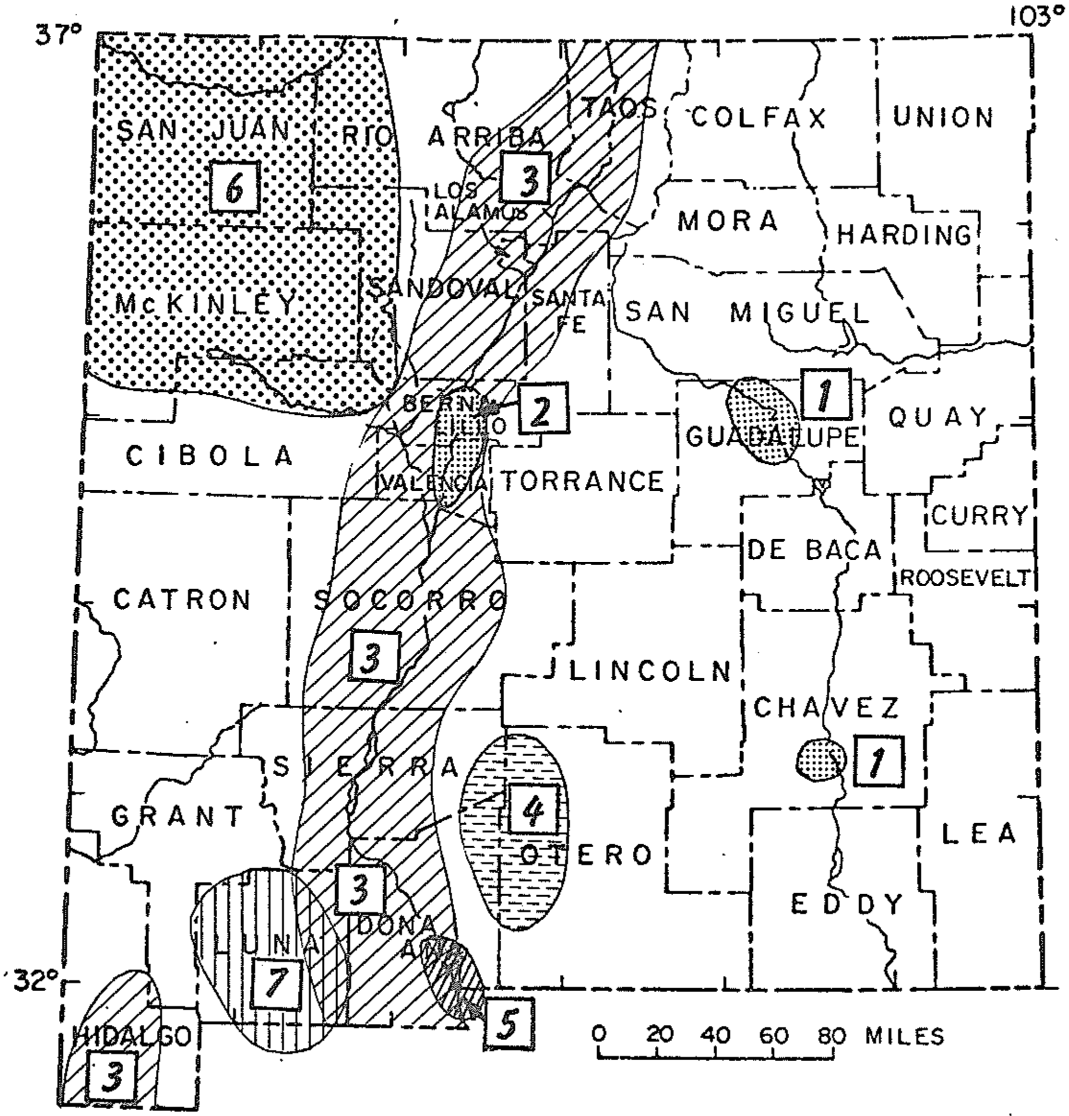
4. Provide information for predicting floods and the location of areas vulnerable to flooding

5. Provide information that can be used in the design of structures that must be flood resistant, such as bridges, dams and levees

6. Provide information on sediment transport and deposition by streams

7. Provide hydrologic data needed for the conservation of fish and other wildlife

The locations of active basin assessment projects in New Mexico are shown in figure 3. Projects are currently in progress in parts of the Pecos and Rio Grande basins. The Southwest Alluvial Basin (SWAB) Regional Aquifer System Analysis is concentrating efforts in the Albuquerque-Belen, Socorro, Palomas-Engle, Mesilla, and Animas basins. A water resources investigation, including surface geophysical studies, is underway in the Tularosa Basin. The geohydrology of the Mimbres Basin and effects of development on the ground water resources of the San Juan Basin are also being studied. A new effort, in addition to the SWAB studies, is being



EXPLANATION

1. Parts of Pecos River Basin
2. Parts of Rio Grande Basin
3. SWAB
4. Tularosa Basin, Geophysical Studies
5. Southern Mesilla Basin
6. San Juan Basin Ground Water
7. Mimbres Basin Ground Water

Fig. 3. Locations of Basin-Assessment Study Areas, Active Projects 1983

attempted to quantify vertical hydraulic gradients and the river-aquifer relationship in the southern Mesilla Basin.

Goal. Identify, conceptualize and quantify the components of water budgets for the major bolsons and river basins in New Mexico.

Program Steps. Planned or needed new projects (figure 4) to:

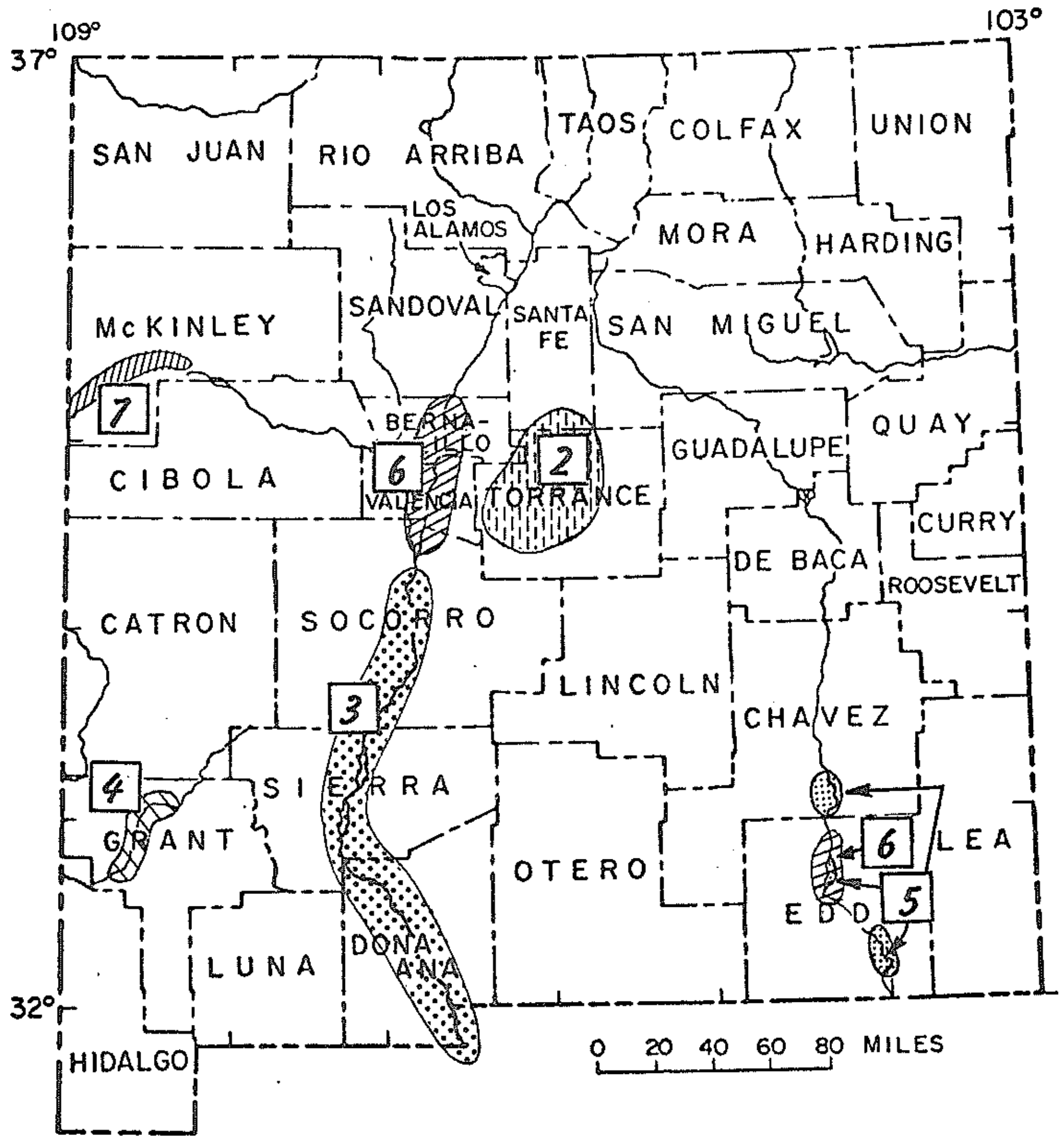
1. Study the ground water/surface water interaction and effect on streamflow. The effect of ground water withdrawals on flow in rivers that are subject to legal constraints should continue to be quantified. In addition, the effect of future withdrawals on river flows and existing ground water users will have to be known (predicted) in order for regulating agencies to make informed management decisions. A corollary to this is to better quantify the recharge effects of river flow on the ground water system.

2. Evaluate the water resources in the Estancia Basin. The Estancia Basin contains a complex aquifer system that includes the Madera Formation, Glorieta Sandstone and alluvium. A quantitative study of the basin will result in a better conceptualization of the flow system, determination of quantity of water available, and improved prediction of effects of present and future development. This is a complimentary effort to the areal assessment step regarding the east slope of the Sandia and Manzano mountains.

3. Assess water quality in the middle Rio Grande area. Past and present studies of the middle Rio Grande area have concentrated on the quantity of water and have only generally described the quality of water. A study that will identify variations in ground water quality (areally and vertically) and variations in streamflow quality will enable planners to make informed decisions regarding future development.

4. Quantify surface water and/or ground water interaction in the Gila River Basin. Studies of the effects of ground water development in the Gila River Basin on the flow in the Gila River are needed to evaluate the effects of changing water use patterns, potential construction of surface water impoundments and alternative conjunctive use management of the river-aquifer system.

5. Study streamflow quantity and quality of the Pecos River. The effects of changing land use and industrial development on the quality and quantity of flow in the Pecos River need to be evaluated. Such studies could include channel losses,



EXPLANATION

1. Ground Water/Surface Water Interaction (Numerous Areas)
2. Estancia Basin
3. Middle Rio Grande Water Quality
4. Gila River Basin
5. Pecos River Studies: Roswell, Brantley, Malaga
6. Albuquerque-Belen, Roswell Basin Freshwater/Salt Water
7. Puerco River Water Quality

Fig. 4. Locations of Basin-Assessment Study Areas, Planned or Suggested Projects

reservoir bank storage, water quality changes in specific reaches, water budgets, and ground water/surface water interaction. Specific areas to be studied include the Roswell area, Brantley damsite, and Malaga Bend.

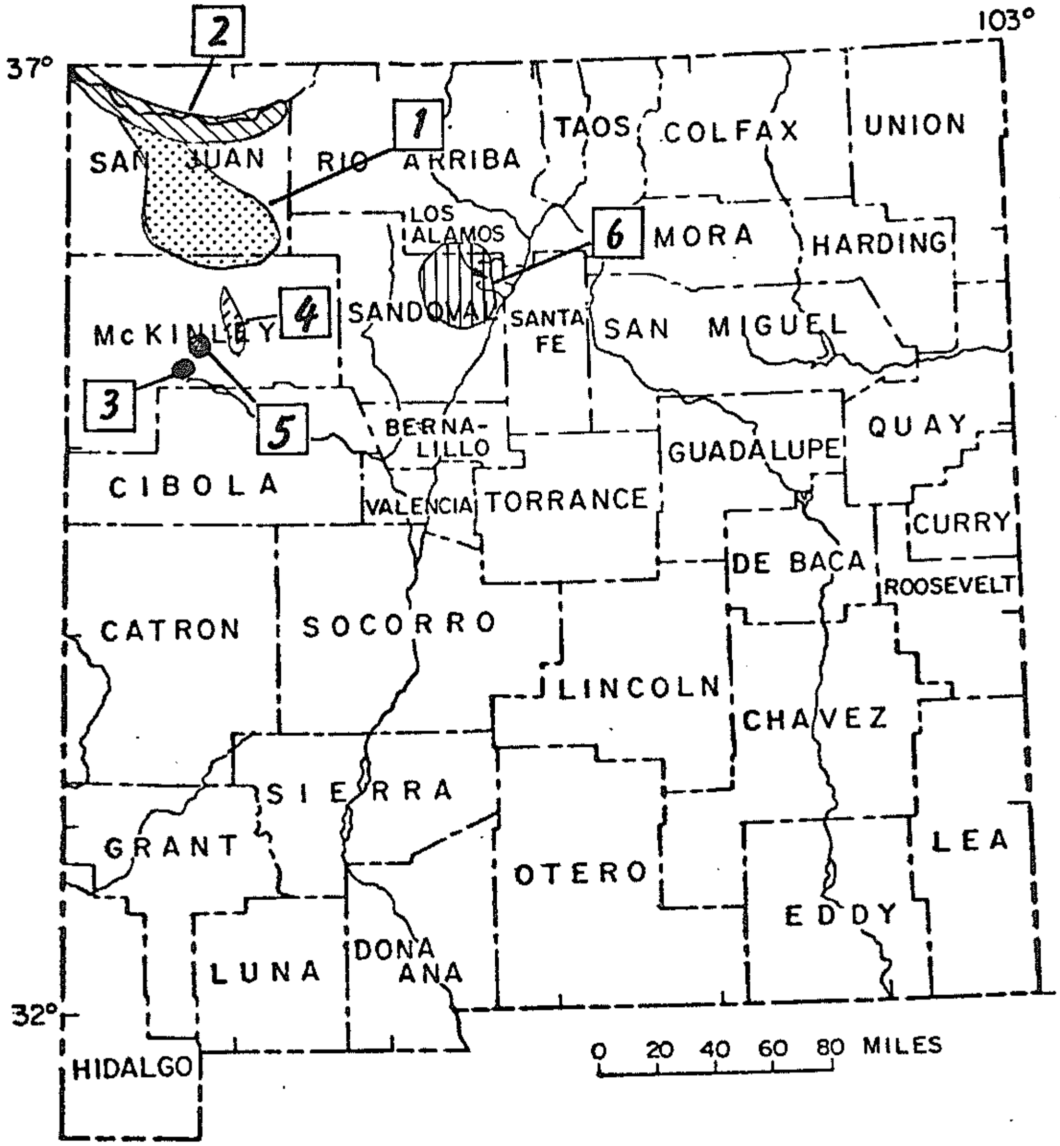
6. Identify depth of the fresh water-salt water interface in the Roswell and Albuquerque-Belen basins. The vertical and areal extent of fresh water in these basins needs to be determined. Changes in extent and depth due to present and future development will have to be evaluated.

7. Study water quality in the Puerco River and associated aquifers. The extent of current aquifer contamination caused by a tailings pond breach and the hydrologic processes involved in contaminant migration need to be further defined. An evaluation of the effectiveness of the cleanup operation that already has been conducted on the Puerco riverbed needs to be assessed.

Fossil Fuel and Mineral Extraction

The studies in this element evaluate the effects of energy related activities on the hydrologic system. These activities include oil and gas exploration, coal, copper and uranium mining, and geothermal development.

Active fossil fuel and mineral extraction projects currently under investigation by the New Mexico district are shown in figure 5. The USGS is currently involved in surface water/ground water, and rainfall/runoff modeling in coal-lease areas of northwestern New Mexico. The effects of coal development on the San Juan River also are being studied. The resaturation of Marino Lake uranium mine and the subsequent effects on the quality and water levels of the ground water system are being evaluated. The effects of dewatering the Phillips mine on the quantity and quality of flow in Kim-me-ni-oli Wash, an ephemeral stream, are being quantified. In addition, the USGS is assisting the BLM in evaluating the processes and requirements for adequate monitoring networks for in situ uranium leach-



EXPLANATION

1. RF/RO Model Coal Leases, San Juan Basin
2. Effects of Coal Development on San Juan River
3. Resaturation of Mariano Lake Uranium Mine
4. Effects of Mine Dewatering on Kim-Me-Ni-Oli Wash
5. Hydrology of In Situ Uranium-Leaching Mining
6. Jemez Geothermal Studies

Fig. 5. Locations of Fossil-Fuel and Mineral-Extraction Study Areas Active Projects 1983

ing mining operations. The effects of potential geothermal development on water resources in the Jemez Mountains area also are being studied.

Goal. Provide water quality and quantity data and interpretations for informed evaluations of the effects of energy-related activities on the state's water resources.

Program Steps. Planned or needed new projects (figure 6) to:

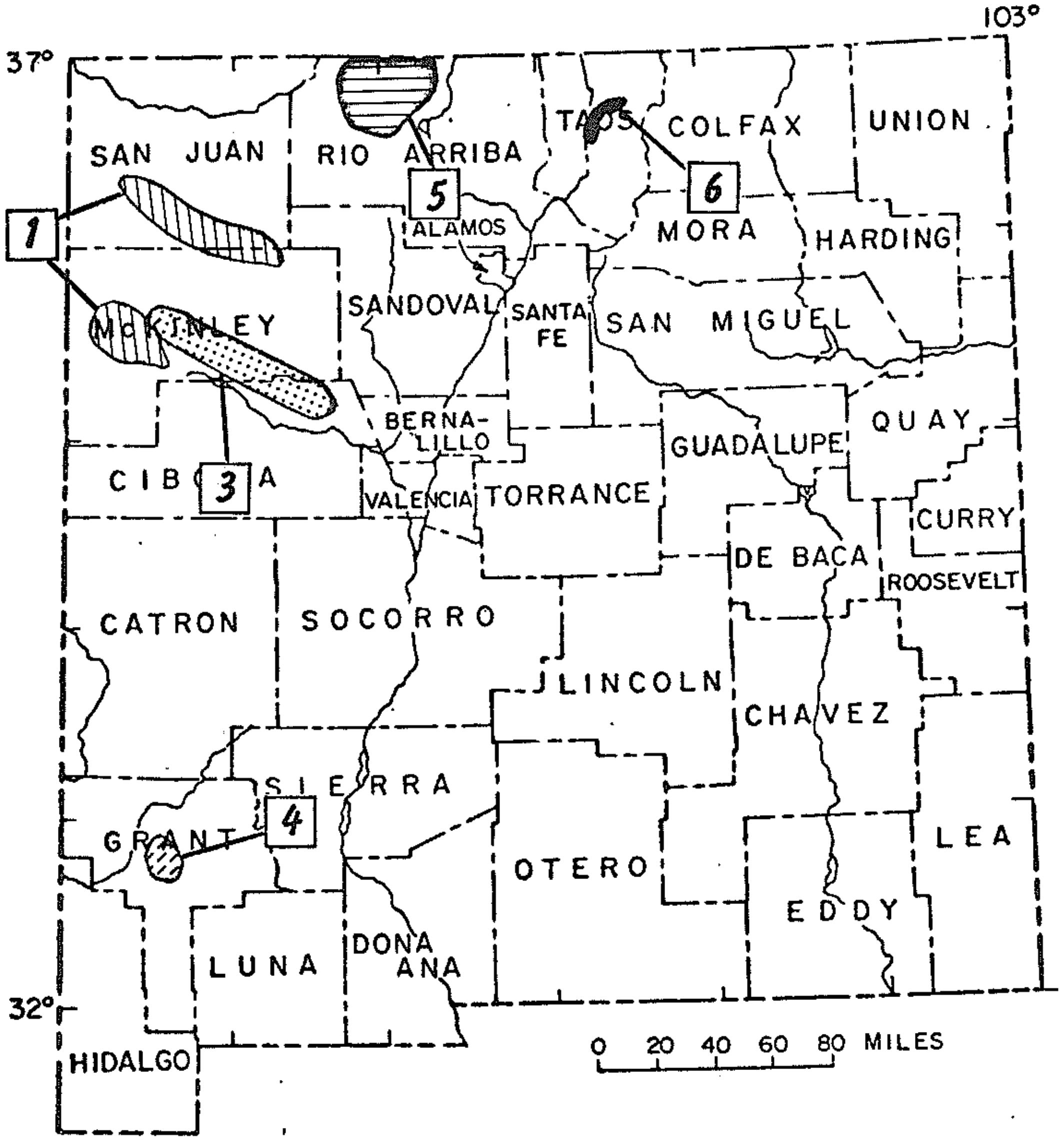
1. Evaluate the effects caused by resaturation of coal mines. Studies within this step include the evaluation of impacts of surface coal mines on ground water and processes active in reclaimed coal areas. The effects of backfilling coal mines and resaturation on the quality of water near the mines need to be investigated.

2. Evaluate the effects of milling operations located on floodplains. Milling operations may be located on alluvial floodplains that consist of permeable material. The effects on the quality of ground water and surface water near the mill sites need to be determined. The hydrologic processes and monitoring requirements at these sites need to be identified.

3. Describe quality of water in the Grants Mineral Belt area. Energy development, at some level, will continue in this area. Before effects of additional activities can be quantified, background conditions must be known. It is imperative that water quality variations, areally and vertically, be described and monitored on a periodic basis.

4. Evaluate the quality of ground water and surface water in the Silver City area. Development of mineral resources and milling in the Silver City area have taken place for years. The effects of past, present and future development on the quality of water in the surface water and ground water systems need to be described.

5. Describe the occurrence and effects of acid precipitation in the Four Corners area. Current water quality conditions in mountain lakes and streams both west (for background data) and east of the area need to be determined. The quality of precipitation, the chemical changes in precipitation, and the water quality changes in streams and lakes need to be evaluated.



EXPLANATION

1. Resaturation of Coal Mines
2. Effects of Mill Tailings (Selected Areas)
3. Quality of Water in Grants Mineral Belt
4. Quality of Water in Silver City Area
5. Acid Rain, Four Corners Area
6. Quality of Water Near Questa

Fig. 6. Locations of Fossil-Fuel and Mineral-Extraction Study Areas, Planned or Suggested Projects

6. Evaluate the effects of mining near Questa. The quality of ground water and surface water (Rio Grande and Red River) in the area needs to be described and the ground water/surface water relationship quantified. The processes active in the hydrologic system and the effects of mining molybdenum and associated minerals in the area need to be conceptualized and described.

Waste Disposal

Activities within this element include the processes involved with the disposal of domestic, minicipal, industrial, radioactive and hazardous wastes.

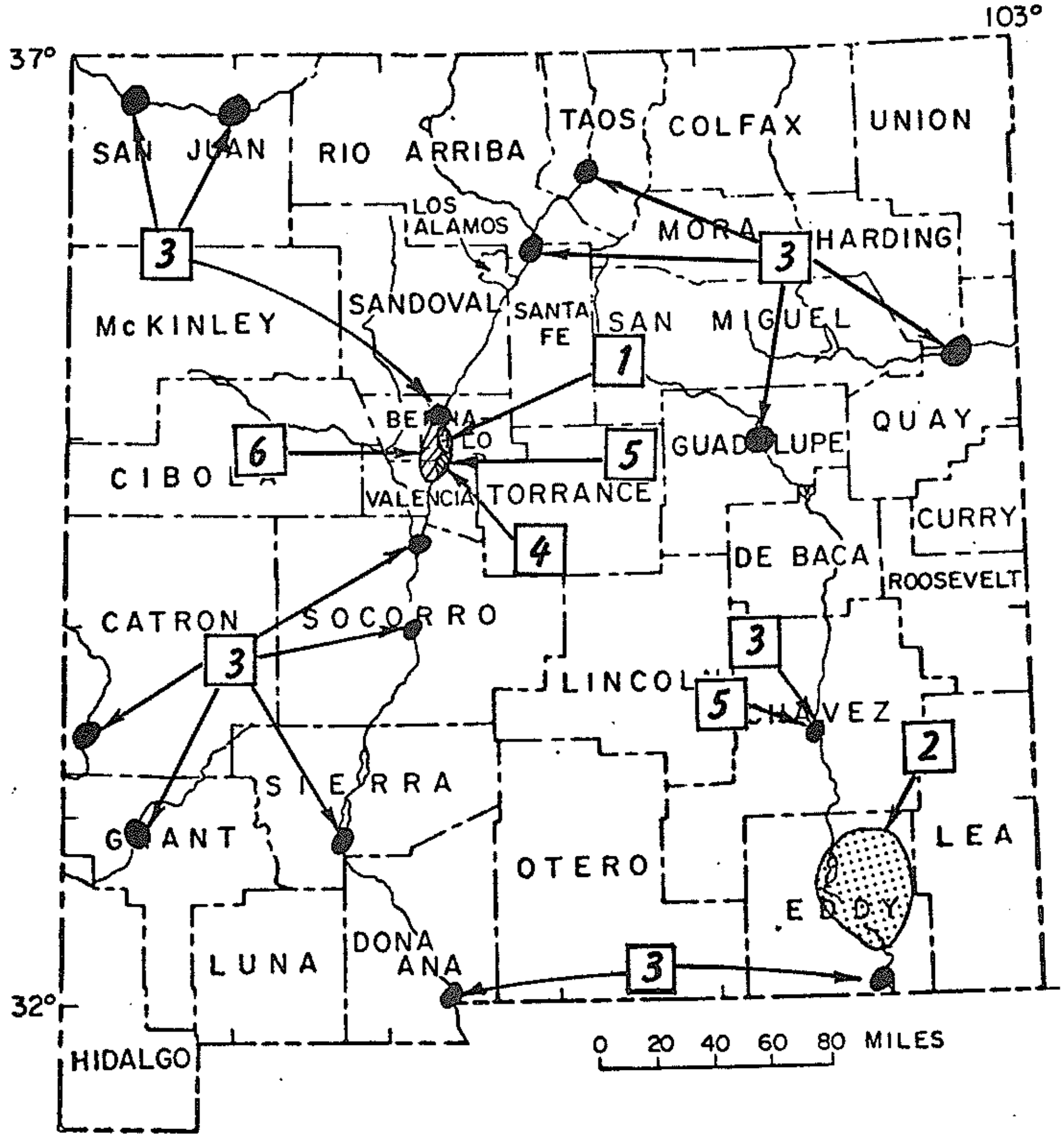
The USGS currently is describing the hydrology in the WIPP area (figure 7) and serving as an advisor to the Department of Energy on WIPP related hydrologic matters.

Goal. Identify and obtain the data and provide the interpretations necessary for informed evaluation of the effects of waste disposal on the quality of waters in New Mexico.

Program Steps. Planned or needed new projects (figure 7) to:

1. Evaluate the hydrologic factors affecting the feasibility and assessment of the potential for cleanup at the Albuquerque South Valley "superfund" site. The Albuquerque South Valley has been designated as a priority "superfund" site by the U.S. Environmental Protection Agency. The extent of contamination, hydrology of the area of the site, effects of ground water withdrawals, influence of vertical hydraulic head gradients, and relationship of ground water to the Rio Grande need to be quantified.

2. Establish a long-term monitoring program at the WIPP facility. Upon authorization to construct the facility, a network for long-term monitoring of water levels and water quality in the principal hydrologic units in the area needs to be established. An observation network based on an informed concept of the hydrologic system could provide the necessary information with the most efficient distribution of data collection sites. An efficient observation network will result in



EXPLANATION

1. Albuquerque South Valley "Superfund" Hydrologic Study
2. Long-term Monitoring Network at WIPP
3. Time-of-Travel for Hazardous-Waste Spills
4. Extent of Hydrocarbon Contamination
5. Effects of Landfill and Feedlot Sites
6. Denitrification Potential of Soils

Fig. 7. Locations of Waste-Disposal Study Areas, Active 1983, and Planned or Suggested Projects

considerable cost savings without sacrificing the monitoring capability.

3. Perform time-of-travel studies on all streams crossing identified hazardous waste transportation routes. A potential exists for spills of hazardous wastes along transportation routes. Authorities will have to know the timeframes involved for the downstream movement of these wastes. Time-of-travel studies conducted before any spills occur will provide useful information for management decisions during times of potential crises. These studies are also needed to typify saturated and unsaturated areas of the state. The subsequent transfer value to other semiarid areas should also be investigated.

4. Evaluate the hydrology in areas with hydrocarbon contamination. Hydrocarbons in ground water have been identified in the southwest valley of Albuquerque. The extent of contamination, potential rates and direction of flow, and mineralogy of sediments in the area need to be defined.

5. Study the effects of landfill and feedlot sites on the quality and quantity of ground water. Landfill sites in Albuquerque may be located on permeable material near sources of potable water. The effects of leachate and the rates of movement in the ground water system in these areas need to be described. Feedlots are another potential source of ground water contamination. Programs for monitoring the changes in ground water quality near feedlots need to be developed.

6. Quantify the denitrification potential of soils in the Middle Rio Grande Basin. Current regulations about spacing and design of septic tank systems are based upon assumed denitrification potentials. The influence of hydrology on the ability of soils in the area to denitrify waste from septic systems needs to be evaluated.

Scientific Methods Development

New problems often require new methods and/or improved instrumentation for the development of new approaches. "Old" problems may require innovative techniques using improved state-of-the-art tools for evaluation. This program element attempts to recognize research needs that could be conducted at the field level in an applied situation.

Current studies in the New Mexico district that either directly or indirectly are developing scientific methods include:

1. The use of trend analysis techniques to determine the effects of individual coal mines on the hydrologic system.

2. Development of monitoring criteria for in situ uranium leachate mining. Both projects are applying the techniques to "real world" field problems.

Goal. Identify development needs and assist in the developing and testing of new instrumentation and techniques.

Program Steps. Planned or needed new projects to:

1. Develop analytical techniques to aid in the use of the results of digital model analyses. Predicted effects from digital models are representative of the areas of the finite difference or finite element blocks. Water resources planners and regulators often require site-specific effects that are more exact than the degree of detail available from the model analysis. Techniques such as weighted averaging and practical uses of digital model results need to be investigated and documented.

2. Estimate recharge from and study influence of ephemeral streams on alluvial aquifers. The location, quantity and rate of recharge from ephemeral streams are important to studies of semiarid basins. The factors influencing recharge from ephemeral streams are essential elements of the hydrologic processes that are active in such environments.

3. Quantify the effects of gases in aquifers. The presence of gases in aquifers may influence pH and other chemical constituent determinations. Research into methods of collection, identification and effects of gases in water samples from aquifers is needed to better interpret the chemical analyses. This step also needs to include development of in situ samplers for gases and radionuclides.

4. Standardize techniques for sensitivity analyses of digital model results. Statistically valid techniques for demonstrating sensitivity analyses need to be developed in order to permit comparisons of different models of similar areas. These techniques need to include methods demonstrating model sensitivity to boundary assumptions.

5. Develop solid-state recorders for monitoring fast changing, deep and shallow water levels. Recording "fast" water level changes at depths greater than 700 feet below land surface may be critical in the analysis of aquifer test data. Sensitive transducers connected to recorders that are capable of receiving rapidly transmitted signals are needed to provide these data in a timely manner.

Water Management Appraisals

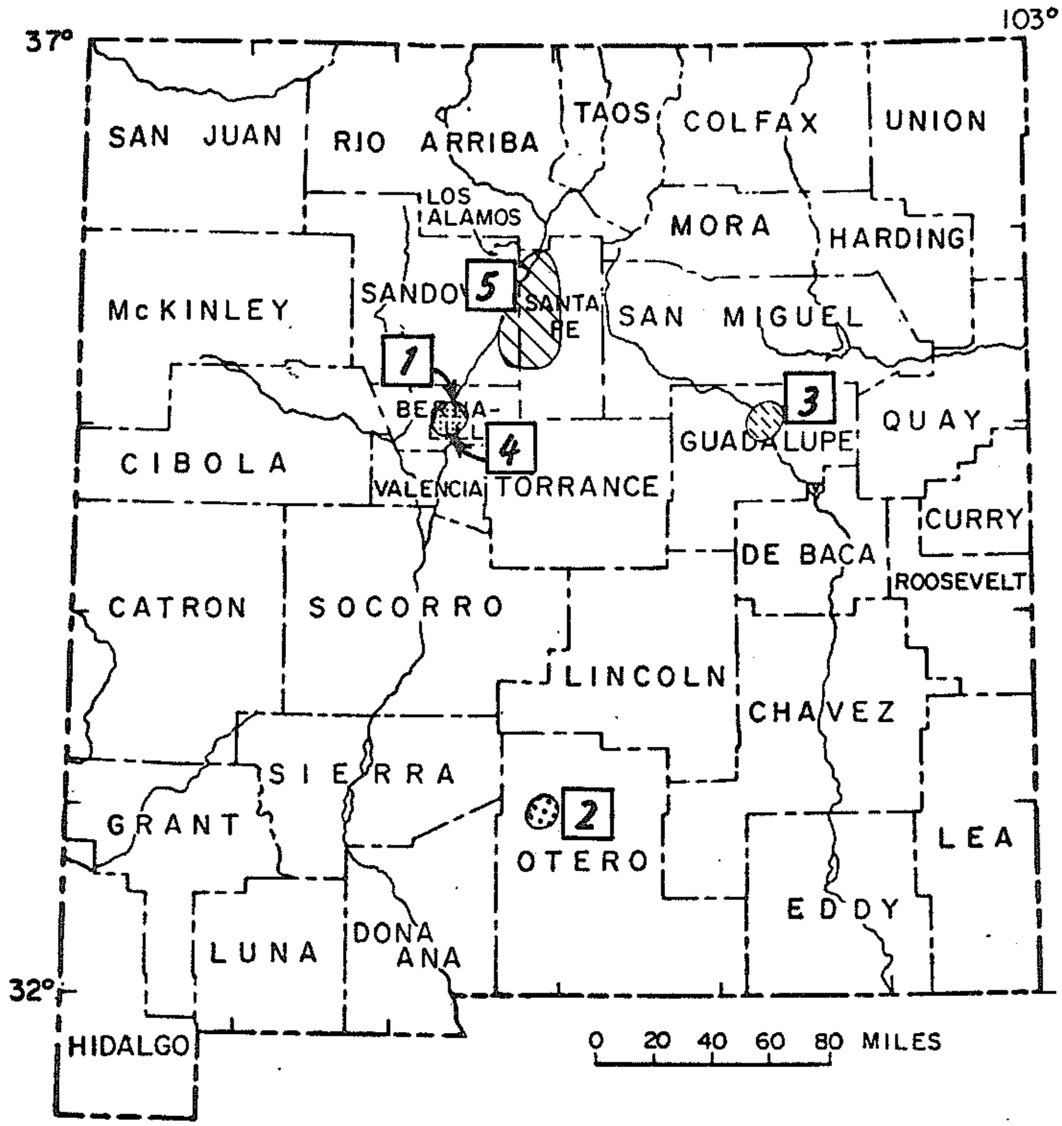
Water resources development often is accompanied by new problems because no amount of planning and information acquisition can foresee all possible effects of that development. This program element includes projects specifically designed to provide information for management of water resources. This element is presented in recognition that presently unforeseen problems will need to be addressed as high priority items.

Active projects providing information to water managers (figure 8) include the urban flood hydrology and water quality of urban runoff in the Albuqueque area. A preliminary evaluation of the effects of withdrawals in the Alamogordo area, the effects of leakage and bank storage at Santa Rosa Reservoir, and evaluation of urbanization effects on the ground water and surface water in the Albuquerque metropolitan area also are in progress. The effects of past, present and potential future development in the Santa Fe Basin are being studied with a digital model.

Goal. Provide hydrologic information that will assist water resources planners in solving water development problems.

Program Steps. Planned or needed new projects (figure 9) to:

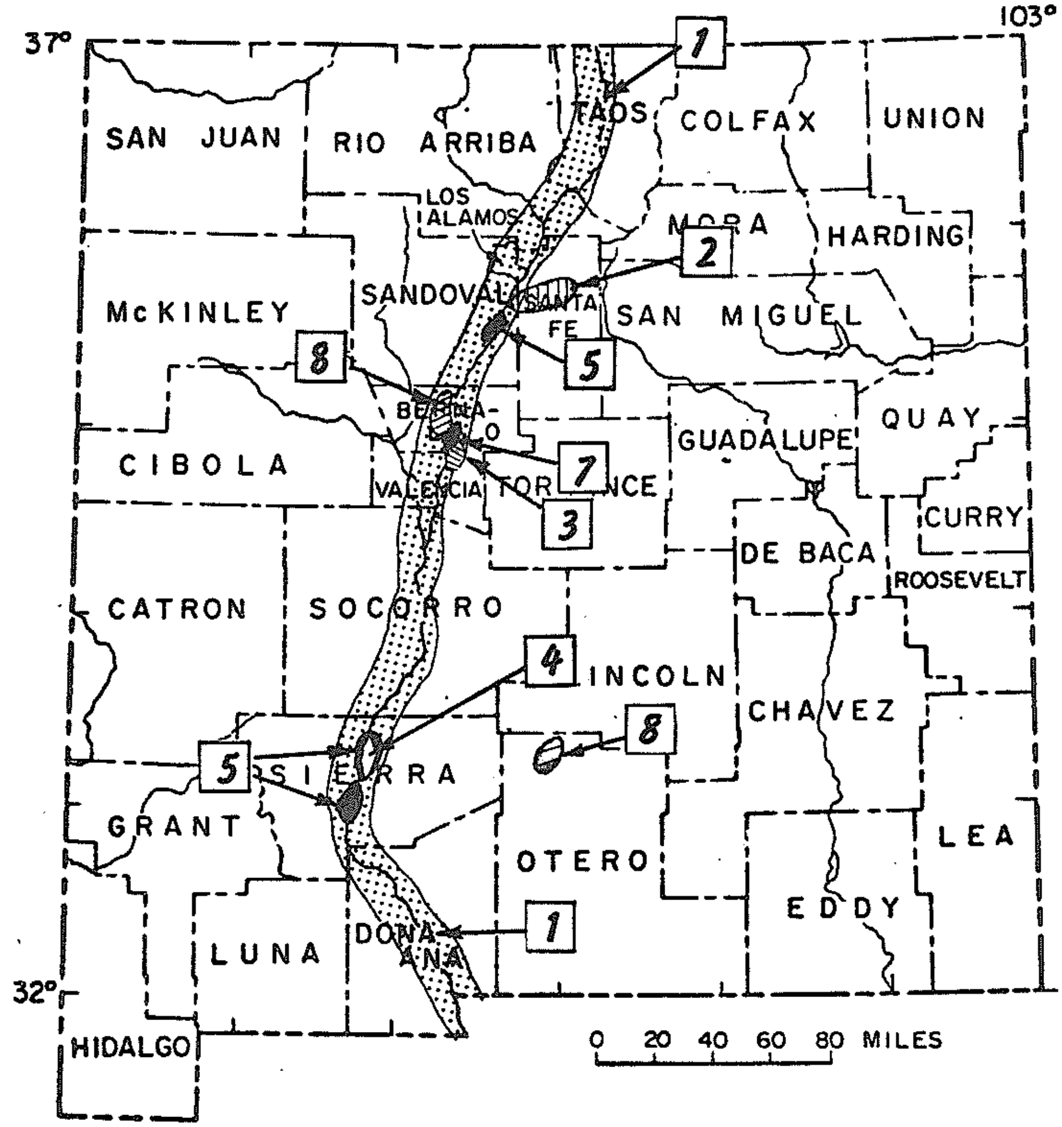
1. Develop a model of the Rio Grande Basin(s). Continued municipal, industrial and agricultural development throughout the Rio Grande Basin will place an even greater stress on the hydrologic system. In order to utilize the existing water resources most efficiently, the interaction between recharge,



EXPLANATION

1. Albuquerque Flood and Water Quality Runoff
2. Effect of Withdrawals Near Alamogordo
3. Santa Rosa Reservoir Effects
4. Albuquerque Urbanization Effects on Ground and Surface Water
5. Santa Fe Model Study

Fig. 8. Locations of Water-Management Study Areas, Active Projects 1983



EXPLANATION

1. Rio Grande Basin Comprehensive Hydrologic Model
2. Effects of Santa Fe Urbanization on Return Flow to Rio Grande
3. Water Quality Changes Near Small Communities
4. Effects of Recreational Development Near Elephant Butte Reservoir
5. Middle Rio Grande Reservoirs Effects
6. Remote Sensing and Water Use (Statewide)
7. Source of Nitrates in Albuquerque South Valley
8. Artificial Recharge Albuquerque West Mesa and Alamogordo

Fig. 9. Locations of Water-Management Study Areas, Planned or Suggested Projects

discharge, urbanization, flow in the Rio Grande, and pumpage amounts and distribution will have to be understood. The factors influencing the hydrologic system will have to be quantified if a reasonable comprehensive model to be used by various water managers is to be developed.

2. Determine the effects of urbanization on return flow to the Rio Grande near Santa Fe. Return flow credits for ground water withdrawals from the Rio Grande Basin by Santa Fe have not been fully quantified. Urbanization may have affected the amount of water returning to the Rio Grande. The effects of paving, natural drainage alteration, plastic covered rock yards, sprinkler systems, and infiltration of treated effluent need to be determined. The ground water/surface water relationship in the Santa Fe metropolitan area needs to be described and quantified.

3. Determine the effects of urbanization on water quality near a "bedroom" community. Population increases in "bedroom" communities, such as Los Lunas, that obtain their water from alluvial aquifer sources place a greater stress on the hydrologic system. The effects of septic systems, increased ground water withdrawals and alterations to surface drainages need to be understood in order for community planners to make informed decisions.

4. Investigate the effects of development near Elephant Butte Reservoir on the quality of water in the area. Increased water use, drainage alterations and installation of septic systems have occurred in the Elephant Butte Reservoir area. The effects of these changes on the quality of ground water and surface water in the area need to be investigated.

5. Determine the effects of reservoirs on the quality and quantity of flow in the middle Rio Grande. Changes may have occurred in ground water flow and water quality due to construction of reservoirs at sites on the Rio Grande. Documentation of any such changes and the factors causing the changes may have transfer value to other proposed reservoir sites in similar hydrologic regimes.

6. Apply remote sensing products to assist in quantifying water use information. Remote sensing techniques have been used to identify urban areas and consumptive water use of irrigated plants. By adapting (if necessary) and applying these techniques to areas in New Mexico, more complete and detailed information may be possible at a relatively low expense.

7. Identify source(s) of nitrates in the Albuquerque South Valley-Mountainview area. Nitrate concentrations in excess

of recommended public health limits have been noted for years. The source(s) of nitrates and the flow system (vertical and areal) need to be identified to aid in an informed evaluation of the extent of, and potential solutions to, the problem.

8. Evaluate the potential for artificial recharge in the Albuquerque West Mesa and Alamogordo areas. Artificial recharge may be a valuable means for decreasing pumping costs and increasing the availability of fresh water. Because the demand is expected to continue in these areas and because water supplies for recharge may be available, an evaluation of the hydrology is needed to further quantify the potential.

Information Services

Program steps within this element include activities that disseminate data and provide the public with an understanding of the results of hydrologic studies. No set of data or interpretations can be of value until it reaches the proper user. The dissemination of information is as important as the collection and interpretation.

Current projects funded specifically for the dissemination of information are evaluating the water resources of the San Juan Basin and coal area no. 62, which includes parts of McKinley, Cibola and Catron counties. A separate project for information distribution and program planning also is ongoing. Virtually every project in the New Mexico district will result in at least one report.

Goal. Continue to provide water resources information to the proper user(s) in a timely manner and in the most usable format.

Program Steps. Planned or needed new projects to:

1. Define new program needs. Efforts to regularly interact with selected water users will continue. This step reflects a desire to develop programs that are designed to provide information for anticipated water problems consistent with the USGS mission.

2. Conduct hydrology question-answer sessions at local levels. An interagency (federal and state) team of water resources specialists will meet with local citizens groups to explain the hydrology of the area, answer questions, talk about local concerns and present issues in a clear, nontechnical manner.

3. Prepare a report on the Mesilla Basin for the lay reader. Considerable local interest has been generated by the El Paso, Texas-New Mexico lawsuit. A report or pamphlet describing the hydrologic system and the factors influencing that system, the hydrologic issues, and the hydrologic unknowns or uncertainties is needed.

4. Prepare a report on scarcity of water in New Mexico for the lay reader. A report or pamphlet presenting the water situation of the state in a perspective that is clear to a nontechnical person is needed. The methods and need for water conservation and a discussion of water related problems will be presented.

SUMMARY

This plan presents projects and programs designed to obtain needed water information. Sections may have been outdated as soon as they were committed to paper, but the report will help focus on short-term efforts in the context of long-range needs. An evaluation of how these efforts are meeting these needs will be a continuing process.

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WATER QUALITY NEEDS OF THE NEW MEXICO INTERSTATE STREAM COMMISSION AND STATE ENGINEER OFFICE

Philip B. Mutz
Interstate Stream Engineer

New Mexico Interstate Stream Commission

The New Mexico Interstate Stream Commission (ISC) and the State Engineer Office (SEO) cooperate with the U. S. Geological Survey (USGS) in an ongoing program to collect basic data on streamflow, reservoir content, ground water, physical and chemical quality of water and water use, and to make certain investigations of ground water aquifers in the state. Biochemical quality is also monitored at some sites.

The surface water and quality of water programs are statewide and of a continuing nature. The ground water monitoring program, also of a continuing nature, is generally confined to underground water basins declared by the state engineer and to areas outside declared basins where ground water has been extensively developed. These programs consist of data collection relative to streamflow, chemical quality, sedimentation, ground water pumpage and water levels. In addition, various noncontinuing, project-type investigations of geology and ground water resources are made in specific areas.

Very little water quality data, except for grab samples or sampling for limited purposes, were routinely collected in New Mexico before about 1940. Sediment sampling of any magnitude did not start until about 1950.

It is important to note that to be able to quantify water quality data--that is, to determine the salinity, sediment concentrations or load--it is necessary to know the flow of the stream at the point where water quality is sampled. For that reason, most water quality sampling points are located at stream gauging stations.

The present water quality program of our office consists of collecting basic water quality data including both chemical quality and sediment load at selected surface water stations around the state. We also maintain the New Mexico Water Quality Control Commission (WQCC) surveillance network and collect suspended sediment and bed load information along the Rio Grande. We also conduct network analyses of both the chemical quality and suspended sediment collection program and limited ground water quality collection and analysis.

As of June 30, 1982, the ISC and SEO were cooperating with the USGS in the operation of 190 reservoir level and stream and canal gauging stations. In addition, our office, through the Costilla Creek Compact Commission and the Pecos River Commission, participates in the operation of 48 streamflow stations and three chemical quality stations. Chemical quality and/or sediment of surface waters is monitored at an additional 38 sites, including 11 water quality surveillance network stations necessary for the New Mexico WQCC program under the Clean Water Act. As a constituent agency of the WQCC, our office budgets funds for the commission's surveillance network.

In January, February and March of each year, personnel from the SEO and the USGS make depth-to-water measurements in wells throughout the state. In 1982, a total of about 3,190 depth-to-water measurements were made.

In addition to the cooperative program, the SEO, through the various watermasters which are appointed to administer the surface and ground waters of the state, measures or determines certain diversions for beneficial use by ditches and pumps. Surface and ground water quality is also determined by the watermasters where quality impairment is or could be a problem. In addition, water quality data is collected by the four State Engineer district offices when required for water right transfers and where quality impairment may occur.

We have a number of cooperative ground water investigations underway which also address water quality aspects in general. These are:

1. Model Study of the Roswell Basin--The study initiated in October 1979 will produce a basin digital model that will simulate the major hydrologic components of the basin. The state engineer is particularly interested in refinement of the estimates of transmissivities, storage coefficients and leakage between the aquifers. A report on the steady state model has been prepared and is currently under review.

2. Reconnaissance and Evaluation of the Water Resources of the Mesilla Basin in New Mexico--This is a three-way cooperative study with the city of Las Cruces, the State Engineer and the USGS. The survey matches the contributions of the city and the SEO. The study began in October 1982 and will define the quantitative interconnection between the Rio Grande, the floodplain alluvium and the Santa Fe group aquifer and define chemical changes due to irrigation and pumping stress. It is expected that the monitoring phase will require a number of years to establish a good data base.

3. Mimbres Model Study--A two-dimensional model study of the Mimbres Basin has been completed and the report is currently undergoing colleague review. The report includes a discussion of the general hydrology of the basin and describes hydraulic properties of the aquifer.

4. Ground Water Resources of Catron, Cibola and Socorro Counties--These three investigations of the USGS are supported by the New Mexico Bureau of Mines and Mineral Resources and the SEO. The studies will define the ground water resources in each county. The report on Cibola County is scheduled for completion in fiscal year (FY) 1983 and the reports on Catron and Socorro counties are scheduled for completion in FY 1984.

5. Lea County Model Study--A draft report has been completed on the Lea County model and it should be released to open file in the current fiscal year. The steady state, two-dimensional model may be helpful in making projections of water availability.

6. Ground Water Resources of the San Agustin Plains--The State Engineer staff assisted the USGS in the investigation of San Agustin Plains. The final report, in preparation, will provide basic geohydrologic data and describe ground water availability, quality and the relationship to adjoining basins.

7. Ground Water Effects of San Juan Basin Mineral Development--This study, supported by the Bureau of Indian Affairs, the Bureau of Land Management and the SEO will develop a predictive three-dimensional model to evaluate effects of ground water withdrawals. The USGS is working on a revised project proposal which will include a schedule for completing the study.

8. Hydrologic Effects of Geothermal Power Development in the Jemez Mountains--This study is also supported by the Bureau of Indian Affairs and the SEO. The principal objective of the study is to assess the effects of development of the geothermal aquifer. As no production is now taking place, most of the current effort is devoted to developing a better understanding of this complex system. Continuation of SEO support of this project is dependent upon geothermal development.

9. Digital Model Study of the Santa Fe Area--The Santa Fe model study is a cooperative effort of the Santa Fe Metropolitan Water Board, the SEO and the USGS. The study is under the direction of the survey and will produce a digital model that can simulate aquifer responses to pumpage and return flow.

Water quality information is needed for a variety of reasons by the water users and by water management, planning and administrative agencies. Water users, such as municipalities, irrigation districts and industries, utilize quality information for planning and design of diversion, distribution and water treatment systems. Some of the more important uses by the water management planning and administrative agencies include information for:

1. Designing and maintaining the channel of the Rio Grande for flood control, sediment transport, water salvage and water conservation

2. Designing, operating and maintaining the flood and sediment control and water storage facilities

3. Cooperating with the Colorado River Basin states to investigate salinity sources and develop salinity alleviation projects in order that the 1972 salinity levels in the lower mainstem of the Colorado River can be maintained while the Colorado River Basin states continue to develop and utilize their compact entitlements to beneficial use of water

4. Monitoring water quality, including biochemical quality, at selected sites on New Mexico streams for the New Mexico Water Quality Control Commission's program under the Clean Water Act

5. Monitoring ground water quality to determine the extent of water quality degradation and saline water encroachment in certain areas for use in water rights administration to prevent impairment of water quality

6. Studying erosion rates, reservoir sedimentation, water use, river channel aggradation and degradation, presence or absence of aquatic life, operation and maintenance of projects, and problems and costs associated with water diversion and use, including water treatment costs

The chemical quality of the state's water resources ranges from less than 100 mg/l in the headwaters of some streams to as much as 40,000 mg/l in the lower Pecos River. Similarly, suspended sediment ranges from nearly zero in some headwater areas to as much as 270,000 mg/l during flood events on the Rio Puerco, which enters the Rio Grande above Socorro.

In general, chemical quality of our streams degrades downstream from the headwaters. The degradation results from both man-made and natural causes. The major causes of degradation result from consumptive use and the presence of more soluble formations along the lower reaches of many of our stream systems. The consumptive use of water results in the concentration of salts. Generalizing, in agriculture about two-thirds of the water applied to beneficial use is evaporated and transpired and about one-third returns to the stream or ground water system. The amount that is evaporated and transpired is essentially pure water; therefore, all of the salts in the water diverted are carried in the return flow. Again generalizing, if two-thirds of the water is evaporated, the concentration in the return flows would be increased threefold.

Sediment rates are a function of soil types, watershed slopes, vegetative cover, precipitation intensity and other factors. Sedimentation of some reservoirs is a major problem. Alamogordo Reservoir, now known as Lake Sumner, has lost about 30 percent of its original capacity since 1937, while McMillan Reservoir has lost about 65 percent of its original capacity. Elephant Butte Reservoir has lost about 20 percent of its original capacity to sediment which has not greatly impaired its conservation function because of its large capacity. Ramah Reservoir, a medium capacity reservoir, has lost 60 percent of its original capacity and its water conservation function is greatly impaired.

Sediment deposition in the Rio Grande channel is a major problem. Aggradation of the riverbed reduces the capacity of the channel to carry flood flows and contributes to drainage problems. At some locations, the river level is above the invert of the outfall of the drains, thus impairing their function. Resulting shallow ground water levels create problems for agriculture users and septic tank sewage disposal. Information on the amount and type of transported sediments is important in dealing with these problems.

The quality of much of the state's waters exceeds the recommended drinking water standards. However, some of the waters contain constituents which are harmful to irrigated crops and make the waters unsuitable for municipal or industrial use without treatment. In addition, chemical and biological quality monitoring is necessary to make proper and best uses of these waters.

In the present fiscal year, the state's cooperative work with the USGS for the three basic data programs--surface water, quality water and ground water--amounts to about $1.3 million. Under the cooperative program, the costs are split between the USGS and the state on a 50-50 basis which helps stretch state and federal dollars.

In developing and maintaining a monitoring system, care must be taken in selecting the monitoring points and the parameters to be monitored for baseline data to obtain correct answers to the quality problems and to attain cost effectiveness.

One complete monitoring station, including the collection, analysis and publication of the data, may cost as much as $25,000 annually. The operation of a single stream gauging station varies with the size of the stream and the location and will range in cost from about $5,000 to $8,000 per year. Chemical quality collection and analysis, depending on the number of parameters and the frequency of sampling, range from about $3,000 to $6,000 per year per station. Daily sediment sampling and analysis run about $12,000 per year per station for major stations like those along the Rio Grande. Bed load samples run about $1,500 per year. Some of the pesticide, herbicide, radio chemical and trace element sampling and analysis can amount to nearly $10,000 per year per station.

Even though it is an expensive program, the growing water demands of the state make it essential to continue monitoring our water supplies for quantity and quality so that we can make the maximum utilizaton of this most precious resource.

PANEL

Federal Water Quality Information Responsibilities, Activities and Needs

Frank Jones, Head

Rights Protection Group
United States Bureau of Indian Affairs

In New Mexico, our office--the Rights Protection Group of the U.S. Bureau of Indian Affairs--is primarily interested in water rights. We're the half of the bureau that is always in court along with the state engineer. Our interest in water quality focuses on water quality that crosses Indian reservations.

Some of the water quality issues we've recently been involved with include the Indian pueblos in the southern quarter of the South Valley, mine tailings ponds on Indian lands and mine dewatering. We've also been concerned about a city that has dumped the water from its sewage upstream from Indian lands.

One of the reasons we're looking at water quality on Indian lands is for the possible development of Indian water resources. The Pueblo Indians, in particular, have religious as well as agricultural and domestic uses for the surface water. Our primary responsibility then, is to assure that the quality of water available to the Indian people of New Mexico is sufficient to meet their needs. Delfin Lovato, the chairman of the All Indian Pueblo Council, will discuss Indian water needs in more detail later.

PANEL

Federal Water Quality Information Responsibilities, Activities and Needs

Eugene Hinds
Regional Director

United States Bureau of Reclamation

Most of you may be aware of the U.S. Bureau of Reclamation's function in this part of the country. We were established under the authority of the 1902 Reclamation Act. We function in the 17 western states in water resource development. In developing these water supplies, we have to look at water quality which is a very important and integral part of all our planning process. Our water quality studies vary in complexity depending on the proposed use of the water, its source, and how it will be transported to the point of use. Generally, as we complete our planning studies we get more sophisticated in determining water quality. Today, I will concentrate primarily on what the U.S. Bureau of Reclamation is doing in New Mexico. We perform water quality investigations to determine the usability of water for irrigation, municipal and industrial purposes, and we assess the quality conditions for these purposes. In doing that, of course, we have to look at not only the quality of ground water, subsurface flows and return flows, but also at the instream uses and the resulting water that goes into a reservoir system. The quality of return flows within a project service area is an important consideration in all of our studies. In looking at the quality of return flows, we consider on-farm uses, the return flow from irrigation and the return flow from underground that reaches a particular river or drainage system. We also look at municipal and industrial return flows, urban runoff, and runoff and return flows from fish and wildlife refuges. When we are studying water in the project service area, we try to determine the quality of that water, its impact on the project we're studying, and of course, its use once we complete a project. Today I'm going to dwell on some of the things we've been looking at in New Mexico. The first one is a 1976 feasibility study of the potential for water resource development for Raton, New Mexico. This particular study looked at two alternatives. One was a diversion from the Cimarron River and the other was ground water in the Capulin Basin. We determined that these would be the two best sources for Raton's water supply. Before we progressed very far in that study, we looked at the water quality of these two sources. Our studies of the diversion from the Cimarron River revealed that there really was no major primary or secondary drinking water parameters which exceeded the drinking water requirements at that time. Although the study revealed some coliform bacteria in the Cimarron about eight miles downstream from Ute Park, by the time the bacteria reached Raton, the bacteria count met the state standards which, of course, also brought the water within the Environmental Protection Agency's (EPA) standards. We also looked at wells on the Capulin Mesa and found that the quality of the water in the deposits would be chemically suited for use as a public supply. After we finished our studies, Raton took the results into consideration in the final design and the city is now in the process of completing that project.

The Canadian River Project in eastern New Mexico is experiencing water quality problems in the flows that go into Lake Meredith. The lake is a water supply reservoir for 11 cities in west Texas. Appraisal level investigations of the waters indicated brine contamination in the water supply coming from some place. In 1979, we completed the appraisal which identified some brine aquifers in the area around Logan, New Mexico, about two miles below Ute Reservoir. This identification was made only after we had thoroughly tested the riverbed sands and the subsurface water conditions of the Canadian River and the aquifer. It appears that the aquifer can be brought into control and thereby reduce the salinity of this water supply system. The salinity concentrations of the aquifer are in excess of about 30,000 milligrams per liter. Our plan is to pump the aquifer and dispose of the water. However, we haven't yet decided how to dispose of it. Much of the time, we dispose of the water through evaporation. At any rate, we have been funded this year for a feasibility investigation to continue those studies of the water quality in the Canadian River Project.

In 1980, the Southwest Region of the U.S. Bureau of Reclamation initiated a three year study of the problems, needs and resources of the Tularosa Basin here in New Mexico. We found vast amounts of ground water reserves, ranging from brackish to fresh, underlying that basin. These reserves provided, of course, a good opportunity for water development and energy related development. Water in nearly all the communities that we studied in the basin contained secondary parameters that exceeded the recommended secondary drinking water criteria for the state of New Mexico and the EPA. The cause of the poor quality water can be blamed on high levels of dissolved solids including calcium, chloride, sodium and sulfates, which result in poor taste, excessive pipe corrosion and increased treatment costs to make the water suitable for use. We studied several alternatives for improving the water quality to make it usable in the Tularosa Basin. Of course we haven't concluded what the best alternative is at this time, but one alternative we have looked at includes blending the poor quality with better quality water. We also have considered desalting as a possibility, but desalting is very expensive. Also, the investigation of new sites--new wells--is a possibility. If better quality waters were available, communities' purchase of those waters is an alternative.

Communities on the western side of the state near Gallup, New Mexico, are also having problems with their water supplies. Number one, there isn't enough water to provide for their needs and sustain economic growth. Second, although the water in their wells is potable, it's not particularly good. Wells contain high concentrations of manganese, sodium, sulfate and iron and marginal concentrations of the total dissovled solids. In most instances, the concentrations exceed the recommended levels set by the Public Health Service in the Gallup area. Our study, which we call the Gallup-Navajo Project, is aimed at alleviating both quality and quantity problems. The project is looking at a plan to divert water from the San Juan River through about 250 miles of pipeline and some nine pumping plants, and deliver water en route to a number of Navajo communities before reaching Gallup. This study is underway and we're hopeful that we'll be able to complete it in the next few years. This project would provide Gallup with a better quality of water. Not only could they use it as it is with some treatment, but they also could blend it with some of the more brackish well water, which would increase their supplies.

These are just some of the areas we've looked at in the Southwest Region, particularly New Mexico, over the past few years. Salinity and water quality are continuing problems and experience has shown us in reclamation that it's necessary to completely evaluate the quality of the source water we're going to use in our projects. We've learned from experience during the planning studies, that water quality can change over the years. These changes can be attributed primarily to upstream uses that are increasing the salinity in some streams either by putting return flows into the system or by taking water out. So by experience, we've learned that it's better to do a good job in analyzing the quality of the waters you're going to use in a project before you go ahead and build a project. We've had some instances where we've had to go back in after a project is completed and try to take care of a salinity problem. This has made us very conscious of the need to do a good job of water quality analyses on all our projects.

PANEL

Federal Water Quality Information Responsibilities, Activities and Needs

Julian E. Pylant, Lieutenant Colonel
District Engineer

Albuquerque District
United States Army Corps of Engineers

It is certainly a pleasure to be here today to talk about a subject, the importance of which cannot be overstated. The theme of the 28th Annual New Mexico Water Conference is water quality and this federal panel is addressing specific federal activities in water quality data gathering and interpretation. These are particulary pertinent subjects for the U.S. Army Corps of Engineers, as we consider our involvement in the management of water resources in New Mexico and in the Albuquerque District. The corps owns and operates seven reservoir projects in New Mexico. These projects help manage more than 60 percent of the surface water supply in New Mexico. As a major part of the federal government's Middle Rio Grande Project, the corps built the Jemez Canyon, Abiquiu, Galisteo and Cochiti projects. In the Pecos River Basin, we built and now operate, Two Rivers Dam on the Rio Hondo near Roswell and our most recently completed project, Santa Rosa Lake on the Pecos River near Santa Rosa. In the Canadian River Basin, the corps constructed Conchas Dam in the 1930s which has been operated by the Albuquerque District since that time. We monitor the quality of the water supplies stored in Abiquiu, Cochiti, Santa Rosa and Conchas lakes by conducting monthly surveys of some of their physical and chemical parameters. These lakes are used by the public for outdoor recreation. These data have been collected since

1975 and serve as baseline information for the management of these water resources projects. The Albuquerque District also cooperates with the U.S. Geological Survey (USGS) by providing funds necessary for the collection and publication of water quality data at the various stream gauging sites throughout our jurisdiction in New Mexico.

Water quality is also considered in our authorized studies for additional water resource development in New Mexico. Each of our planning studies is performed in compliance with federal environmental regulations such as the Fish and Wildlife Coordination Act, the National Environmental Policy Act and the Clean Water Act. The Albuquerque District plays an active role in fulfilling the responsibilities charged to the Secretary of the Army by Section 404 of the Clean Water Act. By virtue of this law, we have the task of regulating more than 4,600 miles of New Mexico streams, major tributaries and adjacent wetlands. Historically, the corps has been involved in the regulation of the nation's waterways since passage of the 1899 River and Harbor Act. When Congress passed the Federal Water Pollution Control Act in 1972, the scope of the corps' regulatory program was broadened to include protection of water quality as well as navigation. Section 404A of the act required that the corps control the placement of fill and the discharge of dredge material in navigable waters. The specific purpose of the requirement was to restore and maintain the chemical, physical and biological integrity of the nation's waters. Last year, several enactments had some far-reaching reforms for the corps' regulation. These reforms have, by reducing unnecesssary paperwork, speeded publications processing and extended the use of more convenient national permits. These new regulations also give more authority and responsibility in general permits to those states which are developing general permit programs. The Clean Water Act also created a federal grant program to assist in the planning, designing and construction of wastewater treatment plants and sewer interceptors. The U.S. Army Corps of Engineers has an interagency agreement with the Environmental Protection Agency (EPA) to manage construction and the associated grant administration for those projects which EPA determines grant eligible. The Albuquerque District now is managing 20 actual construction contracts which are being conducted under 15 separate EPA grants for communities throughout New Mexico. The federal share of these contracts amounts to about $56 million. Because of the diverse and multidisciplinary responsibilities carried out by professional engineers, biologists, outdoor recreation specialists and managers of my staff in planning and managing New Mexico's water resources, we will continue to have a comprehensive water quality data collection and evaluation program. I see a particular need in the Rio Grande Basin within New Mexico for an understanding of aquatic systems and impacts upon those systems such as was proposed by the Institute of Ecology at the University of Georgia in 1979. That report, on the role of sediment and nutrients in the aquatic environment, demonstrated a need for an overall, unified or holistic approach to water quality related research. Their overall or holistic approach was proposed as an alternative to previous work which had followed fragmentary or component analysis patterns of research and data collection. Information derived from a systems approach to research and data collection could be immensely important and useful to those of us who manage dynamic and integrated systems of water resource development such as the network of federal reservoirs I've described here in New Mexico. The management of these water resources must be responsive to a myriad of objectives including, but certainly not limited to, public safety, water deliveries, economics and environmental quality. The near future promises to be even more demanding on the skills of those managing water resources. The needs and concerns of the public are becoming more diverse as society develops, changes and creates additional usage of our water supply. For my staff, these future trends already have begun to evolve in our jurisdictions outside New Mexico as well as within the state.

Within the Arkansas River Basin in Colorado, river user densities and conflicts among users such as fishermen and river floaters have increased to an extent that consideration of these types of recreational activities have become a significant factor in the permit process. Outside our area, the conflicts between fishermen and canoe enthusiasts on the Current River in southcentral Missouri have become known nationally. I don't, however, have to look to Missouri or even Colorado to see the increasing diversity of recreation activity making its way to the forefront of water resource management.

In the recently concluded session of the New Mexico State legislature, a bill to establish an extensive state park along the Rio Grande in Bernalillo County was passed. This public action can be considered a formal recognition of the need to more thoroughly integrate a growing demand for recreation along the state's riparian corridors.

The U.S. Army Corps of Engineers is experiencing considerable public pressure to consider river floating and fish habitat in its water regulation activities. Aided by the field data collection expertise of the

USGS, my staff has for the last four years, monitored the response of the Rio Grande to the operation of Cochiti Dam. We've documented a dramatic change in the physical appearance of the stream for the first 20 miles or so below the dam. Clear water leading into the lakes has removed previous deposits of sand and silt. What remains is a stream lined with cobbles and large gravel which, when combined with the improved quality of the clear water itself, has probably activated much greater biological activity in the stream. We're looking forward to the same general response on the Rio Chama below Abiquiu Dam due to the increased storage of San Juan/Chama project water and, of course, the resulting decreased amounts of sediment in the river. The challenge remains for the development of a method to bring data such as in streamflow recommendations for fishery enhancement, river floating, etc., into some forum where they can be considered along with specific requirements for flood control and traditional uses such as irrigation. Such a forum would improve our potential to manage the overall resource without neglecting any one segment. I also perceive a need to develop an increased amount of coordination and cooperation among the agencies who use water and water quality information. As our nation continues its struggle to control the enormous federal budget deficit, pressures on programs such as basic water quality data collection must become more efficient or, as an alternative, be cut back in scope. Pressures like that will intensify. I believe that responsible federal agencies must commit themselves to reevaluating our needs, determining innovative means, or providing information which is necessary to satisfy our common needs. We have to evaluate better methods for identifying information needs and implementing information collection, to sharing programs within and among our agencies. We have to eliminate overlapping and redundancy and, in fact, do our job more efficiently. We have to spread the available funding where it can do the best for all of our programs. Conferences and seminars such as the one we are participating in here today are an initial step toward that end.

PANEL

Federal Water Quality Information Responsibilities, Activities and Needs

Monte G. Jordan
Associate State Director

United States Bureau of Land Management

The U.S. Bureau of Land Management (BLM) is a multiresource land management agency responsible for providing goods and services to the public from the public lands it administers. These goods and services include water as a resource.

Responsibilities

The production of renewable and most nonrenewable resources is intimately tied to the availability and quality of this resource. Water also has finite limits in both quantity and quality which place constraints on its capacity to support various uses. In addition to these natural constraints, there are also executive and legal requirements protecting the water resource that the BLM must comply with in its management of public lands. Examples of some of these mandates are:

1. National Environmental Policy Act
2. Federal Land Policy Management Act
3. Surface Mining Control and Reclamation Act
4. Clean Water Act
5. Safe Drinking Water Act
6. Wild and Scenic Rivers Act
7. Executive Order 11988, Floodplain Management
8. Executive Order 11990, Protection of Wetlands

These and other related mandates require, among other things, that the BLM protect or improve the quality of the water resource, prevent the deterioration of soil and watershed conditions, prepare environmental impact statements (EIS) for major actions significantly affecting the quality of the human environment, and develop and maintain land use plans using ecological information and an interdisciplinary approach. The BLM also conducts and maintains a continuing inventory of water resources, complies with all applicable federal, state and local requirements respecting control and abatement of pollution, improves public rangelands to make them as productive as feasible and rehabilitates areas having unacceptable erosion and runoff conditions. The U.S. Bureau of Land Management responsibilities also are to avoid adverse impacts associated with the occupancy and modification of floodplains and to minimize the destruction or degradation of wetlands.

The BLM water resources program is somewhat unique in that it involves hydrology watershed management and also small drainage basins for which little information is available. The following projects are the major current BLM activities:

> Baseline Data Collection--The BLM is funding the U.S. Geological Survey (USGS) to collect surface water discharge and sediment data at six gauging stations in New Mexico. Data from these stations are used to characterize drainage basins and establish long-term averages and determine trends. Data for these stations are published by the USGS.
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> Water Use Inventory--A water use inventory is being conducted statewide to locate water sources and quantify water uses on public lands for protecting and securing water rights of the United States. Such an inventory will provide the basis for the administration and management of water uses on public lands. The inventory also includes chemical quality of major wells and springs.
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> Areal Investigations--Areal investigations are designed to assess ground water levels, aquifer and surface water characteristics, water quality data, sediment yields, etc. There is need to provide a general description of the water resources in the study area. Areal investigations provide the basic water resources information that is used in the BLM's

land use planning system and environmental assessment program. Investigations are conducted in-house or under contract. Investigations have been completed for EIS areas in east and west Socorro, east Roswell, southern Rio Grande, Las Cruces/Lordsburg and San Juan BLM planning/grazing EIS areas. Preparation plans are underway to complete management plans and EISs for the Roswell and Rio Puerco areas.

Coal Hydrology Studies--These are comprehensive studies of the water resources at specific study sites located in leaseable coal areas of the San Juan Basin. The purpose of the studies is to evaluate the rehabilitation potential of the area following mining and to evaluate potential impacts on the water resources. Data collected include streamflow and ground water characteristics, surface and ground water quality and climatological variables. Results from these studies are published in reports for each study site by the BLM and in basic data reports by the USGS.

Water Quality Monitoring of the Rio Grande and Red River Wild and Scenic River, Taos County--This project is designed to provide water quality data for river administration. This ongoing study of the quality of the Rio Grande and lower Red River in northern New Mexico is being conducted to characterize existing quality, identify and evaluate existing and potential pollution problems and evaluate water quality in relation to water quality criteria and standards. Such data are needed for the administration and management of the designated wild and scenic river. Water quality data including physical, chemical and microbiological characteristics are collected by the BLM and published by the USGS.

Information Needs - In Summary

The foregoing list of current activities is an example of the type of information needed and its application in BLM management programs. Almost all of these activities are expected to continue for varying periods of time.

Water resource information is needed by the BLM not only for water management but also for the management of the many other resources under BLM's jurisdiction. Water resource information is needed on a continuing basis for the BLM's cyclic land use planning system and for the assessment of impacts in environmental impact statements. The first cycle of planning is scheduled for completion in 1989. Information is also needed in the BLM's coal program and asset management program which are receiving more emphasis recently. The coal leasing schedule for the Salt Lake coal field in the BLM Socorro district has been accelerated to accomplish leasing in 1986.

Water quality, ground water and floodplain information will be needed for the application of unsuitability criteria in the coal planning process and for the assessment of hydrologic impacts from mining and reclamation. Floodplain and wetland information particularly will be needed in the asset management program for the sale or other disposition of some 242,000 acres of federal lands identified to date. Such information is essential for compliance with the floodplain and wetland executive orders.

Information to protect the quality of the water resource, to prevent the deterioration of soil and watershed conditions and to assess land use impacts is required in order for BLM to meet its mandated management responsibilities.

We look forward to working with the people and organizations represented here to better our ability to perfect and manage the water resources of New Mexico.

PANEL

Federal Water Quality Information Responsibilities, Activities and Needs

Kenton Kirkpatrick
Deputy Director

Water Division
United States Environmental Protection Agency

It's always nice to be back in New Mexico. I'm pleased to say that in 20 years of professional experience, I've been fortunate enough to have spent at least a couple of those years in this state. I first wanted to compliment Russ Rhoades and his Environmental Improvement Division (EID) staff on the very fine presentations I've heard here today. It's made my job very easy because much of the work and the legislation the U.S. Environmental Protection Agency (EPA) receives from Congress is carried down to the state level in New Mexico by the EID.

When the EPA was created in 1970, we were given the reponsibility of cleaning up the nation's waters and also of protecting them from future pollution. Over the years, Congress has enacted a number of laws to give the EPA the authority it needs to meet that responsibility. I want to touch briefly on three of those laws. The Clean Water Act (CWA) which has been amended several times over the past 27 years and which has been mentioned a number of times here today, is the cornerstone of the national water quality program. And the cornerstone of that law is that it provides for the establishment of state water quality standards that, in turn, designate water uses and the protection of those uses throughout the state.

The CWA, through the National Pollutant Discharge Elimination System, also gives the EPA the authority to regulate all discharges through permits. The law provides for enforcement actions against municipalities and industries that fail to obtain permits or fail to adhere to permit conditions. In addition, the CWA provides a construction grant program to help municipalities build wastewater treatment facilities. This program was initiated in 1956. Congress established the program to provide grant funds to communities to help them clean up the nation's water. The idea then was for the federal government to bow out and allow the communities, through the use of fee systems, to generate the funds necessary to operate their systems and build for future needs on their own. That was in 1956, and in 1983 we still have a construction grants program.

The most recent law passed by Congress in 1980, is the Comprehensive Environmental Response Compensation and Liability Act, better known as "superfund." This law provides the authority to clean up the hazardous waste sites which threaten the public health and the environment. It also provided the authority to develop contingency programs to clean up the spills of oil and hazardous chemicals in the environment. Of course, both ground and surface water are frequently involved in these spills. The other major law directly affecting water quality is one that was passed by the Congress in December 1974. The Safe Drinking Water Act basically has two components. The first is the establishment and regulation of maximum contaminant levels for public water supplies which provides a national program to ensure the quality of the public water supplies in our state and throughout the country. Until 1974, the drinking water standards were recommended by the U.S. Public Health Department.

Most of those recommended drinking water standards were in effect prior to the Safe Drinking Water Act of 1974. The other component of the Safe Drinking Water Act provides for the control and regulation of underground injection wells such as brine reinjection wells, hazardous waste wells and in situ mining wells. One comment I would like to make on the Safe Drinking Water Act is that the EID has established an excellent system for monitoring communities with poor quality drinking water. The EPA is using the EID system developed in New Mexico as a national model for monitoring and improving the quality of drinking water. It's a very good system; we've made presentations on it in Atlanta, Chicago and Washington, D.C.

Each of the laws I've mentioned provides for the delegation of programs to states which are willing and able to handle them. We believe that the best way to implement these and other environmenal laws is to administer them through those closest to the problems. I am pleased to say that New Mexico is one of the first to take on the responsibility for bringing to the state level, the public water supply program, the underground injection control program, the Hazardous Waste Management Program, and the Resource Conservation and Recovery Act. All of the EPA's legislation states right up front that "it is the responsibility of the states to manage environmental control programs." There are provisions for the EPA to delegate those programs to the responsible state agencies willing to run those programs. We're very pleased with what has been accomplished to date in New Mexico. We are encouraging the delegation of both the construction grants program and the National Pollutant Discharge and

Elimination System permit program to the Environmental Improvement Division.

Information plays a key role in the effective administration in delegating the programs. The exchange of information is essential to our success. We rely heavily on our state agencies for environmental data gathered through their monitoring network and through their special studies, many of which we referred to here today. Congress has required under Section 305(b) of the CWA that each state prepare a report every two years describing a status of the trends in the state's water quality. Congress wants to know how we're doing in cleaning up the nation's waterways and how we are doing by extending the construction grants for municipal cleanup. From a national perspective, the data gathered under Section 305(b) is used to assess how our country is doing on water quality cleanup and in preventing further water pollution.

New Mexico's EID also has documented 105 sites where ground water contamination is suspected. The EID also has identified six particular stream reaches in the state that have surface water quality violations in need of improvement.

There was some discussion this morning about the proposed revisions of regulations governing the development, review, revision and approval of water quality standards. This proposal was published in the Federal Register in October 1982 and has been the subject of a series of public hearings around the country. Comments received during those hearings on the proposed revised regulations on water quality standards are now being evaluated. It has been anticipated that the regulations will be pubished in final form in about six months. It might be out in six months, but I think it may be a year or more before publication. The proposed changes are important because they are designed to enable states to use water quality standards as a pragmatic tool to protect water uses. This protection was not always possible under the more rigid regulations initially adopted.

I want to take a moment to amplify on the response to the question raised earlier today about proposed water quality standards. It is the states' responsibility to establish water quality standards and the criteria that affect water uses. The regulations that have been proposed do not allow changes in a stream's given use. It does not provide for removal of that use. That use is there and it must be protected. For example, if the use is for a public water supply, a trout fishery or irrigated agriculture, the proposed regulations provide for protection of that use. These proposed regulations are trying to remedy regulations that, in our haste to pass water quality standards under the 1966 Federal Water Pollution Control Act, were not correct or realistic. As a result, we have streams designated for uses that do not exist. For example, I know of some streams over in the eastern part of one of our states in a region where all these years, since 1966-67, some streams have been designated for use as public water supplies. Those uses simply are not there. The state health department does not want those uses on those streams because better and safer waters are available for drinking water. Under existing regulations--not the proposed regulations--it is very difficult for a state to say, "That use is wrong. It's not there. We have to change it." The new regulations <u>will not</u> downgrade a stream but simply remove a designated use that doesn't exist. In some cases we have found that because a stream's uses are improperly designated, we may be forcing a community to use advanced waste treatment processes unnecessarily, resulting in large expenditures of public funds to protect a use that doesn't exist in that stream.

The other question I want to address concerns public hearings. I believe we will always require public hearings on water quality standards changes. I really can't see that there would be any reason for the states to say unilaterally that we are going to change the standards without telling people and letting them participate in the decision. We will continue to work with the states in resolving problems because our success will depend largely on the two-way flow of information.

INDIAN WATER QUALITY INFORMATION NEEDS

Delfin J. Lovato
Chairman

All Indian Pueblo Council

Good afternoon ladies and gentlemen. Thank you for providing me the opportunity to come before you to express some of the concerns and needs of the Pueblo tribes of New Mexico concerning water quality standards. As many people of the Southwest are aware, water is of great importance to the Indian people, for religious purposes as well as a practical life-giving resource. For years the interest in water has been one of amount available. A major concern among the Pueblo tribes always has been whether or not they would have sufficient water to maintain their crops in their community. However, in recent years the concern for quantity has been compounded by a concern for maintaining the quality of that precious and limited resource. Increased development and population expansion on or near reservations have not only put a strain on the amount of water available to all but has also resulted in altering the quality of those waters.

The concerns of the Pueblo tribes are varied in nature depending on tribal locations. Our pueblos, such as those in Jemez and Zia, have the same concerns as rural communities. Areas such as Acoma, Laguna, Isleta and San Ildefonso have more modern fears brought on by urban development and chemical waste contamination. The rural areas are concerned with the development of wells that will provide usable waters as well as with the maintenance of clean water stream designations from the many streams that run through their lands. Many of these concerns deal with maintaining the purity of streamflows that are coming under increasingly larger recreational uses. This would include the waters of the Rio Jemez and the tributaries of the Rio Grande as they are found in the northern areas of the state near the pueblos of Santa Clara, San Juan, Picuris and Taos. These are areas where the waters provide excellent recreational use and any downgrading of those waters could result in an eventual loss of those recreational benefits to Indians and non-Indians.

The lower waters of the Rio Grande and the waters of the Rio San Jose are of a more immediate concern when discussing water quality standards. The pueblos of Laguna and Acoma are currently confronted with a serious degradation of the Rio San Jose due primarily to inefficient waste disposal from the city of Grants. Each tribe must be made aware of or be informed of municipal actions taken upstream from them which could have direct effects on the waters passing through their areas.

The pueblo of Isleta, which sits right below the city of Albuquerque, has for years been subject to a growing danger due to the expansion of city waste into the Rio Grande. This includes domestic as well as industrial waste. The pueblo does extensive farming, but the recent diminishing of the quality of water is beginning to have an effect on their farming activities. The possible effects that the new nuclear treatment plant at the Montessa Park area might have on waters flowing from the Rio Grande into the pueblo of Isleta have not been totally made known to the Pueblo community.

As the population of New Mexico expands and municipalities come in closer contact with water sources that also feed the Pueblo communities, the effect that these municipalities will have on the pueblo water source will have to be given a higher priority.

For centuries the pueblo water needs have been based on recreational and agricultural uses. The increased industrial and domestic water uses which are rapidly growing around the reservations' boundaries will have direct and dramatic effects on the tribal communities. The Pueblos must not only be informed about the potential effects these changes in water uses might have, but also be given information about what these water uses will be before they have occurred. Without such information, there cannot be any type of worthwhile working relationship between the Indian and non-Indian communities. Until the non-Indian communities recognize the Pueblo tribes as neighbors who also have a great dependency on a shared resource, the fight over water will be never-ending. Because of the preciousness of the resource, the Indian and non-Indian communities cannot afford to expand their energies in a continually combative manner. Planning for water needs is going to have to include all the parties affected and this means, in no small way, the Pueblo communities.

PANEL

Municipal Water Quality Problems and Information Needs

T. E. (Tim) Kelly
President

Geohydrology Associates, Inc.

As Jim Daniel very effectively pointed out, a large number of bureaucrats are in the audience, so as a consultant, I feel kind of like an ugly duckling up here. However, I'm very happy to be a part of a very illustrious panel which will be addressing their information needs and some of the problems of municipal water supplies. The first member is Gus Cordova of the Environmental Improvement Division (EID) who has been involved with the Safe Drinking Water Act and also municipal water supplies within the state. On his left is Frank DiLuzio who is the director of the Santa Fe Metropolitan Water Board. This is a fairly new board which has made great strides in the past couple of years. Paul Noland, next to him, is a director of the Albuquerque Water Department. He has the distinction of being loved and hated by about an equal number of people. The last person on the panel is Don Patterson of the city of Carlsbad. Carlsbad also has some unique municipal problems.

PANEL

Municipal Water Quality Problems and Information Needs

Gustavo Cordova
Health Program Manager

New Mexico Environmental Improvement Division

The water supply program of the Environmental Improvement Division (EID) has oversight responsibility for more than 1,300 public water systems in New Mexico. Of these, 627 are community water supplies and 675 are noncommunity water supplies. Our oversight responsibility, as we see it, expands way beyond that of municipal water systems.

The majority of all the community water systems within the state serves a population of about 3,000 people or less. This accounts for 567 water systems, or 92 percent of all community water systems in New Mexico. It is interesting to note that these systems account for 98.7 percent of all monitoring recording violations of the regulations governing water supplies. They also account for 98.3 percent of all maximum contaminant level violations of the bacteriological drinking water standards. In spite of the large percentage of water systems served in the state, these supplies serve only 183,489 persons, or 15 percent of the population that is served by community water supplies. Communities in New Mexico with a population between 3,000 and 11,000 persons account for only 19 water systems, or 3.1 percent of all the community water supplies for the state. These communities account for only 1.7 percent of maximum contaminant water level violations and serve 121,000 persons, or 10 percent of the population that is served by community water supplies.

The largest communities, those that serve more than 11,000 persons, account for only 19 publicly owned community water systems. These communities endeavor to meet the drinking water standards and have a pretty good monitoring and reporting compliance record. These communities serve 618,299 persons, or 53 percent of the population which is served by community water supplies. Of these, approximately 135,000 persons are not served by public water supplies in New Mexico but instead rely on individual wells, springs, catchments or other sources. The state requires that all these communities monitor not only for the presence of bacteriological contaminants, but also for inorganic, organic and radiological contaminants.

Fifty community water systems in the state currently exceed the maximum contaminant level for fluoride. Selenium, arsenic and nitrate maximum contaminant levels are also exceeded in many of our communities throughout the state. New Mexico has elected not to enforce the fluoride standard at the present time because of the questionable health affects associated with that current standard and the economic impact that would be placed on those communities if treatment was imposed. At present, the New Mexico EID, along with other states, has requested that the U.S. Environmental Protection Agency (EPA) change the standard based on conclusive evidence by the Surgeon General, the American Medical Association, the American Dental Association, and recently the Drinking Water Advisory Council. The remaining inorganic contaminants are currently being addressed to a schedule of compliance for those communities that are currently affected.

Communities serving more than 10,000 people are also now required to monitor the presence of organic by-products that are formed when chlorine reacts with decaying organics present in the surface water supply, and in some instances, the ground water supply. This by-product, known as trihalomethane, is now monitored to determine baseline data and to assess the changes that may be necessary in the communities' water treatment process. A state proposal has been initiated for additional monitoring within the next year to identify organic by-products in community water supplies. The division is proceeding with this additional monitoring because of the health effects and maintenance problems associated with corrosive by-products. Also proposed in the near future is a statewide sampling program for synthetic organics in community water supplies. This sampling program will be necessary in view of the recent studies conducted by EPA that show that these organics are present in the majority of water supplies. Currently, the health effects associated with this organic are questionable and, in some cases, unknown, as in the case of drinking water. Extensive ongoing research may shed additional light on the subject. In the meantime, it is necessary to initiate this monitoring program so that the presence, if any, of this contaminant can be classified.

In the end, the inability to determine any given contaminant in the drinking water supply may adversely affect the public health. We believe that with ongoing training processes, communities across the state will be able to react in an informed and timely fashion. In relation to a point raised by Delfin Lovato a few minutes ago, I'd like to say that the state does not have any oversight responsibility over water supplies that are in the Indian reservations. However, we are available to help any of the Indian communities with technical assistance in any applicable water supply if they should so request that.

PANEL

Municipal Water Quality Problems and Information Needs

Frank C. DiLuzio
Director

Santa Fe Metropolitan Water Board

The Metropolitan Water Board, which is part of the Santa Fe water franchise, was created by a Santa Fe ordinance. The franchise of the water board is unusual in that its senior signatories are the city of Santa Fe, Santa Fe County and the water company. The board is funded through contributions from the city and from the franchise tax received from water sales. This total is matched by the water company. The functions of the Metropolitan Water Board are to preview technical studies, long-range planning for water services, availability of water, and policy recommendations to the principals. In effect, the board is really a technical study group that only makes policy recommendations. It really has no functions of its own except the administration of water which is in the San Juan-Chama project. The authority extends only over water that is purchased under contract and that to which the Metropolitan Water Board holds the allocation rights. We contract with other agencies to have studies performed. For example, we are working in partnership with the U.S. Geological Survey (USGS) and the State Engineer Office (SEO) in designing a three-dimensional model. We are participating by providing the cost of the model. We're talking to them now about doing some other studies for us. We believe that the character of our organization, the lack of our staff and the availability of talent in the state encourages us to use the USGS and the SEO. Even when we formulate programs that we hope to do through consultants, we try to do it with the full understanding of the SEO and the USGS. We do this in hopes that the information developed is useful not only to the Metropolitan Water Board and its principals, but also to other water agencies in the state. I don't think anybody in the state can enjoy the luxury of having single source information only for their use. I think that because the dollars are short and the data requirement is large, we had better work collectively in sharing information. We also believe that in using information from state institutions like New Mexico State University and the New Mexico Bureau of Mines, along with data from the USGS and the SEO, that we are tapping the best brains in the state. In turn, whenever we do things on our own, such as monitoring wells or constructing observation wells, we provide the data we've developed to anyone who has any use for it. I believe more of this must be done.

I was very impressed with the description of the work being done by several of the agencies and others represented at this conference, including the proposed long-range plan of the USGS. I feel much like the little girl who inherited a million dollars. After the lawyers explained to her what it meant in terms of how many dollars a day she could spend and never run to the end of it, she finally said, "But can I have five cents for an ice cream cone?" There are problems in the state of New Mexico that involve small community water supply systems. These problems are very small but they're very serious to these communities. I would like to see some accommodations made for the small problems--not large basic problems, not large watershed problems--in terms of providing them with technical assistance and some type of funding. We've all read stories about how these communities have had to haul in water because their wells ran dry. Perhaps these problems are too small for large agencies to handle, but the state must face up to them. In Santa Fe County, we are taking a look at our own community systems because, under the ordinance, we've got to see what needs to be done to upgrade them. Basically, this is being done because if the city expands its boundaries and the communities become part of the water system, we would like to know the physical conditions of their systems. We hope to be able to improve them as time goes on so that their standards of construction are consistent with those of the main company. I believe that a better coordinated approach to these problems and a much better means of transmitting technical information is a must. The people who operate the systems every day can convert this technical information and these ecological studies into management techniques they can use. I would like to see all the technical information developed in these basins converted into management techniques such as those Lee Case referred to in his talk. Some of us know how to take information, such as the geohydrological data being developed, and use it in making everyday decisions. This information will not only help us operate the system properly but also will help us design better systems--both small and large--in the future. Santa Fe County has 29 community systems of all grades and kinds; some are very good, some are very bad. The one large system in Santa Fe, which serves 50,000 people, has the staff and the funding to improve its own system. But this is not true for every small village in Santa Fe County that has water problems, and will continue to have water problems. The water quality in many of these small systems is very bad and must be taken care of.

Another problem we have in getting information together is that we have a basin in which a great number of studies have been made. I think at last count, there were 156 minor studies and about seven major studies. Information from these studies must be put into a form that can be used in developing management plans for the basin. For example, we really have very limited information on recharge. Until we know these facts, we really can't develop a long-term management plan for the Santa Fe Basin. Fortunately, we have three sources of water in Santa Fe: the Santa Fe River, which gives up somewhere between 4,000 and 5,000 acre-feet a year; the basin, which releases about the same quantity; and the contract water we're buying from San Juan-Chama where we have 5,600 acre-feet and we'll ask for 9,000 more. The saving grace for Santa Fe, and one which will give us the water requirements for growth through the year 2015, are these two sources plus the ability to purchase water from the San Juan-Chama. The combination of resources and proper management will stabilize water requirements for Santa Fe. If managed properly, Santa Fe should not have any serious water problems in the long-term.

PANEL

Municipal Water Quality Problems and Information Needs

Paul Noland
Director

Water Resources
City of Albuquerque

I'd like to begin with an illustration of one of the problems facing an agency like ours in trying to treat water to meet the required standards and deliver potable water to its customers. Right now, State Representative Jim Gonzales, hopefully along with the news media, is out with one of my engineers looking into one of our reservoir hatches. We are doing this to prove that there are no dead dogs in the reservoir. This really does indicate the kind of problems that can occur at a very large water related agency in getting the right information to the customers and the other agencies and to get information from them in a timely manner.

Gus Cordova just mentioned trihalomethanes (THM). Concern over THM first started several years ago when a national newspaper, as well as television stations, carried the story. We were flooded with calls about whether or not our water is safe regarding THM. Since then, numerous studies have been conducted to determine THM standards and those of us who are operating systems are in agreement with the Environmental Protection Agency (EPA) as to what that standard should be. We're now identifying organics of all kinds. Some of the instruments used to identify these organics cannot measure to the level set by the standards.

When we ran into problems with our San Jose well no. 6, we had a communication problem of another kind. It was determined that one of our wells contained a number of organic impurities. I found out about it, however, when the news media called and said that the state Environmental Improvement Division (EID) had put out a news release stating that we had a couple of wells not meeting water quality standards. "Oh," I said, "I'll try to get a copy of the news release and have an answer for you." Since then, we've improved our communications tremendously with the EID and hopefully now we know what each other is doing. We have had to close down San Jose well no. 6, but it turned out that the other well was all right and we've continued use of it. Since then, the city Environmental Improvement Department has been sampling private wells within the city. They put out a news release this week saying that contaminants in the San Jose area were in these private wells and that the city is recommending that these individuals hook into the city system. We think we have found a solution. We went to the state and it established the standards for the identified organics in San Jose. We believe that by blending the water in this well with other wells in the reservoir, we will stay within all standards regarding water quality in the San Jose area. Of course, if we start having trouble with other wells in that area, we're in a serious mess. We will have to build more wells and that's not cheap. It costs between $800,000 and $2 million to fully equip a well. This brings us to the second problem we're experiencing and that is the cost of meeting liquid waste standards. We're in the process of expanding liquid waste treatment plant no. 2 in the South Valley so that we can completely close down treatment plant no. 1 and also handle the load that we foresee in the future. The problems caused by changing the sludge treatment standard from the 60/60 standard to the 30/30 standard was anticipated by only a few engineers in the United States. The change required that sewage treatment leave only 30 parts per million suspended solids rather than the old standard of 60 parts per million. The increased removal rate leaves us with the problem of disposing of a tremendous amount of sludge. For the last five years we've been hauling sludge from the plant to various sites around the city. We are now injecting it into the South Broadway landfill. Part of our program will be to move all of the sludge handling to Montessa Park which is at least 250 feet above the water table and should not cause a problem. What we're talking about overall is a large amount of money to accomplish these programs. With the federal government drawing back, I expect to see continued rate increases unless we are able to get funds from other sources for construction and operation and maintenance costs. We're certainly looking at all kinds of revenue sources--federal and state--to do as much as we can to keep the rates down. But I had to really mention rates because that's why people don't love me!

PANEL

Municipal Water Quality Problems and Information Needs

Don R. Patterson
Director

Community Development
City of Carlsbad

Those of us at the municipal level realize that it is a monumental task to assimilate and compile all of the water quality data that we've heard about today. Ultimately, however, it falls on the shoulders of local elected officials and city staffs to implement the water data that is collected. We are the ones who must provide our residential and commercial users with potable quality water and I think it behooves us as city staff people to find out all we can. Carlsbad, like many other cities and communities in New Mexico, has had its share of water quality and quantity problems. In listening to some of the other problems today, ours seem minor in comparison. However, I want to share with you just briefly, some of the problems we have encountered as a smaller city in New Mexico in providing potable quality water to our citizens. In the late 1950s, the city's ground water source was becoming increasingly depleted by the increased pumping brought about by the city's growth. The city began looking eight or ten miles southwest of the city for better quality water in the Capitan Reef Formation. By 1962, the city had acquired a leased right-of-way for ten new water wells. The water quality was much better and by early 1963, the city had six new wells and two new 5-million-gallon reservoirs on line. As the city's population grew and pumping increased, there was the problem of acquiring the additional water rights necessary to legally pump the water needed to satisfy the demand. The city has, through the years, continued to acquire additional transferable water rights. During this period, by the way, the city administrator has become well acquainted with representatives of the State Engineer Office regarding inadequate water rights. Since 1963, the city has purchased two farms for their water rights. One of these farms had priority on Pecos River rights and part of these rights was used to control water levels on two recreational lakes within the city of Carlsbad. In 1976, the city purchased a privately owned water system in the Ogallala Basin to the northeast of the city. This system included 27 water wells which had a reservoir storage capacity of approximately 1.8 million gallons in approximately 18,000 acre-feet of water lines. The Ogallala Basin also contains a better quality water than that of our original Capitan Reef aquifer to the city's southwest.

To assure that we meet all the water quality standards, the city has maintained, with U.S. Environmental Protection Agency (EPA) support, a monitored water quality laboratory. The laboratory, certified through the the New Mexico Scientific Laboratories Division, conducts bacteriological and limited chemical analyses on potable and waste water. We do all our own biological and chemical analysis with the exception of heavy metals and radiochemical monitoring and most organic analyses. Our water quality laboratory is a part of a recently completed wastewater treatment facility. We are now able to produce a good quality wastewater effluent which is presently discharged into the Pecos River below Carlsbad. The effluent now meets all EPA discharge permits standards which it did not before. It took the city several years to overcome the problem of an outdated wastewater treatment plant. It's a problem that many cities have faced through the years. The problem has become more urgent since the establishment of the discharge permit system in the state and throughout the country. Carlsbad has been able to resolve some of our more pressing water quality problems by utilizing every available source of funding. Any time you provide the capital improvements necessary to meet the standards, it becomes an expensive problem for many cities and municipalities. Several sources of funding were used to build the plant, including local revenue bond issues, matching funds from the state, EPA and federal Community Development block grants; we even requested that federal Housing and Urban Development (HUD) declare our block grants as real property which could be used for the purchase of water rights. It was a peculiar request but HUD granted it. In order for municipalities such as Carlsbad to continue to provide quality water for residential and commercial use, I believe that the following are needed:

1. The state of New Mexico should continue to maintain effective water quality regulations and laws regarding the use of state water basins. We often complain about the water quality standards that are imposed, but overall, we appreciate the fact that the standards help our citizens realize that things must be done to meet quality water standards and to protect the environment.

2. Continued strong leadership and equitable apportionment of water use regulation from the State Engineer Office is very much needed. Steve Reynolds has provided that leadership. I believe the State Engineer Office, in our opinion, even though it has ridden us some during the past 10 years, has been equitable and good for New Mexico because of the water problems that exist.

3. Enforcement of standards to protect water basins and water well fields from oil and gas drilling and pipeline activities is needed. As was mentioned this morning, studies are being undertaken regarding petrochemical

contaminants of our water basins around the state. I think this is very much needed in view of the oil and gas drilling and pipeline activities that are taking place around and within cities' water basins and well fields. Due to the geology in our area, we are very concerned about some of the blasting and fracturing activities that are taking place among five drilling companies.

4. Increased availability of state and federal funding programs which will allow municipalities to make expensive capital improvements affecting water quality in compliance with state and federal standards is needed. Many cities cannot, on their own, provide the capital improvements necessary to meet these standards. There always will be a continuing need for water quality data so that municipalities in New Mexico can properly manage, plan and fund quality control programs, including providing adequate water rights.

We also think there's a need for continuing local, state and federal support for flood control programs which is a water quality problem in many areas of the state. In our instance, we request the continued support of the construction of the Brantley Dam and Reservoir in the Pecos River Basin. The dam will protect Carlsbad and provide the flood control and the agricultural irrigation water necessary for some 25,000 acres of irrigated farmland in the Pecos Valley. There is also a continued need for water quality data affecting our water basins from the various state and federal agencies that we have heard from today.

PANEL

Municipal Water Quality Problems and Information Needs

Question/Answer Session

Question: I know that water quality standards are applicable to the water only after it has been treated. Do you see any value in making the standards applicable to the water source?

Cordova: The drinking water standards we enforce are at the consumer's tap. The studies done by the Environmental Improvement Division on source water or ground water are administered by that division under the Ground Water Program. In our particular program, however, we're concerned only with water at the consumer's tap after treatment has occurred.

Question: If fluorine is not that dangerous, can the standard be changed to reflect an acceptable level of fluorine? We don't know what to do with our water system, whether to go ahead and improve it or just wait for a decision. But, we'd like to have a permanent standard instead of a temporary one.

Cordova: The Environmental Protection Agency (EPA) is attempting to change the standard, but before it can be changed, the EPA has to conduct several studies across the nation to determine the acceptable standard. I understand there are a couple of alternatives being considered. One sets twice the maximum contaminant level as the primary drinking water standard. Any level less than that would be considered a secondary drinking water standard. As you are aware, in New Mexico we do not enforce the secondary drinking water standard. We do recommend that the communities meet those water standards, but we do not enforce them. It is our opinion that "brown" teeth are really not a health problem. Instead it's really an aesthetic requirement. We think that because the problem is an aesthetic one, the secondary standard is adequate.

Question: Different municipalities are regulating the quality of their water. I assume that water samples are being taken at different municipalities to make sure that these waters meet the standards. Are the sampling reports available for public preview?

Cordova: Yes, we have a compilation of all the chemical analyses that have been conducted for every well that serves a public water system in the state. The report contains not only the primary standards, but also the secondary standards.

Question: How frequently is this updated and in what form is the data available?

Cordova: The data are current as of 1980. We're now in the process of trying to update that. We don't see that the data has changed that much from 1980, but we feel that we need to keep it current so we plan to update it every three years.

Question: It seems that a lot of laboratory resources are being used to monitor parameters that barely, if at all, show up as detectable quantities. I am thinking specifically about parameters such as those for pesticides and silver which I've never seen in any drinking water system. Is there some element of overkill in the monitoring for compliance with maximum contaminant levels? Could some of these vital laboratory resources be directed toward more prudent activities such as organics?

Cordova: One reason for the extensive sampling program is that we're mandated to follow it under the state drinking water standards. We recognize that across the nation neither pesticides nor silver have been detected in any public water supply. In addition, there are several parameters we continuously monitored for that have not been detected anywhere in the nation, including New Mexico. However, we do not have the prerogative to stop monitoring even if the parameters are not there. Several groups are concerned about this practice and those concerns have been forwarded to the EPA through the state liaison group. This group is now trying to provide for some changes in the act itself that will allow for reduced monitoring. For example, monitoring would be reduced if over a period of years the community water system did not detect any arsenic, fluoride or any other particular contaminant. Under those circumstances, provisions could be made to allow the community to resample either every 10 years or some other sensible resampling program. We are concerned about organics present in water supplies and, as I mentioned earlier, we are now developing a plan to initiate a statewide sampling program of all community water supplies. So we do want to do some of these things but it really depends upon funding. If the funding is not coming from the federal government, then we have to rely on state government to come up with that additional funding.

Question: Is there a program or schedule to sample for gerardia in any of our water systems?

Cordova: The current method for gerardia sampling has proved ineffective and unreliable. We have sampled for gerardia in some surface water supplies, most recently in Chama. However, proper sampling is not only costly but also very, very time-consuming. We will take samples for gerardia if we have reason to believe that residents in the area may have been exposed to it. However, we don't do routine sampling.

Question: Mr. Noland, it is my understanding that all city wells basically have the same design. You mentioned that wells are very expensive, so wouldn't the city get more money from its investment if each well was designed according to its site-specific requirements?

Noland: Before I came with the city, I understand that this method was looked into. However, it was determined that it was cheaper to use the standard well specifications.

Question: Have the city officials come up with any innovative methods for funding water needs, other than tax increases or sewer tax increases? What sort of funding methods are available in light of decreasing federal and state budgets?

Noland: Albuquerque is looking at everything it can think of. We were approached recently by a large accounting firm that was talking about lease/purchasing programs for liquid waste treatment facilities. It would work, because one of the largest costs we have is in capital expansion. If we can figure out a way to accomplish that without going into debt, it would be beneficial.

Question: I would like to ask Mr. DiLuzio, Mr. Noland and Mr. Patterson if their problems would be reduced if the demand for water was less. And if that's true, have your communities looked into water conservation methods either by decreased rates or by charging differential rates?

Patterson: I think most cities are not looking toward reducing their demand because reduced demand for water means reduced growth in the community. Of course, any time you increase the demand you're increasing the problems associated with the additional water rights needed to legally produce the water. In Carlsbad, the developer pays for the extension of the water line and the city pays for the oversized line necessary for future development in the area. We are looking at some alternative methods because of the slowdown in housing to start to provide incentives, but we haven't come up with any that appear to be working.

Noland: Albuquerque has a volunteer program; we have a Water Conservation Officer and we make information available to people who are interested in it. But to generate much interest in a conservation program you have to have a water shortage and a water delivery shortage. Fortunately, Albuquerque has neither of those problems. Our system is designed to deliver about 250 gallons per day per capita. It costs a lot of money to get into that design and so we need to get some return on the capital investment. However, if people want to become involved in water conservation, I'm interested in it. I'm also interested in it on a long-range term so that we can lower our capital investment and help out there. I think we're anticipating a shortage of water rights in about 2015-2020. I wouldn't see a mandatory program coming about, but I can see water conservation encouraged through the rate structure.

DiLuzio: Water companies tell me that increasing the rates is one of the best conservation measures to be found. Increased rates cause consumption to go down, at least in our community. But when the water company is investor-owned with a fixed cost on their debt, the rates still go up because somebody has to pay the fixed costs. The same thing happened when they put price controls on natural gas. People were griping because they were saving gas but their utility bills still went much higher. So, conservation is a very tricky thing. If you do it right, you can still reduce your capital investments. You also can reduce the cost of treatment facilities because conservation also lowers the sewage flow.

NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE
RESEARCH AND INFORMATION RESOURCES

George A. O'Connor
Acting Director

New Mexico Water Resources Research Institute

You spent yesterday hearing everything you always wanted to know about the New Mexico Environmental Improvement Division (EID) and the U.S. Geological Survey (USGS). Today, it's my turn to tell you about New Mexico's Water Resources Research Institute (WRRI).

First, I'm going to tell you what the institute is <u>not</u>. It is not a water testing laboratory. It is not the sponsor of water utilities management courses and it is not the place to complain about your water utilities bill. We are not a branch of the Interstate Stream Commission, an offshoot of the New Mexico Department of Agriculture nor even "those folks involved in the El Paso water suit." What we are is the New Mexico Water Resources Research Institute and as our name implies, we sponsor water research in New Mexico.

The institute was established in 1963, the first such organization in the United States. Originally, the institute coordinated water research only at New Mexico State University. In the two decades since, the institute has taken on a statewide role in encouraging water resources research--even with the dreaded University of New Mexico Lobos. We now work with all the state universities, state agencies and federal agencies that sponsor water research activities.

Last year, the institute administered 39 projects ranging from basic laboratory research--such as a genetic engineering study of chile--to field research, computer modeling and economic impact studies. The institute also provides a training ground for young scientists. In the past 10 years alone, an average of 90 students a year have worked on WRRI-sponsored research projects.

Although the scope of the institute's research has grown, we have retained our original administrative and informational responsibilities.

Unlike the institutes in many other states, we have no in-house research staff. Instead, the WRRI helps researchers statewide obtain project funding. We also assist granting agencies in determining where to invest research money.

Until 1982, federal funds made up the bulk of the institute's budget. But with federal reorganization now underway, the balance is tilting more toward state and private funding. We have been able to weather this federal drought in part because of the flexibility built into our research program and especially because of the expertise of our researchers. However, funding uncertainty has made us a very agressive lot in searching out new funding sources. This year, for example, we were active in urging the State Legislature to pass a bill naming the institute as administrator of a $500,000 saline water research project in Roswell. The institute will cooperate with other agencies and the city of Roswell on this multidisciplinary two-year project.

The WRRI is not one of the big spenders for research. We rarely allot more than $25,000 for one project. This money often matches or supplements funding from other sources. We encourage researchers to use this as "seed money" to attract other project sponsors. One saltgrass project, for example, started as a small, one-year project but eventually evolved into a long-term multidisciplinary effort.

Most projects selected for funding through the institute have addressed one of five basic issues in water resources. Those issues are: the relationship between surface and ground water, urban and industrial devlopment, water quality, conservation and water rights.

Because we are here today to talk about water quality, I will focus on research that specifically addresses that issue. In the past, the dominant water issue has been one of quantity--conserving the scarce supply. Knowledgeable people, however, realize that protecting the quality of our available water is just as important as conserving water quantity.

New Mexico has to be protective of its water supply because the state only receives about 13 inches of precipitation a year. This precipitation, plus river flows into the state, add 87.7 million acre-feet of water each year to the state's total. Ninty-seven percent of this evaporates. River flows to Texas and other losses take back most of the rest, leaving a net of 1.2 million acre-feet of usable surface water. This water is essentially all appropriated for beneficial uses.

New Mexico has vast underground water supplies--estimated at 20 billion acre-feet--but because most of it is saline or brackish, it is less desirable for public use. Fresh water aquifers are already used extensively and must be protected from degradation.

When most people think of poor water quality, they think of industrial pollution. But in New Mexico, poor water quality is often associated with high salt content. Decreased water quality as a result of increased salinity is a major concern of irrigated agriculture--the state's biggest water user. Most of the water applied to a crop is evaporated or transpired, leaving the salts to accumulate in the soil. Successful, long-term irrigated agriculture necessitates that these salts be periodically leached from the soil.

These leaching waters have elevated salt loads and eventually find their way back to the river through drains as irrigation return flow. An inescapable consequence of irrigated agriculture, then, is the degradation of the water supply where irrigation return flow constitutes a significant percentage of the volume of a stream.

The Rio Grande is a classic example of a stream that suffers water quality degradation as a result of irrigated agriculture. As it flows southward through the state, the flow decreases--water is used in irrigated agriculture--and the salt content increases.

Between Otowi Bridge and Fort Quitman, Texas, the flow registers a five-fold decrease, while the total salt load increases eight times. Larger, less agriculturally developed rivers do not show this striking relationship as markedly, but all rivers used for irrigation are subject to some degree of degredation.

The institute has sponsored several projects that centered on controlling such water quality degradation. One project involved a 450-acre demonstration farm in the Mesilla Valley. Results from the study showed how improved irrigation techniques could minimize unnecessary leaching losses and the concominant stream degradation. These techniques include irrigation scheduling, laser leveling of fields and even trickle irrigation of high value crops such as chile.

Nonagricultural demands on New Mexico's available water supply make up about 10 percent of the total. Although industrial and domestic demands are relatively small, these are the areas where demand is increasing rapidly.

One way to stretch the supply to meet these demands is to judiciously maintain the quality of the available supply. To do that, research has tackled several projects aimed at preserving and conserving New Mexico's water.

One of our current projects is examining the effects of common disinfectants on wastewater. The project researcher is looking at two disinfecting agents--chlorine dioxide and ozone--which are widely used in Europe, but not in the United States because of they are too expensive. The major advantage of these disinfectants over chlorine is that they do not react with organic molecules in the water to produce chlorinated organic compounds. Many chlorinated organics are toxic or carcinogenic.

Another WRRI-sponsored project involved desalting water for public supply. As it stands, many New Mexico communities use water which does not meet the National Drinking Water Standards. The substandard conditions may be caused by the total salinity of the water supply or high levels of specific elements such as uranium or fluoride.

Researchers built the mobile desalting van to demonstrate on-site reverse osmosis and electrodialysis techniques in desalting water. Because the van was taken into the communities, the residents could see if the techniques worked in solving their particular water problem. The communities also were given an idea of how much the desalting would cost.

As you heard in the EID session, New Mexico's water has not escaped the water pollution problems that have plagued many of the industrial states. The WRRI has also tackled that type of water quality problem. For example, one researcher is developing a highly sensitive detector for heavy metals in water. The goal is the instant on-site detection and recording of the levels of certain toxic elements in rivers or industrial waste streams. Previously, samples had to be taken to the laboratory for tedious analysis. This new system allows a plant operator to correct a process or treatment problem before environmental damage takes place.

These projects plus those of the next speakers are a few examples of how water resources research is attempting to solve New Mexico's water quality problems.

The institute is not all research proposals and demonstration plots. There is another facet to our institutional identity--water resources information. The New Mexico Water Conference is our most public outlet for water resources information. Each year for the last 28, the institute, on the recommendation of its advisory committee, chooses a specific New Mexico water problem as the conference theme.

The insitute also publishes the research results of every project it administers. These publications are a valuable source of information for other researchers and water resources agencies.

The Divining Rod, our quarterly newsletter, keeps more than 2,000 persons updated on water resources issues, water research and new publications. If you would like to be added to our mailing list, call the institute.

Researchers, students and the general public have access to the some 4,000 volumes in the institute's water resources library. Scientists often will use the library for literature review before submitting a research proposal and again for reference while working on the project.

In a nutshell, this is what the New Mexico Water Resources Research Institute does. But if you still want to know where to get your water tested, or where to pay your utility bill, give us a call--we also make referrals.

ANALYSIS OF WATER SAMPLES FOR TOXIC VOLATILE ORGANIC COMPOUNDS: STATE OF THE ART METHODS AND STRATEGIES FOR SAMPLING

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INTRODUCTION

Although rapid development of advanced analytical methods for determination of toxic volatile organic compounds (VOC) in water coincided with their discovery in river and drinking waters (1, 2), evidence of interest in this subject dates from rarely cited research reports in the early 1950s (3, 4). Methods of analysis of water for VOC were refined throughout the 1970s so that today rapid analysis of aqueous samples for complex mixtures of VOC at parts per billion (ppb) concentration ranges are relatively rapid and inexpensive. Few major changes have occurred in the basic approach or technology of these methods, except of course, in trends toward even more automated analyses and data management.

The major limitations today then, are found less in analytical instrumentation and more with sample collection, storage and transportation. Objectives of this talk include:

1. A brief overview of principles and practices of analyses of water for VOC at trace concentration levels
2. Presentation of new approaches to management of personnel and resources for monitoring VOC in rivers downstream from points of discharge

Research for this second section was a cooperative effort between civil engineers and analytical chemists at New Mexico State University

(NMSU) and was funded by the New Mexico Water Resources Research Institute (WRRI) for two years. Results from this new approach show the importance of such mangement and provide practical tools for mangement of sampling operations in environmental monitoring of rivers.

GENERAL BACKGROUND

Before a detailed discussion of either section is started, an appraisal of the problems and the special nature of VOC may provide a basis of an understanding of the analytical approach and the need for river models in chemical analyses. Three general aspects of VOC in water were major technical limitations in the mid-1970s. They were:

1. The volatile and thus transient nature of VOC during sample handling
2. An aqueous matrix which may be considered deleterious to expensive analytical instrumentation
3. The presence of VOC at microgram per liter (ppb) concentration levels in sometimes complex mixtures

Nevertheless, detailed well-documented analytical methods were described as early as 1977 by the U.S. Environmental Protection Agency (EPA). Clearly, solutions to the above problems were found. Few major changes in analytical methods have occurred since the late 1970s and few major changes during the next five years may be expected. An appreciation of these procedures may be useful to those of you who depend on analytical chemists. However, only a brief review will be presented since a complete description is beyond the scope of this meeting. Technical solutions to each of the limitations cited above were based on characteristics of volatility or vapor pressure of the toxic organic compounds.

Vapor Pressure

In figure 1, plots of vapor pressure of pure substances are shown as a function of temperature for (a) ethyl ether ($CH_3CH_2OCH_2CH_3$), (b) ethanol (CH_3CH_2OH) and (c) water (HOH). The molecules are relatively small in size or molecular weight. Two conclusions may be drawn from these curves:

1. Not all small molecules have identical vapor pressure (tendency to vaporize)
2. Small changes in molecular structure such as the presence of polar bonds (O-H in ethanol versus nonpolar O-CH_2CH_3 in ether) lead to startling differences in vapor pressure.

Polar groups may have favorable molecule-to-molecule specific interactions, such as hydrogen bonding, and these interactions lead to decreases in vapor pressure. Thus, even though water has a molecular weight of only 18 amu (atomic mass units), hydrogen bonding leads to much lower vapor pressure than ethyl ether with a much greater molecular weight of 74 amu. As a general rule then, VOC are defined as small nonpolar molecules. Polar groups such as OH, COOH or NH_2 in compounds greatly reduce volatility. Compounds containing these polar groups are generally not included in the family of VOC.

Analytical Techniques

Because VOC are often found in mixtures rather than as isolated species, and because molecule-specific detectors do not exist, gas chromatographic (GC) methods are ideal to physically separate individual com-

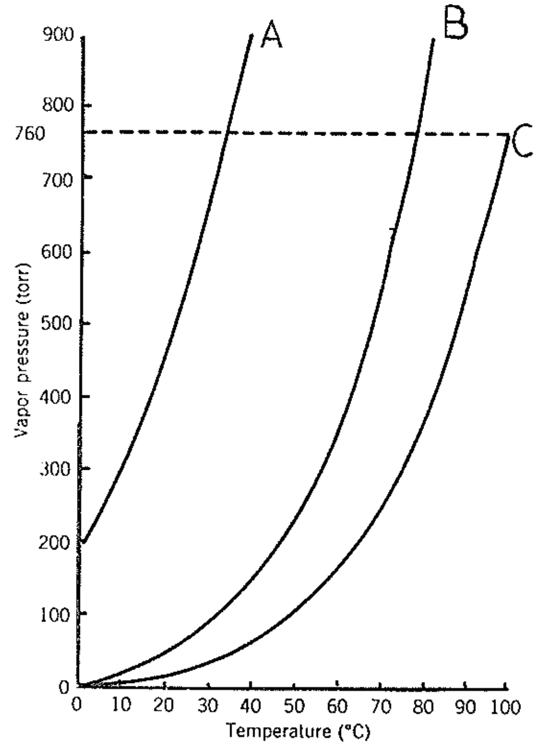

Fig. 1. Plot of Vapor Pressure Versus Temperature for (a) Ethyl Ether, (b) Ethanol, and (c) Water. Taken from Brady and Humeston; General Chemistry; Wiley, 1978, p. 232.

ponents in a sample before measurement using a detector. Unfortunately, direct injection of aqueous samples suffers from artifacts caused by chemical reactions in heated injection ports. Moreover, sensitivity is limited, using direct injection methods for water, to milligram-per-liter (ppm) levels and above because sample sizes are limited to approximately 10 to 20 microliters. In addition, certain detectors are degraded in performance from water introduced into the GC by direct aqueous injection.

Vapor pressure can be used to advantage in two ways: To remove VOC from water and concentrate VOC from up to one liter of solution for GC analysis. The approach used involves dynamic headspace enrichment or purge and trap procedures. These procedures are shown in-series with a GC in figure 2. The heart of this approach is the purging device and sorbent trap. Inert gas is forced into the purging device where 10 to 100 mL of aqueous sample have been placed. The gas is used to force VOC from solution to the vapor phase while gas is flowing through the sample. Thus, extraction efficiencies during 5 to 10 minute extractions may exceed 95 percent for most VOC. However, traces of VOC are diluted into as many as 500 mL of inert gas during extraction of VOC from water. The sorbent trap is used to collect virtually all of the VOC from the inert gas stream which is then released from the system. In the next analytical step, not shown in figure 2, purging is stopped and the trap is placed directly in-series with the GC. When the trap is heated rapidly, VOC are vaporized and carried into the GC for subsequent separation, detection and quantification. An example of results from such analyses is shown in figure 3 and is typical of results found in numerous articles on VOC in water samples. Detection limits of 0.1 ppb are no longer uncommon and the advent of fused silica capillary GC columns portends improved selectivity but not major changes in basic principles. Purging systems are commercially available for connection to GC and my be used to automatically analyze up to 10 samples. As a result of these advances, in 1981 our group at NMSU concluded that a major remaining limitation was that of sample collection and treatment.

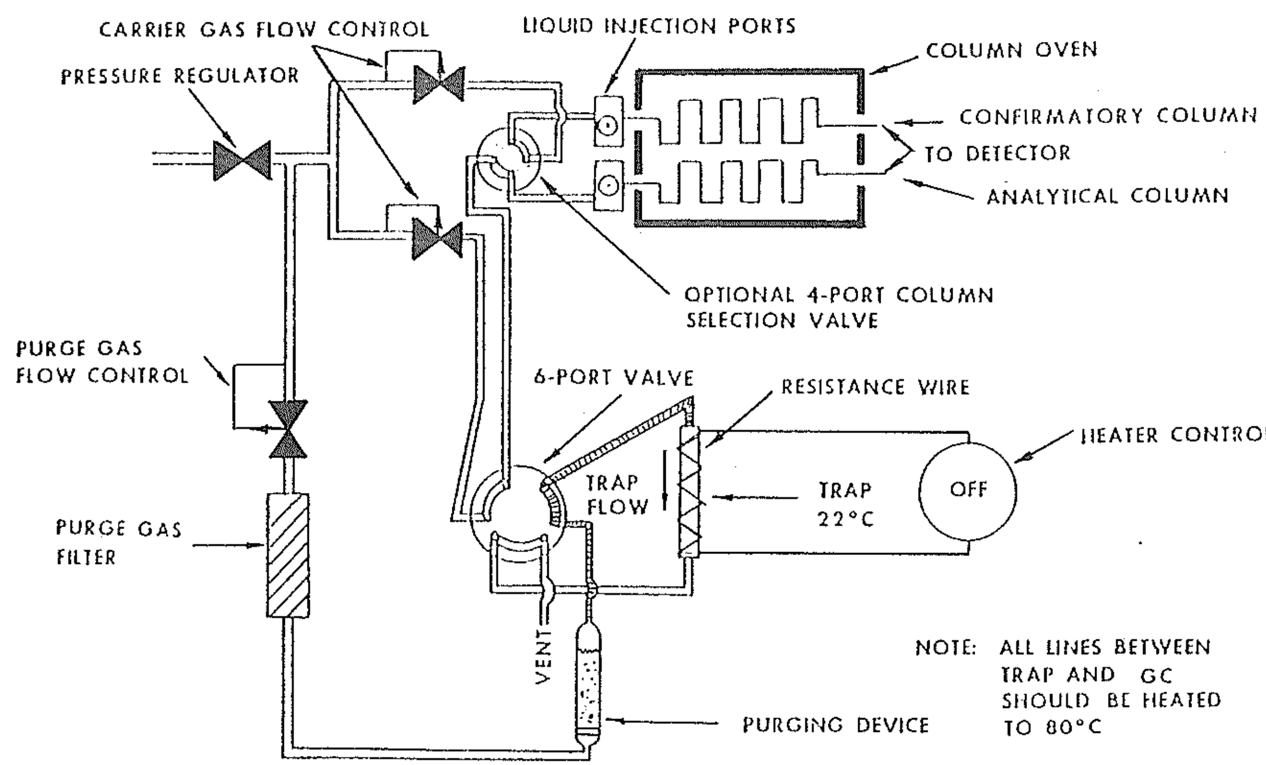

Fig. 2. Purge and Trap Instrumentation Combined In-series with Gas Chromatograph (upper right portion)

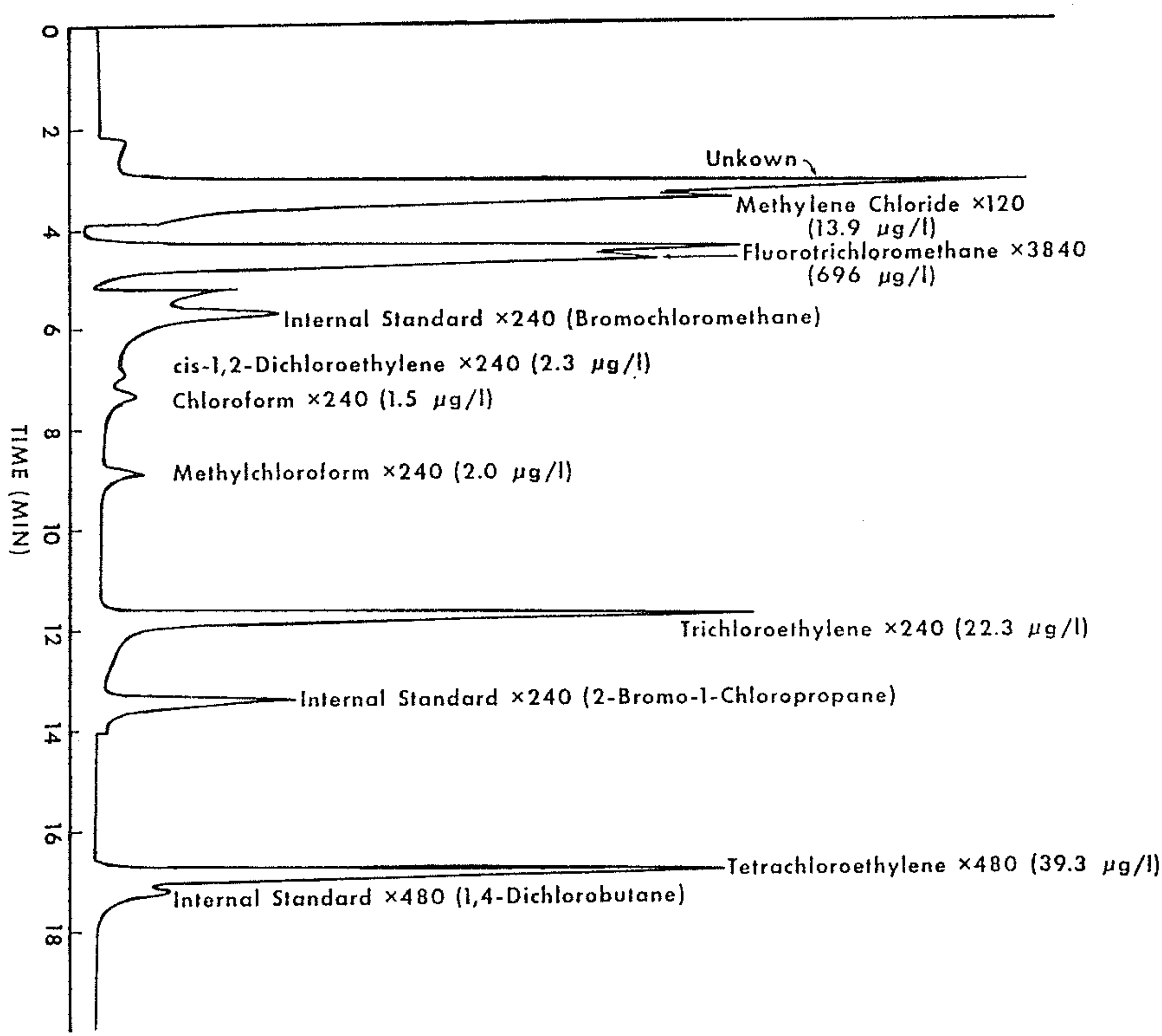

Fig. 3. Results from GC Analysis of Contaminated Well Water Using Purge and Trap Procedures (not original NMSU data)

Sampling Rivers and Streams

Collecting water samples on rivers or streams downstream from a site of discharge includes at least two major factors. These are: number and locations for taking samples, and storage and transportation of samples to preserve sample integrity. Only the first factor is of concern here. The critical nature of choosing where to sample a river can be seen in figure 4 which shows general behavior of VOC in rivers. In the diagram in the river section shown, the concentration of benzene versus distance downstream from the point of discharge is plotted. Decrease in VOC concentration due to volatilization as a discharge moves downstream. This decrease in concentration is common for all VOC in all rivers. However, the rate of decrease for particular VOC on specific rivers will greatly influence a sampling program.

Development and testing of a model for loss of VOC from the river were the major results from our research. The major objective of this work was the presentation of this model in a form that chemists, engineers, laboratory managers, environmentalists, industrial personnel and others could conveniently use. With such a model, decisions on the best placement of sampling sites can be made. For example, in figure 4, collection of samples at points A, C and F would provide little detail on the decay process. However, collection of samples at A, between A and B; at B; and between B and C, would provide a more complete characterization of the environmental effect of the discharge on concentrations. The implications of our research are obvious for cities that are downstream from industrial or domestic discharges and in which the rivers are used as a source of raw water for human consumption. Although photolysis,

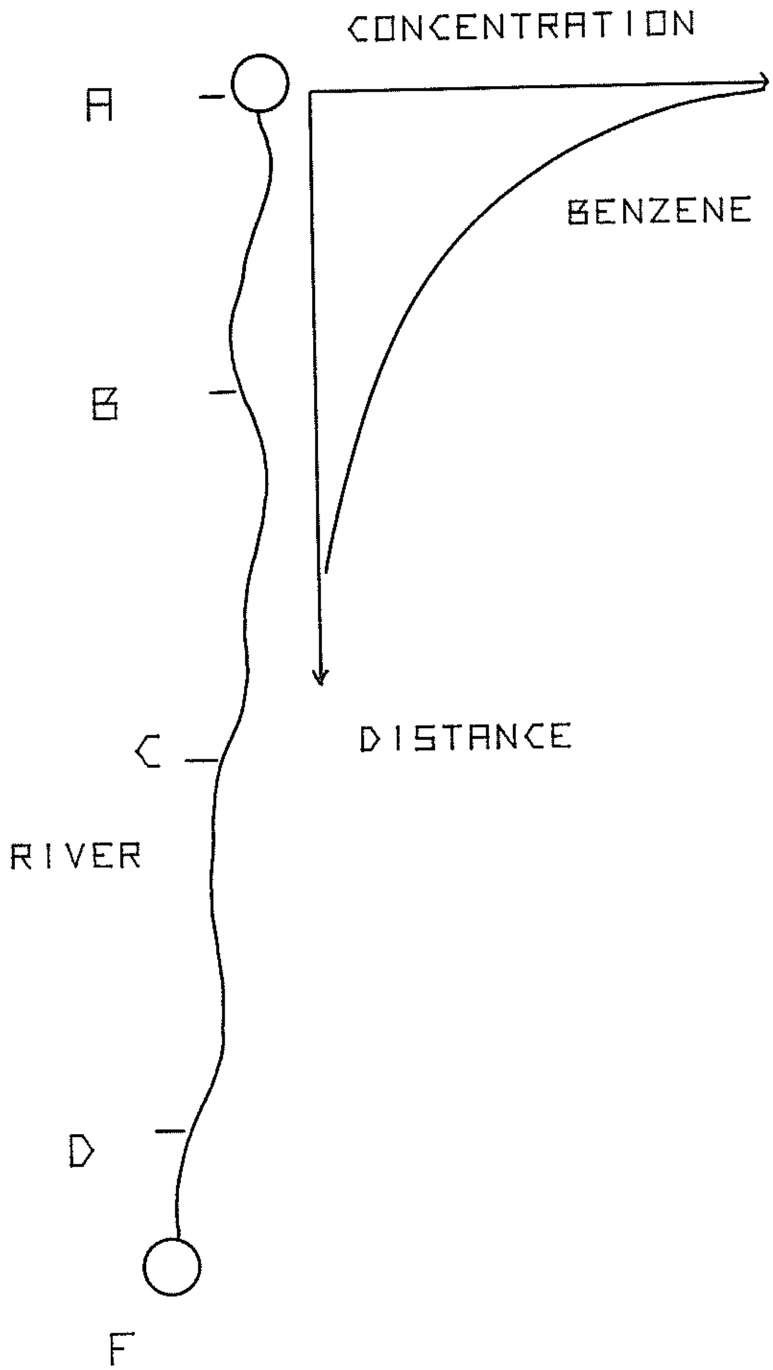

Fig. 4. Illustration of River Section with Behavior of Benzene River Water Concentration Plotted Relative to River Length

biodegradation and adsorption on sediment are other mechanisms for VOC loss, volatilization may be expected to be kinetically preferred for between one to seven days.

Volatilization from Water

In the last two years, NMSU has prepared a detailed description of volatilization of VOC from rivers. Only a summary will be presented here to emphasize major concepts and key ideas for practical use of the equations. Total movement of mass of a VOC from water to air (i.e., volatilization) is given in equation 1, where F is mass flux, K_L is liquid film diffusion coefficient, C_L is concentration of VOC in liquid, C_g is concentration of VOC in gas (atmosphere), T is temperature in °K, R is the universal gas constant, and H is Henry's Law constant.

$$F = K_L(C_L - C_g RT/H) \tag{1}$$

The diffusion coefficient for a VOC across a film is related to both the diffusion coefficient of the respective VOC in solution (D_L) and the thickness of the film (δ), as opposed to the bulk of the phase as in equation 2.

$$K_L = D_L/\delta \tag{2}$$

The problem with direct application of this model to environmental systems is the tremendous uncertainty in knowing the film thickness. Film thickness is a function of river conditions. However prediction of D_L for a wide range of VOC is possible using the Wilke-Chang relationship. Almost all research on river and lake modeling has been directed toward evaluation of the film thickness. Moreover, by determining a tracer compound-to-VOC ratio, the effect of film thickness can be removed as in equation 3, where η represents a measure of river turbulence.

$$\frac{K_L}{K_L°} = \frac{D_L}{D_L°} \times \frac{\delta_L°}{\delta_L} = \left(\frac{D_L}{D_L°}\right)^{\eta} \tag{3}$$

Choice of a tracer to use in a stream has been a difficult issue. Contaminants actually have been added to rivers as tracers. This was the only acceptable approach until the completion of our work. Oxygen might be expected to be a poor choice for a tracer because of its high biological and chemical reactivity. However, reaeration models based on hydrologic data can be used for any river for which such information is available. In contrast, characterization of the film thickness through addition of impurities to rivers is an untenable approach for wide-scale, practical application of models. The decrease of concentration of VOC in a river, if longitudinal diffusion is not important, is shown in equation 4.

$$C_L/C_L^{i} = \exp\left(-K_2 t (K_L/K_L°)\right) \tag{4}$$

Where C_L is concentration of VOC in river as the discharge moves downstream, C_L^{i} is initial river concentration of specific VOC, t is time, $K_2 = K_L° /L$ (average depth) K_L and $K_L°$ are shown in equations 5 and 6.

$$K_L = K_L°(V_b°/V_b)^{0.06\eta} \tag{5}$$

$$K_L° = 5.015\ V^{0.969}/L^{0.673} \tag{6}$$

Equation 5 is derived from equation 3 and the Wilke-Chang relationship. Equation 6 comes from one of many laboratory studies of oxygen reaeration completed during the 1960s. Thus, by using hydrologic properties alone, a model for rivers with different properties can be calculated. If this model can be validated on large-scale systems, including rivers, a simple, practical model would then be available to help solve problems illustrated through figure 4.

APPLICATION

The application and results of our model, which has been shown to be valid within 10 percent on very large-scale studies at NMSU, can be seen in figures 5 and 6. The figures clearly show the need and usefulness of these studies. They show the decay in concentration of VOC in two rivers of widely different character. The Rio Grande (figure 5) is a shallow, broad river that drops rapidly in elevation while the Tennessee River is a deep, slow-moving river which drops slightly in elevation. In addition, decay curves are shown for VOC of two extremes, methylene chloride (very volatile) and dichlorobenzene (less volatile). The behavior of all other VOC falls between these two extremes. Comparison of plots in these two figures shows two major trends:

1. Although large variations in molecular structure exist between methylene chloride and dichlorobenzene, the significance of these differences is not large in the river.

2. Differences in stream or river characteristics lead to major differences in rates of removal through volatilization. For example, in the Tennessee River, 90 percent removal occurs only after 20 to 30 days and 30 to 430 km, while similar removal in the Rio Grande occurs within 1 to 1.4 days and in only 37 to 50 km.

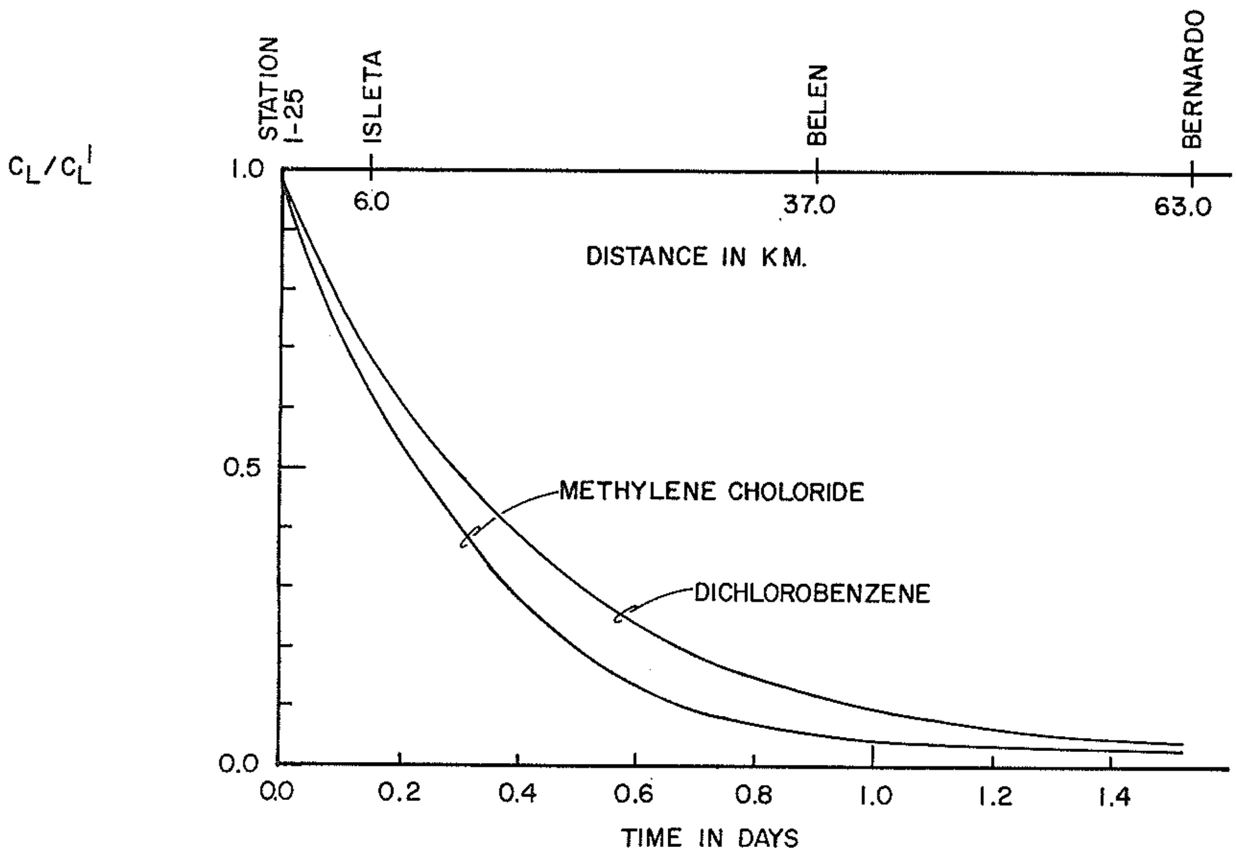

Fig. 5. Volatilization of VOC in the Rio Grande

Application of this model on the entire course of the Tennessee River would have substantial errors quantitatively because dispersion may be expected to become a major factor as the length of time a VOC is in the river is increased. Other mechanisms of removal previously mentioned (and ignored in our model) may become more significant with longer residence time of VOC in rivers.

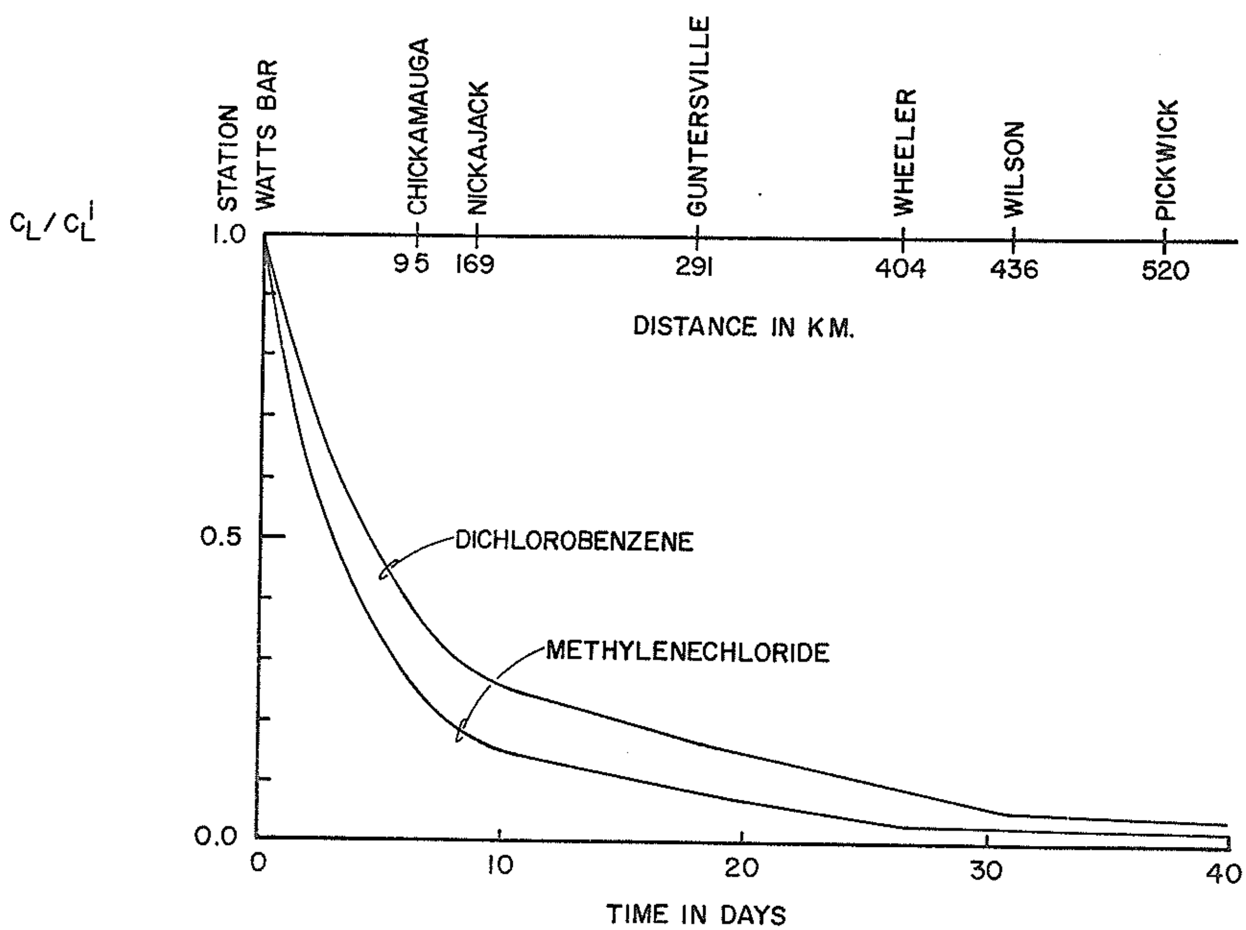

Fig. 6. Volatilization of VOC in the Tennessee River

Nevertheless, this model has been developed to aid decisions on where to sample a river. It may be used to provide a theoretical basis for choosing sites for sampling on various rivers. Field testing of the model is in progress to make fine adjustments, but our major problem here is that New Mexico rivers do not contain sufficient industrial VOC pollutants for confident modeling. Use of other river systems is planned in states with more industry.

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RAINFALL SIMULATORS AND SEDIMENT YIELD ESTIMATES

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INTRODUCTION

New Mexico has a unique climate that lends itself to producing an environment in which soil erosion and sediment yield can be quite pronounced. Most of the state has a semi-arid or arid climate with a distinct summertime rainy period. This creates two problems. First, rainfall is not of sufficient quantity or distribution to promote extensive growth of erosion-preventive plant cover. Second, when rainfall does occur, it is usually of high intensity and short duration. This leads to high energy inputs via the falling raindrops and the resultant water runoff. The runoff water carries the eroded soil into small channels and eventually into the major rivers in the state. Examples of the magnitude of this problem are the measured loads of sediment being carried in the channels of the Rio Grande system. Near the Colorado-New Mexico state line, the highest measured load of suspended sediment carried in the river for 1981 was 54 tons of sediment per day. Three hundred miles downstream, at San Marcial, the highest measured load was more than 62,000 tons per day. Much of this sediment can be attributed to the major ephemeral tributaries to the Rio Grande, predominately the Rio Puerco and the Rio Salado. Measured maximum sediment loads in these tributaries were 241,000 and 31,100 tons per day respectively, for 1981.

Such large amounts of sediment (which also occur in other streams) have negative impacts on water quality, wildlife habitat, flood control and channel maintenance.

One way to decrease these impacts is to reduce the amount of sediment in the water through proper watershed management on the tributary streams. This requires a basic knowledge of the important natural processes that control erosion and transport of the sediment in the water. One method of studying these processes is to demarcate some experimental areas, install the appropriate measuring devices--then wait for rain. In this climate that is impractical because of time and personnel constraints. Instead, it is more cost and time effective to simulate the rain.

RAINFALL SIMULATION

Rainfall simulation has been used in some form or another for more than 30 years. In simulation, water is sprayed through nozzles (one method) or dripped through small capillary tubes (the other method) onto a target area or plot. Plot sizes range from a fraction of a square meter up to a few hundred square meters. Simulators are used for infiltration studies, erosion studies or, as is most often the case, a combination of erosion and infiltration studies. Water is applied to the plots at (typically) a fixed rate and the resultant runoff is collected or measured with some selected device. For small plots, all of the runoff can be collected in a tank, whereas for larger plots it is usually measured with a flume and discharged to another place away from the plot. Sediment samples can be collected from the entire volume in the tank or they can be collected periodically from the outflow of the larger plots. These measurements and samples are then analyzed along with plot characteristics such as soil type, vegetation cover and land slope to define and quantify the processes involved. Another important aspect of simulation is the opportunity for the researchers to view the controlling processes, such as runoff, as they happen instead of after the fact, as is usually the case in other long-term experiments not using simulation.

Rainfall simulators have advantages and disadvantages. On the negative side:

1. Some simulators do not accurately reproduce important natural rainfall characteristics such as drop size distribution, fall velocity or temporal variability.

2. Simulators are limited to relatively small plots which may not incorporate sufficient variation of certain characteristics such as vegetation to be representative of the entire watershed.

3. Rainfall simulators are expensive to construct and they are labor-intensive when in operation.

On the positive side:

1. Simulators can be built and modified to reproduce drop sizes, fall velocities and temporal distributions equivalent to natural rainfall. The positive aspects also have their drawbacks. Simulators may add more variability to the experiment than would be desirable. In any case, a key element is to generate rainfall energies which are similar to natural rain. There are techniques available for analyzing simulator data from low energy applications.

2. Cost-per-unit of data collected is relatively low compared to long-term experiments. Although per-unit costs are low, long-term experiments require initial equipment installation and periodic maintenance and replacement during the study duration. This necessitates a long-term commitment of personnel and research emphasis. With simulators, concepts can be relatively rapidly tested and either verified or modified depending on the experiments.

3. Simulators allow researchers an extreme amount of control over time of operation, choice of rainfall conditions and plot characteristics. With small plots, simulators permit collection of numerous samples thus generating a large quantity of data amenable for statistical analyses.

Rainfall simulators will continue to be used to collect data throughout the United States and the rest of the world. However, it must be cautioned that rainfall simulation is only one type of investigation technique available to the research hydrologist. Improvements to simulators are needed and will continue to occur. Only by using simulators with other long-term experiments can we make full use of both techniques. (More information on rainfall simulators can be found in the excellent publication "Proceedings of the Rainfall Simulator Workshop", U.S. Department of Agriculture-Science and Education Administration, Agricultural Review Manual, ARM-W-10/July 1979.)

APPLICATIONS OF SIMULATORS

Simulators can and have been used in many different environments. I have been associated with several studies through field experiments or data analyses and will briefly describe them here.

Mine Haul Roads

Researchers with the U.S. Forest Service and Montana State University used a large area simulator to determine the quantity and quality of rainfall-runoff from mine haul roads. The roads were located in Montana and Idaho and were primarily associated with coal mining. Ed Burroughs, Jr. and Eric Sundberg of the U.S. Forest Service were leaders in this study and they continue to do simulator work on forest roads in Idaho.

Forest Roads in California

Colorado State University, under contract to the U.S. Forest Service in San Francisco, California, conducted experiments on forest roads in the Klamath and in the Sierra Nevada mountains. Results of that study were used to develop a sediment yield model for the foresters.

New Mexico Rangelands

An interdisciplinary project among George Sabol, civil engineering; M. Karl Wood, animal and range sciences; and John Fowler, agricultural economics; all of New Mexico State University, focused on best rangeland management practices. Data were collected from 25 soil-vegetation-land use complexes at four areas (Fort Stanton, Tucumcari, Cuba and Magdalena) in the state using a small simulator. These data were used along with knowledge of range practices to reduce erosion and sediment yield.

Termite Effects

Ned Z. Elkins, now with Sunbelt Mining Co., used the small plot simulator from the rangeland study to collect data from termite infested and termite devoid desert soils. His results show that runoff is doubled and sediment yield quadrupled from sites where termites have been eliminated. This should be a warning for indiscriminate spraying.

Albuquerque Urban Studies

George Sabol and Larry Coons, who is now with Geohydrology Associates, Inc., developed a trailer-mounted, small-plot simulator well suited to New Mexico conditions of high intensity rainstorms and long distances between water sources. This simulator was first used in the Albuquerque area to collect data from undeveloped and urbanizing sites. Results were used to demonstrate problems that might occur in currently used rainfall-runoff estimation techniques.

New Mexico Forest Roads

Using the small plot simulator developed for the Albuquerque study, I collected data from roads in four national forests in New Mexico. This ongoing study, sponsored by the U.S. Environmental Protection Agency, the New Mexico Forestry Division, and the New Mexico Water Resources Research Institute (WRRI), is aimed toward providing an approach to best management selection for reducing erosion on forest roads.

Pilot Study in Forested Watersheds

This ongoing study with the U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, and the WRRI involves a large (370 square meters) area simulator. The concept here is to use rainfall simulation to help understand through observation and data collection, the important controlling processes in the forest environment. During the summer of 1983, simulations will be made on volcanic soils in the pine forests near Flagstaff, Arizona. With this project, it is hoped that a better understanding of runoff processes can be gained in a relatively short time and then meshed with the long-term (20 years plus) studies conducted in the same area.

CONCLUSIONS

Rainfall simulators are here to stay. They are important devices available to the quantitative hydrologist for understanding runoff and erosion processes. They are not the only techniques however, and must be meshed with our past knowledge so that data are properly interpreted. Ongoing improvements in simulator design, better techniques for data analyses and a growing recognition that we cannot wait 20 years to develop data bases, foretells a strong future for use of rainfall simulation. Through rainfall simulation, we will be better prepared to understand and control soil erosion and sediment yield problems in the Southwest.

REMOVING URANIUM FROM DRINKING WATER SUPPLIES: DEMONSTRATION OF SELECTED ION EXCHANGE AND CHEMICAL CLARIFICATION

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INTRODUCTION

The Interim Primary Drinking Water Regulations for radionuclides issued in 1976 did not set a maximum contaminant level for uranium (1). New Mexico water supply regulations do not set a limit for uranium. Table 1 cites the specific regulation (2). A limit for uranium is specified in New Mexico Water Quality Control Commission Regulations (3). Table 1 includes that limit.

TABLE 1
New Mexico Uranium Standards

Water Supply Regulation 206
Maximum contaminant levels for radium-226, radium-228 and gross alpha particle radioactivity
A. Combined radium-226 and radium-228: 5pCi/l
B. Gross alpha particle activity (including radium-226 but excluding radon and uranium): 15pCi/l
Water Quality Control Commission Regulation 3-103
A. Human Health Standards Uranium: 5.0mg/l

The proposed standard for uranium has been suggested as 10pCi/l (equivalent to 14.7 μg/l). Before establishing this standard, the U.S. Environmental Protection Agency (EPA) must demonstrate available economical control technology for achieving, in routine municipal and domestic water treating operations, this level of uranium.

After identifying possible control technologies and performing preliminary screening experiments, the EPA moved to demonstrate field (pilot-scale) technology. The Engineering Research Center at New Mexico State University (NMSU) was contracted to demonstrate ion exchange and chemical clarification technology.

URANIUM IN DRINKING WATER SUPPLIES

The chemistry of uranium ions in an aqueous solution can be summarized as stated by Cotton and Wilkinson (4):

> Uranium ions in aqueous solution can give very complex species because, in addition to the four oxidation states, complexing reactions with all ions other than ClO_4^- as well as hydrolytic reactions leading to polymeric ions occur under appropriate conditions.

Table 2 lists the simple ions and their properties plus the pH dependency of the uranyl complex ions in the presence of carbonate.

Aqueous solutions of uranium salts have an acid reaction due to hydrolysis, which increases in the order $U^{3+} < UO_2^{2+} < U^{4+}$. The uranyl and U^{4+} solutions are well studied. The main hydrolyzed species of UO_2^{2+} at 25° are UO_2OH^+, $(UO_2)_2(OH)_2^{2+}$ and $(UO_2)_3(OH)_5^+$, but the system is a complex one and the species present depend on the medium. At higher temperatures, the monomer is most stable but the rate of hydrolysis to UO_3 of course increases. The solubility of large amounts of UO_3 in UO_2^{2+} solutions is also attributable to formation of UO_2OH^+ and polymerized hydroxo bridged species. Knowing the uranium ion species actually present is im-

TABLE 2
Uranium Ions in Aqueous Solutions (4)

ION	COLOR	PREPARATION	STABILITY
U^{3+}	Red-Brown	Na or Zn/Hg on UO_2^{2+}	Slowly oxidized by H_2O, rapidly by air to U^{4+}
U^{4+}	Green	Air or O_2 on U^{3+}	Stable; slowly oxidized by air to UO_2^{2+}
UO_2^{+}	?	Transient Species	Stability greatest at pH 2-4; disproportionate to U^{4+} and UO_2
UO_2^{2+}	Yellow	Oxidized U^{4+} with HNO_3, etc.	Very stable; difficult to reduce

In the Presence of Carbonate

pH	4	6	9	10
Uranyl Species	UO_2^{2+}	$UO_2CO_3^0$	$UO_2(CO_3)_2^{2-}$	$(UO_2)_3(OH)_5^+$

portant for successful operation of both chemical clarification and ion exchange.

As mentioned, all of the common anions anticipated in drinking water supplies will complex with the uranyl species. In the pH range of most drinking water supplies, the complexed uranyl species will be an anion. Some complexes, specifically the phosphate complexes, can be either positive or negative depending on concentration. Finally, silica readily adsorbs UO_2^{2+} and U^{4+} at low pHs (5).

The New Mexico Environmental Improvement Division assisted in identifying sources of drinking water containing uranium. Table 3 is a listing of supplies serving 1,000 persons or more which contain uranium (6).

TABLE 3
New Mexico Water Supplies Containing Uranium

SOURCE	URANIUM LEVEL (pCi/l)
Composite	11.2 ± 0.8
Well	16.1
Well	18.9
Well	24.5 ± 2.5
Well	28.0 ± 2.8
Well	1,110. ± 6
Well	23. ± 2
Composite	12.0 ± 1.0
Well	12.6 ± 1.3
Well	22.0 ± 1.0
Well	19.8 ± 1.0
Well	20.0 ± 1.0

While Kerr-McKee Corp. has consented to make one of their mine discharge waters or a process effluent stream available, the levels of uranium in those streams was a factor of 10 greater than anticipated in drinking water. Therefore, the well sampling at a level of 110 pCi/l was selected. This well is located on the NMSU campus and is currently out of service. Detailed analysis of this well water is given in table 4.

Chemical Clarification

Sorg and Logsdon have published a series of articles summarizing existing treatment technology to meet the National Interim Primary Drinking Water Regulations for inorganic solutes (7). Part 5 of their series covers barium and radionuclides. In their review, the radionuclides are treated as radium 226 and radium 228. Apparently, the available work on

TABLE 4
Project Test Well Analysis
(pumped four hours before sampling)

SPECIES	CONCENTRATION (mg/l)
Na^+	17.9
K^+	18.4
Ca^{2+}	375.2
Mg^{2+}	69.0
Cl^-	555.2
$CO_3{}^{2-}$	0
$HCO_3{}^-$	96.4
$SO_4{}^{2-}$	400.0
TDS	2,152
As	0.005
Ba	0.12
Cd	0.005
Cr	0.01
Pb	0.005
Hg	0.0004
Se	0.005
Ag	0.05
$NO_3{}^-N$	0.01
F	0.54
U	0.2 ± 0.1
Fe	1.69
Mn	0.95
Hardness (as $CACO_3$)	1,220
Alkalivity (as $CACO_3$)	79
pH	7.62
E.C.	2.36

uranium removal from drinking waters is the unpublished work of Oak Ridge National Laboratory (8). The Oak Ridge work examined lime softening and coagulation using ferric sulfate and aluminum sulfate with several types of flocculating agents.

In general, chemical clarification is made up of three operations: (1) coagulation; (2) flocculation; and (3) solid-liquid separation, i.e., sedimentation, flotation and/or filtration. The literature does not make a clear distinction between these operations and in some work "coagulation" and "flocculation" are used interchangeably. The description of the process becomes less clear when chemical reactions occur and filtration is substituted for sedimentation. In this project, chemical clarification means the addition of coagulants, flocculants or oxidants which remove the uranium ion through its precipitation or through its adsorption on other precipitated material.

The primary coagulants used in wastewater treatment are: (1) lime; (2) alum; and (3) iron salts, e.g., ferric chloride, ferric sulfate and ferrous sulfate. The materials were tested by Oak Ridge National Laboratory. Typical results of their study are summarized in table 5.

TABLE 5
Chemical Clarification for Uranium Removal (8)

A. LIME SOFTENING	DOSE mg/l	FINAL pH	% URANIUM REMOVED
$CaCO_3$	50	11.5	86
	250	11.5	90
$CaCO_3 + MgCO_3$	50 + 120	11.2	15
	250 + 120	11.2	99
B. COAGULATION			
$Fe_2(SO_4)_3$	25	4	20
	25	6	85
	25	8	45
	25	10	85
$Al_2(SO_4)_3$	25	4	20
	25	6	85
	25	8	50
	10	10	99+
	25	10	99+

While the mechanism of uranium removal via chemical clarification has not been proven conclusively, it most likely occurs through the adsorption of the uranyl ion complex by the coagulant precipitate. Subsequent solid-liquid separation removes the uranium. If filtration is used on granular media or precoal-mechanical filtration, adsorption of the uranyl complex on the filter media might also occur.

Conventional water treating systems which use chemical clarification use either rapid-mix basins, flash-mix basins or in-line mixers. Sedimentation basins are most frequently applied for solid-liquid separation. This project is using a laboratory scale flotation cell as a mixer followed by either rotary vacuum filtration or gravity-bed filtration. The preliminary work showed that the particulate size required solid-liquid sedimentation instead of normal sedimentation.

Filtration is the key process in production of high quality effluents from water treating (wastewaters [9]). The major difference in the operation of the two types of filtration is that the mechanical-straining (rotary vacuum) type filter produces a product cake having 5-8 percent water and the gravity-bed filter produces a slurry (as a result of backwashing to regenerate the bed). Scale-of-operation and cost will be major considerations although ultimate product disposal is a question when separating radioactive nuclides.

Ion Exchange

Ion exchange is a separation process in which ions held by electrostatic forces to charged functional groups on the surface of an insoluble solid are replaced by ions of like charge in solution. Unlike simple physical adsorption phenomena, ion exchange is a stoichiometric process in which every ion removed from solution is replaced by an electrical equivalent amount of another ionic species of the same sign from the solid. Ion exchange is, in general, a reversible process and is selective in the removal of dissolved ionic species. Although many naturally occurring materials exhibit ion exchange properties, synthetic ion exchange resins having a wide range of properties for specific applications have been developed (10).

The characteristic properties of ion exchange materials are due primarily to their structure. These materials consist of a solid matrix held together by chemical bonds. Attached to this framework are soluble ionic functional groups containing ions which are relatively free to move and must possess the following characteristics:

1. Ion-active sites throughout the entire structure, e.g., very uniform distribution of activity
2. High total capacity, that is, a high degree of ion substitution or low equivalent weight
3. Good degree of selectivity for ionic species but capable of being regenerated
4. Extremely low solubility
5. Good structural chemical stability
6. Good structural physical stability
7. Costs competitive with other processes

Ion exchangers are classified by the type of ionic functional group attached to the structure and the charge sign of the exchanging ion. Five major classes of ion exchange resins, categorized according to functional group, are: (1) strongly acidic cationic, (2) weakly acidic cationic, (3) strongly basic anionic, (4) weakly basic anionic, and (5) a broad miscellaneous category of ion-specific structures.

Strong base anion resins have been identified for removing the uranyl complex ion.

Normal ion exchange is operated in a column system as shown in figure 1. There are four distinct steps to one cycle of operation: (1) service period, (2) backwash, (3) regenerate, and (4) rinse.

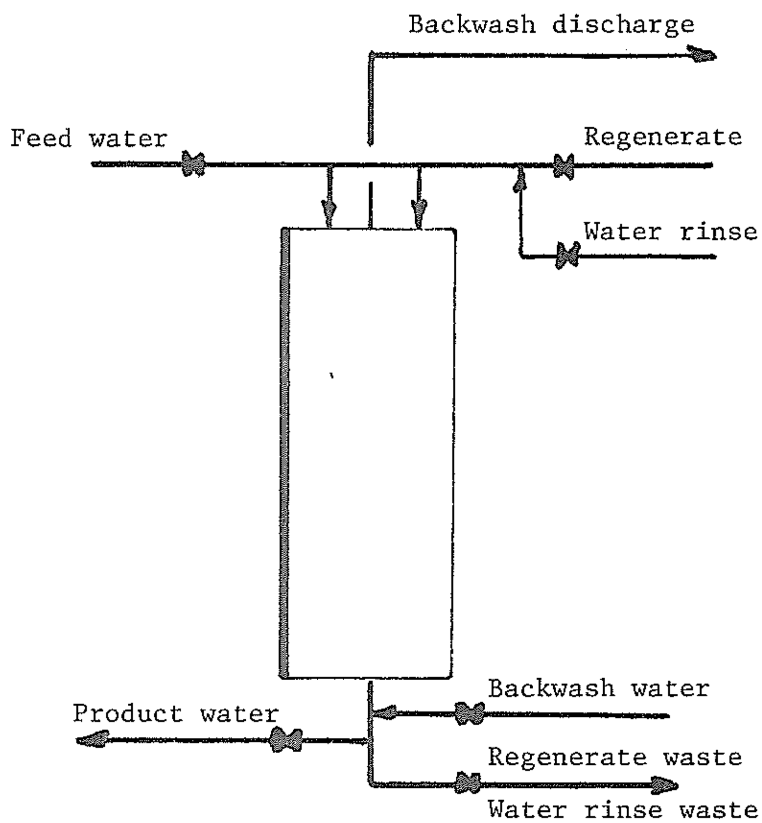

Fig. 1. Typical Single Column Ion Exchanger Flow Diagram

The primary operating parameters in ion exchange units are shown in figure 2, e.g., the exchange zone and breakthrough. These parameters provide the necessary operation period before regeneration. The third operating parameter can only be obtained on pilot-scale experiments using the actual water supply and this is the number of generation/regeneration cycles a given charge of ion exchange resin can undergo. Bottle tests can give some indication of the percentage regeneration (aging) of the resin but are not conclusive.

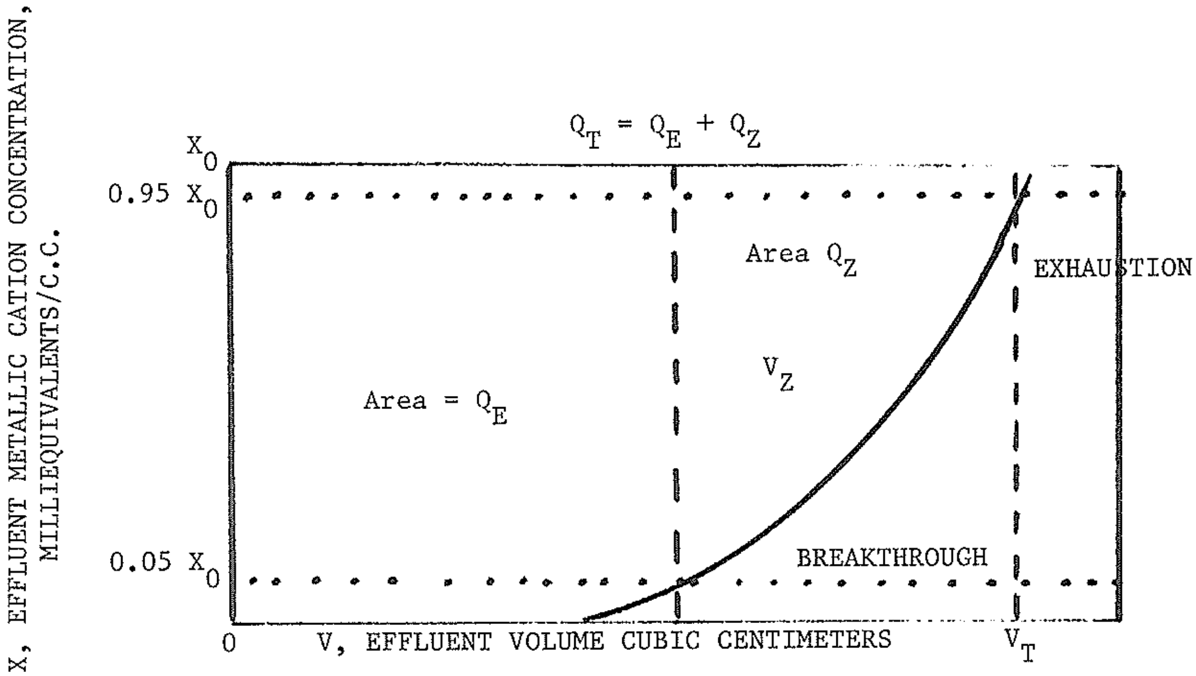

Fig. 2. Ion Exchange Column Operation

Ion exchange has been used as a standard unit operation for the commercial recovery of uranium for many years (11). Recent work by McClanahan (12) used ion exchange for treating uranium mine discharge water. Oak Ridge National Laboratories performed bench scale tests on a synthetic water containing uranium. This work was extended to column tests by the Drinking Water Group of the EPA (8). Table 6 summarizes the results of these tests.

TABLE 6
Ion Exchange Tests

ION EXCHANGE MATERIAL	% URANIUM REMOVAL	COMMENT	REF.
DOWEX SPR	99+	Mine Water	8
DOWEX 50W-X8	35.	Mine Water	8
Clinoptilolite	20.	Mine Water	8
DOWEX 21K	97.	Mine Water	8
DOWEX 1-X2	99+ (Max.)	Parameter Dependent	8
DOWEX SPRB	99	Column Test	8
IONAC A-641	99+	Column Test	8

The project system consists of four 2-cubic feet beds of synthetic resin, i.e., DOWEX SBR, DOWEX 21K and IONAC A-641 (two beds). One IONAC A-641 resin bed will be operated in an upflow mode. Pretreatment for solid filtration and possible iron/manganese control are included. Automatic regeneration using NaCl is included. Previous work indicates 2,000-5,000 bed-volumes of water can be treated before regeneration. Regeneration produces 40-50 bed-volumes of effluent.

PROJECT OPERATION

This project is being conducted with the active participation of personnel from the Water Utility Operation Program located at the Dona Ana Branch of NMSU. Steve Hanson, an instructor, has supervised the construction of the ion exchange system and will supervise its operation by students from the Water Utility program. Doug Roby, an assistant professor in that program, is supervising and monitoring the analytical analysis (chemistry) of the operation.

Graduate students in chemical engineering and civil engineering are assembling the necessary equipment for the chemical clarification evaluation experiments. Suitable Master of Science thesis topics have been identified and their work is progressing.

The project equipment (ion exchange) is on location and operation is commencing. Figure 3 is the project van (used previously for a water treating project under WRRI sponsorship [13]).

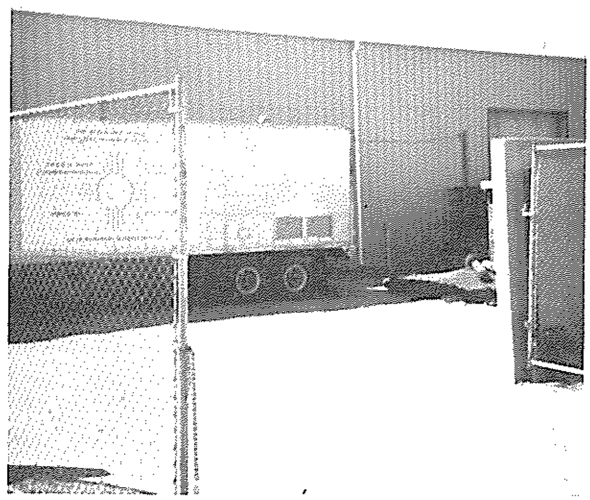

Fig. 3. Project Van. Graduate students in chemical engineering are assembling the necessary equipment for the chemical clarification evaluation experiments. Suitable Master of Science thesis topics have been identified and their work is progressing. The project equipment (ion exchange) is on location and operation in commencing. Figure 3 is the project van (used previously for a water treating project under WRRI and OWRT sponsorship [13]).

The project location is well no. 8 adjacent to the NMSU Physical Plant building. Figure 4 is an interior picture of the ion exchange system

The project covers an 18-month period which began November 1982.

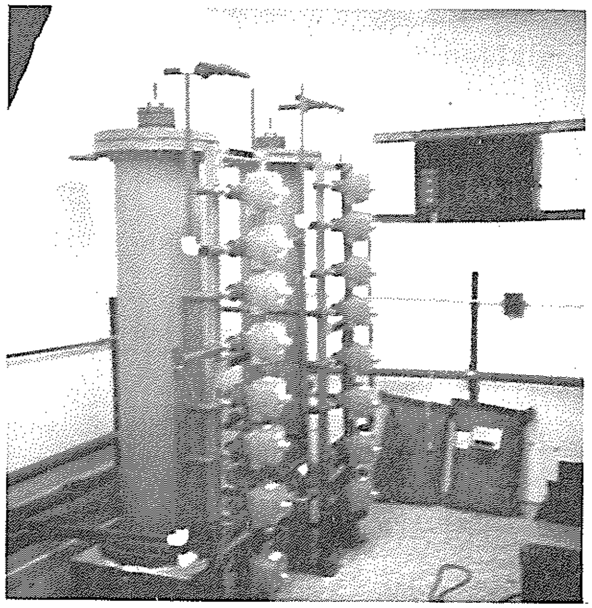

Fig. 4. Ion Exchange System. Project duration is scheduled for 18 months from November 1982. The project location is Well #8 adjacent to the New Mexico State Physical Plant building. Figure 4 is an interior picture of the ion exchange system.

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WATER-QUALITY RESEARCH IN THE WATER RESOURCES DIVISION OF THE UNITED STATES GEOLOGICAL SURVEY

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Abstract

The Water Resources Division (WRD) of the U.S. Geological Survey has maintained a nationwide research program since the late 1950s. Presently, research personnel are located in Reston, Virginia; Bay St. Louis, Mississippi; Denver, Colorado; Menlo Park, California; and Seattle, Washington. About 500 scientists and support personnel conduct water-related research in the six broad disciplines of ground water, surface water, geomorphology and sediment transport, ecology, geochemistry and water chemistry. The last four of these disciplines are concerned with water quality and a discussion of their major activities follows.

Geomorphology and sediment transport presently are concerned with bedload transport, river-meandering phenomena and river-channel change due to the alteration of the watershed and those fluvial processes that maintain the aquatic habitat.

Ecological research primarily is concerned with determining bacterial mediation of chemical processes in ground water, toxicity of heavy metals, and nutrient budgets in lakes. The WRD research program also has research underway at six lakes located throughout the United States. The goal of this research is to understand hydrologic process associated with lakes and nutrient sources in several climatic and geologic areas in the United States.

Geochemical study sites are located throughout the nation with emphasis on brines, redox potential, changes in the chemical quality of ground water after strip mining, and modeling chemical-quality changes.

Emphasis in water chemistry principally is directed toward natural organic material in water and acid rain. This is a shift from past years when emphasis was placed on man-made organic compounds, particularly pesticides. In recent years, significant progress has been made in the determination of specific organic compounds that constitute the dissolved and particular organic carbon in water. It is expected that during the decade of the 1980s, a greater understanding of organic constituents in water will be one of the major breakthroughs in chemical hydrology. With this understanding will come greater insight into ecological systems and ecological modeling.

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