

ELEVENTH ANNUAL REPORT
NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

Fiscal Year July 1, 1974 - June 30, 1975

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J. W. Clark, Director

New Mexico
Water Resources Research Institute
Box 3167
New Mexico State University
Las Cruces, New Mexico 88003

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ELEVENTH ANNUAL REPORT
NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE
JULY 1974 - JUNE 1975

DIRECTOR'S REPORT

by

John W. Clark

Perhaps the greatest challenge facing New Mexico in the next decade is to provide an acceptable balance of economic and social well-being within a quality environment. We can only achieve this goal through adequate comprehensive planning. Such planning assumes a fundamental knowledge of the natural, physical and social sciences necessary to the political decision making process.

While science and technology are enlarging the range of possible alternatives in water management, momentous changes in society are creating new demands. The seriousness of this problem is noted by a recent study of the General Accounting Office which found that in every river basin studied, the quality of water has deteriorated in recent years. This situation is symptomatic of the fact that we have not achieved a sufficient understanding of the basic dimensions of the problem. Much has been accomplished; much more research is necessary.

Water is the most limiting resource in New Mexico and the water that we have is the State's greatest asset. Surface and subsurface water is used to supply growing municipal and industrial demands and to irrigate the land. According to the Senate Select Committee Report of 1961 and the Water Resources Council Report of 1968, a major part of the State is facing the most critical shortage of water in relation to projected demands of any other area of the Nation.

Because New Mexico is primarily a semi-arid region, those few perennial streams within the State have considerably more influence upon the lives and livelihood of the region's inhabitants than any other element of the physical environment. Therefore, any alteration, modification, or subtle change of this resource must be carefully evaluated.

Although a large amount of ground water underlies the State, much of it is either of poor quality or too expensive to develop at present. In the areas where the ground water is of satisfactory quality and can be economically obtained, development and use is underway. The demands on the supply exceeds recharge in many areas and ground water levels are receding.

The most pressing need for a significant portion of the State's population is for improved incomes and economic security. Chronic under-employment is endemic in parts of New Mexico. These factors, coupled with the growth orientation on the part of business and financial institutions, give rise to strong pressures for new industry and employment with minimal consideration for environmental amenities.

The environment versus economic-growth controversy in this region is more explosive in some ways than in other parts of the United States, for almost diametrically opposed in outlook to those looking for improved incomes is a class of people, including a substantial number of professionals and retirees, for whom this region is the last outpost of clear skies and open space; these people are ecologically aware, economically secure, and increasingly organized and vocal. Rural-oriented farming interests use similar ecology and social arguments against the shift from irrigated agriculture to residential use of valley lands.

Within this setting it is important that a plan be developed to determine how New Mexico's water supply needs might be met. These are the objectives of the State Water Plan investigation which is currently underway by the Bureau of Reclamation and the New Mexico Interstate Stream Commission in cooperation with other Federal and State agencies. The main thrust of the New Mexico Water Resources Research Institute is to contribute research information in support of this plan.

A principal project for this past year A-045-NMEX "Analysis of Alternative Water Use Futures for the Rio Grande Region in New Mexico" has been completed. This project involved a socio-economic model, developed to represent the New Mexico economy, with special emphasis on the Rio Grande region.

One of the key elements of this study was the use of a technical advisory committee composed of representatives from local, state, and federal agencies. As data became available it was passed to members of the technical advisory committee. Much of the information developed on the project was used before publication.

Another principal project, B-015-NMEX "Irrigability Classification of New Mexico Lands as a Guide for Water Importation" was completed in 1974. This project answered the question, how much water could New Mexico use for irrigation if it were available. A separate report was developed for each of the state's 32 counties classifying the lands. Results of this work are being used directly by the U.S. Bureau of Reclamation in the State Water Plan. In addition the Bureau of Land Management, State Land Office, State Highway Department, Environmental Improvement Agency, Planners, and many others have requested and are regularly using the information contained in these reports.

The Institute Director has exerted a considerable effort in support of the Rio Grande Region Environmental Project (RGREP). This study is to provide the basic data and information on which to base a regional management plan that will include appropriate implementation procedures. The region under consideration is the lands along both sides of the 285 river-miles of the Rio Grande from Elephant Butte Reservoir, New Mexico, where the surface water supply for the region is stored, downstream to Fort Quitman, Texas, where the last of this water is used. The river forms the boundary between the United States of America and Mexico for 31 miles in the proposed project area and includes lands in two American states and one in Mexico. The problem is not merely one of drafting an apparently workable management plan, but is the considerably more difficult problem of developing the background information and theory on which the plan is to be based.

The New Mexico Water Resources Research Institute hosted several water related meetings involving state and federal agencies and other organizations, and participated in public meetings and hearings.

BACKGROUND OF THE INSTITUTE

The New Mexico State University Water Resources Research Institute was officially organized and approved by the New Mexico State University Board of Regents in February 1963. The Institute Office was opened on March 15, 1965 in the Agriculture Building on New Mexico State University campus.

The Water Resources Research Act, P.L. 88-379, approved by the President July 17, 1964, became effective for the first 14 institutes with \$75,000 allotted to each for FY-1965 effective as of February 1, 1965. The allotment to each of the 51 state institutes, or centers, for FY-1966 was \$87,500 and a similar amount to each institute for FY-1967. The FY-1968 allotment to each state was \$100,000.

New Mexico State University application for designation as the Institute University was among the first applications sent to Washington, D. C. for approval, being filed September 18, 1964 and resubmitted November 25, 1964. Included in the application was a letter dated September 3, 1964 from the Governor to the Secretary of the Interior, designating New Mexico State University as the location for the New Mexico Water Resources Research Institute.

New Mexico Water Resources Research Institute was the first institute to be officially designated among the 14 institutes authorized as of February 1, 1965 to operate under provisions of Section 100 of the Act. The remaining 37 state institutes were approved for funding May 1, 1965.

The Institute is essentially a planning and coordinating activity for research and graduate training in the area of water resources representing all of the universities and colleges in the State of New Mexico. The objectives of the Institute may be stated as follows:

- (a) To plan and coordinate the water resources research and training activities involving faculty and facilities of the various colleges and universities in the state.
- (b) To arrange and conduct water resources research appropriate to the role and scope of the state's college universities for the benefit of the state and the nation including those sponsored by
 - (1) The Office of Water Research and Technology
 - (2) Other Federal agencies
 - (3) State agencies
 - (4) Quasi-public organizations
 - (5) Industry

- (c) To arrange for seminars and conferences involving persons having interest and responsibilities in water problems of the state.
- (d) To provide for publication and dissemination of the results of research conducted by the Institute and other information which bears upon the water resources of the state.

PROGRAM DEVELOPMENT AND REVIEW BOARD

This board originally was designated as the Executive Board. However, the new title, adopted in January 1967 more accurately describes its function. It recommends areas for research concentration, reviews and recommends the relative importance and quality of research proposals, reviews the technical procedures suggested, and recommends means by which certain phases of one project may be coordinated with work being done in other projects in the state. The Board also recommends the projects which qualify on a technical basis, and recommends the priority for project funding each year.

- | | |
|----------------------------|--|
| Dr. Allen V. Kneese | - Economics Department
University of New Mexico |
| Dr. Albert E. Utton | - Law School
University of New Mexico |
| Dr. Lynn Gelhar | - Geoscience Department
New Mexico Institute of Mining and Technology |
| Dr. Gerardo W. Gross | - Geoscience Department
New Mexico Institute of Mining and Technology |
| Dr. Alden A. Baltensperger | - Agronomy Department
New Mexico State University |
| Dr. Fredrick T. Downs | - Economics Department
New Mexico State University |
| Prof. John W. Clark | - Civil Engineer, Chairman and Director of
Institute, NMSU - Ex-officio |

The Board held two meetings during 1974-75 to consider research proposals and to discuss the total water resources research program. Also discussed were Operation and Publication objectives and procedures.

The procedure followed by the Board in reviewing project proposals is as follows:

1. All proposals are called and received by the Director's Office and copies are distributed to each member of the Review Board well in advance of scheduled meetings.
2. Each Principal Investigator is invited to appear before the Board to make a 10 minute statement on his proposal, with questions from the Board following his presentation. Usually one of these meetings is held at the University of New Mexico in Albuquerque, or New Mexico Institute of Mining and Technology, and the other at New Mexico State University, Las Cruces.
3. Following the hearings on all of the project extensions from the current year plus those proposed for the next fiscal year, the Board uses a rating process to select the order in which all worthy projects may be funded. Some projects usually receive outright rejections by the Board due to lack of water orientation or due to poor preparation and presentation.
4. From the group of projects recommended by the Board, the Director works up a schedule of funding which will fit within the money available. This procedure results in some quite acceptable projects not being accepted, due to lack of funds. Often there is considerable consultation between the Director and the Investigators and the Board members during the process of fitting projects into the limited budget.

INTERUNIVERSITY MEMORANDUM OF AGREEMENT

A memorandum of Agreement between the University of New Mexico, New Mexico Institute of Mining and Technology and New Mexico State University Water Resources Research Institute was entered into on the 8th day of July, 1966. The agreement forms a definite basis for accounting for the Federal and matching funds on the projects at the two institutions which have projects operating through the Water Resources Research Institute. The Agreement includes a copy of (1) Public Law 88-379, (2) Public Law 89-404 which Acts together established and funded the Water Resources Research Program, (3) Rules and Regulations pursuant to the Water Resources Research Act of 1964, (P.L. 88-379), (4) Policy Statement issued by the Office of Water Resources Research, and (5) a statement regarding Acknowledgement on Publications for use of Water Resources Research Act funds. A complete copy of the Agreement, including the several documents listed above, as signed by Presidents of each of the three universities involved was supplied to the Comptroller's Offices and the Office of Water Resources Research, and copies of the Agreement were made available to others as required in the project operations.

A supplement to the July 6, 1966 Agreement was signed effective July 1970 to provide for the administration and allocation of the State appropriations made by the 1970, 1971 and future Sessions of the New Mexico Legislature.

COOPERATION

Cooperation between Universities, State and Federal agencies, and others interested in water has been excellent. The use of a Technical Advisory Committee on a project by project basis has proved to be an effective mechanism for optimizing cooperation. The following Technical Advisory Committee on projects, has met on several occasions jointly with the three University study groups:

Mr. Robert F. Stephens	U.S. Bureau of Sport Fisheries and Wildlife
Mr. William E. Hale	U.S. Geological Survey
Mr. T. A. Garrity	U.S. Bureau of Indian Affairs
Mr. W. J. Anderson	U.S. Bureau of Land Management
Mr. James Kirby	U.S. Bureau of Reclamation
Mr. Rowland Fife	U.S. Bureau of Reclamation
Mr. Wayne Cunningham	Elephant Butte Irrigation District
Mr. Ralph Bell	U.S. Soil Conservation Service
Mr. Phil Mutz	New Mexico Interstate Stream Commission
Mr. Pete Metzner	Middle Rio Grande Council of Governments
Mr. Charles F. Youberg	Middle Rio Grande Council of Governments
Mr. Larry Bronaugh	U.S. Bureau of Indian Affairs
Mr. Mile Martinez	U.S. Bureau of Land Management
Mr. Edwin A. Lewis	U.S. Bureau of Reclamation
Mr. Robert Schembera	U.S. Bureau of Reclamation
Mr. Fred Allen	New Mexico State Engineer Office
Mr. Earl Sorensen	New Mexico State Engineer Office
Mr. Ed Gray	U.S. Soil Conservation Service
Mr. Clyde Wilson	U.S. Geological Survey

ANNUAL NEW MEXICO WATER CONFERENCE

The first Annual New Mexico Water Conference was held in 1956. Since then eighteen conferences have been held. The nineteenth was scheduled for April 4-5, 1974. This meeting was not held due to the energy crisis. A set of papers carrying out the proposed conference theme "Water in Food and Fiber Production" was distributed to all persons who attended the 1973 Water Conference.

The twentieth Annual New Mexico Water Conference was held on April 3-4, 1975. The theme of this conference was "Water for Energy Development." The keynote speaker, was George H. Davis of the U.S. Geological Survey.

Stephen E. Reynolds, State Engineer of New Mexico, was presented the Bureau of Reclamation's Citizen Award by the Commissioner of Reclamation Gilbert G. Stamm. "Mr. Reynolds has provided outstanding leadership and counsel in the support of sound water development projects throughout the State of New Mexico, and his efforts have greatly assisted in the progress of his State," said Stamm. "It is this dedication that prompted presentation of the Bureau's Citizen Award to Mr. Reynolds," the Commissioner added.

The award recognizes beneficial contributions provided by private and public citizens in the interest of achieving Bureau of Reclamation objectives and programs for water resource development.

The Annual Water Conference serves a public service by bringing together 200 to 300 leaders each year to discuss water resources which are important to New Mexico and the Nation.

The water conferences are contributing materially to the growth and development of the Water Resources Research Institute and the Institute can greatly assist the water conference. Both are needed in the overall water research and development program in the State of New Mexico.

The annual conference is planned and conducted by an interdisciplinary New Mexico State University Committee with the assistance of a statewide committee of 25 members serving as a Water Conference Advisory Committee. Much credit for the success of the conference goes to dedicated members of these two committees.

WATER CONFERENCE ADVISORY COMMITTEE

Willis H. Ellis
Prof. of Law
University of New Mexico
Albuquerque, New Mexico 87106

S. E. Reynolds, State Engineer
Bataan Memorial Bldg.
State Capitol
Santa Fe, New Mexico 87501

Rogers Aston
South Spring Foundation
P.O. Box 1090
Roswell, New Mexico 88201

Ms. Mally Ribe
League of Women Voters
1232 41st Street
Los Alamos, New Mexico 87544

Col. Robert G. MacLennan
District Engineer
Corps of Engineers - U.S. Army
Box 1580
Albuquerque, New Mexico 87106

Ralph Charles, Consultant
Middle Rio Grande Flood Control Assoc.
510 Second St. N.W., Room 215
Albuquerque, New Mexico 87101

H. E. Gary
Rt. 1, Box 23
Rincon, New Mexico 87940

Warren Weber, Area Planning Officer
Bureau of Reclamation, USDI
Albuquerque, New Mexico 87103

Wm. E. Hale, District Chief
Water Resources Division
U. S. Geological Survey
P.O. Box 4369
Albuquerque, New Mexico 87106

Arthur Zimmerman, Director
Bureau of Land Management
Santa Fe, New Mexico 87501

L. P. Reinig, Head
Engineering Department
Los Alamos Scientific Laboratories
P.O. Box 1663
Los Alamos, New Mexico 87544

Carrol Hunton, State Director
Farmers Home Administration
517 Gold Avenue S. W.
Albuquerque, New Mexico 87106

Lloyd A. Calhoun
New Mexico Electric Service Co.
P.O. Box 920
Hobbs, New Mexico 88240

Wm. D. Hurst, Regional Forester
Forest Service, USDA, Region 3
517 Gold Avenue
Albuquerque, New Mexico 87101

Peter Hanagan, Director
New Mexico Oil & Gas Association
P.O. Box 1864
Santa Fe, New Mexico 87501

Wayne P. Cunningham
Elephant Butte Irrigation District
Drawer A
Las Cruces, New Mexico 88001

Marion E. Strong
Soil Conservation Service, USDA
Box 2007
Albuquerque, New Mexico 87103

Dr. Thomas Gebhard, Jr.
Division of Utilities
City Hall
Las Cruces, New Mexico 88001

John W. Hawley
State Bureau of Mines
NMIMF
Socorro, New Mexico 87301

William J. Stone
State Bureau of Mines
NMIMF
Socorro, New Mexico 87801

Water Conference Advisory Committee (cont.)

Dr. James Kirby
Extension Economist
New Mexico State University
Las Cruces, New Mexico 88003

Dr. Boyce C. Williams
Agronomy - Soils
New Mexico State University
Las Cruces, New Mexico 88003

Dr. W. P. Stephens, Director
N. M. Department of Agri.
New Mexico State University
Las Cruces, New Mexico 88003

Prof. Jesse V. Lunsford
Civil Engineering Department
New Mexico State University
Las Cruces, New Mexico 88003

Ray Cauwet, News Editor
Information Services
New Mexico State University
Las Cruces, New Mexico 88003

Prof. Eldon G. Hanson, Head
Agricultural Engineering
New Mexico State University
Las Cruces, New Mexico 88003

Charles M. Hohn
Extension Services
New Mexico State University
Las Cruces, New Mexico 88003

Gene Ott
Farm and Business Management Specialist
Extension Services
New Mexico State University
Las Cruces, New Mexico 88003

Dr. Gary L. Cunningham
Biology Department
New Mexico State University
Las Cruces, New Mexico 88003

Dr. George R. Dawson
Agricultural Economics Department
New Mexico State University
Las Cruces, New Mexico 88003

Prof. John W. Clark, Director
Water Resources Research Institute
New Mexico State University
Las Cruces, New Mexico 88003

STATE'S CONTRIBUTION

Stucky Hall, a building to house the New Mexico Water Resources Research Institute, was completed in 1970. This building was built entirely with state bond money and is located on the New Mexico State University campus. The New Mexico Legislatures have appropriated the following amounts to the Institute for research support:

1970 -	\$104,000
1971 -	\$108,000
1972 -	\$113,000
1973 -	\$118,000
1974 -	\$126,000
1975 -	\$142,000

These funds are being used for matching funds and for state supported projects.

REGIONAL COOPERATION

The Institute is involved in two regional analysis of priority water resource problems: (1) Consortium of Water Institutes and Centers, Colorado River - Great Basin, including the states of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, and (2) Southern Plains River Basin Region, Colorado, Arkansas, New Mexico, Louisiana, Oklahoma, Kansas, and Texas.

A regional project "Regional Water Management with Full Consumptive Use" is being conducted in cooperation with Texas A & M University through the Annual Allotment program.

EXAMPLES OF RESEARCH FINDINGS AND THEIR APPLICATION TO WATER RESOURCE PROBLEMS

A-045-NMEX - Analysis of Alternative Water Use Futures for the Rio Grande Region in New Mexico.

This project was designed to test the effects of transfers of water, land, and recreation on the economy of the several segments of the 400 mile long Rio Grande Valley from Colorado to Texas through New Mexico.

A key element of this study has been the use of a technical advisory committee composed of representatives from local, state, and federal agencies. As data has become available it has been passed on to members

of the technical advisory committee. Through the advisory committee some preliminary results have been used as inputs into the New Mexico State Water Plan; the "Upper Rio Grande Basin Water and Related Land Resources" by the U. S. Department of Agriculture River Basin Planning Group in Albuquerque; the Middle Rio Grande Council of Governments in their inventory of resources; U.S. Geological Survey, in the ground water investigation of the Mesilla Valley; Bureau of Reclamation in constructing enterprise budgets for the Upper Rio Grande Basin in connection with the San Juan-Chama Diversion.

Lbs Alamos Laboratories used two of the technical completion reports, WRRRI Reports No. 21 and 22, to gain agricultural base line data for a preliminary impact statement.

B-046-NMEX - Regional Water Management with Full Consumptive Use.

This project is part of the RGREP study. "RGREP" is the acronym derived from the Rio Grande Regional Environmental Project. Many different state and federal agencies are participating in this study. The University portions of the project are being conducted through the Water Research Institutes of Texas and New Mexico.

The geographic area of study extends from the upper reaches of Elephant Butte Reservoir in New Mexico to Fort Quitman in Texas. The project extends some 258 river miles along the Rio Grande and encompasses parts of two states in the United States and part of the Republic of Mexico. While the study area crosses state and international boundaries it is one economic and hydrologic province, largely separated from other population centers by vast expanses of semi-arid deserts.

Results from this project to date are being utilized in the re-design and modernization of the Elephant Butte Irrigation District system in New Mexico and the Texas Water Improvement District in Texas. A new well field has been located for the future growth of Las Cruces and wells for the irrigation district have been located and drilled. Several small communities and unincorporated areas located in the study area have sufficient information to drill new wells or to improve existing ones.

A major result of the study has been the solidification of rural and city people in their efforts to understand and work together on their water resources.

C-4060-NMEX - Reduction of Peak Water Consumption in Urban Areas.

This study identified water application practices associated with residential landscapes. In addition it measured some elements of landscape design which were associated with the amount of water used to maintain the landscapes.

The results of this study are being used by the City of Las Cruces, New Mexico to reduce peak water demands. Regular radio programs are being conducted and articles of explanation are inserted in utility billings.

This study shows that psychological attitudes towards water use affect demand and that educational programs can change these attitudes and reduce demand.

3109-144 -- Calcium Carbonate Equilibria in Soils and Irrigation Water.

Irrigation water degradation is of the utmost interest to water and soil scientists throughout the world yet meaningful and accurate equations to describe the equilibria of one of the most important solid phases controlling water quality, calcium carbonate, are lacking. The objectives of this study were to develop a model capable of describing carbonate equilibria in aqueous systems open to the air, and to test the model against data for aqueous and soil-water systems.

A chemical model was developed that adequately described calcite equilibria over a range of ionic environments. The model includes equations to account for activity coefficient and ion-pair effects, and was verified utilizing data from the literature for aqueous systems open to the air.

Although the project was essentially a theoretical study of calcite equilibria in aqueous systems, the results have application to sanitary engineers, soil scientists, and geologists. Parts of the model developed in the study have already been used to explain the limiting value of hardness removal in water treatment procedures which up to now had been unexplainable. The model may also be used in computer simulation of solute movement studies through calcareous soils. Workers at the U.S. Salinity Laboratory have used certain portions of the model in a computer simulation of salt movement in soils. More work with these personnel to modify the model for use in soil systems is anticipated.

OMRT Project No. A-043-NMEX
 NMSU Project No. 3109-54
 Agreement No. 14-31-001-4011
 ICST COMRR Research Category: 3-F

Projecting Consumptive Use with
 Climatological Data

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July 1 ; Year: 1973 Proj. Completed Month: December ; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
F. J. Gregory	M.S.	Astronomy
E. C. Hanson	M.S.	Irrigation Engineering

<u>Student Assistants 1/ None</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
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A. Research Project Accomplishments

1. Consumptive use (evapo-transpiration) has been measured at the Plant
 Plant Science Research Center (Dona Ana County) and the San Juan Branch
 Experiment Station (San Juan County) with crops indicated using the
 neutron probe in field plots and in lysimeters.

Plant Science Research Center

<u>Crop</u>	<u>Year</u>	
Alfalfa	1963*	Field Plots
Alfalfa	1964*	" "
Corn (sweet)	1971*	" "
Corn (sweet)	1972*	" "

A. Continued

<u>Crop</u>	<u>Year</u>	<u>Field Plots</u>
Corn (sweet)	1973*	" "
Fall Onions	1971-72*	" "
Fall Onions	1972-73*	" "
Fall Onions	1973-74#	" "
Lettuce	1974	(Destroyed by storms)
Cotton	1973*	Field Plots
Alfalfa	1975#	" "
Potatoes	1975#	Lysimeters
Wheat	1975#	Lysimeters

San Juan Branch Experiment Station

<u>Crop</u>	<u>Year</u>	<u>Field Plots</u>
Corn	1973**	Field Plots
Alfalfa	1973**	" "
Corn	1974#	" "
Alfalfa	1974#	" "
Corn	1975#	" "
Corn	1975#	Lysimeter
Spring Barley	1975#	Field Plots
Alfalfa	1975#	" "
Alfalfa	1975#	Lysimeter

*Pertains to crops planted prior to commencement of this project on July 1, 1973. Consumptive use data were computed from records on file in the New Mexico Agricultural Experiment Station.

**Measured during a partial growing season commencing July 1, 1973

Results will be contained in final report to be submitted December 31, 1975. (See Par. C pertaining to the extension of the project)

Climatological data (solar radiation, temperature, relative humidity, wind movement, evaporation, precipitation) have been measured for evaluation with the consumptive use.

2. Consumptive use and pan evaporation have been measured. Ratios of consumptive use to pan evaporation have been determined by months for crops reported to date. The remainder will be included in the final report scheduled for December, 1975. The results which are quite variable show the need of extending this type of research over a period of years and to include other parameters or elements of climate for stability. In general for fall-season crops, the ratios increased by months reaching a maximum ratio during August ranging between 0.72 and 1.09.

3. A comparison of currently-used Blaney-Criddle consumptive-use coefficients with average coefficients computed from the 1973-74 report data shown in the table.

Seasonal Consumptive-Use Coefficients

Crop	Frost-Free Period		Frost Period	
	Computed 1973-74 Report	In Current Use	Computed 1973-74 Report	In Current Use
Alfalfa	1.06	0.85	.61	0.50
Corn (grain)	--	0.75	--	--
Corn (sweet)	0.89	*	--	--
Cotton	0.62	0.65		
Onions	0.62	0.65	0.36	0.40

*Not available previously in New Mexico literature

The data indicate that coefficients used in the Blaney-Criddle Method should have some adjustments made for alfalfa. The variability of the data also emphasizes the need of continuing these measurements for a period of years and to include other elements of climate.

B. Publications.

None

C. Project Status.

Approval has been granted to extend the project without additional funding from June 30, 1975 to December 31, 1975 to permit a full season of measurements on crops which will not be harvested until the fall of 1975.

D. Application of Research Results.

The following organizations in New Mexico have expressed interest in this project: New Mexico State Engineer, Santa Fe, New Mexico; Bureau of Indian Affairs, Navajo Indian Irrigation Project, Farmington, New Mexico; Navajo Project, Bureau of Reclamation, Farmington, New Mexico; Rio Grande Project, Bureau of Reclamation, El Paso, Texas; and the Soil Conservation Service (USDA), Albuquerque, New Mexico.

All of the above organizations have expressed their need for this type of data based on measurements made in New Mexico which will make possible more accurate estimates of daily, monthly, and seasonal water requirements of crops.

More accurate information is needed on peak demands for proper sizing and management of irrigation facilities and for irrigation scheduling to provide for greater irrigation efficiency.

It is expected that requests will increase in the future to transfer water rights from agriculture to industry and other uses near centers of urban growth. To make accurate transfers, refined estimates of water consumed by irrigated crops will be of increasing importance.

E.. Work Remaining, and Progress Contemplated During Next Year

Measurements will continue until crops are harvested this fall. Data will be computed and evaluated with the data of the previous year and assembled for the final report in December, 1975.

OMRT Project No. A-044-NMEX
NMSU Project No. 3109-55
Agreement No. 14-31-001-4031
FCST-COMRR Research Category: 7-B

EXPERIMENTAL CALIBRATION AND FIELD TEST OF
A THERMAL PROBE FOR IN-SITU GROUND WATER
FLOW MEASUREMENTS

Name and Location of University Where Project is Being Carried Out:

New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Proj. Began--Month: July ; Year: 73 Proj. Completed--Month: May ; Year: 75

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Marshall A. Reiter	Ph.D.	Geophysics
Allan R. Sanford	Ph.D.	Geophysics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Stephen G. McLin	B.S.	Hydrology

A. Research Project Accomplishments

A thermal probe for the in-situ measurement of groundwater flow rates in a borehole was calibrated in a vertical position. The probe is a long slender metal rod having a heat source along its entire length and a temperature sensor at its midpoint. When a constant quantity of heat is applied to the probe, the rise in temperature is inversely related to the rate of water flowing past the probe.

Full scale calibration of the probe was considered necessary because theoretical studies over-simplify the interaction between the heated probe and the horizontal flow of groundwater. The apparatus for calibration consisted of a central sand-filled chamber having a vertical hole lined with a well-screen in its center. The central chamber was hydrologically connected to upstream and downstream water reservoirs that were used to control the rate of water flowing in the central chamber.

Fifty-eight calibration runs of the thermal probe were made; most of these tests were used to perfect the experimental techniques of data gathering and the design of the calibration tank. Fourteen of the calibration tests were selected to construct preliminary calibration curves. The selection of specific tests was based on a statistical analysis of the A_1 coefficients from a third order polynomial fit of the experimental data. Final calibration curves were constructed on the basis of ten calibration tests. These curves show that if a temperature difference of 0.1 degrees Centigrade can be measured at the end of a two hour test, the probe is capable of distinguishing small differences in specific discharges when the flow exceeds 120 cm/day.

B. Publications

McLin, G. G., M.A. Reiter, A. R. Sanford (1975) Measurement of the horizontal component of ground water flow using a vertically positioned in-situ thermal probe, WRRRI Report No. 055, New Mexico Water Resources Research Institute, 34 p.

C. Project Status

The project was completed the fiscal year ending June 30, 1975 and a final technical report was submitted and distributed as WRRRI Report No. 055.

D. Application of Research Results

Application of research results may be limited because the thermal probe appears quite insensitive to ground water movements of less than 120 cm/day. Where high flow rates do occur, the thermal probe has distinct advantages over conventional techniques, for example, the ability to determine vertical variations in horizontal flow rates within a single aquifer.

OWRT Project No. A-045-NMEX
NMSU Project No. 3109-56
Agreement No. 14-31-001- 4031
FCST-COWRR Research Category: 6-B

Analysis of Alternative Futures for the
Rio Grande Region in New Mexico

Name and Location of University Where Project is Being Carried Out:
New Mexico State University, Las Cruces; University of New Mexico, Albuquerque;
New Mexico Institute of Mining and Technology, Socorro

Proj. Began--Month: July; Year: 1973 Proj. Completed--Month: Sept.; Year: 1974

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Robert R. Lansford	Ph.D	Agricultural Economics
Shaul Ben-David	Ph.D.	Economics
Lynn Gelhar	Ph.D.	Hydrology
Thomas G. Gebhard, Jr.	Ph.D.	Civil Engineer
Bobby J. Creel	M.S.	Agricultural Economics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
James A. Larson	B.S.	Agricultural Economics

A. Research Project Accomplishments

An interdisciplinary approach to the solution of the water resource problems of the Rio Grande Region in New Mexico was centered around a socio-economic model, developed to represent the New Mexico economy, with special emphasis placed upon the Rio Grande Region.

Three sets of alternatives were considered: (1) growth without a water constraint; (2) growth, holding surface water constraint; (3) growth, holding both surface and ground water constraint.

Without a water constraint, in the Rio Grande Region, both production and depletions are expected to exhibit the largest increase (59.7 percent and 47.4 percent, respectively). With a surface water constraint, the value

of production is reduced by \$18.1 million and water depletions decreased 18.1 percent by 2020. With a total water constraint, the value of production decreased \$4.1 million below that expected when using only a surface water constraint, and water depletions are reduced about 3.4 percent.

However, there appears to be sufficient water resources in the Rio Grande Region to carry on a viable regional economy.

The Upper Rio Grande Region is expected to follow the general trend of the total Rio Grande Region but at a lower growth rate.

The Middle Rio Grande Region is expected to follow the general trend of the total Rio Grande Region but at a higher growth rate.

The Socorro Region is expected to follow the general trend of the Rio Grande Region but at a lower growth rate, and Lower Rio Grande Region is expected to grow at a slightly higher growth rate than the total Region.

Another analysis utilizing low and high population growth indicate there are sufficient water resources in the Rio Grande Region to carry on a viable regional economy, either with a low population projection or a high population projection, without affecting the flow of the Rio Grande, thus permitting New Mexico to meet its Rio Grande Compact commitments to Texas.

The level of population growth and domestic per capita consumption of water are critical in determining use of the limited water resources of the Rio Grande in New Mexico. A gradual increase in domestic per capita water consumption schedule causes major structural shifts in the agricultural production sectors and reductions in the value of agricultural production. An educational program for the general public in the Rio Grande Region of New Mexico on conserving water may be in order to reduce or slow down the increase in domestic per capita consumption of water.

B. Publications

Lansford, R. R., et al. An Analytical Interdisciplinary Evaluation of the Utilization of the Water Resources of the Rio Grande in New Mexico--Upper Rio Grande. New Mexico Water Resources Research Institute Report No. 21, New Mexico State University, November 1973.

Lansford, R. R., et al. An Analytical Interdisciplinary Evaluation of the Utilization of the Water Resources of the Rio Grande in New Mexico--Middle Rio Grande. N. M. Water Resources Research Institute Report No. 22, New Mexico State University, December 1973.

Lansford, R. R., et al. An Analytical Interdisciplinary Evaluation of the Utilization of the Water Resources of the Rio Grande in New Mexico --Socorro Region. N. M. Water Resources Research Institute Report No. 23, New Mexico State University, February 1974.

Lansford, R. R., et al. An Analytical Interdisciplinary Evaluation of the Utilization of the Water Resources of the Rio Grande in New Mexico-- Lower Region. N. M. Water Resources Research Institute Report No. 24, New Mexico State University, March 1974.

C. Project Status

The project was terminated September 30, 1974.

D. Application of Research Results

One of the key elements of this study was the use of a technical advisory committee composed of representatives from local, state, and federal agencies. As data became available it was passed on to members of the technical advisory committee. Through the advisory committee some preliminary results have been used as inputs into the New Mexico State Water Plan; the "Upper Rio Grande Basin Water Related Land Resources" by the U. S. Department of Agriculture River Basin Planning Group in Albuquerque; the Middle Rio Grande Council of Governments in their inventory of resources; U. S. Geological Survey in the ground water investigation of the Mesilla Valley; Bureau of Reclamation in constructing enterprise budgets for the Upper Rio Grande Basin in connection with the San Juan-Chama Diversion.

OWRT Project No. A-046-NMEX
NMSU Project No. 3109-57
Agreement No. 14-31-001-4031
FCST-COMRR Research Category: 5-B

The Determination of Content and Origin
of Lead in Surface and Ground Waters in
Northeastern New Mexico

Name and Location of University Where Project is Being Carried Out:

New Mexico Highlands University, Las Vegas, New Mexico 87701

Proj. Began--Month: July; Year: 1973 Proj. Completed--Month: November; Year: 1974

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Sigfredo Maestas	Ph.D.	Chemistry
Anthony F. Gallegos	Ph.D.	Biology

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Donald H. Vigil	B.S.	Chemistry
Marilyn Agbayani	-	Biology/Chemistry

A. Research Project Accomplishments

The major project accomplishments include: (1) development of suitable sampling techniques for natural waters, aquatic species, biological samples, river sediments, and soils for chemical analysis; (2) development and modification of existing techniques for the analysis of lead in waters and biological and soil samples and for the analysis of cadmium, silver, copper, zinc and other heavy metals in waters; (3) development of suitable analytical techniques for the analysis of Pb-210 (a radioisotope) in waters, biological materials and soils; (4) collection of analytical data of lead, silver, and cadmium in natural waters, soils, and biological samples in northeastern New Mexico; (5) collection of some analytical data for the lead content of air in the same geographic

area: (6) collection of analytical data for the content of Pb-210 in water and other natural samples of the region; and (7) the organization of data to facilitate the determination of the origin of lead in waters in the northeast region of New Mexico and the Pecos Wilderness.

The sampling experiments indicate a seasonal variation in the heavy metal content of natural waters. Secondly, conditions and amount of precipitation which occur immediately prior to the sampling determine the amounts of heavy metals present in surface waters. Systematic and select sampling of streams and lakes in the northeast region of New Mexico and in areas in the periphery of the Pecos Wilderness have been conducted over a two year period of time.

Analytical techniques which have been developed or adapted for the determination of trace metals include for the most part methods with the use of the carbon furnace in atomic absorption spectrometry. The use of the carbon furnace for the determination of Pb, Ag, Cd, Cu, Zn, and other heavy metals has proved to be the most reliable means of analysis for samples in which the metal concentration seldom exceeds 0.5 ppm. Preconcentration techniques, together with flame atomic absorption spectrometry, have been used for the determination of the metal content of some samples. Electrochemical methods for the determination of Pb in some samples (such as bone) have proved to be satisfactory for samples containing 1-5 ppm of the metal.

The determination of Pb-210 in soils, sedimentary deposits, and biological materials is readily accomplished with the analysis of the radionuclide by liquid scintillation spectrometry. Methods for the isolation of the radioisotopes Pb-210 and Po-210 have been developed in this laboratory. The analysis of Pb-210 in waters, although less readily accomplished, has been done with the same technique after tedious preconcentration of natural samples.

The analytical data indicate that the amounts of lead found in natural waters in the remote region of northeastern New Mexico result from atmospheric deposition (by precipitation primarily). The amounts of lead in surface and ground waters are generally small and are practically identical to the amounts found in precipitation occurring in the same areas.

b. Publications

Abstract: "Determination of Lead Content in Fish Bone and Tissue." Robert Thatcher, Henry Martinez and Sigfredo Narstas, Bulletin of the New Mexico Academy of Science, 13 (2), 36, December 1972.

Paper presented at the Fall Meeting of the New Mexico Academy of Science.

Paper on the content of lead in aquatic species presented at the Annual meeting of the Rocky Mountain Section of the American Association for the Advancement of Science, | Lubbock, Texas, April 1973.

Gallegos, A. F. and S. Maestas, "Determination of the Content and Origin of Lead in Surface and Ground Waters of Northwestern New Mexico", WRRR Report No. 048, December 1974.

C. Project Status

Project completed November, 1974.

D. Application of Research Results

Available to data banks. Description present in the data bank of the New Mexico Environmental Institute.

E. Work Remaining

N/A

CWRT Project No. A-047-NMEX
NMSU Project No. 3109-58
Agreement No. 14-31-001-4031
FCST-COWRR Research Category: 5-D

IMPROVED WASTE WATER TREATMENT IN ARID
AREAS

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July ; Year: 1973 Proj. Completed--Month: July ; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
William A. Barkley	Ph.D.	Civil Engineering

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Bryan Duff	B.S., M.S.	Civil Engineering
Joseph Archuleta	B.S.	Civil Engineering
Harold Hancock	B.S.	Technical

A. Research Project Accomplishments

The purpose of this investigation was to study the mechanism of dual flocculant agents in destabilizing synthetic colloidal systems. A synthetic colloidal system was selected in order to achieve satisfactory reproducibility. The flocculating agents selected were aluminum sulfate and organic polyelectrolytes. Both cationic and anionic polyelectrolytes were tested. Preliminary testing evaluated the range of concentrations of both flocculants which, when used in conjunction, caused either partial or full latex colloidal destabilization. An experimental design was developed which incorporated these concentration ranges and the time lag between the addition of the two flocculants. Dependent parameters used to evaluate the results included zeta potential turbidity, aluminum concentration, and gravimetric analysis. Zeta potential and gravimetric analyses were the most effective dependant parameters.

It was determined that the time difference between the addition of primary and secondary flocculants affected the dewatering efficiency. From this result it was concluded that water treatment plant operators could improve treated water quality at no additional chemical cost by optimizing the time difference parameter in the flocculation operation.

B. Publications

Duff, Bryan. "Time Study of Addition of Dual Flocculants to a Latex Colloidal Suspension" Master's Thesis, Civil Engineering Department, NMSU, 1974.

C. Project Status

The project is complete. A completion report has been submitted to WRRI

D. Application of Research Results

The results of the work will be applicable to all water treatment systems using dual flocculant systems.

E. Work Remaining, and Progress Contemplated During Next Year

This work will be submitted for publication in a relevant Journal.

OWRT Project No. A-049-NMEX
 NMSU Project No. 3109-60
 Agreement No. 14-31-001-5031
 ECST-COWRR Research Category: 3-F

PROTEIN PRODUCTION BY RUSSIAN THISTLE:
 EFFECT OF WATER AND NITROGEN ON PROTEIN
 YIELDS.

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July ; Year: 1974 Proj. Completed--Month: June ; Year: 1976

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
James L. Fowler	Ph. D.	Agronomy
James H. Hageman	Ph. D.	Biochemistry

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
David Farmer		Chemistry major (junior)
Charles Staples	M. S.	Animal Science
Gordon McDow	M. S.	Animal Science
Finkie Morris		Biology-Chemistry

A. Research Project Accomplishments

a. Water Content

At the outset of the project we thought it essential to compare the water content of Russian thistle with other known forages for two reasons: to evaluate its possible use for grazing and, of course, to calculate protein contents on a dry weight basis. Initially we used samples randomly gathered from volunteer plants, but more recently we have used greenhouse samples. The average of nine samples gave a water content of 87%. The range, however, was rather broad varying between 82 - 91%. Clearly great caution must be used in calculating proteins on a dry weight basis as up to a two-fold difference may be seen with this degree of variation. It appears that

the water content of Russian thistle is significantly higher than alfalfa but is closely comparable to red clover. It may be worth noting that the greenhouse samples all tend to have more water than the samples taken in the field although insufficient data are available to make this a very firm conclusion.

b. Measurement of protein content

As one of the main aims of this project was to study protein production with limited water, it was clearly essential to develop assays for protein which were highly reliable. We chose to measure protein by determining nitrogen by a standard Kjeldahl procedure and by measuring levels of extractable protein with a specific protein assay. The biuret method was attempted but found to be wholly unsatisfactory. In order to extract protein from fresh tissue it was necessary to investigate the usefulness of various buffer and solvent systems.

Of the buffers tested those which gave the most reliable results were MES, sodium pyrophosphate and sodium borate. We have routinely used borate in the subsequent experiments reported here -- partly because it is very cheap and readily available.

We have also studied various methods of tissue disruption to determine which is most efficient. Of the four methods tested grinding in a Virtis homogenizer has proved to be most rapid and most effective and is now used routinely.

After preparing a borate extract of a plant we compared results of doing a Kjeldahl nitrogen determination and a Lowry protein assay on the same extracts. We are, of course, in the process of collecting more data of this sort; most of the subsequent data suggest that the first Kjeldahl assay is rather on the low side and that 18% is rather constantly observed.

One problem encountered with some samples of tumbleweed extracts was the rapid discoloration. This discoloration is evidently due to the oxidation of tannins released upon disrupting the tissue. We found the addition of a small amount (2.6mM) of metabisulfite completely prevents the darkening reactions. One preliminary observations indicate that extracts of Salsola iberica have a much greater tendency to discolor than do those of S. paulsenii.

c. Effect of fertilization on nitrate reductase

Table 1 shows the protein content and nutritive fiber content of mature plants which were subjected to various levels of urea fertilization at a constant level of water application. There is no apparent correlation of either of these parameters with nitrogen levels, but the average values

do compare favorably with mean values of 20.48±2.5% protein and 32.5±2% acid detergent fiber and 7.4±1.4% acid detergent lignin reported for 57 samples of alfalfa grown in New Mexico. Some of the variability observed for the Russian thistle is undoubtedly due to the fact that the Russian thistles which were grown were probably mixtures of Salsola iberica, S. Paulsenii and hybrids thereof.

Table 1. Crude Protein and Nutritive Fiber In Salsola Spp.

N(lb/acre)	% Dry Weight		
	Protein*	Acid Detergent Fiber†	Acid Detergent Lignin
0	17.6±4.9	35.4±5.1	6.1 ±1.4
25	18.9±2.1	31.6±2.6	5.9 ±1.2
50	21.4±1.8	36.4±2.7	7.1 ±1.6
75	20.8±3.9		
100	20.1±4.2	34.4±9.4	6.3 ±2.6

Average overall

N levels	19.8±3.6	34.4±5.3	6.4 ±1.6
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*Average of 6 determinations at each N level.

†Average of 4 determinations at each N level.

The levels of protein and nutritive fiber are somewhat higher than the values reported by other workers for uncultivated plants.

e. Amino acid composition of protein

In addition to having high levels of protein we found the amino acid composition of the bulk protein in Salsola spp. to be very well balanced nutritionally.

Earlier Cave et al. showed in feeding trials with dairy cattle, using thistle hay containing only 9% protein, that the thistle hay provided 55% as much digestible protein and 80% as much total digestible nutrients. It is interesting to note that the Russian thistle seed meal provided for normal weight gain and development of weaning mice.

As high nitrate levels are frequently associated with forages which are high in protein, we have assayed for this in a number of samples. Whole plant levels of 0.037%, 0.0086%, 0.43%, 0.57% and 1.9% were found corresponding to 0,25,50,75 and 100 lb. of nitrogen/acre applications of urea.

Very recently Baker has reported that in field trials Russian thistle yielded 7.14 tons of dry matter/acre, which is comparable to yields commonly obtained with alfalfa. He noted, furthermore, that the water use efficiency of Russian thistle was 4.2 times greater than that for alfalfa. Consistent with this high water use efficiency is the observation that *S. paulsenii* has Kranz anatomy, which indicates that it probably has a C_4 pathway for carbon dioxide fixation.

We feel that the results from these limited greenhouse experiments sufficiently encouraging to merit further study. Because of its low water requirements and drought resistance, it may be adaptable to semi-arid regions which could not be economically cultivated. The relatively high water content of this plant might also simplify extraction of bulk protein for possible use as a food supplement.

B. Publications

We are preparing a manuscript to be submitted to Agronomy Journal.

C. Project Status

This project will continue for the next fiscal year.

D. Application of Research Results

To date only a number of private individuals have expressed interest in the results. One gentleman has offered the use of acreage in the mountains for cultivating tumbleweed. We hope that as the results become more widely known animal science and food technology people will express some interest.

E. Work in Progress

We hope to gather the sort of information we have collected for the greenhouse studies from samples grown in the field. In particular we are evaluating the effects of very limited water on both yields and quantities of protein obtainable under field conditions.

GERT Project No. A-050-NMEX
 NMSU Project No. 3109-61
 Agreement No. 14-31-001- 5031
 ECST-COWRR Research Category: 5-D

EFFECT OF CHILI WASTEWATER ON SEWAGE
 TREATMENT BIOLOGICAL PROCESSES

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July ; Year: 1974 Proj. Completed--Month: December ; Year: 75

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
William A. Barkley	Ph.D	Civil Engineering

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
George Wu	B.S.	Civil Engineering
Yang-Sun Song	B.S.	Civil Engineering

A. Research Project Accomplishments

Existing sewage treatment facilities in New Mexico have regularly experienced operational difficulties in the summer time, concurrent with the chili processing season. Sewage treatment plant operators have felt that chili wastewaters were the cause of the biological treatment difficulties.

The purpose of this investigation was to determine the effect of chile wastewaters on activated sludge sewage treatment units.

In order to accomplish this objective a bench scale activated sludge system was used. It was planned to establish steady state operational conditions in the unit using a fresh sewage and then to subject the unit to a shock loading of pure chili wastewater. This procedure was expected to upset the system; subsequent testing would determine the maximum chili concentration that would not result in shock loading

to the system. This subsequent work proved unnecessary as the activated sludge system proved to be capable of successfully treating a pure chili wastewater after achieving steady state with sewage. It seems clear that the operational difficulties associated with the summer season are not due to chili wastewater. Increased oxygen solubility, increased metabolic reaction rates, and greater sewage septicity, all associated with higher environmental temperatures, are likely reasons for the sewage treatment plant operational problems.

B. Publications

Gebhard, James L.: "The Effects of Chili Waste on our Activated Sludge Process", Master's Thesis, Civil Engineering Department, New Mexico State University, 1974.

C. Project Status

The experimental work of this investigation is completed. The final report will be published prior to December 31, 1975.

D. Application of Research Results

This treatability investigation of a chili wastewater will have applicability to the sewage treatment facilities operation. As chili wastewaters are not associated with operational problems prevalent in the summer season, the STP managers can concentrate on the other potential problem sources.

In addition this work will be of interest to chili processing plants, using package treatment facilities.

E. Work Remaining, etc.

The final report is unfinished, completion is expected prior to December 31, 1975.

OWRT Project No. A-051-NMEX
NMSU Project No. 3109-62
Agreement No. 14-31-001- 5031
FCST-COWRR Research Category: 3-C

THE USE OF BRACKISH WATER FOR COAL GASIFICATION

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July; Year: 1974 Proj. Completed--Month: September; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Donald B. Wilson	Ph.D.	Chemical Engineering

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
James McNeese	M.S.	Chemical Engr.
Paul Deininger	E.S.	Chemistry (currently a Chem. E. M.S. candidate)
Pete Gerhard	B.S. (Dec. 1975)	Chemical Engr.

A. Research Project Accomplishments

One of the major problems in the development of western coal is the availability of water. When coal is utilized for the production of synthetic natural gas, approximately 11,000 acre feet a year are used for the daily production of 288 million cubic feet (STP) of gas. While the gasification reactions consume only a small portion of this water, major advance would occur in coal development if this water could be supplied from brackish water sources. Brackish water could possibly be used in both Lurgi gasification and in in-situ gasification, a major consideration being the disposition of the salts in the brackish water.

This project examined the presence of three salts in a coal gasification reactor. The salts studied were Sodium Chloride, Potassium Chloride, and Sodium Sulfate. The project examines the leachability of these salts from the product coal-ash. It was found that most of the salt introduced into the reactor system were leachable from the product mixture and from the reaction vessel itself. In an in-situ gasification process the leaching of these salts into fresh water aquifers will have to be considered.

B. Publications

James McNeese, "The Use of Brackish Water for Coal Gasification", Thesis for partial fulfillment of the requirements for Master of Science Degree, Chemical Engineering, May 1975.

C. Project Status

This project has been extended to September 30, 1975.

D. Application of Research Results

The results of this research are directly applicable to the development of New Mexico's coal resources.

E. Work Remaining, and Progress Contemplated During Next Year

During the remainder of the research period, the analysis of the use of brackish water in other than the reaction phase of coal gasification will be completed; and a thermodynamic analysis of the optimum ratio steam to coal in the gasification reaction will be completed.

OWRT Project No. A-052-NMEX
NMSU Project No. 3109-63
Agreement No. 14-31-001-5031
FCST-COWKR Research Category: 5-B

SURVIVAL OF BACTERIA AND VIRUSES IN TURBID
AND POLLUTED WATER.

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July; Year: 1974 Proj. Completed--Month: June; Year: 1976

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Robert T. O'Brien	Ph. D.	Bacteriology

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Khalif Ahmad	B. S.	Microbiology
Cynthia Robinson	B. S.	Biology

A. Research Project Accomplishments

Studies on bacterial survival times in surface waters have largely been completed. The survival times of E. coli and Salmonella typhimurium were shown to be temperature dependent with the longest survival times obtained at 25°-30° C. Data obtained with indigenous coliform bacteria in the Rio Grande were similar to data from E. coli and S. typhimurium.

Results on inactivation rates of the coliphages T-2, T-4, f-2 and QB indicate these phages are inactivated in surface waters faster than enteroviruses. However, N-1 a phage of Micrococcus lysodieticus shows promise as an indicator virus since the inactivation rates were similar to rates calculated for poliovirus T-1. Comparative studies with ϕ N-1 and poliovirus T-1 are continuing.

The effects of temperature on inactivation of polioviruses T-1 and T-3 and Coxsachii virus A-13 were determined. The viruses were inactivated most rapidly at 20°-25° C. Poliovirus T-1 was found to be the most durable enterovirus studied.

B. Publications

No publications were submitted during first year of project.

C. Project Status

Project will continue into fiscal 1976.

D. Application of Research Results

Results of the study will be of use in evaluating possible health hazards of virus contaminated water. Interest in the applications of the results will be of greatest interest to state and federal agencies involved in water use planning.

E. Work Remaining and Progress Contemplated During Next Year

Determining inactivation rates of enteroviruses in surface and ground waters.

Movement of viruses through shallow aquifers.

Inactivation rates of enteroviruses in soil and bottom sediments.

Selection of an indicator virus or bacteriophage for use in inactivation studies.

OWRT Project No. A-053-NMEX
 BMSU Project No. 3109-64
 Agreement No. 14-31-001- 5031
 FCST-COWRR Research Category: 2-H

TROPIC STATUS OF SELECTED NORTHERN
 NEW MEXICO LAKES

Name and Location of University Where Project is Being Carried Out:
University of New Mexico, Albuquerque, New Mexico

Proj. Began--Month: Oct. ; Year: 1974 Proj. Completed--Month: Dec. ; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Gordon V. Johnson	Ph.D.	Plant Physiology
L. L. Barton	Ph.D.	Microbial Physiology

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
None		

A. Research Project Accomplishments

A characterization of the algae, the chemical and limnological conditions and the bacteria in several high altitude lakes in northern New Mexico is being conducted to determine the trophic status of these lakes. The conditions which preceded reported algal blooms and the biological and chemical characteristics of the bloom are being recorded. Algal studies include primary productivity measurement and species identification. Examination of the dissolved nutrients has aided in determining the contribution of nitrogen and phosphorus to production of blooms in each lake. Comparisons of the abundance and physiological type of planktonic bacteria to algal populations are being conducted. The use of bacteria as indications of trophic status is being explored.

B. Publications

None

C. Project Status

This project has been granted an extension through December 31, 1975.

D. Application of Research Results

The New Mexico Environmental Improvement Agency, New Mexico Department of Game and Fish and the U.S. Forest Service have all expressed an interest in this project. Each agency has identified lakes which they would like studied and all three have offered their assistance in obtaining data.

E. Work Remaining, and Progress Contemplated During Next Year

Data will be collected through the summer and fall so that a full year cycle can be evaluated. The data will be analysed and the completion report written.

OWRT Project No. A-054-NMEX
 NMSU Project No. 3109-65
 Agreement No. 14-31-001-5031
 ECST-COWRR Research Category: 5-B

FEEDLOT RUNOFF AND SEWAGE EFFLUENT AS POTENTIAL
 WATER POLLUTANTS WITH EMPHASIS ON NITROGEN AND
 PHOSPHATE LEVELS AND OXYGEN DEPLETION.

Name and Location of University Where Project is Being Carried Out:
 New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Proj. Began--Month: October; Year: 1974 Proj. Completed--Month: June; Year: 1976

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Donald K. Brandvold	Ph. D.	Biophysical Chemistry

All the Students worked on research. None were primarily dishwashers. Most plan to go into water research in the future.

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Brenda Anderson	B. S. 1975	Biology (Micro)
Konald Fenstermacher	B. S. 1975	Chemistry
Larry Cordray	Undergraduate	Environmental Engineering
Susan Chavez	Undergraduate	Bio-Chem
Keith Christopher	Undergraduate	Chemistry
Gerald Schmitt	Undergraduate	Pre-vet
Tony Washington	Undergraduate	Chemistry
Ron Meyerink	Undergraduate	Chemistry

(A) Research Project Accomplishments.

This project was funded rather late in the year (October), so we do not have a full year's data as yet. At the present time, the data we have is qualitative or semi-quantitative as far as drawing conclusions since there are apparently strong seasonal variations. The drainage ditch, which is the major project research area, has been analyzed for BOD, boron, sulfide, redox potential, dissolved oxygen, phosphate, temperature, pH, fluoride, COD, and the various chemical forms of nitrogen such as ammonia, nitrate, nitrite, Kjeldahl and urea. Bacterial studies have recently been initiated to further look into the relationships between nitrogen, phosphate, and dissolved oxygen.

The findings thus far bear out that there are relationships between the oxidation states of nitrogen and the dissolved oxygen levels. This also introduces a temperature dependence for nitrogen species.

(B) Publications. None

(C) Project Status. Project will continue through the next fiscal year.

(D) Application of Research Results.

It is expected that the results will be used in water planning as to water use and maintaining water quality. Data on water content is needed in New Mexico by several agencies, some of which have expressed interest. A few examples of those who have asked for a copy of results when available are New Mexico Citizens for Clean air and water, US Geological Survey, and Fred Gross and other NM Legislators.

(E) Work Remaining and Progress Contemplated During Next Year.

Work remaining includes further identification of nitrogen forms present and their relative abundances as compared to other parameters such as dissolved oxygen and redox potential. Data is also needed on the relationships between certain bacteria and the chemical forms of nitrogen present. During a good portion of the present year the Socorro Sewer plant was malfunctioning and so the data collected may be abnormal. More normal data will be obtained. We will also seek data on the baseline condition of many of the ditches when irrigation water is not present. We had some interesting beginnings here before the irrigation season began.

We will pinpoint some as yet unidentified sources of phosphate, nitrogen, bacteria, and boron. These are showing up at elevated levels in places where they were not expected. These will be corrected for. In general, more analyses will be carried out during the next fiscal year and relationships between parameters sought.

It also seems that nitrate can serve as a potential source of oxygen or oxidizing potential for at least some of the microorganisms that are present.

The feedlot has an effect on the nitrogen levels, dissolved oxygen, BOD and certain bacterial counts. However, this only shows up after runoff of surface water or percolation of same and except for some snowfall early in the year we have had little chance to study this. (The thunderstorm season later this year should allow this to be investigated). Under ordinary conditions, the system shows good capability in recovery to normal oxygen levels. The situation with phosphate seems to be rather complex with precipitation and dissolution occurring at various times. Some of the phosphate becomes bound to suspended solids. This amount may be appreciable and together with nitrogen present seems to offer an ideal situation for growth of some bacteria.

Our most surprising findings have probably been higher levels than expected of nitrogen and bacteria in drainage ditches which supposedly are receiving no "sewage" discharge. These are possibly draining septic tank fields.

As stated before, our findings are still somewhat tentative. By this time next year, we will be able to make many positive statements about our findings.

OWRT Project No. B-029-NMEX
NMSU Project No. 3109-132
Agreement No. 14-31-001-3619
FCST-COWRR Research Category: 3-F

Utilization of Water in a Semi-arid
Region

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Plains Branch Station, Clovis, New Mexico

Proj. Began--Month: July ; Year: 1970 Proj. Completed--Month: June ; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
H. D. Fuehring	Ph.D.	Agronomy (Soils)

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
None		

A. Research Project Accomplishments

Utilization of Water in a semi-arid region

It has been established that yields of grain sorghum and sunflowers, when grown on beds receiving runoff from adjacent bare slopes, approached that of irrigated crops. However, yields of the entire area were not superior to solid plantings when runoff was not permitted. Work at the present time is exploring the possibility of cropping the ridges to normal dryland rotation crops while still obtaining runoff for adjacent growing beds. The cost of keeping the bare ridges free of weeds would be a major problem under farming conditions and cropping ridges affords some economic return while controlling weeds at the same time. It is also possible that a very limited amount of irrigation water applied to the growing beds by trickle irrigation along with the runoff from adjacent ridges would result in adequate crop yields in most years.

Winter small grains on the growing beds adjacent to bare ridges did not benefit greatly from runoff probably because rainfall is light during most of the growing season for these crops.

Foliar application of small amounts of atrazine as an antitranspirant agent increased yields of sorghum on the growing beds by up to 30 percent. This work, along with additional work on antitranspirants under limited irrigation, indicates a large potential for improving the efficiency of rainwater utilization by crops over a large portion of the world where moisture stress at sometime during the growing season reduces crop yields.

The groundwork has been laid for developing an improved system of dryland farming in semi-arid regions by combining small scale water harvesting, involving minimal land shaping, with antitranspirant application.

B. Publications

Fuchring, H. D. 1975. Yield of dryland grain sorghum as affected by antitranspirants, nitrogen, and contributing micro-watershed. Agronomy Journal 67:255-257.

C. Project Status:

OWRR support for the project runs out June 30, 1975, and the completion report is being prepared. However, the 1975 crops have been established and the project is being continued.

D. Application of Research Results

Requests for reprints of the above listed publication have been received from numerous countries indicating widespread interest in the subject. However, the continued development of these findings will be slow unless support for further work can be obtained.

E. Work Remaining, and Progress Contemplated During Next Year

While the OWRR project will be officially completed June 30, 1975, it is being carried on and expanded into new areas although on a very limited scale due to lack of funds.

ORMT Project No. B-038-NMEX
 NMSU Project No. 3109-140
 Agreement No. 14-31-001-- 3914
 ECST-COURR Research Category: 2-F

Aquifer Parameters by a
 Chemical Tracer Technique

Name and Location of University Where Project is Being Carried Out:

New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Proj. Began--Month: July ; Year: 1972 Proj. Completed--Month: December ; Year: 74

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Gerardo Wolfgang Gross	Ph.D.	Geophysics
Vernon LeFebre	Ph.D.	Chemistry

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Kim Wortham		Junior, Biology
Robert Hoy		Junior, Geology
Marla Foreman		Soph., Biology

A. Research Project Accomplishments

Soil column tests and chemical analyses of water samples from the Roswell Basin indicate that water is saturated with calcite before entering the aquifer. It is postulated that calcite precipitation and dissolution occurring within the aquifer result from nonlinear mixing effects. Four such effects are developed and applied to the Roswell basin. One result is that mixing caused by leakage from the unconfined to the confined aquifer is clogging the confined aquifer with a calcite precipitate. The calcium content of groundwater can not be used as a tracer in this basin.

B. Publications

V. LeFebre. Aquifer Parameters by a Chemical Tracer Technique. Non-linear Mixing in the Roswell Confined Aquifer. Final Report. WRR1 No. 48.

C. Project Status.

Completed

D. Application of Research Results

Assessment of the effects interaquifer leakage and irrigation return waters may have on water quality and aquifer permeability in the long range.

E. Work Remaining

Not applicable.

OWRT Project No. B-040-NMEX
HNSU Project No. 3109-148
Agreement No. 14-31-001-4106
FCST-COWRR Research Category: 3-D

WATER USE AND URBAN DEVELOPMENT IN ALBUQUERQUE,
NEW MEXICO: A STUDY OF USER PRACTICES, ATTITUDE
AND PRIORITIES

Name and Location of University Where Project is Being Carried Out:

University of New Mexico, Albuquerque, New Mexico

Proj. Began--Month: July ; Year: 1973 Proj. Completed--Month: December ; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Peter Lupsha	Ph. D.	Political Science
Don Schlegel	Ph. D.	Architecture

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Quida Martin	M. A.	City Planning
Mariaana Miller	M. A.	City Planning

A. Research Project Accomplishments

Interviewed 345 households on water attitudes.
Matched household with water use data from city computer.

Preliminary Findings:

- a) Attitudes do appear to have an impact on use.
- b) Landscaping does influence use.
- c) Type of sprinkling system influences use.
- d) Normal economic variables (income, house value, family size), as found in prior studies, are important demand variables.
- e) Given the attitudinal elasticities we found, it should be possible to design an educational program to increase optimal use knowledge and water awareness to lower demand curves.

f) If subdivisions were required to have desert type landscaping or mixed rock and small lawns, great demand saving could be made. But public attitudes are not pro- this type of landscaping.

B. Publications in Progress

We expect to publish a monograph of the study under the auspices of the Division of Government Research, TSRAD, UNM. Copies of this report will be delivered to WRRRI.

Several article possibilities exist, both in city planning and landscape journals, as well as in natural resources and land economics journals.

C. Project Status

The project is presently in the analysis and write-up stage. We expect to finish up some time over the summer of 1975.

D. Application of Research Results

The City of Albuquerque as well as state, federal and national water use planners in agencies and institutions should have use of the findings and study.

E. Work Remaining and Progress Contemplated During Next Year

The work to be completed next year is simply a no-cost extension so that analysis, write-up and publication can be accomplished in the most efficient and complete manner.

OWRT Project No. B-041-NMEX
NMSU Project No. 3109-149
Agreement No. 14-31-001- 4107
FCST-COERR Research Category: 2-F

Application of Environmental
Tritium in the Measurement of Recharge and
Aquifer Parameters in a Semi-arid Limestone
Terrain

Name and Location of University Where Project is Being Carried Out:
New Mexico Institute of Mining and Technology, Socorro, N.M. 87801

Proj. Began--Month: July ; Year: 1973 Proj. Completed--Month: December ; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Gerardo Wolfgang Gross	Ph.D	Geophysics
Charles R. Holmes	Ph.D.	Geophysics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Emigdio Flores	M.S.	Hydrology
John McDermott	B.S.	Geology
Kim Wortham		Junior, Biology
Robertta Hoy		Junior Geology
Marla Foreman		Soph., Biology

A. Research Project Accomplishments

An intense sampling program was carried out with particular emphasis on observation wells, flowing wells, springs, and surface waters in the recharge area of the Roswell Basin. Tritium laboratory procedures were improved, new counting equipment installed and laboratory output maximized.

A correlation was made between observation well levels and atmospheric pressure data from Roswell. These suggest that water in the so-called "Recharge Area" is at least partly confined. Low tritium levels in these waters suggest that the recharge model used in the past is incorrect.

A statistical study of surface flow into the basin and precipitation over the basin was begun. These data will be used in the interpretation of the research results. The latter are being compiled as a first step toward interpretation.

B. Publications

Three papers on Environmental Tritium as a Hydrometeorologic Tool in the Roswell Basin, New Mexico, by D. D. Rabinowitz, G. W. Gross, and Ch. R. Holmes, were submitted to Journal of Hydrology. They have been reviewed, accepted in principle for publication, and are presently being revised by G. W. Gross for final submission later this year.

C. Project Status

The project will be completed during the remainder of the current calendar year.

D. Application of Research Results

The Pecos Valley Artesian Conservancy District is interested in using our results on recharge for management purposes.

E. Work Remaining and Progress Contemplated During Next Year

Processing of samples. Interpretation. Analysis of Results. Writing of final report.

GWRT Project No. B-046-NMEX
NMSU Project No. 3109-154
Agreement No. 14-31-001-4164
FCST-COWAR Research Category: 6-B

REGIONAL WATER MANAGEMENT WITH FULL CONSUMPTIVE USE

Name and Location of University Where Project is Being Carried Out:
New Mexico State University, Las Cruces, New Mexico Texas A & M University, College
University of New Mexico, Albuquerque, New Mexico Station, Texas

Proj. Began--Month: Jan.; Year: 1974 Proj. Completed--Month: Dec.; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Robert R. Lansford	Ph. D.	Agricultural Economics
Shaul Ben-David	Ph. D.	Economics
Bruce Beatty	Ph. D.	Agricultural Economics
Donald L. Reddell	Ph. D.	Hydrologist
Bobby Creel	M. S.	Agricultural Economics
Fred Roach	M. S.	Economics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Jennifer Zamora	B. S.	Economics
James A. Larson	M. S.	Agricultural Economics
Bill Coffman	B. S.	Agricultural Economics

A. Research Project Accomplishments

A. One of the key elements of this study is the use of a technical advisory committee composed of representatives from local, state, and federal agencies. The research group met with the technical advisory committee on April 22, 1974. Among the agencies represented were: Bureau of Reclamation, U. S. G. S., Soil Conservation Service, City of Las Cruces, City of El Paso, Elephant Butte Irrigation District, El Paso County Water Improvement District No. 1, Texas Water Rights Commission, Texas Water Development Board, West Texas Council of Governments, Official from Texas Governor's Office, Southern Rio Grande Council of Governments, New Mexico Interstate Streams Commission, New Mexico State Planning Office, Rio Grande Compact Commission, New Mexico Water Quality Control Commission and Greater Agricultural Income Now Committee.

The model has been chosen, and the needed data identified and methods of obtaining it outlined. The model is essentially a linear programming model designed to represent the regional economy from Elephant Butte Dam, New Mexico to Ft. Quitman, Texas. The model consists primarily of an input-output table of technical coefficients layered on the linear programming model.

(A. continued)

The advisory committee recommended that the region be broken into two regions (one for New Mexico and one for Texas). This has caused some difficulty because two regional input-output models have to be developed and coefficients for trade flows between the two regions developed. The two regional I-O models have been developed and trade flow coefficients between the regions are currently being developed along with developing the model.

B. Publications
None

C. Project Status
Project will continue until December 31, 1975

D. Application of Research Results
Members of the advisory group should find various uses of the results obtained from this study. The advisory group will receive preliminary results as they become available for their own use.

E. Work Remaining and Progress Contemplated During Next Year
All of the analysis should be completed during the next fiscal year and the final report prepared.

OWRT Project No. B-048-NMEX
NMSU Project No. 3109-155
Agreement No. 14-31-001- 5093
FCST-COWRR Research Category: 2-K

CHEMICAL DYNAMICS OF A CONFINED LIMESTONE
AQUIFER

Name and Location of University Where Project is Being Carried Out:

New Mexico Institute of Mining and Technology, Socorro, N.M. 87801

Proj. Began--Month: July ; Year: 74 Proj. Completed--Month: June ; Year: 76

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Vernon LeFebre	Ph.D.	Physical Chemistry

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Tom Ewing	B.S.	Geology
Jim Childers	B.S.	Physics
Virginia Hill	None	Geology

A. Research Project Accomplishments

The water in the Roswell ground water basin is found in two aquifers: an upper alluvium aquifer containing highly mineralized water and a lower confined, limestone, aquifer containing somewhat less mineralized water.

In addition to characterizing the water found at various depths and locations within these two aquifers, the project is concerned with finding chemical indicators of ground water residence time and infiltration area. Also, mathematical models are being developed to determine the interaction between the lower and upper aquifers, and between the lower aquifer matrix (limestone) and the ground water.

A representative group of collection wells (about 50 wells) has been located in the basin and periodic gathering of water samples from these wells has begun. The water samples are analysed in the field and laboratory to determine the concentrations of eight major chemical constituents, ten trace elements, and two dissolved gases (CO₂ and O₂). Sample temperature is determined in the field. Sample tritium concentration is determined by another investigator. Approximately two hundred samples have been analysed so far.

The immediate result of the project is a 3-dimensional map of the water quality in the basin. Over the two year study period trends in this map may become apparent so that the evolution of the ground water in the basin can be studied.

Since the tritium content of the ground water is a gauge of the ground water residence time, correlation studies are being made between the chemical content of the sample and its tritium concentration. Oxygen content seems to reflect the residence time; one half of the oxygen originally contained in the water is lost in seven years. Since oxygen determinations can be made in the field and require only a few minutes, they may provide a much simpler and less costly method of determining residence time.

The chemical composition of the ground water is used to locate areas in the basin where mixing between the lower and upper aquifers occurs. This determination is based on the different chemical and thermal character of water in the two aquifers. Several mixing areas have been found in the northern part of the basin. Because of nonlinear solubility effects the chemical evolution of the limestone matrix in the lower aquifer is occurring most rapidly in these mixing areas. In other words, limestone precipitation and dissolution is greatly accelerated in these mixing areas. Attempts are being made to model these mixing areas to determine the rate of calcite (limestone) dissolution and deposition. This study can be used to predict long term changes in the porosity of the aquifer matrix. Finally, the 3-dimensional chemical and thermal map of the basin is being used as the basis of a mass and energy flux model for the basin.

B. Publications

None

C. Project Status

The first year has just been completed and the second year will be completed at the end of the next fiscal year.

D. Application of Research Results

The results of this project are of use to a variety of individuals. The well water chemical analyses are given to the collection well owners (usually farmers and ranchers) who display an extreme interest in these results. Water quality trends that we find will be of use to state agencies in planning future water management of the basin. The theories of mixing and chemical dynamics may be of some interest to hydrologists and geochemists.

E. Work Remaining, and Progress Contemplated During Next Year

During the next year, water samples will be collected, several new collection wells will be established, and the mathematical models of chemical dynamics in the mixing areas and flow dynamics in the aquifers will be developed.

LRT Project No. B-053-NMEX

MSU Project No. 3109-156

Agreement No. 14-31-001- 5094

CST-COWRR Research Category: 5-B

Terrestrial Contribution of Nitrogen to
Stream Water in Managed and Undisturbed
Forested Watersheds

Name and Location of University Where Project is Being Carried Out:

University of New Mexico, Albuquerque, New Mexico

Proj. Began--Month: July ; Year: 1974 Proj. Completed --Month: Sept. ; Year: 1976

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
James R. Cosz	Ph.D.	Forest Ecology

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Carl White	M.S.	Ecology, Chemistry
Virginia Cluga		Biology

A. Research Project Accomplishments

1. Nitrogen inputs - Precipitation volume has been recorded for 7 stations over the elevational gradient. Chemical analyses of the precipitation will allow us to calculate nitrogen inputs to the watersheds.
2. Nitrogen outputs - stream discharge measurements have been made for all watersheds. Weekly analyses of organic N, NO_3^- , and NH_4^+ allow a calculation of nitrogen outputs. For two watersheds (W-4, Aspen W-1) collections were made at 4 hour intervals during several storms.
3. Nitrogen content of the soil - Four vegetation communities (pinon-juniper, Mixed conifer, aspen, spruce-fir) were selected for soil analyses for organic N, KCl-extractable NO_3^- and NH_4^+ . Samples were taken of the organic layer and 0-15, 15-30, 30-45 cm depths of mineral soil. Five replicate samples were taken during each of 5 sampling periods. The resulting 1200 chemical analyses have been completed and the data are being analyzed.

4. Laboratory studies - Laboratory studies of N variation in soil are being investigated in a pilot study. Containers have been built to hold 4500 cm of soil for studying leaching losses and transformation rates of N.
5. Management effects - A thinning of the aspen watershed was scheduled for the fall of 1974 but because of an insect defoliation it did not occur. If the defoliation does not occur this year a thinning will occur during the fall of 1975.

A poma lift was constructed in the watershed near the Santa Fe Ski area as well as ski trails. We have monitored stream chemistry throughout and subsequent to that operation.

B. Publications

Gosz, J. R. 1975. Nutrient Budgets for Undisturbed Ecosystems Along an Elevational Gradient in New Mexico. Symposium on Mineral Cycling. May 2-4, 1974. Savannah River Ecology Laboratory

Gosz, J.R. 197_. Nutrient Budgets in Relation to Succession, Climax, and Productivity (submitted to Ecology).

Gosz, J. R. 1975. Stream Chemistry as a Tool in Evaluating Ski Area Development. Symposium on Man, Development, and Wildlands: A Complex Interaction. Sept. 14-19, 1975. Vail, Colorado.

C. Project Status

This project will continue into the coming year.

D. Application of Research Results

The results of this research will be of use to the Forest Service and others in determining the effects of timber removal and construction on New Mexico watersheds.

E. Work Remaining, and Progress Contemplated During Next Year

Inputs and outputs of N forms will be quantified for all watersheds as described in the proposal. Additional storm periods will be studied intensively for changes of N in relation to stream volume changes.

Variation of soil N will be studied on a more intensive basis than last year. Only two vegetation types will be studied, however. More frequent collections will be made in relation to wet and dry conditions.

Laboratory experiments will be performed to evaluate the effect of wet and dry conditions on the leaching rate of N. Procedures are outlined in the proposal.

The ski area development will be monitored as to effect on stream chemistry in a manner similar to last year. Hopefully insects will not defoliate the aspen watershed which will allow us to initiate the thinning experiment as outlined in the proposal.

OWRT Project No. C-4060-NMEX
NMSU Project No. 3109-311
Agreement No. 14-31-001--N/A
FCST-COWRR Research Category: 3-D

REDUCTION PEAK WATER CONSUMPTION IN URBAN
AREAS

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July; Year: 1972 Proj. Completed--Month: November; Year: 1974

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
D. J. Cotter	Ph. D.	Horticulture
D. B. Croft	Ph. D.	Psychologist
J. W. Clark	C. E.	Sanitary Engineer
B. J. Reeves	M. S.	Horticulture

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
J. T. Hughes	M. S.	Botany
Elbert Graves	B. S.	Biology
Kathleen Winkles	B. S.	Education

A. Research Project Accomplishments

The major thrust of activities for the project has centered about testing and refinement, and subsequent application of the residential landscape description questionnaire (RLDQ) to urban residential landscapes. Water usage data was available for most of the landscapes evaluated. The instrument met semantic and statistical criteria and had a very high reliability. Results now show that the RLDQ can be used as an assist in identifying attributes of a landscape which contribute to its overall beauty and those which lead to less water to maintain the landscape. The following four areas are measured by RLDQ: harmony, composition, accent and uniqueness. Uniqueness correlated negatively with landscape water use per square foot. Composition negatively correlated with total gallons applied to a landscape.

The progress was made in obtaining definitive data on the knowledge about water usage by urban dwellers. Two preliminary studies show consumers do not have sufficient knowledge on how to use water wisely. For example, luxuriant water users consider themselves to be good stewards of water; those consumers who felt they could not conserve water in their landscapes used twice as much water on their landscapes as those who felt they could conserve water. Programs for the conservation of water on New Mexico State University Campus has been developed and implemented. To date, water savings of 37% on fescue and 11% on hybrid bermuda have been achieved on campus.

Cooperative arrangements were made with Las Cruces Municipal Water and Utilities Department for the purpose of counseling with high water users and encouraging adaption of conservative measures.

B. Publications

Cotter, D. J. and Fabian Chavez. Factors affecting water application rates and urban landscapes, Journal ASHS, accepted for publication April, 1974.

Cotter, D. J. and D. B. Croft. Water Application Practices and Landscape Attributes Associated with Residential Water Consumption. WRRRI Report No. 049. November 1974.

C. Project Status

Project was completed in November, 1974.

D. Application for Research Results

The results obtained to date suggest that a significant means of reducing urban water usage lies in the area of consumer education. Application of RLDQ would identify specific landscape attributes conserving of water.

OWRT Project No. N/A
NMSU Project No. 3109-134
Agreement No. 14-31-001-N/A
FCST-COWRR Research Category: 3-F

CROPLAND USES AND AGRICULTURAL WATER DEPLETIONS
IN NEW MEXICO

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July ; Year: 1972 Proj. Completed--Month: June ; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Robert R. Lansford	Ph. D.	Agricultural Economics
Bobby J. Creel	M. S.	Agricultural Economics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
James A. Larson	M. S.	Agricultural Economics

A. Research Project Accomplishments

A survey was conducted to determine the use of irrigated cropland in 1973, in cooperation with the Statistical Reporting Service, Soil Conservation Service, and Agricultural Stabilization and Conservation Service (all of the U. S. Department of Agriculture), New Mexico Cooperative Extension Service, New Mexico State Engineer Office, and the New Mexico State Department of Agriculture.

The major irrigated crops in New Mexico in 1973 were: alfalfa 234,560 acres; sorghum, 216,210 acres; and cotton, 149,810 acres. Relative to the 1972 planted acreage, alfalfa and cotton decreased by 9,500 acres and sorghum increased by 4,400 acres. These three crops accounted for approximately 57 percent of the total cropland in the state in 1972.

The diversions and depletions for irrigation water in New Mexico were estimated using the Blaney-Criddle method as modified by Henderson and Sorensen.

B. Publications

Agricultural experiment station publication to be printed in August 1975.

C. Project Status

Terminated December 31, 1974.

D. Application of Research Results

The Statistical Reporting Service of the U. S. Department of Agriculture and the New Mexico State Department of Agriculture use the data in preparing state and county estimates of agricultural crops in New Mexico. Data generated from this project have been used in the New Mexico State Water Plan. Basic agricultural data such as these are used by many organizations and firms. Agricultural firms are anxious for this type of data. The New Mexico State Engineer Office plans to use the data generated from this project in preparing the 1975 National Water Assessment. The irrigation water use for the 1975 National Water Assessment will come from acreages derived from this project.

E. Work Remaining

Because of the use of the data generated from this project by the New Mexico State Engineer Office in the 1975 National Water Assessment, an attempt to refine the data for the 1970-1974 calendar years are currently under way. When this refinement is completed, a publication for the five-year project will be prepared.

Project No. N/A
 Project No. 3109-136
 Document No. 14-31-001- N/A
 COWRR Research Category: 5-G

PREDICTING THE QUALITY OF IRRIGATION RETURN FLOW

and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Project Began--Month: July; Year: 1972 Proj. Completed--Month: June; Year: 1974

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Peter J. Wierenga	Ph. D.	Soil Physics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Rein van Genuchten	M.S.	Soil Physics, Soil Plant Relations
Susan Gomez	B.S.	Chemistry

A. Research Project Accomplishments

During the past year a comparison was made between observed ionic distribution in large columns and those calculated using a computer program for the simultaneous transfer of water and salts in soils. The observed ionic distributions were obtained from large lysimeters irrigated with saline water of a known composition. Samples of the soil solution were removed through extraction cups at depths of 25, 50, 75, 100, 125 and 150 centimeters below the soil surface inside the lysimeters. Changes in the composition of the drainage water from the lysimeter columns was also measured. The agreement between observed and computed results was good as far as the water movement part of the model was concerned. Observed water content generally agreed with measured water contents inside the column. Observed and computed calcium distributions within the column agreed with a calcium sodium exchange constant of 3.5 was used in the computer model. The use of a calcium sodium exchange coefficient of 0.71 as published in the literature was totally inadequate for the soil in this study. The prediction of magnesium distribution within the soil profile was adequate when the calcium magnesium exchange coefficient of 0.87 was used in the model. The calcium magnesium exchange coefficient usually found in the literature is 0.67.

Comparison between observed and predicted distributions of chloride, sulfate carbonates and bicarbonates were quite adequate. It appears that the computer model used in predicting the salt distribution is adequate when proper coefficients are used for the exchange coefficients for calcium-sodium and calcium-magnesium. These coefficients were found to be quite different from those published in the literature. Values found in the literature were usually obtained under saturated conditions. However, this experiment was conducted during non-saturated flow and it is quite possible that exchange coefficients determined during saturated conditions are quite different from those obtained during actual unsaturated conditions as is normally the case under field conditions.

In a separate experiment the movement of chloride and tritiated water was measured in a field plot at the Plant Science Farm at New Mexico State University. In most cases there was agreement between observed and calculated chloride distributions, if anion exclusion, caused by the interaction of the chloride with the clay, was taken into account. Tritium was retarded by the soil. Therefore, tritium would not be a good tracer for following water movement in soils as indicated by these results. The soil at the experimental site was very layered with 65 centimeters of clay on the sandy subsoil. This layering of the soil introduced difficulties in sampling the soil solution, especially in the heavy clay layer above the sand. From this data it appears that section cups are not always adequate for sampling the soil solution in a soil profile.

b. Publications

van Genuchten, M. Th., J. M. Davidson and P. J. Wierenga. 1973. An evaluation of kinetic and equilibrium equations for the prediction of pesticide movement through porous media. Soil Sci. Soc. Amer. Proc. 38:29-35.

Cassel, D.K., M. Th. Van Genuchten and P.J. Wierenga. 1974. Simulation of nitrate and chloride movement through gardenia very fine sandy loam. Proceedings Summer Computer Simulation Conference, Houston, July 9-11, 1974.

Wierenga, P.J., M.J. Shafer and S. P. Gomez. 1973. Salinity distributions in large soil columns. Agron. Abst.

van Genuchten, M. Th. and P. J. Wierenga. 1975. Simulation of One-Dimensional Solute Transfer in Porous Media. Final Completion Report to WRR1.

c. Project Status

Project is complete.

e. Application of Research Results

Interest in movement of solutes through soil as measured in this experiment was expressed by the Environmental Improvement Agency in Santa Fe, New Mexico.

SWRT Project No. N/A
NSU Project No. 3109-144
Agreement No. 14-31-001- N/A
FCST-COWRR Research Category: 2-K

CALCIUM CARBONATE EQUILIBRIA IN SOILS
AND IRRIGATION WATERS

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico 88001

Proj. Began--Month: July 1; Year: 73 Proj. Completed--Month: June 30 ; Year: 75

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
George A. O'Connor	Ph.D	Soil Chemistry

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
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A. Research Project Accomplishments

A thorough understanding of calcium carbonate equilibria is essential to the development of computer models capable of predicting the effect of irrigation management on water quality degradation in irrigated areas.

The objective of this research were: 1) to develop a model capable of describing calcium carbonate equilibria in soil solutions, and 2) to test the model against data for calcareous soils equilibrated with waters of various compositions.

A chemical model developed previously and capable of describing calcium carbonate equilibria in aqueous systems open to the atmosphere was applied to soil systems. Published data for large lysimeters irrigated repeatedly with waters characteristic of Western United States rivers were used to verify the model.

The model is chemically sound and compares favorably with a more empirical computer model developed by the U. S. Salinity Laboratory which adequately predicts water quality changes as a function of irrigation management. Lacking further refinement of the models to include additional soil solid phases, the Salinity Laboratory model is preferable to the model based on pure calcite as dominant CaCO_3 form in soils.

Both models are capable of predicting drainage water composition, i.e. total Ca, Mg, Na, K, alkalinity, SO_4 , Cl, pH, EC and SAR given the irrigation water composition and partial pressure of CO_2 in the soil being irrigated.

B. Publications

O'Connor, G. A. and F. Cadena C. 1975. "Calcite Equilibrium in Mixed Ion Aqueous Solutions Open to the Atmosphere". Soil Science (accepted for publication). Reprint to be forwarded upon publication late in 1975.

C. Project Status

Project completed June 30, 1975. Completion report has been submitted.

D. Application of Research Results

A thorough understanding of CaCO_3 equilibria is essential to the development of computer models capable of predicting the effects of irrigation management on drainage water quality. The model used in this study, modified to consider pure calcite as the dominant CaCO_3 form in soils, has been used by the U. S. Salinity Laboratory with great success. Many other soil scientists are engaged in similar irrigation management work. The model will be used to predict the effect of irrigation management on water quality in a field study anticipated for the near future in Eastern New Mexico.

E. Work Remaining and Progress Contemplated During Next Year

N/A

OWRT Project No. N/A
NMSU Project No. 3109-145
Agreement No. 14-31-001-N/A
FCST-COWRR Research Category: 6-E

THE IMPACT OF WATER QUALITY STANDARDS ON
WATER UTILIZATION IN THE RIO GRANDE BASIN
OF NEW MEXICO

Name and Location of University Where Project is Being Carried Out:

University of New Mexico, Albuquerque, New Mexico 87131

Proj. Began--Month: July 1; Year: 1973 Proj. Completed--Month: July 1; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Dr. Shaul Ben-David	Ph. D.	Economics
Dr. William D. Schulze	Ph. D.	Economics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Began L. Whitworth	M.A.	Economics

A. Research Project Accomplishments

The Impact of Water Quality Standards on Water Utilization in the Rio Grande Basin of New Mexico project has developed a complete model of agricultural production (for six major crops) and surface water pollution for the Rio Grande Basin in New Mexico. This model includes statistically estimated equations predicting (a) the impact of acres planted on the level of total dissolved solids in the Rio Grande, (b) the impact of dissolved solids on yields, and (c) the economic losses associated with water pollution. This simulation model has been then modified to yield a pattern of agricultural production which minimizes damages associated with water pollution to agriculture by limiting acres planted upstream.

B. Publications

None

C. Project Status

The project has been completed. The final report is being prepared.

D. Application of Research Results

This study is a continuation of research begun with Project A-045-NMEX. The results will be of use to all Agencies involved in planning for the Rio Grande.

E. Work Remaining, and Progress Contemplated During Next Year

None

OWRT Project No. N/A
BBSU Project No. 3109-146
Agreement No. 14-31-001- N/A
FEST-COWRR Research Category: 6-B

Stream Organics to Evaluate Land
Management

Name and Location of University Where Project is Being Carried Out:
University of New Mexico, Albuquerque, New Mexico

Proj. Began--Month: July ; Year: 1973 Proj. Completed--Month: December ; Year: 1974

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
James R. Gosz	Ph.D.	Forest Ecology
Mary Barr	Ph.D.	Plant Biochemistry

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Stewart Bergman,	M.S.	Organic Chemistry

A. Research Project Accomplishments

The type and amount of organic matter, particulate and dissolved, present in surface water has a very real effect upon the ecological status of the stream itself as well as downstream ecosystems. The objectives of this study were to evaluate the quantity of certain N and C compounds in stream water from 4 communities; pine and juniper, mixed conifer, spruce and fir, and aspen. These studies were performed on gauged watersheds to calculate absolute quantities. Significant differences were found between the streams of different vegetational communities. Concentrations of inorganic N and dissolved C compounds were highest in the stream water of the mixed conifer community. For each community the highest concentrations of all compounds occurred during the high stream discharge following snow melt. Concentrations of tannin and lignin also were highest in the mixed conifer community while phenol concentrations

were high in both the mixed conifer and aspen communities. A number of factors are involved including organic matter accumulation, decomposition rates, plant tissue composition, evapotranspiration, and stream discharge.

B. Publications

Gosz, James R. and Mary L. Barr, "Stream Organics to Evaluate Land Management," WRRRI Report No. 051, December 1974.

C. Project Status

Completed

D. Application of Research Results

Studies of this type are rare, hence this study has provided useful information to researchers in similar fields. Both the U.S. Forest Service and the U.S. Geological Survey indicated an interest in this project and have been sent the completion report. Water quality can be a valuable tool in evaluating land management activities.

CWRT Project No. N/A
NMSU Project No. 3109-201
Agreement No. 14-31-001- N/A
FCST-COWRR Research Category: 3-F

TRICKLE IRRIGATION OF COTTON FOR
OPTIMIZING WATER USE EFFICIENCY AND
ENERGY CONSERVATION

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico 88001

Proj. Began--Month: July ; Year: 1974 Proj. Completed--Month: June ; Year: 1976

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
P. J. Wierenga	Ph. D.	Soil Physics
J. L. Fowler	Ph. D.	Plant Physiology

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Fred Eyherabide	B.S.	Horticulture

A. Research Project Accomplishments

The installation of the trickle irrigation system was completed in May, 1975. A crop of Upland cotton, Strain B8040, was immediately planted and irrigated up. An early maturing cotton strain was used in lieu of the Acala 1517-70 proposed in the project outline because of the late planting date. Both conventionally spaced cotton (40-inch rows) and double rows on 40-inch beds were planted. The stand ranged from adequate to poor and will adversely affect the yield of the crop. Failure to obtain a good stand can probably be attributed to the lack of a firm seedbed. Weeds have been a severe problem as no herbicide was applied to the plots and machine cultivation has not been adequate. Beyond the installation of irrigation system and establishment of crop, no research objectives have been accomplished. The project was funded too late (July 1, 1974) for establishment of a cotton crop in 1974.

B. Publications

None

C. Project Status

Project will continue through the next fiscal year.

D. Application of Research Results

This project supplements project 3109-313. The results of both projects will be of interest to the U. S. Environmental Protection Agency, Bureau of Reclamation and the Elephant Butte and El Paso Improvement Irrigation Districts.

E. Work Remaining, and Progress Contemplated During Next Year

Essentially all the objectives of the project are yet to be accomplished. It is anticipated that progress will continue as per outline for the 1975-76 fiscal year.

DMRT Project No. N/A
MSU Project No. 3109-202
Agreement No. 14-31-001-N/A
CST-COWRR Research Category: 3-F

REGIONAL WATER MANAGEMENT WITH FULL CONSUMPTIVE
USE, ECONOMIC-ENVIRONMENTAL RELATIONSHIPS

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: July; Year: 1974 Proj. Completed--Month: June; Year: 1976

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Robert R. Lansford	Ph. D.	Agricultural Economics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
None		

A. Research Project Accomplishments

- A. Research Project Accomplishments
After several attempts, a model has been chosen and the needed data identified and methods of obtaining it outlined.
- B. Publications
None.
- C. Project Status
Project will continue until June 30, 1976.
- D. Application of Research Results
The Water Quality Section of the New Mexico Environmental Improvement Agency has indicated a strong interest in the results of this project.
- E. Work Remaining and Progress Contemplated During Next Year
All of the analysis should be completed and a manuscript prepared during the next fiscal year.

HISTORY OF THE ELEPHANT BUTTE
IRRIGATION DISTRICT

OWRT Project No. N/A

NNSU Project No. 3109-203

Agreement No. 14-31-001-N/A

FCST-COWRR Research Category: 4-C

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico

Proj. Began--Month: Jan.; Year: 1975 Proj. Completed--Month: Aug.; Year: 1975

Principal Investigators

Degree

Discipline

Paul Lester

B. S.

History

Student Assistants 1/

Degree Held
(if any)

Discipline or Academic Background

N/A

A. Research Project Accomplishments

Thus far research at the New Mexico State University Library has led to many different sources. The U.S. Statutes at Large, House Exec. Documents, Senate Exec. Documents, the Congressional Record, House Reports, Senate Reports, the El Paso Times, and various other sources concerning the Elephant Butte project have been used.

B. Publications

None

C. Project Status

The project will continue through the summer.

D. Application of Research Results

This project will be of use to the Elephant Butte Irrigation District for Educational and Promotional purposes.

E. Work Remaining, and Progress Contemplated During Next Year

This includes more research at the New Mexico State University Library, a trip to the University of Texas at El Paso Library to look at the International Boundary Commission papers, personal interviews, and finally the actual writing of the paper.

FWRT Project No. N/A
NMSU Project No. 3109-308
Agreement No. 14-31-001-N/A
FGST-COWRR Research Category: 5-G

QUALITY AND QUANTITY OF RETURN FLOW AS
INFLUENCED BY TRICKLE AND SURFACE IRRIGATION

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico 88001

Proj. Began--Month: July ; Year: 1972 Proj. Completed--Month: Dec. ; Year: 1974

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Peter J. Wierenga	Ph. D.	Soil Physics
Ted. C. Patterson	M. S.	Agricultural Engineering

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Ron van de Pol	B.S.	Water Science and Engineering
James Sisson	M.S.	Soil Physics
Bill Boyle	B.S.	Chemistry

A. Research Project Accomplishments

Field studies were conducted to estimate the effects of improved irrigation methods on the quality and quantity of return flow to the Rio Grande. The studies included monitoring wells and a major drain in the test area, evaluating a trickle irrigation system and the evaluation of improved surface irrigation management. Due to stratification and spatial variability of the soils studied, no estimate of return flow quality or quantity could be made. It was shown that a positive salt balance could occur and that salinity was affected by the degree of wetting and drying of the soils. The trickle irrigation regime was shown to be capable of accumulating salts in the underlying sands and beyond the roots of cotton. Cotton yield and quality were presented. The water quality and quantity of flow for a major drain in the area were presented and the seasonal quality of the test wells discussed.

B. Publications

Wierenga, P.J. and T. C. Patterson. 1974. Quality of irrigation return flow in the Mesilla Valley. Proceedings of the 19th International Congress of Soil Science, Moscow, USSR, August 12-20.

Patterson, T.C. and P.J. Wierenga. 1974. Irrigation return flow as influenced by drip irrigation. Proceedings International Drip Irrigation Congress. San Diego, California. July 7-14.

Wierenga, P.J. 1973. Irrigation management and its effect on the quality of drainage return flow. Abstract in Science and Man in the Americas Desert and Arid Lands Central Theme, AAAS, Mexico City, June 20 - July 4.

Wierenga, P.J. and T.C. Patterson. 1975. The Influence of Trickle and Surface Irrigation on Return Flow. Completion Report Prepared for Office of Research and Monitoring, U.S. Environmental Protection Agency, Washington D.C.

C. Project Status

Project is complete.

D. Application of Research Results

Organizations that have an interest in this project are the City of Las Cruces, the Bureau of Reclamation, the Elephant Butte Irrigation District and the Environmental Improvement Agency in Santa Fe, New Mexico.

E. Work Remaining, the Progress Contemplated During Next Year

None

CWRRT Project No. N/A
 NMSU Project No. 3109-313
 Agreement No. 14-31-001- N/A
 WEST-COWRR Research Category: 5-G

DEMONSTRATION OF IRRIGATION RETURN FLOW,
 SALINITY CONTROL IN THE UPPER RIO GRANDE

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico
 New Mexico Institute of Mining and Technology, Socorro, New Mexico

Proj. Began--Month: Feb. ; Year: 1975 Proj. Completed--Month: Jan. ; Year: 1978

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
Robert R. Lansford	Ph. D.	Agricultural Economics
Peter J. Wierenga	Ph. D.	Soils Physics
Terry A. Howell	Ph. D.	Agricultural Engineering
Lynn W. Gelhar	Ph. D.	Hydrology
Charles M. Hohn	M. S.	Agricultural Engineering
Gene O. Ott	M. S.	Agricultural Engineering
James B. Sisson	M. S.	Soils
Bobby J. Creel	M. S.	Agricultural Economics
Fred Eyherabide	B. S.	Horticulture
Vijay P. Singh	Ph. D.	Hydrology

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Charles Siepel	B.S.	Agricultural Economics
Ming-Sun Song	B.S.	Civil Engineering
Mark Stilson	B.S.	Agricultural Engineering
C. David Updegraff	B.S.	Hydrology

A. Research Project Accomplishments

This phase of the research effort has entailed primarily planning and construction of physical equipment and structures, obtaining and testing of computer models, and obtaining cooperative agreements with the farm manager on the demonstration farm.

B. Publications

None

C. Project Status

The project began February 16, 1975, and is due to terminate February 15, 1978.

D. Application of Research Results

The U. S. Environmental Protection Agency is very interested in the reduction of salinity in the Upper Rio Grande and are supporting this project. The Elephant Butte and El Paso Improvement Irrigation Districts, and the Bureau of Reclamation are concerned with the salinity irrigation return flows to the Rio Grande and are following the research project closely.

E. Work Remaining and Progress Contemplated During Next Year

The demonstration farm will be monitored closely during the current crop year and methods will be devised to reduce return flows and implemented during the 1976 crop year. In addition, a hydro-salinity model is being tested and will be refined during the next fiscal year.

CBET Project No. N/A
 MSU Project No. 3109-401
 Agreement No. 14-31-001- N/A
 EAST-COWRR Research Category: 6-B

FEASIBILITY STUDY FOR ESTABLISHMENT OF
 ENERGY WATER COMPLEX IN THE TULAROSA BASIN

Name and Location of University Where Project is Being Carried Out:
New Mexico State University, Las Cruces, New Mexico, University of New Mexico, Albuquerque
New Mexico Institute of Mining and Technology, Socorro, New Mexico

Proj. Began--Month: Sept.; Year: 1974 Proj. Completed--Month: August; Year: 1975

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
R. R. Lansford	Ph. D.	Agricultural Economics
Bill Schulze	Ph. D.	Economics
Lynn Celhar	Ph. D.	Hydrologist
Ray Supalla	Ph. D.	Agricultural Economics
Shaul Ben-David	Ph. D.	Economics
A. R. Sanford	Ph. D.	Geoscience
Marshal Reiter	Ph. D.	Geoscience
Stanley E. Logan	Ph. D.	Nuclear Engineering
Bruce Wilson	Ph. D.	Chemical Engineering
Bill Gorman	Ph. D.	Agricultural Economics
Tom Stevens	Ph. D.	Agricultural Economics
James A. Larson	M. S.	Agricultural Economics
M. Iqbal Akhtar	Ph. D.	Agricultural Economics
Richard W. Mead	Ph. D.	Nuclear Engineering
Fred Roach	Ph. D.	Economics

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Jim Brown	B.S.	Chemical Engineering
Jennifer Zamora	B.S.	Economics

A. Research Project Accomplishments

Four coordination meetings have been held between the research investigators, and a coordinated plan for carrying out the research has been worked out for a pre-preliminary economic feasibility study for an energy-water complex in the Tularosa Basin. In addition, personnel from Los Alamos Scientific Laboratory have become active participants in the research effort.

Members of the research team are cooperating with personnel from Los Alamos Scientific Laboratory in preparing a research proposal for submission to the U. S. Energy Research and Development Agency for additional funding for this project.

Progress to Date

1. The plant size has been set at 2000 megawatts of electricity to produce one-half million acre-feet of desalted water.
2. Two areas have been identified as possible water-well field areas; one in the vicinity of Tularosa and one near Orogrande. The Tularosa site has been selected as the study site.
3. Nuclear power concepts are being reviewed as they relate to large multi-purpose applications.
4. Possible geothermal sites in the Tularosa Basin are being explored.
5. Desalting technologies and saline water resources are being reviewed to design a desalting system that will take into account the type of minerals that potentially can be recovered.
6. A survey of land ownership and use is currently under way to help in determining potential sites for the energy-water complex, location of reservoirs, and irrigated agriculture areas.
7. Economic surveys of the Tularosa Basin are being conducted to:
 - a. determine the present economic structure of the Tularosa Basin
 - b. evaluate the market potential for power, agricultural products and water.
 - c. estimate the value and marketability of recovered mineral by-products.
 - d. evaluate recreational potential resulting from the project complex.
 - e. determine the feasibility of a large-scale irrigation project using desalted water.

B. Publications

None.

C. Project Status

Project will terminate August 30, 1975.

D. Application of Research Results

The data generated from this project will be utilized by Los Alamos Scientific Laboratory in a feasibility study for establishing an energy park (10 to 30 1000-megawatt generation plants) in the Tularosa Basin of New Mexico in cooperation with the Federal Energy Administration and the Energy Research and Development Administration.

E. Work Remaining and Progress Contemplated During Next Year

The feasibility study will be completed and a manuscript prepared by August 30, 1975.

NSF Project No. N/A
 CSU Project No. 3109-312
 Agreement No. 14-31-001- N/A
 CST-COWRR Research Category: 6-D

Rio Grande Water Quality Base-Line Study

Name and Location of University Where Project is Being Carried Out:

New Mexico State University, Las Cruces, New Mexico 88601

Proj. Began--Month: Jan. ; Year: 75 Proj. Completed--Month: Jan ; Year: 1976

<u>Principal Investigators</u>	<u>Degree</u>	<u>Discipline</u>
John W. Hernandez	Ph.D	Water Resources
Robert McCaslin	Ph.D.	Soil and Water Chemistry
Andrew Bristol	M.S.	Soil and Water Chemistry

<u>Student Assistants 1/</u>	<u>Degree Held (if any)</u>	<u>Discipline or Academic Background</u>
Ralph Stumpff	B.S.	Civil Engineering
William Horne	B.S.	Civil Engineering
Robert Hill	B.S.	Civil Engineering
Glen Ford	-	Civil Engineering

A. Research Project Accomplishments

The purpose of this study is to provide a base-line for water quality under varying seasonal conditions for the Rio Grande Project in Texas and New Mexico. This research program was initiated in January 1975 with a series of discussions with representatives of the Bureau of Reclamation, the Elephant Butte Irrigation District, the U.S.G.S. Mesilla Valley Ground Water Study and the New Mexico Water Resources Research Institute. Sampling stations, procedures, and schedule were agreed upon and the chemical, biological and physical parameters to be evaluated were established during the course of these sessions. First quarter activities dealt mostly with preparations for the program sampling and analysis.

The study incorporates the collection of water samples from 45 different points on four occasions. The dates for these sampling periods were selected to represent different water-uses and seasonal conditions. As of July 1, two sample collection runs have been completed, the first in March and the second in June.

During the second quarter, the second sample collection period was carried out over a three day period in mid-June. The higher water and air temperatures encountered made it advisable to take samples back to the laboratory for analysis as soon as possible after collection. This resulted in a three-day sampling period rather than two as in the March collection run.

Some minor problems with the fecal coliform analysis surfaced during the analysis of samples from the second run. The fecal coliform procedure incorporates techniques that are sensitive to the test environment. Variations in temperature within an incubator may have caused some of the results to be questionable. After modifications in laboratory equipment were made, a supplementary set of samples was collected a few days after the initial period and these samples were evaluated for fecal coliform content. No significant inconsistencies were noted in the results of this second set of analysis.

The collection of existing water quality data for the Rio Grande Project area was continued during the second quarter. A graduate student with computer programming and statistical analysis experience was employed to carry on this work. Efforts at generalization of the data using various curve-fitting techniques were continued without much success. Visits were made to the Bureau of Reclamation and the U.S.-Mexico International Water and Boundary Commission offices in El Paso to discuss the availability of data not yet in published form.

Other accomplishments during the period April 1 to June 30 were a review of data from the first sampling run, minor adjustments of sampling locations and the addition of surfactants as a parameter. No effort has been made to utilize the results of the various analysis on the samples collected to date. Most of the chemical analysis for the second set of samples have not yet been completed.

B. Publications

None

C. Project Status

This project will continue into the new fiscal year.

D. Application of Research Results

This project is funded by the Bureau of Reclamation. The results will be of use to that agency.

E. Work Remaining, and Progress Contemplated During Next Year

Sampling and analysis will continue as scheduled. The final report will be written. This report will include a summary of all available USGS, EPA, and IWBC water quality data for the region as well as the data collected during the study.

ANNUAL REPORT - TRAINING AND EDUCATION ASPECTS
OF THE WATER RESEARCH PROGRAM UNDER P.L. 88-379

Name of University: New Mexico State University (NMSU), University of New Mexico
(or College) (UNM), New Mexico Institute of Mining & Technology (NMIMT)

REPORT THE INFORMATION SPECIFIED BELOW FOR THE UNIVERSITY AT WHICH THE WATER RESOURCES RESEARCH INSTITUTE OR CENTER APPROVED UNDER P.L. 88-379 IS LOCATED, AND FOR OTHER UNIVERSITIES WITH WHICH THE INSTITUTE OR CENTER IS COOPERATING. REPORT THE STATISTICS ON ENROLLMENTS, NUMBER OF STUDENTS GRADUATING, EMPLOYMENT STATUS OF GRADUATES, NEW COURSES, ETC., SEPARATE FOR EACH UNIVERSITY. IT IS RECOGNIZED CERTAIN OF THE REQUESTED DATA ON STUDENTS MAY NOT BE READILY AVAILABLE. IF SO, PROVIDE BEST ESTIMATE FIGURES. IN OW-9, DATA ON STUDENTS ARE REQUESTED ONLY FOR THOSE STUDENTS WHO RECEIVED EMPLOYMENT AS RESEARCH PROJECT OR PROGRAM ASSISTANTS THROUGH THE P.L. 88-379 PROGRAM. IF EXTRA SPACE IS NEEDED, ADD PAGES AND NUMBER EACH CONTINUATION ITEM IN THE ORDER SHOWN BELOW.

During period since last annual report was submitted provide information on:
(See footnote 1/ below.)

- (1) New water resources related courses developed. (Give title, state whether interdisciplinary, and give brief description of course. Please indicate if any of these were outgrowths of P.L. 88-379 program activities.)

NONE

- (2) Water resources related staff members added to fill new positions. (List highest degree obtained and scientific discipline. Indicate which ones received any salary from P.L. 88-379 funds. Do not list staff replacements.)

NMSU - Terry A. Howell, PH.D.

Agricultural Engineering

Our intent here is to obtain information on improved academic capability for water resources research and training. Indicate for each position, research facility or other item, whether support was provided in whole or in part through P.L. 88-379 funds, or from other sources; however, also list improvements supported by State or other funds.

Interdepartmental, interuniversity agreement between New Mexico State University and New Mexico Institute of Mining and Technology, WRRR Project 3109-313, "Demonstration of Irrigation Return Flow Salinity Control in the Upper Rio Grande," Funding: Environmental Protection Agency.

Interdepartmental, interuniversity agreement between New Mexico State University, University of New Mexico and New Mexico Institute of Mining and Technology, OWRR Project No. A-045-NMEX, "Analysis of Alternative Water Use Futures for the Rio Grande Region in New Mexico."

Interdepartmental, interuniversity agreement between Texas A & M University, New Mexico State University and University of New Mexico, OWRR Project No. B-046-NMEX, "Regional Water Management with Full Consumptive Use."

Interdepartmental, interuniversity agreement between New Mexico State University and New Mexico Institute of Mining and Technology, OWRR Project No. B-037, "An Interdisciplinary Analysis of the Water Resources of the High Plains of New Mexico."

Regional Agreement between Texas A & M University, Texas Water Resources Institute, and New Mexico State University, Water Resources Institute, OWRR Project No. X-134, "Systematic Analysis of Priority Water Resources Problems to Develop Comprehensive Research Program for the Southern Plains River Basins Region."

Regional Agreement between Colorado State University, Environmental Resources Center, and New Mexico State University, Water Resources Research Institute, OWRR Project No. X-138, "Development of a Colorado River - Great Basin Regional Framework for Water Research."

Interdisciplinary, interuniversity, interagency proposal submitted by the New Mexico Resources Research Institute and New Mexico Environmental Institute to The Pan American Health Organization for final review, WRRR Proposal No. 008, "Rio Grande Regional Environmental Project (A Preliminary Proposal for the Preparation of a Research Design that will lead to the Development and Implementation of a Model Environmental Management Plan for an Interstate - International Region)."

Number of students receiving employment as research project or program assistants through the P.L. 88-379 program. (Include only those students, both continuing and graduating, paid wholly or in part with P.L. 88-379 funds during the past fiscal year.)

NEW MEXICO HIGHLANDS UNIVERSITY

No. by Scientific Discipline or Major Field of Study (Engineering, Biology, Economics, etc. 2/
Scientific Discipline of Student

Number

(1) Undergraduates

Chemistry 2

(2) Master's Students

none

refers to educational background prior to employment as research assistant on P.L. 88-379 projects--not to departments in which projects are being con-

Number of students receiving employment as research project or program assistants through the P.L. 88-379 program. (Include only those students, both continuing and graduating, paid wholly or in part with P.L. 88-379 funds during the past fiscal year.)

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

Category of Students	No. by Scientific Discipline or Major Field of Study (Engineering, Biology, Economics, etc. 2/)	Number
Scientific Discipline of Student		
(1) <u>Undergraduates</u>	Biology	2
	Bio-Chemistry	2
	Chemistry	3
	Environmental Eng.	1
	Geology	2
	Pre-Veterinary	1
(2) <u>Master's Students</u>	Chemistry	1
	Geology	2
	Microbiology	1
	Physics	1

This refers to educational background prior to employment as research assistant on P.L. 88-379 projects--not to departments in which projects are being conducted.

Number of students receiving employment as research project or program assistants through the P.L. 88-379 program. (Include only those students, both continuing and graduating, paid wholly or in part with P.L. 88-379 funds during the past fiscal year.)

NEW MEXICO STATE UNIVERSITY

<u>Category of Students</u>	<u>No. by Scientific Discipline or Major Field of Study (Engineering, Biology, Economics, etc., 2/)</u>	<u>Number</u>
<u>Scientific Discipline of Student</u>		
(1) <u>Undergraduates</u>	Chemistry	1
	Civil Engineering	1
(2) <u>Master's Students</u>	Agricultural Eng.	3
	Agricultural Econ.	1
	Biology	2
	Chemical Engineering	1
	Chemistry	3
	Civil Engineering	7
	Education	1
	History	1
	Horticulture	1
	Hydrology	2
Microbiology	1	
Water Science	1	

This refers to educational background prior to employment as research assistant on P.L. 88-379 projects--not to departments in which projects are being conducted.

(Continued)

Category of Students

No. by Scientific Discipline or Major Field of Study (Engineering, Biology, Economics, etc.)

Scientific Discipline of Student

Number

(3) Doctoral Students

Animal Science

2

Chemical Engineering

1

Civil Engineering

1

Soil Chemistry

1

Soil Physics

1

(4) Postdoctoral Students

None

Number of students receiving employment as research project or program assistants through the P.L. 88-379 program. (Include only those students, both continuing and graduating, paid wholly or in part with P.L. 88-379 funds during the past fiscal year.)

UNIVERSITY OF NEW MEXICO

Table with columns: Category of Students, Scientific Discipline or Major Field of Study (Engineering, Biology, Economics, etc. 2/), Scientific Discipline of Student, Number. Includes entries for Undergraduates and Master's Students in Biology, Ecology, and Economics.

This refers to educational background prior to employment as research assistant on P.L. 88-379 projects--not to departments in which projects are being conducted.

(Continued)

Category of Students

No. by Scientific Discipline or Major Field of Study (Engineering, Biology, Economics, etc.)

Scientific Discipline of Student Number

(3) Doctoral Students

Botany 1

City Planning 2

Economics 1

Organic Chemistry 1

(4) Postdoctoral Students

None

C. Employment status of majors in water-related fields who graduated during the school year ending about June and who receive P.L. 88-379 support.

EMPLOYMENT STATUS	CATEGORY OF SCHOOL YEAR GRADUATE BY DEGREE OBTAINED			
	Bachelor's Degree	Master's Degree	Doctoral Degree	Total
1. No. employed in water-related positions in:				
Total-----	4	4		8
Federal Agencies-----	(1)	()	()	(1)
State & Local Agencies-----	(1)	(1)	()	(2)
University or College-----	()	(2)	()	(2)
Other - Including private enterprise-----	(2)	(1)	()	(3)
2. No. graduates returning to school for advanced degree-----	6	7		13
3. No. going into military service-----				
4. No. unemployed or working in other fields-----	1	4		5
5. No. status unknown-----				
6. Totals-----	11	15		26

Type of employment of those school year graduates who received P.L. 88-379 support and who are known to have gone into water-related positions. (Number should agree with total listed under item 1 of the preceding paragraph "C". Graduates enrolled for further course work or training should not be listed here as employed.)

Number of Graduates Engaged In Water-Related Work In:	CATEGORY OF SCHOOL YEAR GRADUATE BY DEGREE OBTAINED			
	Bachelor's Degree	Master's Degree	Doctoral Degree	Total
A. Federal Agencies:				
a. Primarily Research-----	1			1
b. Primarily Planning-----		1		1
c. Primarily Development-----				
d. Primarily Operations-----				
e. Primarily Management-----				
f. Other or not known-----				
B. State & Local Agencies:				
a. Primarily Research-----		2		2
b. Primarily Planning-----		3		3
c. Primarily Development-----				
d. Primarily Operations-----		1		1
e. Primarily Management-----				
f. Other or not known-----				
C. University or College: 3/				
a. Primarily Teaching-----				
b. Primarily Research-----	1	1		2
c. Primarily Research & Teaching-----	2			2
d. Other or not known-----				
D. Other - Including Private Enterprise:				
a. Primarily Research-----		2		2
b. Primarily Planning-----				
c. Primarily Development-----		1		1
d. Primarily Operations-----	2	2		4
e. Primarily Management-----			1	1
f. Other or not known-----				
Totals-----	6	13	1	20

Selected summary of above data -- from the "Total" column:

Research (1Aa, 1Ba, 1Cb, 1Cc & 1Da)-----	9
Planning (1Ab, 1Bb & 1Db)-----	4
Development (1Ac, 1Bc & 1Dc)-----	1
Operations (1Ad, 1Bd & 1Dd)-----	5
Management (1Ae, 1Be, & 1De)-----	1

Do not include here students working as research assistants and receiving course credits.

Identify by name and discipline and briefly describe instances, if any, in which the institute program, in the past year, has resulted in individuals, other than students, doing research or teaching in the water resources field, who, previously, were not involved in water work.

None

Cite any instances you know of, in which individuals who previously served as student research assistants on P.L. 88-379 projects, are now serving as professional investigators of P.L. 88-379 projects following graduation. Do not include individuals reported in this category last year or before.

Fred Roach, Ph.D., Economics, UNM,

Project B-046-NMEX and 3109-401

James Sisson, M.S., Soils, NMSU,

Project 3109-313