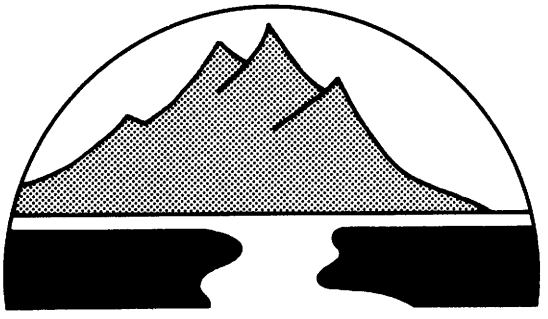
1983 Annual Report

WYOMING WATER RESEARCH CENTER



UNIVERSITY OF WYOMING
Laramie , Wyoming

WYOMING WATER RESEARCH CENTER
The University of Wyoming

Robert W. Brocksen
Director

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FISCAL YEAR 1983 PROGRAM REPORT

OF THE

WYOMING WATER RESEARCH CENTER

This Program Report of the Wyoming Water Research Center focuses on the organization, research program and activities during the period October 1, 1983 through September 30, 1984.

Robert W. Brocksen
Director

Project Number G879-01

The research on which this report is based was financed in part by the United States Department of the Interior as authorized by the Water Research and Development Act of 1978 (P.L. 95-467).

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DIRECTOR'S STATEMENT

Fiscal Year 1983

The State of Wyoming is considered to be a water producing state to the Colorado River Basin, the Snake River Basin, and the Missouri River Basin. Approximately 15.5 million acre feet of water is produced in Wyoming annually, with approximately 12 million acre feet obligated for downstream use through compacts and treaties. Wyoming has embarked on a large-scale water development program with the intended purpose of capturing for its use as much of the excess water produced as possible. The problems associated with the capture, diversion, dispersal, and re-use of these water resources are encompassing. In addition, being better able to forecast quantity and quality of water availability to downstream users is extremely important.

To address the problems and generate needed information associated with water conservation, development, and re-use, a truly interdisciplinary effort, well-managed and coordinated, is essential. The Wyoming Water Research Center is organized in such a manner and can call on the diverse set of disciplinary expertise necessary to address key issues for the state and the region.

DEDICATION CEREMONIES

The Wyoming Water Research Center was formally recognized in the State of Wyoming during dedication ceremonies held September 30, 1983 as part of the University of Wyoming's Homecoming Activities. Introduced as part of the "Dedication Symposia for New University of Wyoming Facilities and Programs in Engineering, Energy and Environment," the Director co-hosted Session 3, "Water Research: Regional and National Challenges". Specific topics included:

a) "Acid Precipitation in the West" presented by Dr. Chris Bernabo, Executive Director, National Acid Precipitation Program, The President's Council on Environmental Quality.

b) "Future Directions in Water Quality Research and Management" presented by Dr. Donald I. Mount, Research Biologist, U.S. Environmental Protection Agency, Environmental Research Laboratory, Duluth, Minnesota.

c) "The Wyoming Challenge: Quantity and Quality of Water" presented by Dr. Robert W. Brocksen, Director, Wyoming Water Research Center; and Dr. Harold Bergman, Director, Red Buttes Environmental Biology Laboratory.

Featured speaker at Dedication Ceremonies was Joseph A. Cannon, Assistant Administrator (Acting) of the Environmental Protection Agency for Air, Noise, and Radiation.

Attendance included: Donald L. Veal, U.W. President, Honorable Ed Herschler, Governor, State of Wyoming, Members of the Board of Trustees, University of Wyoming Administrators, Deans, Department Heads, Faculty, Staff and Students. An open house and a tour of the facilities followed.

ADMINISTRATION

KEY WATER RELATED PROBLEMS IN WYOMING

Water availability and allocation for agriculture, mineral extraction, industrial development, recreation, and municipal consumption continue to be the center of water related problems in Wyoming. The development of new water resources through impoundment, while complying with existing interstate water compacts, is a challenge in planning and implementation. Once additional surface and groundwater supplies are available, the equitable distribution, conservation and maintenance of quality are important and complex issues facing the State.

In an attempt to address those problems most critical to the State, the Wyoming Water Research Center (WWRC), in consultation with its Research Review and Priorities Advisory Committee, established the following three major areas of water research: 1) evaluation of historical and current water use practices; 2) demand analysis and water resources planning and 3) development of water resources. These three major areas include water quality and quantity, as well as the economic and social aspects of water research. We believe this emphasis provides a very logical, step-wise approach to addressing water research needs in the State of Wyoming. Certainly, projects dealing with the economic, technical and legal aspects of historical and current water use practices are necessary for the proper analysis of need for additional water resources development and the appropriate development of water resources can best be determined with information resulting from efforts under items 1 and 2 above. This framework should allow for a meaningful priority structure that can lead to information development germaine to the needs of the State and the western United States.

The projects funded under the U.S. Department of Interior, Federal Water Research Program for FY83 relate primarily to items 1 and 2 of the above established priorities and are listed.

Project USGS-G879-02, "Tectonic Structures Responsible for Anisotropic Transmissivities in the Paleozoic Aquifers, Southern Bighorn Basin, Wyoming" relates to priority #2 in the context of water resources documentation and potential for development.

Project USGS-G879-03, "Organic Contaminant Transport in Groundwater, Surface Water and Surface Water Sediments," is relative to both the evaluation of historical and current water use practices and the potential for water resources development (priorities #1 and #2).

Project USGS-G879-04, "Processes Controlling the Composition of Infiltrating Water in Forested Mountain Watersheds," relates to both priorities #1 and #2 in terms of water quality and quantity.

Project USGS-G879-05, "Migration of Heavy Elements in Ground Water Following Uranium Solution Mining Operations," relates to priority #1, evaluation of historical and current water use practices, as well as to the potential for the reuse of such water in priority #2 relating to water resources development.

Project UGSG-G879-06, "Water Relations of High-Elevation Salix Phreatophytes in Wyoming," is relative to both priorities #1 and #2 in the context of water quality and quantity.

Project USGS-G879-07, "Distribution of Denitrifying and Sulfate Reducing Bacteria Within a Riparian Zone Along a Mountain Stream," relates also to priorities #1 and #2 in the context of water quality and quantity.

Project USGS-G879-22, "Science in Water Resources Management and Development," is in the planning and evaluation process as it relates to all three priorities in the State of Wyoming. This project was designed to designate and gather appropriate information associated with water resources.

In keeping with the WWRC's attempt to implement priority research, we have attempted to indicate how our projects relate to the various subjects falling under our three major priorities. Figure 1 is a schematic of our program to date. The left-hand column exhibits the major research categories, while the boxes to the right are specific

projects funded under this category. Those projects with asterisks were funded using federal funds.

Figure 2 illustrates the categories of research under which specific projects fall for the federal program. These categories are based on the five year plan and priorities set under the OWP program and are reflective of our continuous priority listing.

FIGURE 1
WATER RESEARCH PRIORITIES AND PROJECTS
FUNDED BY WYOMING WATER RESEARCH CENTER
September 1984

State of Wyoming Research Area	Projects FY83-84							
Stream Structure and Management 257.8K	Conveyance Loss 47.3K	Winter Fishery 23K	**** Willow Water Relations 11K	**** Anisotropy of Paleozoic Aquifers 16.2K	WIRSOS 42K	Stream Flushing 48.8K	Bank Storage 48.5K	North Platte Mgmt. Model 21K
Water Quality 150.5K	Flaming Gorge 40K	**** Organic Contaminants 19.9K	**** Composition of Water 13.6K	**** Distribution of Bacteria 12.8K	**** Migration of Heavy Metals 15.2K	Solid Waste Practices 7K	Drinking Water Supply 3K	Contaminant Flows 39K
Watershed Development and Management 185.4K	Green River Evapotranspiration 44.4K	Snowy Range Observatory 35K	Satellite Runoff Model 19.9K	Riparian Habitat Management 20K	Acidic Deposition Evaluation 41.5K	Riparian Restoration 24.6K		
Agricultural Uses 120K	Furrow Compaction 11.9K	Pivot Irrigation Alternatives 19K	Livestock Stocking/ Riparian Vegetation 50K	Undisturbed Weighing Lysimeter 21.6K	Irrigation Practices/ Streamflow Changes 17.5K			
Information Coordination and Transfer 45.1K	Wyoming Water Bibliography 36.6K	Irrigation and Drainage Conference 2.5K	**** Water Resources Mgmt. Devlp. 6K					
Underground Water Resources 15K	Thermal Hot Springs 15K							
Hydroelectric and Geothermal Potential 20K	Geothermal 20K							
Water Quantity 122.9K	Pond Evapotranspiration 19.5K	Wyoming Climate Atlas 42K	Transpiration Water Loss 61.4K					
Waterways Construction and Development								
Economic Analysis 20.6K	Recreation Benefits 20.6K							
Trans-basin Diversion								
Water Law in Wyoming								
Multiple uses								

****Federal Water Research Program FY83

FIGURE 2
FEDERAL-USGS ADMINISTRATED
RESEARCH FOCUS FOR 1983 PROGRAM

1. Hydrologic Processes	Projects FY 83	
Montane zones	Composition of Water 13.6K	
Stream systems	Willow Water Relations 11K	Distribution of Bacteria 12.8K
Groundwater/ground-water recharge	Anisotropy of Paleozoic Aquifers 16.2K	
Agriculture/ conservation		
Water quality	Organic Contaminants 19.9K	Migration of Heavy Metals 15.8K
2. Legal Institutional & Economic Consideration in Water Management & Development		
Trans-basin diversions legal, institutional & economic concerns		
Financial alternatives for water development efficiency/equity considerations		
Conservation/high energy cost adjustments in agriculture		
Water planning models		

ADVISORY STRUCTURE

The organizational structure and operational procedures of WWRC for a high degree of accountability and relevance to state and regional water research seems to be working well. In 1982, the WWRC was restructured to include a Research Advisory and Priorities Committee appointed by the Governor of the State of Wyoming and the President of the University. The membership was designed to reflect the interests and inputs of the Executive Office, the legislative branch of government, the academic community and the University administration (Table 1). The Committee meets at least three times annually to discuss Water Center activities, research needs as they may have been perceived to change, and to approve projects presented.

Prior to presentation of projects to the Advisory Committee, a review process that includes relevant state agencies in addition to scientific peer review has been completed. This process has insured good science directed toward issues meaningful to water research needs in the state.

A Citizens Water Issues Advisory Council was formed in January 1984 and consists of members selected by the Governor and the University of Wyoming President. The Council was formulated to represent a) agriculture, b) recreation, c) municipalities, d) National Forest Service, Bureau of Land Management, Bureau of Reclamation, National Fish and Wildlife Service, e) consulting engineers, f) State Legislature, g) industry, h) environmental interests, i) private citizens, j) legal profession, k) political action groups (e.g., League of Women Voters), l) Wyoming Higher Education System, and m) state agencies. The Council is charged with collecting input from constituencies, water experts within and outside the State, and other available sources, identifying water concerns and transmitting those concerns to the Research Review and Priorities Committee. The Council met twice during FY83. Membership is listed in Table 2.

Table 1. WWRC - Research Review and Priorities Committee

Chairman:

Dick Hartman
State Planning Coordinator
Herschler Building
Cheyenne, Wyoming 82002
(307) 777-7574

Executive Secretary:

Robert W. Brocksen, Director
Wyoming Water Research Center
Room 151, VA Building
University of Wyoming
(307) 766-2143

U.W. Appointees:

Donald L. Veal, President
Office of the President
Old Main, Room 206
766-4121

Robert A. Jenkins
Vice President for Research
Old Main, Room 408
766-5353

Dennis H. Knight
Department of Botany
Aven Nelson, Room 135
766-3291

Donald J. Brosz
Agricultural Engineering
Engineering Bldg., Room 260
766-4396

(All University of Wyoming, Laramie, Wyoming 82071)

Executive Appointees:

Governor Ed Herschler
State Capitol Building
Cheyenne, Wyoming 82002
777-7434

Kenneth Kennedy
Water Development Commission
Circle Drive
Wheatland, Wyoming 82201
322-9789 (office)
322-3100 (home)

Paul Schwieger
DEPAD
Division of Water Development
Barrett Building
Cheyenne, Wyoming 82002
777-7284

Warren White (alternate)
Governor's Office
State Capitol Building
Cheyenne, Wyoming 82002

Legislative Appointees:

George R. Salisbury, Jr.
Representative, Carbon County
Savory, Wyoming 82331
383-2430

Donald R. Cundall
Senator, Goshen-Platte County
Wendover Route
Guernsey, Wyoming 82214
322-3311

Table 2

WYOMING WATER RESEARCH CENTER

Research Review & Priorities Committee

CITIZENS WATER ADVISORY COUNCIL

Myron Goodson, Chairman
Citizens Water Advisory Council
Box 2409
Sundance, WY 82729
(307) 283-2407

Walter Yose, Jr.
P.O. Box 94
LaBarge, WY 82123
(307) 386-2322

Beryl Churchill
848 Road 10-A, Route 3
Powell, WY 82435
(307) 754-4865

John Morris
10401 Experimental Farm Road
Cheyenne, WY 82009
(307) 634-7561

Jim Rumery
North Portal Road
Riverton, WY 82501
(307) 856-7477

Russell Michael
Route #2
Torrington, WY 82240
(307) 788-1711

INFORMATION DISSEMINATION

- Wyoming Water Bibliography

The Wyoming Water Bibliography, a service project requested by the State, is one of the most comprehensive, multidisciplinary, computer-based bibliographic storage and retrieval systems regarding Wyoming's water resources. Currently operational, the WWB contains approximately 12,500 citations which can be searched, free of charge, on a request basis. The User's Manual for the system is available and has been mailed to over 1,000 people in the State involved with water issues, including legislators, agency personnel, representatives of county and municipal governments, libraries, special interest groups and interested members of the private sector. Seminars have been given at all of the regional community colleges.

- Water Resources Data System

The Water Resources Data System (WRDS) has provided water related data to Wyoming researchers for over a decade. The system, through the years, has developed into the most comprehensive single source of surface and ground water quantity and quality, snow quantity and climatological data available for Wyoming. The broad applicability of the system is attested to by the variety of its users. The system has provided information to many state, federal, county and municipal agencies and private firms.

Since quality answers to research questions depend upon accurate and comprehensive information, it is important that WRDS be kept current in its data and analytical capabilities. The system was supported in total by the State Engineer's Office during the 1983-1984 biennium. Resource constraints over the past several years have limited activities on the system's data and program correction and documentation, and data updating through major sources providing magnetic tape data. During the 1985-86 biennium, the Center will cost share with the State Engineer's Office to enhance the WRDS capabilities. This enhancement project will assure that WRDS be maintained at a progressive level through the sustained reinstatement of limited manual data entry and development activities.

- Brochure

An information brochure on the Wyoming Water Research Center was designed to inform the public, state, and federal agencies, faculty and students of the mission, organizational structure, and programs of the WWRC. To date, the brochure has been distributed to universities, industry, state and federal agencies, industrial organizations, and many other private and public entities.

- Technology Transfer

UW faculty, working through the Wyoming Water Research Center, have reported their research results in professional journals and at conferences. Research results are also disseminated through technology transfer efforts by organized workshops, seminars, etc. The Water Resources Publication Series did not continue through 1983. A new publication series from the WWRC has been initiated as part of our information dissemination activities. This series will be of value to the scientific community, state and federal agencies, and to the general community of users in industry and the public sector. It is our intention to key this series to specific users and hopefully realize greater utilization of the WWRC's research results.

In addition to the above activities, the following meetings were attended and presentations made by the Water Center director, associate director and/or staff as listed below. This past year has been extremely busy with these activities and oriented toward transferring information to potential users as well as making individuals and organizations aware of the WWRC and it's activities and products.

Bridger Wilderness Pack Trip, August 12-15, 1984. Attendees included State Congressmen, U.W. President, District Forest Supervisors and Rangers, Bridger Teton National Forest, Wyoming.

Governor's Tour of Sheridan and Johnson Counties, Wyoming, June 20-22, 1984.

Fifth ASCE-EMD Specialty Conference, University of Wyoming, Laramie, August 1-3, 1984.

Department of Environmental Quality - University of Wyoming Joint Presentation on Riparian Grazing/Sediment Studies to EPA Staff, Cheyenne, WY, June 7, 1984.

Workshop on Current and Future National Water Problems and Issues as Related to Hydrology, American Institute of Hydrology, Washington, D.C, May 31-June 1, 1984.

12th International Congress on Irrigation and Drainage. Participation in Educational Exhibition at the request of Governor's Office, State of Wyoming, held in Ft. Collins, Colorado, May 28-June 2, 1984.

State of Wyoming, U.S. Forest Service and Bureau of Land Management Annual Wyoming Affairs Meeting, Cheyenne, WY, May 1, 1984, Invitation by State Planning Coordinator's Office.

Thomas Alva Edison Foundation's 23rd Science Education Conference, Eastern Michigan University, Ypsilanti, MI, April 30-May 1, 1984.

Wyoming Water Research Center Presentation to Wyoming Food and Agricultural Council, University of Wyoming, Laramie, Wyoming, April 17, 1984.

Water Resources Seminar Series: Wyoming Water Bibliography and Wyoming Water Resources Data System; Presented by Wyoming Water Research Center Staff at Western Wyoming Community College, Rock Springs, WY; Central Wyoming Community College, Riverton, WY; Northwest Community College, Powell, WY; Sheridan College, Sheridan, WY; Oil & Gas Conservation Commission, Casper, WY, Eastern Wyoming College, Torrington, WY; Laramie County Community College, Cheyenne, WY; and University of Wyoming, March 26, 1984-April 5, 1984.

Acid Precipitation Workshop sponsored by U.S. Forest Service, Colorado State University, Fort Collins, CO, March 14-15, 1984.

31st Science Institute, Thomas Alva Edison Foundation, University of Oklahoma, Norman, OK, March 12-13, 1984.

1984 Technical Meeting and 21st Annual Meeting, American Fisheries Society, Bonneville Chapter, Utah State University, Logan, UT, February 8-10, 1984.

19th Annual Meeting of American Fisheries Society, Colorado-Wyoming Chapter, Fort Collins, CO, March 7-8, 1984.

U.S. Fish and Wildlife Service Habitat Evaluation Procedures (HEP) Workshop, Denver, CO, February 27-March 2, 1984.

Second Annual Meeting of the National Acid Precipitation Assessment Program, Burlington, VT, February 13-17, 1984.

National Acid Precipitation Assessment Program Annual Meeting, Frederick, MD, January 31-February 1, 1984.

10th Annual Water Management Seminar, Eastern Wyoming College, Torrington, WY, January 9, 1984. Sponsored by Eastern Wyoming College, Wyoming Water Development Association, State Engineer's Office, Department of Economic Planning and Development, U.W. Extension Service, State Department of Agriculture and Water Development Commission.

14th Annual Water Management Seminar, Northwest Community College, Powell, WY, January 4-5, 1984. Sponsored by Wyoming Water Development Association, State Engineer's Office, Department of Economic Planning and Development, U.W. Extension Service, State Department of Agriculture, Northwest Community College, Shoshoni Heart Mountain Irrigation District, and Water Development Commission.

Future Impact of Mineral Resources on Wyoming Seminar, sponsored by Department of Geology/Geophysics, University of Wyoming, Laramie, WY, January 12, 1984.

Office of Industrial Siting Administration, Acid Precipitation, Cheyenne, Wyoming, January 6, 1984.

Wyoming Association of Conservation Districts Annual Convention, December 2, 1983, Thermopolis, WY.

Wyoming Water Development Association Annual Convention, Casper, Wyoming, November 21-22, 1983.

Content, Capabilities and Use of the Water Resources Data System, Presentation by WWRC, University of Wyoming, November 17, 1983.

U.S. Fish and Wildlife Service Water Law Shortcourse, Fort Collins, CO. November 7-9, 1983.

National Association of Water Institute Directors Annual Meeting, Arlington, Virginia, October 26-27, 1983.

Wyoming Water Research Center Seminar, University of Wyoming, Laramie, WY, October 24, 1983. "Solid Waste Disposal Research in the Electric Utility Industry," by Dr. Ishwar Murarka of Electric Power Resources Institute, Palo Alto, CA.

Water Resources Seminar Series, sponsored by Wyoming Water Research Center, University of Wyoming, September 19-October 31, 1983.

Phi Beta Phi Luncheon Meeting, discussion of Wyoming Water Research Center by Robert W. Brocksen.

Guest Lectures at the University of Wyoming, 1983-84.

Attendance at Wyoming Water Development Commission meetings, statewide.

DIRECTOR'S OFFICE ACTIVITIES

As specified in its charter, the Wyoming Water Research Center has been responsible for 1) Service, 2) Extension, 3) Research (both basic and applied) and 4) Instruction. The Director, in keeping with the Center's charter, has spent the majority of his time in organizing the following services.

1. Service:

Service to State Agencies

- Continual liaison with state agency officials.
- Basic technology transfer to state agencies and Wyoming water users and managers.
- Serve as advisor to Wyoming Water Development Commission.
- Continued attempts to integrate state and federal research programs.
- Attend Governor's Water Forum.
- Attend meetings regarding specific research projects.

University Service

- Serve on University committees.
- Continued effort to apprise faculty members of research needs and opportunities in water-related research.
- Work with academic standards committee on Water Resources curriculum.
- Serve on appropriate graduate student committees.
- Serve on appropriate national and international technical review panels.

Other

- Continued effort to be cognizant of regional and national water issues and research opportunities.
- Participation in state water resource management symposium.
- Transfer of research results to appropriate users.

2. Extension

One of the four major missions of the WWRC involves extension activities. Activities over the past year have been listed elsewhere in this report. The WWRC believes in a strong water resources extension effort and the Director is currently recruiting appropriate expertise to expand this activity using state funding. It is our intention that both state and federal research results be packaged and presented in a useful and cogent manner to maximize the utilization of research effort and results.

3. Research

- State Funded Program FY83

The State of Wyoming committed $1.2 million to the operation of the Wyoming Water Research Center for the period 7/1/82-6/30/84. Research support totalled $650,000 of this total. Projects funded by the Research Review Priorities Committee through the Wyoming Water Research Center are indicated on Figure 1 along with the federal projects.

- Federal Program FY83

Research accomplishments of the FY83 Federal Water Research Program were reviewed by the Director and are submitted herein (see page 20).

- Federal Program FY84

The Director prepared the Federal Water Research Program FY84 Request for Proposals which was distributed among interested faculty on campus. Twelve proposals were received and reviewed by state agencies, representatives of the private industry, and regional Water Institute/ Centers. Five were funded under the program.

4. Instruction

The educational program of the WWRC is unique. It is a degree program directed toward a strong interdisciplinary emphasis with special training in water resources. An academic standards committee was appointed by the Director to develop an elitist program. The committee represents eight departments on the University of Wyoming campus. The

committee recommended a program that requires joint approval of a disciplinary department and the academic standards committee of any student program. The resultant degree is awarded in the department with a water resources specialty designated on degree and transcripts. It is felt that this program serves the broadest sector of students interested in water resources and will train the diversity necessary to address water resources problems now and in the future.

WWRC STAFF ACTIVTIES

1. Service to State Agencies:

- Preparation of report for Precipitation Enhancement in Northeast Wyoming (Wyoming Water Development Commission).
- Evaluation of Impacts to Hog Park Area from Cheyenne's Stage II Water Development (Wyoming Game and Fish Department, U.S. Forest Service).
- Critique of Water Resources Section of Peacekeeper EIS (Wyoming Governor's Office).
- Critique of Hydrologic Report for Federal Flood Insurance Program (Wyoming Office of Disaster Preparedness).
- Evaluation of U.S. Fish and Wildlife Service's "Water for Energy" Program (Wyoming Governor's Office).
- Preparation of manuscript entitled "Stream Channel Modifications and Reclamation Structures to Enhance Fish Habitat" (Wyoming Highway Department).
- Hydrologic data reduction services for the Laramie River Basin Water Commissioner (State Engineer's Office).
- Wyoming Integrated River System Operation Study (WIRSOS) - a Comprehensive Hydrologic and Streamflow Basin Model-Evaluation of the Model and Use for Basins Throughout Wyoming (Attorney General's Office, Wyoming Water Development Commission and State Engineer's Office).
- Review of National Governor's Association proposed changes in acid rain control policy (Wyoming Governor's Office).
- Response to Department of Environmental Quality research needs (Wyoming State Legislature).
- North Platte River Model - Update to Evaluate New Development (Wyoming Water Development Commission and State Engineer's Office)
- SCS Triangular Flood Hydrograph Analysis Program (Wyoming State Engineer)
- Evaluation of algae problems in water supply and wastewater discharge, Laramie, Wyoming (City of Laramie).

- Participation in 12th Congress on Irrigation and Drainage, Educational Exhibition (Wyoming Governor's Office)

- Bank Stabilization on North Platte River in the town of Saratoga, Wyoming (City of Saratoga).

2. University Service

Technical staff of the Center have been involved in numerous service activities during the past 18 months for the University in general and in particular for those departments involved with water research, extension and education. These activities are as diverse as assisting with the maintenance of the Water Center Library to organizing seminars by industrial manufacturing representatives on water resources instrumentation.

RESEARCH ACTIVITIES
1983 Federal Water Research Program
14-08-0001-G879

Project synopses of individual projects funded for the Wyoming 1983 Federal Water Research Program are given on the following pages. Projects included are:

USGS G879-02 - ANISOTROPY INDUCED DISTORTIONS OF GROUND WATER FLOW FIELDS, D.L. Blackstone, Jr. and Peter W. Huntoon

USGS G879-03 - ORGANIC CONTAMINANT TRANSPORT IN GROUNDWATER, SURFACE WATER, AND SURFACE WATER SEDIMENTS, Harold L. Bergman, Michael Parker and Peter Huntoon.

USGS G879-04 - PROCESSES CONTROLLING THE COMPOSITION OF INFILTRATING WATER IN FORESTED MOUNTAIN WATERSHEDS, James I. Drever.

USGS-G879-05 - MIGRATION OF HEAVY ELEMENTS IN GROUND WATER FOLLOWING URANIUM SOLUTION MINING OPERATIONS, Michael J. Humenick.

USGS-G879-06 - WATER RELATIONS OF HIGH-ELEVATION WILLOW PHREATOPHYTES, Donald R. Young and Dennis H. Knight.

USGS-G879-07 - DISTRIBUTION OF DENITRIFYING AND SULFATE REDUCING BACTERIA WITHIN A RIPARIAN ZONE ALONG A MOUNTAIN STREAM, Quentin D. Skinner and John C. Adams.

PROJECT SYNOPSIS

ANISOTROPY INDUCED DISTORTIONS OF GROUND WATER FLOW FIELDS

D.L. Blackstone, Jr. and Peter W. Huntoon
(USGS G-879-02)

A. Objectives

The purpose of this research is to use geologic data to develop a framework model relating anisotropy of permeability to the internal structures in the Paleozoic aquifers within anticilines in the southern part of the Bighorn Basin of Wyoming. This discovery step is a necessary prelude to preparing an adequate mathematical description of these aquifers for simulation purposes. Once this crucial geohydrologic model is developed, we will be able to simulate water levels in the region as a function of fluid withdrawals (or injections of secondary recovery fluids) associated with petroleum production.

B. Research Accomplishments

Movement of groundwater in aquifers of Paleozoic age in the southern Bighorn Basin, Wyoming, is influenced by anisotropy which is the result of deformation of the sedimentary rocks. The sedimentary rocks prior to the Laramide orogeny were approximately 12,000 feet (3,657 m) thick of which approximately 2,200 feet (670 m) are of Paleozoic age. The sediments have been deformed into faulted folds ranging in size from intermontane basins (Bighorn Basin) to those with an amplitude ranging from 500 to 5,000 feet (150 - 1,500 m).

The review of the structural geology in the southern Bighorn Basin of Wyoming has established the anisotropy which effects the movement of fluids in the Paleozoic aquifers.

The major observations derived from this review are listed below.

1. Folds in the sedimentary rocks are generated by faults in the Precambrian basement and are asymmetric.

2. Reversal of asymmetry of folds is not uncommon.

3. Faults of low angle (30^{o} +) in the basement steepen upward to a ramp of sled runner form as they propagate upward through the sedimentary column.

4. Drastic thinning of the sedimentary section may occur on the steep limb of large folds. Mesozoic shale sections are particularly susceptible.

5. Reversal of asymmetry creates wedge shaped crustal segments on several scales.

6. Detachment structures occur locally, but are controlled by primary movement of faults at the basement level.

7. The displacement on faults creates anisotropy sufficient to completely disrupt the continuity of the Paleozoic aquifers at many localities.

C. Publications

Tectonic Structures Responsible for Anisotropic Transmissivities in the Paleozoic Aquifers - Southern Bighorn Basin, Wyoming, D.L. Blackstone, Jr. and Peter W. Huntoon, Research Project Technical Completion Report, (14-08-0001-G-879-02) prepared for U.S. Department of Interior, September, 1984, 83 pp., plus pocket.

D. Project Status

This one-year project has been completed effective September 30, 1984.

E. Work Remaining

None.

PROJECT SYNOPSIS

ORGANIC CONTAMINANT TRANSPORT IN GROUNDWATER,
SURFACE WATER, AND SURFACE WATER SEDIMENTS
Harold L. Bergman, Michael Parker and Peter Huntoon
(USGS G-879-03)

A. Objectives:

The objectives of the study are to (1) initiate a literature review on contaminant transport models and develop a conceptual model of contaminant transport at the Laramie River site; (2) conduct laboratory (soil column) and field experiments to investigate oil/water emulsion migration through porous media; and (3) begin a field study analyzing contaminant fate in sediments downstream from the wood-treating facility. A fourth objective, to supply the Wyoming Department of Environmental Quality (DEQ) with a summarization of contaminant transport models, was deferred to FY84 based on requests from DEQ officials to incorporate the Year 2 study and submit a single, final report.

B. Research Accomplishments

To date it appears that no models exist that adequately describe the transport and fate of complex organic mixtures in surface water and/or groundwater systems.

Lab and field studies indicate that, for multi-phase contaminant transport in ground water, there is rarely a uniform front or plume but rather small stringers and isolated globules.

Organic contaminants can be traced several kilometers downstream from the Union Pacific Tie Treatment Plant, and there appears to be heterogeneous distribution of contaminants in downstream backwater areas.

Droplets of free oil (creosote) are probably an important component of the mass flux of contaminants from the site to the river system.

The soil columns, mini-piezometers, sediment sampling methods, and analytical methods (fluorescence and HPLC) developed in FY83 have proven to be satisfactory and will be continued in the FY84 study.

The FY84 studies will require increased sampling of sediments and mini-piezometers and the use of seepage meters to better quantify the rate of contaminant movement to the Laramie River from the Tie Treatment Plant.

C. Publications

Organic Contaminant Transport in Groundwater, Surface Water, and Surface Water Sediments, Year 1 Progress Report, Michael J. Crossey and Harold L. Bergman, Research Project Technical Completion Report (14-08-0001-G-879-03) prepared for U.S. Department of Interior, September, 1984, 33 p.

D. Project Status

This one-year project has been completed effective September 30, 1984.

E. Work Remaining

None.

PROJECT SYNOPSIS

PROCESSES CONTROLLING THE COMPOSITION OF INFILTRATING WATER IN FORESTED MOUNTAIN WATERSHEDS

James I. Drever
(USGS G-879-04)

A. Objectives

The purpose of this study was to investigate the mechanisms controlling cation acquisition in the soil zone, with the long-term objective of predicting the effect of possible future acid deposition. This report discusses cation acquisition in the undisturbed system, which will form the basis of future studies on the impact of acid deposition.

B. Research Accomplishments

An experimental ecology group in the Botany Department at the University of Wyoming has been studying nutrient cycling in eight lodgepole pine (Pinus contorta) stands in the Medicine Bow Mountains of Wyoming (Fahey, 1979, 1983; Knight et al., in press). Three of these sites were selected for this study of chemical weathering; the work reported here relies heavily on the earlier work of the ecology group.

In the shallow soil (40 cm and above), soil water chemistry is dominated by biological process -- uptake by roots and release from decay in the litter layer. Below 40 cm, weathering of minerals becomes more significant.

Soil water compositions at these sites are highly variable, both spatially and temporally. The variability makes it impossible to define any simple weathering stoichiometry. Soil solutions are most concentrated in early spring, as the accumulated products of weathering and biological decay are flushed out.

Uptake by the biomass cannot be ignored in mass balance calculations for weathering in these forests. Elements (particularly potassium) accumulate in the biomass until they are released by fire, which occurs every 100 to 200 years. The biomass can be regarded as being in a steady state only for time-scales of several centuries or longer.

Kaolinite is forming near the surface and smectite at depth in the soils, even though thermodynamic calculations indicate that kaolinite should be favored at all depths. The inconsistency may be because the lysimeters tend to sample preferentially water from high-permeability channels.

Complexing by dissolved organic matter is important in the transport of aluminum and iron. Dissolved aluminum and iron correlate much more closely with dissolved organic acids than with DOC, suggesting that organic acids, rather than DOC in general, are responsible for complexing these elements. The depth at which dissolved organic compounds, and therefore aluminum and iron, are removed from soil solutions appears strongly dependent on soil permeability and infiltration rates. Adsorption on sesquioxides does not appear to be a major factor in the immobilization of dissolved organic compounds.

C. Publications

Chemical Weathering Controls of the Chemistry of Infiltrating Solutions in a Forested Watershed, Medicine Bow Mountains, Wyoming, Alex E. Blum, M.S. Thesis, University of Wyoming, May, 1984.

Processes Controlling the Composition of Infiltrating Water in Forested Mountain Watersheds, James I. Drever and Alex E. Blum, Research Project Technical Completion Report, (14-08-0001-G-879-04) prepared for U.S. Department of Interior, September, 1984, 54 pp.

D. Project Status

This one-year project has been completed effective September 30, 1984.

E. Work Remaining

None.

PROJECT SYNOPSIS

MIGRATION OF HEAVY ELEMENTS IN GROUND WATER
FOLLOWING URANIUM SOLUTION MINING OPERATIONS

Michael J. Humenick
(USGS-G-879-05)

A. Objectives

The objectives of this work were: (1) to develop a simulation model to predict the migration of heavy elements (uranium, molybdenum, vanadium, selenium, and arsenic) under conditions of one-dimensional transport in confined ground water aquifers that have been subjected to uranium solution mining operations within and down dip of the mining area; (2) to produce a model that will account for the processes of advection, dispersion, and mass transfer within the ground water system; and (3) to determine the significance of heavy element migration based on model predictions for typical Wyoming mining sites.

B. Research Accomplishments

Two simulation models are developed to predict the migration of heavy elements from a uranium solution mining zone under conditions of ground water flow. The model thus simulates the transport of residual heavy elements left behind in the mining zone after mining operations have ceased and normal conditions have returned to the aquifer. Both models are one-dimensional transport models that account for advection, dispersion, heavy element mass transfer, and sorption.

The two models differ as follows:

Model A: Mass transfer is two-directional (both to and from the solid phase) throughout the simulated domain.

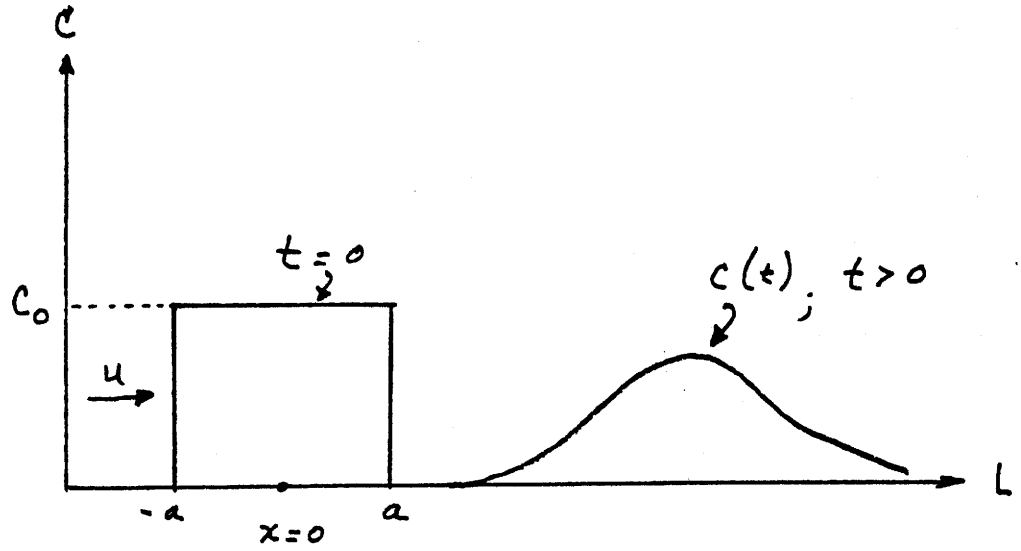
Model B: Mass transfer occurs only within the mining zone and only from the immobile phase to the mobile phase. Outside the mining zone, heavy element migration is controlled only by advection and dispersion.

A number of simulation runs were made with the models, but are not considered exhaustive. They do lead to a number of important conclusions. The simpler model B shows an increase in maximum concentrations downstream of the mining zone with increasing k and size of the mine zone, and with decreasing dispersivity α. This model is probably not very realistic in that there is no mechanism for restabilization of the metal released from the mine zone. Considering the 100-200 year time period for water to travel 1 mile, this seems unlikely, although conservative answers are obtained. Hereafter, just Model A is considered.

The dispersivity is an important parameter inversely related to the maximum downstream concentrations. In reality, the effective value of α

probably increases with distance of migration from the mine, as a greater range of hydraulic heterogeneities are encountered. α could likely be less than 1 ft. in the immediate vicinity of the mine. However, the range 10-100 ft. is probably representative for the region and type of aquifers considered.

The value of k plays a dual role. As k increases from 0.023 to 0.23 yr^{-1}, the rate of migration is greatly influenced. Already at $k = 0.23\ yr^{-1}$ the rate of migration approaches that of an equilibrium model with retardation factor $R_d = 1 + K = 21$. Further increases in k do not greatly affect the rate of migration, but they do result in an increase in maximum observed concentration. For $k = 7\ yr^{-1}$, equilibrium between the mobile and immobile phases is rapidly approached (in hydrogeologic time), and one might suggest a mathematical model as follows:



$$c(x,t) = \frac{c_o}{2}\left\{\operatorname{erf}\left(\frac{R_d a - (R_d x - ut)}{\sqrt{4R_d Dt}}\right) + \operatorname{erf}\left(\frac{R_d a + (R_d x - ut)}{\sqrt{4R_d Dt}}\right)\right\}$$

$R_d = 1 + K$

erf = error function

C_o = initial temperature

$D = \alpha u$

If the metal is reduced and stabilized according to a first order rate law, with rate coefficient λ, then the equation above would be multiplied by $e^{-\lambda t}$. The model above implies chemical equilibrium between a mobile and immobile phase, with decay (stabilization).

C. Publications

Migration of Heavy Elements in Groundwater Following Uranium Solution Mining Operations, Michael J. Humenick, Randall J. Charbeneau, and Brian Hassler, Research Project Technical Completion Report, (14-08-0001-G-879-05) prepared for U.S. Department of Interior, September, 1984, 74 pp.

D. Project Status

This one-year project has been completed effective September 30, 1984.

E. Work Remaining

None

PROJECT SYNOPSIS

WATER RELATIONS OF HIGH-ELEVATION WILLOW PHREATOPHYTES

Donald R. Young and Dennis H. Knight
(USGS-G-879-06)

A. Objectives

The objective of this research is to evaluate ecological factors affecting transpiration by phreatophytic willows (Salix spp.) along high-elevation (3,000 m) streams in the montane watersheds of southeastern Wyoming. Willows often dominate extensive areas of riparian habitat, but little is known about the hydrophysiology of these shrubs.

B. RESEARCH ACCOMPLISHMENTS

High-elevation phreatophytes were studied to identify environmental parameters influencing daily and seasonal water consumption. The water relations of Salix planifolia, S. wolfii, and Betula occidentalis at 2,865 m were similar throughout the day. Transpiration was reduced before 1,000 h as a result of dew on the leaves, but high stomatal conductances to water vapor diffusion and transpiration flux densities occurred from 1,000 to 1,600 h, resulting in a daily water loss per unit leaf area of 4.5, 5.2, and 4.0 Kg m^{-2}, respectively. The period of significant water consumption was from 10 July through 20 September.

For comparison, a site at lower elevation (2,255 m) was examined. Diurnal variations of S. exigua and S. amygdaloides at this site were similar to the high-elevation site, but maximum stomatal conductances were only 51 percent of the high-elevation Salix species. However, transpiration occurred from sunrise to sunset at lower elevations, resulting in a daily water loss of 3.7 and 3.4 Kg m^{-2} of leaf area, respectively. A midday depression in leaf conductance at the lower site may have been in response to xylem pressure potentials below -1.7 MPa. The growth season at the low-elevation site was estimated to be from 15 June to 30 September.

Although differences between the two sites occurred, the data suggest that for both sites and all species examined, stomatal conductance and seasonal water use were most influenced by solar irradiance, dew on leaves, minimum air temperatures in spring and fall, and phenology.

C. Publications

Water Relations of High-Elevation Salix Phreatophytes in Wyoming, Donald R. Young, Ingrid C. Burke, and Dennis H. Knight, Research Project Technical Completion Report, (14-08-0001-G-879-06) prepared for U.S. Department of Interior, September, 1984, 23 pp.

D. Project Status

This one-year project has been completed effective September 30, 1984.

E. Work Remaining

None.

PROJECT SYNOPSIS

DISTRIBUTION OF DENITRIFYING AND SULFATE REDUCING BACTERIA WITHIN A RIPARIAN ZONE ALONG A MOUNTAIN STREAM

Quentin D. Skinner and John C. Adams
(USGS-G-879-07)

A. Objectives

The objectives of this study were to: (1) document the distribution of denitrifying and sulfate reducing bacteria in a mountain riparian zone, and (2) to correlate numbers of organisms to stream flow, water table, soil moisture, and soil organic matter.

B. Research Accomplishments

The occurrence of denitrifying and sulfate-reducing bacteria within the riparian soils of a high mountain watershed was analyzed to determine whether their presence and distribution was related to plant community and soil depth. Denitrification potential, denitrifying bacteria, sulfate-reducing bacteria, and heterotrophic aerobic bacterial numbers were determined for three depths (5, 15, and 30 cm) in five riparian soils and one upland soil. The study was carried out within the Medicine Bow National Forest approximately 50 km west of Laramie, Albany County, Wyoming at an elevation of about 3,170 m.

The findings of this study can be summarized as follows: (1) Nitrous oxide production was higher at 5 cm than at 15 or 30 cm for the soils of riparian habitat in a high mountain watershed; (2) nitrous oxide production appeared greater in soils containing more organic matter, higher water contents, and located near to the stream; (3) denitrifying, sulfate-reducing, and heterotrophic aerobic bacteria appeared more abundant at 5 to 15 than at 30 cm depths, and, in general, increased with proximity to stream side; and (4) organic matter content and water content increased with decreasing depth and proximity to the stream's edge.

The greater apparent abundance and activity of microorganisms in close proximity to the stream's edge indicates that these soils could be of importance in protecting and regulating nutrient inputs to the stream from adjacent lands. The microbial aspects studied here if continuously monitored may provide researchers and land managers with information pertaining to activities such as grazing of livestock, wildlife and recreational use on adjacent uplands. Changes in soil moisture because of decrease in streamflow or increased user activity may well be detected by further studying these organisms and water relationships in riparian zones.

C. Publications

Denitrifying and Sulfate-Reducing Bacteria in Riparian Soils of a Wyoming Mountain Watershed, Quentin D. Skinner and John C. Adams, submitted to Journal of Range Management.

Distribution of Denitrifying and Sulfate Reducing Bacteria Within A Riparian Zone Along a Mountain Stream, Quentin D. Skinner and John C. Adams, Research Project Technical Completion Report, (14-08-0001-G-879-07) prepared for U.S. Department of Interior, September, 1984, 69 pp.

D. Project Status

This one-year project has been completed effective September 30, 1984.

E. Work Remaining

None