



COLORADO WATER

Colorado Water Resources Research Institute

Colorado State University

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FY1986 INSTITUTE PROGRAM FOCUSES ON HIGH-PRIORITY WATER PROBLEMS

The Institute's FY1986 water research and technology development program concentrates on five of Colorado's highest-priority water problems identified by the Colorado Department of Natural Resources and the Colorado Department of Health. The program includes six research projects — one at Colorado School of Mines, one at the University of Colorado, and four at CSU.

Conjunctive Surface-Groundwater Management — Augmentation, Exchanges and Substitute Supply

Principal Investigator: Dr. Lawrence J. MacDonnell
Natural Resources Law Center
University of Colorado

The effectiveness of conjunctive-use management in the South Platte Basin will be evaluated, with special emphasis on the efforts of the Groundwater Appropriators of the South Platte, Inc. (GASP). Augmentation plans have been authorized under Colorado law since 1969 and are now widely used throughout the State. A focus on activities within the South Platte Basin, where conjunctive surface and groundwater use is critical and has a substantial history, will document how well these plans have worked. Of special interest are voluntary, cooperative efforts that have enabled improved water management while preventing injury to senior appropriators. If the Colorado approach is working, it could represent an important model for other western states.

Geochemical Assessment of Aquifer Recharge Effects in the Southwest Denver Basin

Principal Investigator: Dr. Keith Turner
Geology Department
Colorado School of Mines

This research continues an investigation of the geochemistry of potential injection recharge operations in the Denver Basin, including the chemical interactions of injected water with aquifer minerals and the aquifer water. Injection recharge can cause chemical changes to the groundwater and degradation of the water supplies,

depending on the qualities of both the original water and the injected water, and on the potential for chemical reactions between the rock minerals forming the aquifer and the water chemistry.

The first phase of this research has obtained the appropriate aquifer and groundwater characteristics which could be used to evaluate the success of injection efforts. This second phase will adapt a previously developed computer model, designed for calculating the mixing effects of groundwater and recharge water, to evaluate the potential geochemical effects of aquifer recharge in the southwest portion of the Denver Basin. This will identify any potential problems that may affect the overall feasibility of recharging the aquifers by injection well.

Incentives for Improving Irrigation Efficiency in the South Platte Basin: Hydrologic and Economic Impacts Phase II

Principal Investigator: Dr. Robert A. Young
Agricultural & Natural Resource Economics Department
Colorado State University

The population of the South Platte Basin now exceeds 2 million, up from 1.2 million in 1960. The urban sector has obtained water largely by transbasin diversions and by acquiring water rights of agricultural lands being converted to urban use. A variation of the latter would be to encourage more efficient agricultural water use without forcing farmers from irrigated agriculture. Irrigation system efficiencies for agricultural water use in the basin are currently below 50 percent, which means that less than half of the water diverted from the river actually reaches the intended crop root zone. The remainder seeps back to the groundwater aquifer and thence to the stream.

This research will analyze the hydrologic and economic impacts of potential financial and institutional incentives for improving irrigation efficiency in the basin. Special attention will be given to the possibilities of using conserved water for meeting urban-industrial growth while protecting the water rights of all basin water right owners.

Reuse of Treated Wastewater by Groundwater Recharge

Principal Investigator: Dr. James W. Warner
Civil Engineering Department
Colorado State University

Land application of treated wastewaters for groundwater recharge or for disposal to the groundwater system by other means for later reuse is an attractive technology to be exploited if possible. Will objectionable components in the wastewater be removed by interaction with the soil? Will they be diluted when mixed with unpolluted groundwaters sufficiently to make the water safe again for potable reuse? If so, the treated wastewater could either be applied to the land for percolation into the groundwater system or be directly injected into the aquifer through wells. It could then be withdrawn and reused at wells located some distance away.

While many similar wastewater reuse systems are in operation nationwide, the impact of this type of reuse on the groundwater system is site-specific. It depends on the composition of the wastewater and its chemical-physical interaction with the soil and aquifer materials. The economic benefits and the ability to make full use of limited groundwater resources make wastewater reclamation and reuse by injection an important possibility.

This research is designed to provide help needed by state regulatory agencies in developing guidelines for permitting and regulation of this proposed reuse technique. The anticipated changes in aquifer water quality that result from land application of treated wastewater will be evaluated, including the fate of contaminants introduced into the groundwater. A "mixing" zone concept will be investigated which might allow dilution of the treated wastewater with the surrounding groundwater to obtain an acceptable safe concentration level of various contaminants.

Specific Yield of Denver Basin Aquifers by Nuclear Magnetic Resonance

Principal Investigator: Dr. David B. McWhorter
Agricultural & Chemical Engineering Department
Colorado State University

Groundwaters in the Denver Basin bedrock aquifers were tapped initially in the late 1800s for limited industrial use. Aquifer water use grew slowly until the 1950s when well drilling began to rapidly increase. By the early 1960s groundwater withdrawal had increased to the extent that a management policy was required. The Colorado General Assembly passed legislation giving the landowner the right to pump one percent per year of the volume of recoverable groundwater beneath his

property. This "100-year life" policy applicable to the Denver Basin bedrock aquifers requires that the specific yield be estimated in order to calculate the allowable rate of withdrawal permitted. For this reason an acceptable, objective and low-cost method for estimating specific yield of confined bedrock aquifers is needed.

This research will investigate the use of down-hole measurements based on nuclear magnetic resonance as a method of determining the specific yield of the Denver Basin bedrock aquifers. The NMR log has been used in the petroleum industry for about 15 years to estimate "effective" or "drainable" porosity, a concept that is equivalent to specific yield. Point values of specific yield determined from nuclear magnetic measurements will be compared with values determined by suction vs. water content measurements on core samples at the same point to validate the method.

Alternatives for Meeting Crane Habitat Requirements

Principal Investigator: Dr. J. T. B. Obeysekera
Civil Engineering Department
Colorado State University

Habitat conditions for migratory Whooping Crane, Bald Eagle and Least Tern on a specified section of the Platte River in Nebraska are protected under The Endangered Species Act. Minimum instream flow requirements have been proposed that would require releases of entitled water in both Wyoming and Colorado on the North and South Platte Rivers to protect habitats.

The possibility of meeting crane habitat flow requirements by alternative management of flow releases through Kingsley Dam (on the North Platte River) and Narrows Dam (a proposed project on the South Platte River) was investigated in a 1984-85 Institute project. Mean monthly flow was analyzed for 39 years of flow records and a pre-feasibility simulation model was developed to model operation of two reservoirs. In the operations studies irrigation demands were always met. Hydroelectric power production and instream habitat flows were allowed to vary in response to different reservoir operating rules. The study found that present operating policy at Kingsley Dam is not able to fulfill both power and habitat flow demands. A new operation policy was developed for Kingsley Dam that would have met habitat flow requirements had it been used in all 39 years of record except for a 22-month period between July 1955 and April 1957. With the proposed Narrows Dam in operation, irrigation water demands would cause mean annual flow at the crane habitat to be reduced by 11 percent. If Kingsley Dam flow releases were coordinated with the releases at Narrows Dam there would be no irrigation shortage, no reduction in power produc-

tion, and habitat flow would be less than required in only five out of 39 years.

The proposed habitat protection plan also provides for an upstream release of a large flow of 3800 cubic feet per second during October each year to scour out deposits and vegetative growth in the river. The modified Kingsley release plan would satisfy this demand in 31 out of 39 years. However, a smaller scouring flow of 2500 c.f.s. could be provided in 34 out of 39 years. With Narrows in operation the full scouring flow could be met in only 27 out of 39 years.

The second phase of this investigation will apply advanced hydrologic techniques to determine if there are operation alternatives for existing and planned reservoirs that could supply the minimum instream flows and periodic flushing/scouring flows at the protected river reach without reducing hydropower production or irrigation water delivery on the North and South Platte Rivers. Long-term, 1,000-year river-flow records will be generated and statistical measures of recurrence for the critical river flows — both high, sustained scouring flow and minimum flows — will be extracted from the synthetic record. The feasibility of alternative reservoir operating criteria to meet flow requirements will be investigated, and impacts of different flow management strategies will be tested.

RESEARCH IN ACTION

Advances in Reservoir Optimization Methods — A dynamic programming procedure for reservoir operations has been developed for [Bureau of Reclamation] use by Dr. Darrell Fontane of the Colorado State University Civil Engineering Department. The procedure, which was finalized this spring, allows for optimizing annual operations of series of reservoirs in terms of a specified objective function such as power generation. Operational constraints are incorporated into the model by use of penalty terms which reduce the value of the objective function when a constraint is violated.

The model has been used to study operations of the Colorado River Basin with emphasis on Lakes Mead and Powell. Results of this analysis were reported in a technical paper entitled, "**Institutional Constraints and Evaluation of Potential Management Strategies on the Colorado River System**," by Donald Frevert, Darrell Fontane, William Lane, Ronald Schuster, Michael Cowan and Varawoot Vudhivanich. The paper was presented at the American Society of Civil Engineers Irrigation and Drainage Division Specialty Conference in San Antonio on July 19, 1985.

Future research efforts will focus on expanding the

capabilities of the model to allow monthly analysis on the operations of as many as five reservoirs. Research efforts have been funded under the Advanced Hydrologic Techniques research project.

(Research News, U.S. Bureau of Reclamation, Vol. 14, No. 1, Nov., 1985, Donald K. Frevert, E&R Center)

CWRRI FY1984-85 ANNUAL REPORT DESCRIBES WATER RESEARCH ACCOMPLISHMENTS

The Institute's FY1984-85 Annual Report summarizes its 21st year of managed water research in Colorado. Research projects, technology development, public service and educational activities described in the report illustrate the practical, problem-solving purpose of the Institute program.

The report reviews progress made toward solving the following high-priority water problems that confront Colorado:

- **impact of the Endangered Species Act in Colorado**
- **low-flow criteria for effluent discharge permits**
- **meeting crane habitat requirements — South Platte River**
- **geochemistry of bedrock aquifer recharge in the Denver Basin**
- **guidelines for developing basin-of-origin compensation**
- **basinwide water system computer simulation**
- **voluntary, integrated basinwide water management**
- **estimation of evapotranspiration from natural vegetation in the Closed Basin**
- **groundwater recharge technology**
- **optimum reservoir siting and sizing**
- **drought frequency and duration analysis**
- **floodplain management and damage control**
- **urban water conservation**
- **improvements in water quality monitoring technology**
- **land treatment and disposal of sewage effluent**

The report also summarizes CWRRI's technology transfer program, funding and resource allocation, and professional training provided to graduate students.

The CWRRI FY1984-85 Annual Report is available from the Institute upon request (491-6308).

TRANSITION TO DRYLAND AGRICULTURE — SPECIAL REPORT

More than 100 people attended the symposium on **Causes and Consequences of the Transition to Dryland Agriculture** held October 29-31 in Denver. The three-day symposium included an overview of agriculture in the Great Plains and sessions on technological, institutional and policy needs for conversion to dryland agriculture.

Edwin D. Gutentag, U.S. Geological Survey, Denver, speaking on regional water availability said, "More and more wells are pumping less and less water as the water level declines in the High Plains Ogallala Aquifer." Since irrigation began, Gutentag said, water levels have declined more than 10 feet in 50,000 square miles and more than 50 feet in 12,000 miles of the aquifer. "Declines in well yields, increases in energy costs and relatively low crop prices cause many irrigators to stop operation," he said.

Dr. Robert A. Young of CSU's Agricultural and Natural Resources Economics Department told participants, "The transition . . . we're now experiencing in High Plains agriculture is much more dependent on external economic, social and political forces than it is on water supply." Young, using census data for 104 counties overlying the Ogallala Aquifer in Colorado, talked about the relationship between irrigated agriculture and employment. Census figures for 1949 showed 14.8 ag-related

jobs in each county per 1,000 acres of irrigated land. By 1980 agricultural on-farm jobs per county in the study area dropped to 3.5 per 1,000 irrigated acres. Introduction of the center pivot sprinkler, larger tractors and machinery are the major causes of this trend, he said. Average population has remained about the same during the three-decade period, while farm numbers dropped to about 30 percent less than existed in 1949.

(Young and research assistant L.R. Conklin projected the long-term outlook for irrigated agriculture supplied by the Ogallala aquifer in Colorado's High Plains in a 1982 CWRRI report, TR No. 33, \$7.00.)

The primary purpose of the symposium was to develop recommendations on local, state and federal policies needed to ease the transition from irrigated to dryland agriculture in the Great Plains including areas of Montana, Wyoming, Colorado, New Mexico, Texas, Oklahoma, Kansas, Nebraska, and North and South Dakota. The "needs" that surfaced showed that conversion from irrigated to dryland crop production was as much or more the result of the economic situation as it was the depletion of groundwater supplies.

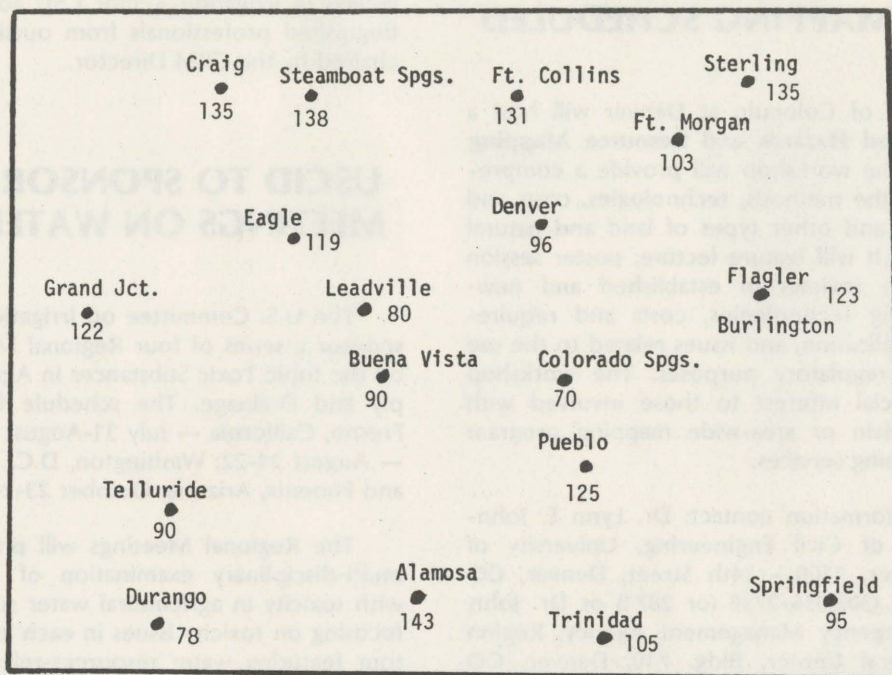
The symposium was sponsored by the Water Resources Committee of the Great Plains Agricultural Council.

CONFERENCE PROVIDES FORUM FOR REGIONAL INPUT ON CONGRESSIONAL GROUNDWATER PROTECTION AGENDA

The January 18 conference on **GROUNDWATER QUALITY PROTECTION POLICIES FOR THE ROCKY MOUNTAIN REGION AND THE NATION** drew approximately 150 participants from the Rocky Mountain region. Several Colorado members of Congress co-hosted the meeting. The conference, and five others like it in other regions of the country, will provide input for a groundwater protection agenda for the U.S. Congress as it begins debate on new groundwater initiatives. The conference featured roundtable discussions among officials from the sponsoring organizations, local and state officials, environmentalists, corporate representatives,

farm groups and others on groundwater protection needs and current programs in the region. Also considered were Federal policy options, legislation and mechanisms to implement policies through what are necessarily local and individual decisions.

Cosponsors of the conference were CWRRI, The Environmental and Energy Study Institute (Washington, D.C.), The Keystone Institute and the Colorado Department of Health. A proceedings is being printed and will be available at \$6.00 per copy from the CSU Bulletin Room (see OFF THE PRESS).



COLORADO PRECIPITATION

(PERCENT OF NORMAL)
October 1985 through March, 1986

AWF ORGANIZES SENIOR FOREIGN VISITORS PROGRAM AND FORMS INDUSTRY COUNCIL

The American Water Foundation, an affiliate of the International Committee on Irrigation and Drainage, will organize technical tours and symposia in the United States for senior foreign professionals in the water resources sectors of their countries. The program's primary objective is to increase the visitors' awareness of U.S. technical services, equipment and products through meetings, site visits and brief but intensive technical education symposia. The program will focus on policy and senior technical representatives of developing nations with the greatest need for American technical and water development expertise. Travel itineraries will encompass both private and public sector organizations and facilities.

AWF has also announced the formation of an Indus-

try Council, to be comprised of representatives from U.S. firms involved in the water resources industry. Council members will advise AWF on issues affecting the transfer of technology and thus increase the benefits of AWF programs to industry participants. AWF will also organize and host meetings between the Council and senior government personnel from both domestic and foreign agencies and provide special reports on relevant trade activities of the U.S. and foreign governments.

For additional information about the Visitors' Program or the Council contact: Michael R. Vaughan, Director of Governmental and Development Programs, American Water Foundation, MIB-Room 7518, 18th and C Streets NW, Washington, DC 20240. Telephone: (202) 343-3935.

WORKSHOP ON FLOOD HAZARDS MAPPING SCHEDULED

The University of Colorado at Denver will host a **Workshop on Flood Hazards and Resource Mapping** June 9-11, 1986. The workshop will provide a comprehensive review of the methods, technologies, costs and uses of floodplain and other types of land and natural resource mapping. It will feature lecture, poster session and demonstration reviews of established and new-generation mapping technologies, costs and requirements for their application, and issues related to the use of the maps for regulatory purposes. The workshop should be of special interest to those involved with planning a floodplain or area-wide mapping program and soliciting mapping services.

For further information contact: Dr. Lynn E. Johnson, Department of Civil Engineering, University of Colorado at Denver, 1100 - 14th Street, Denver, CO 80202. Telephone: (303)556-2739 (or 2871) or Dr. John Liou, Federal Emergency Management Agency, Region VIII, Denver Federal Center, Bldg. 710, Denver, CO 80225. Telephone: (303)235-4836.

COLORADO INSTITUTE FOR IRRIGATION MANAGEMENT FORMED

A new, university-wide institute at CSU, the Colorado Institute for Irrigation Management, will be the central campus organization for all future international, interdisciplinary irrigation research and technical assistance projects. The Institute was developed to provide institutional coordination for such projects. The Institute's task will be to assemble effective working teams from relevant colleges, departments and schools to develop new and innovative approaches to irrigation management. This will facilitate a high level of interdisciplinary collaboration that can provide research, training and technical assistance, both international and domestic.

Two world-recognized leaders in irrigation management have been selected as co-directors of CIIM during its initial developmental phase — Dr. David Karmeli and Dr. David Seckler. Dr. Karmeli is Visiting Professor of Irrigation Engineering in CSU's Department of Agricultural and Chemical Engineering. Dr. Seckler is Professor of Agricultural and Natural Resource Economics and Executive Director of ISARD, the International School for Agricultural Resource Development.

CIIM's Board of Advisors is comprised of represen-

tatives from CSU departments, schools and colleges involved in irrigation, senior CSU administrators and distinguished professionals from outside the campus. It is chaired by the CIIM Director.

USCID TO SPONSOR REGIONAL MEETINGS ON WATER TOXICITY

The U.S. Committee on Irrigation and Drainage will sponsor a series of four Regional Meetings during 1986 on the topic Toxic Substances in Agricultural Water Supply and Drainage. The schedule for the meetings is: Fresno, California — July 31-August 1; Denver, Colorado — August 21-22; Washington, D.C. — September 11-12; and Phoenix, Arizona, October 23-24.

The Regional Meetings will provide a forum for a multi-disciplinary examination of problems associated with toxicity in agricultural water supplies and drainage, focusing on toxicity issues in each area. A one-day study tour featuring water resources-related activities will be available prior to the Fresno, Denver and Phoenix meetings. Each meeting will also feature an exhibition of water resources-related goods and services.

For additional information write USCID, P.O. Box 15326, Denver, CO 80215 or call 236-6960.

J. V. WARD REGIONAL EDITOR FOR NEW WATER JOURNAL

Dr. James V. Ward, of CSU's Zoology and Entomology Department and a member of the Institute's Technical Advisory Committee, will represent the Americas as regional editor for the new Wiley Ltd. international journal, **REGULATED RIVERS**. The journal, which will commence in Autumn, 1986, will focus on research and management of regulated rivers — and be devoted to the rapid publication of scientific and technical papers on biological, ecological, engineering and geographical aspects related to both the developed and developing world. Research papers on reservoir river basin development, wetlands, estuaries, etc. will also be accepted if set in the context of the regulated river system.

The new journal's Editor-in-Chief is Dr. G. E. Petts, University of Technology, Loughborough, England. The Editorial Board for **REGULATED RIVERS** includes members from England, Canada, the Philippines, Argentina, Japan, Italy, Czechoslovakia, France and Norway.

CSU GRADUATE DEGREES IN WATER RESOURCES TOTAL 124 IN 1984-85

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A recent CWRRI poll of CSU departments shows that in 1984-85 a total of 124 students received graduate degrees in some aspect of water resources specialization. The survey was conducted at the request of the Univer-

sities Council on Water Resources (UCOWR). The following tabulation displays results of the survey which apply only to CSU. Water-oriented graduate degrees are also offered at other Colorado colleges and universities.

PH.D. DEGREES				
	Engr. & Phys. Sci.	Environ. & Biol. Sci.	Behavioral & Soc. Sci.	TOTAL
TOTAL PH.D. DEGREES	20	19	6	45
Minorities	0	0	0	0
Women	2	1	1	4
Non-U.S. Citizens	13	2	5	20
M.S. DEGREES				
TOTAL M.S. DEGREES	61	13	5	79
Minorities	4	0	0	4
Women	13	2	3	18
Non-U.S. Citizens	16	2	2	20

As reported in an earlier newsletter, a previous UCOWR survey found that CSU ranks *first* among UCOWR's 73 member universities in number of

graduate-level water resource courses offered. In fact, CSU offers twice as many courses and in more disciplines than any other U.S. university.

COLORADO WATER ISSUES PUBLIC FORUM

The Forum continues the tradition of informing the public on key statewide water issues. Each luncheon, the **3rd Tuesday of each month**, features an expert on a timely topic. **The public is invited and no reservations are required.**

TIME: 11:45 a.m.-1:30 p.m.

LOCATION: Wyatt's Cafeteria-LAKESIDE SHOPPING CENTER, Sheridan and 44th Avenue. Take I-70 to Exit 270-Harlan St., then 2 blocks south on Harlan to Lakeside Mall.

May 20, 1986 **FINANCING COLORADO'S WATER FUTURE**, Felix Sparks, Former Director, Colorado Water Conservation Board.

June 17, 1986 **OUTLOOK AND ISSUES FOR NON-POINT QUALITY CONTROL**, Scott Tucker, Manager, Urban Drainage and Flood Control District.

Please mark your calendar for the **3rd Tuesday of each month** — see you at Wyatt's.

CONFERENCES

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|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| May 1-2 | GROUNDWATER QUALITY AND AGRICULTURAL PRACTICES, Norman, OK. Contact: Debby Fairchild, Environmental and Ground Water Institute, Engineering Lab Bldg., Room 127, 200 Felgar Street, Norman, OK 73019. Telephone: (405)325-5202. | June 9-11 | WORKSHOP ON FLOOD HAZARDS AND RESOURCE MAPPING, Denver, CO. Contact: Dr. Lynn E. Johnson, Department of Civil Engineering, University of Colorado at Denver, 1100 - 14th St., Denver, CO 80202. Telephone: (303)556-2739. |
| May 11-16 | A STRATEGY FOR INCORPORATING SOCIAL AND ENVIRONMENTAL OBJECTIVES IN WATER RESOURCES PLANNING AND MANAGEMENT, Santa Barbara, CA. Contact: Engineering Foundation Conferences, 345 East 47th Street, New York, NY 10017. Telephone: (212)705-7835. | July 17-19 | WHAT WE HAVE LEARNED SINCE THE BIG THOMPSON FLOOD, Boulder, CO. Contact: Eve Gruntfest, Big Thompson Symposium, University of Colorado, Colorado Springs, CO 80933-7150. Telephone: (303)593-3513. |
| May 14-21 | INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, Baton Rouge, LA. Contact: Dr. Vijay P. Singh, Department of Civil Engineering, Louisiana State University, Baton Rouge, LA 70803. Telephone: (504)388-6697. | July 20-24 | AQUATIC PLANTS FOR WATER TREATMENT AND RESOURCE RECOVERY, Lake Buena Vista, FL. Contact: Director of Conferences, IFAS, 1041 McCarty Hall, University of Florida, Gainesville, FL 32611. |
| May 19-20 | CREATIVE THINKING STRATEGIES FOR SCIENTISTS, ENGINEERS AND PROJECT MANAGERS, Denver, CO. Contact: Battelle, 4000 N.E. 41st St., P.O. Box C-5395, Seattle, WA 98105. Telephone: (206)527-0542 or toll free 1-800-426-6762. | July 22-25 | COLD REGIONS HYDROLOGY SYMPOSIUM, Fairbanks, Alaska. Contact: Dr. Douglas Kane, Institute of Water Resources/Engineering Experiment Station, University of Alaska, Fairbanks, AK 99701. Telephone: (907) 474-7808. |
| May 20-21 | ANALYTIC TECHNIQUES IN WATER POLLUTION CONTROL, Lakewood, CO. Contact: Water Pollution Control Federation, 2626 Pennsylvania Ave., N.W., Washington, D.C. 20037. | July 23-25 | 12TH INTERNATIONAL SYMPOSIUM ON URBAN HYDROLOGY, HYDRAULIC INFRASTRUCTURES AND WATER QUALITY CONTROL, Lexington, KY. Contact: Ralph R. Huffsey, Kentucky Water Resources Research Institute, 223 Transportation Research Bldg., University of Kentucky, Lexington, KY 40506-0046. |
| May 28-30 | 16TH NAT'L CONFERENCE ON MUNICIPAL TREATMENT PLANT SLUDGE MANAGEMENT, Orlando, FL. Contact: HMCRI-Sludge, 9300 Columbia Blvd., Silver Spring, MD 20910. | August 4-6 | WATER FORUM '86 — WORLD WATER ISSUES IN EVOLUTION, Long Beach, CA. Contact: Harry Tuvel, ASCE Headquarters, 345 E. 47th St., New York, NY 10017. |
| June 2-4 | WESTERN WATER: EXPANDING USES/FINITE SUPPLIES, Boulder, CO. Contact: Katherine Taylor, Conference Coordinator, Natural Resources Law Center, Campus Box 401, Boulder, CO. 80309-0401. Telephone: (303)492-1286. | August 4-8 | INTERNATIONAL SYMPOSIUM ON DRAINAGE BASIN SEDIMENT DELIVERY, Albuquerque, NM. Contact: Professor R. F. Hadley, Department of Geography, University of Denver, Denver, CO 80208. |

August 18-22 8TH INTERNATIONAL IAHR SYMPOSIUM ON ICE, Iowa City, IA. Contact: Robert Ettema, Iowa Institute of Hydraulic Research, University of Iowa, Iowa City, IA 52242. Telephone: (319) 354-1565.

September 1986 INTERNATIONAL LARGE RIVER SYMPOSIUM TO PROVIDE AN UNDERSTANDING OF THE MANAGEMENT OF LARGE RIVERS FOR FISH PRODUCTION, Toronto, Ontario, Canada. Contact: Douglas P. Dodge, c/o Fisheries Branch, Ontario Ministry of Natural Resources, 99 Wellesley St. W., Toronto, Ontario M7A 1W3, Canada.

September 1986 INTERNATIONAL SYMPOSIUM FOR DEVELOPMENT OF NATURAL RESOURCES ALONG THE BORDER OF MEXICO AND THE UNITED STATES, Chihuahua, NM. Contact: Fernando Cadena, Box 3CE, New Mexico State University, Las Cruces, NM 88003.

October 1-3 CHAPMAN CONFERENCE ON MICROBIAL PROCESS IN THE TRANSPORT FATE AND IN-SITU TREATMENT OF SUBSURFACE CONTAMINANTS, Snowbird, UT. Contact: Microbial Process Meeting, AGU, 2000 Florida Ave., N.W., Washington, D.C. 20009. Telephone toll-free: 1-800-424-2488.

OFF THE PRESS

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\$10.00 and over	\$2.00

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CR137 THE ENDANGERED SPECIES ACT AND WATER DEVELOPMENT WITHIN THE SOUTH PLATTE BASIN, by Lawrence J. MacDonnell. \$6.00

The national policy to preserve/enhance endangered species (the Endangered Species Act of 1973) is an important constraint to flexible use and management of Colorado's water entitlement. Faculty of the University of Colorado Law School analyzed legal aspects of the Act and the limitations it potentially imposes. A major objective was to explore the legal requirements of the ESA as well as the legal limits that exist in its application. A focus of the research was Section 7 of the Act — considering the scope of ESA as expressed in the Act itself, as interpreted by the courts, and as implemented by the concerned Federal agencies.

CR138 THE POTENTIAL OF MODIFIED FLOW-RELEASE RULES FOR KINGSLEY DAM IN MEETING CRANE HABITAT REQUIREMENTS — PLATTE RIVER, NEBRASKA, by H.W. Shen, K.L. Hiew and Eric Loubser. \$7.00

This report shows how an innovative management approach can provide the low flows required for crane habitat conditions on the Platte River most of the time simply by changing the operating procedure of an existing upstream storage reservoir. The needed operating changes can be implemented without seriously interfering with existing hydropower or irrigation release requirements.

CR139 GUIDELINES FOR DEVELOPING AREA-OF-ORIGIN COMPENSATION, by Lawrence J. MacDonnell, Charles W. Howe, James N. Corbridge, Jr. and W. Ashley Ahrens. \$5.00

This research was directed toward producing a set of guidelines for use in negotiating area-of-origin compensation based on acceptable and effective alternatives to compensatory storage. Several approaches are analyzed, including: investment in improving agricultural water-use efficiency in the basin-of-origin, the creation of a development trust fund, and the purchase of instream flow rights to protect the water conditions essential for recreation and tourism in the area-of-origin.

OTHER PUBLICATIONS

FIELD SURVEY OF *GIARDIA* IN STREAMS AND WILDLIFE OF THE GLACIER GORGE AND LOCH VALE BASINS, ROCKY MOUNTAIN NATIONAL PARK, Natural Resources Report Series 85-3. Applied Research Branch, Water Resources Division, National Park Service, Fort Collins, Colorado 80521.

HYDROLOGY DAYS and the 14th Annual ROCKY MOUNTAIN GROUNDWATER CONFERENCE, by Hubert J. Morel-Seytoux and Donald O. Doehring. HYDROLOGY DAYS Publications, 1005 Country Club Road, Fort Collins, CO 80524.

The following publications are available from:

Westview Press
5500 Central Avenue
Boulder, CO 80301

IRRIGATION MANAGEMENT IN DEVELOPING COUNTRIES, CURRENT ISSUES AND APPROACHES, Edited by Kenneth C. Nobe and Rajan K. Sampath. February, 1986. ISBN 0-8133-7158-9 (sc). Book Code: NOBIRRS.

IRRIGATION INVESTMENT AND MANAGEMENT POLICIES FOR DEVELOPING COUNTRIES, edited by K. William Easter. March, 1986. ISBN 0-8133-7177-5 (sc). Book Code: EASIRRS.

NATURAL RADIOACTIVITY IN WATER SUPPLIES, by Jack K. Horner. December, 1985. ISBN 0-8133-0050-9 (sc). Book Code: HORNAT.

ENERGY AND WATER MANAGEMENT IN WESTERN IRRIGATED AGRICULTURE, edited by Norman K. Whittlesey. January, 1986. ISBN 0-8133-7086-8 (sc). Book Code: WHIENES.

FLOOD PLAIN LAND USE MANAGEMENT, A NATIONAL ASSESSMENT, by Raymond H. Burby, Steven P. French, Beverly A. Cigler, Edward J. Kaiser, David H. Moreau, and Bruce Stifftel. 1985. ISBN 0-8133-7070-1 (sc). Book Code: BURFLOS.

MUNICIPAL WATER DEMAND — STATISTICAL AND MANAGEMENT ISSUES, by C. Vaughan Jones, John J. Boland, James E. Crews, C. Frederick DeKay, and John R. Morris. ISBN 0-86531-537-X (sc). Book Code: JONMUN.

THE ACID RAIN DEBATE — SCIENTIFIC, ECONOMIC

AND POLITICAL DIMENSIONS, edited by Ernest J. Yanarella and Randal H. Ihara. August, 1985. ISBN 0-8133-7065-5. Book Code: YANACIS.

The following publications are available from:

John Wiley and Sons, Inc.
605 Third Avenue
New York, New York 10158

WATER AND WASTEWATER TECHNOLOGY, 2nd ed., by M. J. Hammer, January, 1986. ISBN 0-471-05650-2.

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