



# ARIZONA WATER RESOURCES NEWS BULLETIN

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## SOLAR-POWERED IRRIGATION PUMPS

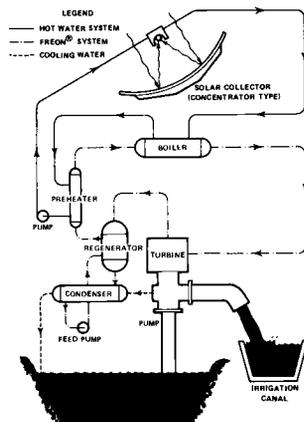
Gila Bend, Arizona, is the site of the world's largest solar-powered irrigation system, a system capable of pumping up to 10,000 gallons of irrigation water per minute.

The closed-loop system consists of a 50-horsepower pump and a 5,500-square-foot array of parabolic sun-tracking, solar-energy collectors. Water is pumped under pressure into the collectors where it is heated to high temperatures to vaporize liquid Freon in a boiler. The vaporized Freon spins a turbine to run irrigation water pumps. The system's automatic solar sensors track the sun during propitious daylight hours. During storms and dark hours, the sensors automatically rotate the collectors to a down position.

During the longest days of the year, in June, the system is capable of delivering up to 5.6 million gallons of water over a nine-and-one-half hour period. The Gila Bend system has no energy storage capability for operating over longer periods of time, but the feature can be added.

In addition to providing energy to pump irrigation water, the system can be converted in the future to dry crops and heat livestock shelters or greenhouses. Developed by the Battelle Memorial Institute, Columbus, Ohio, and supported by Northwestern Mutual Life Insurance Company, the system may provide a realistic, cheaper alternative for pumping irrigation water. Energy costs to farmers pumping irrigation water are predicted to rise at an annual rate of 15 percent. In the 17 states in the West, energy costs during 1977 are expected to exceed \$700 million.

BASIC COMPONENTS AND OPERATION OF THE NORTHWESTERN MUTUAL/BATTELLE SOLAR-POWERED IRRIGATION SYSTEM



## REPORT SAYS DEPENDABLE WATER SUPPLIES IN PORTIONS OF ARIZONA UNLIKELY BY YEAR 2000

There will be no available dependable water supplies in the southeastern quarter nor in a northeastern portion of Arizona by the turn of the century, according to a study conducted by the Center for Agricultural and Rural Development (CARD) at Iowa State University (See Figure 1).

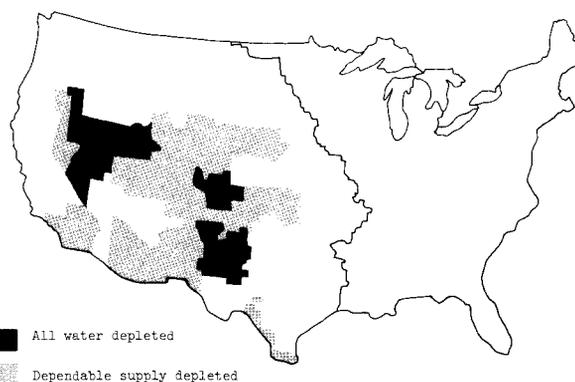


Figure 1. Producing regions that exhaust their dependable water supply under normal export demand levels

The study, *The Impact of Water Rights and Legal Institutions on Land and Water Use in 2000*, bases its finding on the assumptions that the existing systems of water rights institutions and interstate compacts are maintained while irrigated crop and livestock regions in the western United States continue utilizing all available dependable water supplies to meet normal domestic and export demand levels.

Summary and policy implications are excerpted directly from the publication and presented here.

"A national policy that eliminates water rights and real-locates existing agricultural water supplies in terms of marginal value productivities would affect the agricultural land use pattern in the United States, the concentration and stability of production, and the interregional distribution of wealth. The agricultural commodity mix, commodity prices, and efficiency of resource utilization also would be affected.

"Abolition of water rights would cause increased utilization of dryland for crops and decreased use of irrigated land for crops. The increase in required dryland acreage would be greater than the decrease in irrigated acreage, resulting in a net increase in the amount of land planted to crops. The increase in dryland acreage would be concentrated in the North Central



and South Central regions (See Figure 2). **The importance of agriculture in the western regions would decrease both in absolute terms and relative terms.** The eastern regions, although unaffected in absolute acreage, would become less important in relative terms because total dryland utilization increases. **The South Central and Southwest regions would be the residual losers as the distribution of irrigated cropland adjusts in the West.** A main effect of the abolition of water rights on agricultural land would be an increase in the dominance of the North Central region in American agriculture.



Figure 2. The Seven Major Reporting Regions

“Existing water right institutions encourage the production of high value crops and diversification of agriculture in irrigated regions. In terms of model results, if the historical production pattern established under a system of water rights were eliminated, sugar beet production would concentrate mainly in the North Central region and cotton production would concentrate in the South Atlantic region. **Cotton production would decrease 50 percent in the Southwest and by 33 percent in the South Central region.** Production of other high value crops would also become more concentrated but not to the same degree as sugar beets and cotton.

“The shift of production from irrigated cropland to dryland and the concentration and centralization of crops in more localized production areas could be justified on the basis of expected economic efficiency. However, the problem of stability of expected production is not as easily resolved. The variability of crop yields under irrigation generally is less than the variability under dryland conditions. Decreasing the contribution from irrigation and increasing the dependence on weather conditions and dryland cultivation would increase crop production variability. If dependence on annual weather conditions were increased, greater variability in output could cause greater commodity price oscillations and short-run instability.

“Concentration of production into a smaller geographical area also increases the susceptibility of production to the effects of localized weather patterns, insect build-up, and disease epidemics. Weather at planting and harvest time becomes more critical and limitations on storage and transportation systems become more important. When production of a commodity is distributed over a wider area, the isolation effect protects major portions of the crop from disease and insect attacks which begin in other areas.

“The study results indicate that the agricultural commodity mix would change if water rights were removed. Corn and sorghum production would decrease as silage becomes more important in livestock rations. Barley, oats, and wheat would increase in importance. **More soybean oilmeal would be substituted for legume hay in livestock rations as added livestock**

**production shifts from the Northwest, Southwest, and South Atlantic regions into the North Central, South Central, and Great Plains regions.**

“Less land is required to satisfy the needs of the United States under a system of water rights than in their absence. This is true because the acreage of irrigated crops with high yields is greater than under the alternative where right restrictions are not included. The institution of water rights conforms somewhat with the concept of a strategic cropland reserve which could be put into grain production under emergency conditions. Dryland not in crops can be placed in production more quickly and with lower costs than would be required for the reclamation and development of irrigated cropland. A policy that removed water rights would require a larger proportion of total land to be in crop production and would use land and water more fully in line with their comparative advantage. However, if potentially irrigable cropland, rather than dryland, were not used such a policy would decrease the flexibility of American agriculture and its ability to make short-run adjustments in production in response to major catastrophes affecting food production in any part of the world. The high cost of developing and maintaining irrigation systems makes it difficult to place cropland under irrigation for only a short period of time. Dryland is more easily moved into or out of production than irrigated land. The costs of this flexibility are represented in the greater national costs of producing the nation’s crops and livestock.

“Wealth as represented in agricultural land is the capitalized value of the income stream attributable to the use of the land. To avoid the problem of adjusting for original purchase price and subsequent capital gains, it is assumed that all capital gains have been extracted by previous owners and that the rents accruing to agricultural land represent the current rate of return on the investment which the present owner has in the land. On this basis any change in the income stream is directly proportional to the change in wealth. An increase in rent due to a change in policy can be interpreted as an annual increased return and can be capitalized to represent changes in present value at any desired rate of return. Under the condition that everyone must be at least as well off after a policy change as they were before, decreases in rents would represent the level of compensation that must be paid to those individuals who are placed in a less favorable position in order to maintain their level of income if water rights were modified.

“Under these conditions at normal export levels, a policy eliminating water rights would reduce wealth of farmers who now have irrigated land. If compensation were paid to these farmers in an amount reflected in the shadow prices generated in this study, an annual payment of \$449.7 million in compensation would be required. On the other hand, dryland farmers would realize an increased return of \$45.3 million annually. The North Atlantic region would receive \$1.7 million and the South Atlantic region \$10.3 million in increased returns. The North Central region would receive \$27.7 million in increased returns and would require compensation payments of \$34,000. Increased returns in the South Central region would be \$4.5 million while compensation payment would be \$11.7 million. No increased returns would accrue to the Great Plains region but compensation payments of \$53.6 million would be required. The Northwest region would receive \$1.2 million in increased returns and \$24.4 million in compensation payments. **Compensation payment in the Southwest region would be \$361.2 million while no increased returns would accrue in the region.**

"Under high exports, in comparison with normal exports, returns increase to \$1,107.7 million while compensation payments decrease to \$355.5 million annually if water rights are abolished and the nation's land and water are allocated optimally within this framework. This implies that as the nation's food producing capacity is approached, the limit of increased returns endowed by the policy would far exceed the compensation payments. **Positive impacts would accrue to the North Atlantic, South Atlantic, and North Central regions while negative impacts would occur in the Northwest, Southwest, Great Plains, and South Central regions,**" the report states.

#### IMPLICATIONS FOR WATER DEVELOPMENT

"With the existing system of water rights institutions and interstate compacts the analysis indicates that by the year 2000, 22 of the 58 irrigated producing regions will utilize all of their available dependable water supplies in meeting normal domestic and export demand levels. Eleven of these regions will be required to deplete their groundwater supplies. Even with this depletion, eight regions will be unable to maintain their 1975 agricultural water use levels in 2000.

"The 22 regions that exhaust their water resources are not localized but are present in each of the nine river basins in the Western United States. **The most severely affected regions are the Platte River, the Arkansas River, the Texas High Plains area, the Rio Grande River, the Upper and Lower Colorado River basins, and the Great Basin.** Nineteen of the 22 water-short areas have the potential for increasing their dependable water supplies through reservoir construction. Additional interregional transfers also are a potential method of increasing water availability in these areas," the report concludes.

*The Impact of Water Rights and Legal Institutions on Land and Water Use in 2000*, by W. Arden Colette, Earl O. Heady and Kenneth J. Nicol, is a research study completed under a grant from the National Science Foundation's RANN (Research Applied to National Needs) program. The publication, *CARD Report 70*, is available from the Center for Agricultural and Rural Development, Iowa State University, 578 East Hall, Ames, Iowa 50010.

#### WATER HARVEST FROM SURFACE-MINED AREAS

Recent studies indicate that harvesting water from surface-mined areas is a potentially valuable use for mine-spoil materials. The quality of water from mine-spoil surface runoff at a Black Mesa reclamation site on the Navajo Indian Reservation in northeastern Arizona is as good as water from unmined areas. The studies were conducted by John L. Thames, watershed management professor at the University of Arizona School of Renewable Natural Resources.

Water quality was tested by introducing the tropical fish *Talapia* into an impoundment constructed on the spoil. Survival and growth rates were considerably above those usually experienced under caged conditions. In an eight-week period survival rates were 96 percent and weight increases were 16 fold.

No toxic materials were detected in the water and abundant zooplankton were evident. Quantities of totally dissolved salts and their constituents found in the surface runoff water meet proposed standards set by the Environmental Protection Agency for drinking water.

## PUBLICATIONS

### New Source of Water Resources Information Available

A specialized bibliographic information system related to the effects of surface mining on the environment has been developed and is operational at the University of Arizona.

"The program, Surface Environment and Mining, or SEAM, is a cooperative undertaking of the Office of Arid Lands Studies (OALS) and the Colleges of Mines, Agriculture and Architecture," explains Dr. Kenneth E. Foster, project principal investigator and OALS associate director.

SEAM is a U.S. Forest Service project investigating the effects of mining on surface environs in the western United States, west of the 100th meridian to the Pacific Coast, says Mercy A. Valencia, bibliographic coordinator for the grant. However, land-use practices recorded in other regions having application to mined-surface reclamation are included in the monthly publication, *SEAMALERT*.

OALS produces and distributes *SEAMALERT*, described by Mrs. Valencia as an informational alerting service for U.S. Forest Service personnel as well as for other governmental agency personnel and persons in the public and private sectors.

Bibliographic information about literature related to mining and its effects on surface environs and about reclamation programs and research is provided in each *SEAMALERT* issue.

**Each issue contains 150 new citations with about 30 percent of them relating to water resources and management,** Foster says. Printed material ranging from governmental documents to proceedings of scientific and technical colloquia are surveyed as well as books, periodicals, bulletins and research findings. Documents dated from 1970 to the present are included in the survey.

"We limit citations to published documents," Mrs. Valencia points out, "so that persons wishing to make use of *SEAMALERT* will have actual access to the documents cited."

Citations in *SEAMALERT* contain full bibliographic information, including author name, date, title of publication, publishing source, and, if available, ordering information.

The *SEAMALERT* staff is partially involved in document delivery by aiding subscribers to obtain copies of documents cited in the publication.

Citations from each issue of *SEAMALERT* are computerized to produce a cumulative informational base. Specific information stored will be retrievable later in 1977 through queries using of the index terms published in *SEAMALERT*. This system will be known as SEAMINFO. Currently, queries are met with issues of *SEAMALERT* which contain the requested information.

"The products of project, then, are two," Foster notes. "One is the current literature alerting bulletin and the other will be the computerized information storage and retrieval system which makes use of existing OALS software."

The two-year project is funded to September 1, 1978. It is sponsored and funded by the U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station at Fort Collins, Colorado; the Environmental Protection Agency, Washington, D.C.; and the Intermountain Forest and Range Experiment Station SEAM Office at Billings, Montana.

Inquiries about *SEAMALERT* and SEAMINFO should be directed to SEAM Coordinator, OALS, University of Arizona, Tucson, AZ 85719.

### Central Arizona Project Book Published

*The Central Arizona Project 1918-1968* has been published by the University of Arizona Press. Author Rich Johnson,

executive director of the Central Arizona Project (CAP) Association since 1957, draws from personal observations to tell the behind-the-scenes story of Arizona's legal and political struggles to secure the CAP.

The 242-page, illustrated book is available from the UA Press and from bookstores. The publication costs \$11.50 clothbound and \$5.95 in paperback.

#### **Annual Summary of Arizona Groundwater Conditions Released**

Groundwater pumpage in Arizona was about 5.6 million acre-feet during 1975, according to a map report prepared by the U.S. Geological Survey (USGS) in cooperation with the Arizona Water Commission. From the beginning of record through 1975, about 160 million acre-feet of groundwater have been withdrawn from Arizona aquifers, resulting in water-level declines in many areas of the state.

The map report, *Annual summary of ground-water conditions in Arizona—spring 1975 to spring 1976*, was prepared under the direction of H.M. Babcock, USGS district chief in Arizona.

The map shows potential well production, depth to water in selected wells during spring 1976, and change in water level in selected wells during the 1971-1976 period. Groundwater pumpage is shown for 1975. Annual and accumulated groundwater pumpage since the beginning of record is tabulated.

Report copies are available for distribution at the Arizona Water Commission, 222 N. Central Ave., Suite 800, Phoenix, and at USGS offices in Room 5-A Federal Building, 301 W. Congress St., Tucson; Suite 1880, Valley Center, Phoenix; Building 3, 2255 N. Gemini Drive, Flagstaff; and 1940 S. 3rd Ave., Yuma. The report may be perused at USGS office in Room 5312, National Center, 12201 Sunrise Valley Drive, Reston, VA.

*Monitoring Groundwater Quality: Economic Framework and Principles* is a 107-page report, PB-260 919/6WN, available for \$5.50 from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

Divided into five sections, the report defines the major causes of excessive pollution as resulting from poor specification of groundwater property rights and discusses groundwater

adjudication and legislation; overall costs and benefits deriving from groundwater quality monitoring; monitoring needs to establish quality standards and standards enforcement, along with a cost-benefit framework to analyze groundwater quality monitoring; and an alternative approach based on waste relocation rights for property owners.

*Remote Sensing of the Environment* consists of 20 largely nonmathematical papers outlining how aircraft and spacecraft surveillance can contribute effectively to environmental assessments, and natural resource evaluation and development. Areas addressed include agriculture, forestry, hydrology, and oceanography. Edited by Joseph Lintz Jr. and David S. Simonett, the 694-page, hardcover book is available for \$27.50 from Addison-Wesley, Advanced Book Programs, Reading, MA 01867.

*Irrigation Efficiency: A Bibliography, Volume 2* reports the information base of Selected Water Resources Abstracts during the period March 1973-September 1976. The volume, *OWRT/WRSIC 76-206*, is available from the Water Resources Scientific Information Center, Office of Water Research and Technology, U.S. Department of the Interior, Washington, DC 20240.

A finite-element model for mathematically predicting flood hazards from specific land-use practices is available in *Predicting Flood Hazards*.

The 118-page publication, *Bulletin 99*, is available from the Virginia Water Resources Research Center, Virginia Polytechnic Institute, Blacksburg, VA 24061.

Please address your news items or comments on the News Bulletin to any of the three editors:

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