New Waves
The Research Newsletter of the Texas Water Resources Institute
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TWRI-Funded Projects Will Tackle Water Quality, Rural Water Issues

The Texas Water Resources Institute will fund six research projects this year and five of the six relate directly to water quality. The projects began September 1.

Work at Texas Christian University by biologists Kyle Hoagland and Ray Drenner will deal with methods to assess the impact of pesticides on aquatic systems. Using 30,000-gallon, fiberglass storage tanks on the TCU campus, the researchers will carry out experiments to examine the combined effect of a herbicide (atrazine) and an insecticide (bifenthrin) on non-target species. The research could provide insights into problems caused by agricultural runoff into rivers and lakes. Results could lead to better recommendations for chemical use and surface water protection.

Controlling pollution from runoff in urbanized areas through the use of natural vegetation is the focus of a research project to be conducted by Tom Thurow of the Range Science Department at Texas A&M University. The research will consist of field experiments where filter strips comprised of oak trees, bunch grass and sod grass will be evaluated on different slopes along parts of Barton Creek in Austin. The study, which is being co-sponsored by the City of Austin, will determine if natural vegetation is effective at removing pollutants from urban runoff and may lead to better scientific-based designs for filter strips.

Work at the Civil Engineering Department of the University of Texas at Austin is seeking to extend and refine the existing data base about sediment transport into bays and estuaries. The research, which is being led by Ed Holley, is using quantitative measurements to define spatial and temporal characteristics in the flow channel of coastal rivers. In the study, sediment samples will be taken from the delta region of San Antonio Bay near the confluence of the Guadalupe and San Antonio rivers. Results could provide data to understand how varying amounts of freshwater inflows impact the amount of sediments transported to bays and estuaries.

The impact of the dairy industry in Erath County on groundwater quality is the focus of a study by agricultural engineers John Sweeten and Mary Leigh Wolfe of Texas A&M University. Sweeten, a specialist with the Texas Agricultural Extension Service, and Wolfe, a researcher in the Agricultural Engineering Department, have been monitoring dairy operations in the region to determine if groundwater and surface water supplies are being affected. A number of dairies which have large numbers of cows confined to small

amounts of acreage have moved into the area since the early 1980s. There are concerns that runoff of animal wastes may degrade surface water quality and nitrogen may leach into soils and pollute aquifers. Results will be used to assist dairy operators in designing and operating waste treatment and disposal facilities to protect water quality, and in planning the number of dairy cows per acre that can safely be utilized before water quality is threatened.

The toxic potential of municipal landfills is being investigated in a project led by Kirk Brown of the Soil and Crop Sciences Department at Texas A&M University. The study involves sampling water samples and leachate from five selected landfills to define if chronic toxic problems are present. Bioassays using living organisms will then be used to determine if the pollutants present in the landfills cause mutations. The study may help decision-makers determine if more strict regulations are needed to prevent pollution from such landfills. It will also provide community leaders with information they can use to develop risk benefit analyses that could compare alternative methods of treatment and health risks.

Emerging issues in rural water systems are being targeted by researchers at East Texas State University. Raghu Singh of the Sociology and Anthropology Department and Norm Ellerbrock of the Agricultural Sciences Department are studying problems that face rural water supply corporations including water losses, water pollution, rising water costs and new legislation. The research involves surveying leaders and consumers of 12 rural water systems in four regions of Texas, sending questbnnaires to roughly 200 rural water systems, and collecting additional information. Results will help evaluate the effectiveness of rural water systems and allow decision-makers to learn about specific problems of rural water supplies.

For additional information on any of these projects, contact the Texas Water Resources Institute at (409) 845-1851.

Taste and Odor Problems at Waco Lake

Researchers: Owen Lind and Samuel Katzif, Biology Department, Baylor University, Waco, TX.

Problem: Earthy tastes and odors have been a problem in drinking waters supplied by Waco Lake since the 1960s. Problems can last for as long as several weeks from March to October.

Objectives: To determine environmental factors which produce taste and odor problems in Waco Lake.

Methodology: An actinomycete (a bacterium that resembles fungi) was utilized as the test organism. Samples were taken from mud and bottom sediments of the lake. Actinomycetes were identified to genus levels. Two species which produced the most intense odors were selected for additional analyses. The organisms were subjected to nitrate and ammonia nitrogen at various concentrations. The Threshold Odor Number

(TON) procedure was utilized to compare odors produced by the actinomycete under different nitrogen forms and concentrations. A panel smelled the odors and characterized them as being none, faint, mild or definite.

Results: Growth of the test organism was governed by the concentration of nitrogen but not by the form. Odors in the water increased with increasing nitrogen concentrations but not with the form of nitrogen supplied. The ratio of odors to mass of the actinomycete was more influenced by the form of nitrogen (ammonia) than by nitrogen concentrations. Results suggest that nitrogen concentration may be a controlling factor in the production of taste and odor problems in the lake.

Related Publications: Owen Lind and Samuel Katzif, "Nitrogen and the Threshold Odor Number Produced by an Actinomycete Isolated from Lake Sediments," *Water Science and Technology*, New York, NY, Vol. 20, No. 8,1988.

Using Dye Tracing to Define Subterranean Streams

Researchers: Albert Ogden, Edwards Aquifer Research and Data Center, Southwest Texas State University, San Marcos, TX.

Problem: Texas water law states that landowners also own groundwater beneath their property, unless it can be shown that well- defined subterranean streams are present. However, defining the existence of underground rivers is difficult.

Objectives: To utilize tracer dyes to determine the origin of Old Faithful Spring in Real County and San Marcos Springs.

Methodology: Old Faithful Spring near the City of Camp Wood emerges from the Glen Rose Limestone formation. The source of the spring was thought to be Camp Wood Creek. Tributaries of the creek have cut into the Edwards and Glen Rose limestone formations. The creek was traced to the spring using green (flourescein) and red (rhoadime) dyes and optical brighteners. Packets of activated charcoal were placed at the springs to absorb the dye and were later retested in the laboratory. The same tracers and analytical methods were used at six orifices at San Marcos Springs.

Results: Dyes from the Old Faithful Spring experiments traveled four miles in 24 hours. Based on the velocity and movement of the dye from the creek to the spring, and the amount of dye present (the spring waters turned visibly green shortly after the dye arrived), the Texas Water Commission decided that the spring was part of a well defined subterranean stream and should be regulated as surface water. In the studies at San Marcos Springs, the concentration of the dyes never exceeded the lowest detectable limit although the charcoal samples indicated the dye traveled 1500 feet per day. Results suggest that more than 94% of the springflow emerging from San Marcos Springs originates from the main portion of the Edwards Aquifer to the west although small amounts of localized recharge also contribute to springflow.

Related Publications: Albert Ogden, "Dye Tracing: Its Application to Groundwater Law for Defining 'Subterranean Streams' in Karst Terranes," *Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference,* National Water Well Association, Dublin, OH, 1986.

Increasing the Efficiency of Agricultural Chemical Application Through the MultiFunction LEPA System

Researchers: William Lyle, James Bordovsky, Edsel Bynum and Thomas Archer, Texas Agricultural Experiment Station (TAES), Lubbock, TX.

Study Duration: 1985 to 1987.

Problem: Traditional methods of distributing agricultural chemicals including aerial application and chemigation (applying chemicals through traditional sprinkler systems) are often inefficient and expensive. As a result, excessive amounts of chemicals may be applied posing a threat to the environment and greater expenses to individual farmers.

Background Information: In the early 1980s, TAES scientists developed the Low Energy Precision Application (LEPA) system which saves water and energy by applying water near the plant surface at low pressure. A modification of that system, called "multifunction LEPA," has been developed to efficiently apply insecticides and other agricultural chemicals. Multifunction LEPA utilizes two sets of nozzles - one for applying water and chemicals and another for just applying chemicals. The spraying angle of the nozzles can be adjusted and programmed to move up and down the plant.

Objectives: To compare the efficiency of the multifunction LEPA system versus other methods in applying agricultural chemicals to specific crops.

Methodology: Tests compared the efficiency of multifunction LEPA, stationary overhead sprinklers and aerial application. The chemical Lorsban was used to control greenbugs in grain sorghum. Three chemicals were used to control corn pests: Azodrin and Comite were applied to fight grass and spider mites, and Dipel was used to combat borers.

Results: Agricultural chemical application with the multi- function LEPA system was superior to overhead chemigation in every test and was far superior to aerial application in tests where the two methods were compared. The system controlled greenbugs using only 6% of the labeled amount. Mites were effectively controlled with multi- function LEPA because the nozzles sprayed the underside of leaves where the mites resided; overhead chemigation did not control the mites. Fewer corn plants were damaged by borers when the multi- function LEPA system was utilized.

Related Publications: William Lyle, James Bordovsky, et al., "In- Canopy Chemigation for Increased Efficiency," Presented at 1988 International Summer Meeting of the American Society of Agricultural Engineers, St. Joseph, Ml, 1988.

Community Water Demand in Texas

Researchers: Ron Griffin and Chan Chang, Agricultural Economics Department, Texas A&M University, College Station, TX.

Study Period: 1981 - 1985

Problem: Anticipated growth in Texas' population and economy will place increased pressure on the state's natural resources, including water. As developing new water supplies, including reservoirs, becomes more costly, communities may turn to pricing mechanisms and rate structures as part of a demand management strategy. Studies need to be conducted to determine the ways in which water prices affect demands.

Objective: To analyze water demands for selected Texas communities and to investigate the influence of water pricing and selected demand factors on domestic and municipal water demands.

Methodology: Surveys were mailed to 1140 Texas water systems having more than 500 connections, and 47% responded. Follow- up telephone surveys were also conducted. Eventually, 255 communities were selected for analysis. Data were also provided by the Texas Water Development Board on per capita monthly water use and groundwater use and the Texas Natural Resources Information System supplied census and climate data. Variables in the study included per capita daily water use, household average price, household marginal price, per capita income, percentage of population with Spanish origin, number of days without rainfall, monthly average temperature, and average annual precipitation. Economic analyses were conducted using linear demand models, logarithmic models, and an original supply model using both real and nominal price variables. Monthly price elasticities were also computed.

Results: Monthly and annual water use were calculated and results were grouped according to community size and geographic region. Other analyses identified water and sewer rate structures and marginal water and sewer prices by year. Monthly and annual water and sewer bills were calculated by year, region, and community size. Regression analyses suggest that Texas consumers respond to high water prices by reducing demands, especially during the summer months, and that sewage rates represent a statistically significant component of water price.

Related Publications: Ron Griffin and Chan Chang, *Community Water Demand in Texas* (TR- 149), Texas Water Resources Institute, Texas A&M University, College Station, TX,1989. Also published as TAES report B1625 by Texas Agricultural Experiment Station, Texas A&M University, College Station, TX.

Assessing Water Quality Using Covariant Analyses

Researchers: Kenneth Dickson, John Rodgers, and Frederick Fisher, Inst. for Applied Sciences, Univ. of North Texas, Denton, TX; Keith Anderson, Texas Water Commission, Tyler, TX; and John Slocomb, International Paper Co., Tuxedo Park, NY.

Problem: The relative importance of factors that influence water quality is difficult to determine using routine monitoring. Although monitoring data usually focus on the effect of effluent discharges, other factors including seasonal patterns, storms, river flows, and pollutant concentrations also influence water quality in rivers and streams. These factors cannot be readily separated using standard statistical approaches.

Objective: To utilize covariant analysis to separate variations in water chemistry concentrations into components that can be attributed to different factors.

Methodology: The study area included the Sulphur River between Wright Patman Reservoir in northeast Texas and the confluence of the Sulphur River and the Red River in Arkansas. Along this stretch, the river is impacted by effluents from a paper mill and the City of Texarkana sewage treatment plant. Monthly samples were collected from July 1980 to November 1981 at nine sampling stations. Analysis of covariance (ANCOVA) was used to develop curves to estimate the response of chemical and biological parameters to river flows at particular times and locations. Curves were developed for water chemistry parameters including apparent color, true color, conductivity, hardness, total dissolved solids, sulfate, dissolved organic carbon, biochemical oxygen demand, chlorophyll and other factors and for in- stream concentrations of chloride, ammonium, nitrate and total suspended solids. Samples were grouped according to the presence or absence of discharges from the paper mill. Additional analyses were also performed to investigate unexplained variances.

Results: Total dissolved solids were affected by effluents both from the paper mill and the wastewater treatment plant. Six parameters were only affected by the municipal wastewater treatment plant, three parameters were affected only by the paper mill effluent and five parameters showed a response to riverflows. Most parameters showed decreasing concentrations as river flows increased. Study results suggest that, in the absence of effluents, stream chemistry in the area is mainly affected by processes occurring within and upstream of the lake and stream system. Relatively high values of chlorophyll, organic carbon, and dissolved oxygen occurred at low river flows.

Related Publications: Frederick M. Fisher, Kenneth L. Dickson, John H. Rodgers, Jr., Keith Anderson and John Slocomb, "A Statistical Approach to Assess Factors Affecting Water Chemistry Using Monitoring Data," *Water Resources Bulletin*, Washington, DC, October 1988.

Impacts of Mosquitofish on Zooplankton and Chlorophyll Levels, and Water Clarity

Researchers: Ray Drenner and J. D. Smith, Biology Department, Texas Christian University (TCU), Fort Worth, TX.

Problem: Fish that eat microscopic plant and animal organisms called plankton may alter the size and distribution of plankton in lakes. This may impact phytoplankton (microscopic algae) levels and water quality. Most studies on this subject have contrasted

only two variables (if fish are present or absent). There is little information on how dynamic relationships between fish and plankton change as a function of fish density.

Objectives: To examine how the size of changing mosquitofish populations affect levels of zooplankton (microscopic aquatic animals), phytoplankton, and chlorophyll concentrations.

Methodology: The experiment was conducted in 12 1,500- gallon outdoor fiberglass tanks at TCU. In October 1988, water and plankton were pumped into the tanks from the pond. Mosquitofish were taken from the pond and were stocked in the tanks at rates ranging from 0 to 500. Ammonium chloride and potassium phosphate were added to stimulate phytoplankton growth. Tanks were sampled before fish were stocked and at 7-day intervals throughout the study for 3 weeks.

Results: After 3 weeks, mosquitofish significantly increased levels of turbidity and chlorophyll and decreased populations of copepods and water fleas. The study indicates that mosquitofish may enhance phytoplankton populations by consuming zooplankton (the zooplankton would otherwise eat the phytoplankton). Effects of fish on water clarity and chlorophyll levels not only occurred at high fish densities but also when fish densities were as low as 10 to 50 fish per tank. The study suggests that biomanipulation (improving water quality by reducing populations of plankton- eating fish) may only be successful if fish populations are reduced to less than 10% of normally occurring levels.

Related Publications: Ray Drenner, K.D. Hambright, et al., "Experimental Study of Size Selective Phytoplankton Grazing by a Filter Feeding Cichlid and the Cichlid's Effect on Plankton Community Structure," *Limnology and Oceanography,* Lawrence, KS, September, 1987.

Shrimpers Clash with Regulators Over Use of Turtle Excluder Devices

A battle between Texas and Louisiana shrimpers and the National Marine Fisheries Service (NMFS) over the use of turtle excluder devices (TEDs) has been simmering all summer and shows no signs of being finally resolved.

TEDs are devices that can be installed into trawling nets that allow turtles which are caught in the nets to safely escape. Environmentalists contend that shrimpers are accidentally killing up to 2,000 Kemp's Ridley sea turtles each year when the endangered turtles get caught in shrimping nets and can't escape without being drowned. Shrimpers, on the other hand, are fighting the use of TEDs saying that the devices allow too many shrimp to escape and are bulky, dangerous and expensive to pull.

Regulations requiring the use of TEDs on most shrimping boats in the Gulf of Mexico went into effect May 1. In mid- July, angry shrimpers blockaded numerous Texas ports including Brownsville, Galveston, Rockport, and Port Arthur. The U.S. Secretary of Commerce, Robert Mosbacher, created a temporary compromise in early August when he ruled that TEDs were not necessary if shrimpers' nets were only in the water for 65 minutes at a time. That compromise expired in early September.

As many as 10,000 shrimpers (10 to 15% of the shrimpers in the Texas Gulf of Mexico) may still fight the use of TEDs through blockades or other means. NMFS officials warn that vessels blockading shipping lanes will be forcibly removed, if necessary, and their operators will be subject to fines and penalties.

November Elections Set for Aid to Colonias

Voters throughout Texas will go to the polls November 7 to decide if $500 million in bonds should be issued for water supply, water treatment and flood control projects. If approved, an estimated $100 million of the bonds would go to provide water and sewer services for "colonia" residents along the Texas- Mexico border (colonias are subdivisions without basic water and sewer services that have been likened to Third World conditions).

The Texas Department of Human Services has estimated that roughly 140,000 residents live in colonias and some state officials project that population to increase to more than 200,000 residents by the year 2000.

Texas Receives $14 Million in Pecos River Lawsuit

New Mexico has agreed to pay Texas $14 million for past violations of the Pecos River Compact, but some west Texans are questioning if the settlement was adequate.

In 1987, the U.S. Supreme Court ruled that New Mexico had violated the compact by not delivering 340,100 acre-feet (AF) of Pecos River water over the past 35 years. That court ruled that New Mexico must comply with the compact in the future and increase the amount of water it sends to Texas from 70,000 AF of water per year to 80,000 AF annually.

A Special Master, appointed by the Supreme Court, heard testimony from both states this summer to determine the amount of damages and if damages should be paid in water or cash. Originally, Texas had estimated that New Mexico's excess usage of Pecos River water resulted in economic gains of nearly $1 billion in New Mexico and monetary losses of $52 million in Texas. Texas had originally asked to be repaid in water. The settlement, which was agreed to in August, grants Texas only $14 million.

Reports indicate that New Mexico outspent Texas 8 to 1 in preparing for the case. Some experts say that Texas may have received a settlement of at least $20 million if state officials had approved funding of studies to refute New Mexico's testimony months before the lawsuit took place. Funds were approved only a few weeks before the trial.

The judgement is significant because it marks the first time that one state had to repay another for damages resulting from violation of an interstate water compact. In previous similar cases, judgements required parties to abide by terms of the contract in the future but did not award past damages.

State agencies are now working to see if the award can be used to improve agriculture in the region by improving irrigation efficiency or lining canals. West Texas residents are

concerned that the $14 million could go directly into the state's general revenues and not be used to assist Pecos Valley farmers.

El Paso Plans to Drill Groundwater Wells in Texas Near New Mexico Border

El Paso is considering drilling as many as 48 deep water wells near Anthony, TX, along the Texas- New Mexico border, and New Mexico farmers in Las Cruces are threatening to file new lawsuits as a result.

Officials with the El Paso Public Service Board (PSB) predict the wells could produce as much as 70 million gallons a day at a cost of roughly $12 million. Lawyers in New Mexico argue that even though the wells will be located in Texas they may be taking water that belongs to New Mexico and/or lowering water levels for farmers in both states.

In late 1987, the New Mexico state engineer rejected applications from the PSB to drill 300 wells in New Mexico.

Measures Eyed to Stretch, Protect San Antionio Area Water Supplies

The City of San Antonio, the Edwards Underground Water District (EUWD), and other water suppliers in the San Antonio region have begun actions to augment their water supplies because of concerns about the reliability of water supplies from the Edwards Aquifer.

The EUWD has approved a $140,000 study to determine if Medina Lake should be purchased and operated to improve recharge to the aquifer. The lake now provides roughly 66,000 acre- feet (AF) of water annually to irrigators and contributes 40,000 to 60,000 AF of recharge to the aquifer per year through faults and fissures in the lake bottom. Studies indicate that keeping the lake full and eliminating diversions could increase recharge by up to 40,000 AF per year. The purchase price of the lake could be up to $100 million.

Meanwhile, San Antonio officials are considering a plan that would store surplus ground and surface water supplies in the Carrizo- Wilcox Aquifer south of the city. The aquifer, which is comprised of fine sands, may filter out impurities in the water while retaining moisture and minimizing losses from evaporation. Although city officials say they would only pump as much water as they put in, residents in the Pleasanton area where the underground storage would take place are concerned the plans may threaten their water supply.

Applewhite Reservoir is finally a step closer to becoming a reality. The U.S. Army Corps of Engineers issued a permit in September that clears the way for construction of the dam which could provide an average of nearly 50,000 AF of water annually. Construction is set to begin in 1990 and it will take at least until 1994 for the reservoir to be completed.

In a related development, reports indicate negotiations are under way that may settle a lawsuit filed by the Guadalupe Blanco River Authority (GBRA) to declare the aquifer an underground river. The reports indicate GBRA may be willing to drop the lawsuit if a plan that guarantees certain levels of streamflow can be agreed to.

Del Rio Groundwater Supply Survives Cave-In, Plans for Underground Testing

Del Rio residents recently had to deal with two threats to the fragile San Felipe Springs that feed the city's groundwater supply. In midAugust, the town's drinking water turned murky. As a result, bottled water was used while analyses were being performed. The water has since been declared safe and experts believe a cave-in of an underground cavern or erosion caused the short-term drop in water quality.

The springs were also threatened by plans of the Defense Nuclear Agency (DNA). The federal agency originally wanted to set off a series of massive underground explosions to simulate the impact of nuclear blasts on subterranean missile silos. Critics were concerned that the testing could cause some of the geologic formations that comprise the springs to collapse and that could jeopardize the area's groundwater supply. At last report, DNA was no longer considering the Del Rio area for the testing program but several other Texas sites are still possibilities.

State Fee To Fund Cleanup of Leaking Underground Storage Tanks

The state began collecting a new fee September 1 to create a fund to clean up leaking underground storage tanks (LUSTs). The fee, which will be charged to oil companies, suppliers and distributors that take petroleum products from bulk facilities for sale to retail outlets, is expected to bring in as much as $66 million in its first year.

The fund and cleanup program will be administered by Texas Water Commission (TWC) officials, who hope to begin cleanup operations by the end of the year at some of the estimated 15,000 LUSTs in the state. Under the program, individuals responsible for a leaky tank will pay the first $10,000 of the work and anything more than $1 million. The cleanup fund will pay the rest. LUSTs are thought to be a major source of potential groundwater contamination.

Summer Rainfall Raises Reservoir Levels, But May Have Hurt Oyster Harvest

Above average amounts of summer rainfall helped Texas reservoirs reach their highest recorded level ever, but the news wasn't entirely good. Officials with the Texas Sea Grant Program at Texas A&M University at Galveston say the excess precipitation spelled disaster for the state's oyster crop.

According to the Texas Water Development Board (TWDB), the state's 74 major reservoirs contained a record of more than 31 million acrefeet (AF) of water representing 91 % of storage capacity as of July 1. TWDB officials also noted that 33 of those reservoirs contained more than 100% of their storage capacity and 15 reservoirs that were

not designed to store floodwaters were releasing excess water. Lake Texoma contained the most water of any reservoir (925,900 AF) and Lake Livingston contained the most water (nearly 200,000 AF) of reservoirs not designed to hold floodwaters.

Meanwhile, Sammy Ray, a researcher at Texas A&M University at Galveston, said the unusually high rainfall and runoff have all but wiped out oyster production in Galveston Bay. Late spring flooding followed by tropical storm Allison and Hurricane Chantal lowered salinity readings to nearly zero. Sea Grant officials are predicting oyster kills will range from 50 to 90% and say losses in Chambers and Galveston counties could be as much as $10 million this season. They predict that it may take up to 18 months for the oyster population to recover to normal levels.

Galveston Bay Program to Include Christmas Bay, Armand Bayou

The Galveston Bay National Estuary Program has received a grant from the Environmental Protection Agency (EPA) that will allow Christmas Bay and Armand Bayou to be included in the planning effort. The $189,000 grant will fund efforts of the Texas Coastal Preserve Program, which is administered by the Texas General Land Office (GLO) and the Texas Parks and Wildlife Department, to develop a sound management plan to address environmental problems in the bay. The Galveston Bay program is funded by a $700,000 grant administered by the Texas Water Commission.

Christmas Bay was chosen for the program because of its natural sea grasses and other unique environmental features, while Armand Bayou was selected because it is one of the few bayous in Texas still unaltered by man's activities. Under the Coastal Preserve Program, lands are turned over to the GLO and are then leased to TPWD for a nominal fee.

Two examples of why planning efforts are needed to combat water quality problems in the Galveston Bay area recently made headlines. As much as 300,000 gallons of oil spilled into the Bayport Channel in upper Galveston Bay in mid-June when a Panamanian tanker collided with a barge. The cleanup took three days and environmental damage was minimal. Also, the EPA reported it issued more than 160 citations against the City of Houston since 1984 for spewing millions of gallons of raw sewage into the bay. One EPA official said that the Gulf of Mexico off the coast of Texas is a "dead zone" for marine life.

Channel Dam Proposed for Lower Rio Grande Valley

A dam is being proposed on the Rio Grande near Brownsville to trap and utilize as much as 200,000 acre- feet (AF) of water that is released from Falcon Reservoir but is never used, but the idea is being questioned by agricultural interests.

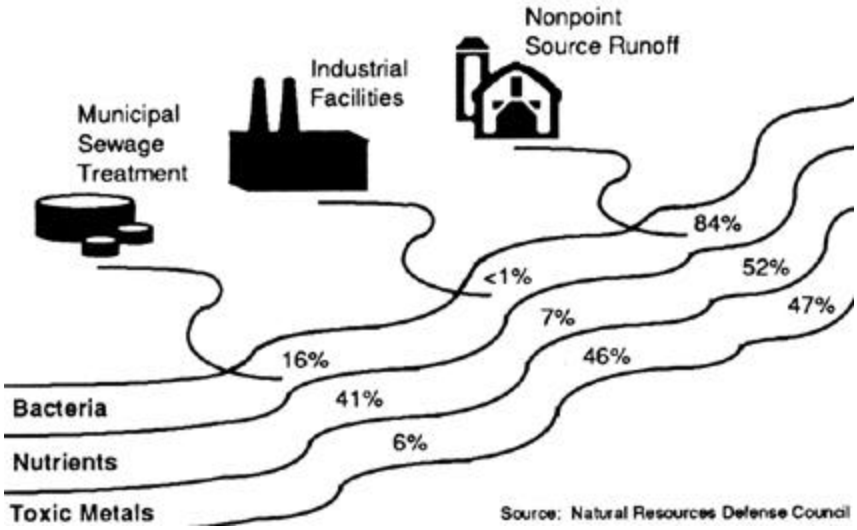
The channel dam is based on the premise that it takes roughly a week for irrigation water to travel downstream from Falcon Reservoir to Brownsville. If irrigators decide they don't need the water after it's been released--rainfall could make it unnecessary to use the irrigation water that was released, for example--the water will flow unused into the Gulf

of Mexico. The $30 million project is being supported by many cities and water districts in the lower Rio Grande Valley.

However, some irrigation districts have expressed worries that the channel dam would raise salinities in the region to levels that could be detrimental to agricultural production and human health. They counter that the freshwater flows are needed to flush salts out of the river.

Ebb Tide for Pollution *Outlines Actions to Clean Up Coastal Waters*

The Natural Resources Defense Council has recently produced a report titled *Ebb Tide for Pollution: Actions for Cleaning Up Coastal Waters* that details a strategy for improving coastal water quality.



According to the report, more than 5 trillion gallons of industrial effluents and 2.3 trillion gallons of treated sewage are dumped into the nation's coastal waters each year. As a result, beaches in Texas and other states are being polluted by medical waste, fecal bacteria and other pollutants, and sea creatures slated for human consumption are being contaminated with chemicals, heavy metals and bacteria.

To correct these problems, the report indicates that toxic discharges should be eliminated from both municipal and industrial wastewater treatment plants, that sewage treatment plants should be improved, that pollutant limits should be revised to better protect water quality, that offshore dumping of sewage sludge should be eliminated, and that nonpoint source pollution should be reduced.

The report is available for $8.50 from: Natural Resources Defense Council, 40 West 20th Street, New York, NY, 10011. The phone number is (212) 727-2700.

UT Reports Examine Water Distribution Systems, Lake Water Quality

Two technical reports are available from the Center for Research in Water Resources at the University of Texas at Austin. *New Methodologies for the Reliability Based Analysis and Design of Water Distribution Systems* (CRWR-227) was co-authored by Larry Mays, Yixing Bao, Lehar Brion, M. John Cullinane, Jr., Ning Dusan, Kevin Lansey, Yu-Chun

Su and John Woodburn. The report focuses on utilizing computers to maintain and analyze data on how aging makes water systems fail, and ways to repair them. Methodologies were developed to help design water system expansions at the least cost, to assess the reliability of water distribution systems, and to rehabilitate and replace existing pipes, pumps and other components.

Eutrophication Analysis Procedures for Texas Lakes and Reservoirs (CRWR214) was co-authored by Neal Armstrong, James Miertschin, Karen Cleveland, Rebecca Svatos, Henry Goyette, Nadine Gordon, Robert Thomann and Dianna Tupa. The report describes how increasing urbanization in the Austin area may be contributing to heightened levels of nitrogen and phosphorous in the Highland Lakes. The study developed models to predict the effect of increased nutrient loadings from point and nonpoint waste discharges on water quality in the lakes of the region. The models were then used in a case study of Lake Travis.

For information on ordering any of the reports, contact: Center for Research in Water Resources, University of Texas at Austin, 10100 Burnett Road, Austin, TX 78758. The phone number is (512) 471-3131.

Red Drum Aquaculture is Focus of Proceedings by UT Marine Science Institute

Red Drum Aquaculture is a new 197page report available from the University of Texas Marine Science Center at Port Aransas. The book, edited by C.R. Arnold, G. Joan Holt and Peter Thomas, contains papers presented at a conference in Corpus Christi in 1987.

Papers cover such topics as culture and nutrition; reproduction and genetics; natural history and larval biology; and stress physiology, diseases and environmental requirements. The report contains information on culturing other warm water species and describes the development of a marine finfish culturing system.

The report is available for $15 from: Library, University of Texas Marine Science Institute, Port Aransas, TX 78373. or call (512) 749-6723.

Gulf Waterway Adds $3 Billion a Year to Texas Economy, Sea Grant Reports

A recently published study by the Texas Sea Grant College Program suggests that the Gulf Intracoastal Waterway makes a direct contribution of more than $3 billion to the Texas economy from port revenues, payrolls, and expenditures for maintenance and operations. The waterway runs the length of the Texas coast eastward to Fort Meyers, FL.

The study, *Economic Impact of the Gulf Intracoastal Waterway System in Texas,* was co-authored by Hillary Garrett and Dock Burke of the Texas Transportation Institute at Texas A& M University. Findings from the report indicate that nearly 73 million tons of cargo worth more than $21 billion were moved through the waterway in 1986, and that

more than 80% of all boaters visiting coastal waters utilized the waterway for recreation, water skiing, fishing and other activities.

Single copies of the report are available free from: Texas Sea Grant Program, Texas A&M University at Galveston, PO Box 1675, Galveston, TX 77553, or call (409) 740-4460.

New U.S. Geological Survey Publications Feature Data on Streamflows, Flooding

A number of new publications from the U.S. Geological Survey (USGS) contain specific information about Texas' water resources. A three volume set titled *Water Resources Data for Texas: Water Year 1988* contains detailed monthly hydrological information for the state's rivers, streams and reservoirs and should be valuable to researchers. *Water Resources Activities of the U.S.G.S. in Texas: Fiscal Year 1988* (Open File Report 89-73) contains brief summaries of all the agencies' work in Texas. Examples of USGS research in Texas last year include urban hydrology in the Houston area, analyses of the Edwards regional aquifer system, sources of nutrients to Lake Lewisville and many others. Information about Texas' water issues is also contained in the *U.S.G.S. Yearbook: Fiscal Year 1988*. The report highlights the impact of the 1988 drought, discusses the amount of sediments and pollutants that are transported from the Red River and many other areas into the Mississippi River, and describes the USGS mapping and information systems activities.

Three additional reports provide specific regional information. *Effects on Water Quality Due to Floodwater Detention by Barker and Addicks Reservoirs, Houston* (Water Resources Investigations Report 86-4356) describes how retaining stormwaters in dams and reservoirs may actually improve water quality. *Effects of Urbanization on Floods in the Austin Metropolitan Area* (Water Resources Investigations Report 86-4069) analyzes if changing land use patterns and widespread development have increased the risk of flooding in the region.

For ordering information, contact: Library, U.S. Geological Survey, 8011 Cameron Road, Bldg. 1, Austin, TX 78753, or call (512) 832-5791.

Shore Ecology of the Gulf of Mexico now available from UT Press

A new 400-page book titled *Shore Ecology of the Gulf of Mexico* sheds new insights into the animals and plants of the Texas coast. Joseph Britton of the Texas Christian University Biology Department coauthored the book with Brian Morton of the University of Hong Kong.

The book is unique in that it uses a "whole habitat" approach and groups more than 1,000 species of plants, birds, mammals, mollusks, crustaceans and invertebrates for each habitat. The book also discusses changes in plant and animal life that result from differences in the climate, shore geology and rainfall

patterns that occur along the Gulf Coast. Drawings and photographs of more than 800 species complement the text.

The book is available in both hard cover and paperback editions from: University of Texas Press, PO Box 7819, Austin, TX 78713. The phone number is (512) 471-7233.

Playa Lakes Can Recharge Ogallala Aquifer, Texas Tech Study Says

A new study from Texas Tech University asserts that placing filters in shallow trenches in playa lake bottoms and providing a way for water to drain from the lakes to nearby wells may increase the amount of recharge available to the Ogallala Aquifer. The study, *Aquifer Recharge Utilizing Playa Lake Water and Filter Underdrains (Final Report),* also suggests that the concept could enhance habitats for wildlife and waterfowl and points out the need for additional recharge in the design and operation of recharge facilities.

The report was co-authored by Lloyd Urban, B.J. Claiborn and R.H. Ramsey of Texas Tech's Civil Engineering Department. For information on ordering the report, contact: Water Resources Center, Texas Tech University, PO Box 4630, Lubbock, TX 79409. The phone number is (806) 742-3597.

Ogallala, Edwards Aquifers Highlighted in Geological Survey Reports

New reports about the Ogallala Aquifer, Edwards and Gulf Coast aquifers have recently been published by the U.S. Geological Survey. *Effects of Future Ground Water Pumpage on the High Plains Aquifer* (USGS Professional Paper 1400-E) and *Summary of the High Plains Regional Aquifer System Analysis* (USGS Professional Paper 1400-A) provide hydrogeological data about the region, review pumping practices, and estimate the impact of future management strategies on the amount of water available from the aquifer in the future. The USGS has also developed machine readable files for the Ogallala Aquifer that contain information on aquifer geometry, aquifer and water characteristics, water levels, water use data, and climatological data. Those files are available on magnetic tape and are described in *Machine Readable Files Developed for the High Plains Regional Aquifer System* (Water Resources Investigations Report 86-4063). New information about flow patterns in the Edwards Aquifer is available in *Simulation of Flow in the Edwards Aquifer and Refinement of Storage and Flow Concepts* (USGS Water Supply Paper 2336-A). The study detected the presence of major barrier faults such as Knippa Gap in Uvalde County which significantly alter patterns of groundwater movement, and identified barrier faults that divert water from parts of Bexar, Comal and Hays counties toward San Marcos Springs. *Hydrogeology and Predevelopment Flow in the Texas Gulf Coast Aquifer Systems* (Water Resources Investigations Report 874248) provides a detailed account of Texas' groundwater systems and describes a model that simulates flows that naturally occurred in the aquifer before man's activities took place.

For ordering information, contact: Library, U.S. Geological Survey, 8011 Cameron Road, Bldg. 1, Austin, TX 78753. The phone number at the Austin office is (512) 832-5791.

TWC Studies Discuss Water Quality in Streams, Rivers

Stream water quality is the emphasis of two publications of the Texas Water Commission (TWC). *An Assessment of Six Least Disturbed Unclassified Streams* (LP 89-04) examines environmental, physical, chemical and biological data from minor streams across the state to assess the level of water quality standards needed to protect them. Historically, the TWC has provided unclassified streams only limited water quality protection. One of the streams in the study (James River) was given an exceptional aquatic life use classification, while four others (Yegua Creek, Cow Bayou, Garcitas Creek, and Sweetwater Creek) were given high ratings.

Segment Identification Maps for Texas River and Coastal Basins (LP 8501) displays river and stream segments that exhibit common biological, chemical, hydrological, natural and physical characteristics. Stream segments are used by the TWC to issue permits, plan for future growth, and allot monies for construction of water and wastewater facilities. The report contains oversized, easy to read color maps that identify the locations of specific stream segments.

The *Annual Report of the Hazardous and Solid Waste Program* (LP 89-01) describes the TWC's strategy for monitoring and evaluating such facilities, lists areas of concern and summarizes other information. To order any of these reports, contact: Library, TWC, PO Box 13087, Capitol Station, Austin, TX 78711. The phone number is (512) 463-7834.

Videos on Geographic Information Systems Available from TNRIS

The Texas Natural Resources Information System (TNRIS) is taking a lead role in the development and use of geographic information systems (GIS). TNRIS has videos available from a GIS conference it hosted in March 1989 titled '[Geographic Information Systems: A Technology Whose Time Has Come." TNRIS may develop educational materials about GIS technology, coordinate GIS activities among state agencies, and supply general information about GIS technology.

TNRIS is a state agency that serves as a repository for data on many natural resources, including water. Water-related information available from TNRIS includes data on streamflows, sediment loads, coastal water quality, surface water temperature, runoff, reservoir capacity, flooding, groundwater supplies, aquifer quality, and many other issues. Much of the information is available for use with computer equipment. For more information on TNRIS or its services, contact: TNRIS, PO Box 13231, Capital Station, Austin, TX 78711. The phone number is (512) 463-8337.

Pan American Research Focuses on Laguna Madre, Texas Tortoise

Pan American University's Coastal Studies Lab is located on South Padre Island, and researchers are taking advantage of the unique location to study south Texas coastal ecosystems.

Research now underway at the lab includes a National Science Foundation funded study of the community ecology of the Laguna Madre estuary and South Padre Island led by Terry Allison, Robert Edwards, Frank Judd and Robert Lonard.

Other work in progress includes a study by Robert Edwards of the fish communities of the Laguna Madre; investigations of flowering plants of South Padre Island by Robert Lonard; and a survey of populations and demographic characteristics of the Texas tortoise by Frank Judd, the lab's director.

A flow- through sea water system has also been installed recently at the lab. The system, which includes three 40,000galion tanks, will enhance the ability of the lab to rear and maintain aquatic organisms such as pinfish and Ridley's sea turtles.

For additional information, contact: Director, Coastal Studies Lab, PO Box 2591, South Padre Island, TX 78597. The phone number is (512) 7612644.

Reforms Could Strengthen Water Rights of Estuaries, Texas A&M Study Says

Modifying Texas' water permitting system or using the Public Trust Doctrine to challenge Texas water laws could help assure that estuaries receive the amount of freshwater inflows they need, according to a recent report by Ronald Kaiser, an attorney with the Texas A&M University Recreation and Parks Department.

In the report, Kaiser said that instream flows to estuaries could be protected by setting aside basic levels of streamflow below which no new water rights could be granted; that minimum flows could be granted on a seasonal basis; and that state agencies such as the Texas Parks and Wildlife Department could be allowed to purchase or acquire and then manage water rights specifically assigned to freshwater inflows. Kaiser also suggests that the Texas Water Commission could expand its system of cancelling water rights to void those permits which cause environmental degradation to estuaries by depriving them of freshwater inflows. While permitting or regulatory approaches would probably be applied on a case- bycase basis, Kaiser says applying the public trust doctrine through the courts could provide protection of water rights to estuaries throughout Texas.

Kaiser suggests that testing of the public trust approach may best be postponed until the courts indicate whether or not they favor Judicial tools to protect estuaries.

The study, "Water Rights for Texas Estuaries," was co- authored by Kaiser and research associate Sharon Kelly, and was featured in the Vol. 18, No. 4 (1987) issue of the *Texas Tech Law Review*. Kaiser can be contacted at: Recreation and Parks Department, Texas A&M University, College Station, TX, 778432261, or call (409) 845-5303.

Texas A&M University-Galveston Scientists Evaluate Oil Spill Clean-up Techniques

Marine biologists at Texas A&M University at Galveston investigated ways to clean up oil spills without damaging salt marsh ecosystems. Researchers Steve Alexander, Russell Kiesling and James Webb of the Marine Biology Department applied fuel oil and crude oil to test plots at the northern edge of Pelican Island in the Gulf of Mexico. To simulate delays in actual response times, cleanup didn't begin until 18 to 24 hours after the spill first appeared.

The researchers used three methods to clean up the oil: natural tidal flushing, clipping of vegetation and burning. Flushing was the most effective way to remove oils from sediments (up to 83% cleanup). Clipping removed roughly 44% of oily residues and burning actually increased the amount of oil in sediments by as much as 72%. None of the techniques proved to be effective at reducing initial damage to plants or at enhancing long-term recovery. The research was featured in an article titled "Evaluation of Alternative Oil Spill Cleanup Technologies in a *Spartina alterniflora* Salt Marsh" in Vol. 55, No. 3 (1988) of *Environmental Pollution.*

For more information, contact: Marine Biology Department, Texas A&M University at Galveston, PO Box 1675, Galveston, TX 77553. The phone number is (409) 740-4528.

Lamar Scientists Study Lower Neches Valley Authority Canal System

Scientists with the Civil Engineering Department at Lamar University are studying supplies, demands and losses in the Lower Neches Valley Authority canal system. The 400-mile system provides raw water to cities, industries and rice irrigation farmers in the southeast Texas communities of Port Arthur, Winnie and Fannett.

The study involves monitoring water use, surveying water levels in the main canal, digitizing the system with computer aided design (CAD) software, and computing the hydraulics of the system with digital data and mathematical codes. Results of the study may increase water distribution efficiency within the system.

For more information, contact: Peter Mantz, Civil Engineering Department, Lamar University, Beaumont, TX 77710. The phone number is (409) 880-8759.

Systems to Reduce Pumping Costs Being Developed at Texas A&M, UT-El Paso

Researchers at Texas A&M University and the University of Texas at El Paso are involved in two separate projects to determine if water pumping costs can be lowered.

Tep Sastri and Joseph Foster of Texas A&M University's Industrial Engineering Department are developing an expert system that will provide hourly predictions of water demand based on current data on water distribution systems such as flow rates and pressure drops, on- line weather information and seasonal demands. Additional

information will be provided to operators at water treatment plants on actual flows, pressure readings, tank levels and pump characteristics through a knowledge- based expert system.

The expert system is unique because it combines the knowledge of the operator, an on-line predictive system and a dynamic programming module to recommend which pumps should be turned on and off at key intervals up to 24 hours ahead of time. This may reduce energy usage and maximize energy efficiency. The expert system is being developed for the City of Arlington and the researchers hope to cut the city's raw water pumping costs by 10 to 20%, saving Arlington up to $200,000 annually in water pumping costs. More information on this project can be obtained by contacting: Tep Sastri, Industrial Engineering Dept., Texas A&M University, College Station, TX 77843. The phone number is (409) 845- 5448.

Meanwhile, at the University of Texas at El Paso, Anthony Tarquin with the Civil Engineering Department and Jack Dowdy with the Mechanical and Engineering Department are identifying the most cost- effective pumping combinations based on flow rates and hydraulic head. The scientists studied a booster plant in a mountainous area of El Paso and determined rule curves for optimizing pumping efficiency and hydraulic head. Results indicate that water pumping costs at the booster plant could be cut by 9% if optimum pumping schemes are selected, saving El Paso $32,000 annually.

Results of the UTEP studies are included in an article titled "Optimal Pump Operation in Water Distribution" in the February 1989 issue of the *Joumal of Hydraulic Engineering.* For more information, contact: Anthony Tarquin, Civil Engineering Department, University of Texas at El Paso, El Paso, TX 79968. The phone number is (915) 747-5464.

Brazosport Prepares for Oil Spill Disasters With Help of Sea Grant Program

The Texas A&M University Sea Grant Program is aiding Texas communities such as Brazosport in dealing with emergency and contingency planning to guard against disasters such as the massive Alaska oil spill caused by the tanker *Exxon Valdez.*

Texas Marine Advisory Service agent Charlie Moss said the Sea Grant program worked with the Coast Guard, local government leaders and industrial representatives to review contingency plans. A particular concern is the Department of Energy's Strategic Petroleum Reserve which is located near Brazosport. A drill simulating a large oil spill from the reserve is scheduled for October.

Brazosport officials are especially aware of the need to be prepared if emergencies such as this occur. Five years ago, a wreck involving a tanker spilled 10,000 gallons of crude oil off the coast of Galveston. Moss said that damage from that spill could have been lessened if plans had been in place to allow the cleanup to begin immediately after the spill took place.

The information was featured in the June 1989 issue of *Texas Shoreline.* To receive a copy, contact: Texas Sea Grant Program, Texas A&M at Galveston, PO Box 1675, Galveston, TX 77553, or call (409) 740-4460.

TCU Researchers Sample Water Quality of 51 Metroplex-Area Lakes

TCU biologists Ray Drenner, J. Durward Smith and Kyle Hoagland led an effort to sample the water quality of 51 Dallas- Fort Worth area lakes this summer. Water quality parameters including total phosphorous, total nitrogen, water clarity, chlorophyll, phytoplankton and zooplankton were evaluated.

The sampling helped identify lakes that will be used in a 2- year study funded by the National Science Foundation (NSF) to look at the relationships between plankton- eating fish (plankton are microscopic aquatic plant and animal life), plankton populations and phosphorous concentrations.

Water and plankton from three selected lakes are being transported by tanker truck to 30 1,500- gallon fiberglass tanks on the TCU campus where the experiments will take place. Based on the results of the sampling program, TCU scientists identified Lake Wichita (a lake with high phosphorous levels) Eagle Mountain Lake (a lake with intermediate phosphorous concentrations) and Stilihouse Hollow Reservoir (a lake with low phosphorous levels) for use in the NSF study.

Bluegill will be stocked in the tanks at concentrations ranging from zero to eight fish per tank. The scientists hope to establish relationships between fish populations, water quality parameters and plankton growth to evaluate lake management strategies.

For more information, contact: Ray Drenner, Biology Dept., TCU, Fort Worth, TX 76129, or call (817) 921-7165.

UT Study Will Devise Method for Determining Freshwater Inflows in Bays, Estuaries

Researchers at the University of Texas at Austin are developing a methodology for determining the minimum freshwater inflows required to increase fish and shrimp production in Texas bays and estuaries. Scientists participating in the project include Larry Mays (the former director of the Center for Research in Water Resources at UT, see story below), George Ward and Yixing Bao of the University of Texas, and Yeou-Koung Tung of the University of Wyoming.

The methodology will refine existing procedures utilized by the Texas Water Development Board and will be demonstrated in a case study involving Matagorda Bay and the LavacaTres Palacios estuary system. Freshwater inflow into the bay system has been a concern in recent years. Emergency freshwater releases were required from Lake Texana into the bay during the 1984 drought and diversion of the Colorado River into the bay is currently being pursued by the U.S. Army Corps of Engineers.

For more information, contact: Center for Research in Water Resources, University of Texas at Austin, 10100 Burnett Road, Austin, TX 78758. The phone number is (512) 471-3131.

Charbeneau New Director of UT Center for Research in Water Resources

Randall Charbeneau, an associate professor of Civil Engineering at the University of Texas at Austin, has been named the new director of UT's Center for Research in Water Resources. Charbeneau replaces Larry Mays who has become chairman of the Civil Engineering Department at Arizona State University.

Charbeneau is widely recognized for his work in the areas of groundwater supplies, contamination and management, and has served as a consultant to government agencies and industries.

Cloud Seeding May Increase West Texas Rainfall, Texas Tech Researchers Say

Results of experiments conducted by Texas Tech University researchers as part of the Southwest Cooperative Program suggest that seeding developing thunderstorms with silver iodide crystals increased rainfall in individual cells by 100% and boosted the likelihood that rain- carrying clouds would enlarge and merge with neighboring clouds by a factor of two.

Jerry Jurica of Texas Tech's Atmospheric Sciences Group is leading the research effort which was centered in an area between Big Spring and San Angelo. The studies involve identifying developing thunderstorms in a target area. Silver iodide is then aerially applied using a twin- engine airplane which penetrated targeted thunderstorm cells. Jurica says there are a number of signs the research is working: water levels in lakes and reservoirs in the San Angelo region rose steadily during the program and analysis of aircraft and radar data confirmed that target cells were successfully seeded. Future research could involve penetration of seeded and unseeded clouds by highly instrumented aircraft to document how processes within the clouds are affected by seeding operations.

For more information contact: Atmospheric Science Group, Texas Tech University, PO Box 4320, Lubbock, TX 79409, or call (806) 742-3113.

Applications for USGS Matching Grants Due Nov. 21

The U.S. Geological Survey (USGS) is accepting proposals for its matching grant program. Guidelines and application forms are available from the Texas Water Resources Institute by calling (409) 8451851. Proposals must be received by the USGS in Reston, VA by **November 21.** Funding for selected projects will begin in September 1990.

Last year 35 projects were funded including two Texas studies: "An Economic Evaluation of Water Marketing in a Low Transaction Cost Setting" by Ron Griffin of the Agricultural Economics Department at Texas A&M University and Extensions of

Random Walk Modeling" by Ed Holley of the Civil Engineering Department at the University of Texas.

TWRI Announces Call for Research Proposals; Deadline Nov. 1

Preproposals for research, technology transfer projects and information management systems are now being accepted for the Texas Water Resources Institute's FY 1990 Cooperative Research Program. The program is funded by the U.S. Geological Survey.

TWRI is particularly interested in projects dealing with issues such as groundwater quality and urban water management.

Detailed instructions for submitting preproposals are available by calling TWRI at **(409) 845- 1851.** Preproposals must be submitted to TWRI no later than **November 1.** The preproposals will then be evaluated by the Institute Director and TWRI's 14- member Advisory Committee.

Later in the process, full proposals of selected projects will be required.

Researchers should be aware that the program requires that TWRI federal funds be matched with non- federal dollars at a ratio of 2- to- 1.

Funding for selected projects will begin Sept. 1, 1990. TWRI anticipates funding four or five projects with budgets of up to $25,000. Six projects are currently being funded by TWRI under the federal program.