New Waves
The Research Newsletter of the Texas Water Resources Institute
Volume 1, Number 3, August 1988

Advanced Technology Research Program Announces Grants

The Texas College and University System Coordinating Board awarded $60 million in research grants in April. The grants originated from the $20 million Advanced Research Program and the $40 million Advanced Technology Program, created in the last session of the Texas Legislature. Coordinating board officials said that more than 3,200 proposals from researchers at 80 institutions were received and reviewed by panels consisting of science, technology and engineering experts.

Abstracts and additional information about these investigations will be included in upcoming issues of *New Waves*. Projects that were funded in the general area of water resources include the following:

Technological Solutions to the Major Problems of the Developing Red Drum Industry in Texas, C.R. Arnold, G.J. Holt and P. Thomas, University of Texas at Austin.

Playa Irrigation Strategies to Enhance Habitat for Wetland Wildlife, L.M. Smith, Texas Tech University.

Galveston Bay Model Robert Reid and Robert Whitaker, Texas A&M University at Galveston.

Exact Calculation of Second- Order Hydrodynamic Loads and Motions for an Array of Floating Structures in Regular Waves, Anthony Williams, University of Houston.

Nonlinear Interaction Between Short and Long Surface Water Waves - A Numerical Study, Jun Zhang, Texas A&M University.

Construction and Testing of an In-Situ Nitrate Analyzer, Terry Whitledge and Howard Liljestrand, University of Texas at Austin.

The Laguna Madre Estuary: How Does a Hot, Hypersaline Lagoon Maintain a Large Fishery?, P. Montagna, K. Dunton and P. Parker, University of Texas at Austin.

Spatial and Temporal Variability of Precipitation in Texas: Application to Drought and Flood Prediction, Steven Lyons, Texas A&M University.

Investigations of Potential Man-Induced Climatic Change: Guidance for the Planning of New Technology, Tamara Ledley, Rice University.

Natural Radio nuclides in Coastal Waters, Peter Santschi, Texas A&M University at Galveston.

Natural Radioactivities as Indicators of Marine Biological Productivity, David Schink, Texas A&M University.

Seismic Stratigraphy and Geologic History of the Gulf of Mexico Basin, Richard Baffler, University of Texas at Austin.

Influence of Holocene Sea Levels on the Morphology of the Texas Coast: Seismic and Stable Isotope Studies, James Lawrence, University of Houston.

Assessment of the Ecology of a Potentially Threatened Turtle (Graptemys caglei), Flavius Killebrew, West Texas State University.

Personnel Changes

An assistant professor's position in hydrology is opening up at Tarleton State University. It is a tenure-track position in the Bachelor of Science degree program that requires a Ph.D. in engineering with a strong emphasis in water resources or related areas. The applicant must be familiar with fundamental soil mechanics and groundwater flow analysis. Practical experience and/or toxic waste cleanup experience is desired. Resumes, including three references, must be sent to: Tarleton State University, Michael J. McLatchy, Box T- 8, Tarleton Station, Stephenville, TX 76402 by October 1, 1988. The phone number is 817-968- 9863.

J. Hari Krishna, a hydrologist with the Texas Agricultural Experiment Station's Blackland Research Center in Temple, has been named the Director of the Virgin Islands Water Resources Research Center. He replaces Darshan Padda. At Temple, Krishna was involved in furrow diking studies and other water- use efficiency studies. Krishna assumes his new duties in August. His new address is: Virgin Islands Water Resources Research Center, Caribbean Research Institute, University of the Virgin Islands, St. Thomas, VI 00802. The phone number is 809-776-9200.

Drought Resistance Comparisons Among Major Warm -Season Turfgrasses

Principal Investigator: Ki S. Kim, James B. Beard, and Samuel I. Sifers, Texas A&M University.

Project Duration: 1986-1989.

Funded by: United States Golf Association Green Section grant.

Problem: A green turf provides an aesthetically pleasing landscape with a number of functional roles such as evaporative cooling, soil and dust stabilization, safety, and reductions in noise, glare, and air pollution. Recently, water availability has become a major limiting factor in growing turfgrasses in many areas. Without water, turfgrasses go dormant, and may eventually die. While a brown turf can add an attractive dimension to landscapes, its functional roles of evaporative cooling, safety, air pollutant absorption, and recuperative ability are minimized. Furthermore, dead turf areas usually need to be replaced, probably at a higher cost.

Objectives: To assess the available turfgrass species and cultivars for their comparative drought avoidance and drought resistance, thereby providing sound information regarding which turfgrasses should be planted in drought prone environments.

Methodology: The study delineated the comparative drought resistance among 11 major warm-season turfgrass species. Twenty-two bermuda grass, 5 St. Augustine grass, 6 zoysiagrass, and 4 centipedegrass cultivars, were tested. Drought stress was imposed on these turfgrasses for 48 days before irrigation was reinitiated. The turfs were grown in the field on a 30-inch deep sand root zone over 8 inches of gravel in a randomized block design with four replications. Shoot recovery following drought stress was the plant parameter used to represent drought resistance.

Results: Leaf firing during moderate to severe drought conditions should be taken into consideration since quality is an important factor in growing functional turfs. Most zoysiagrass and centipedegrass cultivars showed good to excellent drought resistance with minor leaf firing. St. Augustine grass had very poor drought resistance, but bermudagrass was determined to be highly drought resistant. Floratam and Floralawn were the only St. Augustine grasses that exhibited excellent drought resistance and very little leaf firing. Midway, Texturf 10, and Tifgreen bermudagrasses ranked high in drought resistance. In contrast, Santa Ana, Tifway, and Tifway II bermudagrasses showed poor drought resistance and high leaf firing. Those turfgrasses which turn yellow or brown earlier tend to have poorer post- drought stress shoot recovery or poor drought resistance.

Publications: Kim, K.S., S.I. Sifers, and J.B. Beard. Comparative drought resistance among the major warm-season turfgrass species and cultivars. *Texas Turfgrass Research*, Texas Agricultural Experiment Station, College Station, TX, 1987 (in press).

Economic Potential for Development of Increasing Groundwater Storage Beneath a High Plains Municipality

Principal Investigators: K.A. Rainwater, R.H. Ramsey and M.J. Dvoracek, Texas Tech University, Lubbock, TX.

Project Duration: 1986-1988.

Funded by: Texas Tech University Water Resources Center Problem: The rising water table has caused complications with: 1) Below-grade structures and future sub-surface construction; 2) Flooding of the Lubbock Lake landmark archaeological dig site; and, 3) Drainage problems involving the interaction of surface runoff and the water table.

Objectives: To obtain data on the amount of groundwater stored below the city of Lubbock and the potential costs of developing that water for a portion of the local drinking water supply.

Methodology: Eighty wells were measured for depth to the water table. Water samples were collected from 30 wells for analyses which included testing for most of the chemicals in the primary drinking water standards in the Safe Drinking Water Act of 1986. The data were compared to historical information collected in a study by the City of Lubbock and a consulting firm which ended in 1981. Economic costs of development were evaluated and expenses for pumping, transmission and water treatment were compared.

Results: Diminished pumping from private wells combined with increased recharge of storm runoff through the city's playa lakes contributed to an increase in groundwater storage. The water table has risen most dramatically in the southwest portion of the city, with rises of 20-40 feet since 1981; however, the quality of water varied throughout the study area. The best quality water was found near the major recharging playas. However, some of the water is classified as very hard and contains fluoride at roughly twice the primary drinking water limit. A small number of wells in the northwest part of the study area contained water with concentrations of trace metals which would require removal before potable use. Several treatment schemes have been analyzed to improve the quality of the water, including various combinations of reverse osmosis, ion exchange, activated carbon absorption and pressure filtration. In this study, the unit cost of developing groundwater was shown to be very competitive with the cost of the city's major water supply from Lake Meredith. To Lubbock, the use of increasing groundwater reserves could mean enhancement of local agricultural prospects, growth of industry, and the solution to health hazards associated with poor water quality.

Publications: Chen, Y.C., K.A. Rainwater, R.H. Ramsey and M.J. Dvoracek, *Economic Potential For Development Of Increasing Groundwater Storage Beneath A High Plains Municipality* (Final Report), Texas Tech University Water Resources Center, Lubbock, TX January 1988. "Quantity and Quality of Recharge to the Ogallala Aquifer from Urban Runoff," by L.S. Stecher and K.A. Rainwater. *Proceedings, Focus Conference on Southwestern Ground Water Issues,* Association of Ground Water Scientists and Engineers, Albuquerque, NM, 1988.

Rainfall and Runoff Model for Unregulated, Houston Area Streams During Tropical Storm and Hurricane Events

Principal Investigator: John Samuel Grounds III and Jerry Rogers, University of Houston, Houston, TX.

Project Duration: 1985 to May 1988.

Problem: No present method exists to project large rainfall amounts from a tropical storm or hurricane to simulate spiral rain bands.

Objectives: To develop a model to derive hourly rainfall values for a typical Houston storm event, based on storm strength, velocity, and distance.

Methodology: Hourly rainfall data were gathered on 11 tropical storms and hurricanes occurring along the Texas Gulf Coast. Basin parameters of initial loss, uniform loss, time of concentration, and storage coefficient were found for the Brays, Greens, and White Oak bayou drainage basins. The parameters are necessary for relating rainfall to streamflow. The calculated maximum streamflows for each drainage basin and each storm event were estimated.

Results: The calculated maximum streamflows were accurately estimated, and the range of expected maximum streamflows was accurately calculated in 14 of 15 simulations. It was found that: 1) The length of a tropical storm or hurricane is inversely proportional to the velocity of the storm; 2) The number of peaks is related to the length of the storm; 3) Average rainfall is a direct function of the sustained winds and is inversely related to the product of the storm eye distance from Houston times storm velocity; 4) Sustained rainfall is equal to 0.6 times average rainfall; 5) Maximum peak rainfall was directly related to the length of the storm times average rainfall and inversely related to the number of peaks; 6) Time between peak rainfall is equal to the storm duration divided by the number of peaks plus one; and, 7) Variance of hourly hurricane rainfall for sustained, peak, and intermediate rainfalls is a direct function of hurricane strength and inversely related to the distance and velocity of the storm. Predicted maximum streamflow from the Harris County Flood Control District was overestimated by more than 400deg./O in comparison to the proposed streamflow model. Performance of this model was significantly better than the methods used in practice in the Houston area, and the model has potential usefulness for other coastal areas.

Publications: Grounds III, John Samuel. "Rainfall and Runoff Model for Unregulated, Houston Area Streams During Tropical Storm and Hurricane Events," *Texas Civil Engineer,* American Society of Civil Engineers, Lubbock, TX, February 1988.

*Assessment of the Ecology of a Potentially Threatened Turtle (*Graptemys Caglei*)*

Principal Investigator: Flavius Killebrew, West Texas State University, Canyon, TX.

Project Duration: 1988-ongoing.

Funded by: Texas Advanced Technology Research Project (TATRP).

Problem: Cagle's map turtle (*Graptemys caglei*) is a potentially threatened turtle from the Guadalupe River. Its populations can no longer be confirmed in the San Antonio River and are greatly reduced in Canyon Lake. Two new impoundments are being proposed for the Guadalupe River. However, the impact of these impoundments on the turtles cannot be determined without baseline data.

Objectives: This project will produce baseline data on the ecology of Cagle's map turtle Data resulting from this project will determine the populations of this species in the San Antonio River and Canyon Lake and similar data will be gathered on other major river turtle populations that are present. This study will provide an understanding of the ecology of the communities occupied by the turtles in the Guadalupe River. TATRP funds will also be used to establish an Aquatic Turtle Research Institute at West Texas State University.

Response of Shortleaf Pine Families to Acidic Precipitation and Ozone Stress in East Texas

Principal Investigator: Richard B. Flagler, Texas Agricultural Experiment Station, Texas A&M University System, College Station, TX.

Project Duration: 1987 to 1992.

Funded by: U.S. Forest Service.

Problem: Environmental factors such as moisture and nutrient limitations, air pollutants and increasingly acidic rainfall have affected the growth of Southern pine species. Concentrations of ozone in ambient air have decreased yields of crop species in field experiments and growth of forest species in short-term laboratory experiments.

Objectives: To determine: 1) The functional relationships between acidity of precipitation and tree response for selected shortleaf pine families; 2) The functional relationships between ozone levels and tree response for selected shortleaf pine families; 3) Whether ambient acidities of rainfall and/or doses of ozone reduce growth of young shortleaf pines; and, 4) Interactions between rainfall acidity and ozone concentrations and the responses of shortleaf pine to those pollutants.

Methodology: A research site developed in the Stephen F. Austin Experimental Forest in 1987 will utilize open-top chambers to measure the relationships between seasonal doses

of air pollutants and growth of pine seedlings. The chambers are also used to test for interactions between acidic precipitation and ozone. The approach involves the study of tree responses over a range of acidities of rain simulant and concentrations of ozone. Treatments began in June 1988, and will continue for three years.

Expected Results: This study will provide: 1) Improved models to estimate the effects of acidity of precipitation and ozone dose on shortleaf pine growth responses; 2) Indications of any interactions between acidity of rainfall and ozone; and,3) Indications of mechanisms of action of acid precipitation and ozone.

Use of a Solar Pond to Produce Electricity and Desalinated Water

Principal Investigator: Andrew H.P. Swift, University of Texas at El Paso, El Paso, TX.

Project Duration: July 1983 to 1988.

Funded by: The University of Texas at El Paso Department of Mechanical and Industrial Engineering; Advanced Energy Applications Program, U.S. Bureau of Reclamation; and El Paso Electric Company.

Problem: Developing reliable renewable nonpolluting sources of energy is a major challenge facing the nation while providing an environmentally sound method for desalting brackish groundwater is important for the immediate future of inland desert areas of Texas.

Objective: To deliver energy (electricity and processed heat) and desalted fresh water on demand using a renewable environmentally sound method appropriate to inland desert regions of Texas.

Methodology: A solar pond has three main layers. The top layer is cold and contains little salt. The bottom layer is hot and very salty. In the middle layer (gradient zone), salt content increases with depth. This layer acts as an insulator, trapping sunlight in the bottom, from which useful heat is withdrawn. In El Paso, an existing pond has been converted to a solar pond by: 1) placing a new liner over the existing one; 2) constructing evaporation ponds; 3) building inlet and discharge diffusers to deliver hot brine from the pond bottom, and; 4) installing wave suppression nets and an instrumentation tower. The salt gradient was then established and the pond storage zone temperature rose rapidly.

Results: The bottom layer of the pond maintains a temperature of 70-100 degrees Celsius (C) and delivers thermal energy on demand. The lowest temperature reached was 68 C in February of 1987, when the top of the pond froze. The project demonstrates that it is possible to efficiently produce potable water from brackish water. The reject brine can then be used to construct new solar ponds, eliminating waste brine disposal which is a major cost of inland desalination.

Publications: Swift, Andrew and Robert Reid. "Electricity and Desalinated Water," *SunWorld,* Vol.11, No.3, Berkeley, CA.,1987.

Enhanced Biographical Nutrient Removal in a Municipal Wastewater Treatment Plant

Principal Investigators: S.R. Qasim and C.E. Parker, University of Texas at Arlington (UTArlington), Arlington, TX.

Project Duration: May 1985-November1988.

Funded by: City of Fort Worth, Texas.

Problem: The importance of nitrogen and phosphorus in stimulating eutrophic conditions in receiving waters has been well documented. As a result, over the last decade an increased emphasis has been placed on limiting these elements in wastewater effluents. In the future, new discharge permits will include limits on both of these elements.

Objective: To evaluate how an existing biological wastewater treatment plant may be upgraded to remove nitrogen and phosphorus.

Methodology: In 1980 a program was initiated at UT-Arlington to evaluate a simplified biological nutrient removal regime that would require minimum unit process additions, and use a single recycle line. A bench-scale study was conducted using an anoxic/ anaerobic/aerobic reactor sequence with recycle from the settling basin following the aerobic unit to the anoxic unit. Results show enhanced BOD5, TSS, and phosphorus removal along with nitrificationdenitrification.

In 1985 a research program was initiated with the City of Fort Worth to conduct a pilot plant study of an anoxic/ anaerobic/aerobic treatment train using primary effluent. The pilot plant was designed for maximum flexibility: influent capacity of up to 18,000 GPD while independently varying unit detention times; return flow/influent (Qr/Q) ratios of 1-3; and varying air supply. It was fully instrumented to control and record flow. The facility was operated at varying flow and Or/ Q ratios, and at effective mixed liquor suspended solids (MLSS) concentrations of 3100 mg/L. Under operational conditions the sludge age varied from 12 to 15 days, and the average food to mass ratio was 0.12.

Results: The results of the first 13-month operational phase indicated that the effluent concentrations of BOD>, TSS and nitrate nitrogen were consistently less than 5mg/L. Ammonia nitrogen was less than 0.2 mg/L. The solids settleability was excellent, and foaming due to *Norcadia,* a bacteria, was effectively controlled. The average overall phosphorus removal was 48%. Influent BOD5 concentrations of less than 100 mg/L significantly reduced the system's ability to remove phosphorus. A strong relationship between the amount of carbon source in the influent; phosphorus release in the anoxic and anaerobic tanks; and phosphorus uptake in the aeration basin was established. Recycle rate, influent BOD>, and control of anoxic/anaerobic conditions were significant factors enhancing biolo gical nutrient removal.

Publications: Qasim, S.R., and K. Udomsinrot, "Biological Nutrient Removal of Anoxic-Anaerobic-Aerobic Treatment Process," International Journal of Environmental

Studies, London, England, 30:257 (1985). Qasim, S.R., C.E. Parker, and K. Matouk, *Pilot-Plant Study on Biological Nutrient Removal at Village Creek Wastewater Treatment Plant* (A Report to the City of Fort Worth, Texas), Civil Engineering Department, University of Texas at Arlington, Arlington, TX, 1987.

Edwards Aquifer Debates Water Use, Drought Management Plans

Two plans for managing water use in the Edwards Aquifer are being discussed this summer. A water use plan has tentatively been approved. It would allow farmers to use the average amount needed to irrigate crops between now and 1995. Urban users would be limited to the average amount they use between now and 1992. New users would be restricted from drilling new wells, but water rights could be sold to cities with some use restrictions. The plan must get approval from the Board of Directors of the Edwards Underground Water District and the Texas Legislature. A drought management plan is still being considered, and must be finalized by September 1, according to a mandate from the Texas Legislature. This plan would trigger restrictions as certain drought conditions occurred. The draft of that plan calls for irrigation usage to be reduced to 2 acre-feet per year when the level of the Edwards Aquifer drops below 829 feet in Uvalde County and below 628 feet in Bexar County. At that time municipal, industrial and miscellaneous uses would have to be trimmed by 60%. Draft copies of the Drought Management Plan are available from: Edwards Underground Water District, PO Box 15830, San Antonio, TX 78212. Their phone number is 512-222-2204.

In related matters, the San Antonio City Council has given tentative approval of the construction of Applewhite Reservoir. Surface water development by the City of San Antonio was seen as a key to passing both plans. Also, the Guadalupe-Blanco River Authority (GBRA) has published a report which makes the case that the Edwards Aquifer is really an underground river and not percolating groundwater. This could be a significant distinction because, according to Texas law, underground streams and rivers are regulated in the same manner as surface water bodies. The book, *The Edwards Aquifer: The Underground River of Texas*, is available from: Guadalupe-Blanco River Authority, PO Box 271, Seguin, TX, 78156. The phone number is 512-379-5822.

Exercise Program may Help Ridley's Turtles Survive

An exercise program has been developed to help Kemp's Ridley sea turtles raised in captivity survive in the "real world" conditions of the Gulf of Mexico. The program, being conducted by the National Marine Fisheries Service (NMFS) at Galveston, will subject young turtles to currents of swirling water, forcing them to flap their flippers to maintain control. The turtles blood pressure and hormone levels will be tested regularly to make sure they aren't subjected to too much stress. The intent of the program is to make the turtles develop stronger muscles before being released, thus making them less vulnerable to shark attacks. Roughly 1,000 young lab-bred turtles are released annually, and NMFS officials say too many become easy targets for predators.

TWC Approves Little Cypress Creek Reservoir

The Texas Water Commission has approved construction of Little Cypress Creek Reservoir to supply water to Kilgore, Longview and Marshall. The $105 million project will take several years to build and will cover 13,000 acres in Harrison County. It will provide water for Harrison County, Gregg County and Rusk County. The reservoir project was opposed by the Texas Committee on Natural Resources and other environmental groups who said it was unnecessary and reduced wildlife habitat.

City of Kennedale Mulls Wellhead Protection Program

The City of Kennedale in Tarrant County is working with the Texas Water Commission to establish welihead protection areas to protect the drinking water supply. The city produces water from the Trinity Aquifer. Kennedale conducted an inventory of potential sources of contamination and found that pollutants from abandoned, uncapped, and improperly constructed domestic wells had the potential to enter the city's drinking water wells. The welihead protection proposal would limit certain land uses in a 1/4 mile area surrounding each of the city's water wells. Currently, Del Rio is the only Texas city to enact welihead protection ordinances while other areas arc contemplating similar programs. For more information on the welihead protection program, contact: Groundwater Conservation Unit, Texas Water Commission, PO Box 13087, Capitol Station, Austin, TX 78711-3087. The phone number is 512-463-8028.

Possum Kingdom Reservoir May be Required to Release Water for Fish and Wildlife

Freshwater releases from Morris Shepard Dam on the Possum Kingdom Reservoir may be required to benefit fish and wildlife downstream in the Brazos River, if a proposed amendment for the dam's license is approved.

The Texas Water Commission and the Texas Parks and Wildlife Department have requested that a continuous flow of water be released. The Brazos River Authority, however, opposes the releases saying they will lower the level of Possum Kingdom Lake and will hurt area businesses.

TWC Approves New Water Quality Standards

The Texas Water Commission (TWC) has approved new water quality standards that are expected to raise the cost of sewage treatment by up to $3.5 billion over the next several years. Average sewer rates will be increased by about $7 month because of the new standards, according to TWC officials.

The new standards are significant. For the first time, numerical limits for 30 pollutants have been set. Previously, the standards contained only general language. The standards also apply to smaller and intermittent streams that make up 75% of Texas' 80,000 river miles. The standards were approved by the EPA in June. A complete text of the standards was printed in the April 15,1988, *Texas Register*.

EPA Sponsors Galveston Bay Study, Begins Gulf Initiative

The EPA has begun two projects that may provide more information about the Gulf of Mexico and enhance its long-term water quality. EPA is now in the the initial planning stages of a "Gulf Initiative that would develop and implement a strategy for protecting the resources of the Gulf of Mexico. The Initiative would be patterned after similar EPA programs in the Great Lakes and the Chesapeake Bay. The project will focus on: 1) Developing Effective Management Organization and Implementation Strategies; 2) Assessing and Characterizing Gulf Resources; 3) Identifying and Studying Regional Problems; and 4) Integrating the Initiative with Ongoing Programs in the Gulf. EPA has produce a booklet describing the project, *The Gulf Initiative: Protecting the Gulf of Mexico.*

EPA has also announced it will fund an $850,000 study into water quality in Galveston Bay as part of its national estuary program. EPA said university researchers, government officials, and others may participate in the study which may eventually develop a plan for cleaning up the bay. For more information on either of these programs, contact: U.S. EPA,1445 Ross Ave., #1200, Dallas, TX 75202, or call 214-655-7145.

1987 A Banner Year for TWDB Loan Program

The Texas Water Development Board (TWDB) made more loans for water supply and wastewater projects than for any previous year in its history, according to the April 1988 newsletter of the Texas Water Alliance.

Since November,1985, TWDB has loaned $159 million for water supply projects, $40 million for water quality projects, and $31 for flood control projects. In addition, 72 political subdivisions have adopted water conservation plans to qualify for TWDB loans and grants. The loan and grant programs and conservation provisions were part of a package of constitutional amendments passed by Texas voters in 1985.

In another related matter, TWDB is phasing out the Environmental Protection Agency's (EPA) construction grant program. Instead, the agency is beginning a state managed revolving loan fund. Under the new program, EPA will provide $105 million per year for three years. TWDB will match this amount making more than $126 million per year available for wastewater treatment projects. This will be a perpetual fund to provide assistance on a revolving basis. For more information, contact: TWDB, Construction Grants Div., PO Box 13231, Austin, TX 78711. The phone number is 512-463-8489.

High Plains Water Wells Rise for 2nd Straight Year

Groundwater levels in the Texas High Plains have risen for the second straight year, according to the annual survey of the High Plains Underground Water Conservation District.

The district's 1987 survey of 960 observation wells showed that levels in the Ogallala Aquifer increased an average of 0.9 feet. That translates to an additional 702,000 acre-feet of groundwater throughout the 5.2 million acre district.

The increase in the past two years follows 35 years of decline. Reduced irrigation, above-average rainfall, and the use of water-saving irrigation technologies are factors which contributed to the increased water levels.

TDH Closes Lavaca Bay because of High Mercury Levels

For the first time ever, the Texas Department of Health closed a portion of Texas waters to fishing for red drum and crab due to risk of mercury poisoning.

Part of Lavaca Bay near Point Comfort was closed April 21 after TDH officials measured levels of mercury in fish at 45 parts per million (the federal standard is 1 part per million). Sampling showed that 80 percent of redfish and blue crabs in the area exceeded the mercury standard.

TDH closed the area under the Aquatic Life Law, passed in 1985 by the Texas Legislature, which authorizes TDH to close contaminated waters. The area will remain closed until mercury levels revert to normal levels.

Houston Master Plan Looks to East, West for Future Surface Water Supplies

The City of Houston is considering importing surface water from the Toledo Bend Reservoir and developing new reservoirs north and west of the city to meet its future needs, according to executive summaries of an initial alternative screening process conducted under the Houston Master Water Plan.

According to the plan, Houston is considering transporting water from Toledo Bend near the Texas-Louisiana border.

The water could be routed from that reservoir to Sam Rayburn Reservoir to B.E. Steinhagen Reservoir and eventually to Lake Houston in a 650 million gallons per day (MGD) conveyance system. As an alternative approach, the city is also considering developing Bedias Reservoir in Madison County and Millican Reservoir in Brazos County. Those reservoirs would store roughly 300 MGD of surface water.

The recommended options, which will undergo further study, were developed from a list of more than 30 options that were prioritized based on cost, technical and engineering criteria, legal issues and environmental concerns. The Houston area currently has a demand of 1,333 MGD, but that is expected to rise to 2,000 MGD by the year 2000.

"Super MUD" May Bring Surface Water to North Harris County

The Texas Water Commission has approved formation of a "Super Municipal Utility District (MUD)"which would bring surface water to more than 60 square miles of North Harris County now serviced by groundwater. If approved by voters in an August election, the Super MUD would be able to sell more than $84 million in bonds to bring treated

drinking water from Lake Houston. The district, tentatively named the Harris County Regional Water District No. 2, would work at solving subsidence problems in the area.

Abilene Considers Water Reuse Project

The City of Abilene is investigating the feasibility of reclaiming wastewater to supplement its water supply and to reduce demands on its potable water supply.

The project would consist of constructing a 3 MGD water reclamation facility. The reclaimed water would be discharged to tributaries of Lake Phantom Hill Reservoir, and would be used to irrigate golf courses and park land in the city and at Dyess Air Force Base. As much as 500,000 GPD could be made available and the water supply in Lake Phantom Hill Reservoir could be increased by 1.5 to 2 MGD.

TWRI Publishes New Technical Report, Publications List

The Texas Water Resources Institute has recently produced some new publications which are available to the public at no cost. *Forecasting Water Use in Texas Cities* (TR-142) was written by David Maidment of the University of Texas at Austin. The report describes a method for forecasting seasonal water use utilizing short-term and long-term variables (see related article in "News Briefs").

TWRI has also recently produced a publications list which references all technical reports and newsletters produced by the Institute. Recent issues of the *Texas Water Resources* newsletter have dealt with natural wastewater treatment systems, the impact of brush control on water yields and sludge reuse.

To order any of these publications, contact: Texas Water Resources Institute, Texas A&M University, College Station, TX 77843-2118. The phone number is 409-845-8571.

Plan Proposed for Protecting U.S. Water Quality

The U.S. should adopt policies to protect wetland areas and should create a new "Aquafund" program to clean up polluted bays and estuaries, according to a new report.

Saving Our Bays, Sounds and the Great Lakes: The National Agenda is a report that summarizes the findings of a 1987 conference in Rhode Island that focused on water quality issues in coastal areas. The report includes recommendations concerning the broad areas of controlling water pollution; land planning; and coastal habitats for fish and wildlife.

The report is available from: Save the Bay, Inc., 434 Smith St., Providence, RI 02908, or call 401-272-3540.

Congressional Report Identifies Wastes in Marine Environments

The quality of water in the nation's estuaries will continue to decline, unless additional measures are undertaken, according to a recent report of the Congressional Office of

Technology Assessment (OTA). The report, *Wastes in Marine Environments,* summarizes the work of two Congressional committees. Other findings suggest that the water quality in open oceans is better than in estuaries and near-coastal waters, and that bottom waters of the Gulf of Mexico near the Texas-Louisiana border are suffering from extremely low oxygen levels. The report is available for $13 from: Congress of the United States, Office of Technology Assessment, Washington, DC 20510-8025, or call 202-224-9241.

Reports on Reservoir Storage, Matagorda Bay Printed by UT

The Center for Research in Water Resources at the University of Texas has produced two new technical reports. *Diffusion Theory for Stochastic Storage Analysis* (CRWR 224) was written by Steven Buchberger and is available for $20. It deals with equations that define storage in reservoirs operated according to a general release rule. *Studies Regarding the Distribution and Biomass Densities of, and the Influences of Freshwater Inflow Variation on Finfish Populations in the Matagorda Bay System* (CRWR 192) was written by G.L. Wetzel and N.R. Armstrong and is available for $11. It details investigations regarding 11 finfish species in Matagorda Bay.

The publications are available from: Center for Research in Water Resources, University of Texas,10100 Burnet Rd., Austin, TX 78758-4497. The phone number is 512-471-3131.

Aquifer Recharge Model Produced by Texas Tech

A new technical report, *A Mathematical Model for Estimation of Vertical Air Permeability in the Unsaturated Zone*, is available from Texas Tech University. It was written by T. Lee, a Texas Tech graduate student, who was supervised by K.A. Rainwater, B.J. Claborn and R.H. Ramsey. In general, a zone exists between the ground surface and the water table that contains air and water. The flow of water into and within this zone is of prime concern in understanding groundwater recharge and the transport of pollutants. This report dealt with development of a mathematical model to estimate vertical air permeability in such systems. The report is available from: Water Resources Center, Texas Tech University, PO Box 4630, Lubbock, TX 79409, or call 806-742-3597.

UTSA Study Probes Link between Water Quality, Health Problems

The University of Texas Health Science Center at San Antonio recently released a report that examined the effects of drinking water quality and the health of residents of San Elizario, a community without water and sewer service near El Paso.

The report, *Assessment of Oral Health, Treatment Needs, and Alternative Treatment Strategies in the San Elizario Community,* was based on a five- month study headed by Lars Folke.

The report found that 70% of the community's residents showed evidence of infection with hepatitis A, which is often caused by poor sanitation, and roughly 75% of the population drinks water contaminated by human waste.

New Guide Explores Water Issues Along Upper Rio Grande

The upper stretch of the Rio Grande River, from the El Paso area to Colorado, is the focus of a new report from the Western Network. *The Upper Rio Grande: A Guide to Decision-Making* provides an overview of the management and decision making processes that regulate the flow of the river, explores relationships between state, federal and local agencies, and provides a history of water use and water politics in the area.

The report is available for $15 from: Western Network, 1215 Paseo de Peralta, Santa Fe, NM 87501. The phone number is 505-982-9805.

"Superfund Notebook," Other New Reports Available from TWC

The Texas Water Commission has recently produced four new reports. *Texas Superfund Notebook: A Briefing on National Priority List Sites in Texas* (LP 86-02), contains detailed information on 26 Texas sites that are part of the "Superfund" program and includes maps, project histories, information on remedial procedures, and feasibility studies for each site. *Analysis of Fish Kills and Associated Water Ouality Conditions in the Trinity River: Texas* (LP 88-06) presents *results* of studies conducted during 1985-86. The study's major finding was that low levels of dissolved oxygen, *not* biotoxicity, were the most significant factors contributing to the fish kills. *Survey on Ground Water Protection Attitudes* (LP 88-05) summarizes results of a questionnaire that was sent to officials from city and county governments and water agencies. The survey found that the majority of respondents believed that septic tanks or a combination of activities were most responsible for groundwater contamination, and that most of the local communities surveyed indicated that they could finance qroundwater protection programs. *The State of Texas Water Quality inventory* (LP 88-04) is a comprehensive summary of surface and ground water quality throughout the state, and contains specific information about many associated issues. For more information about any of these publications, contact: Texas Water Commission, PO Box 13087, Capitol Station, Austin, TX 787113087. The phone number is 512-463-7834.

Survey Lists National Water, Sewer Rates

A listing of national water and wastewater rates has been compiled by Arthur Young International, a consulting firm. The report, 1988 *National Water and Wastewater Rate Survey,* includes information on monthly water and wastewater charges, one-time charges, rate structures and billing cycles.

According to the survey, Houston had the highest monthly residential water charges in the state totaling $58 for 22,000 gallons, and the highest industrial rate, $37,000 for 11.2 million gallons. El Paso had the lowest residential water rates in the state, totaling $17 for

22,000 gallons. Dallas had the lowest industrial water rates, averaging $7,976 for 11.2 million gallons.

The 1988 rate survey is no longer in print. For more information contact: George Raftelis, Arthur Young, 1500 Independence Ctr., Charlotte, NC 28246, or call 704-372-6300.

Study says Public Works Need Added Investment

The National Council on Public Works Improvement, a commission created by Congress to report to the President, has recently published a report recommending increased public works spending.

The report, *Fragile Foundations: A Report on America's Public Works*, states that the U.S. infrastructure including water supply, water quality and wastewater facilities is insufficient to meet the demands of future economic growth and development. The study also suggests that capital spending for public works projects should be doubled to $90 billion annually.

Copies of the report are available from: National Council for Public Works Improvement, 1111 18th Street, NW, Suite 716, Washington, DC 20036. The phone number is 202-653-0298.

Book by UT Professors Focuses on Hydrology

University of Texas researchers David Maidment and Larry Mays, and Ven Te Chow of the University of Illinois have co-authored a new 570-page book titled *Applied Hydrology.* The book is divided into sections dealing with hydrologic processes, analysis and design. The book emphasizes a numerical approach and provides the basis for understanding computer codes used in hydrologic practice.

The book is available for $48.95 from: McGraw Hill, Princeton Rd., Hightstown, NJ 08520, or call 609-426-5000.

Computer Model Developed by UT Scientist will be Used to Project Los Angeles Water Use

A computer model developed by David Maidment of the University of Texas at Austin and funded in part by the Texas Water Resources Institute will be used to predict how weather affects water usage in the Los Angeles, California, area.

The model, which will be utilized by the Metropolitan Water District (MWD), makes annual predictions based on slowly changing variables such as population, income and water pricing. Monthly projections are based on rapidly changing variables such as weather. MWD recently approved a $75,000 contract with Maidment to refine the model so that it will forecast water use within the district utilizing local rain and air temperature patterns. The model is the subject of a new technical report published by the Texas Water Resources Institute. For more information on that report, check the "Publications" section of this issue.

Texas A&M Report says Deepening Texas Ports May Increase Export Volume

Deepening the Houston Ship Channel from its current depth of 40 feet to 45- 50 feet would increase export volume substantially, according to a study conducted by Stephen Fuller, an agricultural economist with Texas A&M University.

The report, "Estimated Effect of Deepened U.S. Gulf Ports on Export Grain Flow Patterns and Logistics", was printed in the Vol. 23, No. 2 (1988) issue of *Logistics and Transportation Review.* Fuller's study found that deepening the ship channel to 50 feet would increase grain exports by 1.16 billion bushels per year. The study was based on production and export levels and transportation routes.

Maidment, Shaw win AWRA award for best paper of 1987

David Maidment and Doug Shaw of the University of Texas at Austin have been chosen as the winners of the Boggess Award by the American Water Resources Association. The award honors the best paper submitted to the *AWRA Bulletin*. The paper, "Intervention Analysis of Water Use Restrictions, Austin, TX," was chosen over 120 other entries. The paper was published in December 1987.

SW Texas State University Researchers Investigate Water Conservation, Reuse

Personnel of The Edwards Aquifer Research and Data Center at Southwest Texas State University are conducting a water reuse and efficiency study on the university's San Marcos campus. The project will assess the amount of water used for toilet flushing, showers, irrigation and cooling towers. After the data have been evaluated, researchers hope to present a report outlining opportunities for reuse in residence halls, other campus facilities such as the SWTSU Library, and landscape watering. The study is sponsored by the Lower Colorado River Authority, the Edwards Underground Water District, and the Hays County Water Development Board.

Other water-related activities now underway at SWTSU include: developing information for groundwater protection for Hays County; assessing water quality in rural areas; increasing water testing and biomonitoring capabilities for municipal water suppliers; and the development of a play about the Edwards Aquifer.

For information about these projects, contact: Edwards Aquifer Research and Data Center, SW Texas State University, San Marcos, TX 78666-4616, or call 512-245-2329.

Texas A&M University to Coordinate U.S. Effort in WOCE Program

Texas A&M University is the national planning office for the U.S. effort in the World Ocean Climate Experiment (WOCE), an international study of the earth's oceans and their effect on climate change. The program may lead to more accurate projections of the global climate, based on observations of ocean circulation changes.

WOCE recently produced a draft report which summarizes the role U.S. scientists will play this project. U.S. researchers will be involved in satellite missions, modeling efforts, hydrographies, and observations of the global ocean surface layer.

To obtain more information about WOCE, contact: Worth Nowlin, WOCE, Oceanography Department, Texas A&M University, College Station, TX 77843. The phone number is 409-845-2947.

Center for Environmental Research Dedicated

The Center for Environmental Research, a joint venture between Texas A&M University, the University of Texas at Austin, and the City of Austin, was dedicated May 10. The center is located at the Hornsby Bend Wastewater Treatment Plant outside of Austin. The center will provide opportunities for on-site wastewater treatment and water quality research including sludge management and reuse; irrigation with treated effluents; use of water hyacinths for wastewater treatment and other areas. The City of Austin is providing a new $2.1 million facility and staff support. The universities are responsible for seeking research funds and carrying out the work. For more information, contact: Center for Environmental Research, PO Box 1088, Austin, TX 78767. The phone number is 512-445-3000.

Texas Tech Researchers Participate in Drainage Study

The Water Resources Center at Texas Tech University is taking part in a study to develop a flood plain management plan for a portion of the City of Lubbock's playa lake system. The initial phase of the study involves extensive data collection and base model development. The second phase will utilize computer model analysis. The plan may provide developers, planners and engineers with an update of information which can be utilized to improve overall watershed management and to identify and prioritize long-term water problems and solutions. Others taking part in the study are Albert Ham Associates and Abacus Engineering Services. For more information, write to: Water Resources Center, P.O. Box 4630, Texas Tech University, Lubbock, TX 79409.

Sea Grant Program says Erosion is a Threat to Texas Coast

Two-thirds of Texas' shoreline is suffering from erosion and at least 400 acres of coastlands are being lost each year, according to the Texas A&M University Sea Grant Program's *Texas Shores* magazine.

The Spring 1988 issue of *Texas Shores* focuses on different aspects of coastal erosion. The magazine reports that: 1) 78% of the Galveston Bay shoreline retreated between 1850-1980; 2) Sargent Beach has the worst coastal erosion problem in Texas, losing more than 100 feet annually; and 3) Replanting areas vulnerable to erosion with cord grass or other sea grasses may slow the erosion problem.

Texas Shores is available from: Sea Grant Program, Texas A&M University, College Station, TX 77843. The phone number is 409-845-7524.

North Texas researchers Study Dallas Watershed

Scientists with the Center for Remote Sensing and Landuse Analyses (CRSLA) at the University of North Texas are conducting research on 1.6 million acres of four Dallas-Fort Worth area watersheds. The study involves interpreting satellite data collected during 1974-86 from watersheds surrounding Lake Ray Roberts, Lake Lewisville, Lake Grapevine and the Elm Fork of the Trinity River to determine land use patterns. The satellite information was combined with data on elevations, soils and rainfall to predict levels of erosion. The erosion rates have been used to calculate rates of sedimentation for area reservoirs. The data provide insights into where potential water quality problems exist.

Other projects underway at the University of North Texas include nonpoint pollution control in the Trinity River, and water quality modelling using remote sensing. For more information, contact: Applied Science Institute, University of North Texas, Denton, TX 76203. The phone number is 817-565-2694.

UT Project Assesses Impact of Land Treatment of Wastewater

The long-term effects of land disposal of wastewater on soils and groundwater at the Campbell Soup plant in Paris, Texas, are being investigated by University of Texas professor Raymond Loehr.

Loehr's project began in June 1987 when the EPA drilled groundwater monitoring wells at the 700-acre site that has been receiving treated effluent for more than 25 years. Samples of the groundwater, soil and vegetation are currently being analyzed for potential organic and inorganic contaminants, nutrients, solids and changes in soil characteristics. The study should be completed by the spring of 1989.

USGS Announces New Deadlines for Matching Grant Program

The U.S. Geological Survey has changed the deadline for receipt of grant proposals under the Section 105 matching grant program under the Water Resources Research Act to early October. A formal announcement of the FY 1989 program is expected in early August and proposals will be due in Washington October 3. Program announcements and application forms will be available from: Texas Water Resources Institute, Texas A&M University, College Station, TX 77843-2118. The phone number is 409-845-8571.

Energy Research in Applications Program Soliciting Hydropower, Geothermal Proposals

The Texas Higher Education Coordinating Board is now accepting proposals for a $15 million Energy Research in Applications (ERAP) program established in the last legislative session. The program will consider research projects dealing with hydropower and geothermal energy in addition to many other energy-related topics. Researchers from all Texas colleges and universities are invited to submit proposals. Proposals must be postmarked by September 12,1988. For an information packet describing the program or

for additional details, contact: Texas Higher Education Coordinating Board, PO Box 12788, Austin, TX 78711-1278. The phone number is 512-462-6470.

National Coastal Resources Research Institute Now Accepting Preproposals

The National Coastal Resources Research Institute (NCRI) is now accepting preproposals for research projects for 1989. Projects should emphasize environmentally compatible economic diversification and development in the coastal United States. Particular attention will be directed to projects that have a high potential for drawing investment into nonmetropolitan areas plagued by high unemployment. For more information, contact: Tom Maginnis, Director, National Coastal Resources Research Institute, Hatfield Marine Science Center, 2030 South Marine Science Dr., Newport, OR 97365. The phone number is 503-867-3300