New Waves
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Gulf of Mexico, Groundwater, Key Issues at 22nd Water for Texas Conference

This is a special issue of *New Waves*, focusing on the Texas Water Resources Institute's 22nd Water for Texas conference. All of the abstracts featured in this issue were papers presented at the conference. Additional abstracts of papers from the conference will be featured in upcoming issues of *New Waves.*

The conference was held October 19-21, 1988, in League City, just south of Houston, and was centered around the theme, "Managing Texas Waters: Stewardship in a Regulatory Environment." More than 265 people from across Texas participated in the conference.

In the opening plenary session, William Kellogg of the National Center for Atmospheric Research presented a paper dealing with the implications for Texas of global climate change; Tudor Davies of the EPA Office of Marine and Estuary Protection in Washington spoke about the Chesapeake Bay program and how similar programs could protect Galveston Bay; Neil Grigg of the Colorado Water Resources Research Institute at Colorado State University described current governmental responses to drought; and Julian Andelman of the University of Pittsburgh examined exposures and risks to human health from water contaminants.

Subsequent sessions focused on gulf coast issues, groundwater management, Galveston Bay, non-point source pollution, surface water management and groundwater quality.

The closing plenary session featured a mix of speakers including representatives from state agencies, city governments, the Texas Legislature and the university community. G.E. "Sonny" Kretzschmar of the Texas Water Development Board presented some of the preliminary water demand figures that will be included in the 1991 Texas water plan. Wayne Jordan of the Texas Water Resources Institute outlined the need for an ongoing water research program based in Texas universities. Representatives from the cities of Dallas (Dennis Allen), Houston (John Vanden Bosch) and San Antonio (Weir Labatt) then participated in a panel discussion about municipal water needs. A second panel discussion detailed water issues that were likely to be discussed in the next legislative session. Panelists included Sen. John Whitmire, State Rep. Dan Shelley, and State Rep. Terral Smith.

A proceedings from the conference is now in press and will be available for $25 early next year. To order an advance copy of the proceedings or to obtain a free list of the speakers and the titles of their presentations, contact TWRI at: Texas Water Resources Institute, Texas A&M University, College Station, TX 77843-2118. The phone number is (409) 845-8571.

TWRI Research Awards

The Texas Water Resources Institute has announced that the following projects have been selected for its September 1988 - August 1989 federal allotment program. Funds for this program are provided to the Institute through the U.S. Geological Survey. Project duration is shown is parentheses.

- Sediment Transport Into Texas Bays, Edward R. Holley, Center for Research in Water Resources and Civil Engineering Department, University of Texas, Austin, TX (2 years).
- On Managing Texas Rural Water Supply Systems: A Socioeconomic Analysis and Quality Evaluation, Ranghu N. Singh, Dept. of Sociology/Anthropology and Michael J. Ellerbrock, Agricultural Sciences Department, East Texas State University, Commerce, TX (2 years).
- Water Resources Management and Education, Ricard W. Jensen, Texas Water Resources Institute, College Station, TX.
- The Institute is also continuing federal funding for the following projects, which were originally funded in September 1987.
- The Role of Particles in Controlling Toxic Chemical Contamination in Surface Waters, Desmond F. Lawler, Civil Engineering Department, University of Texas, Austin, TX (2 years).
- Stochastic Simulation of the Nonpoint Source Runoff Process, Michael A. Collins, Civil Engineering Department, Southern Methodist University, Dallas, TX (2 years).

The Institute is also providing funding for the following projects with state funds.

- Evaluation of the Mutagenic Potential of Municipal Waste Landfill Leachate, K. W. Brown and K. C. Donnelly, Soil and Crop Sciences Department, Texas A&M University, College Station, TX (1 year).
- Oxygen Transfer in Hyacinth Wastewater Treatment Lagoons, C. E. Woods, Civil Engineering Department, Texas A&M University, College Station, TX (1 year).
- Oxygen Demand Potential of River Sediments and Their Effects on Waste Load Allocations in Urban Areas, C. P. Giammona, Civil Engineering Department, Texas A&M University, College Station, TX (1 year).
- The Expanding Dairy Industry: Impact on Groundwater Quality and Quantity, J. M. Sweeten, Texas Agricultural Extension Service and M. L. Wolfe, Agricultural Engineering Department, Texas A&M University, College Station, TX (1 year).
- Evaluation and Improvement of Drought Resistance of Dryland Crop Species, W. R. Jordan, Texas Water Resources Institute, College Station, TX (1 year).

For more information on any of the projects, contact: Texas Water Resources Institute, Texas A&M University, 301 Scoates Hall, College Station, TX 77843- 2118. The phone number is (409) 845- 8571.

Water Resources Planning: The Update and Revision of the Texas Water Plan

Author: Gilbert E. Kretzschmar, Deputy Executive Administrator, Texas Water Development Board (TWDB), Austin, TX.

Problem: Due to changes in **the** economy, water use projections developed for the 1984 Texas water plan, *Water for Texas*, need to be revised to be more accurate in light of today's conditions. This paper presents revisions made in water demand projections for the proposed 1991 Texas water plan.

Discussion: Various components of the new plan are being developed at this time. Currently, sources of water supplies are being analyzed and updated. In the spring of 1989, needed facilities for water and sewer treatment and dam and reservoir facilities will be evaluated in consultation with local and regional entities. Public hearings on the plan are tentatively scheduled for the summer of 1990 and the plan will be presented to the 1991 session of the Texas Legislature.

TWDB has developed tentative projections of the upper and lower amounts of water demand for 254 counties and 752 cities in Texas. Preliminary projections of total water demands for the state in the year 2000 range from a low of 14.8 million acre- feet (MAF) to a high of 17.1 MAF. For the year 2020, a low of 16.2 MAF and a high of 19.9 MAF are projected. A major difference between the current preliminary projections and 1984 estimates is in irrigation water usage. The 1988 plan projects slower growth in irrigated agriculture during the planning horizon and assumes that irrigation efficiency will increase. The plan also incorporates municipal and residential water conservation in its estimates. A statewide savings ranging from 371,000 AF to 389,000 AF is projected by the year 2000 based on those conservation activities.

Related Publications: *Water for Texas: A Comprehensive Plan for the Future*, Texas Department of Water Resources, Austin, TX, 1984.

Organic Contaminants in the Gulf of Mexico

Authors: Terry L. Wade, Texas A&M University, College Station, TX, and C. S. Giam, Texas A&M University at Galveston, Galveston, TX.

Problem: Rivers transport organic contaminants from point and non- point sources into Texas estuaries and the Gulf of Mexico. Organic contaminants that are resistant to bacterial degradation may eventually reach coastal areas of the Gulf of Mexico. Because coastal estuaries are important for a number of reasons including biological productivity, recreation, and commercial and sport fishing, it isvitalto understand the relationship between water quality in bay and estuary systems and river water quality.

Discussion: The concentration of various organic contaminants in such components of the estuary ecosystem as water, sediments and aquatic species is a good indicator of the amount of pollution in an estuary system.

This paper reviewed historicaldata and current research that measured levels of organic contaminants in sediments and aquatic species in the Gulf of Mexico. Objectives of the study were to assess the current water quality of the Gulf of Mexico and determine if it was improving or declining Analyses of sediments and oyster tissues (the "Mussel Watch Program") have been conducted for the past three years at 51 Gulf of Mexico sites including 19 Texas locations.

The study reported that coprostanol, which indicates the presence of sewage or runoff from barnyards and pastures, was found at all collection sites. Concentrations of pesticides, PCBs and butyltins (chemicals used to paint boat hulls) were all found to be greater in oyster tissues than in surrounding waters and sediments. Elevated concentrations of pesticides and PCBs were found at isolated locations including Galveston Bay.

Related Publications: Wade, Terry L., E.L. Atlas, et al, "National Atmospheric and Oceanic Administration (NOAA) Gulf of Mexico Status and Trends Program: Trace Organic Contaminant Distribution in Sediments and Oysters," in *Estuaries, 11:* 171 - 179, Rockville, MD,1988.

Implications for Texas of a Global Climate Change

Author: William W. Kellogg, National Center for Atmospheric Research, Boulder, CO.

Problem: The burning of fossil fuels and the addition of carbon dioxide and other infrared- absorbing gases into the atmosphere have been predicted to result in significantly increased temperatures throughout the Earth. The specific impact of this phenomena,"thegreenhouseeffect,"onTexas is discussed in this paper.

Discussion: Many scientific papers have theorized that as the concentration of such gases as carbon dioxide, methane, nitrous oxide, chlorofluorocarbons and others doubles the average surface temperature across the Earth will be 5 to 9deg. F warmer than it was at the beginning of the 20th century. Additionally, temperature changes in polar regions may be 2 to 3 times greater than average. However, these models have generally dealt with equilibrium conditions where the amount of gases emitted into the atmosphere remain constant, and do not reflect current trends which show increased emissions.

The most current predictions project that gas concentrations will double by the middle of the 21st century. If that happens, average surface temperatures will rise by roughly 0.5- 1 deg. F each decade, and may increase by as much as 2deg. F per decade in temperate and higher latitudes.

The study compared the results of five different models that are utilized to predict the impact of climate change. The results suggest that coastal Texas may receive increased

precipitation and that inland parts of the central U.S. may receive significantly lesser amounts of precipitation and be subject to more frequent droughts.

Related Publications: Kellogg, W.W., "Mankind's Impact on Climate: The Evolution of an Awareness," *Climatic Change,* 10:113- 136, Hingham, MA, 1987.

Balancing Water Development with Fish and Wildlife Resources

Author: Larry McKinney, Texas Parks and Wildlife Department (TPWD), Austin, TX.

Problem: The levelsof instream flows needed to protect fish and wildlife populations have historically not been provided. There is now a need to provide these flows to keep pace with increasing demands on limited natural resources.

Discussion: The economic value of resources depending on instream flows is becoming better known and is contributing to increasing public sentiment to protecting these flows. Judicial and Legislative relief has been somewhat successful at protecting instream f lows when the Appropriation Doctrine has failed. The Public Trust Doctrine, for example, protects the interests of fisheries, navigation, and commerce; and the Federal Energy Regulatory Commission (FERC), has recently been charged to give consideration to fish and wildlife resources when it reviews hydropower licenses.

In Texas, recent amendments to the Texas Water Code include fish and wildlife considerations as part of the water rights permitting process. The effect of the changes to the Water Code has been to involve TPWD in evaluating in streamflow and mitigation needs on a case by case basis. In the future,TPWD may be involved in state wide planning of instream flow needs. To resolve environmental issues such as instream flows, it must be acknowledged that nonconsumptive uses of water also are beneficial and economically important uses. Competing needs can be balanced to meet the needs of water development while maintaining environmental quality. For example, the Guadalupe Blanco River Authority (GBRA) recently worked with TPWD to develop a plan that will protect the yield of Canyon Reservoir and the Guadalupe River fishery during droughts, and will provide more downstream flows during non- drought periods. Other agencies are also studying instream flow needs in Texas.

Related Publications: Reiser, D.W. and T.A. Wesche, *Status of Instream Flow Legislation and Practices in North America,* American Fisheries Society, Bethesda, MD,1988.

Pesticides and Groundwater: What We Know about Actual and Potential Contamination in Texas

Author: Nancy L.J. Cox, Texas Department of Agriculture (TDA), Austin, TX.

Problem: Agricultural use of pesticides has more than tripled since 1964 with the amount of pesticide applied in the U.S. estimated at 1.1 to 2.2 billion pounds annually. In the past 10 years, pesticides have been discovered in groundwater supplies. In 1988, more than 73

pesticides were detected in groundwater supplies of 34 states, including Texas. Texas accounts for 10% of the pesticides applied nationally and groundwater supplies more than 60% of the water used in the state. Unfortunately, little is known about the environmental fate and degradation time of pesticides once they enter groundwater systems. This paper discusses the potential for groundwater contamination by agricultural pesticides and the potential dangers from pesticide contamination.

Discussion: Certain agricultural operations, in particular pesticide spills during mixing or filling, chemigation, and the application of pesticides with irrigation, can all threaten groundwater quality. Improperly constructed wells may provide a direct pipeline to groundwater, increasing the risk of contamination.

Human exposure to pesticides can result in either acute or chronic effects. Acute effects are those that stem from contact with high levels of pesticides for a short period of time, while chronic effects usually result from long term exposure to low levels of contaminants. Although there are gaps in the data, evidence suggests that some of the risks from chronic exposure to pesticides include cancer, birth defects, kidney and liver damage. The author suggests that rural Texans may be especially vulnerable because they come into contact with pesticides where they work as well as in their drinking water and food supplies.

The author also describes the TDA's Rural Drinking Water Monitoring Project which is going to study potential effects on rural groundwater quality from agricultural chemicals in selected sensitive areas of the state as identified by TDA. So far, the project has sampled groundwater supplies in Knox, Haskell, Commanche, Howard and Martin counties, and studies of Terry, Lynn, Dawson, El Paso and Hidalgo counties are under way. Preliminary results confirm the presence of arsenic in many areas and the evidence of pesticides in other areas. Other reasons that Texas should be concerned include the amount of pesticides applied in the state. Specific instances of contamination at Runnels County in 1968; in Seymour and Knox counties in 1978; and in Knott on the southern high plains are also presented.

Related Publications: King, Robert, Edwin Cobb and Rick Piltz, *Protecting Texas* Groundwater, Texas Department of Agriculture, Austin, TX,1987; Auerelius, Lea, *Investigation of Arsenic Contamination of Groundwater Occurring Near Knott* TX, Texas Department of Agriculture, Austin, TX,1988.

Use of Remote Sensing and Geographic Information Systems for Predicting Sediment and Nutrient Loadings to Water Supply Reservoirs

Authors: Samuel Atkinson and Kenneth L. Dickson, Center for Remote Sensing and Land Use Analyses, University of North Texas, Denton, TX, and Kennth Del Regno, Dallas Water Utilities, Dallas, TX.

Problem: Surface runoff in the Dallas- Fort Worth area is suspected of contributing nonpoint source pollutants to surface water reservoirs and area rivers. Changing land use patterns may also alter the types and amounts of nonpoint source pollutants. This paper

looks at the use of two recent technologies - remote sensing and geographic information systems (GIS) - to measure sediment and nutrient loadings in north central Texas.

Discussion: The project's objectives are to measure and document land use changes and assess how nonpoint pollutant loadings have changed in the last 14 years (19741988). The project will also identify critical areas of intense non- point source pollution, conduct water quality sampling and analyses, and recommend best management practices (BMPs) that may reduce non- point source pollution. The project involves acquisition of satellite data, establishment of databases, development of GIS models, identification of critical areas, and collection and analysis of water quality data. Later, the study will begin pilot projects that utilize BMPs and may suggest incentives for landowners to adopt those practices.

This paper describes the results of phase l of an ongoing project that uses remote sensing technology in watershed management studies covering more than 1.6 million acres in the Dallas- Fort Worth area. In phase 1, watersheds including Lake Grapevine, Lake Ray Roberts, and the Elm Fork of the Trinity River between Lake Lewisville and Frazier Dam in Dallas were analyzed. Satellite data from 1974 to 1988 were used to analyze land use and land use changes in the selected watersheds. Soil loss in the watersheds was determined using the Universal Soil Loss Equation. The largest land use changes were seen in the rapidly urbanizing Elm Fork of the Trinity River where urban land use has nearly tripled since 1974. Other findings were that the Elm Fork of the Trinity River and Lake Ray Roberts have experienced significant increases in sedimentation during the study period, and that as much as 72% of total phosphate in the watersheds was the result of non- point source pollution.

Related Publications: DelRegno, Kenneth, and Samuel Atkinson, Nonpoint Pollution and Watershed Management: A Remote Sensing and Geographic Information System Approach," Lake *and Reservoir Management,* Vol. 4, No. 2, Merrifield, VA, 1988.

Relationship of Mobility Persistence and Usage of Pesticides to Groundwater Interception

Author: John R. Abernathy, Texas Agricultural Experiment Station, Lubbock, TX.

Problem: A number of herbicides have been detected in groundwater wells including bromacil, alachlor, atrazine, DCPA, dinoseb, EBD, aldicarb, simazine and others. Factors which cause pesticides to be potential groundwater contaminants include their mobility in soils, biopersistence, and human toxicity. This paper discusses the mobility of pesticides in soils and bio- persistence.

Discussion: Downward movement of herbicides is usually greatest in sandy soils with low organic matter under high rainfall or sprinkler irrigation. Under bedded and furrow irrigated conditions, some herbicides may move laterally or upward. Some of the factors influencing herbicide movement include soil, clay, and organic matter; soil pH, soil moisture- holding capacity, topography, rainfall intensity, and tillage. Characteristics of

the herbicide molecule, water solubility, and chemical formulation and additives also influence herbicide movement.

Techniques for studying herbicide movement were discussed. Typically, such studies utilize tubes and soil thin layer chromatography. Herbicide would be added at the top and would then be leached downward by adding water. Movement of the herbicide and leaching could then be analyzed.

The paper also discussed the bio- persistence of herbicides in soils. Bio- persistence is usually dependent on the amount of herbicide adsorbed by the soil and the soil environment. Herbicide persistence is generally greater in high pH soils and is very pronounced with chlorsulfuron and other related herbicides.

Related Publications: Abernathy, J.R. and J.W. Keeling, "Efficacy and Rotational Crop Response to Levels and Dates of Dinitroaniline Herbicide Applications," *Weed Science*, 27: 312- 317, Urbana, IL, 1979; *Agricultural and Groundwater Quality,* Council for Agricultural Science and Technology, Ames, IA, 1985.

Assessing the Economic Impacts of Recreational Activities Along the Texas Gulf Coast

Authors: T. Ozuna and Lonnie L. Jones, Agricultural Economics Department, Texas A&M University, College Station, TX; and D.R. Fesenmaier, Recreation and Parks Department, Texas A&M University, College Station, TX.

Problem: The Texas Gulf Coast offers a challenging and diverse environment for studying the economic impacts of recreation, commercial fishing, sport fishing and other activities. This paper summarizes the findings of six reports on Texas bays and estuaries which estimated the amount of these activities. Results are expected to assist coastal planners and decision makers in formulating policy for the Gulf Coast.

Discussion: In this study, the Texas Gulf Coast was divided into six regions consisting of specific bays and estuaries.

Data was collected through personal interviews and mail surveys for each region. Survey data was used in conjunction with a regional input- output model to estimate the economic impact of coastal- based recreation. Survey questions included asking respondents to estimate their expenditures for such goods and services as overnight lodging, transportation, groceries and restaurants, rental of recreation equipment, and fees from charter fishing trips and other items.

Results indicate that there were more than 10 million visits to the Texas Gulf Coast during 1986 and nearly 60% of those were by fishermen. Half of those visits were during the summer. Other findings were that Texas households travel an average of 170 miles to get to the coast and that sea trout, flounder and red drum, respectively, were the fish caught most open. Visitors to the coast spent more than $586 million in 1986 with 62% of that total spent by fishermen. Of the money spent by fishermen, transportation

accounted for $111 million; restaurants for $145 million and groceries for $109 million. Fishing expenditures along the Texas Gulf Coast accounted for $364 million of direct impacts and $1.16 billion statewide and earned the state nearly $43 million in tax revenues.

Related Publications: Ozuna, T., Lonnie L. Jones, et al, *Regional and Statewide Economic Impacts of Sport Fishing, Other Recreation Activities, and Commercial Fishing Associated with Major Bays and Estuaries of the Texas Gulf Coast* (Executive Summary), Texas Water Development Board, Austin, TX, 1987.

Global Warming May be Disastrous for Texas Coast

A recent study performed for the EPA suggests that the greenhouse effect may be disastrous for the Texas coast. Stephen Leatherman, the Director of the University of Maryland's Coastal Research Laboratory, performed the study for EPA which focuses on the implications of rising global temperatures for Galveston Island, Texas City, LaMarque and San Leon. He projected that: 1) The sea level of the Gulf of Mexico would rise by more than 5 feet; 2) Huge hurricanes, which typically occurred only once every 100 years, would be more frequent and more intense; and, 3) Waves generated by such storms could go over the Galveston seaway causing four times as much damage as they now cause. The only options to combat these effects, Leatherman said, would be to move development away from the coastline, to build higher seawalls, and to fortify the beaches with extra sand.

Odessa May Try Reverse Osmosis to Improve Water Quality

Water from Lake Thomas and Lake Spence near Odessa often contains high amounts of sodium chloride, magnesium, and total dissolved solids (TDS). As a result, the City of Odessa is considering a 6- month experiment with reverse osmosis filtration and electrolysis that will begin in early 1989.

If successful, reverse osmosis could be used to purify the entire city's water supply. Recent samples of Odessa's water supply showed TDS levels of 992 parts per million (PPM) more than the EPA standard of 500 PPM but less than the Texas Department of Health regulations of 1,000 PPM. Although the water is safe, it tastes unpleasant and speeds up the decay of machines and appliances.

Sea World Designs Water World Especially for Shamu

Keeping Shamu, the killer whale, penguins, and other assorted animals happy in inland San Antonio is no easy task. In fact, at the newly opened Sea World theme park, it requires a one- of- a- kind water system. Sea World continuously recycles 15 million gallons of salt water to keep the animals' habitats sanitary and attractive. The water quality in each pool is tested three times each day. Shamu, meanwhile, requires a system that filters 7 million gallons per day and could support a city of 250,000 people. The pools are also unique; they are specially shaped with sides that are sloped to the bottom

so that animal wastes fall to the bottom where they are sucked out of the pools and into a purification system.

Texas State Aquarium Being Built in Corpus Christi

Construction of a Texas State Aquarium is now underway in Corpus Christi. A 43,000 square foot Gulf of Mexico Exhibit Building is under construction and is scheduled to be completed in 1990. An education and research center is also planned. When the complex is completed, it will include exhibits that provide accurate scientific information about marine life and will serve as a central source of ecological, geological, and environmental data relating to the Gulf of Mexico. The aquarium may also offer opportunities for research including daily study records and observation of marine life and environments. Specific research areas could include nutrition, physiology, seawater system technology, and others. Planned exhibits include the bottlenose dolphin, sharks, swordfish and other species. For more information, contact: Texas State Aquarium, PO Box 331307, Corpus Christi, TX 78463. The phone number is (512) 880- 5858.

EPA Estimates Cost of New Drinking Water Regulations

New regulations for drinking water and wastewater treatment could cost homeowners an average of $100 in municipal fees by 1996, according to a study by the EPA. The study said that farms and some small businesses, particularly dry cleaners and gas stations, could face significant costs from 85 major regulations proposed in the past two years.

Another significant impact will be the result of the EPA's recent proposal to reduce lead in water supplies to less than 5 parts per billion. This proposal, which would cost as much as $367 per family per year in the hardest hit areas, would include a corrosion control program. The study also found that the increases would be greatest in the smallest towns and in cities with more than 250,000 residents.

Chicot Aquifer May be Contaminated by Brine Injection

Oil industry pumping practices and natural water quality changes in a giant salt dome may be contaminating the Chicot aquifer that serves the City of Mont Belvieu and parts of Chambers, Harris and Liberty counties, according to a recent article in the *Houston Chronicle.* Mont Belvieu is situated on top of a giant salt dome, and oil companies have carved caverns inside the dome to store oilfield brine (roughly 15.4 million barrels of brine are injected into the dome each year). However, recent findings have suggested that about 10 percent of the salt water that is injected is leaking into the city's freshwater supply. Chloride levels have been as high as 510 parts per million (PPM) and sodium levels have risen to as much as 360 PPM.

Rio Grande May Provide Drinking Water Supply for Colonias

A new environmental study says that tapping the Rio Grande for drinking water in El Paso's colonias will not overload the area's sewage system or devastate farming in the Lower Rio Grande Valley. The study, prepared by the Rio Grande Council of Governments in El Paso and the Lower Valley Authority District, was forwarded to the

U.S. Bureau of Reclamation. The Bureau said it would not allow diversions from the Rio Grande to aid the colonias until an environmental impact study was completed.

Marble Falls Mulling Wastewater Irrigation System

The City of Marble Falls is considering using its wastewater to irrigate grasses and other crops and, at the same time, possibly enhance the quality of the Highland Lakes. Marble Falls is working with the Lower Colorado River Authority (LCRA) to investigate the feasibility of a system where the city would use secondary treated wastewater to grow turfgrasses and alfalfa on roughly 300 acres as an alternative to discharging wastewater into the Highland Lakes. By the year 2010, the project could reduce projected wastewater disposals into the Highland Lakes from 1.5 million gallons per day (GPD) to 860,000 GPD. Proponents say wastewater used for irrigation would also require less treatment, which could lower utility bills. The system is now under consideration by the TWC.

Palo Duro Reservoir Now Under Construction

The Palo Duro River Authority (PDRA) has begun construction of an earthen dam and reservoir with a capacity of 60,900 acre- foot (AF), seven miles north of Spearman in the Texas panhandle. The project, scheduled to be completed in the summer of 1990, will cover 2,500 acres. When the lake fills, its elevation will be 2,892 feet above sea level. The project is significant because it is the last undeveloped spot in the panhandle capable of supporting a reservoir, according to PDRA officials.

Effluent Irrigation Suspected of Raising Nitrate Levels in Lubbock Area Wells

Water wells serving residents near Buffalo Springs and Ransom Canyon outside of Lubbock showed higher than desirable levels of nitrates, chloride and sodium, according to a recent Texas Water Commission study. Tests from five wells near Buffalo Springs showed nitrate- N levels of between 6 and 17 milligrams per liter.

The study said that the Frank Gray Farm, which the City of Lubbock has used for wastewater irrigation since the 1930s, may be part of the problem. The farm may have been applying too much effluent and the application area may need to be expanded. Possible solutions include construction of a $5 million wastewater storage facility, and replacing cotton with crops that consume more water and nutrients.

Contamination Detected in Water Wells at Reese AFB in Lubbock

Trichloroethane, a poisonous substance, was found in three wells at the Reese Air Force Base in Lubbock last August. Five groundwater wells have been closed and 26 monitor wells have been installed at the base while investigators study the cause of the pollution. Two other wells have been closed to prevent the migration of contaminants to unpolluted areas. Although the exact cause of the contamination is not known, a landfill on the base is a suspected source. Until the problem is resolved, the base will rely on water from the City of Lubbock.

GBRA to Print Monthly Index of Water Quality

The Guadalupe- Blanco River Authority (GBRA) will publish monthly reports about the quality of water between Canyon Dam and the Gulf of Mexico. The reports will list information on the amount of fecal coliform bacteria, other pathogens, total suspended solids, turbidity, alkalinity, temperature, dissolved oxygen, phosphorus and nitrate nitrogen in the Guadalupe River. A "perfect" score of 100 points is possible. If the index would have been used earlier this year, rankings would have ranged from as high as 92 between Seguin and New Braunfels to as low as 21 near a saltwater barrier in Calhoun County. GBRA officials say the monthly notices should provide basic information their users need about water quality in the region.

Former Superfund Site Being Converted to Wetlands

For the first time, a group of industries has agreed to replace wetlands that were damaged by an EPA Superfund site. The Motco Trust Group, a group of 22 industries that dumped hazardous wastes at the site, agreed to spend $325,000 to purchase and develop 31 acres of wetlands as part of a court- ordered settlement. The wetlands will be planted with cordgrass and will provide nursery areas for fish and shrimp. The Motco site was originally an 11 - acre site that was contaminated with hazardous wastes and eventually polluted 20 acres of nearby wetlands.

New TWRI Reports Look at Reservoir Operation, Reaeration, Forecasting Water Demands

The Texas Water Resources Institute has recently published four new technical reports (TR) that are now available to the public at no charge. Forecasting Water Use in Texas Cities (TR-142) was written by David Maidment and Doug Shaw at the University of Texas at Austin. The report details a method for projecting municipal daily water use utilizing short-term and long-term variables. Preliminary Investigation of Tracer Gas Reaeration Method for Shallow Bays (TR-141) was written by Edward Holley and Sarah Baker of the University of Texas at Austin. This report describes a method of using tracer gas to predict the rates of oxygen transfer in experiments on Lavaca Bay. Hydrologic and Institutional Water Availability in the Brazos River Basin (TR-144), written by Ralph Wurbs, Carla Bergman, Patrick Carriere and Brian Walls at Texas A&M University, evaluated current methods for estimating reservoir yields and increased yields from system management of reservoirs. Evaluation of Storage Reallocation and Related Strategies for Optimizing Reservoir System Operations (TR-145) was also written by Ralph Wurbs and Patrick Carriere. It focused on reallocating reservoir storage capacities to optimize reservoir management and described models that may assist in the reallocation process.

TWRI also has two other recent free publications which are available. The new issue of the *Texas Water Resources* newsletter is titled "A New Approach to Regional Management: Two Plans Are Developed to Manage and Protect the Edwards Aquifer." And a new brochure details the water testing capabilities of the Texas Agricultural Extension Service and provides information on other labs in the state which also perform water analysis. The publications are available at no cost from: Texas Water Resources

Institute, Texas A&M University, College Station, TX 77843-2118. The phone number is (409) 845-8571.

National Wildlife Federation Study Charges Safe Drinking Water Act Not Being Enforced

A new report by the National Wildlife Federation suggests that the Safe Drinking Water Act is not being enforced. *Danger on Tap: The Government's Failure to Enforce the Federal Safe Drinking Water Act*, says that 1,579 of Texas' 7,640 public water systems violated provisions of the Act in 1987. However, only 304 of those violations (9%) resulted in enforcement actions from state or federal agencies. The report also says that although 3,400 violations occurred in Texas, no public notices were issued by state or federal agencies. Finally, the report projects that more than 2 million Texans were served by water systems that did not meet the Act's water quality or testing requirements in 1987.

For a copy of the report, write to: Environmental Quality Division, National Wildlife Federation,1400 16th Street N.W., Washington, DC 20036.

River Authorities are Focus of Agricultural Experiment Station Study

A recent report by the Texas Agricultural Experiment Station provides a detailed look at the river authorities throughout Texas. The publication, *Regional Management of Water Resources: River Authorities in Texas* (MP- 1666), was written by Ron Griffin and Jayson Harper in the Agricultural Economics Department of Texas A&M University. The report assesses the powers and programs of the river authorities in the state including such areas as water supply, reservoir operation, pollution control and others. The report is available from: Agricultural Communications Dept., Texas A&M University, College Station, TX 77843- 2112. The phone number is (409) 8452211.

60% of Nation's Groundwater May be Naturally Contaminated

A new report by the Edison Electric Institute (EEI) states that the natural quality of almost 60% of the nation's groundwater above depths of 2,500 feet may not meet all federal drinking water standards. The report, *Natural Quality of Groundwater in the U. S. Compared to Drinking Water Standards*, was produced by EEl's Groundwater Task Force. The task force utilized U.S. Geological Survey data on naturally occurring chemicals, and information from the public domain to reach its conclusions. The report says that roughly half the groundwater exceeded the standard for total dissolved solids (TDS) and iron. The report also contains specific information on naturally occurring levels of chloride, sulfate, radium, nitrates, and other constituents in Texas aquifers. The report is available from: Edison Electric Institute,111 19th St. NW, Washington, DC 20036- 3691. The phone number is (202) 778- 6641.

Geological Survey Report says U.S. Now Uses Less Water

Water withdrawals in the U.S. in 1985 were 10% less than they were in 1980, according to a new report by the U.S. Geological Survey. The report, *Estimated Use of Water in the*

United States in 1985 (USGS Circular 1004) says that nearly 400 billion gallons per day (BGD) of both fresh and saline water were withdrawn from ground and surface water sources in 1985. All but 1 BGD were freshwater withdrawals.

The decreases in water use were widely spread across the U.S. and 37 states reported using less water. Factors leading to the decrease in water withdrawals include: 1) Increased groundwater pumping, resulting in higher pumping costs, encouraged conservation; 2) Increased use of recycled water; and, 3) Less economical irrigation due to depressed agricultural prices. According to the report, Texas withdrew 1.230 BGD of groundwater and 1.76 BGD of surface water in 1 985. Per capita water use in Texas was 194 gallons per day. The report is available from: U.S. Geological Survey, Books and Open- File Reports Section, Federal Center, Box 25425, Denver, CO 80225.

Water Resources Abstracts Now Available on Compact Disks

Searching for technical articles dealing with any aspect of water resources just got a lot simpler. The U.S. Geological Survey recently announced that its series of *Selected Water Resources Abstracts*, which compile the most current technical water research information, are now available on compact disks. Twenty- five years of abstracts are stored on just 2 disks. The system allows users to select articles based on key words, authors, organizations or ID numbers. The system is now operating in the Technical Reports Section of the Evans Library at Texas A&M University.

The laser disk system is available from two vendors. For more information, contact the Online Computer Library Center at (800) 848- 5878 or the National Information Services Center at (301) 454- 8040.

TWC Publications List Now on Microfiche

The Texas Water Commission released a new microfiche publications catalog that lists the holdings of the TWC library. The publications are grouped alphabetically by author, title, subject and series. The list includes all publications written by the Texas Water Commission, the Texas Water Development Board, the Texas Department of Water Resources, and their predecessor agencies, as well as other publications that deal with Texas water issues. To receive a free copy of the list, contact: Texas Water Commission, Library, PO Box 13087, Capitol Station, Austin, TX 78711 3087. The phone number is (512) 463- 7834.

Measuring Soil Moisture with Gypsum Blocks May Save Water

Utilizing gypsum blocks to monitor soil moisture can reduce the amount of water used for irrigation, according to a new report titled *Winning With Water*. The book, produced by INFORM (an environmental research group) reports using gypsum blocks to monitor soil moisture resulted in cutting the amount of irrigation water used by as much as 50% without cutting yields. The book is available for $24.95 from: INFORM,381 Park Avenue South, New York, NY 10016. The phone number is (212) 689- 4040.

Proceeds from SMU Conference on Water Planning and Financing Now Available

Southern Methodist University has recently published *Water Planning and Financing for the 21st Century,* a proceedings from a conference it hosted in 1987. Topics covered in the proceedings include the economics of water development and pollution control, alternative strategies for funding major water projects, the impact of tax reform on water financing, water marketing, water conservation and use, and surface water issues. The 397- page proceedings includes 33 talks and is available for $60 from: Center for Urban Studies, Southern Methodist University, Dallas, TX 75275- 0335. The phone number is (214) 6923060.

TDA Report Cites Excessive Arsenic Levels in Ogallala Wells

A new report by the Texas Department of Agriculture reveals that portions of the Ogallala Aquifer near Knott, Texas, on the Southern High Plains may be contaminated by arsenic. The report, *Investigation of* Arsenic *Contamination of Groundwater Occurring near Knott, Texas,* states that 34 of 101 wells sampled in the area contained arsenic concentrations above the maximum allowable limit for human drinking water of 0.05 milligrams per liter. The report says contamination seems to stem from nearby cottongins or from sites treated with arsenic pesticides and cotton gin waste which is used as mulch.

The report is available from the Texas Department of Agriculture, PO Box 12847, Capitol Station, Austin, TX 78711. The phone number is (512) 463- 7504.

Water Industry Guide Lists Federal, State, Local Water Agencies in Texas

Confused about who to turn to with water- related problems? Help is now available from the *Texas Water Industry Guide.* This publication lists government agencies, water related associations, water districts, Texas Rural Water Association members, and businesses that offer services and supplies for the water, wastewater and hazardous waste industry. In several cases, a description of the group is provided.

The *Guide is* available for $12.50 plus $1.80 handling and tax from: Texas Water Industry Guide, 9600 Great Hills Trail, Suite 150 W. Austin, TX 78759- 9838. For more information, call (512) 343- 1218.

New Extension Service Fact Sheets Deal with Irrigation, Water Quality

The Texas Agricultural Extension Service has recently produced some fact sheets that are available to the public at no cost. New irrigation fact sheets include: *Managing Pecan Orchards with Limited Water Supplies* (L- 2299); *Crop Water Management for the High Plains* (L- 2298); *Managing Private Groundwater Through Underground Water Conservation Districts* (B- 1612); *Soil Moisture Monitoring* (B- 1610); and *Water Management Strategies for Cotton (L- 2297).* New water quality fact sheets include: *Hard Water: To Soften or Not to Soften* (L- 2277); Home Water Quality Problems Causes and Treatments (L- 2279); and *Home Water Treatment Systems* (L- 2280). To order any

of these publications contact: Agricultural Communications Department, Texas A&M University, College Station, TX 77843- 2112. The phone number is (409) 845- 2211.

Offshore Technology Center to be Joint Venture of NSF, Texas A&M University, University of Texas

The National Science Foundation announced it will provide more than $28 million over the next five years to sponsor the construction of an Engineering Research Center for Offshore Technology that will be housed at the Texas A&M University Research Park. The center will be a joint venture between scientists from Texas A&M University and the University of Texas at Austin. Dr. John Flipse of Texas A&M University will serve as the director of the center, and Richard Miksad of the University of Texas will be the associate director of the center.

The center, scheduled for completion in 1990, will be housed in a $5 million facility that will contain a 12- foot deep 100 x 100 foot wave tank to be used to simulate offshore conditions and test drilling platforms. The center would be the only U.S. facility working on marine hydrodynamics research which tests wave forces on structures in the ocean. It will also develop offshore drilling techniques that could be effective at depths of more than 4,000 feet.

For more information, contact: Offshore Technology Research Center, Texas A&M University, College Station, TX 77843- 3400. The phone number is (409) 845- 6000.

American Institute of Hydrology Offers Professional Certification

The Texas Section of the American Institute of Hydrology (AIH) is encouraging applications from hydrologists and hydrogeologists who wish to be considered for professional certification. Information on AIH certification requirements can be obtained by contacting Mike Collins, president, AIH Texas Section, Center for Urban Water Studies, SMU, Dallas, TX 75275. The phone number is (214) 692- 3060.

Drought May Dry Up Texas Oyster Harvest

Galveston Bay oystermen could be facing one of the worst seasons in recent memory due to this summer's drought. Sammy Ray, a professor at Texas A&M University at Galveston, said the drought resulted in higher salinity levels in Galveston Bay, which increased oyster predators like crabs and conches. But, the drought may increase the oyster supply next year. Oysters spawn best in warm, salty water - just the kind of water brought on by this year's drought.

Texas Researchers Submit 10% of Proposals to USGS Matching Grant Program

The U.S. Geological Survey announced that nearly 10% of the proposals it received for its matching grant program came from Texas researchers. The U.S.G.S. received 265 proposals for its FY 1989 matching grant research program, and 20 of those were from

Texas. Four proposals were received from Texas A&M University; six from the University of Texas at Austin; four from Rice University; and two from Texas Tech University. Southern Methodist University, the University of North Texas, and Southwest Texas State University each submitted one proposal.

The U.S.G.S. expects to announce the projects it has selected for funding in April.

High Pressure Water Jets Improve Carrot Processing

Texas A&M University Researchers have developed a device that uses water jets (high pressure water) to cut the tops off carrots which may make carrot processing more efficient. In the first phase of the project, John Posselius and Ralph Morgan, agricultural engineers with the Texas Agricultural Experiment Station in Weslaco, determined that 10 carrots could be cut per second using a water jet. In the second phase, agricultural engineer Matthew Batchelor developed a computer vision system that determines precisely where the cuts should be made. In the final phase of the project, the computer vision system and the water jet will be integrated. Similar water jet systems are currently being used in other aspects of food processing and for other applications.

Ocean Drilling Program Probes Sea Floors

The Department of Oceanography at Texas A&M University and the Institute of Geophysics at the University of Texas at Austin are among the institutions taking part in the Ocean Drilling Program (ODP). The ODP also brings together scientists and governments of 15 European countries, Canada and Japan to study the geology of the oceans.

By taking core samples of the ocean floor in a continuous series of cruises aboard the drilling ship *JOIDES Resolution,* scientists are discovering such things as the age of ocean basins, the evolution of life in the oceans, the history of worldwide climatic changes, and the shifting of the continents. The ship is equipped with 12 laboratories containing

such instruments as a cryo genic magnetometer, a scanning electron microscope, X- ray machines and a variety of computers to analyze the core samples taken from all over the world. Last summer, the ship explored the eastern Indian Ocean and associated remote subantarctic regions. After each cruise, qualified scientists may request core samples for their own research.

For further information contact: Karen Riedel, Ocean Drilling Program, Texas A&M University, College Station, TX 77840 or call (409) 845- 9322.

Corpus Christi State University Scientists to Measure Gulf Tides

Researchers from Corpus Christi State University's (CCSU) Blucher Institute for Surveying and Science have begun a project to study the tides off the Texas coast. The project will initially model the characteristics of the tides in the Corpus Christi Bay area. Later, the researchers will use a computerized gauge that was developed at CCSU to

measure the tides and relay that information to the university. The end result may be more accurate and current tide data.

The information could be useful for hurricane and storm surge prediction, determining marine boundaries, and Gulf navigation. Eventually, the system may be expanded to include the entire Texas coast.

The project was funded by the Texas General Land Office, CCSU, and the City of Corpus Christi.

Researchers say Huge Tidal Wave May have Hit Texas Coast 66 Million Years Ago

Four university researchers have suggested that a giant tidal wave 150 to 300 feet high may have crashed against the Texas coastline about 66 million years ago. What's more, the scientists believe that the tidal wave may have been caused by an asteroid or other extraterrestrial object crashing into Earth, possibly as far away as the Atlantic Ocean. The results were reported in the July 29 issue of *Science* magazine.

Thor Hansen, now a researcher at Western Washington University and formerly a professor at the University of Texas, is one of the scientists who developed the theory. The researchers discovered the evidence by studying an outcrop of sedimentary rock near the Brazos River in Falls County, south of Waco. They found large clumps of mud 3 feet thick that were interspersed with chunks of limy material, apparently ripped from the ocean floor. Similar strata have been reported in Mexico, Arkansas and off the coast of North Carolina. Unusually high amounts of iridium also were found leading the researchers to believe an asteroid may have caused the tidal wave.

University of Houston Law Center Focuses on Environmental Liability

The University of Houston Law School has established an Environmental Liability Law Program to study how the legal system can better respond to health and natural resource damage from pollution. The program, established in 1985, sponsors academic research projects that analyze environmental issues. It also sponsored a 1987 conference on '*Managing Liability from Hazardous Wastes."

The focus of the program is man- made contamination of water and other natural resources. The program is limiting its research to cases where claims of personal injury or property damage resulted from pollution. It hopes to create legal incentives to reduce pollution.

For more information, contact: Dr. Sanford Gaines, Environmental Liability Law Program, University of Houston Law Center, Houston, TX 77204- 6370. The phone number is (713) 749- 1393.

Rice University Researchers Study Water Quality in Lake Houston

Researchers with Rice University's Department of Geology and Geophysics have documented the transport of suspended solids and other pollutants in Lake Houston to determine how those processes influence water quality. John Anderson and Robert Dunbar were involved in the research which included placing sediment traps at strategic locations in the lake to collect suspended sediments. The samples were analyzed along with information on rainfall intensity, the configuration of the lake and other factors.

Findings from the study suggest that rainfall intensity strongly influences sediment input to the lake, and that storms that occur when lake levels are low may resuspend sediments and may seriously impair water quality. The research was reported in the Vol. 10, No. 3 (1987), issue of *Environmental Geology and Water Sciences.*

UT Filter Research May Make Wastewater Reuse More Likely

Scientists from the University of Texas at Austin are investigating the use of filters that may be effective in removing particles from water and wastewater, which could make wastewater reuse more practical. The research is being conducted by Desmond Lawler and Jeannie Darby of UT's Civil Engineering Department. The research will focus on explaining the physical and chemical interactions that cause particles already trapped on a filter to attract and retain other suspended particles. Laboratory studies are now underway and field experiments will be conducted later that will utilize water from Town Lake, a sludge treatment facility, and samples from Austin's wastewater treatment plant. The studies are funded in part by the U.S. Geological Survey.

University of North Texas Hosts Regional Conference on Water Resources Challenges

The Institute of Applied Sciences at the University of North Texas sponsored a conference titled "Land and Water Resources Challenges in North Central Texas" September 22- 23. The conference examined such issues as surface water management, groundwater and hazardous waste management, water law, and water quality issues on the Trinity River. Other issues included watershed management, nonpoint source pollution, and biomonitoring of wastewater discharges.

Additional information and copies of some of the talks presented at the conference are available from: Institute for Applied Sciences, University of North Texas, PO Box 13078, UNT Station, Denton, TX 76203 or call (817) 5652694.

Ocean Archaeologists Excavate Remains of Jamaican City

A team of Texas A&M University underwater archaeologists has been making a detailed study of Port Royal Jamaica, a city where an estimated 2,000 lives were lost in an earthquake in 1692. Apparently, when the earthquake hit, buildings and homes that were built on sandy soils sank as their foundations crumbled. The project has involved more than 100 Texas A&M University students who perform research at the site each summer

and is headed by Dr. Don Hamilton of the University's Institute of Nautical Archaeology. Most of the excavation is performed in shallow waters 6 to 25 feet deep although artifacts have been recovered from as deep as 250 feet. Among the items discovered by the researchers were a die for making counterfeit doubloons, porcelain, medical equipment and a sundial. For more information, contact: Nautical Archaeology Department, Texas A&M University, College Station, TX 77843- 4352. The phone number is (409) 845-6398.

EPA Accepting Research Grant Proposals

The U.S. Environmental Protection Agency (EPA) has recently produced a publication detailing research opportunities and guidelines in the areas of environmental biology, environmental health, environmental engineering, and environmental water quality and physics.

Solicitation for Research Grant Proposals - 1989 (E PA/ 600/8- 88/086) outlines the procedure for applying for grants and describes eligibility requirements in EPA's General Grants Program and Special Targeted Grants Program. Specific research areas listed by EPA include: 1) Environmental health studies that focus on human health risk assessment after exposure to environmental pollutants; 2)Environmental biology studies that examine risk assessment, ecosystem structure and function, and toxicological effects; 3) Environmental engineering research that investigates cost- effective pollution control technologies; and 4) Environmental water chemistry and physics looking at pollution of freshwater, marine and estuarine waters, and groundwater supplies.

To receive a copy of the publication, write to: EPA Center for Environmental Research Information, Cincinnati, OH 45268. For more information on any of the research areas, call (202) 382- 7445.