



Volume 3, Number 2, May 1990

Texas Celebrates Earth Day's 20th Birthday

There were a lot of parties and educational activities, but is the Earth going to be any better off?

More than an estimated 200 million people around the world - including many areas of Texas - celebrated the 20th anniversary of Earth Day in April. However, the focus was more on educational efforts than on pronounced policy changes.

In Dallas, environmental activist groups created their own blend of "toxic soup" with sludge, motor oil, plastics and a symbolic cup of bureaucracy to protest pollution in the Trinity River. Dallas newspapers called for the implementation of widespread recycling programs to reduce the amount of solid waste going to landfills which could ultimately threaten groundwater supplies. Other proposals urged that less pesticides be used in city parklands.

In Houston, an "environmental report card" showed that the water in the Houston Ship Channel had improved dramatically. It used to be so polluted that corrosives in the water ruined ships' hulls, anchors and pumps but now fish inhabit the Channel's upper reaches. However, the evaluation also noted that roughly half the area's wetlands are vanishing and that contaminated wastes are showing up regularly.

In San Antonio, environmental advocates called for halting the construction of the proposed Applewhite Reservoir, improving water conservation efforts, and increasing recharge of the Edwards Aquifer. They also urged a "greenbelt" of natural vegetation be maintained where construction and development would be limited.

In Austin, residents protested what they believed were high levels of phosphates and nitrates that run off into and pollute the Colorado River.

Some state agencies also participated in Earth Day festivities. The Texas Department of Agriculture sponsored an "adopt a tree" program where people who wanted to plant trees were matched with corporations who donated them.

The biggest disappointments were on the policy front. While corporations billed themselves as being "pro-environment" many of them rejected shareholders' requests to adopt measures like the "Valdez Principles" to protect the environment. Those proposals

included making environmental specialists mandatory members of corporate boards of directors, allowing environmental audits conducted by independent groups, and other actions.

Earth Day made it difficult to sort out who really was concerned about the environment. Chemical manufacturers and others told us how they were protecting the environment but rejected plans that would have cut their pollution levels.

While President Bush expressed support for raising the EPA to Cabinet level status, he rejected a bill passed by the House of Representatives because he felt it made the EPA too strong. Bush also proposed a ban on offshore oil drilling in environmentally sensitive areas while some groups had wanted a complete ban.

A New Fight over Fluoride- Is It Good for Your Health?

Preliminary results from a study by the National Toxicology Program suggest that there may be links between fluoridation and bone cancer in rats.

While the scientific jury is still out, it appears that the study - which was summarized in the February 5 issue of *Newsweek* and elsewhere - may resurrect fears among some that fluoridating water supplies may be unhealthy.

The study suggests that laboratory rats given fluoridated water had a higher rate of a type of bone cancer (osteosarcoma). The rats that didn't drink the fluoridated water didn't get the cancer.

Earlier experiments have linked fluoride to rare instances of mottled teeth, skeletal damage, genetic defects and other ailments.

Fluoridation of water supplies has cut tooth decay by 50 to 70% and that makes it worthwhile. However, opponents argue that because of the widespread availability of fluoridated toothpastes and rinses most children are getting a healthy supply of fluoride anyway and therefore may not need fluoridated water.

Impact of Runoff from Septic Tanks and Agricultural Activities on Lake Weatherford

Researchers: Sharon Hayes, Leo Newland, Ken Morgan, and Kirk Dean, Environmental Sciences Program, Texas Christian University, Fort Worth, TX.

Problem: Lake Weatherford is the primary source of water for the City of Weatherford, TX. Septic tanks are commonly used to dispose of wastes near the lake and there are concerns that they might impair the lake's water quality. Agricultural activities may also be contributing to lake pollution.

Objective: To determine the relative contributions of runoff from agricultural activities, increasing urbanization, and septic tanks to Lake Weatherford utilizing a geographic information system (GIS) as well as biological and chemical sampling methods.

Methodology: Agricultural runoff was estimated by using a GIS to determine the amount of chemicals applied, the acreage in cultivation and the types of crops grown. Animal wastes were estimated from aerial photography and field surveys. Sampling of the water was conducted for such parameters as fecal coliform, fecal streptococcus, nitrate-nitrogen and organophosphates. The chemical and biological analyses were then used to infer the sources of pollution. For example, high levels of nitrate usually indicate the presence of biological waste from fertilized fields or septic tank effluent. Elevated phosphorus levels often originate from fertilizers, but usually not from septic tanks. The ratio of fecal coliforms to fecal streptococcus can help determine if the pollutants were from human or animal wastes.

Results: More than 4500 persons live within a mile of Lake Weatherford's shoreline and their septic tanks contribute roughly 267 pounds of organics and 49 pounds of nitrogen and phosphorus into the lake each day. Agricultural fertilizers add roughly 87 metric tons of nitrogen and 99 metric tons of phosphorus to the lake each year. Much of the fertilizer is applied in February and March when the most intensive rainfall occurs. Based on biological sampling, most of the non-agricultural pollutants originate from the southwestern portion of the lake. Results also suggest that both animal and human sources are contaminating the lake.

Reference: Hayes, Sharon, Leo Newland, Ken Morgan, and Kirk Dean, "Septic Tank and Agricultural Non-Point Source Pollution within a Rural Watershed," *Toxicological and Environmental Chemistry*, vol. 14 (1990), pp 137- 156, New York, NY.

Water- Related Uses of Integrated Geographic Information Systems (GIS)

Researchers: Therese Steenberghen, Melody Bruner, Thomas Woodfin and Harlow Landphair, Center for Urban Affairs, Texas A&M University, College Station, TX.

Problem: There is a growing need for integrated watershed management. Integrating a number of water models may help solve this problem, but is expensive and time-consuming. Geographic Information Systems (GIS) offer several advantages that allow a more comprehensive approach to water resources planning. GIS technologies provide automated data input, increased processing speed, userfriendly interfaces, and output in tables, graphs, and maps.

Objective: To illustrate the use of a GIS to integrate a rainfall prediction model, a surface hydrology model, and a water budget model.

Methodology: A set of maps was digitized representing topography (slopes), hydrology, structures and soils in a pilot study of the Wolf Pen Creek watershed in College Station, TX. A database associated with these maps was created to provide the required inputs for the models. First, a simple Markov chain simulation model was utilized to project

weather patterns and rainfall events. The Texas ARM watershed model (a surface water hydraulics model) was utilized to forecast flooding, to provide inputs to a water budget model, to analyze hydrologic data, to simulate stormwater routing, and to forecast flooding. Output from both models provided input to an adapted version of Mather's water budget model.

Results: Results based on the water budget model were presented in a comprehensive way. The results also provided insights on the total water budget within the watershed and incorporated data on evapotranspiration, precipitation, soil moisture, runoff and reservoir storage. The GIS was used to produce maps, charts, and tables.

Reference: Steenberghen, Therese, Melody Bruner, Thomas Woodfin and Harlow Landphair, "Linking Water Budget Models and Surface Hydraulics Models to Geographic Information Systems for Land Planning," *GIS/LIS '89*, American Society of Photogrammetry and Remote Sensing, Bethesda, MD, 1989.

Chemistry of the Bad Water Zone of the Edwards Aquifer

Researchers: Tonia Clement and John Sharp, Geology Dept., University of Texas, Austin, TX.

Problem: The Edwards Aquifer is currently the subject of much public attention as policy makers and politicians attempt to determine optimal pumping strategies. A major concern is the amount of pumping that could be allowed before the waters from the "bad water zone" could migrate into and pollute quality water supplies. Little information is currently available about the characteristics of the bad water zone.

Objective: To quantify changes in water chemistry in the bad water zone of the Edwards Aquifer and to explain some of the processes that result in these variations.

Background: This paper summarizes and interprets the results of data from numerous state, federal and university studies dealing with the geology, hydrogeology and chemistry of the Edwards Aquifer.

Results: The southern boundary of the Edwards Aquifer is defined by the presence of a bad water line (an arbitrary line where levels of total dissolved solids exceed 1,000 milligrams per liter). Analyses show that differences in water quality within the bad water zone exist in four geographic regions (see map). In the far western part of the aquifer in Kinney and Val Verde counties, the dissolved components in the bad water zone are mainly calcium and sulfate which apparently resulted from the dissolving of gypsum. From southwestern Uvalde County to southern Bexar County, the bad water contains calcium, magnesium, and sulfate, but also has significant amounts of sodium and chloride. High levels of sodium and chloride in this area may be attributed to migration of salty brines through fault zones (thermal data indicate this movement is still occurring). Between northern Bexar County and Travis County, sodium and chloride are the dominant constituents, but significant amounts of calcium, magnesium, and sulfate are also present. In this region, faults restrict the movement of bad water into the aquifer.

However, chemical analyses suggest that water may be leaking from the Glen Rose formation into the Edwards in this region. In Williamson and Bell counties, the bad water is comprised of sodium, chloride, sulfate, and bicarbonate (HCO_3) and closely resembles water from the underlying Trinity Aquifer. Upward migration of groundwater from faults may be causing significant changes in the water chemistry in the fresh water zone of this region.

Reference: Clement, Tonia, and John Sharp, "Hydrochemical Facies in the Bad- Water Zone of the Edwards Aquifer," in *Proceedings of the Groundwater Geochemistry Conference*, National Water Well Association, Dublin, OH. 1988.

Evaluating Methods to Remove Radium from Groundwater

Researchers: Dennis Clifford, Winston Vijjeswarapu, and Suresh Subramonian, Environmental Engineering Dept., University of Houston, Houston, TX.

Problem: Roughly 500 communities in the U.S. that depend on groundwater are estimated to exceed the EPA standard for radium in drinking water. In many cases, alternative water supplies are not available at a reasonable cost. Effective methods to remove radium must be evaluated and developed. Ironically, methods that tend to remove high levels of radium present a disposal problem because they concentrate highly- loaded adsorbents that are regulated as low- level radioactive wastes.

Objectives: To assess the effectiveness of various systems including packed beds containing granular or beaded adsorbents such as radium- specific complexers (RSC), barium sulfate (BaSO_4) impregnated activated alumina, point of use (POU) treatment systems, and reverse osmosis (RO) technologies.

Methodology: The University of Houston EPA mobile drinking water treatment unit research facility was used in this project. Research took place using radium- contaminated groundwater at Lemont, III. Pilot scale adsorption experiments were performed using glass columns. Source water was pumped through a main flow system using a centrifugal pump. A 2.5- foot deep bed filter containing aluminosilicate was used for prefiltration. Three types of RO units were tested including a hollow fiber (HF) membrane, a spiral- wound (SW) thin film composite (TFC), and an experimental low pressure SW TFC. Barium sulfate- impregnated adsorbents scavenged radium from the solution. Several experimental adsorbent beads were tested including CYC (a non- toxic, noncorrosive cellulose material), RadiSorb (a polymer containing an internal oxidizing catalyst and manganese dioxide), and activated alumina adsorbents. A POU treatment system was also evaluated in which water passed through a fiber- wound cartridge, a granular activated carbon (GAC) filter, a RO unit, and another GAC filter.

Results: Filtration of the groundwater removed 30% to 50% of the radium. Adsorption of the radium onto manganese oxide (MnO_2) was probably the main mechanism for removal. The RSC was the best adsorbent tested for radium removal. An experimental adsorbent, barium sulfate- loaded activated alumina, performed nearly as well as the RSC and could prove to be a good alternative. POU treatment systems producing 8 gallons per

day of product water and utilizing TFC or SW membranes were very effective for radium removal with overall removal rates of 95% for the TFC system and 92% for a cellulose acetate system. The presence of Ra- 224, a short lived progeny of Ra- 228, caused great difficulty in interpreting gross radium alpha results. However, aging all radium samples for 20 days prior to Ra- 226 analysis solved the problem by allowing Ra- 224 to decay.

Reference: Clifford, Dennis, Winston Vijjeswarapu, and Suresh Subramonian, "Evaluating Various Adsorbents and Membranes for Removing Radium from Groundwater," *American Water Works Association Journal*, Denver, CO, June, 1988.

Impact of Land Use on Runoff and Water Quality in Lake Austin

Researchers: David Todd, Wray & Todd, Houston, TX, Philip Bedient and John Haasbeek, Environmental Science and Engineering Dept., Rice University, Houston, TX, and John Noell University of Texas, Austin, TX.

Problem: Rapid development has taken place in the Austin area from 1979 to 1984. As a result, the amount of paved area (roads and parking lots) roughly doubled during that time. There are now concerns that Lake Austin may be impacted by increasing amounts of non- point source pollution and runoff, primarily from urban and suburban sources. Higher rates of runoff may result in algal growth (eutrophication) and increase taste and odor problems in the lake.

Objectives: To determine the impact of urbanization that is occurring in the Lake Austin watershed and to gauge the impact of increasing amounts of paved surfaces on non- point source pollution.

Methodology: Characteristics of the watershed including hydraulics, sources of runoff, rainfall, geology, and land uses were reviewed. A simulation model was developed to calculate daily loadings of phosphorous (P) and total suspended solids (TSS) based on mixing within the lake, settling, and the amount of nonpoint source pollutants entering the lake. The model, which can be run on personal computers, provides quick graphic outputs which are easy to illustrate and calibrate.

Results: Simulated levels of P and TSS from the model were roughly similar to measured results. The model was also used to estimate P and TSS concentrations if the amount of paved areas was increased by 10% to 40%. Results suggest significant eutrophication could occur if phosphorus levels increased by 30% or 40%. Higher TSS levels could also result in taste and odor problems in the lake.

References: Todd, David, Philip Bedient, John Haasbeek, and John Noell, "Impact of Land Use and NPS Loads on Lake Quality" *Journal of Environmental Engineering*, June, 1989.

Hard January Freeze May Have Killed 24 Dolphins in Matagorda Bay

A record number of 147 dolphins were stranded off Galveston and Port O'Connor during January, February, and March of 1990. While scientists don't know for sure, it appears that this year's hard winter freeze may have played a major role in many of the deaths.

Roughly 24 dolphin carcasses were spotted along East Matagorda Bay during the Christmas holidays. Necropsies (autopsies of dolphins) were completed at Texas A&M University at Galveston but test results have not yet been interpreted.

Game warden Arthur Lawrence said the freeze killed thousands of fish along the coast and may have also killed the dolphins. Lawrence speculated that the intense cold weather may have caused diseases that weakened the dolphins, and that ice formed on the water and made it hard for the dolphins to surface and breathe. "Several acres of the bay were covered with a slushy type of ice and some of the dolphins probably became disoriented and stunned n he said. "They could have suffocated or suffered pneumonia."

In a related item, the EPA Gulf of Mexico Program said it will sponsor research to determine whether the one- celled animals that cause the "red tide" or water pollution may have caused the deaths.

Three Texas Areas Included in National Pesticide Study

Three Texas areas are being included in a two- year national study to determine if pesticide and herbicide residues are contaminating groundwater, even when they are properly applied.

Groundwater supplies in Martin, Erath, and McCullough counties will be sampled in the study which is being conducted by the EPA and the Texas Water Commission. The study hopes to examine the relationships between the presence of agricultural chemicals in groundwater and agricultural practices.

Uvalde Rejects TWC Edwards Aquifer Compromise, Sierra Club Joins Suits

The ongoing struggle to find a way to manage the waters of the Edwards Aquifer that all parties can agree to has taken a few more twists and turns.

The Uvalde County Underground Water District (UCWD) has rejected a compromise plan proposed by the Texas Water Commission (TWC) that would have allocated Uvalde and Medina counties 32% of the water in the aquifer when levels reached a critical stage. Bexar County would have received 47%, while Comal and Hays counties would have been awarded 4%. UCWD officials are demanding that no restrictions be placed on agricultural interests as long as there is no waste and that there be no restrictions on drilling agricultural wells. They also want any reductions in agricultural water use to be no greater than limits placed on urban areas.

In the meantime, the Lone Star Chapter of the Sierra Club said it will join two lawsuits that seek regulation of the aquifer. One suit has been filed by the Guadalupe- Blanco River Authority to declare the Edwards an underground river. The other suit has not been filed but seeks regulation of the aquifer to protect endangered species.

Sierra Club officials say they are filing the suit because the San Antonio area could be doing more to conserve water. They want the city to approve mandatory water conservation measures that would be in place at all times (San Antonio's drought management plan now calls for mandatory restrictions in water use only when aquifer levels are low).

Oil Spills along Texas Coast Raise Concerns about Safety of Whooping Cranes in Aransas National Wildlife Refuge

Two oil spills along the Gulf Intracoastal Waterway (GIWW) in March have raised concerns about the risk to coastal wildlife preserves from such accidents.

A wreck between a tanker and a barge near Port Arthur released 14,700 gallons of vinyl acetate monomer that is used to manufacture plastics. In another incident near Freeport, roughly 30,000 gallons of crude oil were spilled when a barge struck an abandoned barge.

Those incidents have heightened concerns of officials at the Aransas National Wildlife Refuge because an estimated 23 million tons of cargo (most of it petroleum products) are shipped through 35 miles of the GIWW that runs through the preserve. The refuge is nationally known as being the winter home of endangered whooping cranes. Officials with the refuge have expressed interest in rerouting the GIWW away from the preserve.

Finally, U.S. Coast Guard officials and others are expressing concerns that "lightering" (a practice where huge tankers transfer crude oil to smaller ships because the tankers can't navigate through narrow ship channels) may produce a major offshore oil spill. Lightering operations have increased by an estimated 200% off the Texas coast since 1986 and as much as 250 million gallons per year are transferred off Galveston. Because of the *Exxon Valdez* oil spill, Coast Guard officials are now reviewing plans to anticipate and cope with such incidents.

Snail with "Jaws" Appetite, Attorney General's Inquiry, May Threaten San Marcos Springs

Two very different threats - one natural, the other man-made - may soon affect San Marcos Springs.

Officials with the Texas Parks and Wildlife Department say that large patches of aquatic vegetation have been stripped bare by the Ram's Horn Snail. The snail is native to Colombia but thrives in the temperate waters of the springs. It was apparently introduced by owners of home aquariums who got rid of their pets by flushing them down toilets.

Aquatic vegetation provides small fish, salamanders, and other aquatic animals a place to hide from predators and a healthy food supply, but if the snails eat all the plants, the fish are vulnerable to predators. Lower than normal springflows may be making it easier for snails to hang on to aquatic plants where they breed and feed.

Meanwhile, the Texas Attorney General's Office has released a report that concludes that the water of Spring Lake (home of Aquarena Springs) belongs to the state and that the public has the right to use the waters.

The study also found that a San Marcos ordinance that bans people from using the lake on the basis of trespassing may be unconstitutional and that although Aquarena Springs has a right to use the lake it does not have the right to bar the public from using it. The report recommends that a "public spirited steward" be appointed to manage the lake, including its endangered and threatened species and archeological finds. Many fishermen and divers have used the lake since the report was published.

Proposed Copper Smelter in Texas City Spurs Environmental Debate

Several environmental groups say they fear a proposed copper smelter near Texas City would release heavy metals into shallow bay waters that could harm fishery areas, but a preliminary study by a Texas A&M University scientist suggests the impact would be negligible.

Texas Copper Corporation is proposing a plant that would discharge more than 23 million gallons of wastewater per day that would contain trace amounts of several metals.

B.J. Presley of the Texas A&M University Oceanography Department estimated the impact of the smelter's discharges of small amounts of metals like copper, lead, arsenic, cadmium, mercury, and zinc into the environment. The study suggests that it is unlikely that adverse chronic or long-term biological effects will result from small increases in trace metal levels in sediments and bay waters. Presley said the only area that might be vulnerable would be within 100 yards of the discharge point. Some concerned citizens' groups have argued that the plant may endanger critical nursery areas for fish, shrimp and crabs.

Fish and Wildlife Service Requests "Comprehensive EIS" for Formosa Expansion

The U.S. Fish and Wildlife Service is seeking a complete environmental impact statement (EIS) on the effects of Formosa Plastics' \$1.3 billion expansion of its Calhoun County facility.

The Texas Water Commission proposed a record \$244,000 in fines against Formosa in April for 54 alleged violations of the conditions of its wastewater discharge permit. Formosa now discharges 1.4 million gallons per day (mgd) of industrial wastewaters into Lavaca Bay that are comprised of olefins, caustics, chlorine, ethylene dichloride and other pollutants. After the expansion, discharges will jump to 6 mgd.

Fish and Wildlife Service officials say they are concerned that the increased discharges could endanger whooping cranes, Kemp's ridley sea turtles, bald eagles, and pelicans that live near the site.

TWC Studying Link Between Groundwater Contamination, Illnesses in Midland

The Texas Water Commission (TWC) and the Texas Department of Health studied the contamination of water wells in a 2- square mile area of south Midland in February. The studies were prompted by complaints from residents who feared the pollution was causing a large number of deaths and illnesses.

The area contains rural homes surrounded by active and abandoned oil and gas wells and caliche pits. Although only roughly 1,000 people live in the area, residents say 8 people have died from leukemia and 40 others have died from cancer in the past 10 years.

In January an oilfield service company announced that levels of dichloroethane and carbon tetrachloride broke EPA drinkingwaterstandards. Although state officials said it was unlikely that the pollutants could have migrated to the area via groundwater systems, residents say that the pollutants run off into the caliche pits and aquifers after storms.

Increasing Cost of Water May Put a Squeeze on Rice Farmers

Scientists working with the Texas coastal rice industry say increases in the cost of water may threaten the ability of producers to survive.

James Stansel, the Director of the Texas A&M University Research and Extension Center in Beaumont, said that rate increases proposed by the Brazos River Authority (BRA) would have tripled prices for irrigation water by 1995 and that hike may have forced some farmers out of the market. Although BRA extended current prices for a year, Stansel and A&M researcher Garry McCauley say there are still other economic threats. The Lower Colorado River Authority has increased its rates for irrigation by 7% this year and will raise them an additional 7% next year.

A new subsidence district in Fort Bend County could result in annual pumping fees of \$6,000 per year and one- time meter and installation charges of roughly \$5,000 for irrigators. A similar district with similar charges is being proposed for Wharton County.

Dallas Area to Study Flood Damage, Dam Safety

The North Central Texas Council of Governments has given its final OK to a study that will estimate the types of damage caused by major floods of the Trinity River and will recommend best ways to mitigate the damages.

The study will take five years to complete and will cost \$7.5 million. The study will follow up on a recently completed report that concluded that a major flood of the Trinity would cause more than \$11 billion in property damages.

The focus of the new study is to identify strategies that can be implemented to prevent flood damage including early warning systems, levees, and restrictions on development in floodprone areas.

Meanwhile, the Texas Water Commission (TWC) said that Lake Arlington's dam and spillway may not meet state requirements to protect downstream residents against floods. Arlington city officials are considering spending \$4 million to widen the dam and increase the capacity of the spillways to hold heavy rains. Other possible actions include developing computer projections of the effects of worst- case flooding and evaluating what various construction projects around the lake could do to prevent damages. Floods last spring flowed over the dam's spillway by more than 2 feet for the first time since 1957.

Irrigation, Chemigation, Focus of Texas Agricultural Extension Service Reports

The Texas Agricultural Extension Service has recently published two reports dealing with irrigation and chemigation.

Proceedings of the *1990 South Texas Irrigation Conference* includes papers dealing with managing aquifers with groundwater conservation districts, chemigation equipment and safety, irrigation scheduling, irrigation timing, the economics of chemigation, low energy precision application (LEPA) irrigation and management, and irrigation pumping costs. Copies can be obtained for \$5 by contacting Guy Fipps, Texas Agricultural Extension Service, 207C Scoates Hall, Texas A&M University, College Station, TX 77843 or by calling 409- 845- 7451.

The 1990 Chemigation Workbook (B- 1652) describes groundwater protection from fertilizers and pesticides, federal regulations, economics of chemigation, and safety issues. Several papers include details about applying fertilizers, fungicides, insecticides, and herbicides through irrigation systems. The report can be ordered for \$5 from Agricultural Communications Dept., Texas A&M University, Reed McDonald Bldg., College Station, TX, 77843 or by calling 409- 845- 2211.

EPA Computerized Database on Clean Lakes Available

A computerized database with information on lake restoration, protection, and management has been developed by the EPA and is available free to university researchers, water managers, and public libraries.

EPA's *Clean Lakes Clearinghouse* provides abstracts and citations of technical materials, journal articles, conference proceedings, and government documents. Subjects covered include lake ecology, eutrophication, acidification, toxic substances, lake management policies, restoration techniques, watershed management, point and nonpoint source pollution, and water quality modeling.

The program requires IBM- compatible personal computers and is currently in operation at the the Texas Natural Resources Information System. Their phone number is 512- 463- 8337. To order the program, contact Clean Lakes Program (WH 553), EPA, 401 M Street SW, Washington, DC 20460 or call 202382- 7111.

Changing Water Levels in Ogallala Aquifer Subject of Geological Survey Report

According to a study by the U.S. Geological Survey (USGS), water levels in the Ogallala Aquifer in Texas and other Great Plains states actually rose in some areas in during the 1980s.

The report, *Water Level Changes in the High Plains Aquifer- Predevelopment through Non- Irrigation Season of 1987-88* (WRI Report 89- 4073), says that water levels generally rose by an average of 0.28 feet in the aquifer between 1987 and 1988. The rise was due to above average rainfall, a decrease in the total amount of irrigated acreage, and a decline in the amount of water pumped for irrigation. In Texas, water levels rose an average of .078 feet during 1987- 88 because rainfall was 5 to 10 inches greater than normal and because playa lakes helped recharge the aquifer.

The report can be ordered from USGS, Books and Open File Reports Section, Box 25425, Federal Ctr., Denver, CO 80225. The phone number is 303- 236- 7476.

UT Studies Examine Reliability of Distribution Systems, Water Storage

Two studies dealing with the reliability of water distribution systems and methods to evaluate water storage systems have been published by the Center for Research in Water Resources at the University of Texas at Austin.

New Methodologies for the Reliability- based Analysis and Design of Water Distribution Systems (CRWR 227) was written by Larry Mays, Yixing Bao, Lehar Brion, John Cullinane, Ning Duan, Kevin Lansey, Yu- Chu Sun and John Woodburn. The report describes several methodologies, mathematical models, and computer software packages that were developed in the project. These include simulation models to determine the optimal design and expansion of new water distribution systems. The reliability of both new and aging water distribution systems can be evaluated and schedules for rehabilitating and replacing system components can also be measured.

Stochastic Analysis of Non- Linear, Non-Statutory Water Storage Systems in Continuous and Discrete Time (CRWR 228) was written by Fidel Saenz de Ormijana and David Maidment. The report describes the use of a technique it calls "netflow" (the difference between inflow and outflow) to analyze water storage. The methodology can be applied to evaluate water storage not only in reservoirs but also in aquifers, large natural lakes, and wastewater ponds. The report includes a case study of storage in the Edwards Aquifer.

Both reports can be purchased from: Center for Research in Water Resources, 10100 Burnett Road, Austin, TX 78758 or by calling 512- 471- 3131.

TWDB Reports Describe Groundwater Systems

The Texas Water Development Board (TWDB) has published a series of reports describing groundwater supplies and quality in many regions of Texas. The reports are part of an overall effort to study "critical groundwater areas" in the state and provide recommendations to protect water quality and increase overall water supplies. Information in the studies will help the TWDB determine areas where groundwater conservation districts may be formed.

Evaluation of Groundwater Resources in the Lower Rio Grande Valley (Report 316) examines conditions in Cameron, Starr, Hidalgo, and Willacy counties. *Evaluation of Groundwater Resources in Parts of Loving, Pecos, Reeves, Ward and Winkler Counties* (Report 317) assesses conditions in the Trans- Pecos area. *Evaluation of Water Resources in Part of North Central Texas* (Report 318) includes information on ground and surface water resources in Montague, Cooke, Grayson, Fannin, Lamar, Red River, Wise, Denton, Collin, Hunt, Parker, Tarrant, Dallas, Rockwall, Kaufman, Hood, Johnson, Ellis, and Navarro counties. *Evaluation of Water Resources in Part of Central Texas* (Report 319) describes groundwater conditions in Milam, Burnet, Bell, Falls, McLennan, Coryell, Lampassas, Mills, Hamilton, Bosque, Hill, Somervell, Erath, Eastland, Callahan, Commanche and Brown counties. Report 320 is titled *Evaluation of Water Resources of Orange and Eastern Jefferson Counties* and Report 321 is titled *Evaluation of Water Resources of Fort Bend County*.

For details, contact: Library, Texas Water Commission, POBox 13087, Capitol Station, Austin, TX, 78711- 3087 or call 512- 463- 7834.

In- Depth Guide to Texas Water Systems Available

Details on more than 7,200 Texas water suppliers are contained in a new resource titled *Texas Water Systems*.

The report is divided into sections that list water suppliers alphabetically and by county. The listings include information such as the address, phone number, and president of each water supplier, and whether such treatment techniques as aeration, prechlorination, coagulation, sedimentation, filtration, softening, taste and odor control, iron removal, ammonization, flouride adjustment and corrosion control were utilized for each system. Water supply information includes data on the type of ownership, the population served, the number of meters and connections, total production capacity, total storage capacity, total elevated storage, average daily consumption, sources of seH- supplied water, the number of water wells and other data.

The 386- page book was published by Austin Publishing which also producer guides to Texas wastewater systems, landfills, and the annual *Texas Water ant Environmental Guide*. For details, contact Austin Publishing, 9600 Great Hills Trail, #150W, Austin, TX 78759, or call 512- 343- 1218.

TWC Studies Examine Pollutant Monitoring, Effects of Cold Weather on Bays

Three Texas Water Commission (TWC) reports detail results of priority pollutant monitoring, analyze the role of toxic chemicals in the Trinity River fish kills, and describe the impact of extreme cold weather on Texas bays.

Results of Intensive Priority Pollutant Monitoring in Texas (LP 89- 07) summarizes the results of studies of the Sabine River, the upper San Antonio River, the inner harbor of Corpus Christi Bay, the Arroyo Colorado, and the Sabine- Neches River tidal area. The study involved analyzing effluent, ambient water quality, sediments, tissue samples from aquatic organisms, toxicity testing, and field surveys. Results suggest overall contamination from toxic chemicals has been substantially reduced since 1981. The report recommends that additional studies be conducted on levels of toxic chemicals in organisms consumed by humans and that sediments in Corpus Christi harbor be analyzed in more detail.

Analysis of Fish Kills and Associated Water quality Conditions in the Trinity River-Toxicological Considerations (LP 90- 03) describes the results of water sampling during a "rise event" (high flow conditions associated with fish kills) in May of 1987 on the Trinity River. Results of the study suggest that areas immediately below Dallas' southside and Central wastewater treatment plants contain high levels of toxic chemicals. Toxic chemicals of most concern sampled in the river were ammonia, chlorine, iron, lead, silver, zinc, chlordane and diazinon. More studies should be conducted to determine the levels of toxic chemicals (especially diazinon) in stormwater and in major wastewater treatment plant effluents, and to measure the impact of sediments in generating toxic chemicals, the report says.

Extreme Cold Weather Effects on Eight Texas Bays (LP 90- 01) documents the impact of a cold weather system that swept through the Texas Coast in February 1989 and lowered temperatures to 28deg.F in Corpus Christi. The study suggests that shallow bays (average depths of less than 3 feet) and areas located further inland experienced the largest temperature changes.

Watermaster - Local Monitoring of the Use and Allocation of Texas Waters (C 90- 02) is a pamphlet that explains the watermaster process, and *Election Procedures for Water Districts* (C 90- 01) is a booklet that details how such elections should be held.

To order any of the reports, contact: Library, Texas Water Commission, PO Box 13087, Capitol Station, Austin, TX, 78711 - 3087 or call 512- 463- 7834.

TDH Study Characterizes Quality of Public Drinking Water Systems

The Texas Department of Health has recently published the 1990 version of a report titled *Chemical Analyses of Public Water Systems*.

The 149- page report lists levels of calcium, magnesium, sodium, manganese, iron, sulfate, carbonate, chloride, fluoride, nitrate (as nitrogen), total dissolved solids, total alkalinity, phenolphthalein alkalinity, pH and total hardness that were found in random tests in each of Texas' public water systems. Most of the samples were taken after 1987. The report is comprehensive and includes information from all sizes of water suppliers ranging from major cities to small rural water corporations.

To obtain a copy, contact Water Hygiene Division, Texas Department of Health, 1100 West 49th Street, Austin, TX 78756 or call 512- 458- 7533.

LCRA Study Says Wastewater Reuse Is Feasible Near Austin

A new study conducted for the Lower Colorado River Authority says that expanded use of reclaimed wastewater in the Lakeway Municipal Utility District (MUD) near Austin is now technically and economically feasible.

The report, *Feasibility Study of Water Reclamation for the Lakeway Municipal Utility District* was performed by Malcolm Pirnie Associates. They examined such factors as projections of population and wastewater flows, the cost of various policies such as dedicating some lands to receive effluents, and the price users would pay for reclaimed wastewater. Results suggest that the most cost- effective strategy is to use reclaimed water to continue irrigating golf courses and park medians, and constructing a dual pipe distribution system to provide reclaimed water to irrigate residential yards and landscapes in new developments.

The study said reusing wastewater makes sense for Lakeway MUD because the area has a no- discharge policy, and lands currently have to be set aside for wastewater irrigation. These lands cannot be developed and could reduce the potential value of new areas to be developed within the district. The report also noted that reuse virtually guarantees a supply of water to irrigate landscapes (even during droughts), that revenues of roughly \$1.25 per 1,000 gallons (about half of the cost of potable water) could be generated from the sale of reclaimed water, and substantial wastewater treatment costs could be avoided.

To obtain a copy, contact: Nora Mullarkey, Lower Colorado River Authority, PO Box 220, Austin, TX 78767 or call 800- 776- 5272 extension 4009.

TDA Study Says Reuse, Conservation, May Clean Rivers, Help Streamflows

A recent report by the Texas Department of Agriculture suggests reusing wastewater and boosting water conservation could clean up Texas' rivers without damaging streamflows.

The study, *Cleaning Texas' Water through Conservation and Wastewater Reuse* (June 1989), was co- authored by Gary Keith and Robert King. The study says that Texas should increase wastewater reuse and conservation because current practices flush nutrients down rivers and stream quality still deteriorates in spite of higher levels of wastewater treatment. The study suggests wastewater reuse and conservation would be

less costly than upgrading of wastewater treatment plants and would improve the quality of surface water.

Increasing conservation by 13% could maintain existing streamflows, even if all a city's treated effluent would be utilized in wastewater reuse programs, the report says. The study suggests that reuse and conservation could be successfully implemented in the Nueces, Rio Grande, Cypress, Colorado, Canadian, Brazos, Red, Sabine, Sulphur, and Trinity river basins.

For details, contact: Texas Dept. of Agriculture, Natural Resources Div., PO Box 12847, Austin, TX, 78711 or call 512- 463- 7504.

GAO Studies Cover Safety of Lawn Chemicals, Health Effects of Imported Produce

The General Accounting Office (GAO) has recently produced a number of reports dealing with water- related and environmental issues.

Lawn Care Pesticides: Risks Remain While Prohibited Safety Claims Continue (March 1990) investigated safety issues associated with the use of chemicals on lawns and landscapes. The report says that safety claims about many pesticides are being exaggerated and that the EPA is too slow in assessing the health risks from those chemicals. *Food Safety and Quality: Five Countries' Efforts to Meet U.S. Requirements on Imported Produce* (March 1990) examined whether produce is being grown in some Latin American countries with chemicals that have been banned in the U.S. and is then being exported back to the U.S. *Water Pollution: Serious Problems Confront Emerging Municipal Sludge Management Program* (March 1990) analyzed whether new EPA sludge management programs are being implemented. *Superfund: A More Vigorous and Better Managed Enforcement Program is Needed* (December 1989) evaluated EPA's efforts to clean up hazardous waste sites. The report says EPA has been unable to find liable parties to fund cleanups and has recovered only 35% of the monies it hoped to collect from those responsible for the pollution.

Other recent GAO studies deal with farmers' opinions about alternative agriculture, federal costs from the *Exxon Valdez* oil spill, profiteering from sales of lands where the federal government developed water supplies, global warming and disposal of medical wastes.

To order any report, contact: GAO, PO Box 6015, Gaithersberg, MD, 20877 or call 202- 275- 6241.

UTSA Probing Safety, Public Perceptions, of Hazardous Waste Sites

How safe are structures designed to contain hazardous wastes and how much risk is the public willing to accept? These are two of the questions that researchers in the Engineering Division at the University of Texas at San Antonio (UTSA) are trying to answer.

Chia Shih and Alberto Arroyo have developed an integrated methodology to evaluate pollution risks posed to groundwater supplies from concrete hazardous waste storage tanks. The methodology consists of two steps. First, the likelihood that specific components of the facilities may fail (for example, the risk from malfunctioning liners) is predicted. That information is then used to estimate the level of risk the public may tolerate from specific pollution incidents.

Results suggest that pollution resulting from engineering and design mistakes and operational and maintenance accidents are not usually forgiven by the public, especially when innocent persons are the potential victims.

For details, contact Chia Shih, Engineering Div., University of Texas at San Antonio, San Antonio, TX 78285.

UT Determining if Bacteria Can Cut Selenium Levels

High levels of selenate (a byproduct of selenium) in agricultural drainage water have caused death and deformity in birds and wildlife in California and other areas. Now research at the University of Texas at Austin is investigating if sulfate-reducing bacteria could lower levels of the deadly chemical.

Graduate student Larry Owens is working with Joseph Malina of the Civil Engineering Department. When lands with high selenium levels are irrigated and drained, selenium is leached from the soil by water as selenate. Owens and Malina want to see if a bacteria that reduces sulfate to sulfide could also reduce selenate to selenide. Selenide is a less deadly form of selenium because it is more easily treated than selenate. Selenium is not a major problem in Texas yet but some parts of the state could have troublesome levels.

For details, contact Center for Research in Water Resources, University of Texas, 10100 Burnett Road, Austin, TX 78758 or call 512- 471 - 3131.

Baylor Uses Predictable Phantom Midge Fly Larvae to Study Pesticide Impacts

The clock-like behavior of the larvae of the phantom midge fly can be used to study the impacts of pesticides on the environment, according to Baylor University biologist Darrell Vodopich.

Vodopich says the midge flies usually stay at the bottom of lakes during the day to avoid predators. At night, they come to the surface to eat zooplankton. Vodopich placed 20 larvae in test tubes and exposed them to different sublethal concentrations of diazinon, a commonly used pesticide, and other chemicals to see how the pesticides affected the midge flies' activities.

Results suggest that the midge fly larvae were less likely to migrate up to the surface at night as diazinon levels increased. Vodopich says the study is an example of a simple experiment that's easy to conduct in a laboratory that yields real world results. For details,

contact Darrell Vodopich, Biology Dept., Baylor University, Waco, TX 76798 or call 817755- 2911.

Corpus Christi State to Begin Masters Program in Mariculture

Corpus Christi State University will begin offering a Master of Science degree in Mariculture this fall.

The program will focus on cultivating and harvesting selected saltwater species such as oysters, fish, and shrimp that live off the Texas coast, as well as economics and student internships.

For details contact: David McKee, Biology Dept., Corpus Christi State University, 6300 Ocean Drive, Corpus Christi, TX 78412.

Texas A&M Using GIS to Protect Endangered Toad, Control Mosquitos

Scientists at Texas A&M University are utilizing geographic information systems (GIS) to learn more about how to protect the endangered Houston toad while still allowing the use of pesticides that control disease- carrying mosquitos.

Graduate students Sharon Spradling is working with professors Robert Coulson and Jimmy Olson of the Entomology Department on the project. The goals of the study are to determine areas where pesticides could be threatening toads, to compare the results to areas identified by federal agencies, and to develop ways to both control the mosquitos and keep the toads alive.

The research involved identifying and mapping the toad's habitat (tadpoles need standing water but later, when the toads bury themselves into the ground, they require sandy soils). The amounts and types of pesticides being applied were also determined. The GIS was then utilized to display prime habitat areas for the toad that could be affected by pesticides used to control mosquitos.

The results were surprising. While federal agencies believed that areas south and east of Houston were most vulnerable, the Texas A&M study suggests that a region north and west of the city (see map) ought to be the area most toads call home. Another finding is that some of the pesticides shouldn't be a threat to the toads because they're applied after the toads bury themselves in the sand.

For details, contact Robert Coulson, Entomology Dept, Texas ARM University, College Station, TX, 77843 or call 409845- 9725.

Angelo State Develops Method to Determine Groundwater Radium Levels

A more accurate way to determine concentrations of radium (Ra) in groundwater systems is being developed by researchers at Angelo State University.

David Loyd of the Physics Department and Edgar Drake II of the Chemistry Department have developed a methodology that involves measuring alpha particles with a silicon surface barrier detector. The technique measures the radioactivity of Ra- 226, Ra- 228, and Ra224 by determining the activity several times 12 to 300 hours after precipitation. The researchers feel the new test may reduce errors that plague currently used tests including interference from other radium isotopes and other problems.

Loyd and Drake surveyed levels of radioactivity in 13 wells in the Hickory Aquifer in McCullough, Mason, and San Saba counties in 1987. Results suggest that values for Ra- 228 using the new technique were roughly had of the levels produced by conventional tests.

The research was reported in an article entitled "Alternative Method for Ra Determinations in Water" that was published in the July 1989 issue of Health Physics. For details, contact Edgar Drake, Chemistry Dept., Angelo State University, San Angelo, TX 76909.

Texas Tech Researchers Hope to Reduce Urban Water Use

Urban areas throughout Texas could save more than \$70 million a year if only a third of lawns and landscapes in the state were watered by a technique called irrigation scheduling. Irrigation scheduling involves timing landscape watering when it will be most efficient and when the plants most need water.

Texas Tech University researchers John Borrelli and Richard Zartman of the Agricultural Engineering Department are leading the effort which will involve adapting lawn and turfgrass irrigation scheduling methods for use by Texas communities. Educational materials to support and promote water conservation programs and implementation plans for cities will also be developed.

Another benefit of the project will be increased water efficiency due to irrigation scheduling that may delay or lessen expansions of water treatment facilities. Tech civil engineers Hayward Ramsey and Robert Brashear will be assisting in the project to help assess the impact of irrigation scheduling on the need for these facilities.

For more details, contact: John Borrelli, Agricultural Engineering Department, Texas Tech University, Lubbock, TX, 79409 or call 806- 742- 2812.

UT to Begin "Environmental Solutions Program"

The University of Texas at Austin is hoping a new program will bring together scientists interested in environmental studies and the private sector.

The Environmental Solutions Program allows companies to sponsor research for an annual fee (tentatively set at \$20,000). The monies will be used to expand uTS research base in environmental studies. Corporations will get to play an advisory role in research planning and will be able to attend presentations of research results. Companies will receive access to research results six to 24 months before they are published and may be

issued non-exclusive licenses to patents. The project hopes to make up to 200 reports, articles, and computer programs available to sponsors by 1991.

So far, roughly 18 UT faculty have elected to take part in the program. Raymond Loehr of *urS* Civil Engineering Department has been named director of the effort. Research will involve such subjects as minimizing wastes, treatment of water, wastewater and sludge and environmental assessments.

A meeting has tentatively been set for June 26 about the program. For details, contact John Howell, Energy Studies Center, University of Texas, 10100 Burnett Rd., Austin, TX 78758 or call 512- 471- 0939.

Medical Help Is on the Way for Sick Aquatic Animals

The field of medicine is highly specialized - there are doctors for just about every known ailment. Now, to assist a booming aquaculture industry, Texas A&M University is increasing its effort to keep catfish, shrimp, and other aquatic animals healthy.

Texas A&M is a member of a new consortium of six universities in the southeast that will train veterinarians to understand and deal with diseases of fish, marine mammals, and other aquatic animals.

The aquaculture industry is growing rapidly and was worth an estimated \$550 million nationally in 1987. In addition, sales of pet fish totaled more than \$250 million nationally last year. Texas is also the second largest crawfish producer in the U.S.

One of the main goals of the program is to provide professionally trained individuals who can diagnose, treat, and reduce economic losses associated with fish diseases and fish health problems. For example, catfish farmers lose about 10% of their crop to illness each year. The program will also be more active in efforts to preserve marine mammals, many of which are stranded and die along the coast of the Gulf of Mexico.

For details, contact: Don Lewis, Veterinary Microbiology and Parasitology Dept., Texas A&M University, College Station, TX, 77843 or call 409845- 4282.

Lamar University Tests "Water Jets" to Scour Sediment from Harbors

An economical way to remove sediments from docks and harbors is being studied in the Civil Engineering Department at Lamar University.

Peter Mantz is studying whether submerged water jets can effectively scour sediments which have built up on docks and other structures, and how easily different sands and silts can be removed. The studies include laboratory experiments with small-scale prototypes and collecting field data which can be used in computer simulations.

In the system, compressed air is pumped into an underwater pipeline. The water jets (which are small openings or orifices) can then direct water at high pressure to the area

that needs to be scoured. The new method could be much less expensive and time consuming than dredging or other conventionally used technologies.

For more information, contact Peter Mantz, Civil Engineering Dept., Lamar University, Box 10024, Beaumont, TX 77710 or call 409- 880- 8759.

Canoeists May Be Damaging Texas Wild Rice, SW Texas Scientists Say

Nothing could seem more pleasant than canoeing or floating in an innertube down the San Marcos River during a hot summer day. Jane Maler, a researcher with the Edwards Aquifer Research and Data Center at Southwest Texas State University, says that even such seemingly harmless activities could threaten Texas wild rice and other species.

The range of the rice has been cut to one small stretch of the river near San Marcos because of development. Maler says that canoeists in the area often unintentionally hit the rice with their oars and displace emerging seed heads which are necessary for reproduction.

Maler is part of a team of SW Texas researchers who are measuring recreational use patterns and assessing the impact of recreation and tourism on threatened and endangered species in the river. The goal is to develop a plan to protect these species while allowing for safe recreational use.