New Waves
The Research Newsletter of the Texas Water Resources Institute
Volume 3, Number 4, December 1990

23rd Water for Texas Conference to Focus on Solutions to Non- Point Source Pollution

The Texas Water Resources Institute's 23rd Water for Texas Conference will focus on the theme of "Solutions to Non- Point Source Pollution."

The meeting will be December 5 and 6 at the Lubbock Plaza Hotel and Conference Center. Co- sponsors include the Water Resources Center at Texas Tech University, the High Plains Underground Water Conservation District No. 1, the Texas Agricultural Experiment Station and the Texas Agricultural Extension Service.

"Non- point source pollution is Texas' most important water quality problem," said TWRI Director Dr. Wayne Jordan. "Considerable attention has been focused on conventional point sources of pollution such as industries and wastewater treatment plants, but we're still contaminating surface and ground water supplies. Non- point source pollution could be the final piece of the puzzle to bring water quality to the point where we all want it to be."

The conference will open with a plenary session that will feature individual talks on pesticide levels in drinking water wells throughout the U.S. and new directions for preventing nonpoint source pollution (NPS).

A session on urban NPS management will detail ways to minimize pesticide risks in urban environments, aquatic recreation in urban stormwater management systems, the cost of enforcing environmental regulations, and other topics.

Agricultural nutrient management will be emphasized in a session that will include talks on physical, economic and policy factors that impact the movement of contaminants, nitrogen fertilizer throughout Texas and its impact on groundwater quality, and others.

A session on pesticide management will include such topics as environmental perspectives on agriculture in the 1990s, pesticide availability for Texas crops, and others.

Finally, a panel discussion will allow representatives of state agencies to discuss their organizations' NPS control agendas.

Registration for the conference is $100 and includes a banquet and a proceedings. Additional banquet tickets are $25 each.

A block of rooms has been reserved at the Lubbock Plaza Hotel and Conference Center for the meeting. You can call 806- 797- 3241 to reserve your rooms. If you mention the Water for Texas conference, you'll qualify for a special rate.

Reducing Taste and Odor Problems from Richland-Chambers Creek Reservoir

Researchers: Syed Qasim and S.A. Hashsham, Civil Engineering Dept., University of Texas at Arlington, Arlington, TX.

Problem: The Tarrant County Water Control and Improvement District in Fort Worth has developed Richland- Chambers Creek Reservoir for use as a drinking water supply and other purposes. However, in the summer months, water from the lake often has an earthy and musty odor that makes it unpleasant for consumers. Tests are needed to determine treatment techniques to make the water more acceptable.

Objectives: To develop bench- scale studies to simulate pipeline and in- plant treatment methods to reduce odors (commonly referred to as threshold odor numbers or TON) in lake water.

Methodology: The impact of treatment methods was evaluated. Preoxidants such as chlorine, chloramines, potassium permanganate, ozone and chlorine dioxide were tested. Powdered activated carbon (PAC), combinations of ozone and hydrogen peroxide, and combinations of preoxidants and PAC were also tested as possible treatment methods. TON levels were determined by a panel of trained persons who smelled the odors of the water and judged its acceptability.

Results: The TON of the raw water ranged from 22 to 70, but was mostly below 35. The chlorine demand of the water increased with chlorine doses and contact time. When chlorine was used, high levels of trihalomethanes (THMs) were formed. Oxidation with chloramine increased TON levels, especially at higher doses, because a strong chlorine odor was present. Potassium permanganate reduced TON concentrations by moderate amounts. Ozone pretreatment changed the odor from earthy and musty to sweet and fruity. However, although the new odor was more pleasant it still resulted in sizable TON levels. Chlorine dioxide was only marginally effective at reducing TON concentrations. PAC when used with alum coagulation and settling provided, by far, the best results. Follow- up studies still need to be performed to accurately simulate conditions at large water treatment plants. Reference: Qasim, Syed and S.A. Hashsham, *Bench Scale Testing Program on Water Samples from Richland Chambers Reservoir,* Civil Engineering Dept., University of Texas at Arlington, 1990. (The final report was sumbitted to CH2M Hill in Dallas).

Health Effects of Wastewater Reuse for Public Park Irrigation

Researcher: Roger Durand, Bureau of Research, University of Houston at Clear Lake, and Gerhard Schwebach, Wastewater Division, City of Colorado Springs, CO.

Problem: Wastewater reuse for purposes such as public park irrigation will be increasingly common in the future. However, there is little evidence on the health impacts of using treated wastewater and recycled water for irrigating parks that have public access.

Objectives: 1) To determine if the irrigation of public parks with recycled wastewater, rather than potable water, results in a greater incidence of gastrointestinal illnesses, and 2) To determine whether higher degrees of exposure to nonpotable water used in irrigation leads to a higher incidence of gastrointestinal diseases among park users.

Methodology: Epidemiologic data were compiled by telephone surveys from 1984 to 1987 in public parks in Colorado Springs, CO. The parks had either been irrigated with treated wastewater that had been chlorinated to a level of 4- 6 mg/L, potable water, or city runoff. The researchers surveyed more than 2600 persons who were asked about their activity at the park and whether they were exposed to the irrigation water. Followup interviews were conducted 10 to 12 days later to determine whether they had experienced gastrointestinal illnesses such as stomach discomfort, diarrhea, vomitting, cramps, fever, weight loss and other symptoms. Microbiological samples of irrigation water were collected periodically in all of the parks and analyses were performed on common indicator bacteria.

Results: Persons exposed to parks irrigating with treated wastewater or runoff water experienced roughly the same number of gastrointestinal disease as those who visited parks irrigated with potable water. Wet grass conditions during activities such as football or golf resulted in greater numbers of symptoms, regardless of whether the parks were irrigated with potable water, treated wastewater or runoff. People active in parks irrigated with runoff were exposed to higher concentrations of fecal bacteria and total coliforms than those in parks irrigated with treated wastewater. The number of gastrointestinal diseases was greatest when fecal coliform levels were greater than 500 per 100 m L. The study indicates that recycled wastewater and runoff can often be used for public park irrigation without undue hazards to health. **Reference:** Durand, Roger, and Gerard Schweback, "Gastrointestinal Effects of Wastewater Reuse for Public Park Irrigation," *American Journal of Public Health*, New York, NY, December, 1989.

Impact of Tropical Storms and Hurricanes on Flood Control and Drainage Design

Researchers: John Grounds III, Brown and Root, Houston, TX, and Jerry Rogers, University of Houston, Houston, TX.

Problem: The design of flood control and drainage systems for coastal areas must incorporate structural features including floodplains, dams, storm sewers, as well as

characteristics of the storm event. However, many currently used models to simulate the impacts of flooding are based on thunderstorms rather than hurricanes and tropical storms. These models may not accurately reflect actual flood risks from storms in coastal areas.

Objectives: To incorporate thunderstorm and tropical storm data into models used to develop flood control and drainage structures and to assess which data sets and models most accurately reflect actual conditions in the Houston area.

Methodology: Data from typical thunderstorms and hurricanes were analyzed. A hypothetical detention pond was sized to provide adequate storage to reduce peak flows for both thunderstorms and hurricanes.

Results: Thunderstorms that were analyzed typically had one prominent peak of rainfall and a duration of less than 24 hours, while hurricanes and tropical storms occurred over a longer period and exhibited several rainfall peaks. A 1 00- year, 24- hour storm was simulated by the U.S. Army Corps of Engineers' critical rainfall pattern (typical of a thunderstorm) and a hurricane event. The simulated hurricane had a strength of 140 miles per hour (mph), a translational velocity of 3 mph, and made landfall 30 miles west of Houston . The simulated hurricane produced a peak rainfall of 1.7 inches per hour and 12.5 inches over 24 hours. The simulated thunderstorm produced a simulated peak of 4.6 inches per hour and 12.5 inches over 24 hours. Runoff was simulated for both storms by the HEC- 1 model and a detention pond was sized. Comparisons suggest that a detention basin based on the Corps' critical pattern storm will be 2.5 times larger than a pond based on the simulated hurricane. The peak runoff from the Corps' critical pattern storm is much larger than the peak runoff produced from smaller multiple peaks of the simulated hurricane. Simulated tropical storms and hurricanes may be more representative of 1 00-year storms in the Houston area than Corps' critical pattern thunderstorms.

Reference: Grounds, John, and Jerry Rogers, "Design of Flood Control and Drainage in Coastal Regions Subject to Tropical Storms and Hurricanes." Presented at Civil Engineering Convention, New Orleans, LA, 1989.

Reducing Uncertainty in Modeling Stormwater Runoff

Researcher: John Warwick, Institute of Environmental Science, University of Texas at Dallas, and J .S. Wilson, U.S. Environmental Protection Agency, Dallas, TX.

Problem: The overall lack of water quality data often makes it difficult to accurately simulate projected pollutant loadings from runoff and other nonpoint source pollutants. Studies are needed that can establish the likelihood that various simulated scenarios will actually occur.

Objectives: To investigate data sets from 11 storm events, only one of which includes water quality data, and to utilize Monte Carlo simulation techniques to establish a probable range of model predictions for selected water quality parameters.

Methodology: All storm events that were analyzed had at least two weeks of dry weather prior to the actual storms. STORM (the storage, treatment, overflow, and runoff model) was utilized to generate runoff and water quality data. The model was also verified and calibrated. Accumulations of pollutants were determined by factoring the total mass of pollutants on given land uses at the beginning of each storm, the rate of pollutant buildup, the area of land use, the number of days without runoff since the last storm, and the amount of pollutants remaining on the land at the end of the storm. Data were transformed so that they could be used in Monte Carlo simulation models. Uncertainty analyses were performed for pollutants including total suspended solids (TSS), biochemical oxygen demand (BOD), phosphates (P) and total nitrogen (N), as well as water quantity. Scenarios were simulated using data from Seattle, Tulsa, and the Bachmann Creek watershed in Dallas.

Results: To achieve a 95% occurrence interval (a range that defines 95% of all likely modeling results), 1,000 model runs were simulated. For the Seattle data, ail water quantity data and all water quality parameters except TSS were within the 95% occurrence intervals (modeled TSS values were too low). The lack of agreement could be due to measurement errors, uncertainty of model input parameters, and erroneous model formulations. For the Tulsa and Bachmann Creek data, all water quantity and water quality data fell within the 95% occurrence intervals. This study restates the need to utilize well defined model input parameters and to characterize uncertainties associated with runoff.

Reference: Warwick, John, and J.S. Wilson, "Estimating Uncertainty of Stormwater Runoff Computations," *Journal of Water Resources Planning & Management,* New York, NY, March 1990.

Computer Simulations of Droughts in the Edwards Aquifer

Researcher: Nisai Wanakule, Edwards Aquifer Research and Data Center, SW Texas State University, San Marcos, TX.

Problem: Increased pumping in the Edwards Aquifer may result in Comal Springs drying up by the year 1995 and San Marcos Springs by the year 2010, according to simulation models used by State agencies. Simulation models are needed that accurately predict the impact of various pumping levels on aquifer levels and springflows in the region, particularly during droughts.

Objectives: To investigate the stochastic nature of hydrologic droughts (shortages of stream flow, reservoir levels and aquifer storage) in the Edwards Aquifer.

Methodology: The study considered the duration and severity of drought events. Drought analysis was performed on an annual basis using demand levels that varied from year to year, according to growth rates and recharge conditions. A stochastic model was developed to estimate annual recharge. The model uses historical hydrologic records to predict likely future scenarios. A deterministic demand model, comprised of variable and fixed demands, was also developed. Variable demands are a function of time and regional

climate conditions. Since the early 1950s, pumpage was relatively constant even when recharge fluctuated widely, those years were omitted from simulation runs.

Results: The models were used to simulate 10,000 recharge events. Variable demands were computed for each recharge scenario. Total demands were used to calculate the amount of shortfalls. Impacts of downstream demands ranging from 100,000 acre feet (AF) to 300,000 AF were also simulated. At 1989 pumpage levels, the mean drought duration varied from 3.2 to 4.9 years while drought severity ranged from 1 to 2.3 million AF. By the year 2000, the mean drought duration could rise to 4.8 to 8.6 years and the drought severity could total 1.9 million to 4.7 million AF, if pumpage levels continue to increase. Water demands of 200,000 AF in the Guadalupe River basin could increase the chance of a drought of five years to 25%. Results also suggest current drought management plans could be triggered every three or four years and that each drought event could be expected to last an average of five months. **Reference:** Wanakule, Nisai, *Stochastic Drought Analysis of the Edwards Aquifer* (R1 - 90), Edwards Aquifer Research and Data Center, Southwest Texas State University, San Marcos, TX, 1990.

Dioxin Found in Fish, Shellfish from Houston Ship Channel

State health officials are warning the public to limit consumption of fish, blue crabs, and catfish harvested from certain areas of the Houston Ship Channel and pans of the Brazos and Neches rivers because of dioxin contamination. The advisory covers catfish and blue crabs from the Ship Channel. All fish from the Brazos River (from Brazoria to the Gulf of Mexico), and the Neches River (from Evadale to the 1- 10 bridge near Beaumont) are also included.

Officials with the Texas Department of Health (TDH) say that children and women of child- bearing age should avoid eating the fish and shellfish because dioxin is a "probable" cancer- causing agent. Adults should not eat more than 1 meal a month of more than 8 ounces from the impacted areas. Eating seafood contaminated with dioxin over long periods of time may also cause other health problems.

The finding is significant because the State does not have any program in place to regularly monitor toxic contaminants in seafood meant for humanfort. Several states already have such programs in place. Finally, the EPA is in the process of issuing tougher discharge permits to control dioxin releases to avoid similar problems in the future.

TWC to Delay Expanding "Watermaster" Plan in Colorado River Basin

The Texas Water Commission has delayed expanding its Watermaster Program into the Colorado and Lavaca river basins until at least next year. The delay will allow lawmakers to review the program to determine H it should be continued.

Watermasters are already in place in the Guadalupe, San Antonio, and Nueces river basins. The program monitors surface water use. It prevents unauthorized use of water, and accurately measures the amount of water that's actually withdrawn from rivers and streams.

However, the program had drawn some complaints because it requires users to install meters at their own expense to measure water usage. Some legislators had sought the delay because they felt it was unneeded. Only 11 violations had been registered since the program was implemented.

Mediator Appointed to Negotiate Edwards Aquifer Settlement; Must Solve Issues Including Catfish Farm, Applewhite, San Antonio Pumpage

A mediator has been appointed to negotiate a long- term solution to water problems in the Edwards Aquifer and it appears he may have his hands full. A number of other factors including a watergulping catfish farm, possible delays in the construction of the Applewhite reservoir because of environmental concerns, and possible pumping by San Antonio in Uvalde County are just a few of the latest wrinkles that continue to make the Edwards Aquifer the state's most interesting water controversy.

John Folk- Williams of the Western Network, a water resources "think tank" in Santa Fe, NM, has been appointed to mediate a settlement in the region. FolkWilliams is now meeting with representatives of water using groups in the region to determine if there is some common ground that a solution can be based on.

Meanwhile, a proposed catfish farm in southeast Bexar County points out the need to develop some groundwater pumpage regulations in the region. The farm will use as much as 35,000 acre feet of water from the aquifer each year that's about 75% of the yield of the proposed Applewhite Reservoir. The farm's owners are not planning efforts to conserve or recycle water at the facility. Furthermore it seems that there is little that the Texas Water Commission (TWC) or other agencies can do to prevent the project from becoming operational

Speaking of Applewhite Reservoir, that project may be temporarily put on hold until its impact on endangered species and downstream flows can be assessed. The U.S. Fish and Wildlife Service has requested that the U.S. Army Corps of Engineers develop a biological assessment of the project.

Three other items are worth noting.

Some San Antonio officials are investigating whether the City could begin pumping in Uvalde County on the other side of the Knippa Gap - a physical barrier that divides the Edwards Aquifer into western and eastern pools. That could provide more water for Medina and Bexar counties. Officials in Uvalde County oppose the plan.

Also, the San Antonio City Council has asked the Edwards Underground Water District to fund a study to determine K it is feasible to artificially augment springflows with large pumps when those flows are low. Some critics say that limiting pumping to levels that guarantee natural springflows unnecessarily restricts the amount of water that can be taken from the aquifer. Augmenting springflows could make more water available.

Finally, the TWC has increased the size of the Edwards Aquifer recharge zone so that it now stretches as far north as Williamson County. As a result, state programs designed to prevent pollution of the aquifer will be put into place in the newly expanded area.

Austin Debates Barton Creek Development, Other Water Quality Issues

Officials with the City of Austin and the Lower Colorado River Authority (LCRA) are now working to solve two potential water quality headaches.

The City was considering developing tougher water quality controls to protect Barton Creek and Barton Springs after a developer proposed a 4,000- acre subdivision along the creek. Opponents of the project are concerned it may lower the excellent water quality now present in the creek and the springs. The new controls could include limits on the amount of land that can be paved, additional structural controls including wet detention basins to improve the quality of urban runoff, extending the new standards to existing homes and developments, and others. Meanwhile, the developers have proposed paying for independent water quality monitoring and say they will meet the goal of preventing any water quality degradation in the creek and the springs.

In a separate story, the City of Austin and the LCRA are working on proposals that could improve the water quality of the Colorado River. The proposed new policy could include ordinances that regulate development of creeks emptying into Town Lake and the river below Austin to reduce runoff, retrofitting already developed urban areas with runoff controls, extending runoff controls to all the Highland Lakes (the regulations now cover only Lake Travis), and monitoring pesticides and herbicides. Two major points of contention remain, however. LCRA is demanding that Austin remove phosphorus from its wastewater. Austin says that's unneeded and would cost $30 million. Also, Austin has requested that LCRA provide increased flows through the Highland Lakes to periodically flush out algae blooms. LCRA counters that would be using clean Highland Lakes water to dilute Austin's pollution.

Houston Ship Channel "Most Dangerous" Nationally, Barge Operators "Play Chicken" to Get Through

There are a few interesting footnotes to this summer's oil spills in the Houston Ship Channel.

A study by the *Houston Post* revealed that the Ship Channel ranks first nationally in the number of collisions and groundings of tankers and barges. In the past decade, the Houston Ship Channel suffered twice as many mishaps as any other commercial waterway.

If that weren't bad enough, as many as 20 tank and barge operators must execute a dangerous and complicated maneuver called the "Texas Chicken" just to navigate through the narrow waterway. It works this way. Two vessels establish contact and head directly toward each other. At the last possible moment, both vessels turn hard to the right. After the bows have safely cleared, the ships add power and straighten themselves so they are

separated by 50 to 100 feet. Although many experts say the procedure is safe H practiced by experienced tank operators and may be the only way to steer large vessels through the Channel, it can backfire. This summer's accident involving the *Shinoussa* occurred after that tanker played "Texas Chicken" and ran into a barge.

There is now more evidence oil eating microbes that were applied following the spills apparently did their jobs. A scientist with the Austin company that applied the microbes said that a wide variety of fish were observed in areas that had only recently been covered with oil before being treated with the bugs. An oil company consultant added that many of the organisms needed to degrade oil spills are already present in the Gulf of Mexico and other open waters. All that's needed is to apply nutrients to stimulate the bacteria.

Texas Decides How to Use Pecos River Settlement; Canadian River Next

Texas received $14 million last year after a lengthy lawsuit determined that New Mexico illegally withheld Pecos River water. Now it appears that future settlements may be forthcoming after a ruling that New Mexico illegally stored water from the Canadian River.

West Texas officials are trying to determine the best way to use the monies from the Pecos River settlement. Various ways to spend the $14 million have been proposed including construction of a concrete pipeline from Red Bluff Reservoir to Barstow, relining canals, eliminating seepage from Red Bluff Dam and reducing salinity in the river. One idea is to identify areas in the river where large natural salt beds occur and to divert the course of the river around those bends to reduce the buildup of salinity.

Meanwhile, a Special Court Master has recommended that the U.S. Supreme Court find that New Mexico violated the Canadian River Compact by holding back water from Texas and Oklahoma. The Master's ruling found that New Mexico has knowingly and willfully violated the compact since 1987 by impounding more than the 200,000 acre feet of water allowed by the treaty.

If the Supreme Court rules that New Mexico violated the compact, it could determine Texas is entitled to receive increased water deliveries or a cash award.

TWDB, TWC to Study Critical Groundwater Areas

The Texas Water Commission (TWC) has designated four regions as "critical areas" needing groundwater management and protection, while the Texas Water Development Board (TWDB) has announced it will begin studies in another three areas to determine if severe groundwater problems exist.

The critical areas named by the TWC include portions of Midland, Upton and Regan counties, all of Swisher County as well as portions of Briscoe and Hale counties, and a part of Dallam County. A section of the Hill Country was also designated including all of Bandera, Blanco, Gillespie, Kendall and Kerr counties and pans of Comal, Hays and Travis counties.

Meanwhile, the TWDB announced that it and the TWC will conduct joint studies in three areas identified as having groundwater problems. These include a portion of the Winter Garden area (Zavala, Dimmit, LaSalle, McMullen, Webb, and Maverick counties), a seven- county region of the southern Texas High Plains north of Midland, and a huge 44-county area west of Mineral Wells and north of Abilene.

The Winter Garden studies began October 1. The Southern High Plains study is slated to begin in January of 1991.

The **Texas Turfgrass Conference and Show** will be held December 1719, 1990, at the San Antonio Convention Center. For information about attending the conference, contact: Texas Turfgrass Association, 1003 Howe, College Station, TX, 77845 or call 409845-4826.

Research Could improve Health of Trinity River, Scientists Say

More than 175 persons attended an Oct. 2 symposium at Texas Christian University in Fort Worth titled "How Healthy is the Upper Trinity River?" The meeting was sponsored by the Texas Water Resources Institute (TWRI).

Attendees listened to talks by university scientists as well as presentations from representatives of state and federal agencies and industry experts. Sessions focused on biological issues, urban and agricultural runoff, water quality trends and relationships between wastewater and water quality. Specific topics that were discussed included how wetlands and marshes could be used to reduce nitrogen and phosphorus levels, how landscapes that require less water and chemicals can reduce runoff, how geographic information systems can provide quick access to computerized maps and information that can be used by decision makers, and others.

Participants also took part in a panel discussion in which State agency personnel and local government representatives debated proposed water quality standards for the river. The standards are somewhat controversial because - although they set more stringent limits that allow less pollution in the river - they also contain clauses that exempt the criteria from having to be met during extensive low- flow periods. Since nonpoint source pollutants now contribute much of the material that lowers water quality, there are concerns that more information needs to be developed on runoff before tighter pollution controls are implemented on point sources such as wastewater treatment plants.

Many researchers at the meeting said that substantial progress has been made in controlling point sources of pollution such as discharges from industries and wastewater treatment plants. The time has come to shift the emphasis to "non- point pollutants that originate from uncontrolled runoff from parking lots, streets, lawns, croplands, dairies and grazing lands.

Non- point source pollution is still a puzzle to both the scientific and regulatory community," said Wayne Jordan, TWRI Director, "because it's difficult to identify which areas and activities are generating the most contaminants. When you look at runoff after a

storm you can measure and identify the chemicals that are involved. You can't easily determine the origin of the pollutants."

Research Plan Developed to Improve Trinity River Quality

The day after the symposium roughly 25 researchers from local universities conferred with leaders from local governments and State and Federal agencies to agree on research priorities that could improve the water quality in the area.

Potential research areas were identified and ranked in the following order:

1. Identifying the sources of point a... nonpoint source pollution that enter the Trinity River during storms, normal conditions and droughts and developing strategies to control those pollutants.
2. Determining the effectiveness of "best management practices on reducing levels of nutrients, pesticides and toxic chemicals from urban, agricultural and industrial runoff.
3. Assessing the impact of toxic chemicals on aquatic life in the river including the impact of chlorination, heavy metals, and pollutants in sediments.
4. Educating the public and building acceptance for non- polluting activities such as use of best management practices, water conservation and reuse, and discouraging nonpoint source pollution.
5. Assessing long- term river conditions in the main part of the river and minimally polluted tributaries and measuring populations of aquatic species and species diversity.
6. Determining the sensitivity of aquatic species that live in the river to specific levels of contaminants.
7. Assessing current and future flows in the river and developing ways to manage flows to improve water quality.

Non- Point Source Pollution is Focus of TWRI Study

The Texas Water Resources Institute (TWRI) has published a technical report describing efforts to stochastically model rainfall and runoff to predict non- point source pollution. *Stochastic Modeling of the Rainfall Runoff Process for Non- Point Source Pollutant Load Estimation* (TR148) was written by Roger Dickey and Michael Collins .

The report describes techniques to estimate loadings of non- point source (NPS) pollution and development of models and methods that can be used when only limited databases are available. Field studies that included more than a year's collection of rainfall and runoff data near Lake Ray Hubbard in the Dallas area are also detailed. Other sections of the report include stochastic (or random) simulation models, and ways to transform flow rates, runoff volumes, and hydrographs for use in other models.

Results of the study could be especially useful in predicting NPS concentrations in situations where data are limited and hard to get. A new method was developed to derive information from the rainfall- runoff process from field data that could be easily applied to real- world engineering problems.

To obtain a free copy, contact: Texas Water Resources Institute, Texas A&M University, College Station, TX 77843- 2118 or call 409- 845- 1851.

UT Reports Look at Models of Urban Regulations, International Wastewater Management

The Center for Research in Water Resources at the University of Texas has published three technical reports dealing with knowledge- based models of municipal regulations, waste management in developing countries, and supercritical water oxidation.

Site Code: A Knowledge- Based Model of Municipal Site Development Regulations (CRWR 194) was written by Douglas Shaw and David Maidment. The report describes the development of a knowledge- based computer model that extracts all the state, federal and local regulations that apply to a particular development from a large data base. This could include laws governing floodplain development, easements and setbacks, and many other issues. This type of model could be useful to developers who are trying to cope with a large number of standards.

Incrementalism and Industrial Waste Management in Developing Countries (CRWR 196) was co- authored by Timothy Whitington and Earnest Gloyna. The report describes the development of engineering design and cost models that can be used to guide the implementation of regulations. Guidelines for industrial waste management are recommended.

Heat Transfer to Water in Countercurrent Flow within a Vertical, Concentric- Tube Supercritical Water Oxidation Reactor (CRWR 195) was coauthored by Robert Michna and Earnest Gloyna. The report describes heat transfer in supercritical water oxidation systems. The process is extremely efficient at destroying organic pollutants in a totally enclosed facility. Results of experiments on near- critical and supercritical water in oxidation reactors are summarized.

For details, contact: Center for Research in Water Resources, Balconies Research Center, University of Texas, Austin, TX 78712 or call 512- 471- 3131.

Furrow Dike Designs, Irrigation Management, Water Quality, Reviewed in TAES, TAEX Studies

Many new reports dealing with agricultural water issues have been published by the Texas Agricultural Experiment Station (TAES) and the Texas Agricultural Extension Service (TAEX) at Texas A&M University.

Design of Furrow Dikes to Optimize Rainfall Retention in Texas (MP- 1681) was co-authored by Mohammed Estiri, Kirk Brown and Gene Lindemann. The study, which was funded by the Texas Water Resources Institute, determined the optimum height of furrow dikes and the proper spacing between dikes to capture rainfall and prevent erosion. Optimal dike heights for various row spacing, climatic regions, and slopes are shown in a series of tables.

Managing Irrigation Water Salinity in the Lower Rio Grande Valley (B- 1667) was written by Guy Fipps. The publication includes such topics as how to test for salinity, general salinity problems, the impact of salinity on crop yields, and determining proper irrigation amounts. *A Drought- Avoiding Soybean Production System for Northeast Texas* (MP- 1680) was co- authored by G.R. Bowers, L.R. Nelson and G.A. Finch. The report explains how the use of new soybean *varieties* that *are* planted *earlier* in the growing *season may* help overcome traditional limits of drought stress. *Crop Yield and Profit Implications of Alternative Rotations and Tillage Practices: Texas High Plains* (B- 1619) was coauthored by Ron Lacowell, John Lee, Charles Wendt, Robert Lascano and J. Wayne Keeling. The report addresses the crop yields, net returns and wind erosion implications of reduced tillage farming systems. *Water Quality: Its Relation to Livestock* (L2374) was coauthored by F.C. Faries, John Sweeten and John Reagor. The brochure describes the impact of high levels of minerals, nitrogen, bacterial contamination, algae and accident spills of agricultural chemicals on cattle and livestock health.

For details, contact: Agricultural Communications Dept., Texas A&M University, College Station, TX 77843 or call 409845- 2211.

Lamar U. Center Publishes Hazardous Wastes Report

Studies of ways to treat and dispose of hazardous wastes are the subject of a proceedings published by the Gulf Coast Hazardous Substance Research Center at Lamar University.

The proceedings is titled *Solidification and Stabilization: Mechanisms and Applications.* Papers deal with the leaching of toxic metals, ways to treat landfill leachate, physical and chemical technologies for aqueous organic hazardous wastes, degradation processes of hazardous wastes in deep injection wells, and other topics.

For details, contact the Center at 409- 880- 8768.

Ways to Dispose of Dredged Materials from Gulf Waterway Examined in TTI Study

Each year, roughly 25% of Texas' navigation channels including the Gulf Intracoastal Waterway (GIWW) must be dredged to provide safe conditions for recreation and commercial maritime traffic. Disposing of the dredged materials is becoming more difficult because of stiffer environmental regulations.

These issues are examined in a new report by Texas A&M University's Texas Transportation Institute (TTI) titled *Optimum Disposal Methods for Use on the Gulf Intracoastal Waterway.* The report was co- authored by Kelly Wooters, Roy Hann, Dock Burke, and Charles Giammona. In the study, technological, economical and social categories were analyzed to identify the best solutions.

According to the report, dredged materials should not be placed where they will pose a risk to the environment and where they could benefit society. Promising concepts that may meet some of these objectives include transfer of dredged materials to inland

locations, use of lightweight concrete "riprap" to slow erosion, interim storage, and the use of subsurface dikes.

For details, contact: Texas Transportation Institute, Texas A&M University, College Station, TX 77843 or call 409-845- 1734.

Southwest Texas State Reports Emphasize Barton Springs, Drought Impacts

Two new reports from the Edwards Aquifer Center at Southwest Texas State University focus on the hydrogeology of the Barton Springs segment of the Edwards Aquifer and the impact of droughts on area groundwater supplies.

Lineaments and the Edwards Aquifer- Barton Springs Segment was written by C.M. Woodruff, Laura de La Garza and Fred Snyder. The study used satellite data to determine patterns in the terrain and slope of the land called lineaments. More than 2,700 lineaments were observed and transferred to topographic base maps. The maps were later combined into a single large sheet. Results suggest that the location of the lineaments may indicate areas of groundwater recharge and discharge, directions of groundwater flow, and may help locate sites for recharge dams.

Stochastic Drought Analysis of the Edwards Aquifer was written by Nisai Wanakule (see Abstracts section of this issue for details) and describes the possible impacts of drought in the region based on computer simulations.

For details, contact: Edwards Aquifer Research and Data Center, Southwest Texas State University, San Marcos, TX 78666 or call 512- 245- 2329.

Texas - New Mexico Water Wars Chronicled in 2 New Books

Two new reports provide additional insights into water rights disputes between Texas and New Mexico.

Whose Water Is It, Anyway? Anatomy of the water battle between El Paso, Texas and New Mexico was coauthored by Linda Harris, Robert Czerniak, Richard Earl and William Gribb. Harris was formerly the information specialist at the New Mexico Water Resources Research Institute and Czerniak teaches geography at New Mexico State University.

The book chronicles the decade- long struggle between the City of El Paso and New Mexico over the right to pump southern New Mexico groundwater. Sections of the book describe differences in Texas and New Mexico water law and the hydrology of the area. This 48- page book contains 22 photographs, illustrations and maps. For details, contact: Arroyo Press, P.O. Box 4333, Las Cruces, NM 88003, or call 505- 522- 2348.

Another controversy, whether New Mexico delivered the amount of the Pecos River water it was obligated to send to Texas according to an interstate compact, is examined in

The 34th Annual New Mexico Water Conference Proceedings. Papers in the proceedings describe summaries of the Pecos River adjudication, overviews of the Texas- New Mexico settlement, future outlook for water use in the Pecos River system, and other related topics. The proceedings is available from: New Mexico Water Resources Research Institute, New Mexico State University, Box 30001, Dept. 3167, Las Cruces, NM 88003, or by calling 505646- 4337.

USGS Reports Cover Water Quality, Groundwater

The U.S. Geological Survey has produced a number of reports dealing with Texas' water supplies. *Trends in Water Quality Data in Texas* (Report 894178) was written by Terry Schertz. it summarizes surface water quality data taken from 117 stream stations from 1969 to 1986. *Relation Between Urbanization and Water Quality of Streams in the Austin Area* (WRI Report 90- 4017) was written by Jack Veenhuis and Raymond Slade. Results suggest that urban runoff produced higher concentrations of many pollutants than runoff from rural areas. *Groundwater Flow in the Gulf Coast Aquifer Systems* (WRI Report 89- 4071) was written by Alex Williamson, Hayes Grubb, and Jonathon Weiss. The study utilized digital models to simulate groundwater flows. *Groundwater Withdrawals, Water Level Changes, Land Subsidence and Groundwater Quality in Fort Bend County* (WRI Report 90- 4012) was written by Glenn Locke. The report notes that roughly 67% of the county subsided at least 0.5 feet since 1906. *Relation of Water Chemistry of the Edwards Aquifer to Hydrogeology and Land Use in the San Antonio Region* (WRI Report 87- 4116) was written by Paul Buszka. The study evaluates 1,500 water quality samples from 280 wells and three springs and links that data with land use patterns.

To order any report, contact the USGS at 512- 832- 5791.

Texas A&M Press Books Highlight Growth of LCRA, Mapping of Texas Coast

Two books are now available from the Texas A&M University Press.

Damming the Colorado: The Rise of the Lower Colorado River Authority, 19331939 by John A. Adams, Jr. traces the development of the Lower Colorado River Authority - one of the earliest New Deal reclamation projects. Over 25 drawings, maps and photos are included. *Mapping Texas and the Gulf Coast: The Contributions of Saint- Denis, Olivan, and Le Maire* was written by Jack Jackson, Robert S. Weddle, and Winston De Ville. The book reveals the cooperative/competitive relationship of the Spanish and French through the study of eighteenth- century map making. Several previously unpublished maps and memoirs are included.

For details, call The Texas A&M University Press at 800- 826- 8911.

Corpus Christi State May See Increased Training, Research Following Oil Spills

To almost all Texans, this summer's oil spills in the Houston Ship Channel were disastrous. However, the tragedies may actually benefit Corpus Christi State University's National Oil Spill Control School.

The school was the only university- based facility in the U.S. that was included in recently passed federal legislation that establishes response centers around the nation's coastline. The school will also provide training on spill prevention and control.

The legislation may also increase CCSU's research capabilities. The university says it will expand studies into environmental assessments and evaluation of innovative technologies to fight oil spills. Faculty from the School, the Center for Coastal Studies and other research groups will also participate.

For details, contact: National Oil Spill Control School, Corpus Christi State University, 6300 Ocean Dr., Corpus Christi, TX 78412 or call 512- 991 - 8692.

Texas Tech Studies Ways to Restore Aquifer Quality

Researchers at Texas Tech University are studying the chemical and physical processes that control the removal of volatile organic chemicals from groundwater systems.

Texas Tech scientists are now investigating whether intermittent, pulsed air flows may allow time for diffusion and improve the costefficiency of the process while maintaining similar removal rates. Researchers are now comparing the effectiveness of the pulsed air flow and conventional processes in laboratory experiments. For details, contact: Water Resources Center, Texas Tech University, P.O. Box 4630, Lubbock,TX 79409 or call 806- 742- 3597.

Bacteria Are Key Part of Microbial Based Food Web, UT- Arlington Scientist Says

The presence of bacteria in Texas lakes may impact pollution abatement and rates of nutrient cycling and may mitigate the availability of those materials to other organisms, according to studies at the University of Texas at Arlington.

Tom Chrzanowski of the Biology Dept. has been studying bacteria in Lake Arlington. His work focuses on competition between bacteria and algae for nitrogen and phosphorus, factors that regulate growth of the microbes, and the amount of energy they produce.

Chrzanowski's studies suggest that bacteria levels in Lake Arlington, and probably many other Trinity River reservoirs, have decreased markedly during the past 5 years. Bacteria populations normally increase rapidly during early spring and summer and are still active in early fall. The size of individual cells also appears to be seasonal and may be related to water temperatures. Cells are large when water temperatures are low and are smaller

when water temperatures are high. Studies suggest that bacteria can degrade and assimilate organic acids and other pollutants. Bacteria may also be sensitive to short-term environmental shifts, especially rainfall. Data indicate that bacteria display unusual peaks of high activity immediately after rains of roughly 1 inch or more.

For details, contact: Tom Chrzanowski, Biology Dept., Box 19498, University of Texas, Arlington, TX 76019 or call 817273- 2871.

Improving Impact of Rangelands on Water Quality is Focus of TAEX Seco Creek Project

The Texas Agricultural Extension Service (TAEX) is working with state and federal agencies to evaluate the relationships between rangeland management practices and water quality and quantity in the Seco Creek watershed west of San Antonio.

The project is intended to demonstrate and transfer technology that agricultural producers and the general public can adopt to prevent potential water quality problems. The effort is part of a new initiative by the U.S. Department of Agriculture- Soil Conservation Service to protect ground and surface water from potential contamination from agricultural chemicals and wastes. The Texas State Soil and Water Conservation Board is also taking part in the project.

The main focus of the project is the use of agricultural chemicals used on rangelands and croplands, evaluating the impact of mechanical brush controls on water quality, maintaining wildlife habitats, and nutrient and pesticide management.

The project is especially significant because brush control has been advocated as a way to increase water yields in the region, and because the Edwards Aquifer is especially vulnerable to pollution.

For details, contact: Robert Lemmon, TAEX, Soil and Crop Science Dept., Texas A&M University, College Station, TX 77843 or call 409- 845- 2425.

Environmental Resource Center Established at UTEP

The University of Texas at El Paso has established a Center for Environmental Resource Management.

The Center will investigate many water- related subjects including impacts of overpumping of local aquifers, saline water intrusion, contamination of surface and ground water resources from inadequate sewage facilities, international pollution from both sides of the Rio Grande, methods to clean up polluted aquifers, wastewater reuse and others. Many existing UTEP research labs will also be associated with the Center.

For details, contact: Center for Environmental Resource Management, UTEP, El Paso, TX 79968 or call 915-747- 5494.

Strategies to Control the Rams- Horn Snail Goal of SW Texas Researchers

The giant rams- horn snail, a species native to Colombia that was originally imported to clean household aquariums, has been creating ecological havoc in Comal Springs, Landa Lake, and the Comal River. Now, scientists in the Biology Dept. at Southwest Texas State University (SWTSU) are investigating just how bad the problem is and ways to control the pesky mollusk.

Since being introduced into Comal Springs seven years ago, populations of the snail have increased dramatically. The result is that sections of Landa Lake which once supported large masses of aquatic plants have been completely denuded. The loss of aquatic vegetation may upset the delicate balance that many endangered species in the area require. Scientists are also worried that, in the future, the snails could destroy endangered Texas wild rice in San Marcos Springs.

SWTSU biologists Tom Arsuffi and Bobby Whiteside are studying the snail and ways to control it. The studies focus on determining the habitats the snail prefers and estimating the number and size of snails in the lake. The researchers have set up eight sampling sites along the Comal River to monitor flow rates, the type of aquatic vegetation that's present, and snail populations. Laboratory experiments have studied the foods the snails prefer (they prefer Red *Ludwigia),* and the amounts they consume and destroy. The researchers have also identified ways of reducing populations of the snails including introducing fish that could prey on the snails such as sunfish or sending divers into the lake from January to March to collect adults and newly laid eggs.

For details, contact: Tom Arsuffi, Biology Dept., Southwest Texas State University, San Marcos, TX 78666 or call 512245- 2284.

UT Studies Combines Impact of Sea Level Rise, Land Subsidence on Texas Coast

Many studies suggest that global warming will raise the level of seas and and increase the risk of flooding of coastal areas. Now, scientists at the University of Texas are investigating relative sea level rise (combined impacts of subsidence and sea level rise) on the Texas Gulf Coast.

Jeff Paine of UT's Bureau of Economic Geology estimated the vertical movement of coastal lands south of Galveston Bay from land surveys taken from 1951 to 1982. The surveys were correlated to tide gauges at Galveston (upper coast), Rockport (central coast) and Port Isabel (lower coast). Rates of relative sea level rise were estimated for coastal areas between the tide gauges.

Results show that the combined impacts of subsidence and sea le vel rise are most severe at Galveston where the relative sea level rose at 0.3 inches per year. The lower Texas coast had lower rates of relative sea level rise of about 0.15 to 0.3 inches per year south

of Galveston Bay, but reached as much as 1.0 inches per year locally. Land subsidence may account for at least 50 to 75% of the relative sea level rise.

For details, contact: Jeff Paine, Bureau of Economic Geology, University of Texas, Austin, TX 78713 or call 512- 471 - 1534.

Rice University Researchers Use GIS Techniques to Define Wellhead Protection Areas

Many Texas cities are developing wellhead protection programs to protect drinking water wells from contaminants.

Studies now underway at Rice University are investigating whether computerized maps and databases called geographic information systems (GIS) may make the process of defining wellhead protection areas quicker and more easily updated.

In the project, a GIS database was developed containing information on hydrography, topography and other natural resources. Information about public water wells, hydrology, hazardous waste facilities and underground storage tanks were also entered into the database. The GIS database was then linked to EPA's Wellhead Protection Code (WHPA) computer program which defines the boundaries of warhead protection areas. WHPA uses data from the GIS as inputs to its computer models. The GIS can then integrate WHPA output back into the database and can also create computerized maps. A case study is now in progress to define wellhead protection areas for Houston's 200 water wells.

For details, contact: Phil Bedient, Environmental Science and Engineering Dept., Rice University, Box 1892, Houston, TX 77251 or call 713- 527- 4951.

Conjunctive Management Models Developed at WTSU

Models that could ultimately help coordinate the management of surface and ground waters are being developed at West Texas State University.

Duane Rosa of the Economics Dept. is working on a computerized planning method that combines the use of linear and dynamic computer models. Those results interact with equations that dictate groundwater flows in systems where streams and aquifers interact.

A linear model determines the optimal water resources management schemes, based on the type of water use, the distribution system, the pumping capacity of the wells, depths that water has to be pumped from, and other factors. A groundwater flow model projects water availability throughout given time periods. Dynamic programming analyzes factors which impact the following year's water levels including decisions on whether an aquifer should be overpumped, the number of wells that should be drilled, and others. Rosa used the model to conduct a case study of the Edwards Aquifer. He hopes the modeling framework can also be applied in other regions such as the High Plains. For details,

contact: Duane Rosa, Economics Dept., West Texas State University, Canyon, TX 79016 or call 806- 656- 2511.

Biologists at Texas A&M Think Kemp's Ridley Turtles May Follow Their Noses

The aroma of human development may be making it impossible for endangered Kemp's Ridley sea turtles to find their way home again, according to Texas A& M biologists David Owens and Heather Kalb.

The scientists think that chemical changes from development along the Texas coast may interfere with the turtles' ability to smell their way back to a beach near Brownsville (where they were born) so they can lay eggs.

To test the theory, the behavior of 12 adult male and female turtles will be studied in a large 20- foot diameter saltwater tank and a narrow current of treated seawater will be pumped across the tank. A video monitor will record how the turtles respond to the treated seawater (the water was circulated through sands from North Padre Island, where the turtles were hatched).

Owens said he believes the turtles use the position of the sun and the Earth's magnetic field to navigate over long distances. He thinks the sense of smell may be vital to detect the particular stretch of beach where the turtles were born. If the turtles encounter an oil slick or some other form of pollution, it could reduce their ability to locate their home by interfering with their sense of smell.

For details, contact: David Owens, Biology Dept., Texas A&M University, College Station, TX, 77843 or call 409845- 7784.

TCU, TPWD Study If Shad Help or Harm Sport Fisheries

The impact of gizzard and threadfin shad on reservoirs in Texas is controversial. Some studies have shown that populations of sport fish increase after shad are introduced. Other investigations suggest that shad compete with young sport fish for foods and may actually decrease levels of crappie and other game species.

To answer these questions, Ray Drenner of the Texas Christian University Biology Dept. worked with Clell Guest of the Texas Parks and Wildlife Dept. to determine how shad impact the supply of zooplankton that young white crappie use as a food supply. The study was conducted in 20 ponds on the Lewisville State Fish Hatchery. Fish were collected from including Lewisville, Arlington, Texoma and other area lakes. All the ponds were stocked with white crappie. Four treatments were used: no shad, gizzard shad only, threadfin shad only, and gizzard and threadfin shad together. Zooplankton levels were sampled.

Results suggest that the total number of young white crappies was reduced in the presence of shad, but the size of individuals increased. Drenner says that the food sources

required by young crappies and shad species overlap. The research suggests that shad may be better at competing for zooplankton and may not leave enough food to support young crappie populations. There is also evidence that shad may be eating young crappie. The results may be important to fisheries managers. H white crappie populations are inadequate, introducing shad could be detrimental to the sport fishery. H young crappie are too small, introducing shad may actually significantly increase crappie size.

For details, contact: Ray Drenner, Biology Dept., TCU, Fort Worth, TX 76129 organ 817921- 7165.