New Waves
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WWW Users Meet at Texas A&M to Share Ideas, Experiences

More than 40 people working with the World Wide Web (WWW) met at Texas A&M University (TAMU) December 12 to learn about the latest ways to use the Internet to share water resources information. The workshop was sponsored by the Texas WWW Water Users Group and was hosted by the Texas Water Resources Institute (TWRI). This is the third time the group has met.

Upcoming issues of *New Waves*, we will feature many of the presentations made at the meeting. Links to the web site of each presenter have been made on the links page of the TWRI WWW site. TWRI has a limited number of copies of materials that were distributed at the meeting.

Dennis Hoffman (facing camera) of the TAES Blackland Research Center discusses his WWW site with participants at the workshop.

"These meetings are valuable," says Marshall Jennings of the U.S. Geological Survey, who helped originally organize the group, "because there are so many efforts throughout Texas where individual agencies and universities are developing WWW sites that focus on water resources and the environment. By getting together, we can see what our colleagues are doing, learn from their experiences, build networking relationships, better take advantage of existing resources, and avoid the duplication of efforts."

The presentations at the meeting covered a wide range of topics. In the morning session, Michael Pilant of the TAMU Mathematics Department spoke about a site that contains text, graphics, and video segments showing how plumes of contaminants flow through groundwater; David Maidment of the Civil Engineering Department at the University of

Texas at Austin discussed efforts to publish student papers and research projects on the WWW; and Marshall Frech of the Texas Environmental Center in Austin demonstrated a multi-media WWW site and CD-ROM that are being developed to tell the story of Barton Springs.

For the first time, there were separate sessions devoted to technical issues and live demonstrations. Some of the technical presentations included an overview of the Hydrologic Unit Model of the United States being developed by Hailing Wang at the Blackland Research Center at Temple, TX, and creation of the Potential Evapotranspiration WWW site by Guy Fipps and Paul Tillman of the TAMU Agricultural Engineering Department. Some of the live demonstrations included a presentation of the Bad Water Line Monitoring Program WWW site developed by the Edwards Aquifer Research and Data Center at Southwest Texas State University, and use of the WWW for real-time monitoring of coastal water resources by Patrick Michaud of Texas A&M University - Corpus Christi.

"The WWW is an area that has to become a focal point for activities of TWRI and many other academic programs and units in Texas," says TWRI Director Wayne Jordan, "because it is an excellent method to communicate, share and obtain needed information. We will continue doing what we can to develop WWW resources and to help others learn how to use them."

For details, contact TWRI at (409) 845-1851 or twri@tamu.edu.

NIWR Western Region Program Issues RFP; Deadline is March 14

The Texas Water Resources Institute (TWRI) has issued a request for proposals (RFP) for water research . The RFP is part of the National Institutes for Water Research Western Region program, which consists of Texas, Alaska, Arizona, California, Colorado, Idaho, New Mexico, Nevada, Oklahoma, Oregon, Utah, Washington, and Wyoming.

For the second straight year, the program is administered regionally, not by individual states and institutes. The competition is funded by the U.S. Geological Survey.

Program objectives are to conduct research relevant to important water resource problems of the region, to disseminate research results, and to help train scientists in related water resource fields. Some of the high priority research topics identified by the NIWR Western Region include ecosystem approaches to managing riparian areas, improving decision making for managing major rivers, water quality impacts of livestock production, and flood frequency forecasting.

Significant features of this RFP include the following: 1) all projects must provide substantive collaboration among faculty from two or more states; 2) proposals must address water resources problems of regional significance; 3) the total amount available to the Western Region is approximately $800,000 for FY 97. Other important aspects to consider are that: 1) proposed projects should be 1 to 3 years in duration and cannot

request more than $350,000, 2) the institution of each principal investigator must provide a match of two non-federal dollars for each dollar of federal funds requested, and 3) proposals will be accepted only from faculty members or affiliates at institutions of higher education.

TWRI Director Wayne Jordan says there are some ways that the Institute is assisting in the RFP. For example, TWRI has limited funds to assist in meeting the matching requirements. Proposals that request TWRI assistance in meeting the matching requirements will be prioritized by the Director and selected for matching to the extent resources are available.

Proposals with a lead PI from Texas must be submitted through TWRI. Proposals must be received at TWRI by March 14 at 5 p.m. Projects selected for funding will start in September 1997.

A Computer Model to Analyze Water Rights in Texas

Researchers: Ralph A. Wurbs and David D. Dunn, Civil Engineering Department, Texas A&M University (TAMU), College Station, TX.

Note: The Texas Natural Resources Conservation Commission (TNRCC) is in the process of incorporating the TAMU Water Rights Analysis Package (WRAP) into its water availability modeling efforts. The model was developed Ralph Wurbs and graduate students over several years. In September 1996, Wurbs completed an update of the water availability model of the San Jacinto River basin in conjunction with TNRCC.

Problem: Water management agencies, consulting firms, and university researchers need accurate determinations of river and reservoir system water availability to evaluate water rights permit applications and to assess the capability of a river to satisfy existing and potential water rights holders. Such an accounting of water volume should allow input of existing water rights, constant annual water use requirements over the course of a year, streamflow sequences, and reservoir evaporation rates. The ability to manipulate these input values allows alternative strategies for water management to be considered, and assessment of streamflow capability to support water rights applicants.

Objectives: 1) To perform sequential periodic, water volume accounting computations for a river basin or multiple-basin region, addressing water rights in priority order, and 2) to summarize simulation results in user-specified tables and reliability indices for the stream, reservoir, and water rights system being modeled.

Model Development and Description: The TAMU WRAP software provides an accounting system for tracking streamflow sequences, subject to reservoir storage capacities, diversions, and instream flow requirements. Any combination of input variables may be used. Input data include naturalized streamflows, reservoir storage capacity, operating rules, and return flows. Outputs include tables and data listing diversions, diversion shortages, hydroelectric energy generated, reservoir storage levels, return flows, streamflow depletions, and unappropriated streamflows. The model can be

applied to settings involving water rights developed by prior appropriation or any other system. The model provides flexibility over a broad range of modeling approaches. The flexibility of this model provides the capability for simulating a stream/reservoir/use system involving essentially any stream tributary configuration. Although it is designed for a monthly computational time interval, the model can be modified for weekly or daily time intervals. Either natural gaged or synthetic streamflows can be used. A configuration with interbasin transfers and closed loop pipelines with pumps, as well as river channels, can be simulated. The WRAP3 version of the model extends the capability of WRAP2 to allow a range of reservoir system operating rules to be specified and an inclusion of hydroelectric power generation. The TABLES module performs manipulation of input and output files, and displays simulation results. WRAP programs are coded in standard FORTRAN 77 and have been compiled and executed on both IBM-compatible microcomputers and VAX mini-computers.

Guidelines for Input Development: Policy issues inherent in water availability modeling involve aspects of water management such as meeting instream flow needs, effects of return flows on water availability, reservoir storage priorities, multiple-reservoir system operations, reservoir sedimentation, and drought management. Collection and management of data on streamflows, evaporation, water management, and water use are major concerns. Much of the information required to develop a WRAP input file is available from earlier input and output water availability models, such as data from the TNRCC Interactive Water Rights Retrieval System. Current water rights modeling information is also maintained by the TNRCC. A system of rivers, reservoirs, and water rights are represented by interrelated control points, basin hydrology, and water rights. Return flows, hydroelectric power, and reservoir system operating rules are all features of the water rights component.

Reference: Wurbs, R., and D. Dunn, "*Water Rights Analysis Package (WRAP) Model Description and Users Manual*, (TR-146), TWRI, October 1996 (rev.). Texas A&M University, College Station, TX. **NOTE:** A printed copy of this report is available from TWRI at (409) 845-1851 or twri@tamu.edu. The full report and the WRAP software are available at the TWRI WWW site under the technical reports section.

Impact of Highway Construction, Operation on Water Quality

Researchers: Michael E. Barrett, Joseph F. Malina, Jr., Randall J. Charbeneau, and George Ward, Center for Research in Water Resources, the University of Texas at Austin, Austin, TX.

Problem: A highway construction corridor crosses and parallels three creeks overlying a portion of the recharge zone of the Barton Springs segment of the Edwards Aquifer. The Edwards Aquifer Conservation District and other environmental organizations became concerned about the potential for contamination, as the thin soil cover and cavernous structure of the Edwards make it susceptible to degradation from nonpoint source pollution. Both the Environmental Protection Agency and National Pollution Discharge Elimination System (NPDES) regulate storm water runoff to protect the water quality of receiving streams. Since 1990, the Texas Department of Transportation has been required

to assess surface water quantity and quality impacts of highway construction in the Edwards aquifer recharge zone. Surface water quality has a direct impact on water quality in the aquifer, as 85% of recharge occurs through beds of major creeks.

Objectives: 1) To assess the impact of new highway construction on water quality and quantity in creeks flowing across the Edwards Aquifer recharge zone, and 2) to add to the general body of knowledge regarding storm water runoff.

Methodology: Danz Creek, an intermittent stream that flows in a natural channel beneath both lanes of State Highway 45 (the Austin Outer Loop) was selected as a representative receiving water body. A literature review on the effects of highway construction and highway operation revealed that sediment transport was the most significant cause of water quality degradation, although changes are usually temporary. A two-phase sampling program was undertaken at the highway crossing of Danz Creek. In the initial phase, paired grab samples were collected above and below the highway crossing. The second phase relied on a flow measuring station constructed for this project. Automatic water quality samplers were installed at two monitoring sites, instrumented to record and measure flow and rainfall. Since the creek is dry except during periods of runoff, the structure was capable of measuring very low flows. The automatic sampler allowed accurate measurement of flow and collection of flow-weighted composite samples. Parameters monitored were chosen to provide a general indication of water quality in creeks receiving highway runoff. Constituents measured included total coliform, total suspended solids (TSS), turbidity, biochemical oxygen demand (BOD), nutrients, and metals.

Results: A total of 14 samples from 10 storm events were analyzed during the initial phase of the study. The greatest differences between upstream and downstream concentrations are shown by suspended solids, turbidity, iron, and zinc. The turbidity of the creek

increased more than TSS, which is attributable to the relative ineffectiveness of silt fences for removing the smaller sediment particles in runoff. During the study period, the highway was opened to traffic, so the sampling program was able to establish hydrologic effects of a new operating highway. Characteristically, runoff from the paved portions of the highway resulted in higher flow rates and larger discharge volumes than in an undeveloped area of the same size. Collecting runoff in a storm water collection system reduced the time of concentration and increased the flow rate of Danz Creek. A comparison of water quality samples after the roadway was opened show only TSS, oil and grease, and zinc increased significantly due to highway runoff. Parameters showing marked reductions included bacteria, BOD, and nutrients.

References: Barrett, M., J. Malina, R. Charbeneau, and G. Ward, *Effects of Highway Construction and Operation on Water Quality and Quantity in an Ephemeral Stream in the Austin, Texas Area*, (Technical Report 262), CRWR, UT, September 1995.

A Decision Support System for the Edwards Aquifer

Researchers: Frank Masch, Richard Howe, and Weldon Hammond, Jr., Center for Water Research, University of Texas at San Antonio (UTSA), San Antonio, TX.

Problem: Water managers and policy makers in the Edwards Aquifer region need a user friendly method to make informed decisions about such issues as groundwater pumping, recharge, well levels and springflows. Although many computer simulation models for the Edwards Aquifer exist, most are technically and computationally complicated, and are meant to be used by scientists and engineers rather than planners and administrators. A need exists to develop a computer model that can be used as a management tool for water managers and decision makers in the region.

Objectives: To develop a user friendly computerized decision support system (DSS) containing a readily accessible database for the Edwards Aquifer that can assist water managers in evaluating various issues concerning the aquifer.

Methodology: The simulation model in the DSS is identical to the Texas Water Development Board (TWDB) GWSIM-IV model. GWSIM-IV is a finite difference numerical model that simulates flow and piezometric levels (heads) over a horizontal grid that represents the Edwards Aquifer. The database in the DSS contains monthly recharge data (computed by the U.S. Geological Survey) for eight river basins and covers the period of 1934-96. Monthly recharge values are allocated to each active recharge cell in the model through a recharge multiplier matrix developed from statistical characteristics of recharge data. Pumpage information by cell and by month was provided for 1947-59 by TWDB. Pumpage information by cell, month, and type of use was provided by TWDB for 1989. To solve the initial value problem, GWSIM-IV requires that piezometric levels be known in every cell at the beginning of a simulation period. To characterize recharge conditions in the region, "typical," "wet," and "dry" recharge levels were identified based on the period of record (1934-90). Typical recharge periods are defined as 600,000 acre-feet (AF) annually, wet periods as 1.153 million AF per year, and dry years as 197,000 AF annually. Monthly occurrences of typical, wet and dry conditions in the DSS are distributed in accordance with the recharge multiplier matrix. Pumpage from the aquifer is distributed according to the 1989 data on monthly pumpage by cell and by use. The finite difference GWSIM-IV model utilizes a rectangular grid consisting of 80 columns and 31 rows superimposed over the aquifer (2,480 cells). Approximately 33% of these are computational cells where flows and heads are computed subject to the aquifer characteristics specified for each cell and the assigned pumpage and recharge, as appropriate for each cell. GWSIM-IV was run from 1947-94 to provide initial conditions, and year-ending heads were created for each year through 1994. The DSS pre-processor enables users to select and edit information on recharge and pumping in the system's database. Estimates of monthly recharge can be edited as a percentage or amount. Monthly pumpage can be edited as a percentage or amount, according to changes in municipal, industrial, irrigation, or domestic use. Input files are created with the pre-processor and input directly to GWSIM-IV for processing with conditions specified by users over a planning horizon. Once processing is complete, the DSS provides users with flows or heads at selected sites. Users can specify any cell or

combination of cells to observe results. Cells and cell blocks are specified in the model by names for geographical features (counties, river basins, springs and wells). Outputs from the DSS include graphs and tables that can be exported to spreadsheets.

Results: A major advantage of the DSS is that it eliminates the need for users to develop an extensive database required to interface with a complex simulation model. GWSIM-IV has been converted to a PC environment and provides the same answers as using GWSIM in its original environment. Execution time has been significantly improved by using pre- and post-processors and the time required to generate input and output files has been minimized. A Pentium PC running at 166 mhz requires less than one minute to access the database, build input files, run the model, construct the output files, and develop output graphics for one year. Users are able to develop any pumping and/or recharge scenarios of their choice. Limitations of the DSS are those of the GWSIM-IV model and the availability of reliable pumping and recharge data. The DSS does not allow users to change the model or database from current configurations. This does not mean that enhancements to the model or database cannot be made a part of the DSS.

NOTE: The DSS is now being utilized by the San Antonio Water System and the Guadalupe-Blanco River Authority. The DSS requires a 386- or better model PC with 16 megabytes of RAM, a VGA graphics board and monitor, a math co-processor, and a hard disk with 50 megabytes of available memory. The model runs under Windows 3.1 and Windows 95. For information on how to use the model, contact Hammond at (210) 458-4455 or contact the Center at hydro@lonestar.utsa.edu.

Reference: Masch, F., A. Armstrong, and W. Hammond, Jr., *UTSA Decision Support System for the Edwards Aquifer*, UTSA Center for Water Research, 1995.

Economic Development Options for the Cooper Lake Region

Researchers: Steven Shwiff, Economics and Finance Department, and R.N. Singh, Sociology Department, Texas A&M University-Commerce (TAMU-C), Commerce, TX; Turgut Var and James Stribling, Recreation, Parks and Tourism Science Department, Texas A&M University, College Station, TX; Mary Cole, Hunt County Extension Agent, Texas Agricultural Extension Service, Greenville, TX; and Mark Small Kelly Barbour and Melanie Cobb, MJS Resources, Inc., Commerce, TX.

Problem: Cooper Lake was recently constructed by the U.S. Army Corps of Engineers (COE) for water supply and flood control purposes. It is a 34,000-acre reservoir with an open water surface area of more than 10,000 acres. In addition, 15,000 acres surrounding the lake are environmentally protected and designated for mitigation. These lands may attract bald eagles and other wildlife species. The designation of the lake as a water supply and flood control reservoir is somewhat problematic for tourism development, because it means that the lake level will vary with rainfall and water demands. COE studies suggest the lake level may range from 440' to 450' above sea level. Individuals may be unwilling to construct homes near the reservoir if they will see a view of mud (not a lake) at some times and be partially under water on other occasions. COE development of the lake restricts the amount of acres that can be developed for tourism,

since some of the lakefront will be controlled and managed by the COE. Cooper Lake stretches into Delta, Hopkins, and Hunt counties. Camping facilities been constructed at the lake site to attract tourists, but no other plans have been developed or implemented to utilize the lake to generate tourism. Improvements to the lake and the creation and use of a tourism plan could lead to significant economic impacts to the region.

Objectives: 1) To determine feasible, sustainable, and acceptable options to develop tourism for the Cooper Lake region, and 2) To identify and assess factors that may influence whether tourists will want to come to the lake and nearby facilities.

Methodology: Many types of tourism were considered for the lake, including those based on historical, environmental, recreational, entertainment, business and interpersonal themes. Tourism patterns affecting reservoirs in East Texas were analyzed, including the number of visits individuals and groups made to the region, the origin of tourists, income levels and spending habits of regional residents and tourists, the types of attractions they preferred, and population and demographic trends. The economic effect of recreation on Cooper Lake was estimated using anticipated direct and indirect spending by visitors and multiplier effects (the number of times money changes hands in a local economy). A reservoir developed by the COE (Russell Lake in Georgia) for flood control and water supply purposes was used as a surrogate to help compare the economic benefits that Cooper Lake may bring to the region. A COE study of water recreation in the Upper Mississippi River was utilized to suggest typical patterns of how tourists use lakes and rivers. More than 350 regional residents and leaders were surveyed about the types of development they would like to see surrounding the lake (hotels, restaurants, retail stores, and convention centers). Existing and potential tourism resources were identified, including the lake, recreation areas, existing hotels, restaurants, and development in nearby towns, opinions of community leaders, and tourism facilities. Some basic recreational facilities including parks, public boat ramps, and access to natural areas are now being developed by the Texas Parks and Wildlife Department.

Results: The study concluded that there are not currently sufficient opportunities for the lake (by itself) to generate tourism. As an alternative, they suggest that a tourism strategy be developed that focuses on multiple alternatives within the region impacted by the lake. Several types of development were identified that may be targeted for development near the lake. Results of surveys of area residents and leaders shows that some of the most favored options included extending marinas and parks, building a convention center, theme park and/or amphitheater at the lake, exploring possibilities for ecotourism, improving roads that provide access to the lake, and development of a coordinated marketing strategy. Casino gambling and the sale of alcohol were opposed by more than 67% of area residents. It was also recommended that resources be developed specifically to attract tourists. Potential entertainment tourism resources identified in the study include a working ranch showing life in the region in the early 1900s and a museum based on the Caddo Indian culture. The research suggests that tourists who come to the lake for contact recreation (fishing, boating, skiing) will not be adversely affected by the changing lake levels. The researchers suggest that a three phase strategy be implemented to develop the lake that consists of Phase I (improvements to nearby towns), Phase 2

(improvements to the lake, including development of a resort) and Phase 3 (improvements to the region, including a golf course). The projected economic impact of Phase 1 could range from $342,000 to $821,000, while Phase 2 could generate $740,000 to $1.8 million.

Reference: S. Shwiff, R.N. Singh, M. Small, T. Var, J. Stribling, M. Cole, K. Barbour and M. Cobb, *Economic Development Options for the Cooper Lake Region*, Center for Rural Water Studies, TAMU-C, 1994.

Ability of Texas K-12 Teachers to Use the WWW

Researcher: Ric Jensen, Texas Water Resources Institute, Texas A&M University (TAMU), College Station, TX.

Problem: The World Wide Web (WWW) is an exciting technology that may dramatically change the way water resources education is taught in public schools. The WWW has been in existence only a short time. It is important to measure if Texas teachers are interested in using the WWW for classroom instruction, and to assess the number of schools now using the WWW for classroom teaching. Creators of WWW sites intended for K-12 education need feedback on the perceived usefulness of their sites from classroom teachers. Exposing K-12 teachers to innovative WWW sites may hasten the use of the Internet because teachers will be more likely to "surf the web" after they have seen creative and useful home pages.

Objectives: 1) To assess the ability and willingness of Texas K-12 teachers to use water resources information from the WWW for classroom instruction, 2) to evaluate the usefulness of the TWRI WWW site (Texas WaterNet), and 3) to determine if use of Texas WaterNet has increased since TWRI visited schools and demonstrated use of the WWW to teachers.

Methodology: The TWRI WWW site, Texas WaterNet, contains a directory of water experts, on-line newsletters and technical reports, powerful search tools that allow Boolean conditions, updated postings of meetings, and links to other sites. TWRI also provides a list server, TWRI WaterTalk, that regularly sends e-mail messages on timely issues to subscribers. These messages are archived on the WWW site. In 1995, Jensen and Glenn Shinn of the TAMU Agricultural Education Department developed a survey to assess the capability and interest of Texas K-12 teachers to use the WWW for classroom instruction. The survey contained questions that dealt with the ability of Texas teachers to use the WWW and the Internet, modem speeds, type of connection, and software used for web browsing. The survey contained questions structured along a Likert scale, where teachers ranked how they felt about key statements on a scale ranging from 1 (negative or not likely) to 5 (positive or likely). Questions asked if respondents would use certain types of web sites, and opinions of the TWRI WWW site. Texas schools and districts with WWW sites were identified using Texas Education Agency data. Schools with WWW sites were contacted to schedule live demonstrations. Jensen visited 15 schools throughout Texas in the spring and summer of 1996. At each site, a 30-minute presentation was provided about the use of the WWW for classroom science teaching and

the TWRI WWW site. At the end of each demonstration, the survey was distributed, completed by teachers, and collected. Results were analyzed by TWRI at the end of the project. Later, a brief follow-up survey instrument was developed and sent out to determine if teachers were more likely to use the WWW site after viewing the demonstrations.

Results: Preliminary surveys were collected from 100 teachers. Results show that, as of the summer of 1996, only 45% of teachers surveyed used the Internet. The number of people using hard-wired connections was equal to those using modems and that more than 75% of teachers used modems with speeds of more than 14,400 bps. Only 45% of the schools provided a computer lab where students could use the Internet, while 40% of the schools did not provide any Internet access. Netscape was the most popular software used by 75% of teachers, while Lynx (a text-only Internet software) was used by 12%. Most teachers surveyed taught general sciences (47%), computing (26%), and mathematics. Most taught grades 6-8 (45%), 31% taught high school, and 31% were instructors in elementary schools. Teachers responded that they wanted WWW sites describing the work of Texas universities in water research, and other sites with information about Texas water resources. Participants said that they wanted to use the WWW to help students do research (average Likert score of 4.3 or "more likely") and to supplement existing lessons (4.2), but they were less enthusiastic about using the WWW for class presentations (3.8) and to develop new lessons (3.5). Teachers said they were likely to use sections of the TWRI WWW site containing newsletters (3.1), links to other sites (3.1), and search engines (3.5), but were less apt to use TWRI's technical reports (2.9) and a university water experts directory (2.6). Unfortunately, only a few post-survey results have been returned and the results are not statistically significant at this time. TWRI is still continuing to work with schools that were visited to gather more post-visit survey responses. The implication is that materials on the WWW meant for K-12 educators must be geared to student needs and cannot be too technical. They should be lively, entertaining, and written in such a way that students will understand and enjoy interacting with them.

NOTE: This project funded by the EPA Environmental Education Grant program. An interim progress report can be obtained by contacting TWRI at (409) 845-1851 or twri@tamu.edu.

USDA Develops Infrared Automated Irrigation System

When you drive past an irrigated field, you'll often see a farmer working to water his crop. Farmers often move sprinkler lines, set siphon tubes, and program center pivots. Now, an automatic irrigation system is being tested and developed by scientists at the U.S. Department of Agriculture's Agricultural Research Service (USDA/ ARS) in the Texas High Plains that may lessen the number of day to day decisions farmers would have to make. Ultimately, this system would sense how much water plants need and would apply the appropriate amount of irrigation.

The system is being developed by Steven Evett, Terry Howell and Arland Schneider of USDA/ ARS at Bushland in cooperation with Dan Upchurch and Don Wanjura of

USDA/ ARS at Lubbock. An infrared thermocoupled thermometer (IRT), which is mounted on an adjustable mast, is placed in each irrigated plot. The thermometer gathers data on the temperature within the plant canopy each second and transmits it to a computerized data logger. The data logger is connected to a solenoid valve and a drip irrigation system. When temperatures in the canopy rise above a pre-determined threshold temperature, the system records this and uses the information to decide when to irrigate. Typical values are 78deg. F for soybeans, 82deg. F for corn and 86deg. F for cotton. There is also a threshold time for each crop. This is the time that the crop can have canopy temperatures above the threshold without being stressed. If the threshold time is exceeded in any given day, the system applies sufficient water to replace that lost by evaporation and transpiration.

Evett says the system shows promise in knowing when and exactly how much irrigation water needs to be applied. That's because it relies more on precise scientific information and less on human judgment. The threshold time and temperature can be adjusted to obtain irrigation amounts that are equivalent to those provided manually, but with better timeliness and equal or better yields. Time and temperature yields can also be adjusted so they are more sensitive to plant stress, which may maximize yields but apply more water. For details, contact Evett at (806) 356-5775 or srevett@ag.gov.

UTSA Economist Advocates Use of Sensitivity Analyses in Considering Pros, Cons of Water Projects

An economist at the University of Texas at San Antonio (UTSA) is advocating the increased use of sensitivity analyses when conducting benefit cost analyses (BCA) for water resources and other public works projects. John Merrifield is a researcher in the Economics and Finance Division of UTSA and is a leader of these studies. He has written extensively about the economic pros and cons of constructing the ill-fated Applewhite Reservoir.

In general, a BCA is developed as part of a decision-making process. In broad terms, the analysis weighs the benefits of a project (increased water supply, new recreational opportunities, and possible economic development) against the costs (the price of

building dams and conveyance facilities, the loss of revenue in using the money for this project investing it elsewhere, the life of the project, and environmental losses).

A critical point, Merrifield says, is that traditional BCA methods often generate only one dollar amount. BCA analyses of Applewhite Reservoir performed by Merrifield suggest that the benefit-cost ratio would probably have been around 0.4, and the net present value (NPV) would probably have been around -$117 million (based on a discount rate of 6%, a project life of 40 years, demand growth of 1.1% per year, and non-production costs of $200 per acre-foot). It is important to demonstrate that it would take very large changes in those parameters to generate a positive NPV. Unless sensitivity analysis (SA) is extensive, and all the SA results are published, unprincipled project proponents could generate a positive NPV by cherry-picking parameter values. Such deliberate bias to further political ends is well-documented. It is one of the main reasons why environmental organizations have traditionally been strong opponents of BCA. Extensive, published SAs would do much to discourage such politically-motivated abuses.

Merrifield says the advantages of SA are significant. It will make a BCA much more informative, and make it much more difficult for decision-makers to ignore politically incorrect numbers. It will substantially reduce abuse, and make inadvertent bias more transparent. Controversy about appropriate parameter values, assumptions, and calculation procedures can be handled in a non-confrontational manner by carefully selecting the upper and lower bounds of the SA. The use of SA extends the time period in which a BCA can be used. Even if conditions change over time, it is likely that relevant information will have been incorporated into a SA scenario. Merrifield concludes that significant decisions should be subjected to a BCA that includes extensive, published SAs, and that a draft analysis should precede the final BCA.

A report on this subject, "Reinventing Benefit-Cost Analysis: A Quantitative Case Study Example of the Proposed Applewhite Reservoir," was published by the Austin Office of the Environmental Defense Fund (EDF) in 1996. For more details, contact Merrifield at (210) 458-5310 or jmerrifi@pclan.utsa.edu. EDF can be contacted at (512) 478-5161.

Corpus Christi Bay NEP Reports Describe Coastal Bend

Technical reports about the water and environment in the Coastal Bend have recently been published by the Corpus Christi Bay National Estuary Program (CCBNEP) at Texas A&M University-Corpus Christi (TAMUCC).

Four volumes have been printed under the overall title, *Current Status and Historical Trends of the Estuarine Living Resources within CCBNEP Study Area*. Volume 1 includes a comprehensive summary of issues facing the region and was written by Wes Tunnel, Quenton Dokken, Elizabeth Smith and Kim Withers of TAMUCC. Volume 2, *Current Status and Historical Trends of Avian Resources in the CCBNEP Study Area*, was written by Allen Chaney, Gene Blalock, and Sharon Bartels of Ecoservices, Inc., in Kingsville. Volume 3 is the *Project Summary*. Volume 4, *Checklist of Species within*

CCBNEP: References, Habitats, Distribution, and Abundance, was edited by Wes Tunnel and Sandra Alvarado of TAMUCC.

Volume 4 contains extensive information on such issues as the physical environment of the study area, such living resources as plants and animals, habitats including the open bay, hard substrate, oyster reefs, seagrass and coastal meadows, tidal flats, and the gulf beach, and such target organisms of concern as whooping cranes, sea turtles, fish, and marine mammals.

To obtain any of these reports or for more details, contact the CCBNEP at (512) 985-6767 or visit their World Wide Web site at http://www.sci.tamucc.edu/ccbnep/.

UNT Book Describes History, Preservation of Big Thicket

A new book about environmental resources in the Big Thicket region of Southeast Texas has been published by the University of North Texas (UNT) Press.

The book, *The Big Thicket: An Ecological Reevaluation*, was written by Pete Gunter of the UNT Philosophy Department. The book describes how the Big Thicket National Preserve was created and the environmental debates and planning that led to it. It also includes a history of the region as well as detailed descriptions of stream segments and their habitats as well as sites for canoeing and hiking.

The book can be ordered through the UNT Press at (800) 826-8911.

Texas A&M Engineer Writes Book on Reservoir Management

A new book describing modeling and analyses methods for reservoir operations has been written by a Texas A&M University (TAMU) researcher. *Modeling and Analysis of Reservoir System Operations* was written by Ralph Wurbs of the TAMU Civil Engineering Department. Sections of the book contain background information on reservoirs in the United States, reservoir systems operation, measures of system performance, hydrologic data, water accounting, routing and hydraulics, reliability and risk analyses, reservoir system simulation models, optimization techniques, reservoir system optimization models, and water quality models. The book was published by Prentice Hall PTR and can be ordered by contacting them at (800) 643-5506.

New Book on East Texas Climate Produced by SFASU

Stephen F. Austin State University (SFASU) has published a book titled, *Characteristics of a Humid Climate: Nacogdoches, Texas*. The book was written by Mingteh Chang, Larry Clendenen, and Hershel Reeves in the SFASU College of Forestry. The book describes the region's environment, and contains information on hydrology, precipitation, humidity, and streamflows. Case studies describe water use, urban runoff, and hay production. Data on solar climates, thermal climate, precipitation, and streamflows are provided. For details, contact the SFASU College of Forestry at (409) 468-3304.

HARC Report Describes Houston Environmental Issues

A new report that describes environmental issues and challenges in the Houston area has been published by the Houston Advanced Research Center (HARC). The report, *Houston Environment: 1995*, was edited by John Wilson, Sabrina Strawn, and David Hitchcock of HARC. A scientific advisory panel that guided production of the book included Neal Armstrong and Susan Hadden of the University of Texas at Austin; Jim Lester of the Environmental Institute of Houston at the University of Houston - Clear Lake; Paul Deisler, a retired vice president of Shell Oil Company; Janet Kohlhase of the University of Houston, and B.C. Robinson of ERM - Southwest. Major sections of the book describe risks to ecosystems, human health issues, and socioeconomics. Specific topics covered in the book include water pollution, water supplies, flooding, global climate change, drinking water quality, and landfills. For details, call HARC at (713) 363-7913 or visit their WWW site at http://www.harc.edu/.

Geology, Hydrology of Ogallala Aquifer is Focus of New Book

A new book has been published that describes the Ogallala Aquifer. The book was written by C.C. "Tex" Reeves, a professor emeritus of the Texas Tech University Geosciences Department, and Judy Reeves, a geologist and hydrogeologist with the Compliance Services Group of Lubbock. The book, *The Ogallala Aquifer of the Southern High Plains (Volume 1),* focuses on the origin, source and distribution of the formation, stratigraphy, structure, geomorphology, and paleoclimatology. Sample geophysical logs are included, and previous studies are reviewed. The book can be ordered from Estacado Books at (806) 799-1986 or estacado@aol.com.

Book on Rainwater Harvesting Available from TWDB

The Center for Maximum Potential Building Systems and the Texas Water Development Board (TWDB) have developed a new handbook that describes the basic concepts of rainwater harvesting. The project was funded by the Texas TWDB, which is publishing and distributing the book and an accompanying videotape.

Gail Vittori, who wrote the handbook, stands near some cisterns used as part of a prototype rainwater harvesting system at the Center's site east of Austin.

The book, *Texas Guide to Rainwater Harvesting*, was written by Gail Vittori of the Center with input from TWDB staff. It is a primer on how to design, construct and use cisterns to collect rainwater. The handbook emphasizes the use of cisterns for residential and small-scale commercial applications. Sections of the book describe such issues as the

water cycle, advantages of rainwater, water quality considerations, how rainwater harvesting systems work, cost considerations and code and safety issues. Case studies showing systems constructed of masonry and concrete, plastic, and metal are included. The book states that rainwater catchment systems often provide a source of soft, high quality, water, reduce reliance on wells and other conventional water sources, and are cost-effective in many cases.

Vittori also produced a video that can be used to promote the concepts of rainwater harvesting and to generate interest in cisterns.

Currently, TWDB is distributing limited numbers of free copies of the book and is selling the videotape. To order one free copy of the book or for information on how you can purchase the video, contact Patsy Waters at TWDB (512) 463-7955 or salinas@twdb.state.texas.us. For more information on the concepts presented in the book, contact Vittori at the Center at (512) 928-4786 or max_pot@txinfinet.com.

TWDB Study Assesses Possible Adverse Impacts of Edwards Aquifer Irrigation Transfers

How would the economy, population and lifestyle of the Edwards Aquifer be impacted if large amounts of groundwater were transferred from the region. That's the focus of a new report that was prepared for the Medina County Groundwater Conservation District (MCGCD). The study was funded by the Texas Water Development Board (TWDB) and MCGCD. The report, *Social and Economic Impacts of Water Transfers: A Case Study of the Edwards Aquifer*, was produced by BBC Research and Consulting, Inc., of Denver, CO; the G.E. Rothe Company of Hondo, TX; and R.L. Masters Environmental Consulting of San Antonio.

The report focuses on how a transfer of water supplies from the Edwards Aquifer may impact agricultural irrigators in Medina and Uvalde Counties. The analysis makes a number of assumptions, including the following: 1) as much as all the irrigation supplies in the region could be transferred; 2) irrigators might be compensated at a one-time price of $1,000 per acre to no longer pump from the Edwards for irrigation; 3) only water supplies (not land) will be transferred; 4) groundwater pumping for domestic use, landscaping, small gardens and livestock would be still be permitted; and 5) irrigation based on wells that tapped into aquifers other than the Edwards would be allowed. Scenarios that described the impact of lesser amounts of water transfers were also developed.

The analysis shows that transferring all the Edwards Aquifer's supplies used for irrigation to other uses would generate significant adverse effects in Medina and Uvalde Counties. For example, roughly 75,000 acres in the two counties would revert to dryland agriculture production in the region if all Edwards Aquifer groundwater were transferred to other uses. Throughout the region, that total could rise to more than 86,000 acres. Total crop values would decline from $52 million to $30 million. Net farm income would be cut nearly in half (from $15 million to $8 million). If no compensation were provided, farmers who owned 1,000 acres and irrigated with Edwards groundwater would stand to

lose as much as $500,000, although the adverse impacts would be much less severe if compensation were offered. Farmers who lease agricultural lands would also be adversely impacted. Roughly 25% of all harvested crop acres in Uvalde County and 13% of croplands in Medina County are now leased. Farmers who lease farmlands would face losses in crop yields and revenues because they would not be able to irrigate, but would not receive any compensation for the lost irrigation supplies.

The report also describes many third party impacts which are not related directly to irrigation. For example, it suggests that sales in the two counties would drop by $126 million annually, that value added revenues would fall by an additional $48 million each year, and that more than 1,500 jobs would be lost. Finally, it suggests that as many as 3,800 people would move out of the region if all the water were transferred. Many perspectives of the economic impacts are described.

The report suggests that the region may be wise to shift remaining water supplies to the production of vegetables and other high value crops, if as much as half of the water rights were transferred. Vegetable production with these limited water supplies would reduce job losses to only 300 and would mean that only 800 people would likely move out of the region.

The report was published by TWDB. The report is available upon request for the cost of photocopying. To order the report, call TWDB at (512) 463-3154. Luana Buckner of MCGCD can be contacted at (210) 741-3162.

WTAMU Researchers Investigate Use of Wind, Solar Power to Pump Irrigation, Drinking Water

Research technician David Davis of the WTAMU Dryland Agriculture Institute inspects the blade of this wind turbine.

Research projects at West Texas A&M University are exploring the potential of harnessing the wind to provide the power to pump water for irrigation and drinking water supplies.

The studies are coordinated by the WTAMU Alternative Energy Institute, which is led by Vaughn Nelson. Currently, five wind turbines are installed on the WTAMU campus. Some of the projects now underway at the Institute include research into which configurations of wind turbines are most cost-effective at capturing wind at different speeds and from different directions, and evaluations of various types of solar panels to generate electricity. For example, some of the wind turbines being evaluated include models with tapered fiberglass blades that lessen turbulence and increase efficiency.

"There's now more enthusiasm for producing solar power than wind power, in large part because wind

turbines often have to rely on a large number of moving parts that can be easily damaged and require maintenance," said research technician David Davis. "The use of photovoltaic panels is much simpler, and two small solar cells can still generate up to 24 volts of electricity during sunlit hours.

Two concurrent projects are being conducted at the United States Department of Agriculture's Agricultural Research Service (USDA/ ARS) Laboratory at Bushland, under the supervision of Nolan Clark. These studies use wind and solar energy to supply water from various pumping depths and prove their performance is comparable or even better than the typical farm windmill.

Davis says the benefits of alternative energy are numerous, regardless of whether wind or solar power is being harnessed. "The ultimate goal is to develop systems that rural homeowners can use to reduce the cost to pump groundwater. These methods are especially important for people in isolated areas who live too far away from an existing power grid to be easily and economically connected. As a result, we've seen some interest in this research from developing and sparsely populated countries." The Institute is also working with researchers at the U.S. Department of Agriculture's Research Service at Bushland to develop a system that combines solar, wind and diesel power to generate enough electricity for small towns, and to teach university classes and workshops about the use of these technologies.

For details, contact the Alternative Energy Institute at (806) 656-2295 or aei@wtamu.edu or visit their WWW site at http://www.wtamu.edu/academic/gradres/aei.

SFASU Researchers Map Caddo Lake Wetlands, Vegetation

Researchers at Stephen F. Austin State University (SFASU) are now working on a project to map, identify and analyze the wetlands vegetation of Caddo Lake. The study is led by James Van Kley and D. Hine of the SFASU Biology Department.

Caddo Lake is a unique ecosystem. The Caddo Lake State Park and Wildlife Management Area covers more than 7,500 acres and is one of the largest "natural" lakes in the South (most of Texas' lakes were created by damming rivers). It also contains extensive areas of relatively undisturbed cypress wetlands. Recently, it was designated as an international wetland of importance.

Until recently, relatively few scientific studies have been conducted to inventory the Caddo Lake ecosystem. In this project, Van Kley and Hine first identified distinct vegetation types on aerial photographs of the lake and created polygons to identify where these sites were located. Later, they visited 119 of these areas and identified the vegetation that was present including overstory trees, saplings, and ground flora. The vegetation was ranked on a five point scale based on the abundance of different tree and plant species. A database was compiled and subjected to TWINSPAN classification and DCA ordination. Finally, the polygons were classified into seven community types and the results were verified with an independent data set. As a result, a map and description

of the study area was developed that park managers and other resource specialists can use to make decisions about wetlands resources near the lake.

For details, contact Van Kley at (409) 468-2268 or jvankley@sfasu.edu.

UTEP, El Paso, Sign Agreement to Develop, Manage, Wetland

The University of Texas at El Paso (UTEP) and the City of El Paso will jointly develop and manage a public, wildlife refuge for waterfowl. The agreement, which was signed in November by UTEP President Diana Natalicio and El Paso Mayor Larry Francis, authorizes the UTEP Center for Environmental Resource Management (CERM) to develop and manage the Rio Bosque Wetland Park.

Construction of the 372-acre wetland is scheduled to begin in February. It is being funded by the U.S. International Boundary and Water Commission and Ducks Unlimited.

When completed, the park will be a natural laboratory for researchers of all ages to study waterfowl and other wildlife in a carefully preserved habitat. "The wetland is a unique, recreational resource for the area that will give El Pasoans a wonderful opportunity to see a facet of nature they would otherwise be unable to see," says Charles "Chip" Groat, the Director of CERM.

For details, contact Groat at (915) 747-5494 or cgroat@utep.edu.

TWRI Fellowship Helps Student Return for Ph.D.

Can the Texas Water Resources Institute's (TWRI) Ph.D. Fellowship Program make a difference for prospective graduate students and Texas A&M University (TAMU) faculty members? If you speak with researchers Marty Matlock and Clyde Munster of the Agricultural Engineering Department and Larry Demich, who recently was awarded a TWRI Fellowship, the answer is a resounding "Yes!"

Larry Demich (left) and Marty Matlock discuss plans to design and install constructed wetlands to treat wastewaters from a shrimp farm and a redfish aquaculture site along the Texas Coast.

TWRI began the Fellowship program three years ago. The program provides supplemental funding to help TAMU academic departments recruit outstanding graduate students. If a TAMU academic department offers a recruit an assistantship, and if the candidate meets the Fellowship criteria, the program can provide as much as $4,000 per year. To be eligible, a candidate must have an outstanding GRE score and grade point average and an interest to study a high priority Texas water problem. The

program is meant to recruit new students, not retain current ones, Therefore, students now attending TAMU are not eligible. Currently, five students are receiving the Fellowship.

"We want to focus the Fellowship on helping TAMU academic departments be nationally competitive in bringing the best Ph.D. candidates to Texas A&M," says TWRI Director Wayne Jordan. "This increases the amount of quality research that faculty members are able to perform and helps train outstanding future scientists."

Demich's case illustrates how the program works. Before coming to TAMU, he worked as an engineer in California and Washington state, worked extensively with computer-assisted design, and studied coastal engineering problems. He first heard about the program through an advertisement Munster placed in an engineering journal that offered students a chance to come to TAMU and receive a U.S. Department of Agriculture Fellowship. After Demich corresponded with Munster, he was encouraged to also apply for the TWRI Fellowship. "I had been wanting to go back to school and obtain a Ph.D. for many years, but I'm raising a family and without substantial support it didn't seem practical," Demich says. "The key reason I'm here is that the TWRI and USDA programs have given me the assistance I needed to make graduate school possible."

His professors also like the program. For example, Matlock and Bruce Lesikar have utilized Demich to help design constructed wetlands that will treat wastewater from a redfish aquaculture facility near Palacios and a shrimp mariculture plant in College Port. The sites will utilize wetlands cells planted with cordgrass to treat effluents from the sites. Cordgrass was chosen for use in the wetlands because it can tolerate a wide range of salinities and flows and it is readily available. "There is a lot of interest in improving wastewater treatment from aquaculture operations in Texas," Matlock says, "because there are concerns about the environmental consequences of discharging poor quality waters. If we can develop meaningful strategies to improve effluent quality, it could make aquaculture more viable over the long-term in Texas."

The research is challenging because of the short distance between sites where aquaculture facilities discharge effluents and the nearby coast. Adding to the difficulties, the shrimp farms often discharge large volumes of water at the end of the growing season when they drain their ponds to harvest the crop. The project is a joint effort between TAMU, Matagorda County Extension Agent Nancy Webb, and the Texas Natural Resource Conservation Commission. The team hopes to construct the wetlands in the next few months and have them ready to receive wastewater this Spring. Once in operation, the sites will be extensively monitored for water quality. A goal of the research is to develop quality data on how these systems improve water quality discharges from aquaculture facilities.

"It's been very valuable to have Larry work with me on this project," Matlock says, "because he already has significant experience in the real world. Larry provided some valuable insights into how these wetlands should be designed and generated design schematics of what the system should look like and how it will look when finished. The

TWRI Fellowship program is valuable because it encourages experienced professionals to return to TAMU to work on a Ph.D."

For details on how to apply for a TWRI Ph.D. Fellowship, contact TWRI at (409) 845-1851 or twri@tamu.edu. To learn more about this project, contact Matlock at (409) 862-7476 or mmatlock@agen.tamu.edu.

New Issue of "Water Science Reporter" Available from TWRI

Limited copies of a new issue of a newsletter, *Water Science*

Reporter, are available from TWRI.

The newsletter is printed by the National Institutes for Water Research (NIWR), which are funded by the U.S. Geological Survey. TWRI is a member of NIWR.

The theme of this issue is "Effluent Allowance Trading: A New

Approach to Watershed Management." Articles in the newsletter deal with such issues as what is effluent allowance trading, conditions needed to establish an effluent allowance trading system, creating a demand, developing a system to facilitate trades, the no-net loss wetland goal and wetland credit trading.

To receive a copy, contact TWRI at twri@tamu.edu">twri.tamu.edu or (409) 845-1851.

SWTSU WWW Site Describes Bad Water Line

Detailed information about water quality changes in the Edwards Aquifer is contained in a new WWW site developed by the Edwards Aquifer Research and Data Center at Southwest Texas State University (SWTSU). The site is titled "The Bad Water Line Monitoring Program." It was developed by graduate student Stephen Ansley and researchers Glenn Longley and Nisai Wanakule of SWTSU.

The site describes efforts by SWTSU and many agencies to monitor groundwater quality in selected wells and springs along a bad water line that stretches along much of the Edwards Aquifer. Generally, wells to the north of the bad water line contain fresh water while wells to the south of the line have saline levels of more than 1,000 milligrams per liter. There is concern that wells along the line, which now produce fresh water, could begin producing water with high levels of salts if excess pumping occurs.

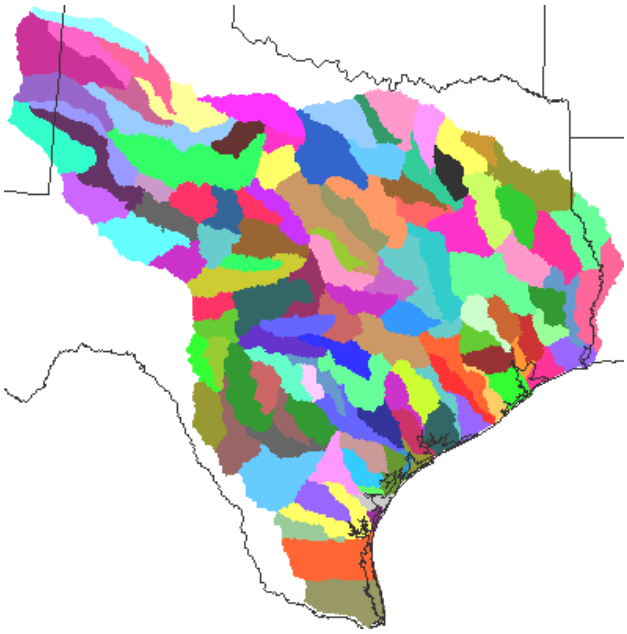
The site describes current issues, discusses research underway at SWTSU and cooperating agencies to gather groundwater quality data, provides water quality and groundwater level data, and depicts maps of sampling sites. Cooperators include the Texas Natural Resources Conservation Commission, the U.S. Geological Survey, the San Antonio Water System, and the Guadalupe Blanco River Authority. The monitoring network consists of seven wells in San Antonio, six wells in New Braunfels, and three wells in San Marcos. When springflows are low, water quality data is taken from wells sited along 13 aquifer transects in Medina and Hays Counties, including municipal and

domestic wells and spring discharge sites. A continuous monitoring database includes information on water temperature, pH, specific conductance, and dissolved oxygen from wells at SWTSU and San Marcos and Comal Springs. A database triggered by low springflows contains information on those values and well depths, flow rates, total dissolved solids, and chloride, sodium and potassium levels. The address of the site is http://www.eardc.swt.edu/~ansley. For details, contact Longley at GL01@swt.edu or Wanakule at nisai@eardc.swt.edu.

Blackland Research Center WWW Site Contains Hydrology Data

Researchers at the Blacklands Research Center (BRC) at Temple, TX have created a World Wide Web (WWW) site that allows users to search for data on river basins and watersheds from throughout the United States. Project leaders are Hailing Wang, Raghavan Srinivasan, Ranjan Muttiah and Paul Dyke of the Texas Agricultural Experiment Station, and Jeff Arnold of the U.S. Department of Agriculture/ Agricultural Research Service (USDA/ ARS).

The WWW site contains and displays information from BRC research projects to develop the "Hydrologic Unit Model for the United States" (HUMUS). It also includes interfaces between HUMUS databases and the Soil Water Assessment Tool (SWAT) water quality simulation model. The overall purpose of the project is to scientifically evaluate the impact of a wide range of agricultural activities on water quality in rivers and streams. HUMUS contains information on more than 350 watersheds located in 18 major river basins. Other HUMUS databases store information on historical and current weather conditions, soils, slopes, and natural vegetation. SWAT allows scientists to predict the impact of agricultural management decisions (for example, what crops to plant and whether to irrigate) on runoff, erosion, and non-point pollution.



The WWW site includes many innovative features that allows the public to dynamically interact with the HUMUS database. Users can generate maps for specific watersheds, subwatersheds, and hydrologic units showing data for such topics as runoff, sediments, nitrogen, and phosphorus. Users can also create watershed maps depicting such physical features as rivers, lakes, cropping patterns, slopes, and soil types. The site also contains many pre-formatted outputs of GIS work done at BRC showing erosion, and loadings of phosphorus, nitrogen, and suspended solids from watersheds throughout the U.S.

The web site is located at http://brcserv0.tamu.edu:8000/humus. For details, contact Wang at wang@brcsun0.tamu.edu or Muttiah at muttiah@brcsun0.tamu.edu.

TEC Develops Kiosk, CD-ROM, WWW Site About Barton Springs

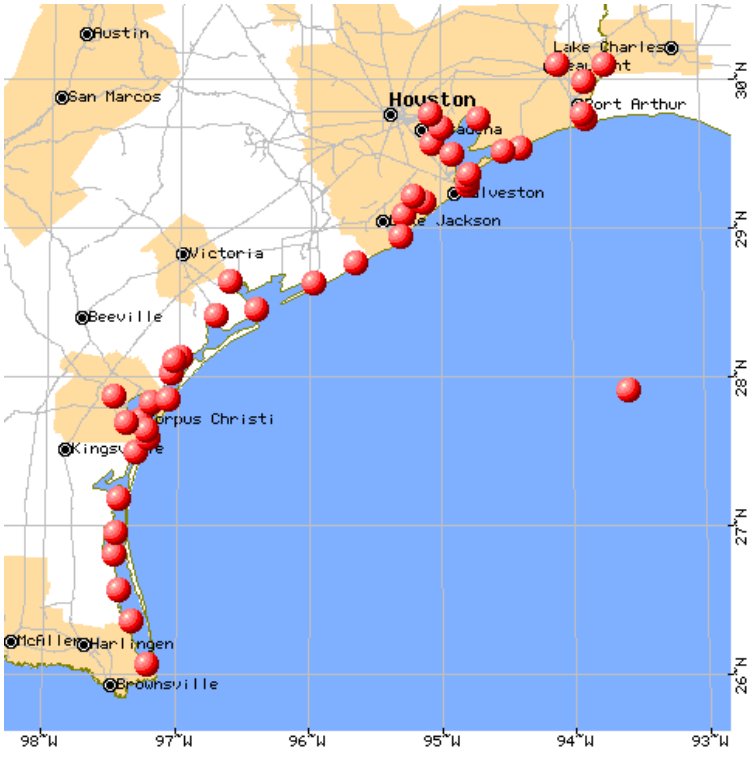
A multimedia kiosk, companion CD-ROM and World Wide Web (WWW) site are being developed to tell the story of Austin's Barton Springs and the Aquifer which gives life to this treasured swimming hole and community gathering spot. The project is led by Marshall Frech of the Texas Environmental Center in Austin.

The kiosk will be featured in the City of Austin's "Splash" exhibit, a museum and educational center currently being built in the bathhouse at the Springs. The CD-ROM will be available in the nearby gift shop. One of the more innovative plans for the kiosk is the ability of the user to launch from a topic on the kiosk to relevant information on the World Wide Web (WWW).

TEC is currently building a comprehensive project which features many aspects of the springs, including animals that live within that ecosystem, how man's activities impact the springs, and perspectives and individual experiences of how local residents have interacted with the springs throughout history. When finished in the spring of this year, the CD-ROM will include stereo sound, professional photographs, movies, and an interactive quiz.

For details, you can visit the WWW site at http://www.tec.org.

Data from Texas Coast Available from TAMUCC WWW Site



Real time data about water levels and water quality from many sites along the Texas coast are available from a new World Wide Web (WWW) site developed at Texas A&M University - Corpus Christi (TAMUCC).

The site was developed by the Coastal Observation Division of the Conrad Blucher Institute for Surveying and Science (CBI) and the Computer Sciences Department at TAMUCC. Project leaders include Patrick Michaud of the Computer Sciences Department and Michael

Speed of CBI.

Data on the site includes continuously updated information from 22 sites maintained by TAMUCC, 20 locations operated by Lamar University, and eight sites supported by the National Oceanic and Atmospheric Administration and the National Ocean Service. The data are gathered as part of the Texas Coastal Offshore Observation Network. Data can also be accessed from nine sites instrumented to gather information on salinity and dissolved oxygen. Archived information is available from 25 discontinued sites.

Users are first shown a clickable map with all the monitoring sites along the coast. Users can select a station and access and download information on water levels, wind speed and direction, barometric pressure, and air and water temperatures and can create tables or graphs. Michaud is now working on a project to gather data on salinities at sites in Nueces and Corpus Christi Bays. The goal of this study is to provide data to help determine freshwater inflow requirements for the Corpus Christi region.

The WWW site address is http://dco.cbi.tamucc.edu/. For details, contact Michaud at TAMUCC at (512) 994-2751 or pmichaud@tamucc.edu.