Texas On-Site Insights
Information about On-Site Wastewater Treatment Systems in Texas
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Roughly 1,000 Participants, 70 Exhibitors, Take Part in 2000 TOWTRC Conference in Waco

Roughly 1,000 people gathered in Waco February 29-March 1 for the 8th Annual Conference of the Texas On-Site Wastewater Treatment Research Council (TOWTRC). This year's Conference discussed a variety of issues, including such topics as enforcement, soil properties, drip irrigation, long-term infiltration rates, microbial pathogens, and shallow groundwater tables. Other presentations centered on the performance of chlorinators used in aerobic systems near Lake Livingston, evaluation of systems which incorporate evapotranspiration and soil absorption, and Council outreach and public information efforts.

"We feel that this Conference is one of the most valuable services we can provide," says Warren Samuelson, Executive Secretary of the TOWTRC. "It provides an opportunity for people involved in this industry to learn about current issues, trends, and technologies they need to know about. Even better, it gives them a chance to ask questions to agency staff and Council members and to meet with colleagues and co-workers from across Texas."

For many participants, the most valuable part of the Conference was gaining insights into the rules revision process now underway by the Texas Natural Resource Conservation Commission (TNRCC). Another important feature of the Conference is that it provides eight certified hours of continuing education (CE) credits, which fulfill annual requirements set by the TNRCC. More than 70 exhibitors displayed information about new technologies and management systems.

For more details about this Conference, contact Warren Samuelson of the TNRCC at (512) 239-4799 or wsamuels@tnrcc.state.tx.us. A copy of the Conference program can be downloaded from the Council's World Wide Web site, http://towtrc.tamu.edu.

TAEX Provides Tips on How to Design, Operate, Drip Systems

Russell Persyn of TAEX checks the performance of this drip irrigation system used to apply wastewater on-site in College Station.

Drip irrigation has become a very popular method to dispose of effluents from on-site wastewater systems for many reasons. They can be efficient and cost-effective, can work in problem soils or on small lots, and are an alternative to spray irrigation. Drip irrigation requires maintenance and attention to detail if the systems are to function properly.
At the 2000 Conference of the Texas On-Site Wastewater Treatment Research Council, Bruce Lesikar and Russell Persyn of the Texas Agricultural Extension Service provided practical advice about the proper design, operation and maintenance of these systems. Their information suggests that drip irrigation can provide a useful, reliable, disposal option, if systems are carefully designed and operated.

Background Information

Since 1994, TAEX has field tested the performance of drip irrigation used in conjunction with on-site wastewater systems at several sites throughout Texas, including Bryan, College Station, Houston, Stephenville, Bandera, Weslaco, and D'Hanis.

Interest in drip irrigation systems in Texas has increased recently, Persyn says, for many reasons. First, this technology can be used in heavy clay (Class IV) soils, where other methods will likely not work. Second, Texas regulations reduce the distance to restrictive horizons (like karst rock) when drip irrigation or low-pressure dosing are used. Third, because drip systems can provide flexible designs, this technology may work well on small or irregularly shaped lots.

A major problem facing the successful use of drip systems is the clogging of emitters. For example, if drip emitters clog, the system cannot uniformly apply wastewater throughout the site. Some of the ways that researchers and manufacturers have attempted to prevent clogging involve the design of emitters that use labyrinth patterns and are self-cleaning, as well as pretreatment methods to lessen the amount of solids in effluents before they enter the drip system.

Drip distribution is typically used as an alternative application method following aerobic treatment, sand filters, or constructed wetlands. Some of the important components of these systems include filtration, supply and return flush lines, and air relief valves. The intent of filters is to remove all particles larger than 100 microns. Commonly used filters include screens, disks, and sand filters. Supply lines provide water to the disposal area

and ensure that excessive pressure losses do not occur. Return flush lines pick up effluents at the end of each drip section and return the wastewater back to the treatment device. The relief valve allows air to enter back into the drip lines after the pumps shut off, preventing the emitters from sucking back muddy soils and perhaps clogging the system.

System Design and Layout

When designing a drip system, Persyn says, it is important to place drip lines along contours of equal elevation to help assure that effluents will be applied uniformly. This will also help avoid the possibility that all the lines will drain to one part of the field.

In the presentation, Persyn and Lesikar discussed a number of calculations that should be performed when systems are designed. The equations are included in the Conference paper, but only the broad concepts will be described in this article.

First, the required surface area should be determined by dividing the water use by the long-term application rate. Second, the minimum number of emitters needs to be calculated by dividing the surface area by the application area available to each emitter. Third, the minimum length of tubing can be calculated by multiplying the minimum number of emitters by the spacing between emitters. Fourth, the maximum length of run of the drip lines needs to be identified to maintain equal distribution of effluents, based on data provided by manufacturers. The length of run will vary depending on whether the system will rely on pressure-compensating or pressure-dependent emitters. Fifth, the number of runs can be determined by dividing the minimum length of tubing by the maximum length of runs. Finally, the length of tubing for a specific design can be calculated by dividing the maximum length of tubing by the number of runs.

Operations and Maintenance Issues

Potential users of drip systems need to realize up front that these systems require ongoing maintenance contracts, and that the performance of these units should be monitored at least three times a year.

When maintenance is performed, Persyn says it is critical to examine the entire system. First, pressure gauges should be checked to learn if there are changes in pressure, which could signal that clogging or leaks exist. Second, simply walking around the application area while the system is applying effluents can help discover obvious leaks. Third, it is crucial to check the air relief valve to make sure that this unit is not wearing down or operating improperly. If the air relief valve malfunctions, it is possible that mud can be sucked into the emitters resulting in a problem that is very difficult, if not impossible, to fix. Persyn also recommends that users of drip systems may want to consider installing a flow meter to measure how much wastewater is actually being applied. This can give homeowners a reality check they can use to ascertain if the amount of effluent being generated and applied is exceeding design criteria, thus creating a potential problem.

Finally, field flushing may have to be performed as needed, based on criteria provided by the manufacturer or system designer.

NOTE: Persyn recently completed his Master's degree in Agricultural Engineering at Texas A&M University, where he focused on on-site wastewater issues. He is now pursuing a Ph.D. at Iowa State University. Lesikar can be contacted at b-lesikar@tamu.edu or (409) 845-7453.

Meetings & Conferences

The Texas Engineering Extension Service (TEEX) is offering many on-site wastewater classes. The Installer I class will be given June 27-28 in Houston and July 25-26 in Mesquite, and the Installer II class will be taught July 11-13 in Austin and August 15-17 in Houston. The site evaluator course will meet July 11-13 in Mesquite, and the designated representative class will be given July 18-21 in Bryan. Aerobic irrigation systems: operations and maintenance, will meet June 6 in Corpus Christi, June 8 in Houston, June 21 in Tyler, June 29 in Houston, July 27 in Mesquite, August 3 in Bryan, August 8 in Abilene, and August 10 in Austin. For details, call TEEX at (800) 252-2420.

Soil and site evaluation short courses are being offered by the Texas Agricultural Extension Service (TAEX). They are taught by John Jacob. Soil and Site Evaluation will be offered May 30 in Weslaco, June 20 in Corpus Christi, July 11 in Houston, July 18 in Corpus Christi, Aug. 22 in Weslaco, and Aug. 29 in Corpus Christi. Evaluation of Shallow Groundwater will be offered June 13 in Houston and July 25 in Houston. To register, contact Jacque Hand at (979) 845-8904.

The Texas Agricultural Extension Service (TAEX) will be teaching "Overview of On-Site Wastewater Treatment Systems." The class will provide 8 hours of continuing education credits. It will be taught June 7 in El Paso; June 8 in Fort Stockton; June 22 in Temple; June 27 in Vernon; June 28 in Amarillo; June 29 in Lubbock; July 17 in College Station; July 20 in Beaumont; July 26 in Overton; July 28 in San Marcos; August 1 in Weslaco; August 2 in Corpus Christi; and August 21 in College Station. A class on constructed wetlands will be given July 24 in College Station. To register, contact Jacque Hand at (409) 845-8904.

The Texas Onsite Wastewater Association (TOWA) is offering a Summer School program, which provides 8 hours of continuing education credits. Classes will be offered July 15 in Houston, August 5 in San Antonio, and August 19 in Arlington. For details, fax TOWA at (512) 494-1129.

New Texas Bill Tightens Requirements for Registered Sanitarians; Includes Continuing Education Credits

House Bill 1838, which was passed by the 76th Texas Legislature in 1999, amended the Sanitarian Registration Act by increasing the credibility and professionalism associated with being a registered professional sanitarian (RS). At the same time, the legislation makes it more difficult, and expensive, to become an RS. Now, there are more than 1,900 individuals in Texas who are certified as registered professional sanitarians. For the on-site wastewater industry, an RS designation allows an individual to design treatment and distribution systems. Many individuals who regulate on-site systems also have earned the RS certification. Others who have the RS certification work in environmental health, food safety, and pest control.

House Bill 1838 became effective on September 1, 1999. Some provisions of the bill, which increase educational requirements, will take effect on September 1, 2001. In basic terms, the bill does a number of things. First, it increases fees for individuals making application for and taking the written examination, upgrading from sanitarian-in-training to professional sanitarian, or renewing licenses. Second, effective September 1, 2001, it requires new professional sanitarians to have completed 30 hours of semester credits in basic and natural sciences and to have earned a B.A. or B.S. degree from a college or university. Under the old rules, sanitarians were required to have a B.A. or B.S. and to have completed 15 hours of basic and natural science classes. Third, effective September 1, 1999, it requires new registered professional sanitarians to have two years of experience in the field. Fourth, effective September 1, 1999, it requires that registered professional sanitarians complete at least 12 continuing education (CE) hours related to sanitation, environmental health, or consumer health within the year they renew their RS certification. The CE requirement does not apply to sanitarians-in-training.

The bill also sets forth penalty requirements for persons who violate the amended Act or rules implementing the Act. Penalties may be as severe as a Class C misdemeanor. Individuals who are now registered as professional sanitarians still have to comply with the CE requirement. The amended Act continues to prohibit individuals from using the word "sanitarian" in their title, unless they are in good standing with the Texas Board of Health.

Among the many organizations which pressed to have this bill passed was the Texas On-Site Wastewater Association (TOWA). Charlie Digges, who was TOWA President at the time, said the bill should have a favorable impact. "The result of this bill is going to be increased professionalism and credibility for people with the RS designation throughout Texas," he said. "This will be an additional proof that registered sanitarians are very knowledgeable in the field. It will also help safeguard against individuals who are acting as an RS who are not fulfilling their responsibilities."

NOTE: The Texas Department of Health world wide web site contains extensive information about these new regulations. It can be found at http://www.tdh.state.tx.us/beh/rsguide.htm. Elias Briseno administers the TDH registered

sanitarian program and can be contacted at (512) 834-6635 or Elias.Briseno@tdh.state.tx.us. Digges can be contacted at (830) 895-1809.

Texas AG's Opinion Clarifies Power of River Authorities to Force Users of On-Site Systems to Connect to Sewers

A recent opinion by Texas Attorney General (AG) John Cornyn reaffirms limits on the specific powers of river authorities, counties, utility districts, water districts, and other governmental entities to require people who use on-site wastewater treatment and disposal systems to be connected to a centralized sewer.

In December 1999, the AG's Office published opinion JC-0162 which focused on whether the Upper Guadalupe River Authority (UGRA) has the authority to force users of septic tanks and drainfields within its jurisdiction to be connected to central sewers. Another issue was whether UGRA could enter into agreements with local governments to force people off private systems.

The opinion reexamines an AG ruling written in 1988 when UGRA first asked the AG's Office if it was authorized to compel users of on-site systems within its boundaries to connect to a central sewer system. At that time, UGRA asked if it could enter into an agreement with another government entity to operate such a system. In opinion JM-961, the AG's Office ruled that UGRA did not have the power to compel users of on-site systems to be connected to a sewer system operated by the Authority, or to any system UGRA may have contracted with.
In 1999, UGRA asked the AG's Office to reconsider the 1988 ruling. In the 1999 opinion, the AG's Office states they reexamined the opinion and determined it correctly states the law. The 1999 opinion declares that state statutes show that when the Texas Legislature intends to authorize a political subdivision to compel property owners within its jurisdiction to connect to a sewage disposal system, the Legislature provides this authority expressly.

The ruling clarifies important issues that may affect Texas river authorities and other entities (including counties, municipal utility districts, water control and improvement districts, water supply districts, and others) regulating on-site systems. The AG Office's ruling confirms that municipalities are expressly authorized to require property owners to connect to a city sewer system (Section 214.013 of the Local Government Code). The ruling also states that a city may not surrender its power to compel connections to sewers to a river authority as a condition of a contract to operate a sewer disposal system. The opinion further notes that a provision in the Texas Water Code expressly allows a political subdivision (including a river authority) located in an economically distressed county and receiving State EDAP assistance to operate a sewer system and require property owners to be connected to it. Finally, the AG's opinion states that Senate Bill 821, which was passed in 1999, does not authorize counties to compel on-site wastewater system users to connect to a central sewer system. This opinion can be viewed on the WWW at http://intranet1.oag.state.tx.us/opinions/jc/JC0162.pdf.

Harris County Engineer's Office Evaluates Field Performance of Low-Pressure Dosing Systems

How well are hundreds of low-pressure dosing (LPD) systems actually functioning throughout the Houston area? Finding the answer to this question was the goal of a field survey recently carried out by the staff of the Harris County Engineer's Office. Key participants were Jacob Berry, Don Bennett, Jorge Cedillo, Nelson Durant, Dan McNeil, Dennis Pumilia and Roy Varnon of the Engineer's Office.

Jacob Berry of the Harris County Engineers Office examines a soil sample from an LPD disposal area.

For years, many LPD systems have been installed throughout Harris County. Recently, the staff of the Engineer's Office has been concerned that these systems may not be properly treating wastewater, especially in areas with problem soils and shallow groundwater tables.

Almost all of Harris County (with the exception of the extreme north and east portions) contains seasonal water tables which are less than 2.5 feet deep during the winter months. Most of the County is flat, so providing proper drainage is difficult. Perhaps the most serious problem is the widespread occurrence of restrictive clay horizons which lie under most of the soils in the region. Claypans restrict the subsurface movement of effluents, thus making disposal and treatment very challenging.

How the Study Was Conducted

In November 1998, Berry began this study to evaluate the field performance of LPD technologies in use in the County. First, only systems installed after 1996 were considered, since they had been designed and installed according to current criteria used by the Engineer's Office. Second, systems used for commercial purposes and those which utilized secondary treatment (aerobic units, for example) were excluded. Third, only systems treating wastes from single-family homes were eligible.

Staff members contacted owners and users of LPD systems by telephone to determine if they would take part in this study. Ultimately, 16 representative systems were selected. Telephone interviews were conducted in which system owners or users were asked about daily water use, system maintenance, and problems associated with the operations and maintenance of these facilities.

In the winter of 1998-99, each of the 16 systems was evaluated in the field. Specific features staff members noted were whether a crown or a mound had been built to facilitate drainage, if groundwater was infiltrating back into the septic tanks, and the color and condition of turfgrass growing above LPD disposal areas. Engineer's Office staff looked for signs of surfacing effluent, such as foul odors, algal blooms, as well as

whether the ground had become spongy or mushy. At each site, the team took two core samples at sites relatively close to the disposal area (within 5 feet) and further away from it (20 feet). These samples were analyzed for the presence and indicators of shallow groundwater tables.

Results and Discussion

Of the 16 systems that were studied, six were found to be failing. Each of the failing systems lacked at least one of the following components -- proper drainage (associated with the absence of a mound or a crown), a high water-use turf, and sufficient size, based on current state and county criteria. At many sites, it was obvious that users were not properly operating and maintaining LPD systems. Half of the failing systems were undersized. At each of the failing sites, a shallow groundwater table (sited less than 2 feet below the depth of the trench) was observed.

Berry noted that many common features were associated with systems which were working properly. This includes mounding or crowning of the drainfield to direct flows away from the disposal area, employing St. Augustine or Winter Rye turfgrasses (which both consume a lot of water), and constructing the trenches even with or well above the depth of seasonal water tables. It was helpful if water use rates were estimated conservatively to provide a safety net that could allow some leeway to prevent failures.

Based on this study, the team developed a set of recommendations that should be followed to help LPD systems succeed on marginal and unsuitable soils. First, make sure the site is large enough. Second, install swales, mounds, or crowns to help drainage. Third, sod the field with St. Augustine or another high water-use grass and then overseed it with Winter Rye. Fourth, lower the rate at which effluents will be applied to 0.05 to 0.07 gallons per square foot per day, and practice water conservation to reduce the volume of effluent that needs to be applied. Using a smaller diameter pipe and orifice size will allow dosing to be controlled by a timer, making it less likely that hydraulic failure will occur. Finally, make sure the system is designed and installed so that there is separation between the bottom of the trench and the seasonal groundwater table to enhance drainage.

NOTE: Berry presented a paper on this topic at the 1999 Conference of the TOWTRCl, titled "Field Evaluation of Low Pressure Dosage Systems in Harris County." He can be contacted at jacobberry@hotmail.com or (713) 956-3015.

New Member Appointed to Research Council

Recently, the Texas On-Site Wastewater Treatment Research Council (TOWTRC) gained a new member.

Arthur G. Carpenter, a vice-president for Maritz, Wolff & Co. of Austin, has been appointed by Governor George W. Bush to represent land developer interests. Carpenter's

term expires September 1, 2001. He replaces Tom Dreiss of San Antonio, whose term expired.

A list of all Council members and their addresses and phone numbers is shown on page 2 of this newsletter.

Council Funds Projects to Develop User-Friendly Maps, Enhance WWW Site and Publications

In May 2000, the Texas On-Site Wastewater Treatment Research Council (TOWTRC) approved three projects. The Council approved a contract with John Jacob of the Texas Sea Grant Program and the Texas Agricultural Extension Service to develop a computerized map for several counties to help identify shallow groundwaters. A project extension was approved to work with Ric Jensen of the Texas Water Resources Institute to enhance the TOWTRC world wide web site and the *Texas On-Site Insights* newsletter. The Council approved hiring a contractor to facilitate a meeting between staff of the Texas Natural Resource Conservation Commission and the Texas State Board of Plumbing Examiners to begin the process of developing graywater rules for on-site wastewater treatment and disposal systems. For details, contact TOWTRC Executive Secretary Warren Samuelson at (512) 239-4799 or wsamuels@tnrcc.state.tx.us.

New Manual Discusses Evaluating Soils for On-Site Systems

A new manual which explains how to evaluate Texas soils for on-site wastewater systems has been published by Clark Benson. Benson formerly headed the Texas Engineering Extension's Service on-site wastewater training program and now manages a company which teaches classes about these issues. The handbook is titled "Evaluating Soils for On-Site Sewerage Facilities." Chapters cover such issues as basic concepts of standard and alternative systems, soils, soil texture and structure, soil profiles, and problem soils. The book can be purchased by contacting Benson at (409) 822-6711, or cbenson@engitech.com.

Texas Tech Investigates Whether Use of ETA Systems Can Justify Smaller Areas for Wastewater Disposal

A multi-disciplinary team of researchers and students at Texas Tech University (TTU) is now carrying out a comprehensive study of the performance of systems which combine evapotranspiration (ET) and soil absorption to dispose of effluents from on-site wastewater systems. The project, which is funded through the Texas On-Site Wastewater Treatment Research Council (TOWTRC), could ultimately help determine if it is scientifically justifiable to reduce the size of drainfields used for on-site wastewater treatment systems in arid regions of Texas.

The project began in early 1999 and will run through 2001. The team leaders are Lloyd Urban, a civil engineering researcher and Director of the TTU Water Resources Center and Heyward Ramsey of the Civil Engineering Department. Other researchers taking part

in the study include Richard Zartman of the Soil and Plant Sciences Department, and Tony Mollhagen, Ken Rainwater, Andrew Jackson, and David Thompson of the Civil Engineering Department. Civil engineering graduate student Wesley Ingram recently completed his Master's thesis based on this project, while at least 10 other students are participating. In addition, local regulators such as Mark Rich of the Lubbock City-County Health Department and professionals in the region are working with the Texas Tech team.

"I like the idea that we're doing research that may have practical applications," Urban says. "This is a hands-on study which involves both theoretical and practical work. Everyone in this effort has learned a great deal about how to set up, operate, and evaluate a complicated research site. After we're done, we hope to publish information that may be useful for people in the region."

Background Information

The idea for this study originated in the mid 1990s, when installers and regulators suggested that Texas' standards now used for evapotranspiration absorption systems (ETA) may result in the design of oversized systems, especially in semi-arid and arid portions of West Texas.

In basic terms, evapotranspiration is the process through which water is lost due to evaporation from the soil surface into the atmosphere, and transpiration, which is plant growth. Absorption is the process through which water flows from the distribution network into soils. An absorptive system uses a trench covered with an impervious liner to prevent ET, while an ET system utilizes a trench with an impervious liner to prevent water from infiltrating into underlying soils.

If the area requirements for disposal systems could be reduced, it is likely that the cost of these systems would be lessened, since less land would be required.

As a result, the Council proposed that it would be useful to evaluate if the combined effect of an absorptive system and an ET system could result in reduced system sizes in some regions of Texas. It has been hypothesized that the combined effect of using evapotranspiration and absorption may be greater than using either of these two methods alone. After issuing a call for research proposals, the Council awarded this project to TTU in April 1999.

Designing and Installing the System

Installation of this project began in June 1999 and sampling commenced in September 1999. Testing will continue until the project expires in the Summer of 2001. Fields will be maintained and continue to receive the maximum amount of water they will accept until they show hydraulic failure.

The system is located on a 2-acre site at the Reese Center northwest of Lubbock, which formerly housed Reese Air Force Base. TTU has leased the site for two years, which is the duration of the project. Most of the study is located over Type II soils, which were evaluated for infiltration characteristics by Zartman before the systems were installed.

The systems were installed by Tom Woodruff of Adobe Septic Systems of Lubbock. Nine pairs of trenches were dug perpendicular to the slope of the site and were divided by a water supply line. Once trenches were dug, they were filled with medium- to large-sized gravel, which was spread over a device called a "fill form" which ensures that the gravel forms in a semi-circular shape in each trench. Trenches for the ET units were lined with a 60-mil geotextile fabric. The soil surface over each of the absorption units is covered with a plastic liner which extends out from each side of the trench and is covered with soil. Each trench is 2.5 feet deep, 2.5 feet wide, and 20 feet long. Trenches were covered with Bermudagrass to help transpiration occur. French drains were installed to aid subsurface drainage.

The design of this system consists of installing three replicates of three system types (ET, absorption, and ETA) which receive a mix of "simulated wastewater." The artificial wastewater consists of a blend of 2,000 milligrams per liter (mg/L) of beer (which increases the biochemical oxygen demand or BOD), 42 mg/L of flour (which boosts BOD and suspended solids), 32 mg/L of kaolin (which adds suspended solids), 42 mg/L of urea (which is a form of nitrogen), and 24 mg/L of surfactants. The raw wastewater is blended in a small building built specifically for this project which contains a computer to store information on flows as well as weather data which is gathered on-site. Three units of each of these systems, which serve as controls, are being tested with "clean" groundwater which is pumped from a well on the site. The site is equipped with three 1,500-gallon septic tanks which store the wastewater, while a 750-gallon septic tank houses the groundwater.

Water and wastewater are automatically pumped via solenoid valves to these individual sites on demand, based on readings from soil sensors. The goal is to maintain a constant level of effluents in the top layer of the gravel beds.

The concept was to determine the amount of water and wastewater each of the system types being tested can accept over the long-term, before they show signs of hydraulic failure. That information can then be used to ascertain how well these systems may perform in the real world.

Operation and Testing

Individual water and wastewater fields were originally brought on-line in pairs. Units were continually brought on-line until all the fields receiving clean water and all but two sites that were fed by wastewater were operating.

However, early in the project it became apparent that the seven wastewater fields were accepting roughly 1,000 gallons per day (gpd), which was the maximum capacity of the two septic tanks originally installed at the beginning of this study. Consequently, another septic tank was added so the remaining two wastewater application systems could be brought on-line.

Another complication was that the fields where clean groundwater was applied were demanding more than 6,000 gpd. Soil moisture readings indicated that there was consistently a high moisture content between nearby fields. At this point, the fields which received water were discontinued. This was done to insure they did not influence hydraulic loadings to the areas receiving wastewater.

Currently, wastewater application sites are demanding about 1,200 gpd. Most of the units are operating at close to "steady-state" conditions, with little variation in daily loading rates, although ET units are showing a strong response to climate changes.

Summary and Conclusion

According to Urban, this project has been rewarding at many levels. For example, preliminary work to design the research site has resulted in the development of a planning model others may want to use in similar projects.

NOTE: Urban can be contacted at (806) 742-3597 or lloyd.urban@coe.ttu.edu. A paper about this project was presented at the 2000 Annual Conference of the TOWTRC.