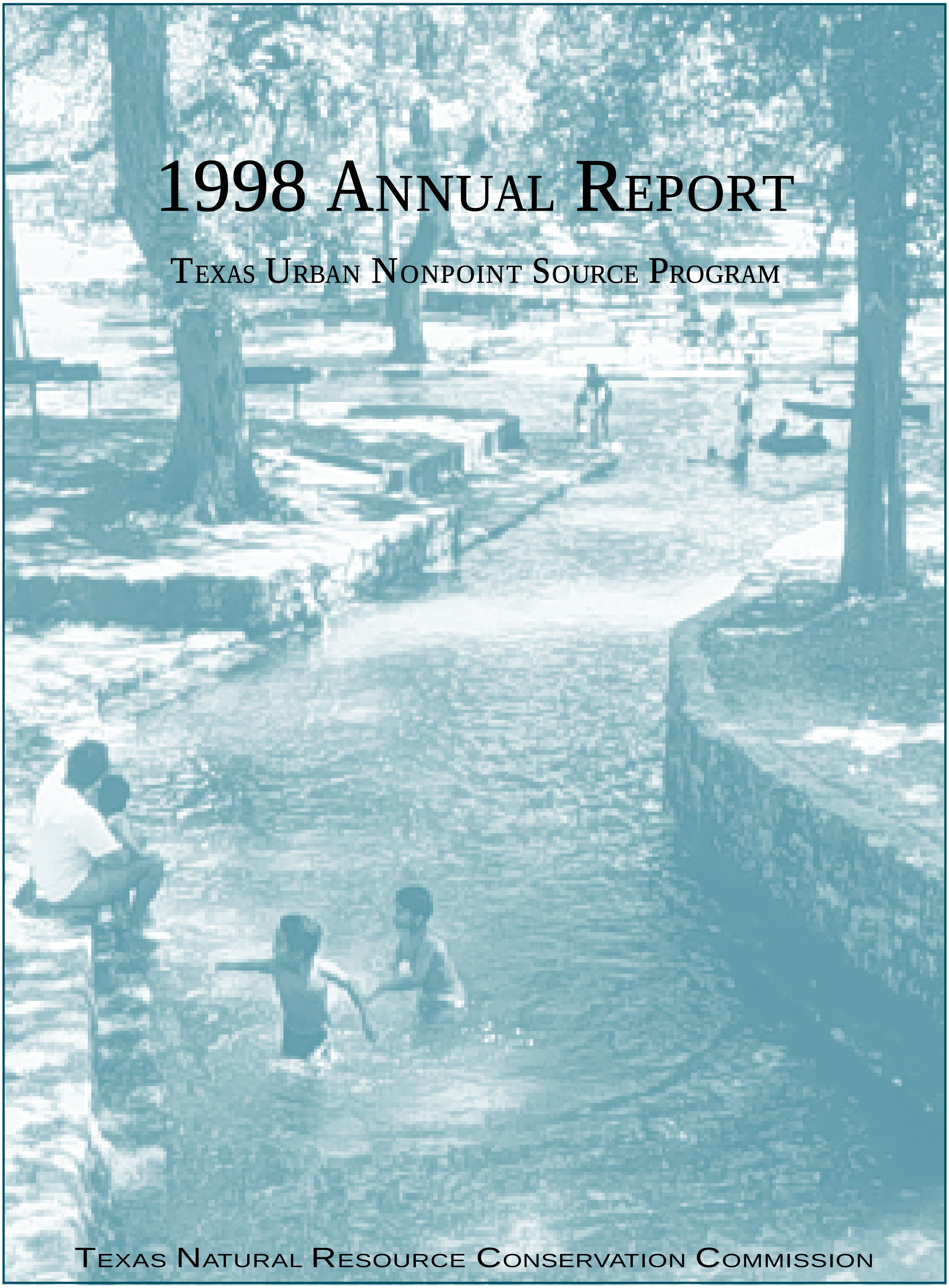
1998 Annual Report

Texas Urban Nonpoint Source Program



Texas Natural Resource Conservation Commission

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TNRCC

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A Letter from Sally C. Gutierrez, Director, Water Quality Division

Water quality management is a complex process involving many different players. Because of this complexity, progress can sometimes seem slow. However, Texas has accomplished a great deal this year in managing nonpoint source pollution, not the least of which is developing strategies for coordinating the state's complex system of water authority. The Texas Natural Resource Conservation Commission (TNRCC) has been designated by the Texas Legislature to lead efforts to manage urban and other non-agricultural, non-silvicultural nonpoint sources of pollution in Texas. To effectively discharge this responsibility, the TNRCC must cooperate with numerous governmental and private groups.

This has been a year of increased cooperation among regional, state, and federal agencies in managing Texas water quality in general, and nonpoint source (NPS) pollution in particular. An updated management program for nonpoint source pollution, in concert with the state's watershed management approach, was developed in cooperation with the Texas State Soil and Water Conservation Board (TSSWCB), and is under review by the Environmental Protection Agency (EPA). Several state and federal agencies collaborated to produce a Unified Watershed Assessment for Texas under the federal Clean Water Action Plan initiative. Under the TNRCC's Total Maximum Daily Load (TMDL) Program, the state has executed memoranda of agreement with several state and federal agencies to increase cooperation in addressing water quality impairments. Clean Rivers Program guidance was strengthened to enhance the quality of data collected to determine the health of watersheds and the success of implementation activities. The Texas Groundwater Protection Committee coordinates multi-agency efforts to conserve and protect groundwater resources.

The TNRCC is working on a schedule for completing watershed action plans over the next eight years to restore water quality in each of the impaired water bodies identified on the 1996 §319 List. The TNRCC plans to use §319 funds for the development of TMDLs and watershed action plans for NPS-impaired water bodies. The state will continue to use §319 funds to remediate NPS-impaired waters and prevent pollution through education, implementation of best management practices, and through protective voluntary and regulatory programs.

Significant strides have been made in NPS education. The seeds sown over the last seven years of the NPS program have resulted in a blossoming of nonpoint source education programs carried out by regional and local organizations across the state. The TNRCC has been active in spreading the word about nonpoint source pollution through grant-supported public service announcements, brochures, manuals, cleanup activities, conferences, and workshops.

Mission Statement

The Texas Natural Resource Conservation Commission (TNRCC) strives to protect our state's precious human and natural resources consistent with sustainable economic development. Our goal is clean air, clean water, and safe management of waste with an emphasis on pollution prevention. We are committed to providing efficient, prompt, and courteous service to the people of Texas, ever mindful that our decisions must be based on common sense, good science, and fiscal responsibility.

New technologies in computerized mapping and modeling are being used to help us better understand the hydrology of watersheds and to develop more effective means to improve water quality. The TNRCC is also working to identify and test better methods for measuring the impact of nonpoint source runoff on water quality.

The TNRCC continues to build on successful regulatory and voluntary programs that control NPS pollution. New rules have been developed to enable legislation that protects the Edwards Aquifer and defines the water pollution control responsibilities of cities. Source water and wellhead protection plans protect surface water and groundwater supplies of drinking water. The Galveston Bay Estuary and Coastal Bend Bays and Estuary programs are active in Texas coastal areas with a variety of programs.

The Nonpoint Source Management Program strives to bring all these diverse activities and agencies into focus to achieve a coordinated, effective approach to nonpoint source pollution prevention and remediation. The goals of the TNRCC Nonpoint Source Program are as follows.

Nonpoint Source Pollution:

Water pollution that results when rainfall runoff carries pollutants such as fertilizers, hebicides, insecticides, oil, grease, sediments, and animal wastes into streams, lakes, and bays. It is called nonpoint source pollution because it comes from many different places, difficult to pinpoint or control (as opposed to point source pollution, which is discharged from a single, easily identifiable source).

Goal 1:

By 1999 and beyond, 84 percent or more of Texas surface water will meet Texas water quality standards.

Goal 2:

Total maximum daily loads or equivalent measures will have begun in all impaired watersheds on the 1998 Clean Water Act Section 303(d) List within the next 10 years [by state Fiscal Year (FY) 2008]. Within the next five years, 30 percent of the necessary TMDLs will be submitted to the EPA for approval. Within 10 years, 90 percent will be submitted for approval. The remaining 10 percent will have begun development by Fiscal Year (FY) 2008 and will be completed by FY 2010.

Goal 3:

Administer the NPS Program effectively and efficiently.

To achieve these goals, the TNRCC will:

- Work to increase the scientific validity of NPS Program methods, tools, and procedures.
- Identify and characterize existing and potential water quality problems due to nonpoint source pollution.
- Work with other state, regional, and local water quality stakeholders to inform the public about nonpoint source pollution issues, and design watershed action plans that achieve environmental goals in priority water bodies within locally viable frameworks.
- Implement state, regional, and local programs to reduce NPS pollution.

Our success in addressing these goals will be detailed in the following sections of this report. I know you will recognize, as I do, just how successful we have been.

Sincerely,

Sally C. Gutierrez, R.S.
Director, Water Quality Division
Texas Natural Resource Conservation Commission

Introduction

This annual report highlights the accomplishments of urban nonpoint source management in Texas, and reports on the progress and financial status of section 319(h) grant projects funded under the Clean Water Act. Many state, regional, and local government agencies are responsible for and active in managing nonpoint source pollution.

Laying the Groundwork

The Nonpoint Source (NPS) Program successfully faced a new challenge in 1998 with the implementation of the Clean Water Action Plan (CWAP). This federal initiative plans to restore impaired water resources assessed as priority Category I watersheds in a state's Unified Watershed Assessment (UWA). To support implementation of the CWAP, the federal government will make additional funds available to the states through the Section 319 NPS grant program. Several steps, requiring the participation and coordination of various state, regional, local, and federal organizations, were necessary to lay the groundwork for Texas to realize the benefits afforded by this initiative.

> ***Nonpoint Source Program Mission Statement***
>
> *To protect the quality of water resources in Texas from adverse effects due to nonpoint sources of pollution through the cooperative implementation of a diverse range of strategies based upon common sense, good science, and fiscal responsibility which emphasize pollution prevention, a watershed perspective, and community-based solutions.*

The required UWA was accomplished through the joint leadership efforts of the United States Department of Agriculture–Natural Resources Conservation Service (NRCS), the TNRCC, and the TSSWCB. Other state and federal partners who assisted in the development of the UWA include the Texas Parks and Wildlife Department (TPWD), the Texas A&M University System (TAMU), the Texas office of the United States Geologic Survey (USGS), the Texas office of the United States Fish and Wildlife Service (USFWS), and the Texas office of the United States Army Corps of Engineers (USCOE). This group of state and federal partners completed the UWA following national guidelines which recommended that each state delineate watersheds using the eight-digit hydrologic unit areas (HUAs). The 210 eight-digit watersheds identified in Texas were grouped into one of four categories.

- Category I: Watersheds in need of restoration.
  This includes watersheds that at the present time do not meet the clean water and other natural resource goals that are summarized in the Clean Water Action Plan.
- Category II: Watersheds in need of preventive action to sustain water quality.
- Category III: Watersheds with pristine/sensitive aquatic system conditions on lands administered by federal, state, or tribal governments.
- Category IV: Watersheds with insufficient data to make an assessment.

After evaluation of available data, 160 HUAs were determined to fall into Category I. Of these, 23 watersheds are currently scheduled for restoration activities beginning in fiscal years 1999 and 2000. A map of high-priority watersheds that will be used to target and leverage the resources and technical expertise of local, regional, state, tribal, and federal agencies was developed during the UWA process.

After the UWA was submitted by its October deadline, NPS Program staff began presenting the CWAP initiative to local stakeholders to encourage their participation, particularly in Category I high-priority watersheds. Through a series of six Clean Rivers Steering Committee meetings in targeted basins, staff solicited project pre-proposals from interested local and regional water resource managers. Some 25 pre-proposals were received as a result of these public outreach efforts. Many proposals involved the collaboration of several organizations to address local water quality issues.

The next step was development of the 1999/2000 Texas Watershed Restoration Action Strategy (WRAS). The WRAS, as required by EPA, details the strategy that Texas will use to allocate the incremental funds being made available through §319. Preliminary discussions were held with the TSSWCB, and it was ultimately determined that due to the differences in agency focus and procedures, a separate WRAS would be submitted for each agency.

For inclusion in its WRAS, the TNRCC chose two activities that stood out as large-scale, regional projects that would meet the criteria for use of the additional funds. The first is a well-plugging project in coordination with the Railroad Commission of Texas (RCT) in the Colorado River basin, specifically those watersheds draining to Segment 1411, E.V. Spence Reservoir. This water body has been assessed as having water quality impairments as a result of sulfates, total dissolved solids, and chlorides. The second project is a collaborative effort by several different organizations to implement control practices for on-site wastewater problems identified in the upper Gulf Coast region of Texas. This entire region of rivers, lakes, bays, and estuaries has been assessed as either partially supporting or not supporting beneficial uses due to the presence of bacteria. Focusing the incremental funds on just two priority watershed projects, with strong local support, will provide the highest return in terms of improved water quality benefits. The coming year will provide the opportunity to further define each project work plan, negotiate and execute contracts, and begin implementation efforts. While both projects have ambitious goals, the high level of local support and the broad base of technical expertise involved in each should result in very successful efforts that will attain the targeted water quality improvements.

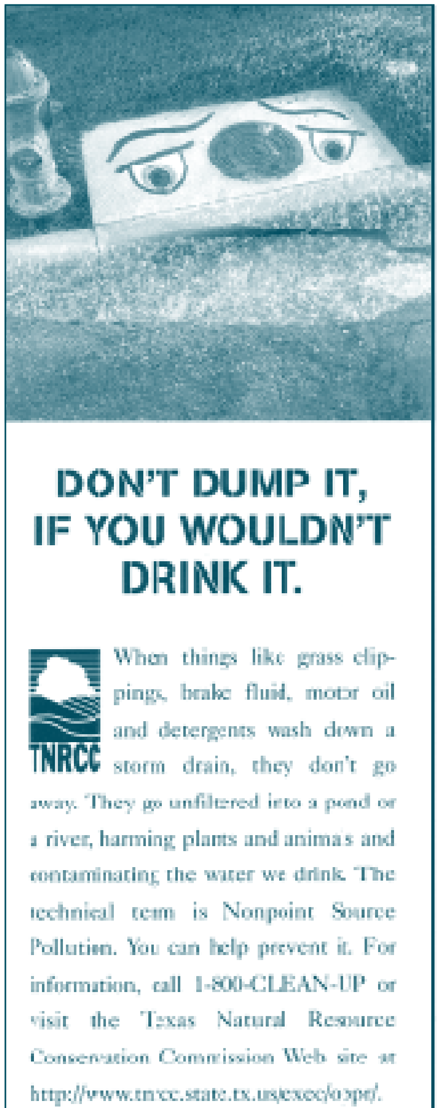
Storm drain stenciling projects build awareness about NPS pollution and how it reaches local water bodies.

Spreading the Word

The are many challenges in addressing nonpoint source pollution. One of the greatest of these is effectively educating the public about preventing nonpoint source problems. Pollution prevention begins with an understanding that every piece of land is part of a watershed, and that man's daily activities on land can have a direct impact on water quality. Spreading the word about polluted runoff and best management practices is important not only to reduce pollution, but to provide Texans with the information they need to preserve our natural resources. To gain public support for state, regional, and local environmental programs, the TNRCC expanded its commitment to nonpoint source pollution prevention through a variety of outreach programs.

Under the FY 94 319(h) grant, the TNRCC completed the final year of its pilot urban nonpoint source statewide educational program. The primary objectives of the project were to educate communities about nonpoint source pollution, facilitate implementation of best management practices, and coordinate the collection of volunteer water quality data that could be used to assess the effectiveness of NPS education and best management practice (BMP) implementation. Pollution prevention was emphasized through educational workshops for both children and adults, ranging from such topics as the hydrologic cycle to proper fertilizer and pesticide application. Volunteer monitors were trained and recruited to collect water quality and biological information in neighborhood streams. During the course of the project, over 27,000 people were educated about the origins of nonpoint source pollution and its prevention through their participation in various events.

The TNRCC's Office of Pollution Prevention and Recycling was very active in 1998, promoting environmental literacy and pollution prevention through an array of hands-on activities for the public. The Clean Cities 2000 Program continued its successful storm drain stenciling program for communities. Mylar stencils were made available for check-out through the TNRCC Regional offices and storm drain stenciling was promoted through Clean Cities 2000 workshops. Additional copies of the *Storm Drain Stenciling Manual* were reprinted due to high demand and were distributed to Keep Texas Beautiful affiliates and Clean Cities members. The Lake and River Cleanup program provided opportunities for residents to remove literally tons of trash and debris from waterways while educating and inspiring volunteers. The Agricultural Waste Pesticide, Texas Country Cleanup, and Household Hazardous Waste Collection Programs reported a record year in 1998 for citizen and sponsor participation in local collection events, thereby reducing the potential for ground and surface water contamination through improper disposal of toxic chemicals.



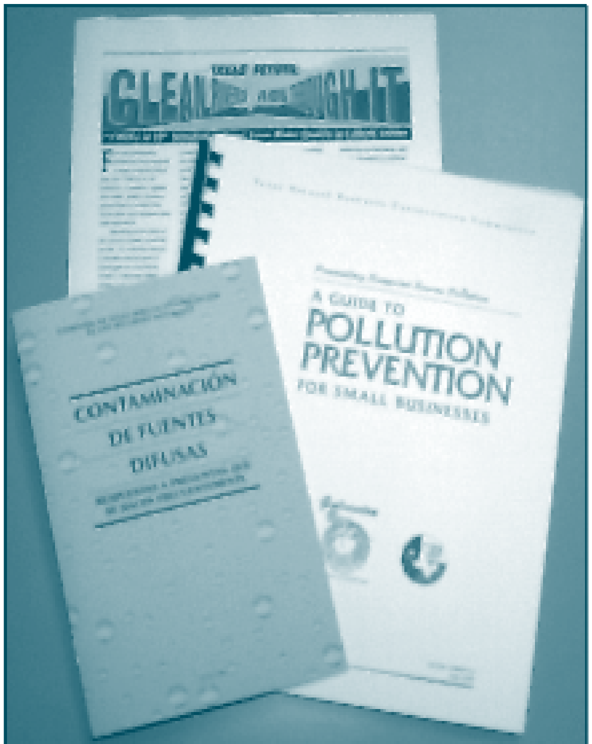
An ad campaign, appearing on posters, in newspapers, and as bookmarks, supported storm drain stencilling efforts.

The Texas Watch citizen's volunteer monitoring program also continued to promote NPS prevention though its ongoing regional and statewide workshops. These workshops, along with a quarterly newsletter, provide technical assistance to attendees and facilitate the development of partnerships to support volunteer monitoring activities and other NPS control efforts. The Texas Watch program recently redesigned its Web site to include a section on nonpoint source pollution and ways it can be prevented.

In March 1998, the TNRCC NPS Program conducted its first ever technology transfer conference in Brownsville, Texas. The theme of the conference was "The Rio Grande Valley's Future: Nonpoint Source and Water Quality," with emphasis on border nonpoint source pollution issues. The conference was international in scope, with presentations by environmental representatives from Mexico. Topics covered included water resource management and policy, innovative technologies to improve water quality, and public education and outreach. The conference also provided an opportunity to highlight the accomplishments of the city of Brownsville in addressing the management of their natural resources, in particular the Town Resaca system which drains into the Rio Grande. The conference was enhanced by the presentation of a technical workshop on stream restoration, and a biological monitoring workshop led by TNRCC Texas Watch staff.

To accommodate Spanish-speaking Texans, the TNRCC NPS Program produced a bilingual version of its nonpoint source *Frequently Asked Questions* brochure. This publication will be distributed statewide, with special emphasis in the Border and Lower Rio Grande Valley regions. Several other TNRCC environmental publications were also disseminated. Agency publication orders for FY 1998 indicate that over 23,000 manuals, booklets, and brochures with a pollution prevention message were distributed statewide.

Another new nonpoint source publication produced this past year was *A Guide to Pollution Prevention for Small Businesses.* This manual was designed to help small businesses improve the quality of their operations and reduce nonpoint source pollution through implementation of good housekeeping practices. The manual was also designed to be used by local governmental agencies, trade associations, nonprofit organizations, or other groups that interact with small businesses and are interested in promoting pollution prevention. This document was a collaborative effort between the TNRCC Galveston Bay Estuary Program and the Galveston County Health District, with support from The Texas General Land Office (GLO).



Publications are used statewide to educate the public about nonpoint source pollution and water quality management. Some are available in both English and Spanish.

The TNRCC's Teaching Environmental Sciences (TES) program provided kindergarten through grade 12 teachers with curriculum and teaching tools that benefit the children of Texas and their families. This program is a free, graduate-level summer course for Texas teachers at Texas universities. The course connects teachers with local experts and resources, and includes field trips and guest speakers. The program completed its fifth year in 1998. Eleven universities participated, more than doubling the number of partner universities in two years. In 1998, the course reached 175 teachers with information about air, water, and land issues linked to their local communities. TES-trained teachers will reach 5,000 students during the 1998/99 school year.

SPLASH!, an engaging new interactive water display, opened in 1998 at Zilker Park in Austin, Texas. This exhibit was developed through a partnership of local organizations and received partial funding through the City of Austin's 319(h) Urban Control Technology project. The TNRCC and the EPA have been recognized as cosponsors of the exhibit. This educational center was designed to help Austin-area residents understand the science and natural history of the Edwards Aquifer which replenishes the popular Barton Springs swimming pool in the park and provides a drinking water source for many central Texans. With rapid urban growth in recent years, questions and concerns about protecting the aquifer have arisen in the Austin community. Nonpoint source pollution and the impact of urban development on water quality is a major theme of the exhibit. The *SPLASH!* exhibit uses tangible, hands-on methods to illustrate exactly where water comes from and where it goes; what the aquifer looks like; how the aquifer water cycle works; and how citizens of all ages can affect and preserve its quality. Interactive and multisensory exhibits are interwoven with text, graphics, live specimens, working models, and analogues. *SPLASH!*, located at a noted Austin landmark, is expected to reach one million visitors annually.

The TNRCC continued to expand its use of the Internet to provide access to information and promote stakeholder input on NPS environmental programs. For example, the TNRCC Office of Water Resource Management Web site contains maps and information related to the state's Clean Water Act (CWA) §303(d) and §319 lists, Unified Watershed Assessment, NPS Assessment and Management Report, TMDL process, Edwards Aquifer Protection Program, and Source Water Protection activities, with links to other related state and federal water programs. Several educational tools developed recently by the TNRCC NPS Program are now available for downloading by educators and other interested Web surfers. These publications include the *Watershed Owner's Streamwalk Guide*, the *Manual for Conducting a Watershed Land Use Survey*, and the *Storm Drain Stenciling Manual*, among others.

The Splash! *exhibit in Austin, Texas brings groundwater concepts alive through interactive displays.*

The focus on nonpoint source pollution education will continue in the upcoming year. The TNRCC's Small Business and Environmental Assistance Division (formerly the Office of Pollution Prevention and Recycling) has launched an aggressive initiative to increase the integration of pollution prevention activities into the agency's regulatory programs. For water-related issues, this group is developing a statewide pollution prevention campaign to increase awareness among industry leaders, agricultural producers, governmental organizations, and the general public about nonpoint source issues. The program will be designed to complement the objectives of TNRCC's watershed management approach and TMDL projects by providing training and technical assistance to address urban and agricultural runoff in priority watersheds. The campaign will include printed materials (brochures, newsletters, magazine articles, posters), special events, and public service announcements.

Doing the Job

Texas has been active on several fronts in implementing practices that will protect and restore water quality. Regulatory and voluntary initiatives and programs promote use of BMPs for nonpoint source pollution control.

TNRCC staff has participated in the implementation of two regulatory initiatives of the Texas Legislature which address water quality impacts from urban nonpoint source pollution—protection of the Edwards Aquifer and amending the Water Pollution Control Duties of Cities. Implementation of these initiatives required TNRCC staff to develop rules and administrative procedures.

The Edwards Aquifer Protection Program rules regulate certain activities that have the potential to adversely affect the water quality of the Edwards Aquifer and hydrologically-connected surface water. The rules are designed to protect existing and future beneficial uses of groundwater. These rules were amended in 1996 and again in 1998 in response to comments provided to the TNRCC at annual public hearings related to the Edwards Aquifer water quality protection program.

Amendments to the Edwards Aquifer Protection Program rules were proposed in the *Texas Register* on March 27, 1998. Revisions were made to the proposed rule as a result of comments received. The Commission adopted applicable technical requirements provided under EPA's National Pollutant Discharge Elimination System general permit for storm water discharges from construction activities (dated July 6, 1998). Inclusion of these requirements provides consistency between state and federal storm water pollution regulations and avoids unnecessary expense for the regulated community. In addition, the Commission adopted a design requirement for permanent, post-development BMPs. These structures must now remove at least 80 percent of the incremental increase in the annual mass loading of total suspended solids caused by the regulated activity. The applicant may choose the most cost effective BMPs for meeting this standard at a particular site. This standard has also been adopted by other jurisdictions such as the EPA/National Oceanic and Atmospheric Administration (NOAA) "g-Measure" guidance in the Coastal Zone Management Act, the Lower Colorado River Authority in Texas, and the states of North Carolina and Florida.

At the Rio Grande Valley NPS conference, participants learned watershed restoration techniques and saw them in practice.

The Commission added provisions to the Edwards rules to avoid state duplication of local water programs that are equal to or more stringent than the Commission's rules. In the proposal preamble, the Commission announced that it had developed a model cooperative agreement to allow for delegation of approval and enforcement authority under the Edwards Aquifer Protection Program to certain local agencies that have sufficient jurisdiction and resources to implement the review, approval, inspection, and enforcement process. The Commission provided a certification process for the assumption of the program by local governments. Certification will not exceed five years and may be revoked or suspended upon written notice by the TNRCC's executive director if the local entity does not meet the terms and conditions of the agreement, or fails to meet the criteria for certification.

The rules added new provisions to regulate activities in the contributing zone of the Edwards Aquifer in eight Texas counties which might pollute surface streams that provide a significant volume of water to the Aquifer at the point where these streams enter the recharge zone. An average of 80 to 85 percent of the recharge to the Aquifer takes place in the stream beds that cross the recharge zone. The regulation of activities that can affect the quality of water flowing into the recharge zone will protect the quality of the groundwater in the Edwards Aquifer, thus protecting the existing and future uses of these water resources. A new subchapter focuses on the regulation of nonpoint source pollution activities such as storm water runoff from construction sites and post-construction industrial and residential sites. A regulated activity under the rules includes, but is not limited to, the construction or installation of buildings, utility lines, underground and above-ground storage tank systems, roads, highways, or railroads.

The rule making process for the Water Pollution Control Duties of Cities will implement Texas Water Code Section 26.177, which established the statutory responsibility of cities for abatement and control of water pollution within their jurisdictions. The statute requires cities with populations greater than 10,000 persons (and allows all other cities) to establish water pollution control and abatement programs when Clean Rivers Program or TNRCC assessments identify water pollution impacts caused by conditions not associated with permitted point sources. Program plans must be submitted to the TNRCC for review and approval. The statute allows the TNRCC to establish criteria for water pollution control and abatement programs through rule making, and allows the agency to assess fees to cover the costs to administer the program. The following requirements are specified for water pollution control and abatement programs: 1) inventory, monitor, and obtain compliance for waste discharges; and 2) provide for "reasonable and realistic plans" for controlling nonpoint source pollution.

Rules implementing Section 26.177 were proposed in the October 23, 1998, edition of the *Texas Register.* The comment period for the proposed rule closed on November 30, 1998. Substantial comments were received from concerned municipalities. TNRCC staff addressed the public comments, and the rule was proposed for adoption by the Commission in February 1999. The proposed rules will require cities that meet the population and assessment conditions to take remedial action within a reasonable amount of time, not to exceed five years, without Commission involvement. If subsequent assessments show no improvement in water quality, the proposed rules would then require the cities to attend a Commission public meeting. The Commission could then determine that the city must comply with the subchapter and develop, implement, and submit a Water Pollution Control and Abatement Program. This program would have to be signed and sealed by a professional engineer licensed in Texas who would certify that the city's program is designed to abate and prevent water pollution not attributed to permitted sources located within the city. If the city and the TNRCC's executive director mutually agree that a plan is warranted, then they may enter into an agreed order requiring the city to submit a Water Pollution Control and Abatement Program. Other alternatives of the Commission include referring the matter to the State Office of Administrative Hearings, or opting to decide that the city does not need to develop a water pollution control and abatement program.

Sink holes are a common groundwater recharge feature and are evidence of groundwater and surface water interaction.

The Texas Coastal Coordination Council appointed a work group to develop the Coastal Nonpoint Source Pollution Control Program for the State of Texas after the federal approval of the state Coastal Management Program in January 1997. The work group consisted of representatives of the GLO, TNRCC, TSSWCB, Texas Department of Transportation (TxDOT), TPWD, and the RCT. During the development of the draft document, public meetings were held in various urban and agricultural communities in the coastal areas of Texas to provide citizens with information about the federal Coastal Nonpoint Source program requirements and the proposed state approach to satisfying those requirements. Public meetings were held by the GLO and the TNRCC in the Corpus Christi and Houston areas during December of 1997, and by the GLO and the TSSWCB in the Weslaco and Wharton areas during January of 1998. The draft Coastal Nonpoint Source Control program was published in the *Texas Register* on June 19, 1998, providing for a 30-day public comment period on the draft document. Representatives of the NOAA and the EPA met with the members of the state work group on September 17, 1998, to discuss comments received on the draft document. The draft was revised in response to comments received. The Coastal Coordination Council approved the submittal of the program to the federal agencies for formal review and approval in accordance with Section 6217 of the Coastal Management Act on December 12, 1998.

The TNRCC has also been active in promoting voluntary programs to prevent and manage nonpoint source pollution. The volunteer program "Texas Watch" conducts regional and statewide workshops throughout Texas, addressing NPS issues and management strategies. These workshops, along with a quarterly newsletter and Web site, provide technical assistance to attendees and facilitate the development of partnerships to support volunteer monitoring activities and other NPS prevention and control efforts.

Tex-A-Syst activities protect rural groundwater supplies. Here, an aquatic scientist monitors water quality at a wellhead.

The TNRCC's Groundwater Assessment Section is responsible for assessing nonpoint source impacts to groundwater and for implementing portions of the Texas nonpoint source management program by addressing groundwater quality issues for the state. The Groundwater Assessment Section is involved in both agricultural and non-agricultural NPS issues. Most of the Section's work in FY '98 was with agricultural NPS activities. Non-agricultural NPS activities of the Section included wellhead protection (WHP) activities, the TEX-A-Syst program to protect rural groundwater supplies, regional aquifer protection, and technical assistance and educational activities.

In FY '98, the Section implemented wellhead protection activities for the City of Falfurrias, as well as for the Naval Air Station and the Country Estates Trailer Park in Kingsville. TEX-A-Syst activities implemented BMPs for the protection of water quality in the emergency drinking water supply wells within Mustang Island State Park, and included follow up activities with several rural well owners in Bell County. Regional aquifer protection strategies underway in FY '98 included targeting NPS problems for protecting groundwater resources in the Galveston Bay area and in the Nueces–Rio Grande basin.

The Section uses geographic information system (GIS) tools extensively. Examples of projects completed include the priority groundwater management area boundary maps for El Paso, recharge boundary maps for the Edwards aquifer in central Texas, and pesticide vulnerability maps developed for the statewide management of four EPA priority pesticides (atrazine, alachlor, metolachlor, and semazine).

The Section is involved in the Texas Groundwater Protection Committee (GWPC), which is a multi-agency task force dedicated to coordinating groundwater management in Texas. The Groundwater Assessment Section is responsible for coordinating the GWPC's Nonpoint Source Subcommittee, which ensures groundwater nonpoint source efforts are coordinated among state agencies. Section staff compiles input on assessment of current and potential groundwater nonpoint source problems from programs throughout the state for updates to the Groundwater Nonpoint Source Assessment Report and Management Plan.

The Groundwater Assessment Section also serves as the chair for the Groundwater Protection Committee's Agricultural Chemicals Subcommittee. In FY '98 the Agricultural Chemicals Subcommittee prepared a generic Pesticide Management Plan for statewide use, developed a pesticide vulnerability assessment model for targeting pesticide groundwater monitoring activities, and provided guidance for pesticide monitoring activities. The Section also completed pesticide monitoring programs in Hidalgo and Bailey Counties.

In addition to its involvement in the GWPC, the TNRCC actively participates with other state, federal, and regional agencies to address solutions to water quality problems, in accordance with the EPA's Key Element Number Two for successful state management programs. In 1998, a multi-agency work group compiled and submitted the Texas Unified Watershed Assessment, as highlighted in the section "Laying the Groundwork."

Revegetation projects provide filter strips for runoff and beautify urban water courses.

Texas is somewhat unusual in that primary authority for controlling nonpoint source pollution is divided between two different agencies. The TSSWCB is responsible for nonpoint source issues related to agriculture and silviculture, while TNRCC focuses on urban and other nonpoint sources of pollution. However, the two agencies work closely together to determine the best and most cost-effective approach to water quality problems when reviewing proposals for 319(h) projects that address situations under the jurisdiction of both agencies. The TNRCC and the TSSWCB also collaborated to compile and submit a joint *Texas Nonpoint Source Pollution Assessment Report and Management Program*, which is under review by the EPA. Annual multi-agency meetings are also held to review and prioritize impaired water bodies on the CWA §303(d) list.

The GLO leads the state's Adopt-A-Beach Program, which promotes beach cleanups and pollution prevention along the Texas coast. An annual poster contest solicits entries from school children around the state, asking them to create posters that show why it is important to keep our beaches clean. The GLO has adopted a two-mile stretch of beach on Mustang Island and has committed to take remedial action in order to preserve it for public recreation. GLO and TNRCC employees, their families and friends, and other volunteers dedicate two weekends a year (spring and fall) to collecting debris deposited on the beach and arranging for its proper disposal. Children and adults are taught how to safely collect the trash and identify its source. Adopt-A-Beach encourages positive changes in personal behavior to decrease pollution and preserve the beach for future enjoyment.

The RCT has the responsibility for nonpoint source water quality impacts related to oil and gas exploration and development. Representatives from the TNRCC and the RCT met recently to discuss a collaborative effort to conduct well-plugging in the Colorado River Basin, specifically in watersheds draining to E. V. Spence Reservoir. This reservoir has been identified as impaired due to total dissolved solids, sulfates, and chlorides, and has been targeted for a TMDL project. The RCT is currently working with the USGS to conduct assessments in this watershed. This cooperative effort is expected to improve water quality to the extent that the reservoir could be used as a public water supply.

Another interagency initiative under consideration would address on-site wastewater problems in several coastal basins located in the upper Gulf Coast region. This effort would also involve cooperative strategies for remediation with the Texas Water Development Board and other state, federal, and local agencies.

The Science of NPS Management

Monitoring and assessment of water quality are critical steps in determining the types, location, and priority of water quality problems around the state. Building on previous efforts to coordinate state and regional assessment activities, Texas produced a Unified Watershed Assessment in concert with the federal Clean Water Action Plan initiative.

The TNRCC continues to work with other federal, state, and regional agencies to coordinate water quality monitoring and assessment to avoid duplication of effort, assure the quality of data, and increase the cost-effectiveness of assessment activities. The TNRCC coordinates a statewide monitoring schedule that provides data for the CWA §305(b) water quality inventory and the §319 list of nonpoint source impaired waters. A particular focus of monitoring currently is to better define the extent of impairments and identify sources of pollution in impaired water bodies. Water quality professionals meet annually in Bandera, Texas, to discuss new techniques, special study findings, and to coordinate monitoring efforts.

The Surface Water Quality Monitoring Program is developing new methods to assess impairments of water quality uses by nonpoint source pollution. In particular, the application of biological sampling and criteria development promises to be an effective tool in determining the support of aquatic life use. Staff have conducted a two-year study of water quality, biological community health, and sources of pollution in several watersheds with varying degrees and types of nonpoint source of pollution. This involved an inventory of land uses and potential pollution sources in each of the watersheds. Results will be presented as a field workbook of biological and habitat measures that can be used to identify impairments of water quality by nonpoint sources of pollution.

Water quality professionals meet annually in Bandera, Texas, to discuss new techniques, special study findings, and to coordinate monitoring efforts.

Modeling of nonpoint source contributions is another important step in water quality management. Two projects for the Arroyo Colorado and the Guadalupe River have advanced technical knowledge of nonpoint source modeling. Geospatial data to be used in assessing nonpoint source impaired water bodies is also being developed.

The newly created TMDL Team within the TNRCC's Water Quality Division is developing technically sophisticated methods for establishing TMDLs in impaired water bodies throughout the state. One of the most ambitious endeavors of the TMDL Team has been the effort to establish a TMDL in the Arroyo Colorado, an important water body located in the Rio Grande Valley of south Texas.

Because of the complex nature of the project, the TMDL in the Arroyo Colorado has given the

TNRCC the unique opportunity to develop and test flexible and sophisticated data acquisition techniques for updating spatial data, and water quality modeling methods capable of simulating many complicated physical and biochemical processes in a variety of physical environments.

Updated hydrography, land use and land cover data sets were developed for the Arroyo Colorado watershed from digital orthophotographic quarter quadrangle (DOQQs) coverages and state-of-the-art cartographic techniques. The Arroyo Colorado watershed was also defined in detail using automated watershed delineation methods and digital elevation models (DEMs) of 30-meter resolution. Using the DOQQs, the computer-generated watershed area was further refined to include man-made features such as irrigation and drainage canals.

Extensive water quality monitoring is required to support determination of total maximum daily loads for impaired water bodies. Complex computer models are used to analyze water quality and land use data in order to characterize watersheds for restoration projects.

The current modeling strategy for the Arroyo Colorado includes the use of the Hydrologic Simulation Program - Fortran (HSPF) software for the non-tidal portion of the water body. HSPF is a dynamic, finite difference model that calculates surface and subsurface pollutant transport from complex watersheds into lotic receiving waters. In HSPF, physical and biochemical reactions are used to describe the transfer and reaction processes and water quality is simulated using a lumped parameter model. For the tidal portion of the Arroyo Colorado, the Environmental Fluid Dynamics Computer Code (EFDC) software is being used to model the complex physical environments found in the Arroyo Colorado near the coast. EFDC is a dynamic finite difference model that solves various hydrodynamic equations of motion and transport in stretched, vertical, and horizontal coordinate systems (Cartesian or orthogonal grids).

HSPF and EFDC are current and future components of the BASINS watershed modeling software. BASINS is a GIS-based watershed simulation software package developed by the EPA for use in TMDL development. The TMDL Team is working with the EPA to modify the BASINS software to incorporate more area-specific information, such as the data developed for the Arroyo Colorado. The BASINS software is also being modified to increase the simulation capabilities of the software so that the modeling complexities found in the Arroyo Colorado (and throughout the state) can be adequately addressed. If successfully completed, the modifications made to the BASINS software will result in a sophisticated, adaptable, and time-efficient tool for developing TMDLs in watersheds throughout the state.

Through the use of Performance Partnership Grants from the EPA, the TNRCC TMDL Team has contracted with the University of Texas Center for Research in Water Resources and the Blacklands Research Center Texas Agricultural Experiment Station in Temple for projects entailing creation and manipulation of geospatial data. Some of these projects include: delineation of water quality segment drainage areas, reconciliation of location data (e.g. monitoring stations, USGS flow gauges, discharge locations) with stream network data, compilation of a current composite land use layer for the state, and creation of an estimated nonpoint source loading coefficient layer in the Trinity River basin. The resultant data sets from these projects will help the TNRCC in the assessment and quantification of nonpoint source pollution contributions via automated modeling approaches.

The TNRCC Instream Uses Team is collaborating with the Guadalupe-Blanco River Authority (GBRA), TPWD, and the Texas Water Development Board (TWDB) on a study to identify appropriate instream flows to maintain fish and wildlife habitat on the Guadalupe River. The project requires an interdisciplinary approach, requiring expertise in biology, hydrology, and water quality. Once completed, the study will produce a hydrological and physical habitat model to be used to evaluate the effects of proposed water management alternatives on instream uses.

The abundance and types of aquatic insects indicate water quality conditions and types of pollution.

The amount of instream habitat available to maintain the biological community of a stream depends on (1) adequate water quality conditions and (2) channel characteristics of the stream (physical habitat); both of which are closely tied to flows.

In this study, the relationship between flow and water quality downstream of the free flowing reaches of the Guadalupe River will be modelled with QUAL-TX, which was developed by the TNRCC from the EPA's QUAL-II model. The model to be used in this study is a version of QUAL-TX that was further modified by HDR Engineering, Inc. specifically for the Guadalupe River. This model will be used to identify low flow conditions that may result in critical water quality conditions.

Instream habitat availability is directly affected by flows, since both water velocity and depth are directly correlated to flow. The different models used for this approach were developed by the USFWS' National Ecology Research Center and are the technical components of the Instream Flow Incremental Methodology (IFIM). IFIM is an institutional model that incorporates the planning, technical, and implementation phases of instream flow issues. In the past, physical habitat modelling has relied on IFG-4, a relatively simple hydraulic model used to predict depth and velocity under different flow conditions. The results of the hydraulic model are then integrated with specific physical habitat observations (for example, substrate size and type; instream cover, overhead cover) and actual habitat utilization data for the fish and invertebrate communities to predict the amount of physical habitat available under different flow regimes.

In addition to the traditional IFIM approach, the present study will take advantage of technological advances in the field. The availability of more precise and automated field data collection systems, improved hydraulic models, and GIS technology provide the flexibility to model entire stream reaches. RMA-2, a finite element, two dimensional hydrodynamic model, will be used in this study. The RMA-2 model predicts hydraulic characteristics (depth, velocity, flow direction) in specific elements (grids) throughout a stream reach. These results can then be linked to physical habitat and biological data in ArcView software. An interface is being developed that will allow the user to query and spatially display habitat available under different flow conditions. This approach will provide increased capabilities in delineating flow-habitat relationships necessary for maintaining stream communities.

Program Administration

Three TNRCC 319(h) categorical grants (Fiscal Years 1992, '93, and '94) were successfully closed in 1998. The TNRCC negotiated with the EPA to carry forward the unexpended federal funds from two of these grants into an active grant award. These funds will be used to support future implementation projects in priority watersheds and supplement federal Clean Water Action Plan incremental funds. The majority of projects in the remaining grants are making satisfactory progress. A status report on each 319(h) funded project is provided later in this report.

FY 1998 also saw the implementation of enhanced financial and performance monitoring oversight on all grants and contracts within the TNRCC Nonpoint Source Program. New fiscal monitoring procedures for contract payment review and approval were implemented to ensure that grant funds are being spent effectively and appropriately in compliance with federal guidelines. Each 319(h) contractor was visited by independent fiscal monitoring staff from the Data Collection Section, who conducted an on-site review of each contractor's business processes and procedures. These visits revealed no significant problems, but identified a baseline for training needs and technical assistance for current and future grant contractors. In addition, NPS staff conducted a meeting with all internal TNRCC 319 grant recipients to define expectations for grant projects and reiterate responsibilities and requirements. With continued 319 program participation under the Partnership Performance Grant (PPG), the importance of internal accountability was especially emphasized.

The P2000 project will enable the TNRCC to sign and submit future 319(h) grant requests electronically to EPA. Here Jeff Saitas, TNRCC Executive Director, demonstrates electronic signature functionality using Lotus Notes software.

The TNRCC has requested, with EPA concurrence, the award of Clean Water Action Plan incremental funds into a separate categorical grant, instead of into the Partnership Performance Grant. This recommendation was based on the state's experience to date that few, if any, significant projects can be completed in one or two years. Placing the funds in a separate categorical grant will provide three to five years for the completion of watershed restoration strategies.

During FY 98, work plan negotiations began with three separate organizations for one million dollars of TMDL development projects under the PPG. One contract has been successfully executed and the other two are nearing execution.

Nonpoint Source Program staff continued to use the Section 319(h) Grant Reporting and Tracking System (GRTS) database to report on all quarterly activity. The transition from a mainframe to a Lotus Notes platform was successfully accomplished in 1998 and staff have been actively using the new system. Other electronic reporting activities included continued participation in EPA's Partnership 2000 grant management pilot project with the test submittal of a 104(b)3 grant in Lotus Notes. Discussions are underway with EPA Region 6 to expand the use of this system with an actual 319(h) grant submittal in Lotus Notes during 1999. The TNRCC and EPA Region 6 have been specially recognized by EPA Headquarters as a state and regional partnership that is leading the way in electronic grants commerce.

Management Program Milestones

The 1998 NPS PPG identified the following areas of need as priorities for §319 funding in support of overall program goals:

- Protecting the Edwards Aquifer from nonpoint source impacts due to development.
- Protecting water bodies throughout the state through restrictions in water rights permits and state review of federal dredge and fill permits.
- Tracking baseline data for TMDL development.
- Reducing NPS impairments from the improper use of sludge and biosolids for beneficial purposes in north central and southeast Texas.
- Reducing NPS impairments from improperly operating on-site sewage facilities (OSSFs) in southeast Texas.
- Developing TMDLs and a watershed action plan for subwatersheds of Big Cypress Creek and Lake O' the Pines.
- Developing a TMDL and a watershed action plan for the E.V. Spence Reservoir watershed.
- Developing TMDLs and a watershed action plan for the Salado Creek Watershed.
- Supporting education and outreach through the Texas Watch volunteer monitoring program.
- Completing updates of the Nonpoint Source Management Program and the Nonpoint Source Assessment Report.
- Administering §319(h) grants efficiently, in accordance with state and federal guidance.

Overall, good progress was made on the 1998 PPG projects.

Edwards Aquifer Protection

Project: Edwards Aquifer Protection Program
Program: Field Operations

Outcome Measures

Goal	Accomplishment
Reduce the number and quantity of contaminants reaching the Edwards Aquifer through natural and unnatural geologic recharge features by 10 percent over five years.	Compliance and follow-up inspections exceeded the goal by 12 percent. Water Pollution Abatement Plan (WPAP) reviews exceeded the goal by 28 percent. Technical assistance exceeded the goal by 7.9 percent. There are not sufficient data yet to calculate the reduction in contaminants reaching the aquifer.

Output Measures

	Goal	Accomplishment
Number of compliance and follow-up investigations conducted, to include all five counties in the Edwards Aquifer Recharge Zone.	130	146
Number of WPAPs reviewed for organizations wishing to construct or develop property over the Edwards Aquifer Recharge Zone.	75	96
Number of agencies to which the Edwards Aquifer Protection Program will provide technical assistance regarding new construction or property development over the Edwards Aquifer Recharge Zone.	1200	1295

Protecting Water Quality Statewide

Project: Permit Reviews and Water Quality Modeling
Program: Water Rights Permit Program, 401 Water Quality Certification Program, Water Quality Modeling

Outcome Measures

Goal	Accomplishment
Reduce sediment loading to water bodies with 404 permit actions by 70 percent, where recommendations are implemented.	An estimated 70 percent reduction was achieved in federal dredge-and-fill permits that had special conditions to reduce runoff imposed by state certification.
Over a five-year period, the Water Quality Modeling Team will develop TMDL load recommendations for five priority water bodies [identified in the 303(d) list] sufficient to maintain the designated uses of those water bodies and prevent degradation of water quality.	The draft TMDL for nickel in the Houston Ship Channel was re-evaluated and a substantially revised draft was developed. The revision will be submitted to the EPA for approval after additional review by the TNRCC.
Maintain greater than minimum required water quality standards for approximately 1,000 stream miles annually on a statewide basis by setting stream flow restrictions above base water quality protection levels in water right permit reviews. Mitigate wetlands impacts by banking between 5,000 and 10,000 acres of wetlands per year through the Interagency Mitigation Banking Review team, of which TNRCC is a member.	In FY 1998, the Instream Uses Team performed environmental reviews on 40 water rights/water use permit applications. Streamflow and/or environmental recommendations including establishing riparian buffers, wetland mitigation, and utilization of best management practices and management plans were made on 88 percent of the applications reviewed. In addition, a joint study to identify appropriate flows to support various instream uses of the Guadalupe River is in progress.

Output Measures

	Goal	Accomplishment
Number of permit actions reviewed through 401 Water Quality Certification process. Recommendations for BMPs for sediment loss prevention will be made as appropriate.	57	48
Number of permits which the Water Quality Modeling Team will track through a database to monitor the permit process for 401 certification and wastewater permits. Information tracked will include receipt of the permit request, completeness of the permit, and the recommendations designed to protect water quality included in the final permit. The tracking of BMPs in this database will be used towards the development and prioritization of TMDLs.	150	103
Number of water rights/water use permit applications which the Ecosystem Research Team will review and condition for potential NPS threats and impact on downstream water rights, in stream uses, bays and estuaries, and wetlands. Areas for special review include projects on the North Bosque River and the San Marcos River, and wetland areas in the vicinity of the Big Thicket National Forest.	50	40
Number of field assessments performed to develop stream or reach-specific instream flow levels to maintain attainable aquatic life uses.	1	1

Reducing Known Impairments from Nonpoint Sources

Project: Reducing NPS Pollution from Beneficial Sludge Use
Program: Field Operations

Outcome Measures

Goal	Accomplishment
Reduce the occurrence of pathogens, priority organics, and metals from contaminated run-off resulting from sludge sites that improperly treat and/or stabilize sludge, or improperly or over-apply sludge to agricultural land in selected areas of the state by 25 percent over five years.	The number of on-site inspections of beneficial sludge use exceeded the goal by 71 percent. The technical assistance for beneficial sludge use program exceeded the goal by 180 percent. There are not sufficient data yet to calculate the reduction in contaminants from runoff from these sites.

Output Measures

	Goal	Accomplishment
Number of on-site inspections to be performed by the Beneficial Sludge/Biosolids Use Program in selected basins in north central Texas (Dallas/Ft. Worth area) and southeast Texas (Houston area) to assess compliance with permit limits which control site application rates, frequency, and the types/amounts of sludge allowed to be applied at the site.	75	128
Number of permits for which Beneficial Sludge/Biosolids Use Program will provide technical assistance to achieve compliance with permit limits.	50	955

Project: Reducing NPS Pollution from On-Site Sewage Facilities
Program: Field Operations

Outcome Measures

Goal	Accomplishment
Reduce the occurrence of pathogens, organics and nutrients in contaminated storm water runoff from improperly specified or malfunctioning on-site sewage facilities by 30 percent over five years.	Four new OSSF inspectors were hired in 1998. As a result, the number of initial and follow-up inspections performed exceeded targets by 71 percent. The number of OSSF plans review exceeded goal by 71 percent, and the number of technical assistance consultations exceeded target by 92 percent. The reduction in pollutants will not be determined until late in the fifth year of the project.

Output Measures

	Goal	Accomplishment
Number of technical assistance consultations with designers, installers, and local permitting authorities desiring to utilize non-conventional OSSFs in selected basins in southeast Texas (Beaumont/Port Arthur and Houston).	1000	1923
Number of OSSF initial and follow-up inspections in the southeast target area.	130	308
Number of plans for new OSSFs that the OSSF Program will review, providing technical assistance and oversight for delegated local governments in the southeast target area.	240	410

Big Cypress Creek/Lake O' the Pines Watershed Project

Project: Development and Implementation of TMDLs and a Watershed Action Plan
Program: Total Maximum Daily Load Team

Outcome Measures

Goal	Accomplishment
Improve water quality in Big Cypress Creek and Lake O' the Pines through the development of a watershed action plan designed to satisfy the TMDL requirement of Section 303(d) of the Clean Water Act.	Contract negotiations between the TNRCC and the Northeast Texas Municipal Water District are still underway; consequently, the project is slightly behind schedule. The Cypress Creek Basin Clean Rivers Program (CRP) Steering Committee will serve as the TMDL Watershed Committee. This committee helped organize and conduct semi-intensive monitoring efforts in August 1998 to capture the extreme low-flow conditions present in the summer of 1998. An initial TMDL work plan was completed and reviewed in November 1998, and is on the Northeast Texas Municipal Water District's Internet site.

Output Measures

	Goal	Accomplishment
Facilitate committee meetings involving outreach and negotiation.	3	5
Produce a mathematical model of acceptable loading.	10 percent complete	Pending
Develop an approved, detailed action plan that establishes overall goals and objectives, load allocations, strategy for load allocation, time table for implementation, and a list of expected results.	10 percent complete	Pending

E.V. Spence Reservoir Watershed Project

Project: Development and implementation of TMDLs and a Watershed Action Plan
Program: Total Maximum Daily Load Team

Outcome Measures

Goal	Accomplishment
Improve water quality in E.V. Spence Reservoir through the development of a watershed action plan designed to satisfy the TMDL requirement of Section 303(d) of the Clean Water Act.	A draft TMDL work plan was completed in December 1998. Contract negotiations between the TNRCC and the Colorado River Municipal Water District have taken longer than expected, which has caused the project to fall behind schedule. However, a contract is near completion.

Output Measures

	Goal	Accomplishment
Facilitate committee meetings involving outreach and negotiation.	3	2
Produce a mathematical model of acceptable loading.	10 percent complete	Pending
Develop an approved, detailed action plan that establishes overall goals and objectives, load allocations, strategy for load allocation, time table for implementation, and a list of expected results.	10 percent complete	Pending

Salado Creek Watershed Project

Project: Development and Implementation of TMDLs and a Watershed Action Plan
Program: Total Maximum Daily Load Team

Outcome Measures

Goal	Accomplishment
Improve water quality in Salado Creek and associated water bodies by the development of a watershed action plan designed to satisfy the TMDL requirement of Section 303(d) of the Clean Water Act.	In October 1998, a contract for $250,000 for the TMDL project was executed between the TNRCC and the San Antonio River Authority (SARA). A Quality Assurance Project Plan has been developed by SARA and is expected to be approved by the EPA in early 1999. SARA has also drafted a report analyzing existing water quality data and developing an analytical approach for the project.

Output Measures

	Goal	Accomplishment
Facilitate committee meetings involving outreach and negotiation.	2	4
Produce a mathematical model of acceptable loading.	10% complete	Pending

Texas Watch Program

Projects: Public Education and Outreach through Volunteer Monitoring
Program: Texas Watch Program

Outcome Measures

Goal	Accomplishment
Ensure an adequate, affordable supply of clean water by monitoring and assessing water quality.	Texas Watch successfully executed three regional workshops and one statewide meeting, designed and implemented a Texas Watch Web page, produced 4 quarterly newsletters, and coordinated both volunteer monitoring and community action projects. The regional workshops and statewide meeting featured sessions on nonpoint source issues and presented a forum conducive to participant networking. Post-workshop surveys showed that the meetings resulted in the transfer of nonpoint source technologies through participation in the workshop and through networking. The Texas Watch Web page provided general information about the Texas Watch program and Texas Watch events, and provided links to other Web sites of interest to volunteer monitors. The Texas Watch newsletter continued its emphasis of nonpoint source issues, with its strong emphasis on nonpoint source control technologies, quality assurance/quality control guidance for volunteer monitors, and perspectives on state and national water policy such as the Federal TMDL and Clean Water Action Plan programs. Texas Watch directly supported volunteer monitoring primarily through the FY 1994 and FY 1995 grants. In addition, Texas Watch coordinated partner-based volunteer monitoring across the state through the Texas Watch partners program. Partner-supported volunteer monitoring was documented this year as a source of in-kind 319 (h) match. Streambank revegetation projects were carried out in Austin and Brownsville. Storm drain stenciling was conducted in several communities in the Rio Grande Valley. A citizen's guide for conducting a watershed survey was produced and distributed statewide.

Output Measures

	Goal	Accomplishment
Texas Watch and its partners will identify areas where management measures are needed by coordinating monitoring on 600 sites.	150	295
Texas Watch and its partners will improve water quality by educating 5,000 citizens about management of nonpoint source pollution by coordinating educational workshops, producing newsletters, and maintaining a Web page.	1000	11,000
Texas Watch and its partners will coordinate 15 community action projects over five years to prevent and remediate pollution through stream bank re-vegetation projects, watershed surveys, and storm drain stenciling.	3	6

Statewide Program Administration

Projects: Management Program and Assessment Report Updates, Grant Administration
Program: Nonpoint Source Program

Outcome Measures

Goal	Accomplishment
An effective and efficient NPS Program that strives to implement the watershed approach, pollution prevention principles, addresses priority water bodies/problems, includes a balanced approach between statewide and local priorities, and strives for environmental accomplishments (loading reductions and water quality improvement). Success of the program will rely heavily upon partnerships with other responsible players across the state to bring additional resources to bear on identified priority problems. Varied outreach efforts will be undertaken to encourage the widest participation possible. Over the next five years, program goal is to address 10 priority water quality issues (5 statewide, 5 local).	The NPS Program conducted extensive negotiations with contractors, amended work plans for a number of contracts, made project site visits, attended nonpoint source conferences at the state, regional, and national level, and participated in a mid-year review with EPA Region 6 staff. Workplan negotiations continued with three interlocal agencies for $1 million of TMDL development projects under the 319 portion of the PPG. Staff made presentations at Clean Rivers basin steering committee and stakeholder meetings concerning the Clean Water Action Plan to solicit proposals for implementation of watershed restoration action strategies. Negotiations began with three organizations for TMDL development in three priority watersheds: Big Cypress Creek, E.V. Spence Reservoir, and Salado Creek. The joint TNRCC/TSSWCB Nonpoint Source Assessment Report and Management Program was completed and submitted to the EPA for approval.

Output Measures

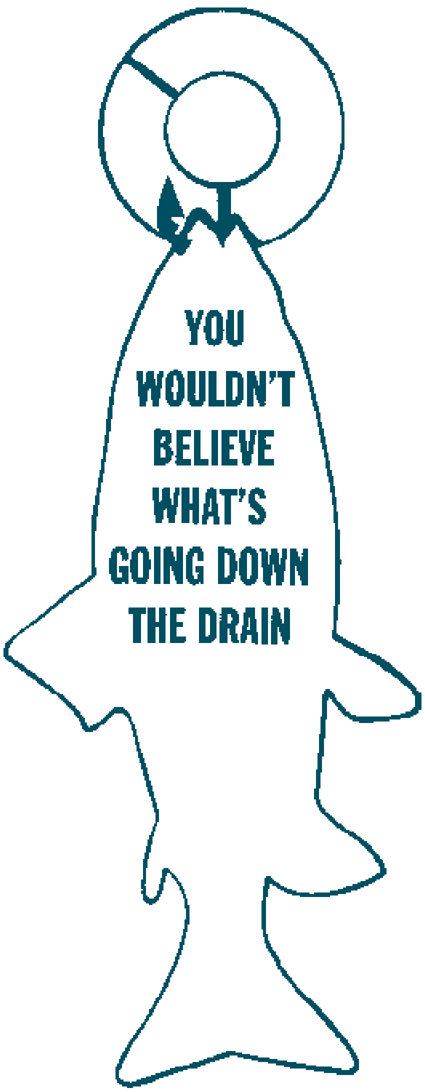
	Goal	Accomplishment
Number of Assessment Report updates developed in accordance with the State and Federal Relationship section of Strategy 01-02-02 of the FY 1997 TNRCC/EPA Performance Partnership Agreement, and in accordance with the FY 1997 Federal Nonpoint Source Guidance.	1	1 Pending EPA approval
Number of Management Program updates developed in accordance with the State and Federal Relationship section of Strategy 01-02-02 of the FY 1997 TNRCC/EPA Performance Partnership Agreement, and in accordance with the FY 1997 Federal Nonpoint Source Guidance.	1	1 Pending EPA approval

Section 319(h) Grant Project Highlights

The TNRCC Nonpoint Source Program Team administers over 50 active Section 319(h) grant projects that represent more than $8.3 million in federal funds and over $5.5 million in state and local matching funds. Progress of these projects is highlighted in this section.

Projects Completed in 1998

Seventeen projects were successfully completed in late 1998 and are highlighted in this section. Greater detail about each project is available in the final project reports, and can be provided on request from the Nonpoint Source Program.



Several different door hangers were used in the outreach project. The reverse side of this one has tips for how individuals can reduce their contribution to NPS pollution.

Statewide Urban Nonpoint Source Pollution Prevention Project, TNRCC Nonpoint Source, Texas Watch, and Clean Texas 2000 Programs, Funded FY 1994

The TNRCC Nonpoint Source Team, in conjunction with the Texas Watch Volunteer Monitoring Program and the Clean Cities 2000 Program, collaborated in an urban nonpoint source public education and monitoring project funded under the FY 94 Section 319(h) grant. Two outside contractors, Galveston Bay Foundation and Moorhouse Associates, Inc., assisted TNRCC staff in conducting outreach activities.

The project goals were to educate citizens about nonpoint source pollution, facilitate implementation of best management practices (BMPs), and coordinate the collection of volunteer water quality data that could be used to assess the effectiveness of the education and BMP implementation. The TNRCC planned to recruit three to five communities adjacent to each of the following metropolitan areas: Lubbock, Fort Worth, Beaumont, Harlingen, Galveston Bay and Corpus Christi Bay. Major tasks of the project were: (a) identifying participating communities; (b) contacting city staff for introductory and planning meetings; (c) identifying and contacting a target audience in each community; (d) planning events to serve as a forum for NPS education; and (e) encouraging individuals to participate in the project activities.

The TNRCC's approach to the education element of this project was two-tiered. The first step was to familiarize residents with the impacts of human behavior on their watershed. The second step was to encourage them to adopt environmentally-friendly alternatives to their daily habits. The communities of Plainview, Carrollton, Harlingen, Grand Prairie, Hitchcock, Lubbock, Rockport, Nassau Bay, Arroyo City, Corpus Christi, Orange, Alamo, Portland, and Ingleside participated in project activities.

This project promoted primarily nonstructural BMPs (i.e. recycling, proper yard care, storm drain stenciling) because they are preventive and cost-effective. Activities included workshops for teachers/students, scout training, Trash Bashes, Earth Day events, and exhibits and presentations at conferences, schools, and public awareness forums. Several of the events received newspaper and television coverage. Many groups contacted went on to perform further activities such as composting and storm drain stenciling.

Two popular publications, *Manual for Conducting a Watershed Land Use Survey* and *Watershed Owner's Streamwalk Guide*, were developed by the TNRCC for use as educational tools to teach residents the connection between water quality and man's activities on land. The *Land Use Survey* was used by groups of Texas A & M University students to conduct surveys of local watersheds in the Harlingen, Lubbock, and Corpus Christi areas.

In urban areas, the most common route for NPS pollutants to run off into waterways is through the network of storm drains that carry excess rain water away from streets and pavements. Many people mistakenly believe that storm drain inlets empty to water treatment facilities, so they pour chemicals or sweep debris directly into storm drains. The Clean Cities 2000 Program attempted to address this issue by launching and promoting a statewide storm drain stenciling campaign with a pollution prevention message. Mylar stencils were purchased and distributed for checkout through all TNRCC regional offices. Door hangers with nonpoint source prevention tips were printed for volunteers to distribute in neighborhoods where stenciling activities took place. A "how-to" publication entitled *Storm Drain Stenciling: A Manual for Communities* was developed and distributed at environmental conferences and through local organizations. Clean Cities 2000 also produced a series of public service announcements based on nonpoint source pollution and various prevention techniques. Topics included yard fertilizing, composting, and proper battery disposal, as well as storm drain stenciling. These videos were incorporated into CLEAN TEXAS REPORTER segments and shown in eight media markets across the state with a viewing audience of approximately 1.8 million households.

Storm drain stenciling projects were carried out in several cities.

The primary focus of Texas Watch volunteers was to use monitoring information to evaluate the effectiveness of educational and nonstructural BMPs by collecting chemical and biological data in watersheds within each target community. Volunteers were trained in the core, Urban Watch, and nutrient monitoring kits. A biological monitoring program called *Bug Watch* was specifically designed for the collection of water quality data in each community. This was a new monitoring effort by Texas Watch to extend the amount of water quality information gathered by volunteers and increase the ecological knowledge of participants. Benthic macroinvertebrates were selected as the target organisms for the monitoring program because they are easy to collect and relatively identifiable by the naked eye. A *Benthic Macroinvertebrate Monitoring Manual* was developed for training volunteers. Balancing volunteers with resources available proved to be challenging throughout this project. Volunteer and partner recruitment was highly dependent upon the initiative of the municipalities, partners, and other local organizations. In some communities, volunteer recruitment exceeded partner recruitment or vice versa. Between 1994 -1998, over 100 Texas Watch volunteers were trained and 17 water bodies were monitored for at least 6 months. The water quality data collected has been incorporated in the TNRCC database and is available on the TNRCC Internet site.

The TNRCC Nonpoint Source Program also participated in the implementation of four regulatory initiatives from the Texas Legislature which address water quality impacts from urban nonpoint source pollution. These initiatives included: legislation providing for the creation of Water Quality Protection Zones, the creation of the Southwest Travis County Water District, the protection of the Edwards Aquifer, and amending the Water Pollution Control Duties of Cities. Implementing these legislative initiatives required TNRCC staff to develop rules and/or administrative procedures necessary to achieve the objectives of the legislature. Final rules and procedures were promulgated and/or implemented for Water Quality Protection Zones, the Southwest Travis County Water District, and Edwards Aquifer Protection. Draft rules have been proposed for the Water Pollution Control Duties of Cities. For more detailed information on TNRCC rules development, see the section entitled "Doing the Job."

Texas Watch volunteers learn biological and chemical water quality monitoring techniques.

The following conclusions emerged from this project:

- *NPS education is vital to the goal of improving water quality*. The enthusiastic responses to the hands-on educational activities in this project revealed that people of all ages care about the quality of their local water resources. They are responsive to learning how to accomplish everyday tasks in ways that help protect water quality. Continued education is therefore necessary to promote BMPs.

- *Long-term educational effort coupled with long-term monitoring is necessary to assess changes.* Changes in water quality brought about by changes in individual behavior are not instantaneous. Along with continued education, monitoring should be continued to assess progress. The volunteer monitoring community represents a valuable resource for collecting data at specific sites and at times of interest. Increased data can be used by resource managers in assessing spatial and temporal trends.

The educational tools, techniques, and materials developed under this project can be used in other urban watersheds statewide. During the four years of the project, approximately 27,000 individuals were contacted directly through training or participation in an activity. This total does not count the potential secondary contact through teachers and the media.

Part of the team that made the Smithville project a reality—representatives of the City of Smithville, the LCRA, the TNRCC and Texas A & M University.

A Watershed Approach for Small Cities, Lower Colorado River Authority, and City of Smithville, Funded FY 1995

The Smithville BMP project began with a citizen complaint. Flooding was a problem in her area of downtown Smithville every time it rained, and the area where most of the flood water discharged into Gazley Creek, a tributary of the Colorado River, was becoming severely eroded and was full of trash. City Mayor Vernon Richards received the call, and decided to ask the Lower Colorado River Authority (LCRA) for assistance. An LCRA engineer, Tom Curran, evaluated the situation and determined that a large-scale project would be required to address the problem. Under project manager Cis Meyers, the LCRA applied for Section 319 grant funds to assist the City of Smithville. The project has received a great deal of publicity, and will be used as a model for other small cities.

The first stage of the Smithville BMP is an extended detention pond with underground filtration chambers.

Smithville is built in a "bowl," and consequently, flooding is a problem in many areas of the city. Therefore, the project proposal went beyond a single solution for the problem on Gazley Creek. The entire drainage system for Smithville (32 subwatersheds) was evaluated, and a master drainage plan for the city was crafted. The master plan takes pollutant removal into account, and will be implemented gradually. The city has committed $50,000 per year over the next several years to implement plan recommendations. However, one project alone will cost approximately $200,000, so the city is working on finding assistance through additional grant funds.

Engineering and architecture students from Texas A & M University evaluated drainage in the city, including the Gazley Creek site, and generated proposals for solutions to city managers. This gave the students real-life experience, and gave city managers a variety of ideas at a low cost. Many of the students' ideas were incorporated in the final plan. According to Mayor Richards, “The students did a magnificent, stupendous, outstanding job. I was very impressed with them. They were smart, polite, and a great resource for us.”

Terraced rock gabion walls form the second stage, and prevent erosion. The terraces were designed to recreate as much of the original bank structure as possible.

The Smithville project was also a model of cooperation. Several organizations came together to make the project a success. City workers, managers, and officials, the garden club, Keep Smithville Beautiful, and local businesses participated in construction and landscaping of the BMP site on Gazley Creek. The TNRCC provided contract and administrative support for pass-through of funds from the EPA. The LCRA managed the project in cooperation with city managers, and designed the BMP structure. Mayor Richards put it well, “People have a tendency not to work together. So it has been very gratifying to see this come together so well.”

The Gazley Creek BMP was designed to address an area of severe erosion which was causing a sediment loading problem in the creek. A 30-inch diameter outfall pipe discharging into the area had, over time, changed a gentle slope to the creek into a deep gully. The BMP recreated as much of the natural bank structure as possible, using rock gabions to form terraces down the bank. An extended detention pond with underground infiltration chambers was built at the top of the slope. At the bottom of the structure, a water quality pond was constructed to polish water coming from the BMP and to further treat discharge from an upstream wastewater treatment plant. In and along the creek itself, wet pond plants harvested from other LCRA extended detention ponds were used to stabilize banks and natural sandbars. The entire site was seeded with native grasses, and covered with an erosion blanket.

A display at a ceremony dedicating the site told the project's story.

Then the infamous Texas weather took over. The area suffered a 50-year flood of the Colorado River that brought water up to the top terrace wall. A 10-year flood of Gazley Creek broke the upstream and downstream dams that formed the polishing wet pond, and filled it with sediment. A 25-year, 3½-inch rain storm washed all the grass seed into the creek. Back to the drawing board.

Members of Keep Smithville Beautiful, the garden club, city workers and officials, and LCRA staff participated in landscaping the project. Many of the plants were donated.

The Gazley Creek BMP drains an urban watershed in downtown Smithville.

The detention basin had worked well. It held the entire one-hour, 3½-inch rain, sending the last flush through the overflow outtake. It became clear, however, that the wet pond idea would not work. Project managers decided to assist the new natural channel the creek began forming in the flood. The banks and a flood-built sandbar were planted with cypress trees and wet pond plants harvested from other LCRA extended detention ponds. Because it was fall, and seeds would not be expected to take hold, the area was replanted with 54 pallets of native grass sod.

Water quality was measured at the inflow and the outflow of the structure. Analysis of storm event data has documented that the BMP consistently reduced the concentration of pollutants monitored, even though a majority of the storms monitored were at or above design capacity of the pond. This seems to indicate that resuspension and discharge of pollutants captured did not occur during more intense rain events. Recorded reductions in mass loads of monitored pollutants leaving the structure were quite high. Phosphorus decreased 87 percent, total dissolved solids decreased 86 percent, ortho- phosphorus decreased 81 percent, total kjeldahl nitrogen decreased 68 percent, and nitrate decreased 64 percent. Additionally, the rainfall/runoff ratio was significantly reduced from 0.68 ($R^2 = 0.83$) during pre-construction conditions to a final ratio of 0.14 ($R^2 = 0.61$). These reductions in both pollutant loads and peak flow are largely attributed to the infiltrative capacity of the pond.

The LCRA and the City of Smithville had a vision for the Gazley Creek project that went beyond water quality treatment. They decided to make it an asset for the local neighborhood as well, so the site was designed to double as a small urban park. The Keep Smithville Beautiful organization and the Smithville Garden Club gave suggestions for landscaping and recruited volunteers for the planting. A row of trees, including redbuds and crepe myrtles, was planted between the site and the parking lot next to it. Cypress and pecan trees were planted near the creek, and lindenheimer muhley grasses were planted in the detention basin and at the edges of the terrace walls. These plants were well established by the spring of 1998. Picnic tables and benches were placed uphill of the detention basin to allow local residents to enjoy the new view of Gazley Creek and appreciate the fruits of this innovative and successful partnership.

The BMP installed along Gazley Creek has proven to be very effective in several ways. The BMP solved the erosion problem that was progressively eating away at the bank around the pipe outfall. It greatly enhanced the aesthetics of the area. And, not the least important, it performs extremely well at removing nonpoint-source-related pollutants and reducing the rainfall/runoff ratio from the contributing subwatershed

The project is a strong success both for the environmental benefits that have been achieved, and for the public awareness and support that has been gained since its inception. The citizens of Smithville, and the many engineering and architecture students who used this project as a living classroom, have gained a much deeper understanding of watershed processes and the technologies available to responsibly manage them.

Several experts shared their experience with attendees at the NPS Technology Transfer Conference held in Brownsville, Texas.

Nonpoint Source Technology Transfer Conference in Brownsville, Texas, TNRCC Nonpoint Source Program, Funded FY 1995

The objective of this project was to provide a forum for the transfer of technology related to the mitigation and prevention of urban sources of nonpoint source pollution. The 319 grant program has been active for a number of years in Texas, and during this time many projects have been implemented to demonstrate the effectiveness of various urban best management practices. The conference provided a formal opportunity to share the success and experiences of those projects with a broad audience. Participants were exposed to practices that could be adapted for their localities. Documented solutions and processes tailored for the urban setting can support the implementation of watershed-wise practices among cities statewide.

Planning began in early 1997 to include the largest number of partners possible and to develop a program that would meet the needs of the area and showcase a number of successful demonstration projects.

Workshops allowed participants to apply their knowledge in the field.

A watershed restoration workshop was held in conjunction with the conference to provide professionals and citizens the opportunity to learn the principles of managing streams and maintaining or restoring stable systems. Ecosystem Recovery Institute conducted the technical training for 2½ days before the conference. The training agenda was tailored to the watersheds in the Lower Rio Grande Valley and included such topics as stream channel classification, watershed assessment, stream processes, and restoration, as well as design, construction, and maintenance of various restoration projects. The training also included field visits to local sites to further enhance attendees' understanding of stream function and watershed relationships.

The conference was held in Brownsville, Texas, the week of March 9, 1998. Welcoming remarks were made by the mayors of Brownsville, Texas, and Matamoros, Tamaulipas, and by TNRCC Commissioner Ralph Marquez. The international theme continued throughout the conference with several speakers from Mexico sharing their challenges and successes in water resource management.

Content of the conference sessions was varied and comprehensive. Topics included water resource management and policy, innovative technologies to improve water quality, structural and nonstructural BMPs, border studies, and public education and outreach. The week ended with a workshop on biological monitoring presented by the TNRCC Texas Watch staff. Over 50 students and teachers participated in this training session.

The conference had the generous support of many sponsors, including Gladys Porter Zoo, Brownsville Convention and Visitors Center, Rancho Viejo, C.C. Lynch & Associates, and Texas Agricultural Extension Service. Feedback from conference attendees has been overwhelmingly positive, noting especially the benefits of hearing directly from the so-called "experts." The most frequently asked question on the exit form was, "When is the next conference scheduled?"

The upper pond of the three-stage wetpond during planting.

Urban Control Technologies for Contaminated Sediments, City of Austin, Funded FY 1992

This project evaluated the pollutant removal efficiency of BMPs in urban areas. The most prominent of the BMPs was a three-stage wet pond built in partnership with private partners on state land managed by the General Land Office. The pond was part of a new development intended to better utilize state lands.

Flooding had historically plagued properties southeast of the area proposed for development. The City of Austin worked with the General Land Office and the developers to incorporate a three-stage wet pond that would control runoff from the new development, dubbed Central Park. The City went further to design the pond to treat contaminants in runoff, and to evaluate the pollutant removal efficiency of the structure and its various components. The pond was also designed to be a key aesthetic structure in a new urban park created under the development project.

The wet pond system controls stormwater runoff for a drainage area of 173 acres. The watershed is composed primarily of single family residential neighborhoods, with some commercial development. The pond system provides flood control and prevents erosion. A recirculation system takes water from the lowest pond back to the upper pond to aid aeration. Downstream water quality is enhanced because sediments and pollutants settle into the pond rather than being discharged directly into downstream creeks. The wetland plants and microorganisms that live in the pond serve as a natural filter for nutrients and other contaminants. In addition, the ponds provide habitat for urban wildlife.

The upper pond after planting.

Because the structure is located in an urban park, planting design considered safety concerns and aesthetics, as well as pollutant removal. Outer edges of the pond are shallow, and marsh grasses were planted near the shore to discourage wading. This

The middle pond during construction.

also protects the pond from intrusions that might damage its ecological system. The pond was stocked with mosquito fish to offset the potential for the pond to support mosquitos.

Section 319 funding supported the evaluation of the efficiency of this structure and other smaller wet ponds, and two other urban BMPs: inlet filters and an oil/sediment treatment chamber. All structures resulted in improvements in water quality. Evaluation results are presented below.

Wet Ponds

Wet pond sediment had a wide range of concentrations, with the lowest of some parameters at the wet ponds located in the residential areas, and some of the highest concentrations among all sites at Central Park. Findings are for the Central Park Wet Pond, which had the highest intensity land use among the wet ponds.

Central Park Wet Pond sediment had a higher fraction of clays and the highest concentrations of metals, polycyclic aromatic hydrocarbons (PAHs), nutrients, and total organic carbon of the BMP types.

The middle pond after planting.

Because of its large watershed and its effectiveness, Central Park Wet Pond removes, by far, the largest loadings of sediments and toxicities of all the project BMPs.

The wet pond system demonstrated its ability to control some nutrient loads with the removal of nitrates and total phosphorus. The removal of nutrients is enhanced by biological uptake. The treatment efficiencies for the constituents are higher than for most other control types. Evaluation results did not, however, demonstrate removal of total nitrogen and ammonia.

Despite the high cost of construction and maintenance, the wet pond is a cost effective method for controlling pollutants because of its ability to treat the runoff from very large drainage areas. The main drawback associated with this control is the space required to implement these large structures, particularly in urban areas. Perhaps some of the most important demonstrations accomplished by the grant for the wet pond were not the pollutant removal effectiveness or high sediment concentrations, but factors which may encourage implementation of ponds in other areas.

The third, or lowest stage of the pond. A recirculation system takes water from the lowest pond back to the upper pond to aid aeration.

Inlet Filters

Most of the material retained by the inlet filters consisted of trash, debris, and organic matter.

High concentrations of pollutants, but low volumes of sediment, are captured by the Austin-designed Street Inlet Filter Traps.

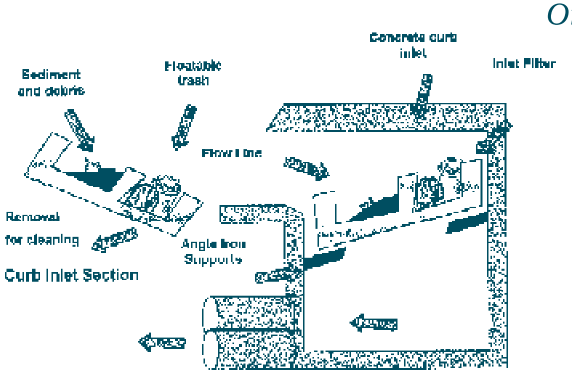
The sediments in the traps consisted of a lower percentage of the fine grain sediment fraction than other control structures.

Sediment captured from land uses associated with high vehicle use (Downtown and Barton Springs Road) had higher concentrations of total petroleum hydrocarbons (TPH), oil and grease, and many metals than did the other sites (residential and parking lot).

Extremely high values of PAHs were seen on several occasions at the Gillis Park inlet filters in a residential area. The source of these PAHs has not been determined, but elevated levels within East Bouldin Creek are also seen. Further investigations will be conducted by the City of Austin to examine sources of PAHs. The removal efficiency of the filters for total suspended solids was not significant.

Guests at the dedication ceremony learned about the construction of the wet pond, and the cleansing properties of the wetland plants.

Despite high concentrations of toxic constituents in inlet filter sediments, water quality sampling indicates that significant amounts of sediment and toxic substances may be bypassing the filters. The filters are, however, very effective at capturing trash and leaf litter. The high concentrations of metals and TPH in the land use areas with high traffic volumes seem to indicate that further design modification of these structures would make them more useful for treatment in areas where space is not available for additional control structures. Because of the high maintenance requirements for these BMPs, they are recommended for areas and receiving water bodies where trash control is the primary goal.



Inlet filter design. This filter is recommended for areas and receiving waters where trash removal is the primary goal.

Oil/Sediment Treatment Chamber

Water quality monitoring indicates no significant removal of pollutants. The lack of capture volume and insufficient flow length to settle fine-grained materials appears to limit performance of these structures. These structures may only be effective for very small drainage areas, if space is available for a proportionally large underground structure.

Like the inlet filters, accumulation of sediment in the chamber did, however, occur. Analysis indicates that the lack of data for small storm events and non-detect data in water samples may have underestimated removal efficiencies to some extent.

Monitoring results indicate that resuspension of sediments limits performance of oil/sediment treatment chambers. They may, however, be useful for "hot spots," or specific areas with a high concentration of toxic substances.

Integrated Pest Management Approach for Irrigation Canal Erosion Control and Rehabilitation in the Gulf Coast Region, LCRA, Funded FY 1993

LCRA maintains two irrigation districts located in Wharton and Colorado Counties. Rice is the principle crop of the area; forty percent of the rice produced in Texas is grown in the Colorado River basin. Undesirable vegetation has been a persistent problem along irrigation canal right-of-way areas. Invasive species such as johnsongrass, ragweed, McCartney rose, hackberry, chinese tallow, and willow do not aid in erosion control and water conservation. These plants also require expensive mechanical and chemical controls. With increased concern about the environmental impacts of herbicide use, the Lower Colorado River Authority applied for and received 319(h) grant funding to conduct a demonstration project that would identify the best grass species for canal revegetation that was low maintenance, provided good ground cover, and deterred weed competition, thereby reducing traditional dependence on herbicide application.

To begin the project, LCRA, along with their cooperators, Texas A & M University and Wharton County Junior College, selected and prepared test vegetation plots along a section of canal bank near the Lane City pumping station. The plots consisted of four replications each of four vegetation types selected for testing: King Ranch Bluestem, Jiggs Bermuda, Kleingrass, and Common Bermuda. The test plots were planted in 1995. A series of rainfall tests and density monitoring inspections were conducted over the next three years. The study design consisted of three replications each of two treatments: herbicide application and an untreated control. Soil testing was done at the Wharton Junior College Soil and Forage Testing Laboratory to obtain fertilizer recommendations for the establishment of each specific vegetation type.

Texas A & M conducted runoff tests in 1996, 1997, and 1998. Each plot was sampled three to five days after herbicide treatment, using a drip-type rainfall simulator to determine infiltration rate and sediment production. Runoff samples were analyzed for suspended sediments, total dissolved solids, and herbicide concentrations. Data results indicated no differences between chemically treated and untreated plots for infiltration rates, sediment loss, total suspended solids, total dissolved solids, or vegetation standing crop. Variability in herbicide concentrations between runoff from treated plots, untreated plots, distilled water, well water, or distilled water spiked with herbicide mix resulted in no significant differences and was therefore deemed inconclusive. This situation pointed to a possible method or laboratory problem associated with analysis for triclopyr and glyphosate used in herbicides. Further study will still need to be performed in order to determine the fate of herbicide movement from vegetated canal banks. However, no short term hydrologic impacts were detected during the study.

Wharton County Junior College was responsible for evaluating the percent cover of desired species in each plot. Final results showed only three percent cover in the

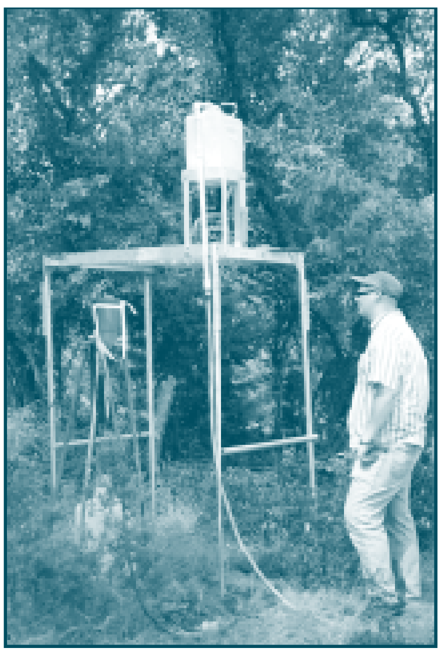
King Ranch bluestem plots and seven percent in the Kleingrass plots, due to poor germination and stand establishments. Common bermuda grass averaged 37.5 percent cover. Jiggs bermudagrass averaged 45 percent cover, but requires relatively high maintenance, making it less desirable. Common bermudagrass was selected as the vegetation cover that performed the best in the experimental plots.

During the course of the project, the Wharton County Junior College used the test plots in conjunction with curriculum associated with pesticides and integrated pest management. Students were given a background on the objectives and procedures of the study. A field day was held at the canal site in November 1995 for the benefit of local landowners and pesticide applicators.

After common bermudagrass was selected as the recommended vegetation, several sites were selected along area canals for rehabilitation. At one site, 31.6 acres of canal bank were disced, fertilized, and seeded with common bermuda in April 1998. An additional 19.5 acres was fertilized and seeded after land preparation had been completed. Local rice farmers assisted with the clearing, discing, and seeding. Spraying, rope-wicking, and shredding enhanced stand establishment. Work progressed on schedule and implementation was completed by August 1998.

Agricultural NPS/Creekside Conservation, LCRA, Funded FY 1993

Effective brush control management by Texas landowners has been shown to reduce erosion, increase water yield and improve wildlife habitat. This demonstration project evaluated different brush control techniques to regulate the encroachment of brush species on deteriorated rangelands of Central Texas. The project used two private ranches in Llano and Blanco counties, each with a different range site, to demonstrate three kinds of control practices for juniper. Best management practices studied at the Blanco County site included: 1) hand slash, pile, and burn; 2) spot treatment with herbicides; and 3) mechanical clearing, pile, and burn. There was also an untreated control. Both the mechanical and hand clearing methods included reseeding as part of the treatment. The BMPs for Llano County included: 1) mechanical clearing, pile, and burn with reseeding; 2) hand slash and leave the residue in place; and 3) a mechanical clearing without reseeding. Again, there was an untreated control.



A rainfall simulator was used to measure the amount and type of runoff in each of the landscaping methods evaluated.

Rainfall simulators were used at both sites to collect runoff data. These data were used to evaluate the changes in water quality and quantity between treatments. Reseeding efforts were hindered by very dry conditions which affected ground cover and vegetative recovery at the Llano site. The herbicide treatment at the Blanco site had very little impact on the brush species present (predominantly Ashe Juniper). Experts in the herbicide industry and brush management field could not provide an explanation as to why the brush was not killed or diminished; however, reseeding treatments after brush removal showed excellent response. Reseeding was conducted prior to rain events of approximately 3 inches over a four-week period. Photo points were established at both locations to track visual changes in treatments.

Final data analysis showed conclusively that infiltration rates at both sites improved with time as soil and vegetation conditions recovered. The infiltration rates for the treated sites were not significantly different from each other, but were significantly higher than the untreated control. Sediment loss is the primary hydrologic response to changes in infiltration rates, soil conditions, and cover. Sediment losses at the Blanco County site lowered as treatments improved soil and vegetation conditions. The soil losses from the mechanical and hand treated sites were one-half to one-third of the untreated site in Blanco County, and at the Llano County site were about two-thirds to one-third of the untreated control. BMPs at both sites produced significantly more standing crop than the control except for the herbicide treatment in Blanco and the mechanical treatment in Llano County. Vegetation standing crop is the visible result of practicing brush management. It is difficult for the land owner to see reductions in soil loss, but the increase in vegetation was readily visible. Increased vegetation production and cover is also a direct benefit to wildlife. By controlling less palatable shrubs, water available to forage plants for livestock was increased.

Each landscaping method was duplicated in a microlandscape. A triangular container captured runoff for analysis.

During the project, five field tours of the Blanco and Llano study sites were conducted. Participants included high school students, college students, ranchers, Soil and Water Conservation Board directors, and state and federal land management agencies. The tour included descriptions of the study, proposed objectives, and a herbicide application work day. Students were shown the effects of vegetative cover on infiltration rates and sediment production. A field day at the Llano site was conducted while field data was collected on May 20, 1998. This allowed participants to see the methods used for data collection. Approximately 25 people from the LCRA, TNRCC, Texas Agricultural Extension Service, Natural Resource Conservation Service, and the local community attended the field day. An informative brochure summarizing the project and its results was completed for public distribution. LCRA also produced a video targeted to local landowners which depicts the purpose of the project, data collection processes, interagency collaboration, and results.

The study proved that BMPs could be used effectively to reduce brush cover, control erosion, and improve hydrologic conditions. The results of this study will help local residents understand the relationships between vegetative cover, sediment production, and water quality. It takes approximately two to three years before soil losses in the treated area are less than they were before treatment. Consequently, it takes roughly the same amount of time to observe improvements in hydrologic conditions. Although soil losses may actually be higher for one or two years after treatment, the benefit of greatly reduced losses for the long term offsets the initial detrimental effects. The results of this study validate the benefits of Ashe Juniper management as a soil and water conservation method.

On-Site Constructed Wetland for Wastewater Treatment in Matagorda County, LCRA, Funded FY 1994

This project demonstrated the benefits of constructed wetlands as an alternative treatment for domestic wastewater from single family homes. Coastal waters in LCRA's jurisdiction (including Matagorda Bay, Tres Palacios Bay, Caranchua Bay, and Powderhorn Bay) are impaired with high levels of fecal coliform. Currently, many on-site septic systems in the region fail because of high rainfall, clay soils that prevent infiltration, shallow groundwater tables, and small lot sizes. A survey conducted in 1990 by the LCRA revealed that 10 to 15 percent of the on-site wastewater systems in Wharton and Matagorda Counties discharge directly into nearby open ditches. These discharges contribute to high fecal coliform levels in state waters and are a public health concern.

Several organizations played key roles in the wetland design, construction, and maintenance. LCRA formulated this project to accomplish following objectives:

- To demonstrate constructed wetlands treatment technology in the coastal region as a viable method to reduce public health threats, improve effluent quality, reduce flow to existing overstressed drainfields, and reduce the pollution threat to ground and surface waters;
- To evaluate wetland effluent against both typical septic tank effluent and secondary treatment level effluent;
- To evaluate flow-through systems and soil loading rates;
- To determine whether the system properly treated and disposed of the wastewater.

This child's ball floating in open sewage is an example of the problem LCRA addressed in its Matagorda on-site constructed wetlands project.

The LCRA, working in conjunction with the Matagorda County Health Department, identified and selected candidate home sites in the community of Blessing, Texas. Candidate sites had problematic wastewater systems with one or more drain pipes discharging sewage into roadside ditches. With the full cooperation of the local home owners, two households with failing septic systems were retrofitted with constructed wetland systems.

Construction of the systems began in July 1996. Wastewater treatment began the following November. One system was designed to receive flows from a two-bedroom

Demonstration wetland constructed at the Deadrick household. Primary treatment at each site was provided by an existing septic tank. A two-cell wetland received and treated effluent from the tank.

Constructed wetland at the Hadden home. Monthly samples were taken at each site for one year. Effluent quality at both sites far exceeded that produced by a typical septic tank.

home (120 gallons per day); the other was designed for a three-bedroom home (180 gallons per day). All construction was done by staff of the Texas Agricultural Extension Service of Texas A & M University. Primary treatment at each site was provided by an existing septic tank. Effluent then flowed from the septic tank to the wetland systems which consisted of two 5 x 2 x 20-foot wetland cells with a drain field nearby. Plants that thrive in the Texas coastal area, such as calla lilies, horsetail, thalia, yellow iris, umbrella sedge, and spike rush were used. These plants were rooted in a layer of gravel below a layer of mulch, which sat atop another layer of gravel about 15 inches underground. As the wastewater flowed through the first cell, the plants filtered out nitrogen, phosphorus, and other nutrients, while bacteria remained in the bottom layers to be broken down by microscopic organisms. The second wetlands cell further filtered the water before it was finally pumped to the drain field to be absorbed into the soil. Four 300-gallon pump tanks were installed at each site to allow for data collection. An effluent meter on each pump line measured the volume of wastewater being generated. A cover was constructed over one of the wetlands to shed heavy rainfall which would have added volume to the drainfield and interfered with the wetland performance. Mounding of backfill and establishment of vegetation over the disposal area was accomplished in order to deter the effect of rainfall saturating the drainfield and to prevent surfacing effluent. Both systems experienced excellent growth of plants.

The Matagorda County Health Department collected monthly samples at each wetland site for a period of one year to determine how well the systems performed. Results from the subsurface monitoring produced an effluent quality which compared favorably with that of secondary level effluent quality requirement. The effluent far exceeded the effluent quality produced by a typical septic tank. Fecal coliform levels were reduced in both wetlands by 99 percent. The following table presents the wetlands' performance during the study period measured against Texas secondary effluent standards and septic tank effluent industry standards.

Wetlands Performance Measurements

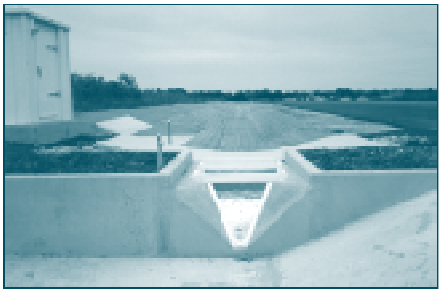
Parameter	Septic Tank Effluent - Type	Secondary Effluent - 30 day avg.	Hadden Wetland	Deadrick Wetland
Biochemical Oxygen Demand 5	140 mg/l	20 mg/l	27 mg/l	9 mg/l
Total Suspended Solids	75 mg/l	20 mg/l	13 mg/l	8 mg/l
Total Nitrogen	40 mg/l	N/A	30 mg/l	2 mg/l
Total pH	15 mg/l	N/A	3.6 mg/l	0.1 mg/l

It was also discovered that high effluent was disposed of through the soil with greater efficiency than typical septic tank effluent. As a result, it follows that substandard drainfields could dispose of more volume after wetland treatment than that following treatment by a septic tank alone. Similarly, drainfields experiencing failure problems as a result of soil plugging may recover previous functionality with the addition of much improved effluent quality generated by a constructed wetland. Wetlands are also feasible in retrofitting a failing drainfield that may have been originally installed under a permit having smaller sizing standards than those currently required. The results of this project indicate wetland technology is a viable option to improve wastewater effluent quality and thereby reduce public health and pollution threats.

Several articles about the project and the benefits of constructed wetlands appeared in various publications and newspapers. A well attended field day was conducted in November 1996 for the benefit of public health officials, environmental organizations, and septic installers. LCRA staff spoke at several environmental conferences about this method of alternative wastewater treatment.

Public health officials, environmental organization representatives, and septic installers learned about the wetlands technology at a field workshop.

Brodie Lane South Roadside Vegetation BMP, Travis County, Funded FY 1994



Reach Number 2 outflow looking north in April 1995. Automatic sampling station on the left.

Travis County's Brodie Lane South Roadside Vegetation Management Practices Project was designed to obtain storm water monitoring data that would demonstrate the effectiveness of a subject BMP in improving roadway storm water runoff quality. The BMP was comprised of a series of vertical gabion berms (rock-filled wire baskets) or "mattresses" placed across the bottom of a specially vegetated roadside channel adjacent to Brodie Lane in south Austin. This type of BMP was selected to slow flow velocities, allow solids to settle, provide for nutrient uptake by the vegetation, provide biodegradation of petroleum hydrocarbons, and increase soil infiltration of storm water. Primary goals for this project included:

- Provide pertinent information and data related to storm water constituent removal associated with the studied innovative BMP that would assist in future roadway designs, water quality retrofit designs, and technology transfer.
- Provide supplemental information and data related to storm water constituent removal for a comparative baseline Bermuda grass channel;
- Implement a successful storm water BMP system along Brodie Lane South, thus reducing storm water pollutant loads within the Bear Creek Watershed and Edwards Aquifer Recharge Zone.
- Provide pertinent information and data to aid in evaluating the studied BMP as an economical alternative on roadway projects to structural pollution control measures such as sedimentation and/or filtration facilities.

Reach Number 2 outflow and vegetation in September 1997.

Travis County successfully established grass cover in the roadside channel despite drought conditions experienced during the project time period. Vegetation was planted upstream of the gabions, with native grasses seeded on the side slopes, shoulders, and ditch bottom. Species such as Buffalo grass, Green Spangletop, Indiangrass, Little Bluestem, and Sideoats Gramma were planted because of their drought resistance and overall hardiness, their extensive fibrous root system, their sturdy above-ground stem mass, and their low maintenance requirements after establishment. Replanting and reseeding was done in spots where vegetation had not reached desired thickness. Erosion matting was put in place in areas with no vegetation. Efforts were made to control the invasion of undesirable grass species with spot herbicide applications. Vegetation coverage eventually reached 95 percent or greater within the roadside shoulder, side slopes, and channel.

Grass planting at Reach Number 5 in April 1995.

The effectiveness of this BMP in removing pollutant loads to the surrounding Bear Creek watershed was measured through storm water sampling. Contaminants typically associated with roadway runoff were monitored. Storm water samples were collected at the inflow and outflow points of the primary BMP reach (Reach No. 2) using automatic samplers and at three supplemental downstream reaches (Reaches 3, 4, and 5) using grab sampling. Reach No. 1, a Bermuda grass-lined channel in the upstream (northern) end of the study area, typified an existing standard roadside revegetation practice that the gabion/vegetation BMP reach could be compared to in terms of storm water pollution reduction.

Reach Number 5 in May 1998.

Unfortunately, due to drought conditions during baseline monitoring, insufficient storm water data was collected in Reach No. 1 to permit a comparison between the baseline and the BMP system. However, sufficient data was collected to assess the positive effects of the BMP in Reach No. 2. A total of eleven storm events were sampled, analyzed, and evaluated at this reach. The BMP removal efficiency for each constituent was computed as a flow-weighted value for all the storms considered. The results are shown in the table "Overall BMP Consituent Removal Efficiencies (percent)."

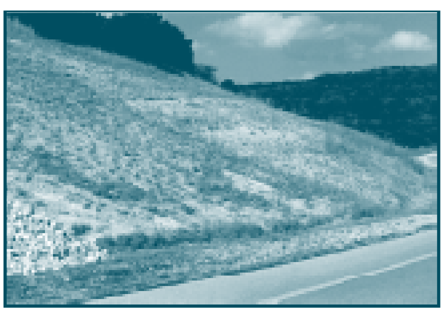
Overall BMP Constituent Removal Efficiencies (percent)

Parameter	All Storms	Small Storms
COD	12.72	11.26
N-kjeldahl	-4.28	59.24
Nitrate+Nitrite Nitrogen	59.86	61.64
Total Nitrogen	5.23	59.60
Orthophosphorus	43.58	75.32
Total Phosphorus	42.07	75.05
Total Petroleum Hydrocarbons	-21.76	-311.06
Total Lead	-25.42	66.67
Total Zinc	48.51	3.05
Total Suspended Solids	15.78	20.97

For all storms sampled and evaluated, the removal efficiencies attributable to the BMP system were positive for 7 out of the 10 constituents monitored. For smaller storms, removal efficiencies were positive for 9 out of 10 constituents. Runoff exiting Reach 2 was measurably less than the volume entering the reach, demonstrating how BMPs of this type provide a reduction in runoff volumes compared to curb, gutter, and storm sewer systems.

Even though data was somewhat limited, the BMP system appears capable of significantly reducing roadway storm water constituent loads to downstream water bodies in comparison to constituent loads that would be expected from impervious roadway drainage systems. In addition, the non-erosive roadway channel offered additional constituent removal as the storm water flowed off of the paved roadway surface over a vegetated roadway shoulder area, down the channel slope, and into the channel bottom.

Prior to the monitoring activities of this project, there was no known existing information or data concerning this specific type of BMP. This BMP is very compatible with the existing Travis County Rural Road system, most of which consists of roadways with roadside grass swale drainage systems rather than curb, gutter, and storm sewer drainage facilities. Given the concern about storm water quality in the Austin/Travis County area, especially in the Edwards Aquifer recharge area, the County has plans to apply this technology to future roadway designs.



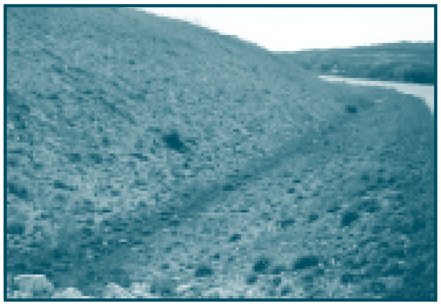
Oasis Bluff Drive site before restoration. Runoff from the site was visibly turbid.

Travis County Roadside Slope Restoration, Travis County, Funded FY 1994

The objective of this BMP implementation project was to restore two roadside slopes in Travis County that had deteriorated from erosion. The roadsides addressed were Southwest Parkway and Oasis Bluff Drive, both located in southwestern Travis County and situated over the Edwards Aquifer recharge zone, one of the most environmentally sensitive watersheds in the state.

Oasis Bluff Drive site after restoration. A total of 6.26 acres of roadside were revegetated under this project.

When these roadways were constructed during the Austin building boom of the mid-1980's, many large, steep roadside slopes were created through excavation of limestone terrain. Due to the steep gradients, lack of abundant topsoil, and rocky outcrops in the area, these slopes are difficult to revegetate after they are disturbed. Many of these limestone slopes were never completely restored with vegetation because the original restoration plan was not adequate, nor did it address the need to salvage topsoil. There were no provisions for collection systems or ponds for nonpoint source pollution control. Despite the efforts of Travis County to restore some of these roadside areas in the past, there were still several large slope areas varying in size with vegetative cover of only 10 to 30 percent. Much of the heaviest sedimentation from the partially restored roadside areas occurred during the last 10 years, but significant amounts of sedimentation were still being observed, especially during large storms. This was evidenced by visibly turbid runoff in the drainage channels below the slopes. The lack of vegetative recovery and topsoil restoration resulted in several negative impacts.



Southwest Parkway site before restoration. Overall vegetation coverage was increased by 60 to 65 percent after the first year's growth.

Southwest Parkway site after restoration. Erosion and soil loss was reduced by 70 percent. Total runoff quantity was also reduced.

Students in the Bouldin Creek area constructed a model of their watershed.

(1) Unstabilized areas facilitated continued erosion, which contributed to poor runoff water quality.
(2) Reduced soil infiltration capacity caused greater total stormwater runoff quantity.
(3) The aesthetics of the area were reduced.

To accomplish the roadway slope restoration, the County implemented the restoration methods documented in their successful Pace Bend Park 319(h) restoration project (completed in 1997) to revegetate and stabilize the roadsides. By the end of August 1998, a combined total of 6.26 acres had been restored at the two roadways through the application of topsoil, grading, seeding with native species, and matting. Channels below the slopes were treated with a technique similar to the Brodie Lane Roadside Vegetation BMP, which involved the installation permanent runoff rock detention berms to capture sediment and additional runoff pollutants as the vegetation grew to maturity. Travis County contracted for irrigation services during April, May, and June 1998 when drought conditions jeopardized initial germination. This action sustained the plants through the critical growing period and ensured the success of the project.

Two primary quality objectives/direct data measurements were utilized to document this project's success:

- photo documentation of vegetative cover percentage of 60-70 percent;
- sampling and analysis to document a minimum clay percentage of 30 percent and a maximum sand percentage of 50 percent in the topsoil.

The establishment of a minimum vegetation cover was the most important single factor to ensure the success of the project. Each slope was photographed and a visual estimate of total vegetation cover percentage performed before and after treatment. Significant rains in late August and September increased the overall vegetation coverage during the first growing season to 60-65 percent. The remaining area was protected for an additional 1 to 2 years by a soil retention blanket which will allow full establishment of predicted coverage.

Sampling of the two major topsoil stockpiles used for the project showed 22.5 percent clay, 58 percent silt, and 20 percent sand. Two other samples showed less than 20 percent clay, but consistently 20 percent or less sand. Based on these samples, the topsoil was under the 30 percent clay minimum goal, but substantially exceeded the 50 percent or less goal for sand content. Based on the fact that the combined content of the topsoil was 80 percent clay/silt and 20 percent sand, the topsoil quality goal was substantially met. Having a topsoil with greater clay content is critical to preventing long-term significant soil loss on the steep slopes.

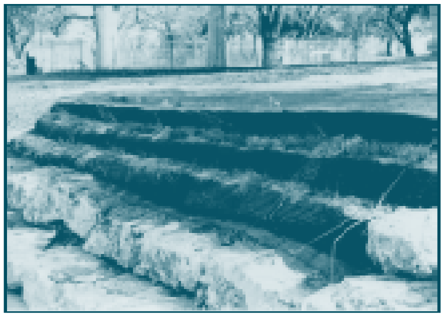
Having achieved these project objectives, the following environmental benefits can be inferred as the vegetation fully matures:

- reduced erosion and soil loss from the unstable areas up to 70 percent;
- plant density and species diversity equivalent to or greater than surrounding natural conditions; and
- significantly increased soil infiltration capacity and reduced total runoff quantity.

East Bouldin Creek BMP Implementation and Evaluation Project, Funded FY 1994

The objective of this project was to decrease the load of toxins, sediment, and other urban nonpoint source pollutants entering Town Lake from East Bouldin Creek. The objective was accomplished by encouraging and implementing effective nonstructural and structural BMPs in the watershed. Effectiveness of those BMPs was evaluated, using volunteer environmental monitors and a paired watershed evaluation design. Project activities included a variety of educational activities.

Bouldin Creek upstream of restoration site.



Bouldin Creek bank revegetation.

Volunteers learned macroinvertebrate sampling techniques.

Project planning and volunteer recruitment began in the Fall of 1995. Since that time, nine sites on East Bouldin Creek, Blunn Creek, and Harpers' Branch were monitored. Twenty-three certified Texas Watch Core Monitors collected a total of 181 ambient samples. The Bug Watch program, another monitoring activity developed under this project, involves volunteer monitors in the collection of benthic macroinvertebrates and the assessment of their habitat. A total of eight macroinvertebrate samples were collected for the project. Four training classes were conducted for approximately 55 project participants. The macroinvertebrate samples collected by the volunteers were identified, and the data were presented at the North American Lake Management Society meeting in Houston, December, 1997. Unfortunately, due to administrative delays in procuring contracts for BMP implementation, the data collection period was not long enough to determine if the BMPs had a positive effect on water quality.

Carla Marshall, an Austin school teacher with an interest in environmental education, developed an NPS curriculum, teacher's handbook, watershed model, and a video for area school children. Her students presented many of the lessons to children from other schools. Ms. Marshall also worked with the Austin School for the Blind to propagate native plants for use in the habitat restoration component of the project. Approximately 500 plants were established along the banks of East Bouldin Creek.

The American Institute for Learning (AIL) gave several NPS educational presentations: to the East Bouldin Creek Neighborhood Association, the 1998 Texas Watch Meeting of the Monitors, the Austin Youth Options Program, the Governor's Environmental Excellence Awards, the True Light Baptist Church, the Austin Jewish Community Day School, and the Texas Land Trust Meeting. AIL also conducted a cleanup of East Bouldin Creek, with 11 Environmental Corps staff and students, 9 students from Austin Youth Options, and two neighborhood representatives. AIL involved five local businesses in the cleanup and found many other sponsors to advertise for the event.

Texas Watch staff made presentations to the following groups: the Austin Sierra Club (who subsequently became very involved in monitoring), 80 students at a summer program at the University of Texas, the Dawson Neighborhood Association, and Palm Elementary School. Participants at these events learned how to conduct ambient water quality tests, how benthic macroinvertebrates sampling can show the effects of NPS pollution, and how to make simple changes in their daily lives to reduce NPS pollution.

To deal with sedimentation problems that have occurred in the watershed, the City of Austin conducted two educational workshops in erosion control. The City is placing increased emphasis on ensuring the effectiveness of erosion controls as a method of reducing nonpoint source pollution. One workshop was conducted in Fall 1997 on stream bank stabilization techniques for landscapers and developers. As part of this workshop, the city successfully stabilized 250 feet of creek bank at Gillis Park in the Bouldin Creek watershed. After the workshop, the City stabilized an additional 200 feet of eroding stream bank. A videotape of the stabilization techniques was produced to assist in teaching them to others.

A second workshop was conducted by the City on state-of-the-art erosion control techniques for developers and city inspectors from the public and private sector. The workshop focused on improving the quality of surface water runoff through the design, maintenance, and installation of erosion controls for development projects. Eighty-four participants attended the workshop. City staff also consulted privately with the workshop instructor, a nationally recognized erosion control expert, who made specific recommendations on revisions to the city's erosion sedimentation standards. Draft rules on erosion control were developed and are expected to be adopted by the City in 1999.

Implementation of Best Management Practices to Reduce Nonpoint Source Loadings to Onion Creek Recharge Features, Barton Springs/Edwards Aquifer Conservation District (BS/EACD), Funded FY 1992

Antioch Cave BMP on Onion Creek during dry conditions. The 26-inch valve in the end of the concrete vault is protected by a welded steel grill. A blanked-off flange for clean-out needs or possible future installation of a second valve can be seen on the side between the buttresses. The BMP is about 6 feet high, 7 feet wide, and 13 feet long.

The Barton Springs/Edwards Aquifer Conservation District conducted this project in Hays County just west of Buda, Texas. The project contract was signed on October 28, 1993, with a contractual starting date of September 30, 1993. The project ending date was March 31, 1998.

This $271,550 project was designed with three primary tasks:

(1) BMP implementation,
(2) monitoring, and,
(3) technology transfer.

Later, a fourth task was added,

(4) purchase and use of $67,483 of water quality monitoring equipment, using funding remaining at the TNRCC from the FY '88 EPA Nonpoint Source Program. The EPA provided 60 percent of the funding and the District matched with 40 percent .

Antioch cave BMP several days after a heavy rain resulted in an 8 to 9 feet deep flood. The first flush has passed and the water is about 6 feet deep and very clear. The valve is open and a small whirlpool can be seen near the far end. The large PVC pipe is a line vent and the smaller one contains monitoring and sampling lines. The stabilized construction entrance and protective fencing can be seen on the opposite bank.

Don Rauschuber, Project Engineer, and Ron Fieseler, Project Manager, designed and installed an innovative BMP over the entrance of Antioch Cave. The BMP consists of a concrete vault with a 36-inch diameter air-operated butterfly valve in one end. Once turbidity in Onion Creek drops to an acceptable level (generally 100 NTUs or less), or after flood debris is greatly reduced, staff opens the valve to allow water to recharge into the cave.

During the first three months of 1998, the Onion Creek watershed received considerable rainfall, resulting in several stream flow events, including a 12.5' flood stage recorded in mid-March. The 36-inch valve was open for a total of 2,509 hours (104.5 days) between January 8, and May 6, 1998, and recharged approximately 9,656 acre-feet or 3,146,500,00 gallons. Recharge averaged 46.6 cubic-feet-per-second (cfs) for the entire period, with the highest flows reaching 94.5 cfs. This far exceeded the previous USGS estimate of 25 cfs for the Recharge Zone below Barber Falls. This increase is a direct result of the installation and operation of the BMP. Permitted pumpage from District-regulated water wells totaled approximately 1.6 billion gallons for FY 1998. In just three and one-half months, the Antioch Cave BMP recharged almost twice that amount of water. This project should be useful in demonstrating the value of implementing future BMP structural controls. The project may also be used as a model for the planning and effectiveness evaluation of other similar BMPs.

The quality of water flowing down Onion Creek is generally very good. As expected, concentrations of some constituents were higher during flood (first flush) conditions. Most of these were reduced as the water cleared. Many of the constituents were below detection limits. Turbidity, trash and debris, and suspended solids entering the aquifer through Antioch Cave were reduced over 90 percent, and possibly as much as 95 to 98 percent, depending on how soon the valve was opened following a flow event. Bacteria counts showed reductions from 30 to 90 percent.

This type of BMP is easily maintained, operationally simple, and virtually tamper-proof, and should prove efficient and cost-effective for installation at similar significant recharge features subject to flow or flood conditions.

The District acquired 38.6 acres containing Antioch Cave and approximately one half mile of Onion Creek at the eastern edge of the Recharge Zone. This acquisition, which removed the property from potential harm from active quarry operations and/or future development, was incorporated into the project as an effective nonstructural BMP.

A cave explorer begins his descent into the 35'-deep entrance shaft of Antioch Cave in Onion Creek. Exploration and mapping efforts are limited to dry weather due to flooding hazards.

A whirlpool forms directly over the natural entrance to Antioch Cave, easily seen in the clear water. The small dark spot in the foreground is a fist-sized hole which connects with the cave.

Despite monitoring equipment damage during the record flood of October 1998, District staff were able to open the valve to capture additional recharge. It is clear that this BMP will provide long-term water quality and quantity benefits to aquifer users far into the future.

Regional Aquifer Protection in the Nueces-Rio Grande Coastal Watershed, TNRCC Groundwater Nonpoint Source Program, Funded FY 1995

The purpose of the Nueces–Rio Grande Coastal Basin project is to protect groundwater from nonpoint source pollution. Methods used to protect groundwater resources from nonpoint source pollution include: wellhead protection activities, the TEX-A-Syst Program, and public education.

Wellhead protection was implemented for the City of Falfurrias, the Naval Air Station–Kingsville, and the Country Estates Trailer Park–Kingsville. These public water supply wells produce water from the Evangeline Aquifer (Goliad Sand). Final wellhead protection reports were prepared and made available to operators and local government representatives. The reports contain maps depicting computer-generated wellhead protection areas, land use, and potential sources of contamination. Since water supply wells are located in the confined portion of the Evangeline Aquifer, abandoned wells and wells with a leaky casing pose the greatest threat to water quality.

Project results for the City of Falfurrias project were presented to city and county officials (Brooks County), who expressed significant interest in water quality issues at the meetings. The TNRCC and its regional office provided follow-up information for on-site wastewater programs and solid waste management.

The TEX-A-Syst Program was implemented for water supply wells within Mustang Island State Park. The project report included a map depicting potential sources of contamination within the park boundary that could impact the quality of water in the freshwater lens present in the barrier island sands.

The major threat to water quality in the Evangeline Aquifer in Brooks and Kleberg Counties and in the freshwater lens on Mustang Island (Nueces County) is the naturally occurring, elevated concentrations of chloride and sodium. Since public water supply wells studied in the Falfurrias and Kingsville area are located in the confined portion of the Evangeline aquifer, abandoned wells pose a threat to water quality. The TNRCC recommended that the City of Falfurrias, the Naval Air Station–Kingsville, and the Country Estates Trailer Park pursue an active program to locate and properly plug abandoned wells.

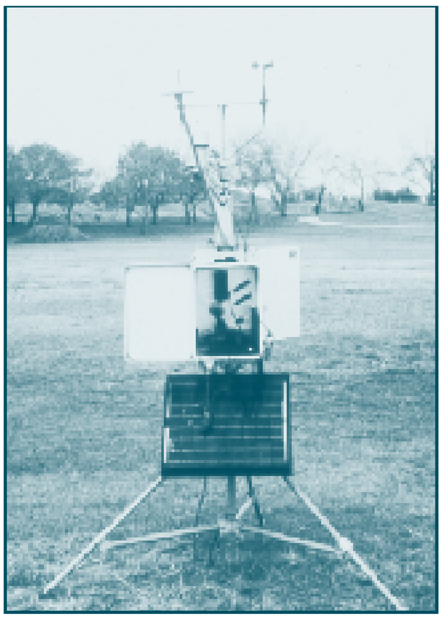
Integrated Landscape Management: Urban Best Management Practices in the Arroyo Colorado Watershed, Texas Agricultural Experiment Station (TAEX), Funded FY 1992

The Arroyo Colorado and its tributary, the North Floodway, is the principal drainage outlet for the Lower Rio Grande Valley of Texas. The Arroyo flows through Hidalgo, Cameron, and Willacy Counties and discharges into the Laguna Madre. Contributing waters to the Arroyo include possible base flow from the Rio Grande, urban runoff, agricultural runoff, irrigation return flow, and municipal and industrial wastewater and effluent. Perennial flow is supported by municipal discharges from the cities of Mission, McAllen, Pharr, Donna, Harlingen, and San Benito.

The Arroyo Colorado above Tidal is designated as segment number 2202 in the Texas Water Code. The state of Texas has adopted designated uses and water quality standards for this stream segment. Segment 2202 has been classified as water quality limited due to periodic eutrophication, low dissolved oxygen conditions, excessive plant and algae growth, and occasional fish kills.

Poor landscape nutrient and water management can be a significant source of nonpoint source pollution. Rainfall and irrigation runoff can carry fertilizer and other chemicals applied to urban landscapes into adjacent water bodies. The purpose of this project was to demonstrate proper irrigation and nutrient practices for urban land-

Automatic samplers were used to measure runoff.



An automated weather station retrieved daily weather information.

scapes using integrated landscape management, and to educate landscape managers on management techniques that reduce the potential for urban nonpoint source pollution.

The project demonstration site, located at the City of Harlingen Tony Butler Municipal Golf Course, was used to demonstrate proper irrigation, nutrient, and monitoring techniques that reduce the potential for urban nonpoint source pollution. Activities included soil sampling and analysis, soil moisture monitoring, small watershed water quality sampling, and daily weather information retrieval with an automated weather station. Several tours were given to local city officials and golf course managers.

Educational events were organized for municipalities, golf course managers, professional irrigation and landscape contractors, and home owners to demonstrate integrated landscape management practices and their benefit in reducing urban nonpoint source pollution. Presentations included discussion of water demand and supply projections, proper fertilizer recommendations and application methods, techniques for troubleshooting, testing, and developing irrigation schedules that improve landscape water use efficiency, and pest identification and treatment methods. The following education programs and products were developed during the project period.

Events

- Landscape Irrigation Auditing and Management Training – Weslaco, 1/96.
- Hidalgo, Cameron, and Willacy Master Gardener Arroyo Colorado Seminar – Weslaco, 7/96.
- Integrated Landscape Management Demonstration Site Staff Training – Harlingen, 9/96.
- Urban Arroyo Colorado—Integrated Landscape Management Seminar – Harlingen, 8/97.
- AmeriCorp Volunteer Irrigation Audit Training – Weslaco, 2/98.
- Urban Arroyo Colorado—Integrated Landscape Management Seminar – Brownsville, 3/98.

Education Media

- Informational brochure that discussed monitoring activities on the demonstration site and integrated landscape management techniques for reducing urban nonpoint source pollution.
- Two thirty-second video news releases on landscape irrigation and fertilizer management.
- Stand-alone Integrated Landscape Management educational display for public meetings and educational events.
- Arroyo Colorado—Integrated Landscape Management Web site. Includes irrigation and nutrient management slide sets and narratives. (http://www.agen.tamu.edu/projects/ArroyoCol).
- Landscape Manager's Guide to Irrigation and Nutrient Management.
- Daily potential evapotranspiration (PET), weather summaries, and water requirements calculator. (PET Web site: http://texaset.tamu.edu)

Approximately 25,000 contacts were made through direct mailing of brochures, training programs, public service announcements, the Web site, and information dissemination through AmeriCorp and Master Gardener volunteers. Sixty percent of the contacts use irrigation and fertilizer as part of their landscape management practices. As a result of the educational efforts, approximately 40 percent of these reduced overall irrigation and fertilizer application.

Arroyo Colorado Watershed Nonpoint Source Pollution Project, Texas State Soil and Water Conservation Board, Funded FY 1992

The objective of this project was to address the impacts of NPS pollution resulting from agricultural runoff in the Arroyo Colorado watershed. Two demonstration farms implementing BMPs were monitored to measure water quality improvements.

Results of BMP evaluations indicated significant reductions in nutrient and pesticide loads from implementation within the study area. Percent reductions in total nitrogen loads exceeding 30 percent were estimated for improved nutrient management, improved irrigation water management, and improved irrigation technology. Improved nutrient management also had the greatest impact on total phosphorus loads with an estimated 15 percent reduction. The two BMPs dealing with irrigation practices (improved irrigation water management and improved irrigation technology) showed the greatest potential for reducing contributions of pesticide and sediment losses from cropland areas. Based on the analysis, BMP #2, Improved Residue Management, displayed only minor reduction in nutrient loads, but effected an estimated 18 percent reduction in sediment loss due to water erosion. Improved nutrient management resulted in an estimated 34 percent reduction in total nitrogen losses and an estimated 15 percent reduction in total phosphorus; however, it showed no change in pesticide contributions.

Although BMPs # 5, and 6, dealing with Land Leveling Practices and Integrated Pest Management (IPM) practices, both displayed rather minor reductions in constituent loads, it is important to note that these practices are largely implemented under the baseline condition and that this evaluation merely dealt with increasing the implementation in each case to 95 percent. It cannot and should not be concluded that the effectiveness of these BMPs has already been realized. It would appear that educational and planning efforts by TAEX, NRCS, TSSWCB, and other organizations in IPM and Land Leveling Practices have been largely successful in effecting implementation among area producers.

The actual environmental benefits associated with these practices may be demonstrated by the differences in surface and subsurface pesticide losses predicted for a single field under the low and full implementation schemes . The average pesticide loss predicted for surface runoff from a cotton–grain sorghum rotation on a soil representative of improved residue management ranged from 5.9 grams/hectare under a low-level IPM program to 4.4 grams/hectare under the fully implemented IPM program. Similarly, the subsurface pesticide losses decreased from 3.4 grams/hectare to 0.01 g/hectare.

The evaluation of all applicable BMPs for cropland within the study area displayed percent reductions of loadings ranging from 21 percent to 78 percent. Percent reductions estimated for total nitrogen, pesticide, and sediment losses exceeded 60 percent for all BMPs combined.

Lake Fork Reservoir Watershed Management Project, TNRCC, TSSWCB, Funded FY 1993 (3 projects)

Cattle in the creeks contributed to the problem in the Lake Fork watershed.

The Lake Fork Reservoir project promoted the adoption of BMPs to reduce nonpoint source pollution in the Lake Fork Reservoir watershed. This collaborative project involved a number of agencies. Participants included the TNRCC Tyler Regional Field Office, the TNRCC Groundwater Protection Team, the Texas State Soil and Water Conservation Board (TSSWCB), Tarleton Institute of Applied Environmental Research (TIAER), the Natural Resource Conservation Commission (NRCS), the Hopkins-Rains Soil Conservation District, the Texas A&M Agricultural Extension Service (TAEX), and the Texas Agricultural Experiment Station (TAES).

The Lake Fork Reservoir watershed is an area of approximately 575 square miles within the boundaries of Hopkins, Rains, Wood, and Hunt Counties. The watershed has a high-density rural population and is also experiencing significant growth in the agriculture industry. Family-operated small dairies (average of 129 head), account for most of the agricultural growth. Only a few of the dairies in the watershed have waste management systems that meet the requirements of the TNRCC. Water quality problems in the reservoir have been associated with elevated levels of bacteria, nutrients, and dissolved oxygen. Due to the intensity of dairy operations in the area, nonpoint source impacts from dairy activities (i.e. inadequate retention, distribution, and control of manure and wastewater runoff) are a concern. This situation prompted a concentrated effort by the agencies involved to encourage implementation of BMPs by local producers. Other potential water pollution issues in the watershed included failing septic systems and groundwater contamination due to shallow water table conditions.

The TNRCC Regional Office in Tyler was charged with identifying the impacted streams and pollutants and monitoring instream water quality to assess differences before and after BMP implementation. The regional TNRCC Dairy Outreach representative performed on-site inspections of dairy facilities and provide owners and operators with information on cost-sharing programs to facilitate BMP implementation. The TNRCC Groundwater Protection Team conducted a sampling program to evaluate the soil profile, groundwater, and perched water bearing zones to provide data on existing background conditions and evaluate any changes that occurred after BMP installation. Concurrent with monitoring, the TSSWCB and their cooperators assisted local dairy operators in development of waste management plans and voluntary installation of BMPs. Other tasks performed included completing an inventory and GIS database, assessing the cost effectiveness of implemented BMPs, and conducting education and technology transfer for dairy operators.

Baseline monitoring on several Lake Fork tributaries was conducted in 1994 and 1995. Water, sediment, biological, and storm water samples were collected. Two subwatersheds were eventually chosen as the focus of the study. The Running Creek subwatershed was identified as the most impacted by NPS pollution. Dairies within this subwatershed were targeted as candidates for BMP implementation. Two dairies with leaking lagoon problems were selected as demonstration dairies for BMP implementation and edge-of-field monitoring. A second subwatershed, Elm Creek, appeared not to be impacted and served as a reference stream. Ambient water quality within these two subwatersheds was monitored on a monthly basis and storm water data was collected as rainfall permitted. Parameters monitored included nutrients, dissolved oxygen, fecal coliform bacteria, metals, organic compounds, and aquatic macroinvertebrates.

Leaking dairy lagoons in the Running Creek watershed were a waste management problem addressed by the project partners and local dairy operators.

The Sulphur Springs District Office of the NRCS designed the specific BMPs for the two demonstration dairies. The waste management plan for one dairy included an underground high pressure pump plus irrigation lines and sprinklers. The existing waste storage pond was relined and enlarged. Additionally, some of the bare pasture areas were seeded with grass and a fence was installed along the creek bed to exclude cattle. The waste management plan for the second dairy included construction of a new waste storage pond with a bottom liner designed to TNRCC specifications. An underground high pressure irrigation pump with irrigation line and sprinklers for lagoon effluent were another BMP used. Cattle exclusion fences were built around the creek bed. Additional acreage was set aside at each dairy for application of liquid waste.

At the conclusion of TNRCC's baseline surface water quality monitoring, concentrations of ammonia-nitrogen, nitrite+nitrate nitrogen, total phosphorus, and fecal coliform bacteria in stream water were significantly greater at stream sites within the Running Creek subwatershed than those sites within the Elm Creek watershed. Results were similar for storm water monitoring samples. No differences were noted in regard to organic compounds or metals in stream water and sediment. Dissolved oxygen levels fell below TNRCC presumed levels during summer months at the Running Creek site. Benthic macroinvertebrates showed signs of stress in Running Creek; however, it could not be determined if the macroinvertebrates were reflecting poor water quality or lack of suitable habitat. Metals and organics were below analytical detection levels or of low priority. A series of comparisons were conducted between the reference

Aerial view of Lake Fork Marina.

subwatershed (Elm Creek) and the impacted subwatershed (Running Creek) based on monitoring data before BMP installation. Although this comparison was not the original goal of the project, the information gained from such comparison may prove useful if BMPs are implemented to a greater degree in the future.

Results of the TNRCC's pre-BMP groundwater monitoring at the two dairies indicated that there were impacts to the perched bearing zones. "Push-point" groundwater samplers were used to monitor the first water-bearing zone around each dairy lagoon. The sampling points were no deeper than 16 feet below the land surface. Sampling points around the holding lagoons were sampled twice before BMP implementation. Nitrates and total dissolved solids levels were significantly elevated above those of secondary drinking water standards. Evidence was conclusive that these two facilities were impacting the surrounding environment.

Edge-of-field monitoring to obtain nutrient data was performed by TIAER during stormwater runoff events at the two dairies. A paired watershed sampling design was implemented at each dairy. The pre-BMP data were statistically analyzed using linear regressions and t-test analyses to allow eventual comparisons with post-BMP data. Nitrogen and phosphorus were the primary parameters measured.

At the end of August 1998, BMPs had not been implemented for a sufficient duration to reflect a significant difference in ground or surface water quality in the Running Creek watershed. Drought conditions in 1996 and wet soil conditions in 1998 also negatively impacted project time lines. As discussed with EPA, it was agreed to conclude the project with BMP implementation accomplished. Even though post-BMP water quality improvements were not documented, the best management practices implemented have proven effective in the past. The TSSWCB is considering a follow-up project in the watershed with a subsequent 319 grant award.

Overall, 12 waste management systems which included numerous BMPs designed to reduce nonpoint source pollution were installed in the Running Creek watershed during the course of this project. Two of these systems were paid for with 319(h) funds. The remaining 10 were funded through other landowner financial assistance programs. BMPs installed or implemented by local dairymen under water quality management plans included improved waste storage ponds, waste transfer pipelines, irrigation/sprinkler systems, pasture planting, fencing, prescribed grazing, and improved waste and nutrient management techniques.

Other project accomplishments included:

- A Lake Fork Reservoir watershed and Running Creek subwatershed GIS Data Report was generated. The report provided an excellent overview of watershed characteristics which will be very useful for any future work performed in the watershed.
- A Dairy Outreach Training Guide for non-permitted dairy producers was developed by TAEX and used in a training program for dairy producers in the project area. This guide contains extensive information on dairy waste management and treatment procedures. In addition, a report was developed by TIAER to provide information for producers on the potential costs and environmental effectiveness of various nutrient BMPs appropriate for the Lake Fork watershed.
- Members of the TNRCC Dairy Outreach Program made site visits to 43 facilities in the watershed to inspect waste management handling procedures and publicize the availability of cost-share funds. Approximately 19 out of the 43 dairies are currently out of business. Approximately 16 owners or operators requested assistance with water quality management plans to be developed by the USDA-NRCS in cooperation with the TSSWCB. Waste management at the remaining facilities was adequate and NPS pollution potential was low.
- The Hopkins County designated On-Site Representative was contacted to discuss and review any records pertaining to on-site sewage facilities in the Running Creek watershed. No records existed regarding problems,

complaints, or installations of on-site sewage systems.

- The TAES disseminated information on wellhead protection to assist rural residents (under the TEX-A-Syst Program) in the Lake Fork watershed in assessing their well water pollution risks. Assessments identified management practices and structures that present pollution risks and recommended actions to reduce or eliminate those risks. Groundwater protection information was presented at seven meetings, five tours, and in numerous radio and news articles.

Illicit Discharge Abatement and Public Education, City of Carrollton, Funded FY 1994

This project focused on subwatersheds of the Elm Fork Tributary of the Trinity River that are threatened by nonpoint source impacts caused by rapid development within the city of Carrollton, Texas. The City targeted illicit discharge abatement, pollution prevention, and public education efforts as areas of activity.

The City completed all work tasks by August 31, 1998. City environmental staff conducted facility inspections for illicit discharges and identified and abated several illicit discharges to the storm sewer system during the course of the project. Approximately 80 major outfalls were screened using the La Motte Storm Drain Pollution Detection Kit and no illicit connections were identified. Dry and wet weather screening and sampling was performed to assess stormwater quality, develop additional baseline data, and identify sources of illicit discharges. Wet weather monitoring was conducted at three locations in different land use areas of the city. Due to extremely dry weather, however, only one rain event was sampled and analyzed.

The City also implemented a BMP education and public awareness program. Public education was conducted through Earth Day celebrations, Trinity River Awareness Days, and distribution of water bill inserts about nonpoint source pollution to home owners. A City-sponsored Open House was held on August 1, 1998 and was attended by over 6,000 residents. Storm water pollution information was distributed and personnel were on hand to discuss water quality issues with the citizens. Provisions of city pollution prevention ordinances were enhanced.

Active Statewide 319 Projects

Demonstrations at the site show how the wetlands work.

Constructed Wetlands for On-Site Sewage Disposal Station, Texas Agriculture Experiment Station, Funded FY 1995

This project was designed to evaluate the effectiveness of subsurface flow constructed wetlands for the disposal of on-site wastewater in a residential setting. Four demonstration sites were constructed over the Gulf Coast and Carrizo-Wilcox Aquifers to document the performance of constructed wetlands for treatment of domestic wastewater. Effectiveness monitoring has been conducted since approval of the Quality Assurance Project Plan. Monthly data collection was completed during the summer, and the data will be analyzed over the next several months. Preliminary data reflect consistently high reductions in total suspended solids, phosphorus, nitrates, and fecal coliforms.

Another project objective was the presentation of findings at educational meetings. Project staff presented information about constructed wetlands as an option for addressing wastewater treatment needs before a variety of audiences at six meetings held in 1998. A number of the presentations were short certification courses for system designers, installers, and regulators. All courses were very well attended.

A nine-month extension has been approved to allow completion of data analysis, as well as completion of the wetland video, and printing and distribution of fact sheets on the design, construction, operation and maintenance of constructed wetlands.

Wetlands, such as this one built under the Texas Agricultural Experiment Station's Constructed Wetland Project, can add beauty to the landscape in addition to removing pollutants.

Cooperative Local Government Initiative to Reduce NPS Impacts, North Central Texas Council of Governments (NCTCOG) and American Public Works Association, Funded FY 1996

The goal of this project is to transfer BMP technology by directing involvement of public works officials from across Texas to create the Texas Nonpoint SourceBook and make relevant information available on the World Wide Web. The draft version of the Texas Nonpoint SourceBook was presented at the Texas Public Works Association annual conference in June 1998. The majority of the committee attended this conference and correspondence was sent to them during the summer regarding review of the draft document. Subsequent revisions, additions, and enhancements occurred in the months that followed.

An article announcing the availability of the draft Texas Nonpoint SourceBook on the Web appeared in the Summer 1998 edition of the Thunderbolt *newsletter*. Information about the Web site will be included in the next quarterly issue of *New Ideas in Technology, Management, and Design*, published by the Carter Burgess consulting firm. An article on the Texas Nonpoint SourceBook appeared in the June 1998 issue of *New Waves*, published by the Texas Water Resources Institute. NCTCOG staff produced a color flyer to advertise the Web site and the presentation of the draft at the June American Public Works Association-Texas conference. An advertisement was submitted to EPA's nonpoint source information Internet bulletin board, which is sent to thousands of subscribers worldwide.

An update and presentation of the draft Texas Nonpoint SourceBook was presented to the Statewide Storm Water Quality Task Force and American Public Works Association-Texas general membership at the APWA-Texas annual conference in June 1998. NCTCOG staff and the project consultant gave a special presentation of the Web site and its capabilities to approximately 15 US EPA Region 6 staff on August 20, 1998. The Project Management Committee chair attended, as did the TNRCC project coordinator. Comments and suggestions were also received.

Information and features continue to be added to the Web site (http://www.txnpsbook.org). Users can connect to the EPA's Surf Your Watershed site and the TNRCC's Clean Rivers Program site, where the user can find water quality information about his or her specific locality of interest. The consultant will continue to add information to the Web site as the Texas Nonpoint SourceBook is further developed. In May 1998, a request for case studies and anecdotes on pollution prevention activities was sent to almost 500 local government staff and elected officials across Texas. NCTCOG staff anticipate that this will elicit useful information for addition to the Web site.

Both the consultant team and the project management subcommittees continue to compile available information resources. A substantial amount of information has been added to the Web site and it is continually revised and improved. The consultant has had some difficulty in receiving products on schedule from subcontractors, which has delayed the review process of some portions of the Web site document. Articles reporting on the status of the Texas Nonpoint SourceBook should be included in upcoming NCTCOG publications such as the *Insider* and *Your Region*, and in the APWA-TX newsletter the Participant. Additional articles may appear in other publications.

The APWA-TX Executive Committee approved the final draft of the Texas Nonpoint SourceBook in October 1998 during their meeting at the Texas Municipal League annual conference in San Antonio. The final draft was also presented to the Statewide Storm Water Quality Task Force at their meeting that same week.

Project objectives call NCTCOG to present three regional technology transfer and training workshops across the state, with the assistance of the Texas Engineering Extension Service. Options are being reviewed for presenting one of these workshops towards the end of the September-November quarter. An extension of the contract has been submitted to allow adequate time for the training workshops to be provided after the final document has been prepared.

Teaching Environmental Sciences, Environmental Education Program, TNRCC, Funded FY 1995

Instructor demonstrates nonpoint source pollution using a watershed model.

The objective of this project is to provide support for more Teaching Environmental Science (TES) courses for kindergarten through eighth grade teachers, a new education initiative being supported by TNRCC staff. The focus of the teacher training is to provide specific nonpoint source pollution education, encourage curriculum development that highlights nonpoint source issues, and share nonpoint source learning projects. A portion of the funding was dedicated to a library cataloging project.

During the summer of 1998, seven universities held TES courses utilizing nonpoint source grant funds. They included the University of Texas at San Antonio, Sul Ross University, University of Houston at Clear Lake, Stephen F. Austin State University, Texas A&M University at Texarkana, Texas Tech University, and Texas Southern University.

Detailed information was provided to teachers at each university relating to the personal responsibility of each citizen with respect to nonpoint source issues. The need to properly dispose of hazardous and common household waste was emphasized and supported with information on household hazardous waste and the historic problems related to its careless disposal.

Each university featured segments of their individualized curriculum devoted specifically to broad-ranging issues related to nonpoint source problems. For example, the University of Texas at San Antonio used Kelly Air Force Base as a stage to conduct their training and illustrate their message. Due to the various contaminants generated by improper disposal of materials during military operations, this site has been targeted as requiring soil remediation techniques to prevent further nonpoint source pollution. Teachers from the adjacent communities who attended this workshop gained valuable information concerning the ongoing controversy between local community leaders, the nonpoint source pollution issues related to the site, and current remediation efforts.

Speakers discussed the overuse of pesticides in range management at the Sul Ross University presentation. The class visited a site that receives waste sludge from New York City, which is then distributed over rangeland near Sierra Blanca, Texas. The danger of contamination of water supplies from locally applied waste materials was the focus of this field trip. Workshop leaders pointed out that when floods occur, contaminants are rapidly routed into local streams and rivers, despite the fact that Sul Ross University is located in an arid region of Texas. Scientific studies are in progress to determine the rate of degradation of potentially hazardous microbial activity due to the sludge operation. Local experts were on hand to answer specific questions related to the potential for groundwater contamination in the region. Teachers were extremely interested in the decision-making process that led to the selection of this site in their neighboring region as a waste facility.

Texas Watch training was completed by the teachers who attended the TES course at Texas A&M in Texarkana, thus qualifying them as official monitors for their region. Their certification will result in greater awareness among their students of nonpoint source pollution in nearby streams and waterways. In addition, the Texarkana teachers visited two local farms, where they gained information on tilling, planting, irrigation, fertilizing, harvesting, and pest control methods. This led to a discussion on runoff controls and the ultimate potential for pesticides and fertilizers to reach local sources of drinking water. The owners and managers of these large farming operations were available to answer questions posed by the teachers.

Through a presentation of the TNRCC's Texas Watch Program, teachers at the Texas Southern University workshop were able to visit a bayou in their downtown region. Staff provided information on the pollution problems that can result due to urban runoff from streets and other impervious surfaces. In addition, teachers visited the National Fisheries in Galveston, where they learned of changes in the estuaries. Estuaries, sometime called "the cradle of the sea," form the breeding ground for millions of fish, crustaceans, and other ocean life. Runoff from farms and other nonpoint sources, if not properly controlled, can upset the delicate balance of this vital habitat, resulting in desecration of some species.

The Texas Tech University is located in a region rich with cotton-producing farms. Teachers at the Texas Tech workshop visited a plant that manufactures fabric from raw fibers grown in the area. The general potential for pollution from runoff and cultivation methods were specifically addressed at this plant.

Efforts to produce a general brochure concerning nonpoint source pollution, a coloring book, a book marker, a poster, ad slicks, and bilingual radio spots are underway through the new NPS Pollution Urban Runoff Education Project. These items should be distributed to the TES teachers who attended in both 1997 and 1998. Final proofs have been approved for the nonpoint source poster, book marker, and newspaper ads. The program will distribute 12,000 posters and 10,000 book markers. TNRCC staff will continue to coordinate with the stakeholder committees in the top three priority TMDL areas to receive feedback on the success of this outreach project.

Nonpoint Source Technology Transfer and Education, TNRCC Texas Watch Program, Funded FY 1996

The goal of this project is to prevent and abate urban nonpoint source pollution by influencing behavioral changes through educational and other nonstructural BMPs. Objectives include increasing interagency coordination, technology transfer, and public involvement in nonpoint source pollution prevention, control, and management.

The first regional workshop for 1998 was held in March, and the second was held in August. Over 1,000 interested citizens, volunteer monitors, teachers, students, environmental organizations, and government agencies were invited. The workshops were well attended, with more than 50 participants sharing information about local water quality and nonpoint source pollution issues related to bayous, lakes, and rivers in their regions. Representatives from various local agencies and organizations discussed and answered questions on topics that included the health of local bayous, fish kill causes, flood control issues, contact recreation health concerns, habitat restoration, and NPS reduction techniques. The second workshop also discussed development of a TMDL for Armand Bayou, and was concluded with a guided tour of nearby Clear Creek that provided examples of the day's discussions.

Field activities at Texas Watch workshops enhance participants' understanding of material presented in the classes.

The Texas Watch Meeting of the Monitors was held April 30 through May 2. All current Texas Watch participants and those desiring to become involved were invited. The statewide meeting provided a forum for partners and volunteers to share successes and concerns. The theme and instructional activities of the meeting revolved around nonpoint source pollution prevention, monitoring, and management.

The Summer Edition of the Texas Watch Newsletter was mailed out to 2,650 volunteers and partners in late August. The Texas Watch newsletter is now also available in the TNRCC's Internet site. Each newsletter features information on NPS issues and highlights new technologies and specific ongoing or completed NPS projects. The summer issue included an article that profiles the recipients of the 1998 Texas Watch Awards for Outstanding Achievement, and an overview of the TNRCC's use of volunteer monitoring data in the TMDL process was given. Also featured was an article describing the value of volunteer monitoring by Mike Bira, Volunteer Monitoring Coordinator, Region 6. In an effort to evaluate the effectiveness of the newsletter, a survey testing awareness of NPS pollution and behaviors was sent out to existing Texas Watch recipients prior to the publication of the first newsletter. At the conclusion of the project, a follow-up survey will be sent to the readership to measure the changes in understanding and behavior related to NPS issues.

The Texas Watch Web site includes five main pages covering all major aspects of the program, including announcements for upcoming meetings and events, online access to the newsletter and other publications, and links to other volunteer monitoring sites around the country. An additional 15 to 20 pages cover a wide variety of subjects including meeting updates, NPS topics, and other volunteer monitoring issues. The Texas Watch Web site also contains a summary of the 1998 Meeting of the Monitors.

Update State NPS Assessment Report and Management Program, TNRCC/TSSWCB, Funded FY 1996

The objective of this project is to collect water quality and associated information in order to identify surface waters in the state that are impacted by NPS pollution and to develop appropriate management strategies to address problems that may be found. This will be accomplished through the collection of information on fish and benthic communities, and sediment and ambient toxicity data in subwatersheds of the Brazos–Colorado Coastal Basin.

Efforts continue to gather and update existing data on instream conditions in the Brazos–Colorado Coastal Basin. Multivariate statistical techniques were used in conjunction with watershed characteristics to identify likely sample sites. Land use maps, combined with digital elevation maps delineating watersheds in the basin, were used to select a set of candidate watersheds from which the study watersheds were selected. Two field reconnaissance trips were conducted, during which candidate sites were visited. Field data, as well as some habitat data, were collected at the sites. Fecal coliform samples were collected five times within a 30-day period at 11 sites. Water chemistry, sediment, and biological samples have been collected on two occasions from 10 sites. Semipermeable membrane devices to assess the occurrence of organic contaminants in water were deployed at three sites during field trips conducted during August 1998. Routine water chemistry and dissolved metals samples were collected from five sites during the same field trip. In addition, multiprobe water quality data loggers were deployed at three sites. Sediment and fish tissue samples to assess the occurrence of contaminants were collected from 10 subwatersheds. Ambient sediment toxicity samples were collected at four sites and results are under review. Fish and benthic macroinvertebrate surveys have also been conducted in 10 subwatersheds on two occasions. Laboratory processing of these samples is underway and will be used to characterize the biological integrity of these streams.

Update State NPS Assessment Report and Management Program, TNRCC, Acquisition of Digital OrthoQuarter Quads, Funded FY 1997

The objective of this project was to collect water quality and associated information for use in identifying surface waters in the state that are impacted by NPS pollution. Acquisition of these data maps, along with additional census and land use data, will be used to provide information on how growing populations and human activities may be impacting the quality of water resources. The coverages have been delivered and are maintained as part of a statewide library project. Plans are underway to acquire land use data to complement these maps and aid in water quality planning activities.

Active Watershed-Specific 319 Projects

Brazos River Basin

Wellhead Protection, City of Lubbock and TNRCC Wellhead Protection Program, Funded FY 1996

The City of Lubbock is identifying potential sources of nonpoint source pollution within the city's delineated wellhead protection areas (WHPAs) by using global positioning systems (GPS) and GIS technology. The goal of this project is to protect underground sources of drinking water by locating and potential sources of contamination (PSOCs) , mapping them, and thereafter implementing recommended best management practices (BMPs) to arrest these threats to the water supply.

During FY 1998, the City of Lubbock purchased GPS satellite receivers for use in acquiring digital positions of potential contaminant sources, and received certified training to operate the equipment properly. City staff have reviewed their Wellhead

Protection report (TNRCC, AS-101/whp) PSOC data to help them determine BMP implementation priorities. Since the data was four years old, the City coordinated with local agencies to verify the existence of the inventoried PSOC's and identify new ones. During an April 27, 1998, meeting, the City Environmental Inspections Department agreed to provide information related to their area of responsibility, including information on septic systems, illegal dumps, and auto salvage yards. TNRCC Region 2 staff agreed to review PSOCs identified as petroleum storage tanks and provide data on water wells. The High Plains Underground Water Conservation District (UWCD) provided information pertaining to PSOCs classified as private and abandoned water wells in addition to information about capped or plugged wells. In targeting these PSOCs, the city completed its prioritization activities during the fourth quarter. Both the City of Lubbock Environmental Inspections Department and the High Plains UWCD reviewed the original survey for above-ground and underground storage tanks. The city is considering using volunteers to verify the remaining surveyed PSOCs that contain incomplete information. These volunteers will focus on abandoned and private wells. On completing these tasks, the city proceeded with digitizing activities, beginning with digitizing all public water supply (PWS) wells located inside delineated WHPAs. The city will then digitize any remaining PWS wells that were not included in the WHPAs. Finally, the city will locate their PWS wells situated in Roberts, Lamb, and Hockley counties. Due to extremely dangerous temperatures, the city pushed back the completion date for this activity to October 1, 1998. They estimate that the PSOCs will be digitally located by March 31, 1999 and entered into the GIS database by June 30, 1999.

The city prepared an outreach and public education campaign to notify citizens of the project activities. The campaign involved radio, television, brochures, speaking engagements, and roadside markers. During the first quarter, the City of Lubbock purchased two groundwater simulators for use in demonstrating basic groundwater concepts. Staff use them to illustrate to the public how contamination of groundwater results from underground storage tanks, septic systems, and abandoned water wells. On October 7-9, 1997, the city participated in the Farmer Stockman Show. This is a large public gathering of the agricultural community that surrounds the city's PWS well field. The Show gave the city the opportunity to talk with rural home owners about abandoned water wells, uncapped wells, and their potential for groundwater contamination. The groundwater models were used to educate this segment of the population about typical contamination issues found in rural areas since the majority of the city's PWS wells are actually located in rural areas. Instructions were offered on how to temporarily cap wells until permanent measures can be taken. Tex-A-Syst brochures were distributed to the approximately 1,000 people that were in attendance. The groundwater models were also used to demonstrate source water protection to 140 students at Hardwick Elementary and Atkins Junior High schools. The groundwater simulators have been employed extensively, giving unprecedented understanding of groundwater principles and how to avoid contamination. These presentations are also essential for spreading the word and for networking with other communities, water systems, and those organizations that may benefit from the program.

The city continued to promote the Wellhead Protection Program by presenting the program before the Water Environment of Texas in January 1998. The purpose of this presentation was to promote the program, explain the goals and objectives, and public expectations and their impact on the project's success. The city made the same presentation before the League of Women Voters on March 10, 1998. On April 27,1998, the city participated in Maedgen Elementary School's Earth Day Fair. Groundwater simulators were used to demonstrate the potential for source water pollution to approximately 200 4th through 6th grade students. Approximately 200 kindergarten through 3rd grade students received a similar message through a presentation called "Fred the Fish." Public outreach activities targeting children are particularly important, since effecting behavior modification at an early age tends to precipitate results in the teenage years through adulthood. These presentations are essential to Lubbock's continued success in the protection program, instilling a sense of responsibility and a recognition of potentially hazardous activities in the participants. On June 1, 1998 representatives from the city presented their program before the TNRCC Source Water Action Plan seminar in San Antonio. The city continues to focus on the schools to promote a long-term understanding in future generations that will ensure that source water protection activities will prevail after the culmination of the project. On June 19, 1998, Gaylyn Chapman, Educational Coordinator, presented the program to area teachers to enhance their environmental awareness program. On August 26, Ms. Chapman conducted a presentation before Brown Elementary.

The city has identified 39 abandoned water wells at an estimated cost of $300 to cap each well, or a total of $10,600. The public outreach and education campaign will be enhanced to include an essay contest in the Lubbock schools. A "Learning to Be Water Wise" program is also scheduled for implementation in the Lubbock schools. Finally, a household hazardous waste collection event will be scheduled for FY 1999.

Corpus Christi Bay Watershed

Oso Parkway Water Quality and Capacity Improvements, City of Corpus Christi, Funded FY 1995

The goal of this project is to construct a low-flow concrete diversion structure to capture low intensity rainfall, divert flow, and allow excess flow to continue downstream. The diversion structure will remove floating debris by means of a trash rack and sump, and a concrete-lined trap will allow sediment to settle. A bioswale, which is a natural system that filters sediment from storm water runoff, and other control systems have been installed to further treat this runoff before discharge into the Oso Creek wetland area. Though Richter Channel was originally chosen as the BMP site for this project, city staff discovered early in the project that the site was unsuitable. Consequently, a new demonstration project site was selected at Oso Parkway, which empties directly into Corpus Christi Bay.

The construction portion of the project was awarded in late February 1998 to Duncan-Russo Inc. Approximately 95 percent of the construction has been completed as of August 31, 1998. The remainder involves regrading the project to the wetland boundaries, and correcting the elevation of the concrete work downstream of the three box culverts, which will allow drainage toward the diversion channel.

Another project objective is to initiate an educational program involving nearby schools and neighborhood associations. This will be achieved by informing the public about the water quality demonstration project and educating the local residents within the drainage basin of the hazards to water quality and the environment in the wetlands of Oso Creek from pollutant loadings. To support this task, Storm Water Department staff met with the editor of the *Corpus Christi Caller Times* in May of 1998 to deliver data and brochures for the Oso Parkway Demonstration Project. They met again later to provide the editor with a tour of the project site and discuss its purpose in greater detail. The Corpus Christi Caller Times published a story on the Oso Parkway project in July 1998. With the assistance of the city's media and productions coordinator, staff contracted with Quadrant Productions to develop a video of pre-existing conditions at the Oso Parkway site. The video has been broadcast a minimum of 10 times on the local government access channel. In addition, Quadrant has almost completed development of a video to depict the Oso Parkway Demonstration Project before, during, and after construction. The City of Corpus plans to coordinate efforts to conduct storm drain stenciling in all area inlets within the drainage boundaries. This will further increase public awareness and promote area neighborhood interactions to help prevent illicit discharges of pollutants into the city's storm water drainage system.

Through the end of July 31, 1998, the City of Corpus Christi was under drought conditions and had not received any significant rainfall. Therefore, the manual collection of storm water flow samples was not possible and the amounts of floatable trash and sediment trapped and removed per rain event could not be quantified. However, two storm water grab samples were collected on the 6th and 14th of August. The

Storm Water Department developed a Quality Assurance Project Plan and submitted it to the TNRCC for approval on August 18, 1998. To date, there has not been any data collected on sediment or floatable trash.

Edwards Aquifer

BMPs to Reduce Sediment Contributions of Stormwater Runoff to Barton Springs/Edwards Aquifer in Hays County, BS/EACD, Funded FY 1995

This project was cancelled by mutual agreement between the contractor and the TNRCC. The TNRCC is considering other projects for use of the 319(h) funds originally allocated to this project.

Ground Water Tracing: Barton Springs Segment of the Edwards Aquifer, BS/EACD, Funded FY 1997

This project was recently initiated to evaluate and describe travel times and paths of groundwater in several watersheds in the Barton Springs segment of the Edwards Aquifer. Watersheds selected include Barton Creek, Williamson Creek, Slaughter Creek, Bear and/or Little Bear, and Onion Creek. Objectives are to conduct groundwater traces using appropriate water traces to map groundwater paths under different aquifer conditions. For each watershed, injection sites will be determined along with a large number of possible receptor sites. The dye materials will be injected, and receptor sites will be monitored to document absorption of the tracers, revealing actual travel paths.

A non-toxic tracer material was poured into a recharge feature in Williamson Creek. The bright green dye was later detected at some private wells near Sunset Valley and at Barton Springs.

To support the study, new staff members Geologist Jim Sansom and Hydrogeologic Technician Rebecca Morris joined the BS/EACD in August. Development of the Quality Assurance Project Plan to ensure accuracy in data collection for the study is progressing. Some minor activities associated with site selection for potential injection sites in the Slaughter Creek watershed have been performed. Commencement of tracing in the Slaughter Creek watershed will await approval of the Quality Assurance Project Plan.

Hydrogeological and Water Quality Assessment: Barton Springs Segment of the Edwards Aquifer, BS/EACD, Funded FY 1997

This project was recently initiated to evaluate previously collected water quality information and flow measurements in order to assess baseline conditions of the Barton Springs segment of the Edwards Aquifer. Other objectives include locating points of major recharge, quantifying flow losses, and assessing groundwater quality through the performance of a comprehensive water quality analysis.

To support the hydrogeological study, new staff members Geologist Jim Sansom and Hydrogeologic Technician Rebecca Morris joined the BS/EACD in August. Development of the Quality Assurance Project Plan to ensure accuracy in data collection for the study is progressing. DGR Associates, a project consultant, has prepared a description of the methodology for the creek flow measurements for incorporation into the QAPP. Forty sites were selected for the water quality sampling component. With the support of the Texas Water Development Board, these same sites will be tested annually for the next five years. Continuous water level monitoring equipment was installed at one well selected in the northwestern corner of the study area. Four additional wells will be selected and fitted with this equipment during the remainder of the study. During August of this year, water level measurements were collected from sites across the study area.

Protection of the Edwards Aquifer from Nonpoint Source Pollution in Hays, Travis, and Williamson Counties, TNRCC Regional Field Offices, Funded FY 1996

Inspectors ensure that BMP structures in the Edwards Aquifer recharge zone are properly maintained so that they continue to be effective in reducing pollutant loads.

The goal of the Edwards Aquifer Protection Plan (EAPP) is to prevent pollution of the aquifer by implementing protective measures that are reasonable, necessary, and the most cost-effective method to address specific, demonstrated water quality threats. Every effort is made to avoid duplication or unnecessary conflict with local regulations.

The TNRCC is specifically charged with the preservation and protection of the quality of water resources in the state, inclusive of groundwater, under the Texas Water Code. The TNRCC has developed and implemented a water quality protection program for the recharge zone of the Edwards Aquifer in eight Texas counties. It was designed to address the concerns of local government and federal action, giving portions of the Aquifer the designation of "Sole Source Aquifer," as well as to respond to strong public sentiment to conserve this valuable resource. The eight counties affecting the recharge zone include portions of Kinney, Uvalde, Medina, Bexar, Comal, Hays, Travis, and Williamson. Bell County is not currently included in the program, but does encompass a portion of the recharge zone.

Preservation of the Aquifer is achieved through the review and approval process of Edwards Aquifer protection plans. Property owners must submit a plan to the TNRCC before beginning a regulated activity. The plan must contain a detailed assessment of the area and site-specific geology identifying all potential pathways for contaminant movement to the Edwards Aquifer. The plan must also include a description of the BMPs and other measures taken to prevent the pollution of surface or groundwater on-site or down-gradient of the site, both during and after construction. Upon approval, the plan holder must file a notice that the property is subject to the regulations of the plan in the deed of records of the county where the property is located. This action puts all third parties on notice that the plan is in effect.

The holder of an approved plan is responsible for compliance with Edwards Aquifer rules as well as any special conditions imposed by the TNRCC upon approving the plan. The TNRCC may issue an enforcement order requiring compliance to person(s) failing to comply with provisions of the rules. These persons may be subject to remedial action. The TNRCC is also authorized to impose administrative penalties of up to $10,000 for each act and each day violations occur.

During 1998, EAPP staff in the Austin regional office of the TNRCC reviewed and approved 129 Edwards Aquifer protection plans. Seventy-seven initial site inspections and 112 compliance inspections were also completed. The program processed seven corrective action requests, issued 28 notices of violations, and referred 11 cases for formal enforcement.

Additionally, the EAPP rules team implemented Phase II of the rule revision, which extended the existing Edwards Aquifer rules into the contributing zone. Staff focused on issues that included determining the scope of regulation, geographic area for inclusion of the contributing zone, and delegation of the program to local governments on a voluntary basis with TNRCC oversight. The rules team is also evaluating a proposal to include the Bell County portion of the recharge zone under the rules and develop performance standards for best management practices.

The revision of the rules included a performance standard for the post-development stage of permanent BMPs. It entailed a design requirement for the removal of at least 80 percent of the incremental increase in the annual mass loading of total suspended solids to hydrologically connected surface water caused by the regulated activity. This performance standard provides flexibility to the applicant in choosing the most cost-effective BMPs to meet required provisions.

Proper maintenance is essential to the continued performance and efficiency of any pollution control device, and BMP maintenance remains a significant problem for the continued preservation of the Aquifer. The TNRCC performed 427 inspections at 166 structural stormwater BMPs over the recharge zone in Austin. Inspectors concluded that these structures had functionality problems due to maintenance and repair problems; however, proposed rules addressed this concern. The proposed rules clarify that the applicant is responsible for post-construction BMP maintenance until such time as that obligation is either assumed in writing by another organization, or ownership of the property is transferred to another person or group.

The Edwards Aquifer Protection Plan has resulted in a comprehensive water quality protection program for the Aquifer and related surface waters. This program provides the most stringent groundwater quality protection measures in the state. EAPP staff in the Austin and San Antonio TNRCC regional offices are currently revising the Edwards Aquifer Technical Guidance Manual; publication and distribution are expected in late spring of 1999.

Galveston Bay Watershed

NPS Pollution Abatement in the Galveston County Health District, Galveston County Health District, Funded FY 1996

This contract was executed in October 1996 and was designed to determine potential locations of cross-connections and investigation of storm sewer outfalls where cross-connections are suspected by conducting water quality monitoring, and to assist cities and districts in correction of these adverse conditions. Galveston County Health District (GCHD) has successfully analyzed existing data for sites of potential illicit cross-connections between the sanitary sewer system and storm sewer systems. During the fourth quarter of FY '98, GCHD conducted 10 new storm sewer investigations. Several of these instances were brought to GCHD's attention through citizen complaints. Additionally, GCHD launched a major effort to locate seasonal, neighborhood car washes in Galveston County. During the summer, surveys were completed in Texas City and La Marque. Other investigations were conducted in response to citizen complaints in the other cities and areas of the county.

GCHD continues to survey municipalities in Galveston County after rainfall events to locate sanitary sewer system overflows. Four storm sewer outfall investigations were conducted in response to citizen complaints. Due to lack of rainfall during the fourth quarter, GCHD did not initiate any independent surveys. However, information related to complaint investigations was immediately furnished to the appropriate authorities within the respective cities or districts to allow for the reporting of these sites within the 24 hours mandated by regulation. These sites were later entered into a database at GCHD that has been established to catalog all known overflow sites within the service areas of the cities and districts in Galveston County. GCHD will utilize this data in meetings with the cities and districts to assist them in the development or implementation of their inflow inspection plans (no meetings were held during the fourth quarter).

At the beginning of the project, a survey was conducted to gauge the public's knowledge, attitude, and behavior with regards to nonpoint source pollution and its prevention. All of the information gathered to date has been reviewed and assessed. GCHD has begun to assimilate different pieces of information into its educational plan. Staff will continue to compile and review nonpoint source information as it becomes available.

GCHD has compiled a series of teachers' curriculum kits for various grade levels as part of its educational plan. GCHD contacted curriculum directors for all the school districts in Galveston County offering these kits, and the training to effectively utilize them, to the teachers. GCHD received positive responses from all the districts and is following up with scheduling the training. They have also contacted private schools located throughout the county and have subsequently delivered kits to 13 schools.

GCHD is planning an intensive, mass media campaign to begin soon. Staff are continuing to review materials they procured from the Washington State Department of Ecology and are planning to modify that material for use in Galveston County.

Another initiative of GCHD is to conduct nonpoint source pollution prevention workshops for small businesses and other specific groups to educate them on best management practices (BMPs) for their specific operations. The BMP manual, "Preventing Nonpoint Source Pollution - A Guide to Pollution Prevention for Small Businesses" was developed by GCHD in conjunction with the Galveston Bay Estuary Program. The manual was published in July 1998. A workshop for auto paint and body shops and auto repair shops was held July 23, 1998, and co-hosted by GCHD and the Galveston Bay Estuary Program. The manual was distributed at this workshop to 23 participants. GCHD intends to use the manual in a direct, face-to-face distribution effort at small businesses throughout Galveston County and also plans to make it available on the GCHD Web site.

GCHD completed the drafting of a model Nonpoint Source Pollution Prevention Ordinance for adoption by the cities and districts in Galveston County. The ordinance was submitted to the TNRCC at the end of FY '97. Following EPA's release of the proposed Phase II stormwater rules, GCHD scrutinized these proposed rules for their potential impact on the cities of Galveston County. At the request of a few cities, GCHD also reviewed and commented on proposed rule changes to be submitted to EPA by a coalition of small cities. GCHD also re-evaluated the model NPS pollution prevention ordinance and concluded that the ordinance, as originally written, was in compliance with the EPA's proposed rules. GCHD is currently developing a strategy to best reach the city and district leaders to encourage adoption of the ordinance.

Staff are also making strides towards cultivating partnerships with municipalities, area industries, and others to develop a household hazardous waste (HHW) collection program and plan a collection day. GCHD worked closely with the Galveston County Local Emergency Planning Committee (LEPC) to plan the HHW collection day. The LEPC has agreed to function as a coordinator and has obtained nonprofit status to allow for tax-deductible donations by local businesses. The HHW Collection Day is scheduled for June 5, 1999, at Texas City's recycling center Biosphere 1. The solicitation package was sent to all of the major and minor industries and small businesses in Galveston County. Follow-up contact with these businesses was made throughout the quarter. The LEPC has budgeted $20,000 in their FY '99 budget to help fund this county-wide event. The Galveston County Purchasing Agent is pursuing an interlocal agreement with the City of Houston to assist GCHD in subcontracting with their company for collection and disposal activities. If this effort is unsuccessful, the Purchasing Agent and the County Legal Office will complete a request for proposals the first quarter of FY '99. GCHD has developed a detailed time line for all activities that need to take place to successfully stage a HHW collection day and has consulted TNRCC's guidance document on this subject. This guidance document will provide a starting point for GCHD to design their own document more specific to the needs of Galveston County.

GCHD continues to monitor water quality in Galveston County according to their approved QAPP. During the fourth quarter, they conducted 32 sampling runs and gathered a total of 332 samples. Staff have completed their analysis of FY 97 monitoring data and forwarded the information to TNRCC.

Alternative On-Site Wastewater Initiative, Houston-Galveston Area Council, Funded FY 1997

The goal of this project is to implement on-site sewage disposal best management practices to reduce fecal coliform bacteria levels caused by inadequacy or failure of such facilities in the Houston-Galveston Area Council's Upper Gulf Coast Planning Region. H-GAC must determine what practices are suitable for the region's soils, climate, and groundwater tables and must consider the issue of cost-effectiveness. The communities affected by inadequate on-site sewage disposal will be made aware of alternative means of funding such as that offered by the Texas Water Development Board, the Texas Natural Resource Conservation Commission, the Texas Department of Housing and Community Affairs, the Environmental Protection Agency and the Economic Development Administration, in addition to the availability of private, institutional, and local governmental grants and loans.

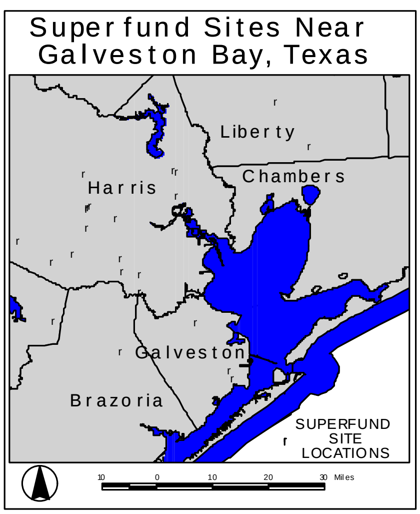
Development of project materials, such as compiling existing materials into two handbooks for local governments, subdivisions, and the private sector outlining potential funding and BMPs for on-site sewage disposal systems is on schedule. Consensus on content and layout for the flow chart, fact sheets, and the brochure on collections systems has been reached. Finalization of an Interagency Agreement with Texas A&M's Extension Service to develop and print Alternative Technologies fact sheets is projected for the first quarter of 1999. These fact sheets on conventional gravity systems, low pressure dosing systems, spray distribution, and drip distribution will be used in tandem with four-page information sheets designed for installers. There will be a multiple-page fact sheet on Alternative Collection Systems, as well as a flow chart and matrix to help home owners decide which type(s) of systems will be appropriate for their home based on lot size and soil type.

Meetings are being held with GIS staff to discuss maps detailing soils and roadways, as well as political subdivision boundaries in regions of targeted communities. Maps showing all the municipal utility districts (MUDs) and water supply districts, delineating MUDs for the targeted communities and detailing the political subdivision in and/or around each targeted community will also be created. Also projected for the first quarter of FY 99 is the production of a map showing which targeted communities are within the extraterritorial jurisdiction of Houston. After preparation of this map, a meeting will be scheduled with the Director of Public Works for the City of Houston to discuss uniformity, demands, desires, and needs the City has for these areas. In the past, the City has preferred conventional systems, but it has been determined that they are not economically feasible in the targeted communities.

The Houston-Galveston Area Council anticipates further discussions with TNRCC on baseline monitoring in the targeted areas. Possible legislative resolution to issues related to installing cluster systems requiring a Certificate of Convenience and Necessity could be pursued. Development of an Internet home page is also projected.

Regional Aquifer Protection in Galveston Bay Watershed, TNRCC Ground-Water Nonpoint Source Team, Funded FY 1996

The goal of this project is to target groundwater nonpoint source problems in and around Galveston Bay and implement best management practices to decrease the potential for contamination in groundwater from impacting the bay. Targeting results completed in FY '98 reported groundwater plumes impacting the Houston Ship Channel; on-site waste water problems around Christmas Bay, Holiday Lakes, and San Louis Pass; chemical contamination to Chocolate Bayou and Chocolate Bay from industry (high levels of metals possibly from groundwater plumes); and groundwater contamination from a Superfund site in Webster, Texas. The targeting report identified two major sources of potential groundwater contamination to the bay as associated with industrial facilities (surface impoundments) and inadequate on-site waste water systems. Coordination with the Galveston Bay Estuary Program (GBEP), Houston-Galveston Area Council (H-GAC), Texas Agriculture Extension Service/Texas A&M, and TNRCC Region 12 Field Operations has resulted in the identification of two project elements.



Facilities with potential to pollute groundwater are mapped to identify and target protection areas.

For the first project element, TNRCC will assist the H-GAC with an alternative on-site wastewater initiative by providing groundwater monitoring for baseline water quality at sites where alternate wastewater systems will be installed. As part of the coordination meetings with H-GAC, TNRCC staff participated in the design of the alternative technologies brochure and pamphlets (published by the Texas Agriculture Extension Service/Texas A&M). The TNRCC has committed to developing a GIS product that will link the technologies identified in the brochures to specific geographic locations within the Galveston Bay area. The map will indicate which on-site wastewater technology brochure to use based on the soil type at specific locations around the bay. The brochures and map will be presented to the public at several planned technology transfer workshops.

The second element of the project will be to address groundwater contamination from industrial sites around the bay. The TNRCC will develop a map to serve as a model for the GBEP to track all of the potential groundwater contamination sources around the bay. The base map will include all of the facilities that have TNRCC solid waste registration numbers, National Pollutant Discharge Elimination System permits, and hazardous and solid waste permits. In addition, the map will include oil wells, pipelines, railroads, land use, and land cover data. The TNRCC continues coordination with GBEP to ensure that the data set will be useful in planning pollution prevention activities in and around Galveston Bay.

North Concho River Basin

North Concho River Urban Runoff/Nonpoint Source Abatement Master Plan and Demonstration Project, Upper Colorado River Authority and the City of San Angelo, Funded FY 1994

This project is a coordinated effort to combine the resources of the City of San Angelo and the Upper Colorado River Authority (UCRA) to develop a control strategy for mitigation of urban nonpoint source impacts within the Concho River. Historically, the Concho has suffered from the detrimental effects of stormwater runoff caused by oxygen depletion in the water (foul smells and fish kills, for example). This project consists of the design, development, and construction of a demonstration structural control in downtown San Angelo.

The structural BMP at Civic League Park rock gabion berm and retention pond.

Structural BMP at Civic League Park as viewed from across the Concho River.

Bids were opened in Summer 1998 for the BMP construction at Civic League Park. A dual bid was let in conjunction with the FY 97 319(h) project at Santa Rita Park to provide a more cost-effective program. Construction was completed during late summer, resulting in an impressive structure. The BMP features a rock gabion berm and retention pond designed to inhibit the flow of storm water and allow pollutants and debris to settle before discharge into the river.

Before construction began, Native American artifacts were discovered at the construction site. All project activity was temporarily suspended while an archeological assessment study was completed. During construction, site tours were organized and conducted by UCRA staff. Participants included UCRA Directors, representatives of the media, city officials and department heads, representatives of various organizations, and private citizens. Additional meetings with media representatives were held and press releases were prepared. In the upcoming year, water quality in the Concho will be monitored to evaluate the effectiveness of the BMP. Funds that were not expended during the FY 94 grant period will be rolled into the FY 96 grant to allow monitoring activities to continue.

The visibility of the Civic League Park structure has contributed to considerable public interest. The UCRA is optimistic that public involvement and interest in local water quality issues will continue. One of the positive outcomes of this project has been the signing of an agreement with a private foundation to cooperate in the completion of approximately $660,000 worth of future Concho River water quality improvement projects.

North Concho Urban Runoff Demonstration Project, Upper Colorado River Authority and the City of San Angelo, Funded FY 1997

The objective of this project is to design and build two structural BMPs to prevent urban runoff from entering the North Concho River. One site is located at Santa Rita Park and the other is located at Brentwood Park. These two projects were listed as priority sites for improvement activities in the urban master plan completed by the City of San Angelo through a 1994 grant under the 319(h) program.

Structural BMP at Santa Rita Park.

Plans, specifications, and contract documents for the Santa Rita site were finalized by the City of San Angelo and the UCRA for advertisement on July 2, 1998. Prospective contractors were given tours of the project site. The contract was awarded to Regency Construction, Inc. Contractor move-in at the Santa Rita Park site met with some initial opposition and considerable neighborhood interest. Construction was delayed for approximately one week, despite a meeting and presentation of the project plans to the Santa Rita Home Owners Association prior to initiation of the project. No opposition was voiced at earlier meetings with this group. During this delay period, the organizations involved with the project addressed several resident concerns related to landscaping and maintenance by city staff. Public interest also sparked considerable media coverage and several subsequent meetings with residents both on and off-site. The project was ultimately redesigned to the satisfaction of residents as well as design staff, UCRA staff, city council members, the city manager, and city department heads. The primary design goal to retain storm water was upheld throughout these efforts. Regency Construction completed the project within the allotted contract time, and a substantial completion certification was issued August 28, 1998.

This statue, the Pearl of the Concho, is the focus of educational materials that promote the Concho River restoration project.

Since this project site is in an extremely sensitive neighborhood and the City's Master Plan calls for many other facilities in residential neighborhoods, the project staff have made an effort to provide a BMP that is attractive as well as fully functional. It has been suggested that a video presentation of this facility, both wet and dry, be prepared for future use. Initial public involvement to air problems resulted in positive resolution and the added element of providing an opportunity for public education regarding nonpoint source pollution and urban runoff. This project was completed with an additional contribution from a local benefactor, Mayme K. Daniel, who was also instrumental in the Civic League Park Project.

Construction plans for the Brentwood Park project should be underway during the first quarter of 1999.

Rio Grande Watershed

Town Resaca System Approach for Resaca Stormwater Runoff Control and Rehabilitation, City of Brownsville, Funded FY 1994 and FY 1995

The Town Resaca system serves as the City's outfall for storm water runoff. Residential and commercial development in the area has resulted in an indeterminate number of pollutants being discharged into the Resaca. Erosion along resaca banks has also created sedimentation problems that are threatening aquatic habitats. The City of Brownsville's Town Resaca System storm water runoff project consists of two phases.

Revegetation projects are just one of the activities the city of Brownsville is undertaking to restore water quality in its resaca system.

A lack of rain in the City resulted in the need to revise the schedule of Phase I project activities in 1998. A reduced sampling plan was proposed by the City and agreed to by the TNRCC and the EPA in order to allow sampling during any rain event that would produce sufficient runoff to be collected. This action was undertaken in order to expedite BMP implementation.

Under Phase I, five out of six subwatersheds in the city were monitored for the types of urban pollutants entering the local resacas, and BMP recommendations were developed for each of the outfalls. As a result of a TNRCC site visit in May 1998, the City of Brownsville committed to an aggressive schedule through August 31, 1998 in order to build structural BMPs for two subwatershed locations (13th Street and Dean Porter Park) recommended by the City's water quality consultant. The remaining BMPs are nonstructural in nature. Plans, specifications, and designs for two stormceptor units were finalized in June 1998. The specifications were let out for bid in July 1998; however, the units were not constructed because the only bid received was rejected as exorbitant and exceeded the remaining project budget. Since the contract terminated without BMP implementation, EPA granted permission for Brownsville to complete Phase I construction with FY '94 rollover funds added to the FY '96 319(h) grant. The post-BMP implementation water quality monitoring task will be performed under Phase II. Phase I should be completed by August 31, 1999.

Built upon the Phase I project, the City of Brownsville targeted twelve additional subwatersheds in the Town Resaca system for demonstration BMP design, implementation, and monitoring during Phase II. Once the severity and source of pollutants have been identified, BMPs will be determined in order to retrofit discharge outfalls with structural improvements. Concurrently, the City is enhancing its pollution re-

Signs like this one are just one small part of Brownsville's public awareness campaign.

duction efforts by instituting a nonpoint source public awareness campaign. Efforts are being undertaken to increase voluntary residential and commercial improvement to resaca banks. The results of this demonstration project will be adopted into a comprehensive management plan for continued mitigation of pollutants into other area resacas.

The City of Brownsville reviewed numerous sites and determined the 12 most representative outfalls in the city for land use sampling. Due to an extended drought period, only one sampling event was conducted by August 1998. Ambiotec Environmental, a project consultant, requested a revision to reduce the number of sampling events due to lack of rainfall. They have evaluated representative sampling locations, taking into consideration certain characteristics such as the mix of single/multi-family housing and commercial properties density, as well as culvert-type outlets in high traffic areas with adequate space for structural BMPs. Other criteria include the highest density of dwellings and the greatest potential for improvement. A site visit was conducted in May 1998 to review progress on Phase I and II projects and revise milestone dates as appropriate. As a result of these project discussions, the number of targeted outfalls has been reduced to six. Measures have been taken to obtain a one-year extension for the project to allow for construction and monitoring of the various structures. Phase II BMP design and construction plans should be completed during the fall of 1998, and post-construction sampling will be performed .

Ambiotec Environmental has developed a small demonstration area to determine the feasibility of the reuse of the Town Resaca spoils for planting of wildflowers and winter vegetables. This will be important as the City seeks alternative uses for the volume of dredged spoils anticipated from the planned clean-out of several reaches of the Town Resaca.

The City also received approval for a demonstration project utilizing subaqueous and terrestrial plants for the purpose of bank stabilization. TNRCC Texas Watch staff led an effort to coordinate materials and volunteers to conduct the planting with United State Army Corps of Engineers/Lewisville Aquatic Ecosystem Research Facility staff. Follow-up visits to the stabilized bank site have demonstrated the effectiveness of the selected plants for mitigating erosion.

NPS Toxic Substances Best Management Practices for Manadas Creek Watershed, TNRCC Border Environmental Assessment Team, City of Laredo, and the USGS, Funded FY 1996

This project was terminated due to the dissolution of the Border Environmental Assessment Team. Negotiations are underway with the City of Laredo to redefine the project.

Laredo Community College Stormwater Management Demonstration Project, City of Laredo, Funded FY 1996

This contract was executed in April 1997 to identify and design appropriate structural best management practices, construct and maintain these BMPs, and to develop a guidance manual and city ordinances to implement additional BMPs. The environmental engineer has successfully completed three courses which provided information that will be applied in creating an artificial wetland, demonstrating the reduction of pollutants from land disturbance areas, and in creating new BMPs such as bioretention, wet ponds, and showcasing techniques.

No land acquisition was required for this project since it will be implemented at the Laredo Community College. The proposed site is owned by the Laredo Community College, and is part of in-kind services provided to match the federal grant. In March of 1998, the City Council awarded the BMP contract to Sepulveda Associates. Sepulveda Associates has submitted the final plan for BMP design and construction. The wetland design and detail drawing is expected to be complete by September 1998. The project should then go out for bids, with procurement of a contractor by October

1998. The maintenance schedule will be developed by November of '98 in order to open the showcase to the public by December 1998.

The development of the local storm water management and erosion control ordinance is complete. The planning and zoning commission, as well as the city council, are approved the ordinance in October 1998. Development of a guidance manual to address drainage criteria, flood control management, erosion control, and water quality management is partially complete. The manual is in draft form and should be adopted along with the new storm water management ordinance.

In an effort to promote storm water and BMP education, the City of Laredo conducted its first pollution prevention workshop on August 28, 1998.

Unfortunately, the City may experience problems in construction of the wetland due to the very low plasticity index (PI) of the soil on the river bank. The wetlands area requires a clay liner at the bottom since the soil is not suitable for construction. The City will submit the detailed design and construction plans to both the TNRCC and EPA upon their completion by the consultant. Also, due to the volume of construction occurring in Laredo, there is a shortage of contractors available, which may delay construction of the project. Because of these circumstances, the City anticipates some delays in the overall completion of the project.

Watershed Management Through Enforcement, City of Laredo, Funded FY 1997

The City of Laredo is the second-fastest growing city in the United States. Land development is at an all-time high due to this rapid expansion. This results in increased waste, pollution, and various environmental problems caused by the rise in population, industry, and traffic. The housing boom is directly related to an increase in illegal dumping of building materials, chemicals, and supplies into creeks and adjacent low-lying areas within the city's floodplain. Dumping of such items, as well as large quantities of fill dirt, asphalt, and concrete will not only endanger the health of neighboring citizens, but will threaten the aquatic habitat of certain species and degrade the aesthetic quality of the environment. Potential flooding conditions created by alterations of flow dynamics in the creeks are threatening local waterways. The Rio Grande is already highly contaminated and these factors are major contributors to that contamination. Therefore, the objective of this project is to preserve local watersheds by developing a public education and enforcement program specifically designed to eliminate indiscriminate dumping in floodplain areas.

The City of Laredo has already developed educational pamphlets and a short video to be aired on the public access channel addressing the issue of illegal dumping and its effects on the river. The first City of Laredo Showcase was held on July 25th and won first place for presentation. The City has successfully conducted its first two workshops. The goal of these workshops was to integrate the whole Laredo community by encouraging cooperative efforts between business, government, and the community, and to promote working together towards a cleaner, safer, and more abundant environment through watershed protection.

The process of updating and revising environmental floodplain ordinances is underway. The City hired a part-time environmental law clerk to complete the revisions of the current ordinances and write new floodplain ordinances which should be implemented by November 1998. The problem with the existing ordinance is that there are no specific regulations concerning illegal dumping into creeks or natural waterways. The City's Garbage, Trash, and Refuse Ordinance currently allows for filling and dumping with the consent of the property owner or person(s) in charge of such property. The new Floodplain Ordinance will make floodplain dumping illegal and will punish property owners and illegal dumpers with severe penalties.

The consultant, Brown & Root, should complete its revision of the floodplain delineation for Chacon Creek by December 1998. They are also proceeding with efforts to revise the Zacate Creek floodplain delineation, which should be complete by December 1999. Similar revisions are planned for Manadas and Sombrerito Creeks.

Because Manadas and Sombrerito Creeks are not funded by the grant, the City will pursue other sources for funds to implement these activities.

Environmental Monitoring and Outreach Activities in Brownsville and Surrounding Counties, TNRCC Texas Watch Program, 1995

The goal of this project is to gather sufficient data through volunteer environmental monitoring to evaluate the effectiveness of BMP implementation in the city of Brownsville. Activities also include educating the public about nonpoint source pollution and the impacts of individual actions on water quality through outreach, participatory learning, and hands-on implementation of nonstructural BMPs. Americorps Volunteers and the Valley Proud Environmental Council have been recruited to assist Texas Watch and involved cities in outreach activities. Texas Watch staff recruited several organizations such as the Brownsville Police Explorers, Texas Southmost College, South Texas Engineering Math & Science Program (STEMS), Brownsville Public Utilities Board, Brownsville Department of Public Health, Brownsville City Engineering Department, the City of San Benito, the City of Edinburg, and Los Fresnos High School to participate in various outreach activities in the Lower Rio Grande Valley. Texas Watch staff will continue to recruit cities, businesses, and schools to support and assist activities in the valley. Storm drain stenciling projects continue to be popular. Texas Watch staff assisted the cities of Brownsville and San Benito in coordination and implementation of these projects, with over 120 drains stenciled in the City of Brownsville. TNRCC also provided Brownsville and San Benito with stencils for future outreach projects. Volunteers and city staff have stenciled approximately 400 storm drains in the Lower Rio Grande area. A stenciling project was also scheduled for November 11, 1998 for the City of Edinburg. Stenciling efforts are continuing within these cities and in surrounding areas.

Texas Watch volunteer monitors learn a variety of chemical and biological monitoring techniques. Here, a volunteer learns how to use a kicknet. Volunteer monitoring raises local awareness and activism about water quality issues.

Texas Watch staff, along with Texas Parks and Wildlife, the U.S. Army Corps of Engineers, the City of Brownsville, and volunteers from the STEMS Program, implemented a bank stabilization and habitat restoration pilot project in April 1998. A bank revegetation project was finalized in the spring in conjunction with the Army Corps of Engineers. Prior to implementation, a two-page general description of the restoration project was distributed to the surrounding neighborhoods. Nine species of native aquatic plants were introduced over a 600-foot section of shoreline in Town Resaca. City of Brownsville staff and Texas Parks and Wildlife have continued to monitor the progress (overall plant survival and growth rate) of the demonstration project. Texas Watch staff provided a description of the project to EPA's *Nonpoint Source News-Notes* newsletter. The City of Brownsville continues to distribute brochures and literature on nonpoint source pollution, nonstructural best management practices, and water conservation to the general public. Several public service announcements have been developed and numerous articles have been published in the Brownsville newspaper on the resaca project. Texas Watch and TNRCC staff conducted the Nonpoint Source and Water Quality Technology Conference in Brownsville in March 1998. Presentations were given on water resources, border issues, nonpoint source pollution, best management practices, and public education and outreach. Educational materials were also provided. Texas Watch staff held a biological workshop in conjunction with the conference. Participants in the workshop completed a pre- and post-workshop test evaluating their knowledge of nonpoint source pollution and benthic macroinvertebrates. Average scores from these tests increased by 40 percent, indicating an increase in understanding of nonpoint source pollution and biological issues.

The Chireno ISD discharge system in Nacogdoches County handles 10,000 gallons per day with three clay lined cells. The system was placed on a steep slope with two cells up-slope and a large third cell shown here under construction.

The clay liner had to meet compaction and moisture specifications. The local fire department assisted the contractor with hauling and spraying water to meet the moisture requirement.

Finished single family on-site system. Wetlands and drainfield are located below the house.

A contracted laboratory monitors each completed wetland monthly.

Hamshire-Fannett ISD Wetlands Wastewater Treatment Facility, Southeast Texas Resource Conservation & Development, Hamshire-Fannett ISD, Funded FY 1996

There are several goals encompassed in this project, including:

- the elimination of nonpoint source pollution from untreated sewage discharged into Taylor's Bayou watershed, the Sabine-Neches watershed, and ultimately into Galveston Bay;
- reduction of nutrient loads and control of aquatic plant growth in the drainage ditches of Jefferson County; and
- provision of acceptable sewage disposal and improved health to the students of the local high school by centralizing collection, and then treating institutional sewage at a distance from the school.

Preparation of environmental education and public information is planned in the form of science curriculum, a documentary video, a brochure, and a table top model to teach the principles of natural systems and promote this technology to the public.

A constructed wetlands was selected as the technology of choice for this project. A mechanical treatment plant would involve great expense, following an already expensive collection system. A wetland adapts readily into the local environment, which supports many natural wetlands. Local contractors are familiar with the construction of rice paddies, which closely approximate the design of a wetland. Therefore, the bidding of this innovative technology was expected to present fewer risk factors and be a reasonable proposition for local contractors. Based on all these factors, project managers determined that the most cost-effective solution the urgent need for treatment in this sensitive area is the one selected for this grant— a low maintenance wetland.

The directors of Drainage District #3 in Jefferson County expect that the success of this project will be obvious to all. The cost of maintaining clogged drainage ditches will decrease, as will the threat of flood damage. The cattails and wildlife in the waste treatment facility will have a positive impact on the quality of life in the county.

The contract for this project has been executed. Unfortunately, there were preliminary delays caused by internal grant and contract review processes. The project is currently being delayed due to the acquisition of the discharge permit required for the constructed wetland; the project cannot begin without the issuance of this permit. Another obstacle to overcome is local protest against the construction of the wetland.

Standardizing Constructed Wetlands in East Texas, Pineywoods Resource Conservation & Development, Funded FY 1996

The goal of this project is to demonstrate the reliability of current EPA design criteria to predict effluent quality from small-flow constructed wetlands for domestic waste treatment. Standard design, construction, and start-up techniques for three sizes of constructed wetlands for waste treatment will be documented. The desired outcome is to demonstrate that effective wetlands can be installed for half the current average cost per gallon of waste treated by conventional means in East Texas.

Construction began on the large wetlands at Chireno ISD. A minority contractor was awarded the bid and work has been progressing well. All the basic site works for the three main cells are nearing completion. This wetland will be completed, planted, and brought on line this quarter. The Groveton and Community Estates wetlands construction projects are due to begin soon and are expected to be completed this quarter. The Quality Assurance document was signed by the EPA and TNRCC, but not received by the Project Principal until September 10, 1998, which caused delays.

The Forest Resources Institute of the College of Forestry has been contracted to develop the first brochure for on-site, single family wetlands systems. This brochure was designed to introduce the wetlands concept and useful aquatic plants for small, single-family residence wetlands for domestic wastewater treatment. A draft of the brochure was sent to the EPA and the TNRCC for comment. The majority of the funds to produce the brochure were raised outside the project. The final draft was approved by the principal funding source, as well as all concerned parties, and has been sent to print.

Stephen F. Austin State University has been waiting for the Quality Assurance Project Plan to begin monitoring of the two small systems that have been in operations since the last quarter. They intend to begin monitoring of these two systems immediately. Construction contracts for the two medium-sized systems at Community Estates and Groveton Community Center have been bid.

Construction will begin next quarter on the two medium-sized systems. Construction data for the Chireno ISD wetlands will begin during the same time frame. Work will continue on the development of publications materials.

Trinity River Basin

High Island Independent School District Wetlands Wastewater Treatment Facility, Southeast Texas Resource Conservation & Development, Funded FY 1995

The need for waste treatment in the High Island Community is obvious to all residents. The failure of local on-site systems is now drawing attention from the health district, the drainage district, and the state regulatory authority. The school has taken action to study its options, although neither the school nor the community is under order. Due to the urgent need for a low cost, low maintenance waste treatment facility, the High Island Independent School District (ISD), together with the Southeast Texas Resource Conservation & Development (RC&D), has prepared this project to address this demand without raising taxes or receiving stringent penalties due to failing systems.

The project will be executed in phases. However, the top priority of all concerned parties is to address the immediate waste disposal needs of the high school. A recent study of the high school's enrollment indicates that the number of students will increase by 10 percent annually. In order to meet the school's needs for treatment and future expansion, four wetland cells will be constructed with a capacity to handle 28,000 gallons per day. The ISD intends to secure the needed acreage from the Houston Audubon Society for eventual development of wetland treatment with adequate setbacks and acreage.

The goals of this project are to eliminate nonpoint source pollution from untreated sewage discharged into a series of ditches that proceed through Horse Marsh, the Intercoastal Waterway of the Neches, the Trinity Coastal Basin, and ultimately Galveston Bay. The reduction of nutrient loads and control of aquatic plant growth in drainage ditches must also be addressed. The primary objective is to provide acceptable sewage disposal and improved health conditions for the students at High Island by renovating on-site primary treatment and then providing secondary treatment of institutional sewage at a distance from the school. Promotional media will be prepared in the form of a documentary video, brochure, and presentation to the public to inform them of the potential of this technology to alleviate nonpoint source pollution across the state.

Preparation and submission of Discharge Permit Applications for the wastewater collection and treatment facilities to the TNRCC and the EPA has been completed. Information is being provided to assist in attaining adequate funding for this project. Site surveying and development of construction plans and specifications for the facility are projected to take place next quarter.

Section 314 Clean Lakes Grant Project Highlights

Clean Lakes Projects Completed in 1998

The TNRCC Nonpoint Source Program also administers CWA Section 314 Clean Lakes projects. The last active Clean Lakes project was successfully completed in 1998.

Lake Worth

As part of the Clean Lakes Phase II restoration efforts at Lake Worth, the City of Fort Worth was required to perform one year of post-project monitoring of lake water quality. All other project activities were completed by the end of FY '97 as described in the 1997 Annual Report. Monitoring for this project was conducted under an agreement with the Tarrant Regional Water District.

Between October 1997 and September 1998, four in-lake monitoring sites on Lake Worth were sampled monthly for field and conventional parameters. Because of prior non-detects on pesticides and metals and the general lack of depth or seasonal variability, the city requested and was granted a reduction in water quality monitoring parameters for the final 12 months of Phase II. Water column analysis showed that lake water continued to meet dissolved oxygen standards, except at some deeper stations during the summer. Temperature and pH values continued to comply with standards. Pre-project and post-project phase monitoring results were compared. Most of the parameter concentrations remained in the same range. Concentrations of chlorophyll *a* and organic nitrogen appeared to be slightly higher during the post-monitoring phase. The reason for this could be that much of the post-project monitoring took place during hot, dry periods.

One portion of the project consisted of the construction of a demonstration wetland system for nutrient load reduction from Eagle Mountain Lake. The wetlands project was to include two years of sampling and testing under varying flow conditions. EPA funding changes resulted in the delay of design and construction and compressed the time allotted for operation into less than one year. Operation was further delayed by beaver activity around the flow control structures. Despite these setbacks, the City of Fort Worth intends to continue operation of the wetlands system with routine monitoring on a monthly basis after correcting problems caused by the beavers. Information derived from this demonstration project could be used to develop other systems in watershed management programs throughout north central Texas.

Grant Program Financial Statement

Nonpoint source programs in Texas have received grant support from the Clean Water Act Section 319(h) Grant Program through the TNRCC since 1992. This table shows the amounts and expenditures of these grant funds.

Grant Year	Federal ID	Total Grant	Cumulative Expenses Thru FY 97	FY 1998 Expenses	Grant Balance
FY 1992	C9006975-92	4,929,343	4,041,252	880,635	7,456
FY 1993	C9996146-01	2,900,336[1]	1,688,730	291,323	920,283
FY 1994	C9996146-02	3,198,848	1,884,791	624,702	689,355
FY 1995	C9996146-03	3,614,167	954,179	606,391	2,053,597
FY 1996	C9996146-04	3,925,000	424,971	553,994	2,946,035
FY 1997	C9996146-05	1,757,166[2]	0	57,737	1,699,429
FY 1998	BG996627-97	3,435,864	727,012	1,480,783	1,288,069

[1] $311,222 in funds were redirected from the TNRCC and transferred to the TSSWCB.

[2] PPG funds for TNRCC programs, shown in the 1997 Annual Report as grant #BG99662-01, were rolled forward into the FY 1998 PPG shown in this 1998 Annual Report under grant #BG996627-97. Funds remaining in the FY 1997 grant (new #C9996146-05) are for pass-through grants to regional and local organizations.

Invitation for Public Comment

The views of those who live and work in Texas are important to the development of policies and programs. Comments about the state's nonpoint source management program are welcome. Call the TNRCC at (512) 239-1000, or write to us at one of the addresses shown below.

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