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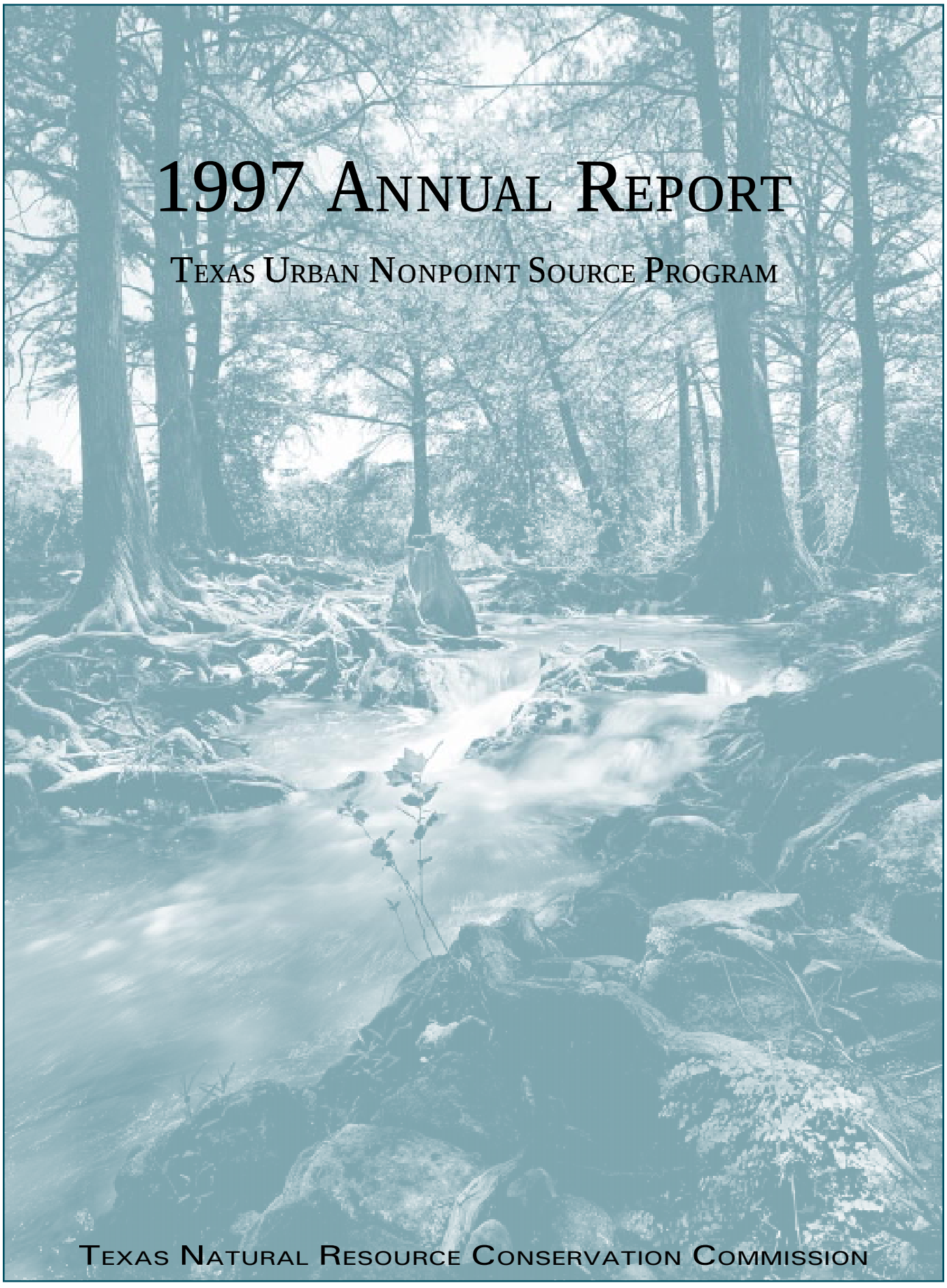

1997 Annual Report

Texas Urban Nonpoint Source Program

Texas Natural Resource Conservation Commission

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A Letter from Sally C. Gutierrez, Director

"Do good and then do it again."

This phrase expresses the challenge and the work before us in fulfilling our mission statement to protect water resources from nonpoint source pollution. Because of the nature of nonpoint source pollution (pollutants from a wide variety of land uses carried by rainfall runoff to water resources), the challenge of controlling it will always be with us.

We've all seen trash in our waterways following a storm. Other contaminants, not so easily seen, are washed into waterways by rainfall runoff in much the same way. When it rains, the rainwater soaks into the ground or runs off, picking up and carrying pollutants to our waterways as it flows. Some of these pollutants are natural, like sediment; many, however, are manmade, and include excess fertilizer, herbicides, insecticides, oil, grease, metals, hazardous household materials, sediment from poorly managed land, and animal waste. Because all of these pollutants come from everyday activities, like driving or caring for our lawns, they will always need to be managed, and each of us can make a difference.

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.

Many people think of pollution from municipal or industrial sites when they think of water pollution; these point sources of pollution, so called because the pollution comes from a single identifiable point, were the initial focus of government agencies in their efforts to clean up the serious problems in our nation's waters which led to the passage of the Clean Water Act in 1976. Due to a vigorous campaign at all levels of government, we have seen remarkable improvement in the quality of our water over the last 20 years. Because of the improvements made in controlling point sources of pollution, and due to general rises in population, nonpoint source pollution has now become a leading cause of water pollution in Texas and throughout the country. The re-authorization of the Clean Water Act in 1987 called for states to prepare management programs for the control and abatement of nonpoint source (NPS) pollution, and provided federal funds, under Section 319(h) of the Act, for supporting implementation projects that further those management programs. The Texas Natural Resource Conservation Commission (TNRCC), then the Texas Water Commission, implemented its most recent management plan for Nonpoint Source Pollution in 1990. That plan is drawing to a close this year, and the TNRCC will be publishing a new program in 1998 for managing NPS pollution. For that reason, I'd like to give some perspective on where we've come in the past seven years, in addition to reporting on this year's accomplishments.

The *1990 Update to the Nonpoint Source Water Pollution Management Report for the State of Texas* sets forth the goals of the TNRCC for managing urban and other sources of NPS pollution that are not agricultural or silvicultural. (The Texas State Soil and Water Conservation Board (TSSWCB) is responsible

for managing agricultural and silvicultural nonpoint sources of pollution.) Four major goals were the focus of the 1990 program:

Goal 1: To conduct a statewide educational program to inform local and regional governments and the general public about nonpoint source pollution: its nature, causes, and the best practices (called best management practices, or BMPs) for preventing, controlling, and abating it. Emphasis will be placed on pollution prevention, since it is less expensive to prevent pollution than to clean it up.

Goal 2: To provide technical assistance to local and regional agencies in implementing BMPs to manage NPS pollution.

Goal 3: To carry out monitoring and assessment to further characterize NPS pollution and to determine the effectiveness of management practices used to control it.

Goal 4: To promote the Section 319(h) grant program and the Section 314 Clean Lakes program as strategic means of implementing projects where they are most needed, to create awareness of the issue, and to administer the grants under that program efficiently.

The State has made major progress on all four of these goals. In 1990, very few people knew what NPS pollution was, and practices for managing it were very new and relatively untested. Today, more than 50 state, regional, and local government agencies are active in managing nonpoint source pollution. Each of those agencies carries out public education campaigns in addition to the efforts of the TNRCC and the TSSWCB in raising public awareness. Numerous state programs provide technical assistance to agencies and individuals who are working to improve practices for controlling NPS pollution. The TNRCC will be publishing an updated assessment report in 1998, with much more detailed information than we have had in the past about where NPS problems in the state are occurring and what some of the causes are. Several manuals are now available from various agencies which describe and evaluate best management practices for NPS pollution, produced with and without the support of Section 319(h) funds. The TNRCC Nonpoint Source Program Team administers more than 50 active Section 319(h) grant projects which represent $8.3 million in federal funds and $5.5 million in state and local matching funds with six full-time employees, assisted by agency administrative and legal support personnel. The program has completed 32 Section 319(h) projects and three Section 314 Clean Lakes projects, 14 of which completed this year (12 Section 319(h) projects, two Clean Lakes projects). Projects administered by the program range from a one-day conference to major pilot projects in the Brazos/Sabine and North Bosque River watersheds, determined to be watersheds of the highest priority based on information from the 1990 Nonpoint Source Assessment Report and other water quality data. The state submitted, and the Environmental Protection Agency (EPA) approved, its 1996 CWA §303(d) list of impaired water bodies which identifies and describes water quality impairments in Texas surface waters, including those from nonpoint sources. The 1998 update of this list should be completed in April of 1998.

Nonpoint Source Pollution:

Water pollution which 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).

It is clear that the State of Texas has accomplished a great deal in managing nonpoint source pollution, especially in light of the sheer size of the state and the complexity of NPS management. But as I said at the beginning of this letter, we have to do good and do it again. In keeping with that, the State has developed a new watershed management approach for organizing the efforts of the TNRCC Office of Water Resource Management and an updated management program for nonpoint source pollution in concert with that approach, which you will read more about in this report. The watershed management approach helps us to use our resources in a strategic manner and to spread our efforts out over five major basin groups sequentially. This allows us to better address problems within local frameworks and to be sure we address all areas of the state. We are working on a schedule for completing watershed action plans over the next eight to thirteen years to restore water quality in each of the impaired water bodies identified on the 1996 §303(d) List. The TNRCC plans to use §319 funds for the development of watershed action plans for NPS-impaired segments on the List.

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 goals of the Nonpoint Source Program today are:

Goal 1:

Identify and characterize existing and potential water quality problems in Texas due to nonpoint sources of pollution.

Goal 2:

Protect water quality by reducing nonpoint source pollution loadings contributing to existing or potential water quality problems.

Goal 3:

Increase the scientific validity of NPS program methods, tools, and procedures.

Goal 4:

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.

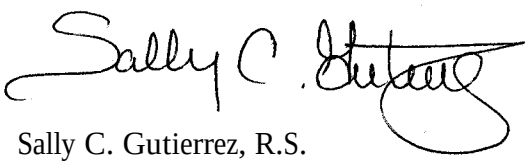
Goal 5:

Administer the NPS program effectively and efficiently.

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.

We have our work cut out for us, and I'm sure that Texas is up to the task.

Sincerely,



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

Introduction

This annual report will highlight the accomplishments of urban nonpoint source management in Texas, and will report 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.

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 and over the last seven years in managing nonpoint source pollution, not the least of which is developing strategies for coordinating the state's complex system of water authority.

Laying the Groundwork

The TNRCC, under direction from the Texas Legislature, established the Clean Rivers Program (CRP) to coordinate the efforts of the river authorities in managing water quality. Coordination efforts have since been hampered to some extent by the sheer size of the state and the wide differences in geographic and hydrologic conditions throughout the state. Resources have also been strained in trying to cover such a large area. To address these problems, the TNRCC has developed a watershed management approach which it will use to coordinate the efforts of the Office of Water, and will be working with regional and local stakeholders on voluntary participation in the process. This watershed management approach consolidates the state's 23 major watersheds into five basin groups which will be addressed in sequence for five major tasks: scoping and evaluation; data collection; assessment and targeting; strategy development; and implementation.

The TNRCC's NPS Program has completed its *1997 Update to the Nonpoint Source Pollution Management Program for the State of Texas*. The management program summarizes current nonpoint source impairments and issues, describes how nonpoint source management will be coordinated with the watershed management approach, and defines milestones for measuring the state's success. The Management Program was submitted to the EPA in July of 1997. Negotiations with EPA led to completion of a second draft of the program, which was submitted in January of 1998. Pending EPA approval, the TNRCC plans to publish the program early in 1998.

The TNRCC's new approach calls for the development of action plans that address water quality problems holistically, by evaluating all potential pollution sources in the watershed and developing strategies for protecting or restoring water bodies. Watershed action plan development is underway for two NPS-impaired watersheds, and was initiated in five more in 1997. Targeting of priority watersheds for 1998 is in progress in conjunction with the development of the 1998 §303(d) list, which will also include a schedule for the progressive implementation of watershed action plans in all impaired water bodies of the state.

A critical component of watershed action plans is the development of total maximum daily loads (TMDLs). TMDLs are complex, technical assessments that determine the maximum amount of a pollutant that a water body can receive and still meet state water quality standards, and serve as the scientific basis for watershed action plans. This maximum load is allocated among all the known sources of the pollutant in the watershed, such as wastewater treatment and industrial discharges, and urban and agricultural runoff. Based on this pollutant load allocation, local, regional, and state water quality managers must then implement a comprehensive watershed action plan that identifies responsible parties and actions needed to restore water quality. At every major step of the process, the public has the opportunity to participate in the development of these plans through the basin steering committees established under the Clean Rivers Program.

The TNRCC believes that the development of TMDLs in priority watersheds is the most effective way to address nonpoint source impairments in Texas water bodies. The public has so far, with good reason, been reluctant to spend large amounts of taxpayer dollars to address nonpoint source problems that are insufficiently defined. Through the development of TMDLs and watershed action plans under the watershed management cycle, NPS impairments will be strategically addressed with plans that have a high chance of success because they have a good technical foundation and local support. For these reasons, the strategic targeting and implementation of TMDLs for nonpoint source impaired water bodies was a major focus of the urban nonpoint source program in 1997 and will continue to be so over the next several years.

The Texas Watch program trains citizen monitors about nonpoint source impacts in surface water bodies.

Spreading the Word

An important element in accomplishing the state's goals for water quality is public awareness and involvement. The TNRCC has been active on several fronts in 1997 to spread the word about nonpoint source issues and solutions.

The goals of the TNRCC's NPS educational outreach are: 1) to familiarize people with the impacts of their behavior on their watershed, and 2) to develop and put into practice specific ways of addressing those impacts. These goals have been addressed through a variety of media.

TNRCC staff have participated in 22 meetings of basin steering committees of the Clean Rivers Program to inform local stakeholders about water quality issues in their areas and to work with some of them to initiate TMDL development under the watershed management approach. The brochure *Clean Water for Texas: Solving Water Quality Problems*, was produced to educate steering committees and other stakeholders about the water quality problems facing the state and methods for addressing them. Approximately 5,000 of these brochures have been distributed, with plans to distribute 10,000 more over the next six months.

The Nonpoint Source Team successfully procured two contractors to conduct educational outreach in four geographic regions surrounding the cities of Lubbock and Harlingen, and in the Corpus Christi and Galveston Bay watersheds. These contractors have sponsored a number of pollution prevention workshops and activities in cooperation with a wide variety of civic and school groups. Examples of activities range from storm drain stenciling to demonstrations of environmentally safe household cleaning alternatives.

The TNRCC published several new nonpoint source educational publications with 319(h) grant funds which have all received favorable public attention. The *Manual for Conducting a Watershed Land Use Survey* was developed by the Texas Watch Citizen's Monitoring Team to show how land uses and our daily activities can impact water quality. This innovative survey has received national and international attention. For example, the National Council of the Paper Industry for Air and Stream Improvement, located in Anacortes, Washington, has requested a copy for use in their watershed research and community activities. The US EPA in Duluth, Minnesota, Terra Environmental Services in LaSalle, Illinois, and VKI,

an independent, nonprofit, research and consulting institute affiliated with the Danish Academy of Technical Science working in many countries around the world, have all requested the publication for use in their respective states and countries. In addition, the survey is a required class project in a graduate level environmental science class at Texas A&M in Corpus Christi. Two other publications produced with 319(h) funds include the CLEAN CITIES 2000 Program's *Storm Drain Stenciling Manual* and the Nonpoint Source Program's *Watershed Owners Streamwalk Guide*. Both of these publications have been distributed statewide, with several requests received from out-of-state parties. Numerous storm drain stenciling projects have been implemented in cities around the state using the *Stenciling Manual* and the stencils provided to TNRCC regional offices. The *Streamwalk Guide* is in use in some junior high school classes, and is used by some regional agencies to conduct streamwalks. TNRCC has also developed a wide array of publications and educational material on pollution prevention, ranging from yard care to recycling, with other sources of funding. Statistics kept by the TNRCC publications department indicate that over 56,000 of these educational pamphlets and brochures were distributed to the people of Texas in 1997.

Several publications have been developed to educate the public about nonpoint source pollution and water quality management

In addition to written material, the TNRCC Office of Pollution Prevention and Recycling's (OPPR) CLEAN TEXAS 2000 Program produced a series of public service announcements (PSAs) on nonpoint source pollution prevention as part of the *Clean Texas Reporter* series. These segments focused on topics such as storm drain stenciling, composting, and used oil and battery recycling. The PSAs aired in eight metropolitan areas of the state, reaching a potential television viewing audience of 1.8 million Texans.

CLEAN CITIES 2000 is a statewide pollution prevention program of the OPPR that involves Texas cities in cooperative projects with a long-term commitment to take care of Texas. Twenty Texas cities with populations over 50,000 participated in nonpoint source pollution prevention projects such as household hazardous waste collections, citizen monitoring, storm drain stenciling, composting, and public education campaigns.

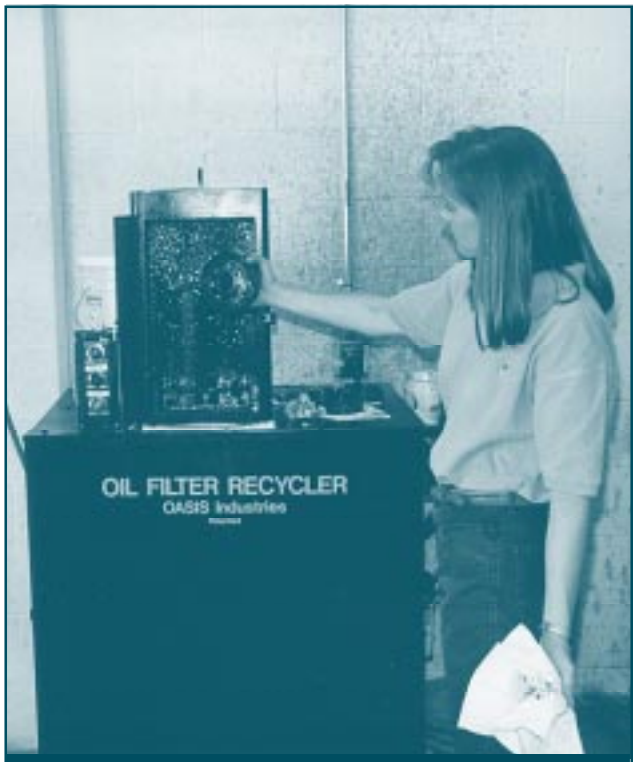
Classroom teachers have also received training and resources about nonpoint source pollution issues through the OPPR. The Education Section of this group participated in teacher training at Texas universities through the Teaching Environmental Sciences program. Lesson plans were distributed, and concepts were conveyed through demonstration. Several new lesson plans have been developed for publication in the upcoming year.

The TNRCC Texas Watch Program provides technical assistance to volunteer groups in the state in collecting water quality samples and performing other water quality related projects. Water quality data collected by Texas Watch volunteers help to fill gaps in the statewide water quality monitoring network. The volunteers become educated about the causes and effects of NPS pollution during the imple-

mentation of the projects through training workshops developed by the Texas Watch staff.

Section 319(h) education projects have often served as the seeds for the growth of local environmental awareness and action. The city of San Angelo is an excellent example of this.

The 1992 and 1994 Clean Rivers Program Assessment reports identified severe impacts from urban nonpoint source pollution in the North Concho River near the city of San Angelo. With structural controls still under construction, educational efforts have blossomed in unexpected ways. The San Angelo River Corridor Commission, representing a broad spectrum of the community, has become the "eyes and ears of the Concho River." A subsidiary committee of this group has been active in creating public awareness and advocating opportunities for improving the Concho River through programs, activities, and media involvement. This committee has been collecting historical data to develop a presentation that will raise local awareness about issues in the watershed. A spin-off group, called the "Friends of the Concho River," produced a video on NPS awareness featuring children and adults from the San Angelo community, and stressing the importance of pollution prevention. There is a renewed sense of involvement and volunteerism in the San Angelo community for promoting the message of pollution prevention and preservation of clean water.



Used oil and oil filter recycling is a widely used best management practice.

In addition to the River Corridor Commission, a Citizen's Advisory Board was formed to give support and insight to the Upper Colorado River Authority's 319(h) Nonpoint Source Urban Runoff Demonstration Project. This group has been instrumental in locating other sources of funding to address local water quality issues. Applications have been made to other funding agencies to finance the development of brush control management, structural control systems, and fisheries enhancements. The Upper Colorado River Authority has also been proactive in creating a citizen's volunteer monitoring group called West Texas Watch. Because of the activities of this group, the UCRA was awarded a Governor's Environmental Excellence Award for NPS education and outreach in 1997.

Doing the Job

Several legislative and program initiatives were completed or begun in 1997 to prevent or control nonpoint source pollution.

The Texas Legislature passed a bill in 1995 creating the Southwest Travis County Water District, a 4,600-acre area situated on the recharge zone of the Edwards Aquifer in central Texas. The bill provides for the protection of water quality from new urban development by requiring the development of a water pollution and abatement program designed to ensure that water bodies in the zone continue to meet state water quality standards. The District prepared their program and submitted it to the TNRCC for review and approval in December of 1996. Staff members of the Nonpoint Source Team led an interdivisional TNRCC team in the review of the District's program. The District re-

vised the program in response to comments from TNRCC staff and the Commission approved the program in June of 1997.

Rules for protection of the Edwards Aquifer were amended in response to public comments. The primary purpose of the amendments was to streamline and consolidate the Edwards rules with existing water code and to clarify certain sections, especially those related to procedural issues regarding the review and approval of water pollution protection plans. The amendment also provides several clarifications and new provisions that strengthen the protection of the aquifer. The amendments clarify that the goal of the rule is non-degradation of groundwater. New requirements for protection plans to address the entry of runoff from control structures into receiving streams to prevent erosion were added. Construction of supporting structures for equipment used to transmit electricity was identified as a regulated activity, and further requirements for setbacks from recharge features were added. Also included are requirements for a geologist to inspect excavations for the presence of sensitive features, lift stations, or tankholds to ensure that these features and structures are documented and protection methods are revised to accommodate them. The construction of municipal solid waste landfills located on the recharge or transition zones was prohibited.

Follow-up inspections of BMPs installed under water pollution and abatement plans for development over the Edwards Aquifer help to ensure protection of this critical water resource.

The TNRCC continues to review water pollution control and abatement plans for development over the Edwards Aquifer. Inspections of structural controls are conducted to ensure that proper maintenance is carried out to keep the structures in good operating condition. An extensive inspection project by the Groundwater Nonpoint Source Program identified malfunctioning or poorly maintained structures over the aquifer, and a draft report of its findings was submitted to the local field office of the TNRCC for corrective action.

The Texas Legislature amended Section 26.177 of the Texas Water Code, which provides for the water pollution control duties of cities in Texas, during the 1997 Legislative session. As part of the TNRCC's Legislative Implementation Project, staff members of the NPS Program are leading a rule-making team to draft rules that support implementation of the statute. The law requires cities with populations greater than 10,000, where a water pollution problem from non-permitted sources is identified, to correct the problem through existing municipal programs or through the implementation of a water pollution control and abatement program approved by the TNRCC. The rules are expected to be adopted by October of 1998.

The Texas Legislature re-authorized the Clean Rivers Program, which coordinates water quality assessment by regional water quality agencies, such as river authorities and councils of governments. The CRP partners, and the basin steering committees established under the program to advise state and regional authorities, play crucial roles in implement-

ing watershed management activities throughout the state.

The state has begun the preparation of a coastal nonpoint source program in compliance with Section 6217 of the Coastal Management Act. The Texas General Land Office is leading an inter-agency effort to compile existing programs into a coastal nonpoint source management program that complies with the federal regulations. The inter-agency team includes representatives of the TNRCC, the TSSWCB, the Texas Parks and Wildlife Department, the Texas Department of Transportation, and the Railroad Commission of Texas. Public meetings are being held in coastal locations to receive public comment on the state's proposed strategy. A draft program document will be prepared for public comment in the summer of 1998, after which it will be revised and submitted to the Coastal Coordination Council and the Texas Legislature in the fall of 1998. A final program document is due to be submitted to the National Oceanic and Air Administration and the EPA in the summer of 1999.

Students from Los Fresnos High School stencil a storm drain in Brownsville, Texas.

The state has several ongoing programs that provide technical assistance for nonpoint source pollution prevention activities or that routinely use NPS best management practices. Examples include the TNRCC's Wellhead Protection Program, Field Operations Beneficial Sludge Use Program, Clean Cities 2000, the Oil Recycling Program, and the Small Towns Environmental Program. The Texas Parks and Wildlife Department operates the Urban Wildscapes and Private Lands Enhancement programs, which encourage proper environmental land management practices. The Texas Department of Transportation uses a number of highway BMPs, such as spill management, construction controls, and integrated landscaping. The Railroad Commission of Texas has established controls over and conducts inspections of petroleum drilling operations.

The TNRCC's Ground-Water Assessment Section is responsible for implementing projects aimed at groundwater problems and pollution prevention issues. The Section implements portions of the Texas Nonpoint Source Program, primarily through wellhead protection activities, the TEX-A-Syst program for concentrated animal feeding operations, other regional aquifer protection activities, technical assistance and education, and assessment of current and potential groundwater nonpoint source problems. Staff are responsible for updates of the *Ground-Water Nonpoint Source Assessment Report and Management Plan*. The Section uses geographic information system (GIS) tools extensively and provides assistance with GIS needs in other areas of the Water Quality Division. Staff provide groundwater input from programs throughout the state for the Nonpoint Source Program annual report. The Section has been developing and implementing ways to use the TNRCC's watershed management approach in the agency's groundwater program with much success, striving to embrace groundwater/surface water issues in a holistic manner and find solutions that do not simply shift the problem to another arena.

The Ground-Water Assessment Section is also responsible for coordinating the Nonpoint Source Subcommittee of the state Ground-Water Protection Committee. The Texas Ground-Water Protection Committee is a multi-agency task force dedicated to

addressing groundwater coordination in Texas. It has a working subcommittee, the Nonpoint Source Subcommittee, that serves to coordinate groundwater nonpoint source efforts among state agencies. This subcommittee met on a quarterly basis last year, and has worked diligently to implement nonpoint source programs at individual member agencies. It was formed in 1995 to provide a forum for implementation of the state groundwater nonpoint source program and to provide for interagency coordination on matters related to the program.

The Ground-Water Nonpoint Source Team has been working on an agricultural project funded under the TSSWCB's §319 grant. The project works in conjunction with TEX-A-Syst activities at rural water supply wells in Bell and Jones Counties. Groundwater was sampled from drinking-water wells to establish background water quality. Well owners in those counties were informed about the best management practices for protecting their groundwater supplies from nonpoint sources of pollution.

Demonstrating groundwater infiltration at a Teaching Environmental Science course.

Of the six TEX-A-Syst sites sampled in Bell County, follow-up samples collected from two locations indicate the presence of fecal coliform bacteria contamination. Potential sources include on-site wastewater and impacts from surface water infiltration. Best management strategies have been discussed with well owners and implementation should follow soon. A monitoring program has been developed to evaluate the effectiveness of the BMPs selected.

Public outreach for FY 1997 included workshops in Bell and Burleson Counties. The workshops were designed to solicit volunteers for the TEX-A-Syst program and introduce general pollution prevention activities. Six volunteers were identified as a result of these workshops. In addition, a presentation was made at the Texas Water Utilities Association (TWUA) meeting in Somerville, Texas. The 65-member audience was introduced to pollution prevention strategies and the TEX-A-Syst and Wellhead Protection programs.

The soil pesticide interactions matrix (SPIM) map developed for this project has been greatly improved over the past year. SPIM now has the capability of evaluating the potential for a loss due to runoff or leaching for more than 150 pesticides.

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. A great deal of progress was made in 1997 in targeting and coordinating these activities.

The Nonpoint Source Program prepared the *1997 Update to the Nonpoint Source Assessment Report for Texas* in cooperation with other TNRCC programs, the Texas State Soil and Water Conservation Board, and the Clean Rivers Program partners. The Assessment Report identified 105 water bodies with nonpoint source impairments from urban, agricultural, and other sources. These water bodies were also listed on the state's CWA §303(d) list of impaired waters. The Assessment Report was submitted to the EPA in July of 1997. The NPS Program hopes to publish it in early 1998, pending EPA approval.

The Surface Water Quality Monitoring Program staff developed statewide schedules for monitoring by TNRCC central and regional field staff and CRP partners. These schedules ensure that in addition to baseline monitoring of water quality, the state is tar-

geting resources to collect information about impaired water bodies on the 303(d) list needed for the development of TMDLs or to determine if TMDLs are needed. This increased coordination should lead to scientifically defensible characterizations of impaired waters, with enough information to make informed decisions about strategies and actions for restoring water quality.

Modeling of nonpoint source contributions is another important step in water quality management. For the development of a TMDL for dissolved oxygen in Armand Bayou, the Modeling Program is taking a new approach to modeling nonpoint source contributions. Previous TNRCC TMDL analyses used a single value to estimate nonpoint source loadings for all types of land uses. With the Armand Bayou model, the program has established procedures to associate estimated average concentrations of particular pollutants with various land uses. These estimated concentrations are then correlated with land uses in the watershed and merged with existing point source models for the area. Building on this effort, the program is also working to automate this process to model NPS loadings for Dickinson Bayou.

Collecting fish samples in the Brazos-Colorado Coastal Basin. Biological monitoring is critical to a comprehensive assessment of nonpoint source impacts.

There are still many issues to be resolved; for example, the models are not dynamic enough. The existing point source models that are used as the base for the addition of nonpoint source loads are based on steady state stream conditions, and may not adequately address the effects of various types of rainfall events, from slow drizzle to heavy thunderstorm. Program members have attended EPA training on a model called BASINS, which is being developed under an EPA contract. This tool also allows for spatial distribution of nonpoint source loadings, but as yet does not adequately address the dynamics of rain events and stream conditions. The program has looked at methods being used in other states, but with no objective review of existing event-based models, there is not enough information to evaluate their effectiveness in comparison to the Texas approach. All states are grappling with the complexity of nonpoint source modeling. Texas will continue to develop refinements to its approach as it develops models for TMDLs to address impaired water bodies around the state.

Geographic information systems mapping is an important tool for understanding watershed relationships and for conveying watershed information. The TNRCC continues to enhance its use of this tool through development of TMDLs for impaired watersheds and presentations to stakeholders about water quality problems in their areas. The TNRCC has developed GIS maps of the impaired segments on the 1996 CWA §303(d) List and in the 1997 §319(h) Nonpoint Source Assessment Report Update. Groundwater Assessment Section staff have used GIS tools extensively to map occurrences of groundwater contamination in the state, to assess groundwater vulnerability, and to map the locations of significant recharge features.

Under an EPA 104(b) grant, the TNRCC has developed the Texas Watershed Planner (TWP), a GIS application used by water quality professionals to analyze, regulate, and protect water quality. There are three modules in the TWP: the Watershed De-

lineator, the Project Finder, and the Priority Finder. The Watershed Delineator module allows the user to define watershed boundaries using spatial criteria. The Priority Finder module provides information about the priority surface water quality issues in the state, such as "Which watersheds are impaired by fecal coliform bacteria?" or "What are the major water quality concerns in Big Sandy Creek?" The Project Finder module allows the user to search for active or completed projects in a watershed. This information helps staff to target future projects and to coordinate with existing projects. Using the Watershed Planner, staff can identify priority water quality problems within a watershed framework. By viewing the watershed as a whole, coordination needs can be identified and integrated solutions to water quality problems can be formulated. This powerful tool will be used in the development of TMDLs and watershed action plans for impaired water bodies in the state.

The Corpus Christi Bay National Estuary Program (CCBNEP) sponsored several studies in 1997 to evaluate sources of NPS pollution and the effectiveness of best management practices in the Coastal Bend region. In the city of Refugio, community leaders, civic groups, and volunteers have joined together to demonstrate how a community can integrate cutting-edge design elements with a public project to reduce nonpoint source pollution for little cost. An enhanced wetland is being constructed adjacent to a creek that flows through a municipal park. The wetland will anchor soil, trap sediments, and absorb nutrients in the water. A companion reflecting pond will provide an aesthetic element while detaining storm water runoff to allow particulate material to settle out before being discharged to the creek.

The CCBNEP also sponsored an assessment of on-site sewage facilities in cooperation with four counties in the area: Aransas, Nueces, San Patricio, and Refugio. The assessment identified activities that need attention for management and regulation and offers recommendations for addressing those issues. For example, computers are needed to enhance record keeping, and local governments need to pursue grant application assistance.

Another Bay Program study is determining how much of the nutrient and other pollutant loading in the bay system comes from atmospheric sources. Two sampling stations have been installed near Corpus Christi, Oso, and Nueces Bays to collect both wet-fall and dry-fall samples. These samples will be analyzed for constituents such as nitrogen, phosphorus, metals, pesticides, and other toxins. Preliminary results from the study are expected in early 1998.

Program Administration

The TNRCC strategy for the use of §319(h) funds has seen significant changes in 1997. Traditionally, the TNRCC has used these funds to support local demonstration and best management practice evaluation projects. While these projects have been fruitful in identifying effective practices for controlling specific types of pollutants, the TNRCC believes a more strategic use of these funds for the future is the development of TMDLs and the implementation of state programs to protect or restore water bodies with known threats or impairments.

For the second year, the state's §319(h) program operated under the TNRCC's Performance Partnership Grant (PPG) with the EPA. The PPG offers the opportunity for streamlined reporting requirements and focuses on results rather than outputs. Thirteen agency program areas are funded in the 319 portion of the 1997 PPG. The results from those programs are discussed later in this report.

The Nonpoint Source Program implemented enhanced grant project and contract tracking systems in 1997. A review of grants showed approximately 90% of all grant projects are making satisfactory progress. Several projects were successfully completed and are highlighted elsewhere in this report. Many of these projects conducted technology transfer events which were well organized and attended. Two Clean Lakes projects for the Oyster Creek Lakes system and Lake Pat Cleburne were also completed.

NPS Program staff have been participating in the EPA's Partnership 2000 pilot project to use Lotus Notes for electronic grant reporting and processing. This state-of-the art Partnership 2000 (P2000) automated system is designed to provide an electronic solution to the paper-intensive grant development, award, and communication process that currently exists. The project is a joint effort of the Environmental Council of States, the EPA, and State partner agencies. The TNRCC has been testing and evaluating this prototype system as one of five pilot states in the nation. P2000 is expected to streamline internal operating procedures and improve the overall efficiency of state and federal grant management. NPS Team participation in this project will continue into the next fiscal year.

Regional and Local Programs

During 1997, the TNRCC NPS Team conducted a statewide survey of public and private agencies on local nonpoint source issues and best management practices. Seventeen organizations replied: six cities, three river authorities, one county, three regional councils of government, two state agencies, one water improvement district, and a private waste handling company.

Each organization was asked to identify sources of nonpoint source pollution in their jurisdiction based on their knowledge of local land uses and conditions. Overwhelmingly, the largest category of NPS concern was hydrologic/habitat modification followed by land disposal, construction, and "other" activities (such as highway runoff, spills, and leaking storage tanks). Several land use activities were listed within each NPS category. Of these, land development was believed to be the largest contributor to NPS pollution, followed by spills and stream bank modification. Urban runoff, channelization, and flow regulation/modification tied for fourth place as perceived contributors.

From a geographical standpoint, the following primary NPS categorical concerns were noted:

- East Texas - Land Disposal
- Central Texas - Land Disposal and Other (spills, highway runoff)
- West Texas - Hydrologic/Habitat Modification
- Panhandle - Other (leaking storage tanks, natural salinity)
- Coastal Zone - Hydrologic/Habitat Modification

No surveys were returned from the South Texas area.

After identifying the local NPS problems, each respondent was asked to provide a brief description of their nonpoint source prevention and abatement programs. The most commonly cited BMPs were detention/retention ponds and hazardous spill contingency plans. Other BMPs frequently noted were onsite wastewater facility inspections, land development codes, watershed protection, and waste management plans. Some of the agencies surveyed have taken measures to establish specific policies and programs which address nonpoint source pollution at its source. Examples of these include erosion control ordinances and septic tank regulations.

Most agencies indicated that they have implemented, or are in the process of developing, some kind of nonpoint source educational program. Examples of outreach activities include workshops for small businesses, citizen monitoring groups, shoreline clean-ups, storm drain stenciling, school presentations, newspaper inserts, and dissemination of brochures. Several cities currently implement curbside recycling and support used oil and household hazardous waste collection centers.

Management Program Milestones

The 1997 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.
- 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 1997 PPG projects.

Edwards Aquifer Protection

Project: Best Management Practice Evaluation
Program: Groundwater Assessment Section

Outcome Measures

Goal	Accomplishment
Starting in FY 1998, 100 percent of the BMP recommendations by TNRCC regional office staff will be made using the information derived from this project. An average reduction of 20% in the long term of NPS loadings of total suspended solids, metals, phosphorous, nitrates, oxygen demand, organic carbon, hydrocarbons, pesticides, and herbicides to surface water in the Barton Creek watershed of the recharge zone of the Edwards aquifer from the use of recommended BMPs with the best pollution reduction efficiency, based on 1995 and 1996 data. Reduction in NPS loadings of the same pollutants as above to surface water in the Edwards recharge zone of the Barton Creek watershed by an additional 30% over 1996 outflow levels, due to the identification of under performing BMPs in the study area and their maintenance or repair.	The TNRCC regional office is using the information from this project for all BMP recommendations. Significant reductions in NPS loadings were observed in surface runoff through maintained stormwater BMPs. For some NPS parameters such as total suspended solids (TSS), oil and gas, and total petroleum hydrocarbons (TPH), the BMPs consistently reduced concentrations by over 75%. The water quality data collected was not conclusive in demonstrating which BMP design is most effective; however, it is evident that correcting problems with underfunctioning BMPs reduces loadings. Inspections found that 54% of the BMPs required some form of repair or maintenance; 27% of these BMPs had been repaired at follow-up inspections. The number of samples taken was not statistically significant enough to support calculation of additional reductions in loadings due to identification of under-performing BMPs.

Output Measures

	Goal	Accomplishment
Number of recommendation sets for TNRCC regional office technical staff to facilitate implementation of Water Pollution Abatement Plans (WPAPs) and all permitted BMPs in the Edwards aquifer recharge zone in Bexar, Comal, Hays, Travis, and Williamson counties. Recommendations will address structural BMP performance and maintenance activities.	1	1

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% over five years.	There was a delay in adding the necessary staff until late in the fiscal year. Consequently, the projected level of inspections was below target. However, the technical assistance goal was exceeded by 302%. 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.	120	16
Number of WPAPs reviewed for organizations wishing to construct or develop property over the Edwards Aquifer Recharge Zone.	45	24
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.	240	74

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%, where recommendations are implemented. 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. 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.	Special provisions to control sediment runoff were included in state certifications of federal dredge and fill permits where applicable. Wastewater discharge permits were reviewed to assure that permit effluent limits will maintain in-stream water quality standards. Through participation in the Review Team, five advanced mitigation agreements are in the process of banking a proposed 175 - 800 acres each for wetland mitigation.

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	113
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	555
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 Big Thicket National Forest.	50	55

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 by 25% over five years.	On-site inspections have not met targets due to late implementation. There was a delay in adding the necessary staff until late in the fiscal year. However, the substantially reduced numbers of new permit applications, as well as increasing facility closings, suggests that there will be fewer facilities operating with better oversight, which should result in reducing contaminated runoff from these sites. There are not sufficient data yet to calculate the reduction in contaminants due to implementation of this project.

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	8
Number of permits for which Beneficial Sludge/Biosolids Use Program will provide technical assistance to achieve compliance with permit limits.	50	51

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% over five years.	New inspection staff were not hired until late in the fiscal year. Consequently, the target for number of inspections was not met. However, technical assistance exceeded targets by 160%. There are insufficient data as yet to quantify reduction of pollutants due to this 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).	180	288
Number of OSSF initial and follow-up inspections in the southeast target area.	120	55
Number of plans for new OSSFs which the OSSF Program will review, providing technical assistance and oversight for delegated local governments in the southeast target area.	240	14

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 which 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 WQ 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 Team conducted extensive negotiations with contractors, amended work plans for a number of contracts, made project site visits, participated in quarterly EPA regional meetings, managed the new PPG process, and started coordination and planning for the 1998 NPS Conference. The Team worked with other TNRCC programs to develop schedules and outcome measures for five new TMDLs in NPS-impaired watersheds. In a mid-year review of 319(h)-funded projects, EPA determined that approximately 90% of the projects were making satisfactory progress.

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
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

Section 319(h) Grant Project Highlights

The TNRCC Nonpoint Source Program Team administers over 50 active Section 319(h) grant projects which 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 1997

Twelve projects were successfully completed in late 1996 and fiscal year (FY) 1997 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.

Pace Bend Park Restoration, Travis County, Funded FY 1994

One of the severely eroded areas as it appreared in 1994.

The same area in 1996, after restoration was completed.

Random sampling of grasses collected in one of the restoration areas.

The ground was almost totally exposed. Deep gullies ran from the hilltops to the lake. Concrete slabs whose tops were once flush with the ground stood like islands atop a sea of soil and exposed rock. The variety of the remaining plant life was reduced to the hardiest of species. The numerous coves were choked with soil that ran unhindered with the water that flowed over this barren landscape to the lake whenever it rained.

These were the conditions just three years ago at Pace Bend Park, a popular recreational spot on the shores of Lake Travis near Austin, Texas. The park is owned by the Lower Colorado River Authority (LCRA) and managed by Travis County. Through a cooperative project of the County, the LCRA, the EPA, and the TNRCC, the landscape at Pace Bend today is remarkably changed. A wide variety of native grasses covers the once bare soil, the gullies have been replaced with controlled drainage areas, and the coves are no longer choked with sediment.

Pace Bend is one of the largest and most popular parks in the region. It covers 1200 acres, and features over nine miles of shoreline. It is located on a peninsula formed by a large bend in the old Colorado River bed, which now underlies Lake Travis. The terrain is typical of the Hill Country west of Austin—thin soils on underlying limestone. Live oaks, junipers, and native grasses are the predominant vegetation, with some areas of post oak and mesquite. In areas that are under water when lake levels are high, Bermuda grass is dominant. The western shore of the park, known as Cliffside, consists entirely of steep rock cliffs, with ten cove inlets. The eastern shoreline consists of the Flats at the north end, and the East Side cliff area to the south. The Flats is the only area of the park with gentle slopes and deep soil, which is alluvium from the old Pedernales and Colorado River floodplain.

For many years, Pace Bend Park was open to unrestricted vehicle traffic in most of its camping and swimming areas. Roads and parking areas were not explicitly designated, and multiple roads led to the same spot in many areas. As the popularity of the park grew to thousands of visitors annually, vegetation in the most heavily used areas was unable to recover from the constant impact of vehicle and foot traffic. The resultant loss of ground cover led to severe erosion and soil loss, with subsequent degradation of the water quality in the cove inlets.

A severe flood in 1993 forced the closing of a 70-acre area in the Flats region of the park. This closing provided an opportunity for Travis County resource managers to devise a plan for restoring the vegetative cover in the area. County staff, using county equipment, restored topsoil and seeded grasses in the most severely disturbed 12 acres within the closed area. The success of this initial effort spurred the restoration of an additional 7 acres on the eastern shore of the park. The County and the LCRA were eager to continue this restoration, but available funds were running short.

In 1994, the LCRA and Travis County secured a grant from the EPA through the TNRCC's Section 319(h) grant program. With this assistance, the County was able to restore an additional 22 acres in 1995 and 1996. Restoration of these acres was especially challenging, because they were located in areas of the park that remained open.

Travis County had six major goals for the 1995-96 restoration:

- to improve water quality in the coves by reducing sediment loads in rainfall runoff by 70% through the restoration of grass cover;
- to reestablish the native grass/woodland ecosystem of the park to enhance wildlife habitat and human enjoyment;
- to close the restored areas to vehicle traffic, while still allowing foot traffic;
- to restore areas that would not be redeveloped under future master planning for the park;
- to replace soil losses and reestablish contours and drainage patterns; and
- to use the deep soil and accumulated sediment in the cove areas for topsoil.

Demonstration of the reapers at a technology transfer workshop.

Concurrently with this project, the County and the LCRA are working on a master plan for the park which will build on what has been learned from the restoration and ensure prevention of high levels of land disturbance in the future.

Working closely with the EPA and the TNRCC, the County and its subcontractor, DLS and Associates, developed a Quality Assurance Project Plan, which lays out the objectives for the sampling program, presents the experimental design, and explains methods used to evaluate data to ensure that the sampling plan is valid. Through this process, the cooperating agencies clarify objectives and plan the project for efficiency and success. DLS developed a random sampling method which selected random sites within 50 grid areas. Sample sizes were determined using paired observations of three different sizes of sample circles. Species individuals were counted within the sample circles using a device which hits points at 1- or 2-decimeter intervals. Soil loss estimations were made using the Universal Soil Loss Equation for pasture lands. The monitoring plan was expected to determine the success of the project with 95% accuracy. Once the sampling plan was defined, targeted areas were then monitored to scientifically define pre-restoration conditions.

In the next phase of the project, County workers dredged accumulated sediment from the coves to provide topsoil for the restoration areas. Many areas had lost from six to eight inches of topsoil over the years, and the remaining soil was hard packed and semi-impervious from constant compaction. Clearly, more soil would be required to increase infiltration and provide for a successful re-vegetation effort. By recycling the soil that had eroded into the coves, the project solved two problems for the price of one. More than 23,000 cubic yards of soil were excavated for use. Lower quality soils were used to fill in gullies, with the better quality used as topsoil. After the soil was filled and spread, it was graded into existing soil and shaped for proper drainage patterns. Before excavation, the top nine inches of soil containing the existing Bermuda grass roots was graded off and set aside. This Bermuda sod was then replanted in areas which are underwater for long periods of high lake levels, as native grasses would not survive in these areas. Work was scheduled so as to keep soil exposure time to a minimum.

Signs like these were used to change the behaviors of park useers.

A subcontractor, Environmental Survey Consulting, was hired to carry out the seeding activities. Two innovative harvesters developed by the firm, the Grin Reaper and the Tractor Reaper, were used to gather wild seed in the fall for spring planting. The Grin Reaper is a converted weed eater; a wide box is mounted behind the cutting mechanism, and the box and a large attached mower bag gather the tops of the plants, which contain the seed heads. For more open areas, the Tractor Reaper uses a front mounted mower and combine to sweep harvested grass into a large box.

The seed mixture used consisted of five common commercially available native grasses mixed with 12 bushels per acre of wild seed harvested from within the park area and from local grassland areas similar to the park. Seeding was done in the spring to take advantage of moderate temperatures and spring rains. The seed was mixed and hand broadcast, after which a metal drag harrow raked the area to ensure good seed contact with the soil. The seed areas were then covered with soil retention blankets which prevent erosion and retain moisture, significantly enhancing seed germination and reducing the need for irrigation. Through experimentation, American Excelsior Curlex Quick Mow wood blanket was identified as best for use in areas

where there will be continued foot traffic. The plastic netting which holds this matting degrades completely within six months; the plastic net in other types of matting used degraded much more slowly, and posed tangling problems for wildlife and human feet. A severe nine-month drought from late 1995 into 1996 stunted vegetation until rainfall increased in late 1996. Despite this setback, the new grasses have done very well, with about 15 varieties of grass present, of which six are performing very well.

Meanwhile, park managers had to work very hard to break park users of long habits. In order to keep visitors from driving in the restored areas, large limestone boulders were hauled from a nearby road construction site and placed as barriers to vehicle traffic. Even so, some visitors moved the boulders so that they could drive into areas where they were accustomed to going. Larger boulders were placed, and park managers placed numerous signs that informed the public of restoration efforts. Through a concerted public education effort, visitors cooperated with the new boundaries.

The County has developed a documentary video of the project to share its results with other management agencies. These results include the restoration of 22 acres, plus the protection of an additional dozens of acres from potential damage by vehicles. Vegetative cover in the restored areas was increased from near zero to 70% in the areas re-vegetated in 1995 and 77% in those re-vegetated in 1996. Eventual mature coverage of 80-90% is expected. Plant species diversity, an indicator of ecosystem health, increased significantly in the restored areas as compared to control grassland plots in the park. Using a species diversity index which compares the total number of species with the total number of individuals, species diversity measured approximately 62% greater than the control sites in the 1995 areas and approximately 77% greater in the 1996 areas. Soil losses have been reduced on severely eroded sites from an estimated several tens of tons per acre per year to an acceptable range of two to five tons per acre per year or less, depending on assumptions.

It is clear from the before and after pictures shown in this report that a remarkable transformation has been made in a very short time due to hard work, creativity, cooperation, and the support of 319(h) funds.

This three-stage sedimentation/filtration BMP, built for the Roadway Runoff BMP project, captures the first 1/2" of runoff from nearby roadways.

Roadway Runoff Best Management Practices, Barton Springs/ Edwards Aquifer Conservation District (BS/EACD), Funded FY 1989-90

This project consisted of three primary tasks: 1) implementation and monitoring of innovative BMPs at two sites over the recharge zone of the Barton Springs segment of the Edwards Aquifer; 2) transference of technological results to other agencies involved in roadway construction and pollution mitigation; and 3) a commitment to implement this technology by identifying at least 20 sites appropriate for BMP implementation in critical water quality or environmentally sensitive watersheds impacted by roadway construction.

Water quality professionals from around the state learned about the innovative Roadway BMPs at a technology transfer workshop sponsored by the BS/EACD.

Construction of the two demonstration BMPs began in August of 1993 and was completed in early March of 1994. The design and construction were a cooperative effort of the BS/EACD, the Texas Department of Transportation, the City of Austin, and the Lower Colorado River Authority. The project team resolved initial installation problems with both the vertical sand filter (wash-outs) and the weir plates (design change).

Monitoring and sampling began in October 1994 and continued through July 1996. A drought occurred between November 1995 and August 1996. Twelve storms resulted in complete sample events at one or both BMPs. Some storms resulted in partial samples only, but still provided useful data. Initial problems with sediment deposition were resolved once vegetation was established over the non-paved drainage areas.

Several improvements and modifications were made to the BMPs during the sampling process as project team members observed specific problems and developed

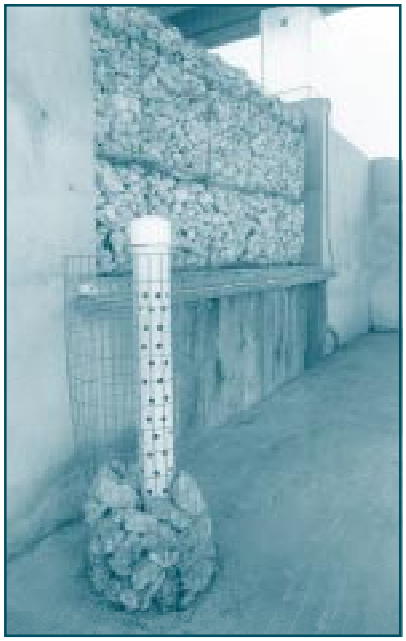
solutions. These included reducing clogging by using nylon grid fabric screen instead of silt fence filter fabric to retain the filter media; draping the nylon grid fabric screen over the leading gabion wall to trap larger organic matter and debris; better clean-out and maintenance procedures; alternative filter media; and revised installation configurations.

The final configurations of both BMPs were more effective in reducing pollutant loading than previous iterations, but were less effective than had been expected. BMP Site 1, with its innovative vertical sand filter, yielded moderate removal rates approaching those of more traditional horizontal sand filters. However, clogging of the filter after only a few storms was an ongoing problem. BMP Site 2 yielded effective removal rates of suspended solids and associated pollutants more closely resembling those of sedimentation basins. Clogging was not a problem in the vertical rock filter at Site 2, and water passed through the structure in a reasonable amount of time. However, minimal filtration and/or adsorption of dissolved solids was noted, and the crushed limestone media used for filtration was obviously not as effective as the sand filter media used in Site 1. While certain design flaws were identified, many of them were corrected. Those not correctable within the limits of the project have been noted, and future design improvements have been suggested for them.

This BMP used an innovative vertical filtration wall. Some experimentation was necessary to select a filtration media that would allow stormwater to flow through at a specific rate.

Five presentations were made to transfer the technologies evaluated in this project. These presentations reached more than 500 people. Workshop attendees were given the opportunity to evaluate the effectiveness and usefulness of one of these presentations, and the results were very favorable. Of the respondents, 90% rated the presentation very good to good, and 75% thought they learned something new; 95% found the information useful, and 65% thought they would use what they learned in their own work.

The cooperating agencies in this project have committed to implement, as appropriate, those BMP technologies deemed successful as a result of this project. The project team identified more than 40 appropriate sites, and as of this report date, 43 structural BMPs have been installed, and one is under construction. These BMPs are located over the recharge zone of the Barton Springs segment of the Edwards Aquifer, and vary from simple hazardous materials traps to huge multi-compartment treatment train facilities. Vertical sand filters are incorporated in many of them, and horizontal sand filters are installed in two of the large sites. Temporary and non-structural BMPs were used to mitigate the impacts of erosion and sedimentation during construction. Regularly scheduled maintenance has been incorporated for the structures, which is very important in preserving the effectiveness of structural BMPs.



After passing through the filter, water collects in the extended detention basin shown here. This water is slowly released through the perforated pipe seen in the foreground.

The project team determined that under constrained situations, such as small drainage areas, limited right-of-way, or lack of suitable terrain, vertical sand filters have certain attributes which may offset some of their disadvantages and could be used to some benefit, particularly if incorporating recommended design changes. While not achieving the degree of removal efficiency demonstrated by traditional horizontal sand filters, vertical filters did remove substantial quantities of suspended solids, and those incorporating a narrow sand layer reduced some dissolved solids.

The importance of properly designed and constructed vegetative buffer strips, ditches, and grassy areas with a stable soil substrate was again confirmed. These BMPs can provide a relatively high degree of removal efficiency of sediment and sediment adsorbed contaminants, and can lower maintenance requirements, reducing maintenance expenses.

The cooperative nature of this project strengthened ties between regional and state agencies responsible for water quality in the Edwards Aquifer, and allowed for significant innovation in the design and improvement of the BMP structures. The project has produced a detailed report with recommendations for the most effective use of vertical filtration structures and their enhancement in future placement through design improvements.

Retrofit Best Management Practices for Existing Urbanized Watersheds, City of Austin, Funded FY 1990

This project provided for the implementation, monitoring, and effectiveness evaluation of both structural and nonstructural control measures and educational outreach activities. Two structural BMPs for retrofitting urban areas were selected for study as part of this project: a retrofitted wet detention pond (St. Elmo pond) and a sedimentation/filtration pond (Barton Ridge Plaza structural control).

The St. Elmo pond was a flood control facility which was retrofitted by deepening an existing detention area to form a permanent pool, grading a littoral shelf into the pond, and establishing aquatic vegetation. Vegetation was established according to a plan appropriate for wetpond landscape design. The St. Elmo pond receives runoff from an area of industrial development consisting of a 27-acre drainage area with 66% impervious cover.

This BMP is a sedimentation/sand filtration basin which treats the first 1/2" of runoff from a large commercial development in the City of Austin.

The Barton Ridge Plaza structure consists of a sedimentation pond, a sand filtration basin, and a diversion channel which diverts the first 2/3-inch runoff into sedimentation and allows the remaining portion to overflow through a side weir. The Barton Ridge pond receives runoff from a 2.95-acre commercial area with 76% impervious cover.

The following conclusions were drawn from an analysis of the monitoring information gathered at these sites, in conjunction with data from previous City of Austin BMP studies.

For a single runoff event, the outflow from a wetpond is the water stored from previous rainfall events and treated in the pond. The overall annual removal efficiencies for a wetpond are generally equivalent to the pond treatment efficiencies since no inflow bypasses or overflows from the pond.

The removal efficiency of the St. Elmo pond for suspended solids is high, at 93%. Values for nutrients vary depending on the form of the constituent. The St. Elmo pond has a permanent pool which is equivalent to about 1.8-inch runoff from the drainage area. Water remains in the permanent pool for a long period, approximately 30 days. The draw-down time of water in the pond during a runoff event varies from one to four days, depending on the size of the runoff event.

This 2.2-acre constructed wetland drains a 33-acre watershed which contains a city maintenance site.

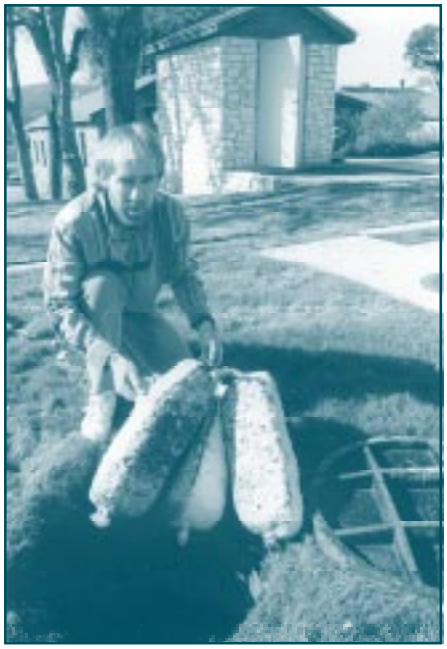
At the Barton Ridge Plaza pond, the treatment efficiency for total suspended solids was measured at 89%. The overall annual removal efficiency was estimated at 71% because 30% of the annual runoff bypassed the pond through the overflow weir, leaving 20% of the total load untreated. As expected, some dissolved forms of nutrients were not adequately removed by the filtration process. The splitter box and sedimentation basin used for the pond system can ease the operation and maintenance of the sand filter.

Pollutant levels in runoff draining to the pond were also identified. Some toxic constituents that were too low to be detected in the inflow water were evaluated by analyzing sediment in the St. Elmo pond for certain toxics, including lead, copper, and zinc. Despite some elevated levels of toxics in the sediments, testing indicates that the toxics are strongly adsorbed and pass tests for landfill disposal criteria.

Project results indicate that large regional wet facilities are most cost-effective and treat a wide range of constituents. For smaller sites, a sedimentation/filtration system may be most appropriate, but must include regular maintenance. A final consideration, which the City is beginning to examine, is the benefit of different structures in terms of downstream erosion control. Often, increased channel flows and sediment produced by subsequent channel erosion are the dominant source of loads in developed areas.

The project also produced educational materials, conducted facility tours, and supported citizen monitoring programs. Specific components included posters targeting both residential and commercial practices, television public service announcements highlighting environmentally friendly tips for landscaping and auto care, seminars for targeted business audiences, and education through the citizen monitoring program and Austin Youth River Watch. A phone survey was conducted to focus outreach efforts to achieve the greatest behavioral modification. A high percentage

of respondents demonstrated a lack of knowledge about the fundamental principles of NPS pollution, water quality problems associated with disposal of organic debris in waterways, and the proper disposal method for petroleum products. A high percentage of respondents also use pesticides and fertilizers, with approximately 50% applying them before heavy rains. Public education campaigns were revised to target specific concerns identified by the survey results.



Oil pillows were used to pretreat water entering an innovative underground filtration BMP which cleans parking lot runoff at the LCRA main office complex. These oil absorbent pillows had been recently replaced. The material used in the pillows is the same material used in oil spill cleanups.

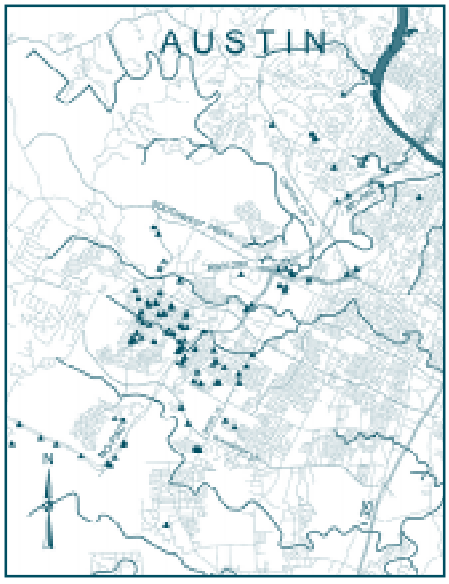
Innovative Best Management Practices in Central Texas, Lower Colorado River Authority, Funded FY 1990

This project designed, constructed, monitored, and evaluated the pollutant removal efficiency of three best management practices treating runoff in the Lake Travis watershed. BMP performance was monitored over a period of three years. The BMPs evaluated were: 1) a peat-sand extended detention pond at McGregor Park near Lake Travis; 2) a catch basin/underground peat-sand filter at the LCRA office complex in Austin; and 3) an enhanced extended-detention wetpond, also at the Austin LCRA complex.

Pollutant removal efficiency of the peat-sand extended detention pond met all requirements of the LCRA's NPS Pollution Control Ordinance. The ordinance contains performance standards for the removal of suspended solids, total phosphorus, and oil and grease for development in proximity to the Highland Lakes. Pollutant removal efficiency of the catch basin/underground peat-sand filter met requirements for total suspended solids and grease, but not nutrients. The extended-detention wetpond met all requirements.

Cost-effectiveness of the BMPs was evaluated by reviewing installation, operating, and maintenance costs. The peat-sand extended detention pond was the most cost-effective. The catch basin was relatively inexpensive to install, but required frequent maintenance, and the underground peat-sand filter had significant loss due to infiltration. The wetpond required replanting of aquatic vegetation, fencing to repel herbivores, and augmentation using excess condensation from the office air conditioning system. These factors, and the possibility that augmentation water might have to be purchased, made the wetpond the least cost effective of the three BMPs evaluated.

The LCRA conducted several tours at its office to transfer this technology to other agencies. The LCRA also sponsored a forum on nonpoint source pollution at the LBJ School of Public Affairs at the University of Texas at Austin. A brochure on innovative BMPs and a video entitled "Innovative Stormwater Runoff Practices" were produced to support education efforts. A computer model simulated NPS pollution in Lake Travis under various development scenarios. Sandy Creek Arm was chosen as a representative microcosm of the lake for modeling purposes. The model showed that increases in nutrient loading, without the controls implemented under the LCRA NPS ordinance, would have a detrimental effect on dissolved oxygen concentrations in the lake. Incremental amounts of pollutant loading allowed under the LCRA ordinance would not have an adverse impact on dissolved oxygen as measured by state water quality standards. Therefore, BMP implementation required by the LCRA under its ordinance is effective in protecting the water quality of Lake Travis.



Sites inventoried for the Edwards Aquifer NPS BMP project in southwest Austin.

Edwards Aquifer Nonpoint Source BMP Evaluation, TNRCC Ground-water Nonpoint Source Team, Funded FY 1992

This project evaluated structural BMP's in the portion of the Barton Creek watershed which is over the Edwards aquifer recharge zone.

Staff performed 432 inspections at 147 structural BMP sites to identify the types of maintenance and repair problems that are most common and to evaluate which BMP designs were the most effective in reducing NPS loadings. An inspection worksheet was developed to set criteria for evaluation of the condition and functionality of the structures.

BMPs that were not functioning correctly were identified and owners of the BMPs were notified of problems. While 54% of all BMPs inspected required some form of repair or maintenance, 27% of the these BMPs had been repaired and were operational at follow-up inspections.

The water quality data collected for this project was not conclusive in demonstrating which BMP designs are the most effective at reducing NPS loading. However, it was evident that proper upkeep of BMPs is important to maintaining their effectiveness in reducing NPS loading. Newer BMPs functioned better than older ones as a percentage of the total. Detention-only BMPs were consistently the best performing in terms of maintenance and repair. The most common types of maintenance and repair problems were documented for use in educational efforts and future inspections.

Educational outreach for this project included a field trip to Barton Creek in Austin, Texas, with students, teachers, and parents from Casis Elementary. The students were introduced to general hydro geologic principles and to the significance of groundwater in the area. Students were taught that pollution from nonpoint sources has a greater potential for entering the aquifer through surface water flow in areas where the Edwards aquifer outcrops.

A very successful technology transfer seminar was held, with 90 people in attendance. Results of research on the effectiveness of various BMP projects was presented, along with the results of completed work on BMPs and updates on work in progress.

Forestry road stabilization was one of the practices taught at BMP demonstrations. Forester displays stabilization material.

Use of stabilization material reduces runoff from forestry roads.

East Texas Silvicultural NPS Project, Texas Forest Service, Funded FY 1993

East Texas, with nearly 12 million acres of timberland, contains the bulk of the state's timber resource. Much of this timberland is actively managed for the sustainable production of timber by forest industries, nonindustrial private forest landowners, and public agencies. Approximately 648,000 acres, or 6%, undergo some type of silvicultural treatment each year, such as timber harvesting, site preparation, and prescribed burning.

Based on available evidence, the timberland of East Texas, without the use of any BMPs, would lose approximately 561,000 tons of soil to erosion each year. Without the implementation of streamside management BMPs, approximately 27,931 tons of this soil, or 4.9%, would reach stream channels. Temporary roads are another major source of sediment in streams.

To prevent erosion from silvicultural activities, the Texas Forest Service conducted a two-year educational program which built on the success of their FY 1991 319(h) outreach program. The objective of this project was to decrease sedimentation and nutrient runoff from silvicultural operations in East Texas by 20% through increased use of voluntary silvicultural BMPs throughout the forestry community. The Forest Service cooperated with the Texas Forestry Association, the Texas Logging Council, and the forest industry to educate thousands of people in the forestry community about the use of BMPs to protect water quality.

The Forest Service conducted BMP workshops for 616 logging contractors and foresters in 24 one-day BMP workshops, and gave BMP presentations to 35 groups, reaching 2611 people. They developed and distributed educational publications, local newsletter and newspaper articles, and a 13-minute BMP video. They also maintain four BMP demonstration forests, where they conduct tours to teach practical BMP application. A rainfall simulator was constructed at one of these demonstration sites to show how properly implemented BMPs prevent erosion.

To evaluate the effectiveness of the program, the Forest service selected 150 forestry sites at random in 36 different counties to monitor for BMP compliance. These sites were distributed geographically and by ownership. Overall compliance with voluntary BMPs, as determined by a "passing grade" (excellent, good, or fair), was 87.3%. The Forest Service estimates that use of BMPs in the region prevented 13,747 tons of sediment per year from entering East Texas streams. Table 1 shows water

quality improvements achieved by the use of streamside and woods roads best management practices.

Compliance Level	% Sites with Streamside Management Zones	% Area with Woods Roads BMPs	Estimated Total Sedimentation (Tons/Year)	Percent Reduction
Baseline (0% Compliance)	0	0	27,931	0
1992 Compliance	70	33	15,932	41.8
1994 Compliance	73	33	15,856	42.1
1996 Compliance	85	88	13,644	50.2

Table 1. Summary of Water Quality Improvements Resulting from an Increase in Compliance with Voluntary Best Management Practices

Pollution Prevention in Urban Landscape Runoff, Texas A & M Research Foundation, Funded FY 1992

The purpose of this project was to demonstrate improvement in urban runoff water quality in the Trinity River watershed through the use of resource-efficient landscapes. The demonstration documented changes in water quality and runoff resulting from the application of best management practices for irrigation and fertilization in contrast with conventional high maintenance landscapes. The project also educated target audiences on the use of BMPs and resource efficient landscapes to reach environmental goals for NPS pollution reduction in the watershed.

Residential landscapes in urban areas have been implicated as contributors of some of the chemicals detected in water supplies. In a comparison of 26 stormwater discharge sites in the Dallas-Fort Worth metroplex, the U.S. Geological Survey found that residential watersheds produced greater quantities of seven pollutant constituents than commercial and industrial land use areas. One of these constituents, diazinon, has been a particular concern in the metroplex area. In addition to pesticides such as diazinon, there has been an increased use of fertilizers in higher income residential landscapes. Conventional landscapes typically require significant chemical inputs and irrigation for proper maintenance. Improvements in water quality could be made by switching to more resource efficient landscapes, reducing chemical use in residential areas.

Microlandscapes at Texas A&M research facility.

A micro-landscape system was constructed to provide demonstration of runoff from four different landscape management systems. BMPs for fertilization and irrigation were implemented on two of the landscapes. The other two landscapes were not irrigated or fertilized. Resource efficient landscapes (RELs) were compared with conventional landscapes.

The facility was constructed on Austin silty clay soil, which is representative of the 12.6 million acres in the Texas Blackland Prairie and much of the Trinity River watershed. The runoff evaluation system consisted of 20 micro-watersheds. For each micro-landscape, 66% of the surface was planted in turfgrass, with the remaining area planted with shrubs and spread with a bark nugget ground cover. Runoff volume and content was sampled at each microlandscape. The sampling, on-site weather station, and individual irrigation systems were computer controlled.

The four landscape management systems uses were:

1) Xeriscape 1: prairie buffalograss, autumn sage, and wax myrtle, with no irrigation or chemical controls.
2) Xeriscape 2 (low maintenance): same plants, but with regular fertilization and irrigation. Herbicide was applied as needed. This system represents a REL with BMPs applied.
3) Conventional 1 (medium maintenance): tifgreen bermudagrass, dwarf yaupon holly, and wax myrtle. This system was fertilized and irrigated regularly. Herbicide was applied as needed. This system represents a

conventional landscape with BMPs applied.

4) Conventional 2 (high maintenance): same plants, but with higher levels of fertilization, irrigation, and herbicide application. Inputs for this system exceed BMPs by 30 to 50%.

The four management systems were replicated five times to form the 20 microlandscapes.

Monitoring station at one of the microlandscapes.

Differences in runoff volume among treatments varied seasonally. During the cool-wet seasons, no significant difference occurred in the degree of runoff between the resource efficient landscapes and the conventional ones. In contrast, during the warm-dry seasons, the conventional landscapes yielded significantly greater runoff volumes. However, any irrigation impacts the level of runoff experienced, and more water maintained in the soil profile tends to reduce the infiltration capacity of the site, which results in greater runoff.

The level of nitrogen and phosphorus runoff during the growing season appears highly correlated to the irrigation and pesticide application levels. These constituents in runoff are also closely correlated with the actual runoff from each type of landscape each year. It appears that the more chemicals you put down, the greater the potential loss. The mean concentration of nitrate nitrogen in runoff from high maintenance landscapes was well below the EPA drinking water standard for nitrogen. Only one storm produced runoff with levels above the safe drinking water limit.

The microlandscapes were rated monthly for appearance. The high management landscapes consistently looked best, but were not always significantly better than the medium or low management landscapes. Depending on the time of the year, the low management plots sometimes ranked better than the medium ones. The xeriscape landscapes with no irrigation almost always ranked lowest, except in 1995 when average annual rainfall was exceptionally low.

Observations made during the study led to the following conclusions:

1) The amount of runoff from a residential landscape is closely associated with the level of irrigation practiced. The more water applied during irrigation, the greater the potential for surface runoff.
2) Selection of plant materials which are adapted to natural environmental conditions enables a reduction in irrigation, fertilizer, and pesticides needed, thereby reducing potential runoff and contamination.

Original educational goals for the project targeted 40% of urban lawn owners and 70% of the landscape professionals in the watershed. Projections indicated that 20% of the landscape professionals would promote or design resource efficient landscapes after the training.

Most of the training was given by the Texas Agricultural Extension Service (TAEX). Numerous meetings were held in target counties of the watershed. TAEX education and training programs are a networking system which includes Master Gardeners, lay horticulturists that have received specialized training from TAEX Agents, who in turn educate others in their communities. Information about RELs and BMPs was transferred outside the Trinity watershed in statewide literature and technical publications. Brochures and mass media were also used to inform people about best landscape management practices. The demonstration and outreach programs have reached well over one million people.

Wellhead Protection Follow-up, TNRCC Wellhead Protection Program, Funded FY 1995

A contract was negotiated with the Texas Rural Water Association (TRWA) to contact wellhead protection program participants and provide assistance in implementing structural and non-structural best management practices.

In FY 1997, this project reached 24 communities that have developed a public water supply protection strategy four to six years ago. These BMPs are recorded for entry into a database. TNRCC/TRWA recorded the type of BMPs being implemented on a standard “BMP Survey Form.”

Wellhead Protection Follow-up, TNRCC Wellhead Protection Program, Funded FY 1993

Through a partnership effort, the Spring Hills Water Management District was contracted to recruit new systems into the state-wide program. This area of the state was selected due to a high number of abandoned wells and the lack of an established wellhead protection program. With the majority of the District's population dependent upon ground water as a source of drinking water, the District was keenly interested in recruiting public water supply systems to implement BMPs. The District employed global positioning system (GPS) and GIS technologies to identify, locate, and map any potential contaminants discovered during the project.

A volunteer conducts a wellhead protection area inventory.

The Wellhead Protection Team has completed all grant commitments associated with the Spring Hills Water Management District (SHWMD) wellhead protection project. GPS and GIS hardware and software systems were purchased and potential sources of contamination were inventoried and delineated. Wellhead protection area markers were erected to delineate the perimeters of the wellhead protection zones. The SHWMD is assisting each wellhead protection (WHP) entity enrolled to develop and implement contingency plans and comply with the state's abandoned well plugging rules. The SHWMD also assisted the City of Bandera and the Bandera Fresh Water District No. 1 in implementing a public awareness program for pollution prevention. The SHWMD will be using a groundwater simulator to help educate citizens about the importance of protecting groundwater. Local BMP implementation efforts will continue.

Wellhead Protection Through Local Implementation, TNRCC Wellhead Protection Program, Funded FY 1994

The goal of this project was to prevent contamination of public water supply wells from nonpoint source pollution in the Galveston Bay watershed. Both structural and nonstructural BMPs were employed.

The Wellhead Protection Team enrolled 150 new participants into the WHP program in 1997. Overall, 217 entities were enrolled statewide. Project activities included training volunteers, conducting wellhead inventories, generating computerized delineations of wellhead protection zones and developing site-specific BMP recommendations. A new list of additional BMPs was developed for official inclusion under the Wellhead Protection Program. TNRCC staff met formally with 61 WHP participants during the course of the project to provide technical assistance and discuss formal implementation of BMPs. Coordination with the Texas Rural Water Association was maintained to target systems in the Galveston Bay Watershed for enrollment into the Program.

Brazos and Sabine Groundwater and Surface Water NPS Project, TNRCC Agriculture Section, Funded FY 1992

This project was implemented in response to water quality problems identified in the Brazos and Sabine basins from livestock and poultry operation sources. A comprehensive approach to the control of nutrient and fecal coliform bacteria contamination in both ground and surface water resources was developed to address these concerns and to protect designated critical water quality areas within the two basins. Particular focus was placed on outreach to dairy operations in the North Bosque and Lake Fork Reservoir watersheds.

The project addressed these issues in a variety of ways, using both regulatory and voluntary measures. Rules for the prevention and abatement of pollution from livestock and poultry operations were developed and adopted by the TNRCC. The regulatory process encourages the use of experimental technologies and BMPs. Animal operations owners are required to apply for permits, for which they must develop plans and implement practices to prevent nutrient and fecal coliform contamination from their operations from reaching water resources. TNRCC staff reviewed and permitted these waste management plans for concentrated animal feeding op-

erations (CAFOs). In the course of these reviews, staff promoted the use of agricultural BMPs and new technologies. Inspections of CAFOs allowed for the identification and correction of inadequate systems and further technical assistance. An estimated reduction in nitrogen of 35 million pounds annually was achieved in dairy outreach areas through the permitting program. BMPs used in waste management plans resulted in an estimated reduction in nitrogen pollution of 13 million pounds per year.

The project team developed a coordinated effort among agricultural agencies to promote sharing of information and data, and helped establish the joint water quality protection responsibilities of the TSSWCB and the TNRCC. Educational materials were developed and distributed to area CAFO operators. Program staff provided technical assistance through inspections and at public educational forums. Six volunteer monitoring sites were set up in the North Bosque subwatershed and two were established in the Lake Fork watershed to increase local awareness of environmental issues and to supplement professionally gathered water quality data.

As a result of this comprehensive approach, the project has reduced potential pollution loading in the target watersheds by 48 million pounds annually. The same successful approaches have been applied to agricultural operations statewide.

NPS Pollution Prevention in the Arroyo Colorado Watershed, TSSWCB, Funded FY 1992

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

During FY 1997, TSSWCB completed an analysis of the Toxic Substances Data Base and summarized the findings at the Arroyo Colorado Seminar held at Harlingen Public Library. Approximately 40 individuals attended the seminar representing a diverse cross section of local interest groups. Four major fact sheets and a documentary video were completed this fiscal year. The video contains aerial and on-river photography of the Arroyo, a summary of water quality problems in the area, and a discussion of nonpoint source pollution and BMPs for controlling it.

Active Statewide 319 Projects

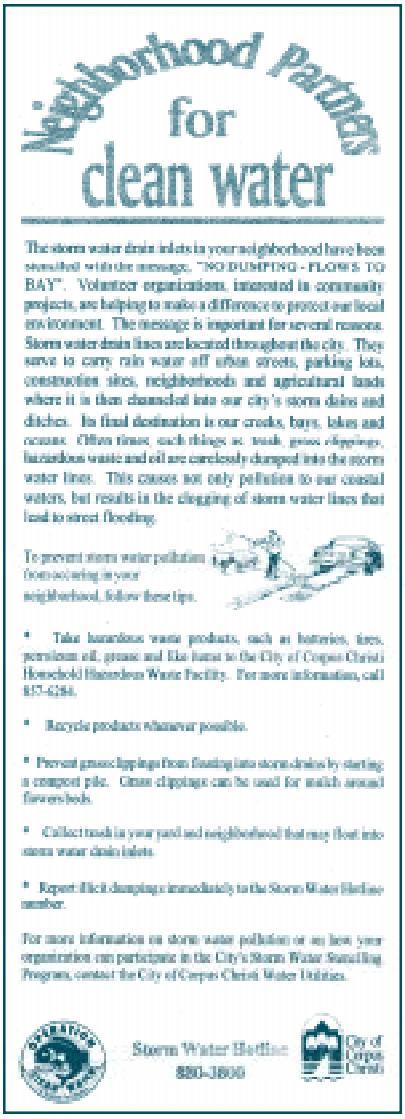
Statewide Urban Nonpoint Source Pollution Prevention Project, TNRCC Nonpoint Source Program, Texas Watch Program, and Clean Texas 2000 Program, Funded FY 1994

The objective of the project is to prevent NPS pollution through a combination of educational and other non-structural best management practices. Educational outreach activities are focused in communities located in areas surrounding the cities of Lubbock, Harlingen, Corpus Christi, and Fort Worth, as well as in communities in the Galveston Bay and Corpus Christi Bay watersheds.

The TNRCC NPS Team has hired two outreach contractors, Moorhouse Associates, Inc., and the Galveston Bay Foundation, to conduct nonpoint source prevention activities in the Lubbock, Harlingen, Corpus Christi Bay, and Galveston Bay areas. These contractors are working in local communities to recruit citizens of all ages to participate in learning activities and workshops which emphasize pollution prevention. The Clean Cities 2000 program has completed a community storm drain stenciling manual and has distributed mylar stencils to all 15 TNRCC Regional Field Offices. These stencils are available for citizens to use free of charge. School and civic group presentations, storm drain stenciling, and watershed festivals are a few of the educational activities that have taken place within the last year.

The Texas Watch citizens' monitoring program has continued to train and recruit monitors in each of the five project areas to monitor for water chemistry and biological indicators. River authorities and governmental entities have been provid-

Corpus Christi students delivered door hangers to residents in storm drain stenciling project neighborhoods.



Neighborhood Partners for clean water

The storm water drain inlets in your neighborhood have been stenciled with the message, "NO DUMPING - FLOWS TO BAY". Volunteer organizations, interested in community projects, are helping to make a difference to protect our local environment. The message is important for several reasons. Storm water drain lines are located throughout the city. They serve to carry rain water off urban streets, parking lots, construction sites, neighborhoods and agricultural lands where it is then channeled into our city's storm drains and ditches. Its final destination is our creeks, bays, lakes and oceans. Often times, such things as trash, grass clippings, hazardous waste and oil are carelessly dumped into the storm water lines. This causes not only pollution to our coastal waters, but results in the clogging of storm water lines that lead to street flooding.

To prevent storm water pollution from occurring in your neighborhood, follow these tips.

* Take hazardous waste products, such as batteries, tires, petroleum oil, grease and like items to the City of Corpus Christi Household Hazardous Waste Facility. For more information, call 857-6284.

* Recycle products whenever possible.

* Prevent grass clippings from floating into storm drains by starting a compost pile. Grass clippings can be used for mulch around flowers beds.

* Collect trash in your yard and neighborhood that may float into storm water drain inlets.

* Report illicit dumping immediately to the Storm Water Hotline number.

For more information on storm water pollution or on how your organization can participate in the City's Storm Water Stenciling Program, contact the City of Corpus Christi Water Utilities.

Storm Water Hotline
880-3800

City of Corpus Christi

Example of door hanger used in storm drain stenciling project areas.

ing additional support to local volunteers where feasible. Texas Watch has also developed the *Manual for Conducting a Watershed Land Use Survey*. This publication helps people learn about the impacts of nonpoint source pollution in their watershed by conducting visual and background surveys. The Watershed Survey has received a number of favorable reviews and is currently being implemented in several watersheds. A benthic macroinvertebrate manual for volunteer training is still in the developmental stages.

For the rule-making component of this project, the NPS Team led an interdivisional team established by the TNRCC to review the Water Pollution Abatement and Control Program developed by the Southwest Travis County Water District in accordance with HB3193 passed by the Texas Legislature in 1995. The District is a 4,000-acre development situated over the Edwards Aquifer Recharge Zone. The statute required the District to develop a water quality protection plan that was designed to meet state water quality standards. The NPS Team is also working in cooperation with the Water Policy and Field Operations Divisions in the preparation of revised rules implementing the Edwards Aquifer Protection program. These revised rules may include specific water quality performance standards for new development in the Edwards Recharge Zone. A technical guidance document supporting the achievement of the required performance standards is also being prepared.

EPA has granted a one-year extension for this project. The additional time will provide more opportunities for data collection, BMP implementation, and project evaluation.

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

The NPS Team will host a technology transfer conference focusing on various strategies to address the impacts of nonpoint source pollution, with highlights drawn from several regional demonstration projects.

The conference is scheduled for March 1998, but staff have done much of the necessary preliminary planning and coordination during 1997.

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

This project will establish four demonstration sites over the Gulf Coast and Carrizo-Wilcox aquifers to evaluate the effectiveness of constructed wetlands for treating domestic wastewater in rural and suburban areas of the state. Constructed wetlands are potentially a low cost, low maintenance alternative to conventional on-site wastewater systems. The project consists of selecting local cooperators, designing and constructing the systems, monitoring the effectiveness of the systems by collecting water quality samples, and developing informational materials about the project including a video and fact sheets.

All four demonstration wetlands have been constructed and vegetated. Effectiveness monitoring has been delayed pending completion of the QAPP. A workshop and field trip focused on the use of constructed wetlands for on-site wastewater treatment was held in late summer and was very well attended.

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

This project will develop a resource document for local governments outlining the benefits and cost effectiveness of best management practices available to address NPS pollution.

A water quality subcommittee was formed in 1997 to determine what water quality information was available and how it should be structured for the Texas Nonpoint Source book. This subcommittee met several times this fiscal year and is currently preparing a summary report of its findings to give to the Project Management Com-

Teacher puts "pollution" on an Enviroscape model to demonstrate how pollutants from runoff reach local water bodies.

mittee Task Force. The Project Management Task Force is reviewing recommendations from a consultant on BMP information that will be needed for the web site. The Texas Nonpoint SourceBook web site can be accessed at *http://tec_net./txnps/* and includes some general information.

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

The objective of this project is to train 75 teachers in the implementation of nonstructural best management practices through a graduate level course at three Texas colleges.

Accomplishments during 1997 include training 52 teachers, developing NPS educational materials, and updating the TNRCC web site with newly available water curriculum.

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

The Texas Watch Program conducts regional and statewide workshops throughout Texas addressing NPS issues and management strategies. These workshops provide technical assistance to attendees and facilitate the development of partnerships to support volunteer monitoring and other NPS prevention and control activities. A bimonthly newsletter reports on program activities and includes educational articles.

Participants at a Texas Watch regional workshop in Beaumont, Texas.

During 1997, Texas Watch conducted two regional workshops held in the Sabine and Neches River Basins. The two-day workshops were attended by volunteer monitors, teachers, students, partners, the scientific community, and government representatives.

Texas Watch developed a web page which includes proceedings from the regional workshops, as well as general program information. Six newsletters were completed and mailed to Texas Watch participants.

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 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 to exist. This is to 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.

Existing water quality data have been reviewed as a part of compiling the 13th Edition of *The State of Texas Water Quality Inventory* (305(b) report) and the 1996 Clean Rivers Program biannual assessment. A lack of data collected specifically to address nonpoint source pollution is a problem. Acquisition of land use maps and the delineation and spatial description of subwatersheds in the basin is well underway. The quality assurance project plan (QAPP) specific to the Brazos/Colorado Coastal Basin, written as an amendment to the TNRCC Surface Water Quality Monitoring Program (SWQM) core QAPP, is currently under review. Field trips have been conducted during the second and third quarters. The primary purpose of these trips was reconnaissance of candidate watersheds. Based on the field trips and land use maps, approximately 62 candidate sample sites were selected. Eleven of these sites were selected as likely study sites. Fish and benthic macro invertebrate surveys were conducted in 10 subwatersheds. These data, coupled with data to be collected next fiscal year, 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 is to collect water quality and associated information 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 to exist. Acquisition of these data maps, along with additional census and land use data, can be used to provide information on how growing populations and human activities may be impacting the quality of water resources.

The coverages have been ordered. Delivery is still pending.

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 identified serious threats to their public groundwater supply from abandoned water wells and leaking underground storage tanks. This project will locate and map the contaminant sources using GIS and GPS technology. Sources will be prioritized and mitigated with funding from existing state programs.

During FY 1997, TNRCC Wellhead Protection executed a contract that will protect the underground sources of drinking water from all potential sources of NPS contamination identified within the City of Lubbock's WHP areas by implementing BMPs and employing GPS and GIS technology. The City has prepared an outreach and public education campaign to notify citizens.

Colorado River Basin

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

This project will demonstrate the effectiveness of controls for the removal of sediments and associated toxic materials from runoff in highly urbanized watersheds.

During FY 1997, all sampling was completed at the inlet filters, the oil/sediment treatment chamber, and in the pond itself at the Central Park water quality pond. Stormwater influent and effluent were sampled for 10 storms. Sediment accumulation and toxic parameters were analyzed for eight storms. Nine stormwater samples (both influent and effluent) were collected from the Central Park Wet Pond and are being analyzed. All analyses will be provided in the final report which is pending.

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

The objective of this project is to evaluate cost-effective and environmentally sound vegetation management practices to deter or eliminate unwanted plant species.

Work under this project has been running behind schedule due to the drought experienced in 1996 and the initial delay in approval of the QAPP. A one-year extension has been granted to allow for a third year of data collection. In 1997 LCRA and its cooperators continued preparing and maintaining the test vegetation plots, monitoring plant densities, and conducting rainfall simulation analyses to determine the most effective vegetative cover for irrigation canal banks. LCRA staff have identified 12 miles of weed-infested canal banks that will be rehabilitated based on the recommended project findings. Wharton County Junior College has been utilizing the study sites in its curriculum associated with pesticides and integrated pest management. Several field days for the benefit of local landowners have also been conducted.

Agricultural NPS/Creekside Conservation, Lower Colorado River Authority (LCRA), Funded FY 1993

The objective of this project is to determine the effectiveness of different brush management practices at two test locations in Central Texas.

Using artificial rainfall simulation, runoff data from two years of field collections are being compiled for statistical analysis to quantify improvements in water quality and quantity from each of the BMP test plots. Changes in the landscape are being documented in photographs as well. Extension of this project through August 1998 will allow for a third year of data collection activities. Several field tours have been conducted by LCRA and their cooperators with students, landowners, and Soil and Water Conservation District Directors in the area.

Two-cell wetland system for treatment of domestic sewage. This system treats waste from one household in Matagorda County. The LCRA is evaluating the pollutant removal efficiency of this natural treatment process.

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

The goal of the project is to demonstrate the use of artificial wetlands wastewater disposal technology as a viable and economical BMP in the treatment of septic tank effluent in a coastal zone area.

In 1997 the LCRA completed construction of two 5' x 20' demonstration wetlands in a residential area of Blessing, Texas. These wetlands are being evaluated to test their effectiveness in domestic wastewater disposal in clay soils of the coastal zone area. LCRA has been collecting bi-monthly samples from the effluent of both wetlands to measure their pollutant removal capabilities. A covered shelter was built over one of the wetlands to evaluate the system's performance without the influence of rainfall. Extension of this project has been approved for an additional 12 months to permit monitoring during seasonal variations. Results from this demonstration project will be incorporated into a TNRCC on-site wastewater study that is evaluating experimental systems for development of wetlands design standards.

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

The goal of this project is to reduce stormwater pollution from roadway runoff using a combination of vertical rock gabion filtration berms and vegetated roadside ditches.

During 1997, growth of vegetation in the Brodie Lane roadside channel recovered from the drought of 1996. Some reseeding, replanting, and herbicide treatments were necessary in several areas where the grasses had not reached optimum thickness. With the approval of the Quality Assurance Project Plan, stormwater and sediment sampling has begun. Baseline monitoring was conducted in early 1997. The County is monitoring for constituents associated with roadway runoff such as petroleum hydrocarbons, nitrogen, phosphorus, lead, and zinc. Results from this innovative roadway BMP will be available in the Fall of 1998.

Preparing the roadside for planting. Brodie Lane, 1995.

Brodie Lane vegetative cover, 1996.

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

This project presents an integrated approach to NPS pollution prevention and reduction by involving citizen volunteers, school children and businesses in the implementation of best management practices in the East Bouldin Creek watershed in Austin. Technical support will be provided to local businesses and to elementary school children. Volunteers will be recruited for stream bank restoration, storm drain stenciling, and water quality monitoring.

Over the past year, Texas Watch volunteer monitors have conducted chemical and macroinvertebrate sampling on East Bouldin and the two control creeks, Blunn and Harper's Branch. Data collected will be analyzed to determine the statistical relationship between water quality variables of the three creeks before and after BMP implementation. A nonpoint source curriculum and teacher's handbook have been

This structural BMP in the City of Smithville solved a severe erosion problem.

Volunteers plant trees at the Smithville BMP site.

developed to educate school children about the impacts of NPS on their local watershed. Texas Watch staff have made additional NPS presentations to area youth and civic groups.

In 1997, a new program element was added to this project. The NPS Team has entered into a contract with the City of Austin to conduct an innovative biotechnical stabilization workshop. The City is interested in emphasizing channel stabilization techniques in Central Texas to control erosion and maintain the natural character of streams. This workshop will be presented to interested contractors, engineers, and landscape architects. Stream banks will be restored for a demonstration site on East Bouldin Creek. Activities planned for the upcoming year include continued monitoring, stream bank restoration, and procurement of a subcontractor who will assist with additional non-structural BMP implementation in the watershed.

A Watershed Approach for Small Cities, LCRA, and City of Smithville, Funded FY 1995

This project involves the design, construction, monitoring, and evaluation of stormwater runoff control measures implemented in the City of Smithville.

Substantial progress was made on this project during 1997. Survey and map work was completed, and a GIS workstation was delivered to the City of Smithville. Designs of an appropriate structure were developed, reviewed, and constructed. A groundbreaking ceremony for construction of the BMP helped to inform the public about the benefits of this project. The project monitoring was delayed pending QAPP approval.

Corpus Christi Bay Watershed

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

This project provides for the design, construction, monitoring, and evaluation of structural improvements to Richter Channel. The channel side-slopes will be widened and perennial vegetation will be planted to provide water quality improvements. The effectiveness of these measures will be documented through the collection of field water quality data. The project includes a public educational campaign emphasizing pollution prevention by property owners.

Record rain events during 1997 caused City staff to re-evaluate the appropriateness of the original demonstration site on Richter Channel. Consequently, staff efforts during the year have been directed at developing a new project work plan at the Oso Parkway site. Work on the new project is anticipated to begin in late 1997.

Edwards Aquifer

This concrete vault completely encloses the entrance to Antioch Cave in Onion Creek. The 36-inch valve on the end can be opened to allow recharge once debris, turbidity, and sediment loads decrease to an acceptable level. (See following photo.)

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

This project will design, construct, and monitor control measures around two large recharge features in the channel of Onion Creek to reduce sediment loads to the Edwards Aquifer.

During FY 1997, the District completed lengthy negotiations with Onion Creek property owners on access, easements, and other ownership matters. The District completed construction of the BMP to address NPS pollution entering a natural recharge feature in Onion Creek. Temporary sediment and erosion controls were installed at the site during construction.

With a turbidity level of zero, the clear, clean water in Onion Creek recharges through the now-open valve.

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

This project is proposed to protect a stretch of Onion Creek that flows directly into the Edwards Aquifer. The District will determine drainage characteristics within the project area and design, construct, and monitor two BMPs to reduce sediment contributions.

The contract was executed in the summer of 1997 after lengthy negotiations. An abbreviated project work plan was submitted and approved by EPA, and implementation has begun.

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

The objective of this project is to delineate ground water flow paths by monitoring the movement of a tracer material. Knowledge of the flow characteristic in the aquifer will aid in the planning, design, and implementation of management measures to protect water quality in the aquifer.

Contracts are in negotiation. Implementation is scheduled to begin in FY 1998.

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

The objective of this project is to measure water quality and hydrological elements of the aquifer system to quantify natural cycles and variations as a result of cultural-induced changes in the aquifer.

Contracts are in negotiation. Implementation is scheduled to begin in FY 1998.

Galveston Bay Watershed

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

The Galveston County Health District (GCHD) will assure storm sewer integrity, map sanitary sewer system overflows, conduct public education activities, coordinate household hazardous waste collection programs, and assist cities in the district in adopting ordinances related to NPS pollution.

In 1997, GCHD obtained the TNRCC's guidance document for staging household hazardous waste collection days to use as a starting point for a document specific to Galveston County. GCHD is currently working on their education program plan that will provide the framework for substantial public education activities to be conducted under the grant. GCHD has received several complaints from individuals regarding suspected cross connections or illicit discharges to storm sewers. These have been investigated and resolved without significant monitoring.

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

The goal of the project is to reduce fecal coliform bacteria levels contributed from failing on-site sewage facilities by providing technical assistance to affected parties regarding alternative fiscal options and best management practices.

Contracts are in negotiation. Implementation is scheduled to begin in FY 1998.

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

The goal of this project is to support resolution of nonpoint source problems in a nonpoint source priority area, the Galveston Bay Watershed, by identifying its groundwater nonpoint source problems and implementing best management practices that provide tangible, measurable results. It will encourage coordination among public

and private agencies in the watershed and develop public involvement in the implementation of BMPs to protect water quality in the Bay watershed. Key public sector cooperators are the Galveston Bay Estuary Program (GBEP) and TNRCC Region 12 Field Operations.

The objectives include identifying groundwater areas and surface water/groundwater interaction areas that are affected by or are vulnerable to nonpoint source pollution; implementing best management practices in the watershed to solve nonpoint source pollution problems; and institutionalizing the ground-water nonpoint source goals of the Galveston Bay Plan (GBNEP, 1994).

Tasks in progress are coordination of meetings and participants; institutionalization of ground-water nonpoint source programs at GBP; identification of nonpoint source problem areas in the watershed; targeting of priority areas for BMP implementation; and BMP implementation through technology transfer, public education, and technical assistance.

The Ground-water Assessment Section used available information on soil, topography, hydrogeology, land use, and human impacts to target high priority NPS areas in the watershed. This information was also used to develop the draft assessment report, which is under internal review.

North Concho River Basin

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

The Upper Colorado River Authority and the City of San Angelo are cooperating to develop a detailed control strategy for the mitigation of urban nonpoint source pollution.

Major developments for this project in 1997 included the adoption of a Nonpoint Source Abatement Master Plan by the City of San Angelo and completion of construction plans for a demonstration BMP. This structural control is a detention pond system that will collect and settle stormwater runoff before it enters the Concho River. The pond was scheduled to be completed by the end of summer 1997; however, the discovery of significant native American historical and cultural artifacts at the project site has temporarily delayed construction. An archeological study is underway at the site and is expected to be completed in the fall of 1997. Due to this unforeseen development, the project has been extended for an additional year. The public education component of this project has been very successful. The Upper Colorado River Authority and its engineering consultant have devoted a considerable effort to working on news releases and meeting with public and private organizations to discuss the importance of water quality protection. A video program was developed by the San Angelo Friends of the Concho River group and is used at public meetings. This video has been very well received and provides a great resource for continuing education efforts.

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

This extension of the 1994 project will construct two additional NPS control structures identified in the NPS Master Plan developed by the City under the 1994 grant. BMP effectiveness will be monitored. The results will be communicated through technical articles in various urban management newsletters and to the local watershed stakeholders through a public meeting.

Contracts are in negotiation. The project is scheduled for implementation in FY 1998.

Nueces-Rio Grande Coastal Basin

The Nueces-Rio Grande Coastal Basin.

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

This project was developed to provide assessment, planning, and technical assistance to protect the groundwater resources in this coastal watershed.

The assessment report was completed and targeted the following areas for inclusion in the study: the Evangeline aquifer in the Falfurrias and Kingsville areas, and the shallow barrier island portion of the Gulf Coast aquifer in Mustang Island State Park.

A model was run on public water supply wells in the Falfurrias and Kingsville areas of the Evangeline aquifer to establish wellhead protection areas. The Wellhead Protection Program was implemented in the Kingsville (4 wells) and Falfurrias (8 wells) areas. Local public water supply overseers for the City of Falfurrias, the Naval Air Station in Kingsville, and the Country Estates Trailer Park (Kingsville) assisted in the wellhead protection efforts by locating wells and potential sources of contamination.

A field trip and lecture was conducted for 140 students of the Falfurrias Middle school. The students were taught general concepts about groundwater and its importance as a community resource.

Rio Grande Watershed

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

The goal of this project is to reduce nutrient loadings in rainfall runoff from urban landscapes by managing routine activities such as watering, fertilizing, and pest management based on an analysis of actual landscape conditions determined through sampling and other technical observations. The BMP is being demonstrated on the municipal golf course in Harlingen. Local landscape managers will be trained in integrated landscape management (ILM) procedures. The project has provisions for public awareness activities.

TAEX conducted the ILM training for site staff on September 19, 1996 at the Tony Butler Municipal Golf Course in Harlingen. Site staff were instructed on topics such as nutrient management, soil sample collection and analysis, and irrigation water management, and were given an overview of monitoring devices. TAEX also developed and distributed an ILM brochure, a 60-second public service announcement, a promotional display, and a slide/tape/lecture program. The project also sponsored the Lower Rio Grande Valley Integrated Landscape Management Regional Seminar on the Arroyo Colorado.

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

The objective of this two-phase project is to restore the natural functioning of the Town Resaca in Brownsville through the design, construction, and monitoring of best management practices in sub-basins contributing stormwater runoff to the resaca. The project also has provisions for the City to institute a public awareness campaign and stream bank restoration activities.

Phase I of this project was granted an extension to August 1998 to compensate for the delay in sampling caused by drought conditions in 1996. Phase II has been delayed by drought and other factors. Negotiated changes in operations are expected to allow the successful completion of this project in 1999.

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

This project will develop a guidance manual for facilities which store hazardous chemicals. The BMPs specified in the manual will be implemented through local ordinances.

The HazMat Advisory Committee worked on developing revisions to the new city ordinance and will present the final version to the city council in the next fiscal year. The Committee and the City manager have determined how the ordinance will be implemented.

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

The objective of the project is to design and construct structural best management practices at the college which will serve to treat runoff from the college as well as provide a model for future development in the area.

Contracts were executed in 1997. Implementation has been delayed due to problems with land acquisition.

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

The City will develop a program to decrease the incidence of indiscriminate disposal of potentially hazardous materials in floodplains throughout the City. The program will provide for education, surveillance, and enforcement activities.

Contracts are in negotiation. Implementation is scheduled to begin in FY 1998.

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

This sign is one of many ways that the City of Brownsville is raising public awareness about water quality in its resacas.

This project recruits volunteers to conduct water quality monitoring in coordination with the City of Brownsville's stormwater management and resaca rehabilitation program. The project also seeks to recruit volunteers to perform other water quality educational activities such as storm drain stenciling, stream bank re-vegetation, watershed inventories, and interpretive streamwalks.

Texas Watch staff recruited several organizations, including Americorps, Valley Proud Environmental Council, Texas Southmost College, and the Public Utilities Board, to participate in outreach activities throughout the Lower Rio Grande Valley. Volunteers also regularly monitor nine sites at urban resaca locations targeted under a comprehensive monitoring plan. Additionally, Texas Watch and City of Brownsville staff have implemented city-wide storm drain stenciling projects that have stenciled over 100 drains this year. Final plans were developed to implement habitat restoration and re-vegetation projects in 1998 with the City and its consultants.

Sabine River Basin

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

This project seeks to implement a comprehensive nonpoint source water quality management program in the Lake Fork Reservoir watershed. The project is a cooperative effort between the TNRCC and the TSSWCB. The TNRCC is responsible for monitoring baseline water quality in the watershed to target priority sub-watersheds for BMP implementation, address groundwater quality issues, and coordinate the implementation of BMPs for on-site wastewater systems. The TSSWCB is responsible for coordinating the implementation of BMPs at dairies and other agricultural operations in the priority sub-watersheds.

During the past 12 months, baseline and stormwater monitoring has continued in the Running Creek priority watershed. Two years of baseline surface water moni-

Aerial view of Lake Fork Marina.

toring data indicate elevated levels of fecal coliform, nitrogen, and phosphorus. The TSSWCB successfully recruited two dairies in the Running Creek watershed to implement voluntary BMPs and develop water quality management plans. Edge-of-field monitoring equipment has been installed to monitor pre- and post-BMP effectiveness. BMP installations by the TSSWCB and its cooperators will be completed in the fall of 1997. Groundwater data will be obtained from soil water samplers at the two target dairies and will be used to monitor any changes in groundwater quality. Educational activities planned for the final year of this project include intensive dairy outreach in the Running Creek watershed, establishment of a training program, and development of a manual on waste management practices appropriate for small dairies. The TSSWCB will also work with the Texas Agricultural Experiment Station to conduct a TEX-A-Syst program to protect groundwater in the watershed. A favorable development for this project in 1997 was the de-obligation of funds from the FY 1993 TNRCC 319(h) grant for re-award to the TSSWCB. These funds will be used by the TSSWCB to supplement their existing SB503 cost share program in order to provide an additional financial incentive for dairy participation.

Hamshire-Fannett ISD Wetlands Wastewater Treatment Facility; Southeast Texas RC&D, Hamshire-Fannett ISD, Funded FY 1996

This project will reduce pollution from poorly functioning on-site wastewater treatment systems by constructing a wetland collection and treatment system for the local high school.

Contracts were executed in 1997. Start of this project has been delayed by problems in acquiring necessary lands.

Standardizing Constructed Wetlands in East Texas; Pineywoods RC&D, Funded FY 1996

The objective of the project is to demonstrate the reliability of current EPA design criteria to predict effluent quality from small flow constructed wetlands for domestic waste treatment; to document standard design, construction and start-up techniques; and to demonstrate the cost-effectiveness of proposed design criteria.

Contracts were drafted in 1997 to enable implementation to begin in 1998.

Trinity River Basin

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

The City of Carrollton is focusing on illicit discharge abatement, pollution prevention, and public education to reduce NPS pollution in selected sub-basins of the Elm Fork of the Trinity River. Dry and wet weather screening and sampling will be performed to identify illicit discharges. Provisions of city ordinances related to illicit discharges will be strengthened. The City will implement a BMP education and public awareness program.

During the past 12 months, the City of Carrollton made progress in identifying and abating illicit discharges within its jurisdiction. Environmental staff conducted facility inspections and eliminated 14 illegal discharges to the city's storm sewer system. The City also continued its pollution prevention awareness campaign with presentations at various public events and forums. Implementation of wet weather monitoring to measure the effectiveness of the city's educational efforts will begin after approval of the Quality Assurance Project Plan.

Section 314 Clean Lakes Grant Project Highlights

Clean Lakes Projects Completed in 1997

The TNRCC Nonpoint Source Program also administers four Clean Lakes projects funded under Section 314 of the Clean Water Act, all but one of which is complete. Two projects were successfully completed in 1997.

Oyster Creek Lakes

The purpose of this project was to define current water quality conditions in the Oyster Creek Lakes system and recommend approaches to improve the system's water quality. With assistance of the Clean Lakes grant, water samples were taken monthly at 16 sites for 14 months beginning in 1994. Evaluation of the data collected and the historical data resulted in the identification of turbidity and nutrients as the primary water quality concerns within the Oyster Creek Lakes system. The City of Sugar Land and the Oyster Creek Community Led Environmental Action Network (OCCLEAN) are developing a strategy to stencil storm drains to warn residents that anything dumped or discarded in or near the storm drain will flow directly into the Oyster Creek Lakes System. The TNRCC and Imperial Holly Corporation are currently initiating an off-channel 8-acre constructed wetlands demonstration project adjacent to Oyster Creek at Dam One. The Gulf Coast Water Authority is proceeding with plans to install the palisade system near the Shannon intake at the Brazos River.

Lake Pat Cleburne

Located in Johnson County, Lake Pat Cleburne serves as the public water supply for the City of Cleburne. With assistance from the Clean Lakes Grant, the Brazos River Authority performed a watershed study to enable cost effective decisions as to what BMPs may be needed in the watershed to improve the water quality and to reduce sediment and nutrient loading in the watershed. The City of Cleburne has not yet determined which approach for remediation would best suit their water quality needs.

Active Clean Lakes Grant Projects

Lake Worth

The City of Fort Worth has been conducting a Phase II Clean Lakes Implementation Project on Lake Worth, a water supply and recreational reservoir on the West Fork of the Trinity River in Tarrant County, Texas. The Phase I Diagnostic Feasibility Water Quality Study and the 1997 Update to the Nonpoint Source Assessment Report have identified impacts to the designated use of the waterways from sediment and nutrients, especially from the Upper West Fork of the Trinity. Since 1993, the City has been conducting activities in the watershed to prevent further deterioration of water quality in the reservoir. These activities include removing old piers and stumps from the lake, increasing the lake depth, extending centralized sewer service to lakeside homes, developing a comprehensive watershed management plan, and evaluating the effectiveness of a demonstration wetland system for removing nutrients from water entering Lake Worth from upstream areas.

By the end of summer 1997, all of the Phase II project tasks, except one, had been completed. Stumps were removed from seven areas in the lake and dock structures were removed at 96 locations. A consulting firm was hired to evaluate sewer service to approximately 100 lake shore residents that were served by individual waste disposal systems. Alternative sewer systems were evaluated and it was recommended that the city provide sewer service utilizing a low-pressure system with a

grinder pump at each lot. At the completion of the project, sewer service had been provided to a total of 92 residences. The sewer system as installed is working well.

The wetland demonstration project consisted of two parallel emergent marsh wetland test cells constructed in a former cut-off river channel with 1.4 acres of total surface area. The operation of the demonstration wetland was observed for less than one year. These limited observations indicate the wetland system provided for a hydraulic residence time of between one and two days and achieved a constituent removal rate of approximately 33% for total nitrogen, 6% for total phosphorous, and 71% for total suspended solids.

During the project period, the elevation of Lake Worth was increased and maintained between 593 and 594 mean sea level by the Tarrant Regional Water District. An evaluation of maintaining this consistently higher lake level indicated that no impact was made on water quality or operation of on-site sewage facilities. Increases and shifts of vegetative communities were observed in areas where the water depth was increased and where the old river channels were inundated.

As part of this Phase II project, the City funded a Lake Worth Watershed Management Plan which made several recommendations to address current and future activities in the watershed. Foremost among the recommendations was the development a master drainage plan to determine the most feasible means for implementing treatment control BMPs. The City was encouraged to pursue a phased collaborative approach involving all affected stakeholders in the watershed to develop consensus on the most appropriate goal for their water resources and to collaborate on a means to achieve those uses. A collaborative consensus-building approach would result in the establishment of water quality goals against which existing and future water quality can be compared and in the implementation of BMPs. More importantly, collaboration among jurisdictions and agencies is mandatory if a comprehensive mangement plan is to be effective.

As agreed among the EPA, the TNRCC, and the City of Fort Worth, the final project task, post-BMP effectiveness monitoring, will continue for an additional 12 months with financial support from the City of Fort Worth. Results of the water quality monitoring will be available in the fall of 1998.

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 96	FY 1997 Expenses	Grant Balance
FY 1992	C9006975-92	4,929,343	3,062,546	978,706	888,091
FY 1993	C9996146-01	3,211,558	1,391,383	297,347	1,522,828
FY 1994	C9996146-02	3,198,848	1,507,266	377,525	1,314,057
FY 1995	C9996146-03	3,614,167	306,895	647,284	2,659,988
FY 1996	C9996146-04	3,925,000	16,192	408,779	3,500,030
FY 1997	BG99662-01	2,230,364	0	727,012	1,503,351

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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