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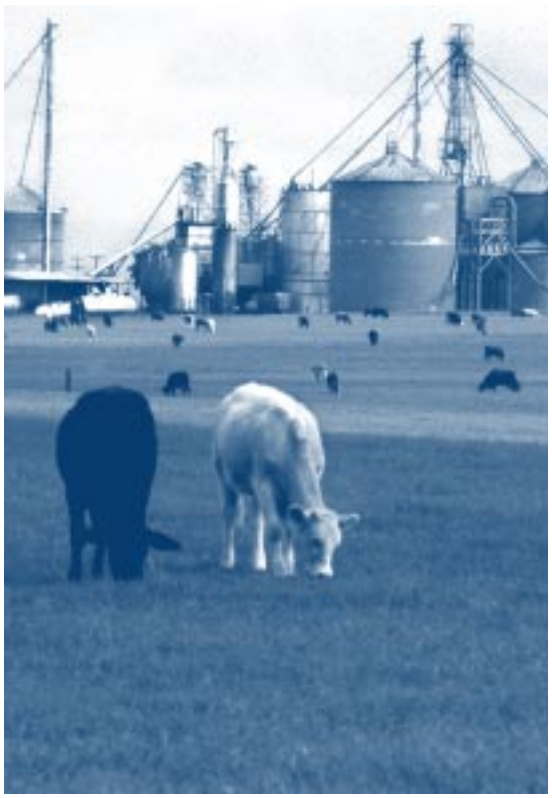
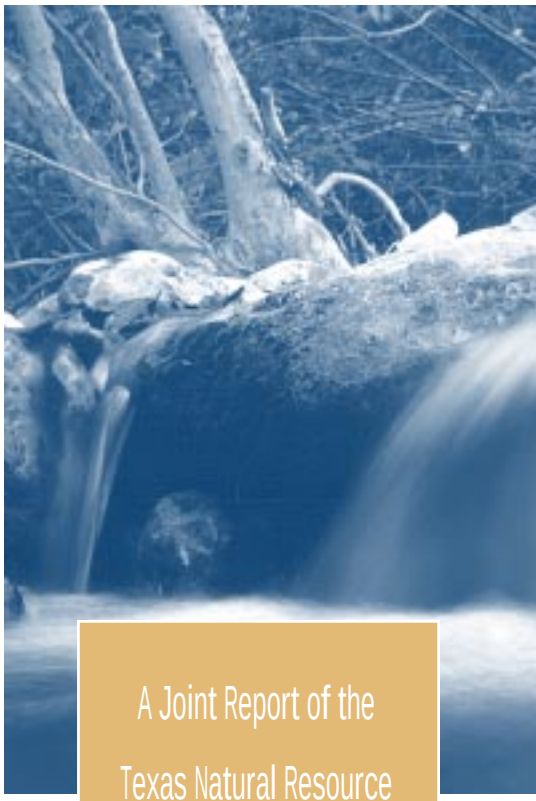
2001 Annual Report:

Texas Nonpoint Source Pollution Management Program





A Joint Report of the
Texas Natural Resource
Conservation Commission
and the
Texas State Soil and Water
Conservation Board

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In This Report

Letter from the Directors

Water that is safe for citizens to swim in, to fish from, to drink. Water that provides a healthy habitat for aquatic creatures and wildlife. These are the goals of water quality programs in Texas. We all depend on clean water.

Water pollution can arise from various sources. Urban growth, suburban development, mining, industry, and agriculture may all be sources of water quality problems. Likewise, solving pollution problems often requires a variety of efforts by many people—from state, regional, and local governments, to industry organizations, concerned citizens, and public interest groups.

Texas manages water pollution from nonpoint sources primarily through voluntary programs, along with common-sense regulations designed to prevent pollution. Voluntary programs put control where it belongs—at the local level, where residents and water quality professionals understand what will work best in their areas.

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 wide range of strategies based upon common sense, good science, and fiscal responsibility, which emphasize pollution prevention, a watershed perspective, and community-based solutions.

Implementing measures to control nonpoint source (NPS) pollution is primarily the responsibility of regional and local authorities and landowners. State government agencies assist them by identifying water quality problems, helping them select and implement the management practices that are best suited to control NPS pollution in their particular areas, and directing funding to support those practices. Where practical, the state develops and enforces regulations aimed at preventing NPS pollution, and assists local governments in developing regulations for their specific needs.

Since the passage of the Clean Water Act in 1972, states have focused on controlling point sources of pollution. As a result, the quality of surface waters across the country has improved significantly. Where problems remain, the chances that they are caused by nonpoint sources have increased over time. Human populations have increased in many watersheds, multiplying the activities that lead to NPS pollution. Currently, 92 percent of the impaired waters in Texas are affected, at least in part, by nonpoint sources.

NPS pollution abatement may very well require funding at the same or higher levels as those that were directed toward point source pollution controls in the past. Section 319(h) of the Clean Water Act provides grant funding for state programs to abate pollution from nonpoint sources. Addressing some of these problems, however, can be quite costly. These grants are not designed to cover all the costs of the state's NPS pollution programs. They also require state or local matching funds.

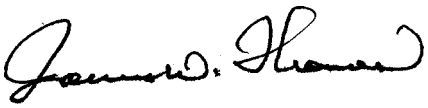
In the past, Texas has used Section 319 grants primarily for projects that either demonstrated the most effective practices for controlling pollution, or that evaluated practices to identify the most effective ones. In the early years of the program, these demonstration projects were a very effective way to educate local leaders and professionals and to increase knowledge about what works and what doesn't. Now that the groundwork has been laid, Texas has changed its focus for the use of NPS grants.

Our efforts are now aimed at supporting state and local programs that have direct impact on improving water quality in the streams, reservoirs, and bays that we have identified as being polluted by nonpoint sources. We are directing our resources to large-scale projects that have an immediate and visible impact in those watersheds. We

may reach more people than we ever imagined if they see what their neighbors are doing and understand why.

The focus has also shifted to developing new partnerships and strengthening old ones. In developing these large-scale projects, we are improving the interagency cooperation that allows us to find new ways to work together, to spark new ideas for solving our problems, and to make the most effective use of our precious resources.

The following report highlights our achievements in managing NPS pollution in 2001. It also highlights key programs that are being used to prevent and restore water quality, so that we may better understand how we can work together to ensure clean water for Texans.



James W. Thomas, Director
Technical Analysis Division
Texas Natural Resource Conservation Commission

Bobbie H. Stephens, Director
Administration
Texas State Soil and Water Conservation Board

Introduction

What Is Nonpoint Source Pollution?

Nonpoint source (NPS) pollution results when small amounts of contaminants from a large number of sources are carried by rainfall runoff into streams, lakes, or bays. For example, pollutants may be washed off lawns, construction areas, farms, or highways during a heavy rain and carried to a nearby creek. Nonpoint source pollution is difficult to control because it comes from the everyday activities of many different people, such as fertilizing a lawn, using a pesticide, or constructing a road or building.

In contrast, pollution from point sources comes in large amounts from a single source, such as an industrial operation or a wastewater treatment plant. Pollution from most point sources is controlled through regulations that require treatment of a facility's wastewater before it is discharged into a nearby lake or stream.

Pollution can alter the integrity of water in one or more ways: chemical, physical, biological, or radiological. Impairment occurs when the rate at which pollutant materials entering water bodies or groundwater exceeds the receiving water's natural capacity to assimilate them.

The large number of nonpoint sources and the fact that they are difficult to regulate make the voluntary efforts of citizens, businesses, service organizations, and other groups an essential part of the effort to address NPS pollution in Texas.

Texas Nonpoint Source Program

NPS management is an effort that requires the combined activities of many organizations at both the state and local level. Fortunately, Texas has many programs to address NPS pollution. Many state agencies are involved in this endeavor.

Leadership in the control of NPS pollution in Texas is divided between two agencies. The Texas State Soil and Water Conservation Board (TSSWCB) is responsible for controlling agricultural and silvicultural NPS pollution. The Texas Natural Resource Conservation Commission (TNRCC) is responsible for managing urban and other NPS pollution. Several other state agencies have programs and responsibilities that play an integral part. Some aspects of the state's program, such as water quality monitoring, may be performed through contracts with research institutions, consulting firms, or state or local government agencies.

Key Terms

Best management practices (BMPs) — practices or combinations of practices that are the most effective practical means of preventing or reducing the amount of pollution generated by nonpoint sources to levels compatible with water quality goals.

Stakeholder — any person or organization involved in or affected by watershed management activities, including the general public, environmental organizations, and the regulated community.

Total maximum daily load (TMDL) — a technical analysis that: (1) determines the maximum amount of a pollutant that a water body can receive and still both attain and maintain its water quality standards; and (2) allocates this allowable amount (load) to point and nonpoint sources in the watershed.

TMDL implementation plan — a detailed description and schedule of the regulatory and voluntary management measures necessary to achieve the pollutant reductions identified in the TMDL. The implementation plan is prepared by taking into account naturally occurring levels of the pollutants, the nature of existing permitted and nonpermitted human sources, the content and expiration dates of existing permits in the watershed, the potential for future growth, and any other known significant factors.

Watershed — a geographic area in which water, sediments, and dissolved materials drain into a common outlet. This outlet could be a stream, lake, playa, estuary, aquifer, or ocean. Watersheds are also commonly called basins or drainage areas.

Watershed action plan — the compilation of a TMDL and its implementation plan. The watershed action plan provides local, regional, state, and federal organizations with a comprehensive strategy for restoring and maintaining water quality in an impaired water body.

Water quality management plan (WQMP) — a site-specific plan that includes appropriate practices, management measures, and technologies to address water quality considerations for a farm, ranch, or forestry operation.

The mission of the state's NPS program, as indicated in the 1999 *Texas Nonpoint Source Pollution Assessment Report and Management Program* (TNRCC, SFR-68/99), is to protect the quality of water resources in Texas from adverse effects of NPS pollution. This protection is provided through cooperative implementation of a wide range of strategies that emphasize pollution prevention, a watershed approach, and a community-based perspective.

NPS Grant Program

Section 319 of the Clean Water Act (CWA) provides for a national NPS water pollution prevention and control program. Through the grant program established under Section 319(h), the Environmental Protection Agency (EPA) provides funding to Texas to implement activities that achieve the goals established by Congress in the Act.

The Section 319(h) grant is awarded annually by Congress to the EPA. The EPA then divides the amount among the states. In Texas, the grant is further divided between the TSSWCB and the TNRCC. These agencies are responsible for maintaining a statewide management program that satisfies the federal requirements contained in Section 319. The state's current management program was approved by the EPA on February 25, 2000.

Section 303(d) of the CWA requires states to develop a list of water bodies that do not meet, or are not expected to meet, state water quality standards. Those waters identified on the 303(d) list with impairment due wholly or in part to NPS pollution comprise the state's list of NPS-impacted waters, which is required under Section 319.

The TSSWCB and the TNRCC target NPS grant funds toward implementation and education projects within the water-

sheds of NPS-impaired streams, lakes, or bays on the state's most current 303(d) list. Grant funds are also used to develop total maximum daily loads (TMDLs) and to implement management practices that support attainment of the restoration goals established in TMDLs. A summary of Texas grant amounts and expenditures is included at the end of this report.

Stakeholder Involvement

Planning, coordination, and grant management are essential elements of a successful NPS program. Texas uses interagency agreements and multi-agency task forces to ensure this coordination. The state has long-standing relationships with federal agencies like the USDA-Natural Resources Conservation Service (NRCS) and the United States Geological Survey (USGS). The NRCS is a very active partner in agricultural NPS management, and the USGS is an invaluable resource in water quality monitoring and assessment activities. EPA Region 6 provides technical assistance and program guidance.

Several state agencies are actively involved with the TNRCC and the TSSWCB in NPS management, including the Texas Department of Agriculture (TDA), the Texas Forest Service (TFS), the General Land Office (GLO), the Railroad Commission (RRC), the Texas Department of Health (TDH), the Texas Water Development Board (TWDB), the Texas Parks and Wildlife Department (TPWD), and the Texas Department of Transportation (TxDOT). Key cooperators from academia include the Texas Agricultural Experiment Station (TAES), which includes the Blackland Research Center of Texas A&M University; the Texas Cooperative Extension (TCE); the Texas Institute for Applied Environmental Research (TIAER); the Center for Research in Water Resources (CRWR) at the University of Texas; the Texas Water Resources Institute at Texas A&M University; and the Bureau of Economic Geology.

Regional agencies that are actively involved in NPS management include soil and water conservation districts (SWCDs); Clean Rivers Program agencies, such as river authorities and water districts; and city and local governments.

Representatives of all of these agencies serve on a number of committees that coordinate NPS management activities, such as the Texas Groundwater Protection Committee, the Clean Rivers Program (CRP) Stakeholders Workgroup and its NPS Technical Workgroup, the State Agricultural/Silvicultural Nonpoint Source Advisory and Coordinating Committee, and the Texas Water Protection Committee.

Program Development

The TNRCC held numerous meetings and events throughout the year to seek input from stakeholders. These meetings allowed the TNRCC to explain how collaborative efforts in every aspect of water quality management have improved the state's ability to address water quality con-

cerns and impairments. They also gave TNRCC staff an opportunity to hear from stakeholders about their concerns and ideas.

Due to this increased involvement, stakeholders now have extensive opportunity to provide review and input on projects proposed for funding under Section 319(h) grants. The review process is supported by information available from all state water quality programs, thereby ensuring coordination among the responsible agencies.

The CRP Stakeholders Group provided a forum for obtaining regional input and informing participants about NPS issues. The CRP stakeholders contributed to the development of new guidance and quality assurance methods for the CRP.

NPS staff members made presentations to the CRP stakeholders on the process for developing proposals to obtain federal NPS grants. A discussion session following the presentation allowed the staff to field questions and suggestions from the participants on improving the process. At the same time, TNRCC staff presented an update on statewide NPS management, current studies and grant projects, and collaborative efforts to address NPS pollution among state agencies. The stakeholders provided feedback and suggestions on funding needs for water quality projects, future plans for NPS management, and NPS issues in the TMDL process.

The TNRCC and the TSSWCB will continue their commitment to ensure that stakeholders are involved in the development of the state's water quality management programs. For more information about the NPS program, visit the TNRCC Web site at **www.tnrcc.state.tx.us/water/quality/nps/index.html**, or the TSSWCB Web site at **www.tsswcb.state.tx.us/programs/319.html**.

Monitoring and Assessing Water Quality

Texas has established standards that describe the ways that water bodies are used and define the measurements used to evaluate whether water quality is good enough to maintain those uses. Four general categories for water use are defined in the Texas Surface Water Quality Standards: aquatic life use, contact recreation, public water supply, and fish consumption. Each of these uses is linked to measurements for specific conditions or pollutants.

Identifying actual and potential impacts from nonpoint sources is a vital aspect of NPS pollution management. A problem must be identified and well-defined before it can be addressed effectively. Monitoring and assessment has to occur at several levels:

- routinely and systematically identifying the status of water quality,
- conducting detailed assessments of problems and identifying their sources, and
- monitoring the effectiveness of best management practices (BMPs) that are implemented to protect or restore water quality.

Surface Water Quality Monitoring

The TNRCC maintains an ambitious monitoring program to characterize existing water quality and emerging problems, define long-term trends, determine compliance with water quality standards, and describe the seasonal variation and frequency of occurrence of selected water quality constituents. The program's monitoring strategy involves:

Surface water quality monitoring staff routinely collect field measurements, such as water temperature, pH, dissolved oxygen, and specific conductance.

- sampling at a large, fixed network of sites statewide;
- special studies and intensive surveys to identify causes and sources of pollutants and to quantify point and NPS loads;
- collecting data for modeling and permitting activities;
- receiving water assessments to determine appropriate aquatic life uses; and
- conducting use attainability analyses to ensure that standards and criteria are appropriately set.

Surface water quality monitoring (SWQM) is conducted by several agencies. In addition to the TNRCC, 15 regional agencies monitor water quality under the CRP. Together, the CRP and TNRCC monitor water quality at more than 2,000 sites throughout Texas. These sites are monitored monthly or quarterly for water chemistry and field measurements. Additional monitoring is conducted at many stations for toxic substances, biological communities, habitat quality, and diurnal variations. Basin

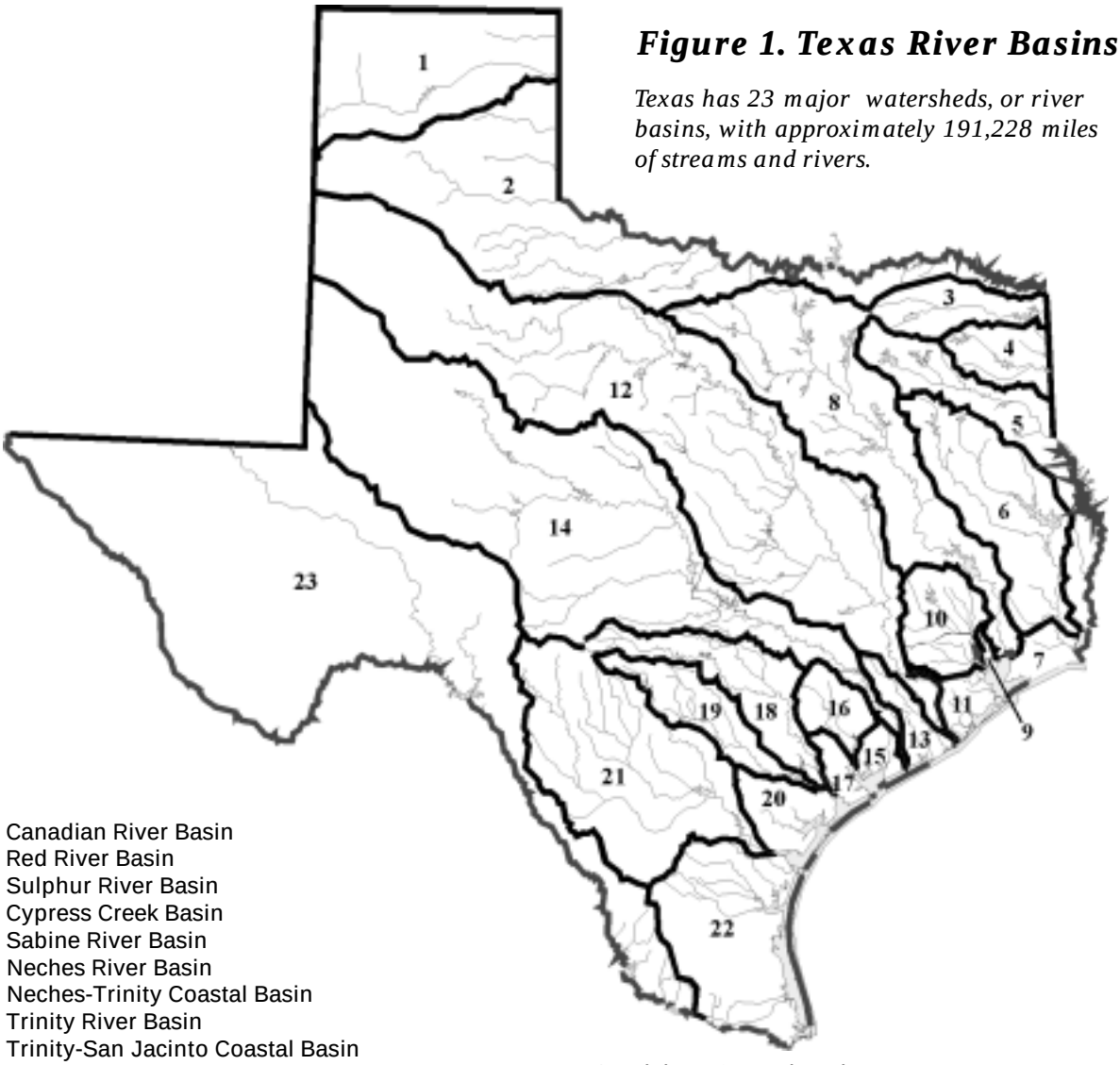


Figure 1. Texas River Basins

Texas has 23 major watersheds, or river basins, with approximately 191,228 miles of streams and rivers.

1 - Canadian River Basin
2 - Red River Basin
3 - Sulphur River Basin
4 - Cypress Creek Basin
5 - Sabine River Basin
6 - Neches River Basin
7 - Neches-Trinity Coastal Basin
8 - Trinity River Basin
9 - Trinity-San Jacinto Coastal Basin
10 - San Jacinto River Basin
11 - San Jacinto-Brazos Coastal Basin
12 - Brazos River Basin
13 - Brazos-Colorado Coastal Basin
14 - Colorado River Basin
15 - Colorado-Lavaca Coastal Basin
16 - Lavaca River Basin
17 - Lavaca-Guadalupe Coastal Basin
18 - Guadalupe River Basin
19 - San Antonio River Basin
20 - San Antonio-Nueces Coastal Basin
21 - Nueces River Basin
22 - Nueces-Rio Grande Coastal Basin
23 - Rio Grande River Basin

Steering Committees for each of the river basins in Texas (Figure 1) work with the CRP agencies to provide stakeholder feedback and set priorities for water quality monitoring activities.

The TPWD carries out monitoring especially designed for the protection of fish and wildlife, such as monitoring of fish populations, aquatic vegetation, and related water quality parameters. In addition, the TPWD investigates fish kills and any type of pollution event that may cause the loss of fish or wildlife resources. The TDH collects fish and shellfish tissue

for laboratory analyses and assesses human health risk associated with consuming contaminated fish and shellfish.

Coordinating Monitoring Efforts

Data from all of these agencies are shared and used by the TNRCC to assess the fitness of Texas surface water for its various uses. The efforts of these agencies are closely coordinated to enhance spatial coverage of monitoring sites, to reduce duplication of monitoring effort, and to ensure consistency in sampling methods.

Annual meetings are hosted by the CRP planning agency within each of the major river basins, and a coordinated basin-wide schedule (plan) is compiled. The basin monitoring plans are then aggregated to produce a statewide SWQM schedule.

By the beginning of 2001, a total of 2,026 fixed sites were being monitored by the TNRCC (563 sites), the CRP (1,400 sites), and the USGS (63 sites). This total represents an increase of 1,580 sites over the number (446) that was monitored by the TNRCC in 1996. This substantial increase of more than 400 percent in the number of monitoring sites demonstrates the power of coordinating statewide monitoring resources.

Nineteen meetings were held with agencies that collect data under approved quality assurance plans to determine what sites would be monitored and what types of information should be collected. The coordination process ensures that local needs and concerns are considered in the development of an overall monitoring plan for the state. It also prevents duplication of monitoring efforts among the various regional, state, and federal agencies that monitor water quality in Texas.

Improving the Data

In 2001, the CRP also developed improved monitoring and quality assurance practices that will increase the quality and consistency of water quality data collection and reporting. The requirements for planning and oversight of monitoring programs were enhanced to improve quality assurance. Any lab that analyzes data for the CRP now must have a quality system in place. New reporting limit requirements were developed that result in data which better supports assessment of water quality as defined in the Texas Surface Water Quality Standards. Training in these new methods was provided to the numerous agencies that monitor water quality data in cooperation with the TNRCC.

Also in 2001, the SWQM Team developed improved procedures and methods for assessing surface waters. A cross-agency team reviewed comments received during the public comment periods for the 2000 305(b) water quality inventory, 303(d) list of impaired water bodies, and the 2000 revisions to the Texas Surface Water Quality Standards. As a result of this review, a diverse group of stakeholders was invited to meet

with technical staff at four different times to discuss potential revisions to the guidance and methodology prior to initiating the 2002 assessment.

Significant improvements include:

- use of new bacterial indicators to better assess risks to public health from swimming and other water sports;
- several changes in monitoring dissolved oxygen to account for variation in stream conditions over time and from site to site;
- use of statistical methods for determining use support, which increases the accuracy of identification of impaired water bodies;
- use of biological and habitat assessment to determine aquatic life use support;
- listing water bodies as not supporting their public water supply use if the toxic contaminant levels established for finished drinking water are exceeded in a water body that is used as a source for drinking water; and
- screening for public health concerns using health-based levels for toxic substances such as perchlorate.

Water Quality Inventory and List of Impaired and Threatened Waters

The results of the state's monitoring and assessment efforts are published in the *Texas Water Quality Inventory*, or CWA Section 305(b) report. The 305(b) report is then used to produce the List of Impaired Water Bodies, or the *Texas CWA Section 303(d) List*. Both of these publications are available on the TNRCC's Web site, or through the state library. See the back of the title sheet for ordering information.

The 303(d) list identifies water bodies that do not meet the standards set for their use and the pollutants or conditions that are responsible. These water bodies are generally referred to as "impaired," though they may still support some of their designated uses. The list also includes water bodies when strong evidence indicates that they probably will not meet standards within two years. The term "threatened" is used to refer to those water bodies.

The TNRCC has identified 368 impairments in 238 of the 517 water bodies assessed in 2000.

The TNRCC has identified 368 impairments in 238 of the 517 water bodies assessed in 2000. Some water bodies have more than one impairment. The types of impairments identified in the draft 2000 303(d) List indicate a complex array of water quality problems.

Groundwater Assessment

The Groundwater Planning and Assessment Program completed a pilot project to test an innovative means of detecting pesticide contamination of groundwater wells—immunoassay. Immunoassay is a portable, fast, and inexpensive way of analyzing water or soil samples for various chemicals, such as the herbicide atrazine. The immunoassay method will detect

chemicals at lower concentrations than will lab methods (in most cases), allowing the TNRCC to detect developing groundwater contamination problems before they become serious health or environmental threats.

In cooperation with the TWDB and the High Plains Underground Water Conservation District #1, the TNRCC analyzed groundwater samples from 721 water wells in the Panhandle–High Plains Aquifer region for occurrence of atrazine. Atrazine was chosen for the pilot because it is the only pesticide that has been consistently detected in wells in the region.

By asking the TWDB and the district to collect the atrazine samples during their regular monitoring visits in the area, and by using the immunoassay analysis method, the state realized greater efficiency in the assessment. The cost was less than the previous method, in which TNRCC staff collected the samples in separate trips and used traditional laboratory analysis methods. Since completion of the pilot project, a cooperative effort has begun to assess pesticide contamination of the Gulf Coast Aquifer using the new methods.

Water Rights and Instream Uses

The Instream Uses team of the TNRCC is responsible for reviewing water rights applications. The team assesses the effects that issuance of a water use permit will have on existing instream uses, including water quality, fish and wildlife habitat, recreation, and freshwater inflows to bays and estuaries. Factors that are considered include the perennial nature of the stream, water quality issues, aquatic life use and biological integrity of the stream, presence of sensitive or endangered species of concern, and recreational uses. Stream flow or elevation restrictions may be imposed to protect these uses. In addition to flow restrictions, mitigation may be recommended for altered, inundated, or destroyed terrestrial or riparian wetland habitats, as well as possible adverse water quality impacts.

During fiscal year 2001, the TNRCC completed 69 environmental reviews of water rights applications. The applications included 48 on perennial water bodies, 17 from intermittent streams, and four from tidal streams. In 71 percent of the reviews, staff recommended either flow or minimum water elevation restrictions, implementation of a mitigation plan, maintenance of a riparian buffer zone, or utilization of other BMPs. In some applications, the staff recommended that residential developments implement an NPS prevention homeowner education program. Other BMPs recommended included water quality monitoring and sampling, creation of wetland habitat, maintenance or enhancement of riparian buffer zones and natural areas, development of vegetated berms and filter strips, and utilization of erosion control measures (such as sustaining walls or vegetation).

In addition to reviewing water rights applications in 2001, the TNRCC continued to manage the Guadalupe River Instream Flow Study. The interdisciplinary study is conducted with the TWDB, the TPWD, and the

Guadalupe-Blanco River Authority (GBRA). In 2001, staff focused on the collection of biological, physical habitat, water quality, and hydraulic data from selected study areas to develop a hydrological and physical habitat model. Data will be used to model conditions under various flow rates in order to determine the best way to protect the existing instream uses in the basin. The instream flow study should be completed in 2002.

The TNRCC also continued to manage a contract with TIAER to conduct the first phase of the Trinity River Instream Flow Project. The Trinity River Basin was selected for study because of the high demand of water use by consumers and the numerous water quality concerns identified on the 303(d) list. The main objective of the Phase 1 study is to identify and organize the existing historical information on the hydrology, biology, physical habitat, and aquatic life use of the Trinity River within the study area. Data and information collected will be used in planning and executing the next phase of the project. The ultimate goal of the instream flow project is to determine the appropriate flows to maintain the existing instream uses, including water quality in the Trinity River Basin above Lake Livingston. The first phase of the instream flow project will be complete in December, 2001.

Protecting Fishable Waters and Public Health

The Commissioner of Health works to ensure public safety by evaluating the risk to consumers of eating fish caught in state waters. The commissioner may issue consumption advice or prohibit the taking of fish or shellfish in any area of the state if health risks due to contamination in fish or shellfish tissue are found to be unacceptable.

The TDH Seafood Safety Division is responsible for collecting fish and shellfish tissue for laboratory analyses and assessing human health risk associated with consuming contaminated fish and shellfish. Surveys of aquatic life to determine these risks are conducted within laboratory and funding constraints.

After a lake, river, stream, or coastal water has been surveyed for chemical contaminants in fish or shellfish, the Commissioner of Health may issue a fish consumption ban or advisory. A news release on such action is made available to the media. Closures and advisories are also published in a booklet that is free to the public. The booklets are also available on the Seafood Safety Division's Web site (**www.tdh.state.tx.us/bfds/ssd/**). Closures and advisories are also disseminated through other means as appropriate.

In 2001, the TDH completed 16 special sampling projects for 13 water bodies, and 9 risk assessments. Three consumption advisories were issued.

On June 4, 2001, the TDH issued Consumption Advisory 19 (ADV-19), modifying the consumption advisory for the Arroyo Colorado in Cameron and Hidalgo counties. The previous advisory recommended that people consume no fish of any kind from the Arroyo Colorado due to contamina-

tion from chlorinated pesticides. The new advisory recommends that people limit consumption of smallmouth buffalo from the Arroyo Colorado upstream of the Port of Harlingen due to unacceptable levels of chlorinated pesticides in this fish species. All other fish species from these waters may be consumed without restriction.

On October 9, 2001, the TDH issued Consumption Advisories 20 and 21. Advisory 21 (ADV-21) rescinds a previous advisory recommending that no fish or blue crab be consumed if caught from an area of Clear Creek in Harris, Brazoria, and Galveston Counties. There is no longer a threat to human health from consumption of fish and blue crab taken from these waters. Advisory 20 (ADV-20) recommends limiting consumption of all species from an area of the Houston Ship Channel in Harris County.

For more specific information on these and other fish consumption advisories and bans issued by the TDH, visit their Web site at **www.tdh.state.tx.us/bfds/ssd/survey.html**.

Implementing Programs to Prevent and Reduce Pollution

Implementing practices to prevent and reduce pollution is the reason for all the coordination, monitoring, and education activities of state agencies and stakeholders. Much of the implementation takes place at the watershed level, and it is described in the section, "Regional and Watershed Activities." However, local implementation is also supported by statewide programs and common-sense regulations, which are described in this section.

TMDL Program

In spite of the successes in improving surface water quality over the last 30 years, 238 water bodies in Texas are still impaired. The Clean Water Act anticipated this possibility and requires that where effluent limitations (that is, point source controls) are not sufficient to attain water quality standards, then a TMDL must be established to solve the remaining water quality problems. The TMDL is an important scientific tool in the state's watershed management approach.

TMDL development is just one aspect of restoring water quality. To be effective, a strategy for implementing the pollutant allocations is also needed. The TMDL and its associated implementation plan are combined in a Watershed Action Plan that lays out the entire program for restoring an impaired water body.

A TMDL report summarizes how the allowable pollutant loads were derived for point, nonpoint, and background sources. An implementation plan is a summary of the management strategies needed to restore the water quality. After the TNRCC commissioners approve a TMDL, its implementation plan is developed. For more information on TMDL development

in Texas, see Developing Total Maximum Daily Load Projects in Texas: A Guide for Lead Organizations (GI-250), available from the TNRCC.

In 2001, the TNRCC approved nine TMDL reports. Two of these reports—phosphorus in the North Bosque River and atrazine in Aquilla Reservoir (near Hillsboro)—were also approved by the TSSWCB because of the agricultural pollutants involved. The remaining TMDLs were for: legacy pollutants in the Arroyo Colorado (lower Rio Grande) and Clear Creek (near Houston) watersheds; volatile organic compounds in the Clear Creek watershed; legacy pollutants in watersheds in Dallas and Tarrant counties; legacy pollutants in watersheds in and around Fort Worth; dissolved oxygen in Salado Creek (near San Antonio); dissolved solids in E.V. Spence Reservoir (Coke County); and dissolved oxygen in Lake Austin (in the city of Austin). Legacy pollutants are chemicals whose use has been banned or severely restricted, but which persist in the environment.

In 2001, nine TMDL reports and eight implementation plans were approved. There are 16 more TMDL projects in progress, and six new projects were initiated.

Eight implementation plans based on TMDLs have been approved by the TNRCC. These plans have not been in effect long enough to have quantifiable results, but are expected to improve water quality in the target watersheds to meet established standards.

There are 16 more TMDL projects in progress, addressing problems in 49 water bodies. Six new TMDL projects were initiated in 2001, addressing 30 water bodies. In the Houston area, a TMDL project will address dioxin in eight bays and four segments of the San Jacinto River, and fecal coliform pollution in the tidal portion of three bayous.

In the Guadalupe, San Antonio, and Nueces basins, a TMDL project is assessing depressed dissolved oxygen concentrations in seven river segments. In those three basins as well as the Colorado, both dissolved oxygen and fecal coliform bacteria concentrations are being assessed in four segments.

Dissolved solids loadings are being assessed in a project for four river segments in the Brazos, Colorado, and the Nueces–Rio Grande basins. A fourth TMDL project will evaluate low dissolved oxygen concentrations in three segments of the Brazos River. In the fifth project, fecal coliform bacteria contamination is being addressed for seven segments of the Colorado, Guadalupe, San Antonio, and Nueces basins.

More detailed information on the TMDL program is available on the TNRCC Web site (**www.tnrcc.state.tx.us/water/quality/tmdl/**) and on the TSSWCB Web site (**www.tsswcb.state.tx.us/programs/tmdl.html**).

Successful TMDL development and implementation requires close coordination between the TSSWCB and the TNRCC, as well as extensive participation by SWCDs, CRP partner agencies, other state agencies, local

governments, and stakeholders in the affected watersheds. The state uses several strategies and existing programs to implement TMDLs in waters with NPS impacts. Many of these are highlighted in the following pages.

Nonpoint Source Education Campaign

Education is a critical component of managing NPS pollution. Unless government agencies, educational institutions, and stakeholder groups spread the word to local communities and citizens about the water quality problems we face—and what works in preventing or solving those problems—people will not step forward to implement solutions. That's why public education is an implementation component of every NPS grant project, TMDL project, and watershed action plan.

The TNRCC initiated an aggressive education campaign in 2001 with support of NPS grants. Phase I was completed in August and included the following activities:

- Distributed NPS materials at more than 26 conferences and seminars throughout the state. Materials included posters, storm drain stenciling manuals, and door hangers.
- Played an NPS pollution message on the TNRCC's telephone system from October 2000 through December 2001 for customers who were put on hold.
- Furnished NPS information to 350 Keep Texas Beautiful cities through state affiliate offices.
- Supplied NPS door hangers and stenciling manuals to support storm drain projects in over 25 communities.
- Distributed over 4,000 NPS posters and bookmarks through schools and the TNRCC's 16 regional offices.

The education campaign will promote proper yard care and other best management practices.

Phase II of the NPS education campaign began in June 2001. A campaign targeting consumers in six media markets where TMDLs are under way will feature events, partnerships, and special activities, such as:

- a pilot program on pet waste in Austin; and
- education on proper yard care and disposal of household hazardous waste, pet waste, and motor oil in Dallas–Fort Worth, San Antonio, Houston, Corpus Christi, and the Rio Grande Valley.

The key components of the campaign are:

- a new campaign slogan for nonpoint source pollution;
- accompanying materials, including posters, brochures, and audio spots;
- statewide radio and TV ad placement;
- special events and activities in targeted TMDL areas;
- alliance with Cyberways and Waterways to target schools;
- public service announcements and special programming for TV, radio, and print media; and
- promotions with corporate, government, and nonprofit partners.

Teaching Environmental Science

Teaching Environmental Science (TES) is a graduate course for elementary through middle school teachers (grades K-8). It emphasizes the importance of understanding air, water, and waste issues that affect environmental and economic health.

The TES course provides balanced information and promotes partnerships among teachers, government agencies, businesses, and community organizations. The course is designed to prepare students to become citizens committed to environmental protection, using critical thinking skills in making environmental decisions.

During 2001, 115 teachers received 600 hours of instruction, 3 hours of graduate credit, and 45 credit hours for professional certification. These teachers reported an annual load of 6,357 students, making the reach of this program very wide. In surveys taken after the course, teachers were very positive in their response to the program, with 96 percent responding that their students will benefit from the information received in the course. They also responded that the course provided a real-world view of water issues in their areas (95 percent) and that they plan to use the materials from the course in their lesson plans (94 percent).

For more information about TES courses, visit the TNRCC Web site at **www.tnrcc.state.tx.us/exec/oppr/pubeduc/teach.html**.

Texas Watch

Texas Watch, which is supported through a cooperative partnership between the TNRCC, Southwest Texas State University, and the EPA, implements public outreach strategies to enhance the TNRCC's NPS pollution prevention programs. In 2000, the Texas Watch mission was revised to place less emphasis on managing data collection programs and more emphasis on the development of partner networks to support a variety of NPS education efforts. Texas Watch goals include educating a broad spectrum of citizens about local water quality issues, and encouraging communication and a sense of community among environmental educators and water resource managers.

Strategies for meeting these goals include volunteer monitoring, watershed education, and community action projects. In carrying out these activities, Texas Watch influences individuals to adopt activities and behaviors that help improve water quality and prevent NPS pollution.

Texas Watch develops and supports partner networks to train volunteers across multiple watersheds. Partners include industries, municipalities, river authorities, regional councils, school districts, and non-governmental organizations. They sponsor groups, supply monitoring equipment, host meetings, and donate staff time and technical expertise. This unique collaboration educates stakeholders; promotes citizen involvement in

Texas Watch trains volunteers to monitor water quality and supports educational activities and events.

addressing water quality issues; produces sound, useable water quality data; provides an outlet for citizens to voice their water quality concerns to the TNRCC and their local partners; and integrates citizen concern with the TNRCC's efforts to prevent NPS pollution.

In 2001, a variety of activities were implemented to emphasize direct contact with volunteers and partners and to spread the word about NPS pollution and its prevention. These included events, site visits, partner and volunteer meetings, workshops, and field activities. Supporting materials included a quarterly newsletter and comprehensive Web site.

Program Coordination and Support

To coordinate Texas Watch activities, five regional meetings, three statewide partner meetings, and a statewide Meeting of the Monitors were held. Texas Watch worked collaboratively with local partners to plan and execute the regional meetings, which were scheduled on the weekend to encourage attendance in Houston, Texarkana, Lake Buchanan (near Austin), The Woodlands, and Rockport. Each meeting attracted about 50 participants. The sessions covered information on local and statewide NPS problems, solutions to these problems, and opportunities for discussion and sharing experiences with the program. Topics included NPS effects of urban sprawl, land-use impacts on water quality, data management and quality assurance, local water quality conditions with an emphasis on local TMDLs, multiyear volunteer water quality monitoring projects, environmental education resources on the Web, federal and state laws and regulations, and panel discussions on topics identified by the audience.

Three statewide partner meetings provided opportunities for partners to meet each other and Texas Watch and TNRCC staff members to provide input about the program, and to disseminate information about the status of the Texas Watch program. At these meetings, partners were introduced to changes in quality assurance procedures, briefed on procedures for documenting an in-kind match, and trained to integrate concepts of NPS pollution into the Texas Watch certification program for water quality monitors.

The Meeting of the Monitors attracted over 100 participants from all over the state. The two-day meeting featured field trips, an awards banquet, a four-track agenda, and a panel discussion featuring a state legislator, government representatives, and environmental activists. The agenda successfully integrated NPS pollution themes throughout the sessions. The participants gave very positive feedback about the level of organization and variety of presentations.

Water Quality Monitoring

Texas Watch and its partners either certified or performed follow-up site visits on 1,636 volunteers. Texas Watch alone conducted 33 events with a total of 349 participants. The NPS education portion of the training sessions was expanded to enhance the monitors' understanding of the effects of NPS pollution on the variables tested.

In the fall of 1999, citizens from Rockport requested Texas Watch's help in addressing their concerns about boat discharges in a local bay. Over the next year, Texas Watch helped organize the Rockport Sentinels and designed a sampling program to evaluate ambient water quality conditions and bacteria levels in Little Bay. After six months of sampling, Texas Watch helped the group produce a report that identified several potential sources of the bacteria.

Special Projects

An Earth Day Sampling event was held in April 2001. Several hundred monitors participated in this event, which brought together professional and volunteer monitors to sample water quality, share their interest in protecting the environment, and post their information on the Texas Watch Web site. In with conjunction with the event, Texas Watch conducted an Online Chat that gave participants the opportunity to talk with experts about various water quality issues.

Texas Watch supported the development of Aquifer Watch, a pilot groundwater sampling program at the Barton Springs/Edwards Aquifer Conservation District. Staff developed an NPS lesson plan and helped District staff incorporate land-use information into their educational materials.

Education

The Environmental Education Initiative set out to research Texas Watch's options for developing a larger role in environmental education at the high school and middle school levels. The project workgroup met three times and identified strategies for expanding its funding in environmental education, for disseminating its curriculum, and for coordinating Texas Watch activities with other organizations using volunteers to collect environmental information.

Texas Watch developed an Environmental Education Toolbox to provide a unique location on the Web for teachers to find lesson plans, helpful links, and other environmental education resources. Texas Watch also developed a companion curriculum for its Volunteer Monitoring Manual and assisted the Cyberways and Waterways organization in conducting workshops and biodiversity training.

Watershed Education Workshops, which were conducted in response to requests from citizen groups and schools, presented information on the relationship of land use to water quality, the water cycle, NPS pollution and its prevention, and correlations between water chemistry and aquatic life.

Communication

Texas Watch also uses a quarterly newsletter and its Web site to spread the word about NPS management. Eight newsletters carried articles emphasizing NPS pollution issues, volunteer and partner activities, workshop announcements, recognition of monitors and staff, and data quality tips. The Web site was restructured to provide more information and features, including a bulletin board that allows volunteers to exchange information. Visit the Texas Watch Web site at **www.texaswatch.geo.swt.edu**.

Source Water Assessment and Protection

Water bodies from which water is drawn for treatment and delivery of drinking water are called source waters. The 1996 Amendments to the Safe Drinking Water Act require, for the first time, that each state prepare a source water assessment for all public water supplies by May 2003. Previously, federal regulations focused on the quality of water delivered at the tap. The 1996 amendments emphasize the importance of protecting the source water.

Groundwater supplies may be susceptible to pollution under several conditions: if a potential source of contamination (PSOC) exists in the contributing area for the public water well; if the time it takes for the contaminant to travel to the well is short; and if the natural filtering and assimilation processes are unlikely to adequately weaken the strengths of the contaminants. In addition, particular types of land use or cover can cause the supply to be more susceptible to contamination. Finally, detection of various classes of contaminants in water from private wells in the vicinity of a public water well may indicate susceptibility of the public supply, even though there may be no identifiable source to account for it.

The area around public water supply wells is surveyed to identify potential sources of contamination.

Surface water systems are by nature susceptible to contamination from both point and nonpoint sources of contamination. The degree of susceptibility of a public water supply to contamination can vary, depending on the environmental setting, water and wastewater management practices, and land use or cover within a source water's contributing watershed. For example, a public water supply intake downstream from extensive urban development may be more susceptible to NPS contamination than an intake downstream from a forested, relatively undeveloped watershed. Surface water supplies are also susceptible to contamination from point sources.

During 2001, the TNRCC Source Water Assessment and Protection (SWAP) team continued working with the USGS to develop and implement a scientifically defensible methodology for assessing the susceptibility of the source waters of Texas. Much of the TNRCC's effort during 2001 was spent developing numerous PSOC databases and the Visual Basic code required for the assessment software. A 30-meter data set with 20 differ-

ent land uses was finished in 2001. It will be critical to the NPS component of the assessments.

In 2001, the USGS completed analyses of data collected for the assessment in 1999 and 2000. Surface and ground water samples were analyzed for volatile organic compounds (VOCs), soluble pesticides, and nitrates. One or more VOCs were detected in 75 percent of reservoir samples and in 9 percent of well samples. Methyl tertiary-butyl ether (MTBE) was the VOC most frequently detected in reservoirs, and toluene was the VOC most frequently detected in wells. One or more pesticides were detected in 98 percent of the reservoirs sampled and in 31 percent of the wells sampled. Atrazine or its metabolite deethylatrazine was the most frequently detected. No VOCs or pesticides were detected at concentrations exceeding the maximum contaminant level (MCL) allowed in drinking water. The only contaminant found to exceed the MCL was nitrate, which was found in 8 percent of the wells sampled.

Work continues on the development of data sets that will better enable the TNRCC SWAP Team to:

- focus its source water protection efforts on public water supplies that are more susceptible to contamination,
- explore ways to reduce monitoring costs associated with ensuring safe drinking water,
- assist the public in understanding the source of their water, and
- support the implementation of BMPs to protect source waters.

Source Water Protection Projects

During 2001, the Texas Rural Water Association (TRWA) was awarded the Source Water Protection contract, which, for the first time, focuses on surface drinking water supplies. The TRWA completed seven projects in the Wichita Falls area during the year and will be moving into the Dallas–Fort Worth area in 2002. The TRWA made it possible for the SWAP team to meet its goal of having a protection strategy in place for the 55 percent of the population whose drinking water suppliers receive water from vulnerable sources. For more information about this and other projects in the Trinity Basin, see the section "Regional and Watershed Activities."

Water Quality Management Plan Program

During 2001, the TSSWCB continued to expand its Water Quality Management Plan (WQMP) Program, through which agricultural and silvicultural producers are assisted in meeting the state's water quality goals and standards.

During 2001, the TSSWCB certified 861 WQMPs, bringing the total number of active plans certified since the beginning of the program in 1993 to 5,130.

The central component of the program is the WQMP itself. A WQMP is a site-specific plan that includes schedules for implementing practices or technologies that address water quality considerations on an entire farm or ranch.

During 2001, the TSSWCB certified 861 WQMPs, bringing the total number of active plans certified since the beginning of the program in 1993 to 5,130.

The WQMP Program focuses extra effort on areas identified by the TSSWCB as priorities due to the existence or threat of NPS pollution. In these priority areas, the WQMP Program provides monetary assistance to the owners of agricultural or silvicultural property to pay part of the costs for the installation of BMPs.

Working through SWCDs across Texas, the program is also implementing WQMPs in conjunction with TMDL projects, and with local SWCD programs in numerous watersheds across every region of the state.

For more information on controlling water pollution by developing a WQMP, contact the TSSWCB or a local SWCD office, or visit the TSSWCB Web site (**www.tsswcb.state.tx.us/programs/wqmp.html**).

State Brush Control Program

Water is one of the most limiting natural resources in Texas. As a result, the state's ability to meet future water needs will significantly impact the growth and economic well-being of all its citizens.

Through the TSSWCB's State Brush Control Program, the state is able to increase water supplies, recharge groundwater aquifers, and enhance spring flow in many areas. The removal of brush can also positively affect water quality by reducing soil erosion and silt buildup in streams and rivers.

Brush control can increase water supplies and reduce soil erosion and silt buildup in streams and rivers.

The State Brush Control Program is a voluntary program in which landowners work with SWCDs to develop resource management plans addressing brush control, soil erosion, water quality, wildlife habitat, and other natural resource issues. Once a resource management plan is completed, landowners may apply for state funds to share the costs of carrying out the brush control described in the plan.

In 2001, the Texas Legislature, acting on the results of feasibility studies, appropriated $15 million for the implementation of brush control in the Upper Colorado River and Pedernales River watersheds. The Legislature also appropriated $7 million for continuing to share the costs of brush removal with landowners in the North Concho River Watershed.

By August 2001, over 130 resource management plans addressing brush and other concerns on over 475,000 acres of land had been completed. With the $7 million appropriated by the Legislature in 1999, contracts have been initiated to control brush on nearly 185,000 acres. To date,

brush has been successfully controlled on over 75,000 acres in the North Concho watershed.

Before a project can begin in a watershed, there must be a study to determine if it is economically feasible to increase water yield through brush control. Currently, feasibility studies are under way in the Lake Brownwood, Lake Palo Pinto, Lake Fort Phantom Hill, and Lake Arrowhead watersheds. To date, feasibility studies have been completed in nine watersheds. All of these studies have found that projects would be economically feasible for the state.

For more information about the State Brush Control Program, contact the TSSWCB or visit their Web site at **www.tsswcb.state.tx.us/programs/brush.html**.

On-Site Sewage Facilities Program

Staff members in the On-Site Sewage Facilities (OSSF) Program provide technical assistance to designers, installers, and local permitting authorities who use nonconventional OSSFs in selected basins in Texas. Plan reviews, initial site investigations, and follow-up investigations are conducted to ensure that designated controls are used and compliance with regulations is achieved.

In 2001, the OSSF rules were updated. The changes included general improvement; changes in maintenance company requirements, planning materials, and construction; permitting authority procedures; and the certification process. The new rules became effective on June 13, 2001. Workshops were conducted throughout the state to aid designers, installers, and authorities in the implementation of these new rules.

Beneficial Sludge and Biosolids Use Program

Under this program, sludge and biosolids are applied to agricultural lands to enrich the soil instead of being disposed as waste. An operator who wishes to install such a system must apply to the TNRCC for a permit to construct and operate the site. Because improper management of these systems may lead to water quality impacts, the TNRCC works to ensure the proper design, construction, and operation of facilities using beneficial sludge through on-site inspections. These inspections examine compliance with permit limits on rates and frequency of application at permitted sites. Currently, there are more than 400 registered facilities in Texas using sludge for agricultural purposes.

TNRCC surface water quality monitoring has identified problems with multiple water bodies in North Central and Southeast Texas that appear to be associated with runoff from sludge-use facilities. In order to address the these concerns, the TNRCC conducts site inspections to assess sludge-use sites in selected basins in the target areas. Initial assessments identify specific water bodies that require further attention, and initiate

activities necessary for the reduction of pathogens, organics, and metals contained in contaminated storm water from mismanaged sites.

New and existing sludge-use operations in these watersheds are systematically inspected for proper design, operation, and compliance with permit or registration limits. During 2001, all of the sites registered in the target area were investigated. Staff were also able to assist with investigations in two other regions of the state that were not included in the target area.

TNRCC staff from regional offices provided technical assistance to operators in the target areas to enable them to comply with regulations, with the result that fewer violations were documented during 2001 than in previous years. Sludge Program staff members shared their knowledge with regional investigators during the Field Operations Division's annual investigator training and during the EPA's Region 6 water quality training.

Water Quality Protection Zones Program

In 1995, the Texas Legislature passed a bill to amend the Texas Water Code, allowing developers to protect water quality from new urban development by requiring them to submit water pollution abatement plans for approval by the TNRCC. In 2001, that legislation was invalidated by a decision of the Texas Supreme Court and an opinion of the Texas Attorney General.

The Supreme Court's decision was rendered in the case of *FM Properties Operating Co. v. City of Austin*, 22 S.W. 3d 868 (Tex. 2000), which held that the pre-1999 version of Texas Water Code Section 26.179 is an unconstitutional delegation of legislative power to private landowners. Following a request by the TNRCC, the Texas Attorney General in Opinion No. JC-0402 (August 2, 2001) agreed with the Supreme Court's decision that the current version of the statute is unconstitutional. Accordingly, repeal of Chapter 216, Subchapter A, is under way.

Texas Wildscapes Program

Texas Wildscapes is a program of the TPWD. It was developed to get the people of Texas involved in restoring habitat lost to urban expansion across the state. Certification of an area as a Texas Wildscape recognizes the efforts of individuals and corporate citizens in providing habitat for wildlife. Principles of the Wildscapes program have been used in a number of other endeavors by urban biologists, including school habitats and outdoor classrooms.

As of 2001, the Private Lands Enhancement program had 14.7 million acres being managed under active, written wildlife management plans. There are currently 1,602 certified properties in the Texas Wildscapes program, representing more than 12,000 acres of land.

In a significant achievement this year, the program completed an agreement with the National Wildlife Federation to develop a new joint certification program that promotes greater use of native plants and requires other environmentally sound practices. This program

should be ready for introduction in the spring of 2002. There are currently 1,602 certified properties in the Texas Wildscapes program, representing more than 12,000 acres of land.

Private Lands Enhancement Program

Through this program, in effect since 1973, the TPWD provides technical assistance to people who wish to include wildlife management considerations in present or future land-use practices. Many of the practices that are used in wildlife habitat management reduce NPS impacts. On request, a biologist will schedule a personal meeting with the land manager and an inspection of the property. The land manager will be asked to define the various needs and uses of the property and to establish an objective for wildlife considerations. The biologist will provide recommendations that may include a written wildlife management plan. Field biologists work with landowners to develop management plans that use environmentally and economically sound land-use practices. Implementation of the plan is completely voluntary. As of 2001, Texas had 14.7 million acres being managed under active, written wildlife management plans.

Landowner Incentive Program

Formerly called the Private Lands Initiative, the Landowner Incentive Program provides funds to assist private landowners to manage their lands in ways that support wildlife habitat. Priority is given to projects that manage, conserve, and restore rare habitats and endangered and threatened species. Another factor considered is the potential to demonstrate the project results to other landowners, since landowner-to-landowner communication has been found to be one of the most effective conservation techniques available. Funds are awarded on a competitive basis as challenge grants, in which landowners share 25 to 90 percent of the cost of implementing habitat management practices. To date, the TPWD has awarded over $1,600,000 in cost-share funds through this program.

Protection and Restoration of Wetland Habitat

The TPWD is involved in wetland conservation throughout Texas using a variety of resources. Partnering with organizations such as the NRCS, the U.S. Fish and Wildlife Service, and Ducks Unlimited, the TPWD delivers technical and financial assistance to landowners throughout the state. In the past year, the TPWD has started a new program called the East Texas Wetland Program. It is similar to the Texas Prairie Wetlands Project, which has been in place over 10 years. These and other efforts work to restore thousands of acres of wetlands in Texas.

Recently, TPWD added more biologists to work directly with private landowners for improving wildlife habitat on their property. These biologists have a "toolbox" of programs to offer the landowners, many of which are related to wetland conservation. These private land programs share the costs of the project with the landowner. The TPWD biologists help the landowner design projects that are well engineered and easily managed.

Preventing Pollution with Conservation Practices

The Environmental Quality Incentives Program (EQIP) is administered by the NRCS. EQIP provides technical, educational, and financial assistance to agricultural producers to address resource concerns. The program works primarily in priority areas where significant natural resource problems exist. The TSSWCB and local SWCDs actively promote landowner participation in EQIP.

Management practices used by agricultural producers include grassed waterways, filter strips, manure management facilities, and integrated pest management.

In 2001, 14 priority areas were addressed where water quality was identified as the primary resource concern. This represents 383 EQIP plans and contracts with landowners on 129,322 acres. A conservation plan developed according to NRCS technical standards guides conservation efforts. EQIP offers producers 5- to 10-year contracts that provide incentive payments and cost sharing to implement the practices called for in EQIP plans. Typical practices include grassed waterways, filter strips, manure management facilities, and integrated pest management. Producers will receive $3.4 million dollars in cost-share and incentive payments to implement these plans.

Since the beginning of the program, landowners have thus far accomplished the following:

- protected 476,000 acres of cropland against excessive erosion,
- applied 41,000 acres of buffers between croplands and water bodies,
- managed nutrients on 606,000 acres,
- employed proper pest management practices on 961,000 acres, and
- planned and installed 408 waste management systems.

Preventing Pollution from Oil and Gas Operations

The Railroad Commission revised its well plugging rule (Statewide Rule 14) in November 2000 to enhance protection against water pollution from oil and gas wells. The revised rule contains additional requirements that must be satisfied before wells that are in violation can be placed into compliance. For instance, fluid levels must be measured on these wells to determine if they are at least 250 feet or more below the base of usable-quality water.

In addition, Statewide Rule 14 contains provisions requiring operators to file for a plugging bond for wells that have been inactive for 12 months or more and are being transferred from one operator to another. A plugging bond is required if the company does not already have a blanket or performance bond on file with the RRC. Those operators who are attempting to place their wells back into compliance after the wells have

been inactive for 36 months or more must also file for a plugging bond, or convert to a blanket or performance bond.

Senate Bill 310, passed in 2001 by the 77th Legislature, provides in part for:

- Increased funding and an increase in certain fees deposited into the Oil Field Cleanup Fund.The cap on the fund has been raised from $10 million to $20 million so that additional wells can be plugged and more sites cleaned up.
- Verification that the cement plug placed across the base of usable water to protect against contamination of the aquifer is properly placed.The cement plug is tagged to verify the proper placement of the plug.
- Development of a program to check fluid levels in wells that have been abandoned and are considered orphan wells because no responsible party can be identified.
- Creation of an Oil Field Cleanup Advisory Committee to oversee the fund and its activities.

Preventing NPS Pollution in Highway Construction and Maintenance

TxDOT is responsible for highway, road, and bridge construction. TxDOT's approach to addressing NPS pollution is to limit land disturbance such as clearing, grading, and cut and fill to reduce erosion and sediment loss. BMPs for highway design are developed and implemented to achieve this goal.TxDOT's design and planning process for all projects incorporates practices that will limit disturbance of natural drainage features and vegetation, especially in areas that are particularly susceptible to erosion or sediment loss.

TxDOT evaluates the location, design, and maintenance of bridge projects to ensure that sensitive aquatic ecosystems and areas providing important water quality benefits are protected from adverse effects. Pollution prevention procedures are incorporated into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters. Runoff management systems are developed and implemented for roads, highways, and bridges to reduce pollutant concentrations and volumes entering surface waters.

TxDOT limits disturbance of natural drainage features and vegetation when constructing and maintaining roadways.

Opportunities are identified to improve existing urban runoff control structures in priority watersheds. TxDOT and the TNRCC have entered into an agreement to assess water quality impacts resulting from transportation projects.

TxDOT has also established a permitting program that notifies utility companies conducting construction activities within a TxDOT right-of-way that they must comply with state and federal stormwater regulations.

Regional and Watershed Activities

Coastal Programs

Coastal NPS Pollution Control Program

The Texas Coastal Management Program was approved by the National Oceanic and Atmospheric Administration (NOAA) on January 10, 1997. The Texas Coastal Management Program is administered by the Texas Coastal Coordination Council and staff of the GLO.

Subsequently, the Texas Coastal Nonpoint Source Pollution Control Program (GLO, 1998) was submitted in December 1998 by the Coastal Coordination Council. A 15-year strategy and a five-year implementation plan support implementation of the coastal NPS program. The TNRCC and the TSSWCB are the primary agencies that are implementing NPS control practices. Other cooperating agencies include the GLO, the TPWD, TxDOT, and the RRC. The Coastal NPS Program will also coordinate with numerous other programs, such as the Galveston Bay Estuary Program and the Coastal Bend Bays and Estuaries Program, to ensure wide participation and input.

In October 2001, NOAA and the EPA issued draft final findings on the Texas Coastal NPS Program. The program was approved subject to conditions on six management measures. Texas has two years to improve certain NPS management program facets in order to obtain full approval of the program.

Texas proposes to implement its Coastal NPS Pollution Control Program through a group of networked programs. Key water quality activities such as monitoring, assessment, data management, permitting, and reporting are coordinated on a basin-wide scale. Several existing programs are used to address NPS pollution in coastal areas. Together, these programs have pollution control measures that are equal to or more stringent than the measures described in federal legislation for coastal management.

Federal Grant Program for the Coastal Zone

Section 309 of the Coastal Zone Management Act, as amended in 1990, created a grant program that encouraged states to propose Coastal Management Program changes in nine potential enhancement areas.

Texas' second assessment under the grant program was submitted to NOAA in February 2001. Development of this assessment and its associated strategies was based on the input of a work group created by the Coastal Coordination Council in August 2000, and was coordinated closely with the Council's strategic plan currently under development. In August 2001, NOAA approved Texas' 2001 Section 309 Strategies and

Assessment document, and agreed with the state's designated priority levels for the nine enhancement areas.

For more information about the strategies, assessment, and the Coastal Management Plan, call 1-800-998-4GLO, or visit the GLO Web site, **www.glo.state.tx.us**.

Beach Watch Project

In August 1998, the GLO first launched a comprehensive program to sample the water at some of the state's most visited beaches along the Gulf of Mexico. The program, called Texas Beach Watch, tests for the presence of bacteria that indicate the presence of disease-causing organisms. In doing so, Beach Watch will establish baseline data on the health of Gulf waters.

The purpose of the program is to protect the health and safety of the hundreds of thousands of people who visit state beaches each year. Beach protection will become even more important over time, since continued growth of population and development is projected for the Texas coast.

Texas has several programs designed to monitor and protect coastal waters.

In 2001, the program monitored 14 beaches in six Texas counties: Galveston, Nueces, Cameron, Jefferson, Brazoria, and Matagorda. Funded by the Coastal Management Program through the GLO, the locally-controlled program involves county and city governments, universities, and organizations representing beachgoers. Recipients of GLO contracts agree to test specified sites for Enterococcus bacteria and to issue public advisories if water samples exceed criteria. If elevated bacteria levels are detected, an additional sample is taken to verify the levels before an advisory is issued.

This program is being conducted by coastal communities, with operating procedures, manuals, and federal grant money provided by the GLO, training supplied by the TNRCC, and expertise provided by the TDH. Training sessions organized by the TNRCC and attended by the GLO and representatives of the local programs were held in Galveston and in Corpus Christi in November 2000.

Adopt-A-Beach Program

The GLO's Adopt-A-Beach program was initiated in the fall of 1986. Since then, more than 265,000 volunteers have removed over 4,900 tons of trash from Texas beaches.

The Texas Adopt-A-Beach program is an all-volunteer effort to remove trash from Texas beaches and to increase public awareness of the prob-

lems of marine debris and beach litter. Twice each year, volunteers check in at sites all along the Texas coast to pick up trash.

At the 2001 spring cleanup, 7,679 volunteers picked up almost 143 tons of trash from 190 miles of Texas beaches. In the fall, a record 11,291 volunteers removed 161 tons of trash from 192 miles.

The Adopt-A-Beach program also played an integral part in the passage of MARPOL Annex V, an international treaty that prohibits the dumping of plastics in the world's oceans. In July 1991, the International Maritime Organization designated the Gulf of Mexico and the Wider Caribbean as a "special area" where the dumping of trash, with the exception of finely ground food scraps, is prohibited.

While the Adopt-A-Beach program is primarily funded by the Texas GLO, a key factor in the success of the program is support from the private sector. Generous contributions have helped carry the message "Don't mess with Texas beaches" to thousands of Texans. Businesses associate their names with a successful and worthy cause by providing Adopt-A-Beach trash bags, gloves, coloring books, T-shirts, caps, and souvenirs.

Clean Marina Program

In June 2001, Texas completed development of a Clean Marina Program. This project, funded by a federal Coastal NPS Program grant (Section 6217), developed a Clean Marina guidebook and checklist this year. The program is designed to encourage marinas, boatyards, and boaters to use simple, innovative solutions to keep Texas coastal and inland waterway resources clean.

The program works to prevent pollution by making marinas, boatyards, and boaters more aware of environmental laws, rules, and jurisdictions. Marinas that work with the program are recognized as Clean Marinas—a designation that raises public awareness and lets boaters know that the marina adheres to or exceeds certain environmental guidelines. The guidelines were developed through examination of BMPs followed by marina operators around the country.

In 2002, the Coastal NPS Program will fund a second phase of the program. Marinas throughout the state will be eligible to participate. Texas Sea Grant at Texas A&M University is coordinating the statewide program. Further information may be found at the Clean Marina Web site, **www.cleanmarinas.org**.

Coastal Bend Bays and Estuaries Program

The Coastal Bend Bays and Estuaries Program (CBBEP) has been working with the City of Corpus Christi and the University Outreach program of Texas A&M University–Corpus Christi to spread the word about NPS pollution prevention. Two public service announcements were devel-

oped in partnership with the City of Corpus Christi and will be aired on local stations this year.

University Outreach spearheaded the CBBEP's public education efforts in 2001, implementing a variety of practices aimed at NPS management in the Coastal Bend area. Activities focused on providing training and technical assistance for communities that will be required to comply with new federal regulations governing stormwater runoff, training for teachers of environmental science, and general events to promote public awareness. The Partnership for Environmental Safety and Outreach Web site (**www.tamucc.edu/~outreach/peso**) added a stormwater component that includes a multitude of useful information.

Stormwater Management

Stormwater permits regulate discharges of stormwater from industrial and construction activities and also from municipal separate storm sewer systems. New stormwater regulations affecting cities were recently passed. Communities that must implement the new requirements will then be classified as point rather than nonpoint sources of pollution from stormwater, according to EPA guidelines.

A great deal of planning and data gathering was accomplished in the Coastal Bend region to support implementation of the new stormwater regulations. Information was collected on pollutant sources and their locations, and contact lists were developed for reaching the responsible parties.

University Outreach and CBBEP staff developed a promotion strategy for fulfilling the stormwater requirements. A variety of recommended practices, regulations, regulatory guides, videos, and Web addresses were collected, reviewed, and sorted for use in supporting implementation.

A Resource Guide for system administrators—such as mayors, city managers, and public works supervisors—was developed and distributed at briefings and site visits. Presentations were made to several cities and groups, and the CBBEP provided technical assistance to the cities of Aransas Pass and San Patricio. Presentations were made to the Coastal Bend Council of Government and the Regional Leaders Forum to promote widespread participation in the effort.

The project team also made site visits to all of the communities that may fall under the new stormwater management practices. At these visits, the new rules were reviewed in depth to help cities understand what will be required and how to get started. Workshops were also given to assist area businesses in understanding how the regulations apply to them.

Other important accomplishments in 2001 included development of a strategy for reducing spills in Conn Brown Harbor in Aransas Pass, and a consensus-based solution for bilge pumpouts in area harbors.

Education and Special Events

Two teacher workshops on wetlands protection and other water quality topics were conducted in Rockport and Beeville. A total of 25 teachers from the region participated. They received training, curricula, and supplies and equipment to use with their students in the field. Twenty-eight teachers took TES courses, to which a stormwater component was added this year.

The program also conducted field trips with teachers and high school students from four area schools. All of these programs emphasized an appreciation of our coastal environment and pollution impacts through activities like kayak trips into bays, marshes, and wetlands and trips aboard the University of Texas Marine Science Institute's "Katy" research vessel.

Special events like Corpus Christi's Bayfest and Earth Day–Bay Day were used to promote public awareness. Over 700 people participated in Bayfest. CBBEP also worked with statewide programs like Adopt-A-Beach and Adopt-A-Wetland, sponsoring local events and workshops.

For more information about the CBBEP and its programs, visit their Web site at **http://tarpon.tamucc.edu/**.

Galveston Bay Estuary Program

In 2001, the Galveston Bay Estuary Program (GBEP) focused a number of efforts on supporting implementation of new rules for controlling stormwater from cities. In August, the Stormwater Management and Implementation Plan for the City of Pearland was completed. The model plan serves as an example for other cities in implementing new stormwater control requirements. The Stormwater Circuit Rider program, which was initiated in Fall 2001, provides information to municipalities on developing and implementing stormwater management plans and related ordinances, and on determining appropriate funding options.

Five workshops were conducted, including topics such as reducing NPS pollution through the use of appropriate plants and gardening practices, complying with new federal requirements for managing stormwater from cities, local NPS problems and priorities, and general NPS education. Technical assistance was provided to several communities through six workshops and conferences.

The Galveston County Health District continues to work with local municipalities by identifying and eliminating illicit discharges to stormwater systems in the Clear Creek watershed, for which there are water quality concerns.

Two assessments were completed. *Ebb and Flow* is an analysis of the status and trends of various parameters in the Galveston Bay ecosystem. A Galveston Bay Lower Watershed NPS inventory was completed in August 2001.

More information about the Galveston Bay Estuaries Program is available on their Web site (**http://gbep.tamug.tamu.edu**).

Protecting Forests in East Texas

The Texas Silvicultural NPS Pollution Project has had a tremendous impact on water quality in the forested region of East Texas. Through this project of the TFS and the TSSWCB, the forestry community has been able to prevent an estimated 13,000 tons of sediment from reaching streams every year by using forestry BMPs.

In a groundbreaking development, this project also led to the creation of the first ever WQMP for forestry operations. By enrolling landowners in WQMPs, project staff are able to increase the implementation of BMPs. Staff also monitor randomly chosen forestry sites for BMP compliance. Compliance monitoring during the last year showed that the forestry community was operating at its highest level of compliance since monitoring began in 1992.

Education has been vital to the success of this project. Staff members made numerous presentations to civic organizations, forestry students at Stephen F. Austin State University and Panola College, and participants in the Teachers Conservation Institute. Thousands of other individuals viewed a BMP display and model of a streamside management zone at various locations throughout East Texas, such as banks, state and county fairs, and businesses. The Silviculture NPS Project also launched an aggressive advertising campaign to educate the general public, targeting over a million people through the use of billboards and radio and television spots.

Billboards were part of a multimedia advertising campaign to educate the public about forestry management practices.

Providing technical assistance to landowners, foresters, and loggers is a major component of the project. A total of 2,500 people have been trained in the use of BMPs at 100 workshops. This class is so well received that 97 percent of the participants indicated they would recommend it to others. Workshop evaluations also show a 71 percent increase in understanding of BMPs and water quality by participants. Specialized workshops for site preparation and road building contractors are being developed.

The project is also very involved in developing and supporting county landowner associations. Participating in these groups allows landowners to learn more about their forested property and the forestry profession in general. Project staff have coordinated several tours for the Metroplex Timber and Forestry Association (absentee East Texas landowners living in the Dallas–Fort Worth area), as well as meetings for many other land-

owner associations. Topics covered during the tours include BMPs, reforestation, and wildlife management.

For more information on the programs of the Texas Forest Service, visit their Web site at **http://txforestservice.tamu.edu/**.

Edwards Aquifer Protection Program

The Edwards Aquifer Protection Program (EAPP) of the TNRCC has stepped up enforcement activities to ensure better compliance with stormwater mitigation requirements. The program has sent more notices of violation to owners of NPS control structures and has referred more cases for enforcement action. These actions have been taken against sites under construction, as well as those that are not providing adequate maintenance of their permanent BMPs.

EAPP staff also investigated more construction sites to make sure they were maintaining temporary controls to prevent discharge of contaminated stormwater runoff. In addition to ensuring better maintenance of these controls, staff has been able to evaluate the adequacy of the temporary controls prior to installation and during construction.

EAPP staff implemented a compliance project in 2001 to ensure that all the sewage collection lines constructed over the Edwards Aquifer recharge zone are being tested. Staff also completed a project that will be implemented in 2002 in conjunction with the Bureau of Economic Geology. The project will improve the effectiveness of the geologic assessment of sensitive features in the Edwards Aquifer recharge zone. Identifying and quantitatively describing karst features in the limestone (sinks, underground streams, and caverns) will enable staff to better protect these features from contaminated runoff.

Southeast Texas

The Houston–Galveston Area Council (H–GAC) is the CRP partner agency for the San Jacinto River Basin, and the Trinity–San Jacinto and San Jacinto–Brazos Coastal Basins. The H–GAC has been engaged in several public education activities aimed at addressing NPS pollution in the region.

Twenty-six communities in the region have been identified as having problems attributable to failing or inadequate on-site sewage systems. In these areas, soil and groundwater conditions can make conventional septic systems problematic. To address the issue, the H–GAC distributed thousands of fact sheets pertaining to proper septic tank system maintenance to community residents and regional health departments. Five public meetings were held in the target communities to educate residents about proper septic system maintenance. Information was also

provided on new technologies, such as constructed wetlands, that are effective in areas where soils are not suitable for conventional systems.

The H–GAC also developed a reference manual on low impact development for the TCE. The manual is distributed to property owners and developers in the region.

Supporting materials for educational activities were developed, including the purchase of two Enviroscape NPS pollution models. These three-dimensional models allow students to simulate the effects of rainfall runoff over various land-use activities. The Watershed Puzzle, at a size of about four square feet, graphically depicts the watersheds of the H–GAC's 13-county service area. An individual piece represents each of the watersheds in the region. Children and adults alike enjoy putting the puzzle together. It has been very useful in starting dialogues about watershed management. A series of maps and brochures highlight basic watershed information, water quality concerns, and watershed management issues. More information about the H–GAC's public education materials and activities is available on their Web site at **www.hgac.cog.tx.us**. Once there, follow the "Water Quality" link at the lower left of the page.

Reducing NPS Impacts from Septic Systems

The Southeast Texas Constructed Wetlands project area encompasses parts of five river basins targeted by the TNRCC for restoration activities—the Angelina, Neches, Sabine, Brazos, and Trinity. NPS in all of these basins includes nutrients and bacteria from improperly designed and malfunctioning OSSFs.

There are several factors contributing to this problem. Over 90 percent of the OSSF treatment in the area involves septic tank filter fields, even though evidence indicates that because of high clay content and saturated soils, only 20 percent of the soils are suited for this method. For problem soil areas, the traditional method involves aerobic treatment of sewage—a biological process in which microbes eat the waste and their bodies transform it into nonpolluting material. The treated wastewater is then sprayed on lawns. This system, although effective, can be expensive to the average homeowner. Many of the problem areas are in rural subdivisions where the average homeowner has a low to moderate income. These homeowners would normally not convert to the expense of an aerobic/spray system unless a complaint has been filed and they are found to be in violation and subject to a fine.

Construction of a lined, single-cell wetland at one of the project sites.

Constructed wetlands offer a more cost-effective treatment for domestic wastewater, with acceptable results. This project is installing individually

designed and engineered constructed wetlands at 30 problem sites in East Texas. This is expected both to improve local water quality and to encourage other homeowners to adopt constructed wetlands as a treatment method. It will also build on previous successful NPS grant projects to document treatment effectiveness and increase support for constructed wetlands as an alternative treatment method. Southeast Texas Resource Conservation and Development (RC&D) and Pineywoods RC&D will supervise this portion of the project under the direction of the Texas Agricultural Experiment Station at Texas A&M University.

In 2001, nine wetlands were designed and installed in the Pineywoods RC&D district. In the Southeast Texas RC&D district, eight sites have been installed and the necessary permits have been obtained for two more.

Design criteria for the wetlands were developed and approved. Project staff participated in a symposium to provide training and information for installers and homeowners about the merits and operations of constructed wetlands.

Brazos River Basin

The Brazos River basin spans 42,000 square miles, is about 640 miles long, and contains five major watersheds. In the upper end of the Brazos Basin, salinity is a concern. Agricultural sources of bacteria and nutrients are the focus in the middle portion of the basin where dairies and other agricultural producers are predominant. Metals are of concern in the lower basin. The Brazos River Authority (BRA) is the CRP partner agency for the basin. Visit their Web site at **www.brazos.org**.

Special Studies and TMDLs

Salts in the Upper Brazos Basin

Analysis by the BRA shows that the upper basin, while contributing only 14 to 18 percent of the flow of the Brazos, contributes 45 to 55 percent of the total dissolved minerals in the basin, and 75 to 85 percent of the dissolved salts, due to high concentration of natural salts in the watershed. The BRA is working with local stakeholders to research possible solutions to this natural, nonpoint source of salts. Possible solutions being researched and tested include diversion dams, impoundment dams, evaporation basins, and deep well injection systems.

Middle Brazos Reconnaissance Study

The BRA is seeking participation from private landowners in the middle part of the basin to test the regional performance of environmental management practices to reduce NPS pollution. Several practices, such as wetlands creation, reforestation, and conservation easements have been identified for use in reducing water quality problems in the region. Preliminary recommendations show that 379 acres may be available for the addition of a riparian corridor and the removal of undesirable vegetation. Nineteen

sites are suitable for wetlands covering at least 120 acres. Five sites are under consideration for low-water dams, and more than 120,000 linear feet of fencing is recommended for conservation easements.

Aquilla Reservoir TMDL

A TMDL for atrazine in the Aquilla Reservoir (Segment 1254) was adopted by the TSSWCB and the TNRCC in March 2001. Aquilla Reservoir is a 3,300 acre impoundment that drains approximately 255 square miles in Hill and Johnson Counties. The reservoir is the source of drinking water for approximately 27,000 people. Monitoring the quality of the drinking water supplied from the reservoir indicated that atrazine levels exceeded the maximum contaminant level specified for safe drinking water in 1997. This level is based on the running annual average concentration of the herbicide in treated drinking water. The TNRCC listed Aquilla Reservoir on the 1998 303(d) List as not supporting its use as a public water supply.

Atrazine is an inexpensive, effective herbicide for a number of broadleaf weeds that impact corn and grain sorghum production. All atrazine loadings originate from nonpoint sources associated with human activities. There are no natural background sources and no point source discharges. The TMDL identified roughly 63,600 acres of corn and grain sorghum production in the watershed draining into the Aquilla Reservoir. The application of weed products to urban lawns also occurs periodically, but their use is a minor source of atrazine in this watershed. The TMDL states that a load reduction of approximately 25 percent will result in attainment of the water quality standards.

An implementation plan for the Aquilla Reservoir has been drafted. The plan identifies voluntary BMPs to be implemented in the watershed, as well as certain regulatory steps to be taken in the event that the voluntary measures are not successful. The Implementation Plan is scheduled to be approved by both the TSSWCB and the TNRCC during 2002.

For more information about this and other TMDLs, see the TNRCC's Web site, **www.tnrcc.state.tx.us/water/quality/tmdl/**.

North Bosque River TMDL

The North Bosque and Upper North Bosque River (Segments 1226 and1255) were listed on the 1998 303(d) List for excessive nutrients. Based on extensive data assessment and modeling of the effects of management practices, the TNRCC prepared a TMDL to address elevated nutrient levels in the two segments.

The goal of the TMDL is to achieve a reduction of approximately 50 percent in the annual average soluble phosphorus (the limiting nutrient) concentration, as observed at specific index sites along the North Bosque River. Both point and nonpoint sources are expected to make significant reductions to achieve the goal.

Although this TMDL only addresses elevated phosphorus levels, it is expected that the project will also reduce bacteria and chlorophyll a levels. The TNRCC presented an outline of the proposed TMDL allocation to the Bosque River Advisory Committee in August 2000. The draft TMDL was released for public comment in September 2000. The final TMDL was adopted by the TNRCC and the TSSWCB in February 2001, and submitted to the EPA for final review and approval.

Development of a draft implementation plan for the North Bosque River TMDLs began in 2001. For more information about this and other TMDLs, see the TNRCC's Web site, **www.tnrcc.state.tx.us/water/quality/tmdl/**.

Watershed Protection Program

The BRA has addressed several significant water quality issues through its Watershed Protection Program. Through it, they have identified perchlorates in groundwater and surface water, supported land conservation and habitat restoration, educated the public about BMPs for atrazine, and evaluated animal waste management practices to reduce nutrient concentrations.

Bosque and Leon Rivers NPS Project

In September 2000, the TSSWCB and the TNRCC initiated an innovative solution to the problem of elevated phosphorus levels in the North Bosque and Leon River watersheds. This ambitious project involves transporting manure from the affected watersheds to composting facilities within the watershed, where it is turned from waste into a beneficial product. From there, the composted manure can be hauled to other watersheds to be used beneficially as a soil amendment.

TxDOT uses the compost throughout the state to promote roadside vegetation. Better roadside vegetation aids in the prevention of NPS pollution from highway runoff—another benefit from the project. Other state and local government markets for use of the composted manure are being explored and developed. The CRP monitors water quality in the watershed to determine impacts from dairies and to verify that improvements in manure management result in improved water quality.

Other project management and implementation partners include the Texas Institute for Applied Environmental Research and the Foundation for Organic Resource Management. Partial funding for the project is provided by federal nonpoint source grants from the EPA.

Removing the Manure

The TSSWCB's portion of the project, the Dairy Manure Export Support (DMES) project, handles the first part of the process—removing the manure.

The DMES project provides incentives to support the export of surplus manure from dairy farms in portions of the North Bosque and Leon River watersheds to compost facilities.

The export of the manure and the nutrients contained in it will help address concerns in the region about NPS impacts associated with land application of manure. The project will also aid in achieving the nutrient load reduction established in the North Bosque TMDL.

The initial amount of manure targeted for export from dairy farms in the area was 300,000 tons during the 36-month project period. Hauling dairy manure under the DMES project has proceeded at a much faster rate than originally anticipated. As of August 31, 2001, about 400,000 tons of manure had been hauled under this project—over 150 percent of the original target amount for the three-year period in only nine months, at an average support cost of about $3 per ton. These incredible results are testament to the popularity of the program with the dairy industry in the project area.

Surplus manure is removed from farms and converted to compost.

In response to the program's popularity and successes to date, Texas will be providing additional funding to the program during the project's remaining two years. Additional efforts are under way to identify and secure even more funds to assist with the export of surplus manure generated by dairies located in the project area.

Building Markets and Support

Efforts are also under way to ensure that markets are in place to support the continued export of manure from the Bosque and Leon River watersheds after the end of the project. The TNRCC is working to promote awareness of composted manure as a soil amendment, and to stimulate markets among government agencies.

As of October 2001, over 11,148 cubic yards of composted manure had been produced and sold since the beginning of the project. To encourage other agencies to use the composted manure, NPS staff developed an application for state agencies to document and claim rebates for their purchases.

In November 2000, both the TNRCC and the TSSWCB hosted an orientation meeting in Stephenville to introduce the project's goals to local dairy operators, haulers, and potential compost operators to get their input on the project design. Because of the high stakeholder interest in this innovative project, TNRCC staff have participated in press conferences, made project presentations at two national NPS conferences, and responded to requests for information from both the media and the state legislature.

During 2001, TNRCC staff conducted 19 training and demonstration events around the state for government organizations and landscape professionals. These events provided information on the use of compost

for establishment of vegetation cover and erosion control. Over 800 people were reached in this way.

TxDOT is spreading the word about the benefits of using compost in highway projects. At several workshops for highway construction and maintenance staff, TxDOT presented the why's and how-to's of compost use. The February 2001 issue of *BioCycle* magazine included an article on the project, which resulted in increased public interest. The word has spread beyond Texas. During 2001, TxDOT and the TNRCC visited the Tennessee Department of Transportation and discussed how that state can expand its use of composted manure. TxDOT has also been working with the Texas Recycling Market Development Board to promote the use of compost or compost-derived products by other state agencies.

Making the Compost

The TNRCC is ensuring that manure at the composting facilities is properly processed and contained, and that it does not exacerbate existing water quality problems.

During the early stages of the project, the TNRCC NPS Program developed guidance, site criteria, and reporting forms for participating compost operators. Six composting facilities were approved under provisional guidelines and began receiving shipments of manure from local dairies. TNRCC staff provided technical assistance on compost production techniques to interested operators.

In addition to technical assistance, the TNRCC is also making sure that the compost meets quality assurance requirements. During 2001, TNRCC staff performed site visits at each compost facility to ensure the product meets TxDOT and other appropriate specifications. The TNRCC is also checking to ensure that stormwater controls, like lagoons and berms, are properly maintained and that other necessary procedures are followed.

Permit for Compost Facilities

All existing and proposed compost facilities must receive approval to operate under a permit. In addition to the site guidelines established under the grant, TNRCC staff drafted a permit that addresses disposal of wastewater from livestock manure compost operations statewide. This action was initiated to address stakeholder concerns that composting activities might adversely impact surface and ground waters in ways similar to large dairy operations.

Under the proposed permit, no discharges of waste into surface waters are allowed. Each compost facility seeking to participate in this project is required to submit a design, certified by an engineer, for retaining all stormwater on the site and, if needed, for disposal of wastewater through irrigation. The TNRCC conducted two public meetings to solicit public comment on the permit. Review and response to public comment was still underway at the time this report was written.

Using the Compost to Prevent NPS Pollution

TxDOT is expected to be the largest governmental purchaser of compost over the next few years. TxDOT has already used over 10,700 cubic yards of manure compost from the Bosque and Leon River watersheds. This use is expected to increase dramatically as the project progresses.

The composted manure is used beneficially as a soil amendment in highway construction and maintenance.

TxDOT has also identified projects among its participating districts that will use in excess of 149,000 cubic yards—more than half of its commitment for the three-year project. TxDOT has been using compost for both construction and maintenance activities.

TxDOT has developed new specifications and revised others to increase compost use among its districts. These cover proper application and use of compost for erosion and sedimentation control. Copies of these specifications can be found on the TxDOT Web site, **www.dot.state.tx.us/insdtdot/orgchart/des/landscape/compost/specifications.htm**.

Monitoring for Success

The TNRCC and the BRA are developing a water quality monitoring strategy for the North Bosque and Leon watersheds to measure water quality improvements attributable to the removal and composting of manure. During 2001, the TNRCC met with the BRA and other monitoring partners to begin designing a monitoring plan. Field monitoring will get under way during 2002.

Assistance to Dairy Producers and Landowners in the North Bosque and Leon River Watersheds

During fiscal year 2001, the TSSWCB initiated work with the Cross Timbers SWCD and the Upper Leon SWCD on an ambitious project designed to reduce NPS-related nutrient losses from agricultural operations that apply animal waste to land in the North Bosque and Leon River watersheds.

It is widely accepted that the application of animal manure and wastewater associated with the everyday operation of a dairy facility provides a good source of nitrogen and phosphorus, both of which are essential nutrients for the production of all agricultural crops. The continual use of this practice without proper management can, however, lead to the accumulation of soil phosphorus within the application fields.

There are approximately 150 dairy operations in the North Bosque River and Leon River watersheds. Nearly all of these dairies use all or a portion of the manure and wastewater they generate as a beneficial supplement

for on-site crops. In the past, the remainder of the manure and wastewater was applied for the same purpose on the land of third parties. More recently, as a result of the Bosque and Leon Rivers NPS Project, a significant portion of dairy manure generated in this watershed is being composted and sold outside the watershed.

These related projects target existing manure application fields within the watershed for several resource management actions. One action is the implementation of BMPs such as the adjustment of application rates and the construction of filter strips. Another activity involves remediation techniques, such as deep plowing and heavy cropping, in an effort to reduce the amount of phosphorus that may be migrating from the soil to surface waters during storm events.

During these projects, technicians from the Cross Timbers and Upper Leon SWCDs will work with landowners to develop new WQMPs for manure and wastewater application fields. In addition, the technicians will update existing WQMPs to make them consistent with the forthcoming TMDL implementation plan requirements and the current standards in the USDA-Natural Resources Conservation Service Field Office Technical Guide. Approximately 200 WQMPs will be developed or updated over the course of the projects. SWCD technicians will work closely with the TSSWCB regional office in Dublin, Texas. Technical assistance provided by local SWCDs allows for greater local support to landowners in the implementation of BMPs.

The TSSWCB has arranged for monitoring of the watersheds to determine the reduction of NPS pollution and to provide data that will inform micro-watershed producer councils of their contribution to NPS pollution. The producer councils will be made up of project participants within each micro-watershed.

The data obtained from the micro-watershed monitoring will establish a baseline nutrient concentration within the smaller streams and tributaries that contribute flow to the 303(d)-listed water bodies within the watershed. As BMP implementation progresses, the micro-watershed monitoring approach will more effectively measure the success of the BMPs. An edge-of-field monitoring demonstration will be carried out so that each producer council will be able to realize the impact of NPS nutrient losses from their manure and wastewater application fields.

Monitoring on a micro-watershed level will allow for more meaningful data concerning the actual NPS pollution that producers may be contributing to the watershed. It will eliminate much of the cumulative agricultural loading from upstream tributaries, urban NPS pollution, and treatment plant effluent that has influenced monitoring efforts in the past.

Canadian and Red River Basins

The Red River Authority (RRA) is the CRP agency for both the Canadian and Red Rivers. The Canadian River Municipal Water Authority (CRMWA) works with the RRA to implement the program in the Canadian Basin. The RRA emphasizes public participation and education for the people of the two basins. Public participation provides for effective watershed planning and management by ensuring that local concerns are addressed and that citizens are well represented. Public participation has led to a broader awareness of water quality conditions, and has allowed the RRA to benefit from the knowledge and expertise of many stakeholders, working together with other agencies and the public to correct identified problems.

Educational programs for kindergarten to high school students are available for public and private schools. The Texas Rivers Project operates a volunteer monitoring program for high school students. Internships with other resource agencies are available at the college level. Presentations on multiple water resource subjects are available for groups. The RRA maintains a Web site with information about water quality in the Red River (**www.rra.dst.tx.us**); and the CRMWA maintains a site for the Canadian River Basin (**www.crmwa.com**).

Lake Meredith Salinity Control Project

High concentrations of salt in the upper reaches of the Canadian River are still a concern due to their effect on Lake Meredith, which is a source of drinking water. The Lake Meredith Salinity Control Project continues to be one of the most important pollution control programs in the basin. The project has determined that a major contributor of saline water to the river system is a shallow brine aquifer under artesian pressure. Approximately 70 percent of the chlorides in Lake Meredith originate from this brine aquifer downstream of the Ute Dam near Logan, New Mexico.

Disposing of the saltwater presents the major problem and expense. Deep-well injection of the highly saline water was determined to be the most effective solution. Construction on the injection well, production wells, injection facilities, pipeline collection system, and all other features was completed in 2001.

Lake Meredith water quality should be improved if the contribution of saline water from the brine aquifer is stopped. However, because salt is stored in the river channel sand, it may be some time before the full benefits of the project can be realized.

Red River Chloride Control Project

One of the primary goals within the Red River Basin is the completion of the Red River Chloride Project. This federal project, under the direction of the U.S. Army Corps of Engineers (Corps), has been going on since the 1950s. By reducing naturally occurring chlorides, the project will increase

the quality and quantity of potable water in the basin, while reducing the high cost of treating drinking water from saline source waters.

The Corps is currently preparing an evaluation of the overall effectiveness of the implemented control features and the environmental impact of reducing chloride levels in the watershed. The studies completed by the Corps so far indicate a benefit-to-cost ratio of more than 2:1. When completed, about 65 percent of the brines from the natural source areas will be prevented from entering the Red River and its tributaries.

Colorado River Basin

The Lower Colorado River Authority (LCRA), the Upper Colorado River Authority (UCRA), and the Colorado River Municipal Water District (CRMWD) all work together to coordinate the Clean Rivers Program in this large basin. Visit the Web site for the LCRA at **www.lcra.org/lands/wrp/**, for the UCRA at **www.ucra-tx.org**, or for the CRMWD at **www.crmwd.org**.

Communicating water quality issues to the public continues to be paramount for Colorado Basin CRP partners. Educational activities in 2001 included speaking at a teacher workshop, training volunteers to monitor water conditions, holding public and steering committee meetings, sponsoring water quality workshops, coordinating the event "A Day in the Life of the Colorado River," and participating in a statewide monitoring event.

E. V. Spence Reservoir TMDL

The E.V. Spence Reservoir drainage basin has been plagued with excessive loads of chloride and total dissolved solids for several years. Through several internal assessments such as the Spence TMDL, and other assessments by the UCRA, the LCRA, and the CRMWD, the TNRCC determined that the loadings are the result of both natural and man-made NPS pollution from numerous locations throughout the basin.

Railroad Commission personnel inspect a leaking oil well in Howard County.

The causes of naturally occurring pollution in the E.V. Spence Reservoir include natural saltwater seeps, evaporation, surface water traveling across mineral beds and salt flats, the dissolution of natural underground mineral deposits, and the concentration effects of plant life. Man-made pollutants include past oilfield management practices used prior to regulation that contributed to situations such as leaking oil well casings, improper brine disposal, and the over-pressurization of downhole formations. In addition, farming practices and manufacturing in the area have contributed to increased loadings.

The TMDL report for E.V. Spence Reservoir summarizes two TMDLs for total dissolved solids and sulfate. These TMDLs

were released for public comment, adopted by the commission, and submitted to the EPA for approval in 2001.

The implementation plan for the Spence TMDLs was also developed and approved by the TNRCC in 2001. The implementation plan includes a description of the control actions and management measures necessary to achieve the pollutant reductions identified in the TMDL, along with a schedule for implementing those strategies. Brush control was recommended as one implementation strategy; the TSSWCB will be considering funding for that in fiscal year 2002. Other strategies already in use include salt diversion and minimization (see following).

Railroad Commission's Salt Minimization Project

To support TMDL implementation, the TNRCC and the RRC are collaborating to fund plugging of oil and gas wells in order to reduce salinity in the E.V. Spence Reservoir watershed (RRC Salt Minimization Project). Together, the agencies have committed $2.6 million to plug approximately 171 wells in the watershed through 2002, enhancing the RRC's current oilfield cleanup program in the area. Partial funding for the project comes from federal nonpoint source grants.

A contractor pumps a cement plug into an unplugged oil well in Mitchell County.

First, the RRC is working to properly plug wells that are leaking or that pose a threat of pollution in the Upper Colorado River Drainage Basin. The RRC is also engaged in the preventive plugging of wells that penetrate the highly pressurized and highly saline Coleman Junction Formation, using BMPs defined under current regulations.

In addition, saline seeps in the Upper Colorado River Drainage Basin related to natural or oil and gas operations are being assessed to determine, if possible, their source. If it is feasible, those sources will be eliminated.

Finally, the RRC is looking into the assessment and possible remediation of abandoned reclamation plants and commercial saltwater disposal facilities within the Upper Colorado River Basin.

The project is in its second year. So far, the RRC has plugged 107 wells, right on track to meet the overall goal of 171 wells. In addition, 17 wells have been taken over by other operators or brought into compliance by means other than plugging.

Assessment activities on eight saltwater seeps in the area have identified some of the ways in which natural salts are entering the Colorado. The results of these assessments will be used to determine appropriate practices to reduce their impacts in the watershed.

Details about the project can be viewed at the RRC Web site under the link "Environmental Protection" (**www.rrc.state.tx.us**).

Salt Diversion

To reduce chlorides in upper Colorado River watersheds, the CRMWD maintains a low-flow diversion system that removes water containing high chloride levels from the river channel. During periods of low flow, naturally saline water is pumped off-channel to reservoirs and then evaporated. The diversion work removes an average of 126,000 pounds of chloride per year from the Colorado River. The CRMWD has the capability of impounding up to 100,900 acre-feet of poor-quality water for evaporation.

Brush Control

The North Concho River watershed has undergone dramatic ecological changes over time; from a prairie grassland to brush-infested valleys and hills. The CRP Upper Basin Steering Committee identified brush control as a means of developing water resources and improving water quality in the region. The UCRA assumed a lead role in working with the TSSWCB and other state and federal agencies to conduct a feasibility study for brush control in the North Concho watershed.

In 2001, the Texas Legislature appropriated $7 million for continuing to share the costs of brush removal with landowners in the North Concho River Watershed. The projects are expected to produce major increases in reservoir yields— an estimated 249,584 acre-feet of additional water per year. The study also indicated benefits to the E.V. Spence Reservoir through increased watershed yields and dilution of salinity sources.

Ninety-three contracts have been issued to treat 184,585 acres of the 950,000- acre watershed. However, the ongoing drought in the region has resulted in conditions that are not optimal for aerial spraying of mesquite. Consequently, only mechanical removal has been done so far, and the total acreage cleared is relatively small in relation to the entire project.

The UCRA is working under contract with the TSSWCB to provide monitoring and assessment of the effects of the brush control program on the North Concho watershed. Monitoring consists of paired watershed studies, groundwater monitoring, and surface water flow measurements. There is not yet enough data to measure gains in water quantity and quality.

Upper Colorado River Authority Nonpoint Source Projects

The UCRA, with assistance of the LCRA, has an ongoing project using NPS grant funds to develop long-term programs for eliminating water quality problems caused by urban runoff. Partnering with local organizations, this program has been highly successful in developing public interest in NPS issues and in constructing BMPs.

San Angelo North Concho Projects

The UCRA determined that the San Angelo portion of the North Concho stream segment is one of the most heavily impacted by NPS pollution within the state. Measured NPS pollutants in the project area include oxygen demanding substances, suspended solids, nutrients, and fecal coliform. Numerous and periodic fish kills have occurred, and conditions are unsightly due to prolific planktonic algae blooms and extreme eutrophic characteristics.

This structure, designed to detain and filter urban runoff, was constructed at Santa Rita Park in San Angelo.

Since 1995, the City of San Angelo and the UCRA have cooperated in the planning and constructing of three BMPs that are designed to improve the quality of stormwater runoff that enters the North Concho River through San Angelo. This work has been financed through federal matching grants provided by the EPA and the TNRCC and administered by the UCRA.

The primary goals of the program have been the improvement of water quality through the downtown San Angelo river segment and the elimination of frequent and recurring fish kills. In addition to construction of BMPs at Civic League Park in 1998, the first project included the preparation of a master plan for NPS management for the city of San Angelo. The master plan was subsequently adopted by the city council. This project was described extensively in the *1999 Annual Report: Texas Nonpoint Source Management Program,* in Chapter 3, Grant Program Success Stories.

The second project was completed in August 2001, and included the construction of a dry pond in Santa Rita Park and the purchase and renovation of an existing privately-owned retention pond in Brentwood Park. Post-construction testing of these facilities indicates very high levels of pollutant reduction.

Brady Creek Project

A project patterned after the San Angelo experience was recently begun in Brady. The UCRA, the LCRA, and the City of Brady have joined together to develop an NPS urban runoff master plan, to conduct an extensive public involvement effort, and to construct a BMP demonstration project.

Brady Lake Dam, located immediately above Brady, was constructed as a part of a major flood prevention project in the early 1960s. Since that time, stream flows in Brady Creek in and immediately below Brady have consisted primarily of urban runoff. Water quality has continuously declined since then. The absence of scouring stream flows and perennial flows has resulted in the stream functioning primarily as a series of stormwater ponds with intermittent stream flows. As a result, Brady Creek through the city often displays eutrophic characteristics, with

prolific algae blooms, odors, and a generally unpleasant appearance. In addition, there is a history of fish kills; the latest kill was investigated by the TNRCC and TPWD in August 1999. The investigation concluded that the event was the result of NPS urban runoff.

Brady Creek through the city still contains perennial pools with significant aquatic life, including species important for fishing. The City of Brady has developed areas along Brady Creek into parks and recreation areas, including fishing piers, playgrounds, picnic areas, and camping sites. Most of the large local events, such as the annual goat cook-off, are planned around the creek. A major improvement project was initiated in the 1980s through a TPWD grant that constructed fishing piers, footbridges, picnic tables, playgrounds, and ball fields.

The Brady Creek project is working to improve water quality so that fish kills are eliminated and aesthetic conditions do not detract from recreational use of the water resource.

Cypress Creek Basin

The Northeast Texas Municipal Water District (NETMWD) is the CRP partner for the Cypress Creek Basin. The program's Web site (**www.netmwd.com**) has been a key factor in the increase of public involvement in the basin, with 486,277 visitors between April 2000 and March 2001. The average monthly number of visitors rose from 2,602 to 6,798 over the last year, an increase of 260 percent.

NPS Water Quality Program

In conjunction with the TMDL for the Lake O' the Pines watershed, the NETMWD launched its NPS Water Quality Program in November 2000 to implement BMPs for nonpoint sources in the area. Several practices are included, such as a complaint investigation program, an OSSF program, and a sanitation program for houseboats and marinas. All have served to increase public awareness and remediate or prevent NPS pollution in the area.

Big Cypress Creek and Lake O' the Pines TMDL Project

Lake O' the Pines (Segment 0403) was identified on the state's draft 303(d) List for 2000 because of low dissolved oxygen concentrations. Lake O' the Pines is located in the Cypress Creek Basin in northeast Texas. The reservoir covers over 18,000 acres, serves as a public water supply for over 14,000 people in the region, and supports significant recreational uses, including fishing and boating.

The TNRCC initiated the TMDL for dissolved oxygen in Lake O' the Pines in 1998 in association with the NETMWD. During 2001, project staff collected additional water quality data and made progress in developing the mathematical models that will be used to evaluate the following: water quality

conditions in the watershed; the implementation of water quality management measures; and the effect of public outreach activities.

Extreme weather conditions characterized the region in 2001. The summer and early fall were extremely hot and dry, while the late fall and winter experienced above-normal rainfall. In spite of the abnormal weather conditions, the project was able to collect representative data from the watershed during the year, including baseline water quality, wet weather water quality, stream flow, and biological assessments. The biological assessments indicated that out of the eight stations which were assessed for indicators of biological health, all exhibited intermediate habitat quality. In their support of aquatic life, two stations were rated as high and six stations were rated as intermediate. Based on these assessments, the aquatic life use is met or exceeded at all stations.

Mathematical modeling of the Lake O' the Pines watershed specifies the development and utilization of four interrelated models: a steady-state stream model, a lentic model, a watershed model, and a dynamic stream model. Early in the project, the QUAL-TX model was selected to simulate the steady-state conditions in the streams flowing into Lake O' the Pines. During 2001, lentic and watershed models were identified for use, and segmentation of the QUAL-TX model was completed. Other modeling resources and techniques for various uses were investigated and implemented.

Implementation in the Big Cypress Watershed

Water quality management measures are being implemented in the Big Cypress watershed concurrently with the development of the TMDL. The TSSWCB provides technical assistance to agricultural and silvicultural producers in the basin. Pilgrim's Pride Corporation has developed a database of BMPs implemented by farmers who work under contract with Pilgrim's Pride. This database indicates that there are 288 farms in the watershed raising a combined total of approximately 21 million chickens per year. Nutrient management plans have been approved by the NRCS for 168 (or 58 percent) of the 288 farms.

The NETMWD has hired staff to perform water quality inspections of poultry operations and on-site sewage facilities to address concerns expressed by the public. The CRP continues to fund studies comparing conditions at sites where there are numerous poultry operations to sites in less impacted areas. The goal is to monitor changes in water quality due to intensive land use for poultry production.

Public outreach activities during 2001 included steering committee meetings, Web site postings, and a conference addressing water quality issues. Three basin steering committee meetings were held. Topics on the agenda of these meetings included updates on the recent activities of the TMDL and CRP in the basin, and planning for ongoing water quality monitoring in the basin. Water quality data, summary reports, committee

meeting agendas, and other related information are regularly posted on the NETMWD Web site to inform the public of activities in the Cypress Creek basin. The ArkTex Council of Governments sponsored a conference in January 2001, which included an overview of the TMDL project, water planning, the activities of the CRP and Texas Watch, and other water quality issues affecting the northeast Texas area.

Guadalupe River Basin

The Guadalupe River basin covers an area of 6,070 square miles in south central Texas. The Guadalupe-Blanco River Authority (GBRA) is the CRP partner agency for the Guadalupe River and Lavaca-Guadalupe Coastal Basins. The Upper Guadalupe River Authority (UGRA) works with the GBRA to monitor water quality in the basin.

Urban Growth Study

The GBRA completed an analysis of the effects of urban growth in the basin's four major communities of New Braunfels, San Marcos, Seguin, and Victoria. The study calculated the change in urban runoff volume and peak flows, and estimated the impacts of current and projected development.

Urban runoff alters the quality and quantity of receiving waters in two main ways. First, the larger volume of flow produced by increased impervious cover tends to scour the streambed. This scour can drastically modify the aquatic habitat. It can also lead to the need to armor the channel to control erosion. The second effect is diminished flows in dry weather. Because more of the land in the watershed has impervious cover, less rain water can soak into the ground and filter to nearby streams to maintain their base flow in dry periods. Effects vary with the nature of the receiving water, such that impacts are not seen in the immediate area of the community, but further downstream. Downstream flooding is another concern.

The study also evaluated the effectiveness of a range of BMPs to minimize the effects of urban runoff. The most effective practice evaluated is low-impact development, which includes a combination of site planning to minimize impervious cover and construction of landscape and drainage features to retain and filter runoff. Essentially, the goal is to control runoff at the source. While low-impact development appears to be the best way to minimize urban NPS impacts, it is a significant change that can be expensive. Communities must be persuaded of the viability and effectiveness of the practices.

The GBRA made several presentations about the study results and low-impact development to stakeholder groups in the Guadalupe basin. Feedback has been positive. The GBRA will continue to promote low-impact development with growing communities in the basin.

For more information, visit the GBRA Web site, **www.gbra.org**, or visit the Low Impact Development Center on the Web at **www.lowimpact development.org**.

San Antonio River Basin

The San Antonio River basin is located in south central Texas and covers approximately 4,180 square miles. Most of the San Antonio River basin is rural, particularly in the southern half. The heavily urbanized central portion of the basin includes the city of San Antonio and surrounding areas. The San Antonio River Authority is the CRP partner agency for the basin. Visit their Web site at **www.sara-tx.org**.

Leon Creek Restoration

The Leon Creek Restoration project is a comprehensive approach to solving water quality problems in the Leon Creek watershed. The project is working to restore Leon Creek, which runs through the city of San Antonio, by addressing detrimental land uses along the creek corridor, installing BMPs, and promoting public interest in protecting and restoring Leon Creek.

Leon Creek was identified on the 303(d) list for 1999 because of recurring low dissolved oxygen concentrations and high levels of fecal coliform bacteria. The San Antonio Water System (SAWS) is the lead organization for the project. SAWS has assembled a project team with representatives from state, federal, and local governments and area businesses. The project is partially funded by a federal NPS grant.

Working with San Antonio Parks and Recreation Department (PARD), SAWS has coordinated the project to ensure that it dovetails with the city's master plan for linear parks. The Leon Creek Greenbelt Coalition, a citizen group, is also involved. Working together, these three groups have identified areas of concern, such as trail damage and dump sites. Cleanup has already started. PARD used heavy machinery to clear illegal "dumps"—large areas where construction and other debris were piled up. Boulders have been placed at illegal access points to restrict vehicles from entering.

Research on land uses is mostly complete. Critical sites for locating BMPs and conducting water quality monitoring have been identified. Working with TPWD, SAWS identified native plants for vegetative buffers and wildlife habitat. They have also agreed upon specifications for path material, needs for the disabled, signs, entrance barriers, seating, and other criteria. Final BMP specifications and construction costs are pending. SAWS, PARD, and a landscape architect have met to discuss engineer surveys and the permits necessary for constructing BMPs. Construction crews from PARD will implement the BMPs under an agreement with SAWS.

Education

Students at local high schools have been trained in monitoring techniques to enhance their understanding and interest in water quality. At the Leon Creek Greenbelt Creek Stomp in May 2001, community members participated in cleaning up the creek. More Stomp events are planned. A newsletter highlighting NPS prevention activities along Leon Creek has been produced and distributed.

TPWD is working with local residents to conduct wildlife and vegetation surveys. Naturalists and local high school students are serving as field personnel for the survey. Naturalists have begun vegetation and songbird baseline surveys, with SAWS providing area maps and sampling equipment.

Abandoned Water Well Monitoring and Abatement

A major consequence of urbanization throughout the San Antonio area, specifically over the sensitive Edwards Aquifer recharge zone, has been abandoned man-made water wells. Many of the abandoned wells are shallow (50-200 feet) and are located near creeks and waterways.

SAWS has two primary objectives for its abandoned well project. With information derived from the abandoned wells prior to plugging, the SAWS Well Abatement program will use innovative geophysical logging equipment to monitor groundwater quality, porosity, well casing or condition, zones of permeability, and formation fluid quality. Every abandoned well that is identified and logged will provide key information about the aquifers in the region.

Abandoned wells are pumped out if necessary, then plugged with cement.

The second objective is plugging the abandoned wells. Many abandoned or malfunctioning wells are not plugged because the well owner is unable to pay the costs. During this project, financial support will be provided to plug 50 such abandoned wells. Wells that are contributing to groundwater or surface water degradation, or are likely to be subject to contamination due to their location, will be targeted.

So far, SAWS has done extensive field work, visiting 202 well sites and identifying 52 wells that fit the project criteria for plugging. SAWS has acquired a geophysical well logging unit that is proving to be a useful tool for collecting information that will be used to develop a subsurface water quality data base. A number of abandoned wells have been logged in the metropolitan area.

To date, SAWS has plugged nine abandoned wells in a low-income neighborhood on Old Corpus Christi Road near Brooks Air Force Base. One additional well has been plugged on Ansley Road. All wells were cleaned

out prior to plugging. Affected homes were hooked up to sewer line laterals to prevent further discharge of raw sewage directly into abandoned wells.

For more information, see the project Web page, **www.saws.org/our_water/**. Follow the link to Source Water and Watershed Protection.

Salado Creek TMDL

Salado Creek is located in the upper portion of the San Antonio River Basin, with its headwaters in extreme north central Bexar County. It is a 218 square- mile watershed, which includes areas in the north and east portions of the city of San Antonio. The upper portion of the watershed is largely undeveloped. The terrain is characterized by limestone hills and sparse vegetation typical of the Texas Hill Country. The lower portion of the watershed has dense urban development. Large numbers of people use the well-maintained parks along the lower reaches of the creek.

Water quality assessments have found that occasional low dissolved oxygen levels in the water may harm the fish community and other aquatic life. Tests also indicated that bacteria levels are occasionally elevated, indicating a potential health risk to people who swim or wade in the creek.

The TNRCC released a draft TMDL for public comment on July 6, 2001. The TMDL was adopted by the TNRCC on October 12, 2001.

Historically, there have been no permitted municipal or industrial wastewater point source discharges into Salado Creek. This circumstance changed in March 2001 when SAWS began discharging treated municipal effluent to augment base flow in Salado Creek under a permit issued by the TNRCC.

Historical water quality data from Salado Creek indicate that concerns about dissolved oxygen are predominately related to a low flow, warm temperature condition. Data was collected to support modeling the stream under steady-state conditions. The QUAL-TX model was applied to simulate water quality conditions in the creek. The model was calibrated and verified against data collected in June 1999 and February 1999, respectively. The modeling demonstrated that dissolved oxygen in Salado Creek is not caused primarily by loadings of carbonaceous or nitrogenous materials, but is affected principally by hydraulics, sediment oxygen demand, and photosynthesis.

Historical data indicates some dissolved oxygen problems exist under storm-flow, nonsteady-state conditions. The BASINS modeling system was used to simulate the response of the receiving stream to mass loadings from the watershed. The modeling results did not indicate the existence of dissolved oxygen problems under storm-flow conditions. This observation is consistent with the historical data, which indicates that dissolved

oxygen problems under nonsteady-state conditions do not occur with sufficient frequency to constitute an impairment under the state water quality standards.

The TMDL used the QUAL-TX model to quantify existing loadings and the assimilative capacity of Salado Creek under low-flow critical conditions. The modeling analysis of these baseline loadings indicate that the dissolved oxygen criteria will be maintained in Salado Creek. The evaluation of the assimilative capacity of Salado Creek indicates that the creek has additional capacity to assimilate loadings and still maintain water quality standards.

Texas A&M University conducted a public education project in the watershed in conjunction with the TMDL project. As a result, the nonprofit Salado Creek Foundation has been revived to provide citizens with an opportunity to help preserve the quality of the creek.

Sabine River Basin

The Sabine River Authority (SRA) and Boles Independent School District recently kicked off a new environmental education program with area schools. "Kids on the Sabine" educates school children and their parents about the Sabine River. "Kids on the Sabine" is adapted from similar successful programs in Dallas–Fort Worth and Houston-area schools. It offers teacher training, field trips to Sabine River environmental education centers, after-school programs, and service learning projects.

An education center will be built on school property, on the shore of Lake Tawakoni. The center, which will be the primary teaching point for the program, will show the restoration of prairie and wetland ecology and will preserve the forest on the land. An outdoor classroom powered by wind and solar energy will complement the habitat restoration and preservation areas.

Other important partners in the project include more than 100 school districts, the TPWD, the National Fish and Wildlife Foundation, and other foundations and corporations providing support through the SRA.

WQMPs for Poultry Producers

Local SWCDs are working with poultry producers in the watersheds above Sam Rayburn and Toledo Bend Reservoirs to reduce NPS pollution from agricultural operations. Approximately 260 WQMPs are being developed to implement BMPs that are expected to reduce pollution and increase dissolved oxygen concentrations in the reservoirs. BMPs will address issues such as litter utilization, disposal of dead animals, and soil testing. Several other water bodies will be affected as well, such as the Angelina River, Lanana Bayou, and Waffelow Creek. Financial assistance is available for implementing the WQMPs.

Trinity River Basin

The Trinity River basin encompasses almost 18,000 square miles from north central to southeast Texas. It includes the Dallas–Fort Worth metroplex, the largest metropolitan area in Texas. The Trinity River Authority is the CRP partner agency for the basin. Visit their Web site at **www.trinityra.org**.

TMDLs for Legacy Pollutants in Dallas–Fort Worth Urban Water Bodies

The Dallas–Fort Worth metropolitan area is one of the few areas of the state with water bodies that have been impaired by banned pesticides and industrial chemicals. In 2001, the TNRCC adopted a total of 20 TMDLs addressing legacy pollutants in fish tissue for four urban lakes and several portions of the Trinity River in the Dallas–Fort Worth metropolitan area. These TMDLs were approved by the EPA in May 2001. The legacy pollutants addressed are chlordane, DDT, DDE, DDD, dieldrin, heptachlor epoxide, and PCBs.

In August 2001, the TNRCC approved implementation plans for the TMDLs. The implementation plans include various ordinances, structural controls, and BMPs. Cooperative monitoring and BMP evaluation efforts to measure the success of implementation include the participation of several local municipal governments and the USGS.

Because of the persistent nature of legacy pollutants, fish tissue contaminant concentrations in the Dallas–Fort Worth area are expected to decrease slowly, even after most of the sources have been mitigated. Therefore, the implementation plans for these TMDLs outline a systematic and periodic evaluation of contaminants in fish tissue in the area and describe contingency plans for further mitigation of persisting contaminant levels.

Atrazine Land-Use Analysis

Atrazine has been identified as a threat to some lakes in the Trinity River basin. The Trinity River Authority and the University of North Texas are analyzing land use in the lake areas to predict which zones are most likely to contribute atrazine to the lakes. The results will be used to target implementation of BMPs.

Source Water Protection Projects

The SWAP Team of the TNRCC works to restore the source waters identified as threatened on the 303(d) list. At this time all water quality measurements for Lakes Bardwell and Waxahachie currently support use as a public water supply. However, atrazine concentrations in finished drinking water from these lakes indicate contamination in the lakes and represent a threat to future use.

Bardwell Lake

Bardwell Lake is located in Ellis County near the city of Ennis.The dam controls drainage from 178 square miles of Waxahachie Creek.This is about 95 percent of the entire drainage area of Waxahachie Creek.The lake covers 3,560 surface acres at its normal pool, and stores 35,000 acre-feet.

Lake Bardwell is the sole source of drinking water for over 16,000 residents of Ennis. Each year, thousands of visitors come to Lake Bardwell to enjoy recreation in the form of camping, fishing, boating, swimming, and hunting. Lake Bardwell is also home to numerous families and businesses.

Project participants first identified a 1,000-foot buffer zone around the edge of the reservoir to serve as the key management area, since the entire watershed for the lake is too large for the city to manage effectively.A comprehensive source water protection inventory has been completed, showing 525 potential sources of contamination, primarily within the buffer zone.

Numerous meetings were organized to get input and share information about the project.They have involved the City of Ennis, Ellis County Appraisal District, U.S.Army Corps of Engineers, City of Waxahachie, City of Midlothian, Ellis County Agents, and other interested parties.

Lake Waxahachie

Lake Waxahachie was completed in 1957 by the impoundment of South Prong Creek. It is located in Ellis County near the city of Waxahachie.The lake covers 690 surface acres at its normal pool, and stores 13,500 acre-feet.Waxahachie uses water from both Lakes Waxahachie and Bardwell for its water supply. During heavy rainfall periods, the Lake Waxahachie spillway flows into Waxahachie Creek and then into Lake Bardwell.

The two lakes are the sole source of drinking water for over 24,000 residents of Waxahachie.The city also sells water to Rocket Special Utility District and Nash-Forreston Water Supply Corporation, which account for another 24,000 customers. Lake Waxahachie is home for numerous residents of Ellis County, with two new major subdivisions being built on the south side of the lake. It is a popular recreation area, frequented for its fishing, boating, and swimming activities.

Project participants first identified a 1,000-foot buffer zone around the edge of the reservoir to serve as the key management area, since the entire watershed for the lake is too large for the city to manage effectively.A comprehensive Source water protection inventory has been completed. Over 325 potential sources of contamination were found, primarily within the buffer zone covering the lake and South Prong Creek.The creek is the primary source of water for the lake.

During the Lake Waxahachie project, numerous meetings have involved the City of Waxahachie, Ellis County Appraisal District, U.S. Army Corps of Engineers, Ellis County Agents, and other interested parties.

The projects on both Lake Waxahachie and Bardwell Lake will include a source water protection strategy that recommends BMPs to address the potential contaminant sources identified during the inventory. The TNRCC will work with the TSSWCB to determine activities and BMP recommendations in the strategy document.

North Central Texas Atrazine Project

The TSSWCB is working with a broad partnership in eight counties across North and North Central Texas to safeguard four important drinking water supplies.

In 1998, Lake Waxahachie, Bardwell Lake, Richland Chambers Reservoir, and Lake Joe Pool were listed as threatened by atrazine on the state's 303(d) list. To remove this threat, the TSSWCB is working cooperatively with the Dalworth SWCD, Ellis-Prairie SWCD, Navarro SWCD, Hill County-Blackland SWCD, Johnson County SWCD, Limestone-Falls SWCD, the TNRCC, TCE, TDA, TAES, and the USDA–NRCS.

While much progress has been made across the project area, the Johnson County SWCD has gotten off to a particularly good start in minimizing problems related to NPS pollution in part of the Richland Chambers Reservoir watershed. During 2001, the Johnson County SWCD developed 24 WQMPs that were subsequently certified by the TSSWCB. Work has already started on 11 of these WQMPs, with the majority of their implementation scheduled for 2002. The SWCD is also working to develop another 12 WQMPs on additional agricultural lands in the watershed.

Each of the WQMPs to be implemented in the watershed may contain numerous conservation practices aimed at curbing atrazine runoff through proper pesticide management and erosion control. Conservation practices included in the approved WQMPs during 2001 included the conversion of 1,388 acres of cropland to managed pastureland and rangeland, pesticide management on 1,407 acres of cropland, and the remediation of 23 acres of land identified as critically eroding.

The TCE sponsored an event for agricultural producers on the proper use of atrazine and other pesticides. Similar events are being planned for 2002.

For more information on the entire North Central Texas Atrazine Project, visit **www.tsswcb.state.tx.us/programs/319.html**.

Rio Grande Basin

The entire Rio Grande watershed covers an area of approximately 335,000 square miles. Approximately half the watershed is in the United States. The other half is in Mexico, where the river is called the Rio Bravo. In Texas, the Rio Grande flows from the borders of New Mexico, Texas, and Chihuahua to the Gulf of Mexico. The International Boundary and Water Commission is the CRP partner agency for the basin. For more information, see their Web site at **www.ibwc.state.go/crwelcome.htm**.

TMDLs for Arroyo Colorado Watershed

The Arroyo Colorado TMDL Project continues to make important strides in the development of a solution to the problem of low dissolved oxygen in the tidal segment of this important coastal stream.

As of September 2001, the TSSWCB has certified approximately 190 WQMPs on 26,000 acres in the Arroyo Colorado watershed. Implementation of these plans is reducing agricultural NPS loadings in the Arroyo. Irrigation water management and nutrient management are the main focus of the plans. However, other BMPs are also included, such as conservation crop rotation, residue management, and pest management.

In May 2001, the TIAER completed calibration and verification of a dissolved oxygen model for the mixed surface layer of the tidal segment of the Arroyo. This model uses the simulated output from a comprehensive dynamic model of the Arroyo watershed to predict dissolved oxygen concentrations. The results of the simulations have revealed complex interrelationships between the physical setting in the tidal environment and the low dissolved oxygen levels observed periodically. The TNRCC is currently evaluating the data and running simulations using alternative loading scenarios to establish an equitable and scientifically defensible load allocation strategy for the Arroyo Colorado.

Also in 2001, the TNRCC adopted four TMDLs for legacy pollutants in the non-tidal segment of the Arroyo Colorado (Segments 2202 and 2202A). The EPA approved the TMDLs in June 2001. The legacy pollutants addressed in the TMDLs are chlordane, toxaphene, DDE, and PCBs.

In September 2001, the TNRCC approved an implementation plan for the Arroyo Colorado Legacy Pollutant TMDLs. In June 2001, the TDH modified fish consumption advisories originally issued for the Arroyo Colorado in 1980 and 1993 as a result of toxic chemicals found in fish tissue, including the legacy pollutants described above. The modified advisory eliminates one of the TMDL legacy pollutants from the list of contaminants of concern and limits the consumption advisory to a single fish species, the smallmouth buffalo.

In the spring and summer of 2001, the TNRCC's Remediation Division conducted additional sampling in the Donna canal and reservoir in an effort to develop a remediation plan for the portion of the irrigation canal contaminated with PCBs. The investigation included sampling and analysis of whole water, bottom sediment, and suspended sediment, and a remotely operated vehicle inspection of the Donna canal syphon. The TNRCC is currently evaluating remediation options for the canal.

The Arroyo Colorado Verification Monitoring Program, a comprehensive monitoring effort designed to measure the effect of load reduction efforts in the Arroyo Colorado Watershed, provided the TNRCC with four quarters of data collected in 2001. This valuable monitoring program will continue in 2002.

Saltcedar Project in the Pecos River Watershed

One of the biggest problems in the Pecos River watershed is the highly invasive saltcedar plant. Originally introduced to the Pecos region in 1925 to control erosion, the saltcedar has since overtaken other vegetation, increasing soil and water salinity, the possibility of flooding from decreased channel width and increased sedimentation, and water loss due to evapotranspiration.

A cooperative project is attempting to determine the most effective practices to reduce the amount of saltcedar by using herbicides in various combinations and different applications. The Upper Pecos SWCD is monitoring water quality to determine the effects of this project on the river.

Leading the project are the Texas Cooperative Extension, the NRCS, the Upper Pecos SWCD, and the TDA. Other cooperating agencies include the International Boundary and Water Commission, the EPA, the USDA, the TNRCC, other area SWCDs, and private companies.

Texas A & M—Constructed Wetlands to Prevent Pollution from On-Site Sewage Disposal

In some areas, high clay content and saturated soils render conventional septic systems ineffective. Conventional secondary treatment in problem soil areas involves aerobic treatment of sewage—a biological process in which microbes eat the waste and their bodies transform it into nonpolluting material. The treated wastewater is then sprayed on lawns. This method is an effective but expensive solution. A project of Texas A&M University demonstrated the use of constructed wetlands as an alternative wastewater treatment system. Wetland systems were tested under different site conditions, and various design criteria were evaluated.

A constructed wetland system for domestic wastewater treatment is designed to mimic the treatment processes of natural wetlands. Plants and microbes are used to improve the wastewater quality. The water flows beneath the land to limit the residents' contact with wastewater.

Design criteria for constructed wetlands were developed by the EPA in 1993. However, these criteria were not extensively tested for different regions of the country. This project constructed wetlands treatment systems at eight residences, five of which had failing systems that contributed contaminants to the environment. Each system consisted of a septic tank for primary treatment; a lined, single-cell wetland for advanced treatment; and a subsurface drip distribution system to apply treated effluent to the land.

Contaminant removal was excellent with the wetland systems. The systems that were monitored maintained an effluent quality close to secondary quality standards for treated wastewater. Fecal coliform bacteria remained in the effluent, indicating the need for further treatment before contact with surface water or groundwater resources.

The technical knowledge gained through this project is advancing the acceptance of constructed wetlands for wastewater treatment. Several journal articles were developed from the monitoring information collected during this project. The function and limitations of this technology are better defined.

Educational materials and presentations were used to disseminate the information gained through the project. A video and fact sheet were developed and distributed. A short course was developed for professionals working in the OSSF field; certified OSSF personnel receive continu-

ing education credits for taking the course. Sixty-five presentations were made, reaching almost 500 people.

City of Laredo—Watershed Protection through Enforcement

The City of Laredo, for the past three years, has been designated as the second fastest growing city in the United States, with an estimated population in excess of 185,000. Due to this tremendous growth, land is being developed at a very rapid rate. Directly related to this growth is the increasing number of illegal dump sites that are affecting area creeks. The short-term consequences of illegal dumping are primarily aesthetic. In the long term, these activities are changing the hydraulic characteristics of the creeks, creating flooding conditions, and discharging indeterminate amounts of pollutants into the already heavily impacted Rio Grande.

To address NPS problems due to rapid growth, the City of Laredo developed four new ordinances aimed at controlling pollution, enhanced its enforcement activities, and conducted an educational campaign. The new ordinances that were developed and enacted include Stormwater Management, Water Pollution Prevention, Industrial Stormwater Pollution Prevention, and Illegal Dumping.

Illegal dumping was a major focus of the project. Since the grant was established, Laredo has cited over 50 people and responded to over 500 calls about illegal dumping and discharges. Thirteen sites were cleaned up by order of the municipal court. Police and enforcement officers received training on applicable city, state, and federal laws to support the inspection and enforcement activities of the program. In 2001, the city saw a decrease in illegal dumping for the first time in years.

To increase awareness of the effects of illegal dumping and the applicable laws, city staff produced four video documentaries through a contract with a local TV station. Various promotional items were used at educational forums to provide a reminder of the message. City staff spoke to several organizations such as businesses and high school science clubs. They also conducted seven workshops on pollution prevention for Laredo residents. Special activities, such as Operation Cleansweep, also served to highlight the program's objectives.

City of Brownsville—Town Resaca Project

The Town Resaca system covers about 3,500 acres in the city of Brownsville, and includes 48 subwatersheds. *Resaca* is the Spanish word for a standing body of water that was previously attached to a flowing body of water, also called an *oxbow lake*. The Town Resaca system serves as the city's outfall for stormwater runoff. At the outset of the project,

assessment indicated that development and erosion along the resacas were causing sedimentation problems and threatening aquatic habitat.

Under Phase I, several subwatersheds were monitored for pollutants entering the resacas. Based on the results, both structural and nonstructural BMPs were designed and implemented. In the final phase, samples were taken after structural controls were in place to determine their effectiveness.

The project also implemented a public awareness campaign in two phases. In the first phase, educational brochures were developed and sent to more than 550 residents and business in three subwatersheds.

The second phase of the awareness program involved work with students and teachers at Brownsville Independent School District. An eight-hour course was provided for elementary school teachers within the three target subwatersheds. A three-hour course was presented to students at two middle schools and one high school. Both courses included a field trip to the resaca and were well-received by teachers and students.

Structural BMPs were built in four different subwatersheds. The first was a stormceptor unit designed to provide a 60 percent reduction in suspended solids for urban watersheds that have up to 5.4 acres of impervious cover. This unit treats approximately 88 percent of the annual stormflow.

The second BMP was a filter composed of rock and vegetation, designed to treat runoff from an average storm event for the city. The filter follows the edge of the resaca and receives stormwater from about 24 acres. Land use in the area is primarily residential.

A detention basin was designed and constructed for the third subwatershed. The basin covers about 1.3 acres and retains runoff from an average storm event for 72 hours, long enough for sediment and pollutants to settle out. The basin receives runoff from the entire 76-acre subwatershed, which is primarily used for residences and open space.

Another stormceptor system was placed in the fourth subwatershed. Approximately 94 acres in size, the subwatershed is primarily residential. About 3.1 acres drain into the stormceptor through two stormwater inlets. Somewhat smaller in size than the other stormceptor, this unit is designed to provide a 60 percent reduction in suspended solids for urban watersheds with up to 4 acres of impervious cover, treating 86 percent of the annual stormflow.

Due to extended drought in the region, the project was not able to complete as many samples of BMP efficiency as were planned. Only one rain event was sampled after the BMPs were in place. Two of the structures did not produce effluent that could be measured.

The results from both stormceptors were highly variable. One treated better for metals, while the other performed better at removing suspended solids. Taken together, they reduced metals in the runoff by 20 percent, suspended solids by about 16 percent, and nitrogen by only 3 percent.

Only one runoff sample was taken at the rock filter. It indicated a 40 percent reduction rate for nutrients. Removal efficiencies of the detention pond are estimated as follows, based on previous studies by the City of Austin on similar structures: 80 percent for metals, 87 percent for suspended solids, and 61 percent for nutrients.

Groundwater Assessment of the Barton Springs Segment of the Edwards Aquifer

Two related grant projects were completed in 2001 by the Barton Springs/Edwards Aquifer Conservation District. To increase understanding of these valuable natural resources, the projects examined the interaction of surface and groundwater and traced the movement of groundwater.

The Edwards Aquifer is a major groundwater resource for central Texas. It is divided into three primary segments—the San Antonio, Barton Springs, and northern segments. The aquifer provides water to a large and diverse population that includes domestic, agricultural, industrial, and commercial users. The Barton Springs segment, where the project was conducted, includes several cities and rural communities that are completely dependent on the aquifer as a water supply. The Barton Springs segment of the aquifer discharges primarily from Barton Springs, the only known habitat for the endangered Barton Springs salamander. The springs and the pool below them are important recreational resources, with more than 350,000 annual visitors.

The findings of the project were compared with data from previous studies to achieve a better understanding of the aquifer and its relationship with surface waters. The knowledge gained through the two projects is of significant importance to policy makers, planners, regulators, scientists, and resource managers working to protect groundwater quality, to enhance the quantity available for extraction, and to maintain spring flow during drought conditions.

Some of the significant conclusions drawn from the first project are as follows.

- The majority of recharge to the aquifer occurs in discrete features, such as sinkholes and cave entrances, within stream beds that cross the recharge zone.
- Many recharge features are plugged with stream sediment and other material that restrict the amount of recharge to the aquifer.
- Groundwater sampling and analysis indicate that contaminant levels in most of the sampled wells and springs were low compared to maximum contaminant levels established by the EPA.

Nine parameters were detected at levels above TNRCC standards. However, samples were collected under only one set of flow conditions, and results could vary under different flows.

- Artesian and unconfined monitor wells, in most cases, respond differently to recharge. The unconfined wells, with one exception, respond more to rainfall events. The artesian wells, when not influenced by local pumping, respond to long-term regional trends in storage and recharge.

In the second project, groundwater tracing was conducted to determine flow directions and travel rates in the Barton Springs segment of the aquifer.

The results show that groundwater recharge from the Barton and Williamson Creek watersheds travels either north or northeast towards either Barton or Cold Springs. Portions of the upper recharge zone of Barton Creek and Williamson Creek contribute flow to Cold Springs and other springs on the south bank of the Colorado River, rather than to Barton Springs. The remaining portions of the recharge zone generally support the main outlet of Barton Springs.

Groundwater recharge in the Slaughter, Bear, Little Bear, and Onion Creek watersheds flows east. Groundwater from these watersheds supplies Barton Springs. It appears that groundwater flow converges into at least three preferred pathways.

The tracers have shown rapid flow rates for first dye arrivals of about half a mile to one mile per day during very low-groundwater flow conditions, to over five miles per day during periods of high flow. Even during low-flow conditions, dye injected at one of the most distant points traveled at least 15 miles to arrive at Barton Springs 14 to 16 days later. The rapid travel rates and strong recovery of dye tracers observed suggest that Barton Springs may be more closely tied hydraulically to groundwater flow recharging from Williamson, Slaughter, Little Bear, and Onion Creek watersheds than was previously believed.

The results of the assessment are being used to improve wellhead protection, to anticipate the fate of hazardous materials spills in the recharge zone, to develop monitoring strategies, to prioritize purchases of land for water quality protection areas, and to evaluate sites for potential recharge enhancement.

TSSWCB—Reducing and Preventing Pollution from Herbicides

The TSSWCB has remained at the forefront in addressing new NPS pollution problems as they arise and is working to meet new problems with innovative approaches. A case in point has been the effort concentrated

on the Central and North Central regions of the state to combat NPS problems associated with the herbicide atrazine.

Atrazine is used by many corn and sorghum producers to control weeds. This herbicide is also an ingredient found in many residential lawn and garden products. It has been identified as a possible threat to source waters in several watersheds in the state, including North Central Texas. Over the last fiscal year, the TSSWCB has initiated several projects in this area with the goal of reducing atrazine runoff through the implementation of WQMPs on agricultural land. These projects join five others in the area that were started in 2000.

Working through 11 SWCDs in the area, the TSSWCB plans to support implementation of approximately 200 WQMPs that will directly and positively impact the way pesticides and sediment move within agricultural areas located in affected watersheds.

In each of the individual projects within the area, the TSSWCB works cooperatively with local SWCDs, providing technical assistance to landowners in the implementation of WQMPs.

The success of these projects will be better measured as they progress, but preliminary data suggest that they will result in a significant reduction in the amount of atrazine reaching area lakes, some of which are sources of drinking water.

The benefits of WQMPs in the area go beyond a measurable decrease in atrazine levels. For example, one WQMP installed by the Ellis-Prairie SWCD on 43 acres of pasture and hayland will conserve an estimated 330 tons of soil annually.

To date, projects have been initiated in the Red, Sulphur, Trinity, Sabine, and Brazos river basins. Lakes and reservoirs in the targeted areas include Big Creek Lake, Lake Lavon, Lake Tawakoni, Lake Joe Pool, Lake Waxahachie, Bardwell Lake, Richland-Chambers Reservoir, Navarro Mills Lake, Aquilla Lake, and Marlin City Lake. The TSSWCB plans to initiate a project in the Little River watershed during fiscal year 2002.

Soil and water conservation districts actively engaged in projects to reduce atrazine include Limestone-Falls SWCD, Hill County-Blackland SWCD, Johnson County SWCD, Navarro SWCD, Dalworth SWCD, Ellis-Prairie SWCD, Upper Sabine SWCD, Collin County SWCD, Fannin County SWCD, Upper Elm-Red SWCD, and Kaufman-Van Zandt SWCD.

For more information, visit the Web site, **www.tsswcb.state.tx.us/programs/ 319.html**.

Program Administration and Financial Report

Program Administration

TNRCC

During 2001, implementation of the TNRCC NPS program was supported with federal funds from the Partnership Performance Grant (PPG) for fiscal year (FY) 2001 and several multiyear categorical grants.

A variety of grant actions took place during the fiscal year. All projects under the FY1997 grant and FY2001 PPG were completed by August 31, 2001. A new work plan and application were developed for Phase II of the North Bosque and Leon Composted Manure Incentive project. Grant amendments were also submitted for the FY2001 and FY2000 base grants to add available funds not previously awarded.

The P2000 automated grant system was used for processing all TNRCC Section 319 grant applications, amendments, and awards. As expected, use of this electronic system has found favorable acceptance from staff and resulted in greater ease and efficiency in internal routing and approval of grant documents.

On other administrative matters, a midyear NPS program review was conducted between the EPA and the TNRCC in April 2001. No significant findings were noted.

NPS contract managers visited several project locations around the state to tour BMP sites and discuss progress with cooperators. EPA staff members accompanied TNRCC personnel during several of these visits.

Risk assessment criteria were developed for fiscal monitoring of TNRCC contractors. Each contractor who received NPS grants through the TNRCC was evaluated and prioritized to determine the need for an on-site visit by fiscal monitoring staff. Visits were conducted with three contractors (Southwest Texas State University, Upper Colorado River Authority, Barton Springs/Edwards Aquifer Conservation District) during 2001 to ascertain if they were following standard operating procedures and to spot-check for potential problem areas. In each situation, fiscal monitoring staff assisted the contractor in addressing and resolving any deficiencies identified. Additional training was provided to each contractor during the visit. For the upcoming year, fiscal monitoring staff plan to develop additional guidance material that will be distributed to contractors and contract managers to improve overall fiscal accountability.

TSSWCB

The TSSWCB closed out two grants during FY2001 (FY1994 and FY1995). All deliverables were accounted for. The remaining balance of funds from these close-outs was rolled into the FY1999 grant for WQMP implementation in the Sam Rayburn Reservoir watershed.

A midyear NPS program review was conducted between the EPA and the TSSWCB in April 2001. No significant findings were noted.

Contract and project managers visited several project locations around the state to tour operations that implemented WQMPs, to discuss progress with cooperators, and to perform fiscal monitoring. EPA staff members accompanied TSSWCB personnel during several of these visits.

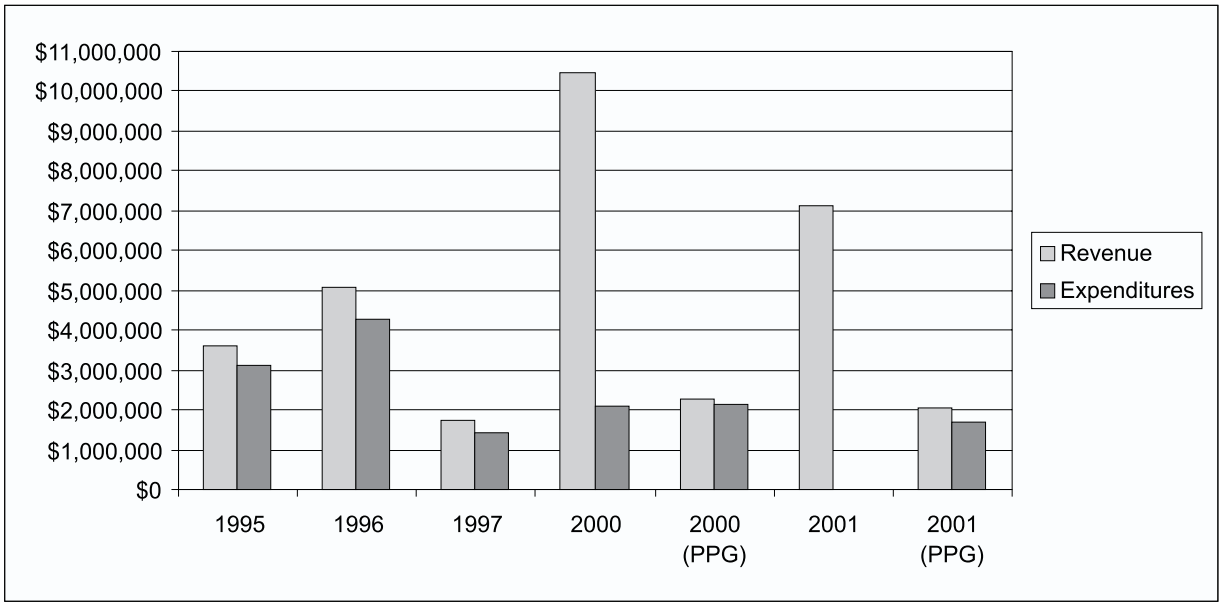
On other administrative matters, TSSWCB staff completed updates to the Grant Reporting and Tracking System and submitted the FY 2002 grant application to the EPA on September 1, 2001.

Financial Report

TNRCC Grant Program Financial Report

Grant Fiscal Year	Grant Number	Total Grant Revenue	Cumulative Federal Expenditures	Cumulative State Expenditures	Grant Balance
1995	C9-96146-03	$3,614,167	$1,875,635	$1,250,424	Closed
1996	C9-996146-04	$5,072,193	$2,563,451	$1,708,731	$800,010
1997	C9-996146-05	$1,757,166	$844,886	$563,257	Closed
2000	C9-996146-06	$10,447,757	$1,245,478	$830,319	$8,371,960
2000 (PPG)	BG-996627-00	$2,286,657	$1,274,539	$849,692	$162,426
2001	C9-996146-07	$7,112,049	$7,465	$4,976	$7,099,608
2001 (PPG)	BG-996627-00	$2,039,033	$1,018,618	$679,078	$341,337

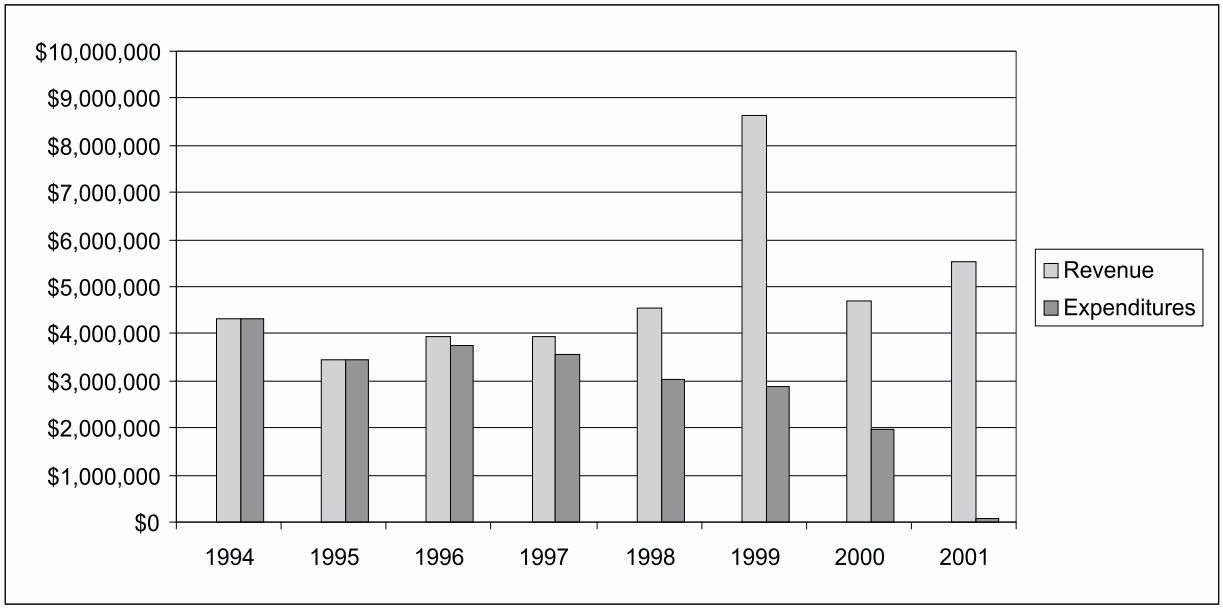
Expenditures listed are through August 31, 2001.



TSSWCB Grant Program Financial Report

Grant Fiscal Year	Grant Number	Total Grant Revenue	Cumulative Federal Expenditures	Cumulative State Expenditures	Grant Balance
1994	C9-996236-01	$4,306,290	$2,580,610	$1,722,516	Closed
1995	C9-996236-02	$3,441,447	$2,064,867	$1,376,579	Closed
1996	C9-996236-03	$3,925,000	$2,205,680	$1,531,543	$187,777
1997	C9-996236-04	$3,925,000	$1,981,903	$1,570,000	$373,097
1998	C9-996236-05	$4,526,959	$1,849,312	$1,169,405	$1,508,242
1999	C9-996236-06	$8,650,255	$1,610,908	$1,273,145	$5,766,202
2000	C9-996236-07	$4,684,000	$1,638,402	$322,384	$2,723,214
2001	C9-996236-08	$5,520,650	$77,369	$2,565	$5,440,716

Expenditures listed are through September 30, 2001.



Contact Us

The views of those who live and work in Texas are important to us. Comments about the state's nonpoint source management program are welcome. Call the TNRCC at 512/239-4416, the TSSWCB at 254/773-2250, or write to us at one of the addresses shown below.

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For More Information
For more specific information about the programs and projects highlighted in this report, visit the Web sites listed in the section "NPS Information on the Web," or contact:

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NPS Information on the Web

There is a wealth of information on the Web describing the programs and practices used to manage NPS pollution. These are just a few sites that we find especially useful. The list includes all the Web sites referenced in this report. Many agencies revise their Web sites frequently, so you may have to do a little browsing around if you find that information has moved.

Texas Natural Resource Conservation Commission
www.tnrcc.state.tx.us

To find information on the TNRCC Web site that is not listed below, follow the "Index" link from the TNRCC home page to search for information by category.

Nonpoint Source Program: www.tnrcc.state.tx.us/water/quality/nps/
Clean Rivers Program: www.tnrcc.state.tx.us/water/quality/data/wmt/
Groundwater Planning and Assessment: www.tnrcc.state.tx.us/water/quality/gw/
Surface Water Quality Monitoring: www.tnrcc.state.tx.us/water/quality/data/wqm/
Total Maximum Daily Load Program: www.tnrcc.state.tx.us/water/quality/tmdl/

Texas State Soil and Water Conservation Board
www.tsswcb.state.tx.us

Nonpoint Source Program: www.tsswcb.state.tx.us/programs/319.html
Brush Control: www.tsswcb.state.tx.us/programs/brush.html
Bosque/Leon River Project: www.tsswcb.state.tx.us/programs/bosqueleon.html
WQMP Program: www.tsswcb.state.tx.us/programs/wqmp.html

Other State Agencies

General Land Office–Coastal NPS Program
http://wwwglo.state.tx.us/coastal.html

Railroad Commission–Upper Colorado Salt Minimization Project
www.rrc.state.tx.us/divisions/og/fops/river/river.htm

Texas Department of Transportation–Compost Project
www.dot.state.tx.us/insdtdot/orgchart/des/landscape/compost/topsoil.htm

Texas Forest Service
http://txforestservice.tamu.edu/

Texas Parks & Wildlife (TPWD)
www.tpwd.state.tx.us/

Conservation Programs: www.tpwd.state.tx.us/conserve/

BMP Resources

Street Edge Alternatives Project
www.cityofseattle.net/util/urbancreeks/SEAstreets/default.htm

Low Impact Development Center
www.lowimpactdevelopment.org

Texas Nonpoint Source Book
www.txnpsbook.org

Water Quality and BMPs for Loggers
www.usabmp.net/launch.html

Educational Resources

Building Environmental Education Solutions, Inc.
www.beesinc.org/

Bullfrog Films
www.bullfrogfilms.com/

Cyberways Waterways
www.cyberwaysandwaterways.com/en/CW3Home/

Texas Watch
www.texaswatch.geo.swt.edu/

Wet in the City
www.wetcity.org

Conservation Organizations

Ducks Unlimited–Wetlands Conservation
www.ducks.org/

Izaak Walton League of America / Save Our Streams Program
www.iwla.org/sos/

National Wildlife Federation–Gulf States Region
http://www.nwf.org/gulfstates/

Sierra Club–Texas
http://texas.sierraclub.org/

The Trust for Public Lands–Texas
www.tpl.org/tier2_rl.cfm?folder_id=264

Estuary and Marina Programs

Clean Marinas
www.cleanmarinas.org

Coastal Bend Bays and Estuaries Program
http://tarpon.tamucc.edu/projects/apdp/introduction.htm

Galveston Bay Estuary Program
http://gbep.tamug.tamu.edu/

Partnership for Environmental Safety and Outreach
www.tamucc.edu/~outreach/peso

Clean Rivers Program Partner Agencies

Angelina & Neches River Authority
www.anra.org

Brazos River Authority
http://www.brazos.org/index.htm

Canadian River Municipal Water Authority
www.crmwa.com

Lake Meredith Salinity Control Project: www.crmwa.com/SCP.htm

Colorado River Municipal Water District
www.crmwd.org

Guadalupe–Blanco River Authority
www.gbra.org

Houston–Galveston Area Council
www.hgac.cog.tx.us/resources/wq/crp/

International Boundary and Water Commission
http://www.ibwc.state.gov/CRP/Welcome.htm

Northeast Texas Municipal Water District (Cypress Creek)
http://www.netmwd.com/index.html

Red River Authority
www.rra.dst.tx.us

Lower Colorado River Authority (LCRA)
http://www.lcra.org

Lower Neches Valley Authority (LNVA)
http://www.lnva.dst.tx.us/

Sabine River Authority
www.sra.dst.tx.us

San Antonio River Authority
www.sara-tx.org

Sulphur River Basin Authority
www.sulphurr.org/

Trinity River Authority
http://www.trinityra.org/

Upper Colorado River Authority (UCRA)
www.ucra-tx.org/index.html

Councils of Governments and Regional Agencies

North Central Texas Council of Governments (NCTCOG) Nonpoint Source
http://www.dfwinfo.com/index.asp

Stormwater Management: www.dfwstormwater.com/index.html

Lower Rio Grande Valley Development Council
www.lrgvdc.org/

Texas Association of Regional Councils
http://www.txregionalcouncil.org/

Cities

City of Austin–Watershed Protection
www.ci.austin.tx.us/watershed/

Fort Worth–Environmental Management Department
http://ci.fort-worth.tx.us/dem/

San Antonio Water System, Watershed Protection
www.saws.org/our_water/Source_Water_Watershed_Protection/

SAWS Well Project: www.saws.org/our_water/Source_Water_Watershed_Protection/GroundwaterProtection/319grant/

Universities and Research Organizations

Center for Research in Water Resources
www.ce.utexas.edu/centers/crwr/home.html

Texas Agricultural Extension Service Resource Center
http://texaserc.tamu.edu/catalog/

Texas Institute for Applied Environmental Research (TIAER)
http://tiaer.tarleton.edu

Texas Water Resource Institute
http://twri.tamu.edu/

Federal Agencies

Environmental Protection Agency–Wetlands, Oceans, and Watersheds
www.epa.gov/OWOW/

Electronic Grant Processing: www.epa.gov/ogd/integrated_grants_management_system.htm

Best Nonpoint Source Documents:
http://www.epa.gov/owow/nps/bestnpsdocs.html#nps

USDA - Natural Resource Conservation Service (NRCS)
www.nrcs.usda.gov/

United States Army Corps of Engineers
http://www.usace.army.mil/index.html

United States Fish and Wildlife Service
http://www.tws.gov/

United States Geological Survey (USGS) in Texas
http://tx.usgs.gov/

Acronyms Used in the Report

ANRA - Angelina–Neches River Authority
BMP - best management practice
BRA - Brazos River Authority
CBBEP - Coastal Bend Bays Estuary Program
CRMWA - Canadian River Municipal Water Authority
CRMWD - Colorado River Municipal Water District
CRP - Clean Rivers Program
CRWR - Center for Research in Water Resources
CWA - Clean Water Act
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane
DMES - Dairy Manure Export Support
EAPP - Edwards Aquifer Protection Program
EPA - Environmental Protection Agency
EQIP - Environmental Quality Incentives Program
GBEP - Galveston Bay Estuary Program
GBRA - Guadalupe–Blanco River Authority
GLO - General Land Office
H-GAC - Houston–Galveston Area Council
IBWC - International Boundary and Water Commission
LCRA - Lower Colorado River Authority
LNVA - Lower Neches Valley Authority
MCL - maximum contaminant level
MTBE - methyl tertiary butyl ether
NETMWD - Northeast Texas Municipal Water District
NOAA - National Oceanic and Atmospheric Administration
NPS - nonpoint source
NRCS - United States Department of Agriculture–Natural Resource Conservation Service
OSSF - on-site sewage facilities
PARD - Parks and Recreation Department
PCBs - polychlorinated biphenyls
PPG - Performance Partnership Grant
PSOC - potential source of contamination
RC&D - Resource Conservation and Development
RRA - Red River Authority
RRC - Railroad Commission
SARA - San Antonio River Authority
SAWS - San Antonio Water System
SRA - Sabine River Authority
SWAP - Source Water Assessment and Protection
SWCD - Soil and Water Conservation District
SWQM - surface water quality monitoring
TAES - Texas Agricultural Experiment Station
TCE - Texas Cooperative Extension
TDA - Texas Department of Agriculture
TDH - Texas Department of Health

TES - Teaching Environmental Science
TFS - Texas Forest Service
TIAER - Texas Institute for Applied Environmental Research
TMDL - total maximum daily load
TNRCC - Texas Natural Resource Conservation Commission
TPWD - Texas Parks and Wildlife Department
TRA - Trinity River Authority
TRWA - Texas Rural Water Association
TSSWCB - Texas State Soil and Water Conservation Board
TWDB - Texas Water Development Board
TxDOT - Texas Department of Transportation
UCRA - Upper Colorado River Authority
USGS - United States Geologic Survey
VOCs - volatile organic compounds
WQMP - water quality management plan