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SFR-066/10
January 2011

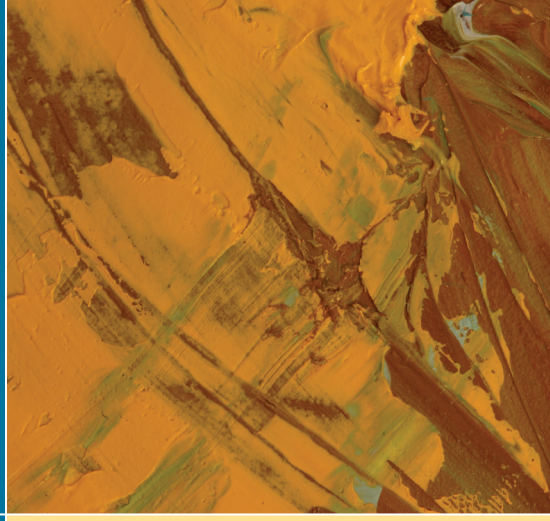
Texas Commission on Environmental Quality

Managing NONPOINT SOURCE POLLUTION IN TEXAS

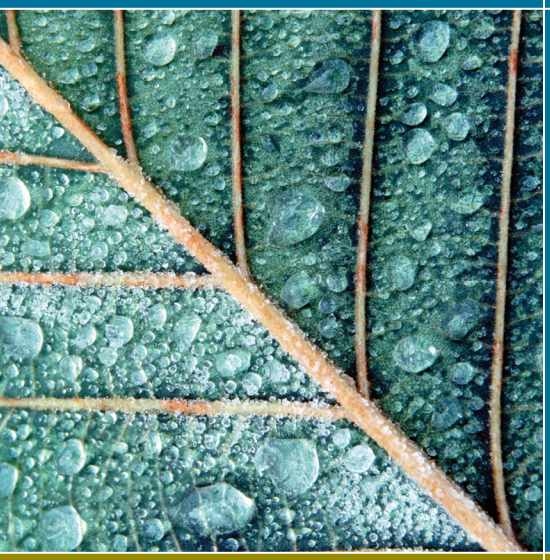
2010 ANNUAL REPORT

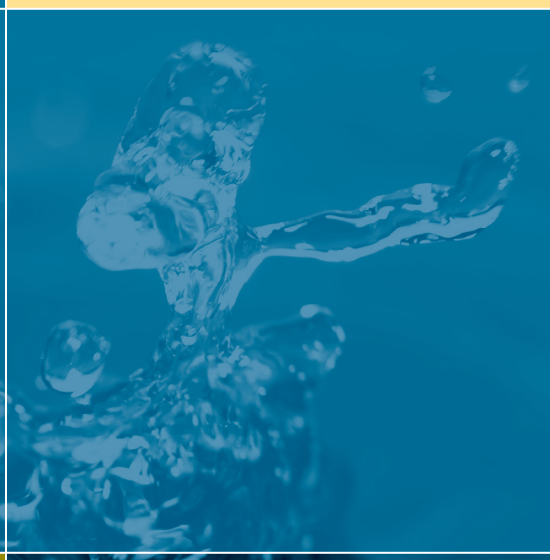
Texas State Soil & Water Conservation Board

Funding provided by the Environmental Protection Agency through Clean Water Act Section 319(h) grant funds



MANAGING NONPOINT SOURCE POLLUTION IN TEXAS





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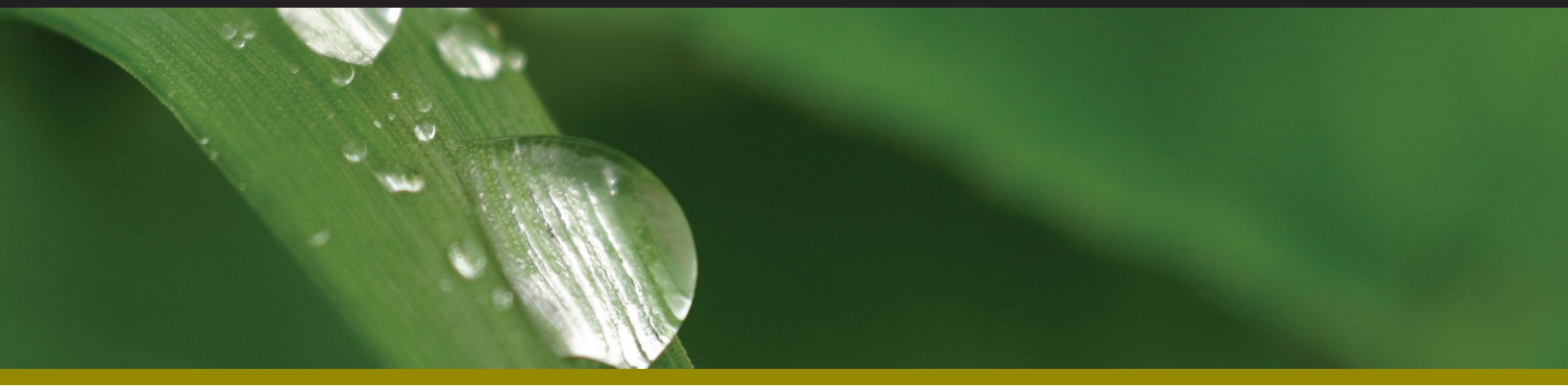

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From the Executive Directors

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The State of Texas *Nonpoint Source (NPS) Management Program* is the state's official blueprint to protect and restore water resources impacted by nonpoint sources of pollution and is jointly developed and administered by the TCEQ and the TSSWCB. The NPS Management Program works with baseline water quality management programs and uses regulatory, voluntary, financial, and technical assistance approaches to achieve a balanced program. The TCEQ and TSSWCB have established goals and objectives for guiding and tracking the progress of NPS management in Texas. The EPA provides grant funding to Texas to implement the NPS Management Program. Success in achieving its goals and objectives are reported annually in this document, which is submitted to EPA in accordance with Section 319(h) of the federal Clean Water Act.

NPS pollution continues to be a focus area for improving water quality in the state. The *2010 Draft Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)* identifies 621 water bodies as impaired, and NPS pollution is identified as a source contributing to approximately 75 percent of those impairments. Considering the extent and variety of NPS issues throughout Texas, cooperation across political boundaries is essential. Many local, regional, state, and federal agencies play an integral part in managing NPS pollution, especially at the watershed level. They compile information about local concerns and infrastructure and build support for the controls that are necessary to prevent and reduce NPS pollution. By establishing coordinated frameworks to share information and resources, the state can more effectively focus its water quality protection and restoration efforts.

We are pleased to present the *2010 Annual Report* of the state's NPS Management Program. The Report documents our progress during 2010 in meeting the goals of the program. In partnership with the EPA and other federal, state, regional, and local watershed stakeholders, the TCEQ and the TSSWCB welcome input into the planning and implementation of the program and look forward to its continued growth and success.

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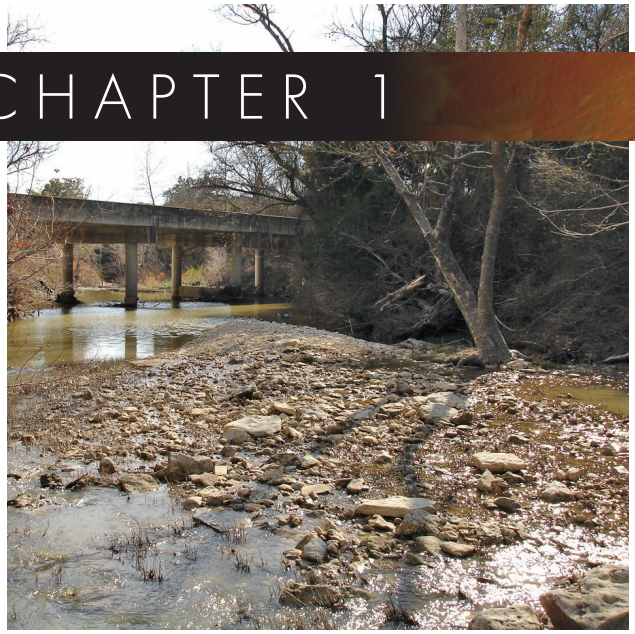
CHAPTER 1



Trimmier Creek, tributary to the Lampasas River/photo by the City of Killeen

Introduction

Defining Nonpoint Source Pollution

Nonpoint source (NPS) pollution is all water pollution that does not come from point sources. Point sources are regulated "end-of-pipe" outlets for wastewater or storm water from industrial or municipal treatment systems.

NPS pollution occurs when rainfall or snowmelt flows off the land, roads, buildings, and other features of the landscape. This runoff carries pollutants into drainage ditches, lakes, rivers, wetlands, coastal waters, and even underground sources of drinking water. NPS pollution also includes flow of polluted water from non-permitted sources such as car washing and leaking septic tanks. Common NPS pollutants include:

- fertilizers, herbicides, and insecticides from agricultural lands and residential areas
- oil, grease, and toxic chemicals from spills, roads, urban areas, and energy production
- sediment from construction sites, crop and forest lands, and eroding stream banks
- bacteria and nutrients from livestock, pet waste, and leaking septic systems

Some NPS pollution orginates as air pollution deposited onto the ground and into waterways (atmospheric deposition). Changes in the flow of waterways due to dams and other structures (hydromodification) can also cause NPS pollution.

What Guides Nonpoint Source Pollution Management in Texas?

Under the federal Clean Water Act (CWA), Texas and other states must establish water quality standards for waters in the state, regularly assess the status of water

Nonpoint source pollution in the Westfield Estates watershed of Halls Bayou/photo by Justin Bower of H-GAC

quality, and implement actions necessary to achieve and maintain those standards. The mission of the *Texas NPS Management Program* is to protect the quality of the state's water resources from the adverse effects of NPS pollution. This protection is provided through cooperative implementation using the organizational tools and strategies defined below.

Partnerships

The Texas Commission on Environmental Quality (TCEQ) is designated by law as the lead state agency for water quality in Texas. The Texas State Soil and Water Conservation Board (TSSWCB) is the lead agency in the state for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural NPS pollution. The TCEQ administers the NPS Program for all other sources of NPS pollution.

Management of NPS pollution in Texas involves partnerships with many organizations to coordinate, develop, and implement the *Texas NPS Management Program*. With the extent and variety of NPS issues across Texas, cooperation across political boundaries is essential. Many local, regional, state, and federal agencies play an integral part in managing NPS pollution, especially at the watershed level. They provide information about local concerns and infrastructure and build support for the pollution controls that are necessary to prevent and reduce NPS pollution. By coordinating with these partners to share information and resources and to develop and implement strategies together, the state can more effectively focus its water quality protection and restoration efforts.

The Texas Nonpoint Source Management Program

The program publication is currently under revision. The *NPS Management Program* is required by Section 319(b) of the federal CWA and prepared jointly by TCEQ and TSSWCB. The *Texas NPS Management Program*, approved by both the TCEQ and the TSSWCB in 2005 <www.tceq.state.tx.us/goto/nps-report> is the state's official roadmap for addressing NPS pollution and presenting the goals, priorities, programs, and milestones for the program.

Pages 12-16 of the *Texas NPS Management Program* present goals and objectives for addressing NPS pollution in the state. *The Texas NPS Management* Program utilizes a balanced approach incorporating baseline water quality management programs and regulatory, non-regulatory, financial, and technical assistance approaches. The goals describe high-level guiding principles for all activities under the Program. The objectives specify the key methods used to accomplish the goals. The *NPS Annual Report*, which is required by CWA Section 319(m), provides an annual update of progress toward meeting the goals and milestones set forth in the *Texas NPS Management Program*. Additionally, the *Annual Report* briefly summarizes the state's NPS Program and how it is integrated with the state's other water quality programs.

Goals for Nonpoint Source Management

Long-Term Goal

The long-term goal of the *Texas NPS Management Program* is to protect and restore water quality from NPS pollution through assessment, implementation, and education.

Education for bacteria sources in the Upper San Antonio River/photo courtesy of SARA

Short-Term Goals

Goal One—Data Collection and Assessment

Coordinate with appropriate federal, state, regional, and local entities, private sector groups and citizen groups and target CWA Section 319(h) grant funds towards water quality assessment activities in high priority, NPS-impacted watersheds, vulnerable and impacted aquifers or areas where additional information is needed.

Goal Two—Implementation

Coordinate and administer the Texas NPS program to support the implementation of Total Maximum Daily Load (TMDL) Implementation Plans (I-Plans) and/or Watershed Protection Plans (WPPs) and other state, regional, and local plans and programs to reduce NPS pollution. Manage all CWA Section 319(h) grant funds efficiently and effectively to target implementation activities to the areas identified as impacted, or potentially degraded by NPS pollution.

Goal Three—Education

Conduct education and technology transfer activities to help increase awareness of NPS pollution and prevent activities contributing to the degradation of water bodies, including aquifers, by NPS pollution.

City of Austin data collection

The Watershed Approach

Protecting the state's streams, lakes, bays, and aquifers from the impacts of NPS pollution is a complex process.

Texas uses a watershed approach to focus efforts on the highest priority water quality issues of both surface water and groundwater. The watershed approach is based on the following principles:

- geographic focus based on hydrology rather than political boundaries
- water quality objectives based on scientific data
- coordinated priorities and integrated solutions
- diverse, well-integrated partnerships
- For groundwater management, the geographic focus is on aquifers rather than watersheds. The approach for addressing groundwater is based on the same principles used to address surface water. Wherever interactions between surface water and groundwater are identified, management activities will support the quality of both resources.

Plum Creek watershed/photo by Nikki Dictson

CHAPTER 2

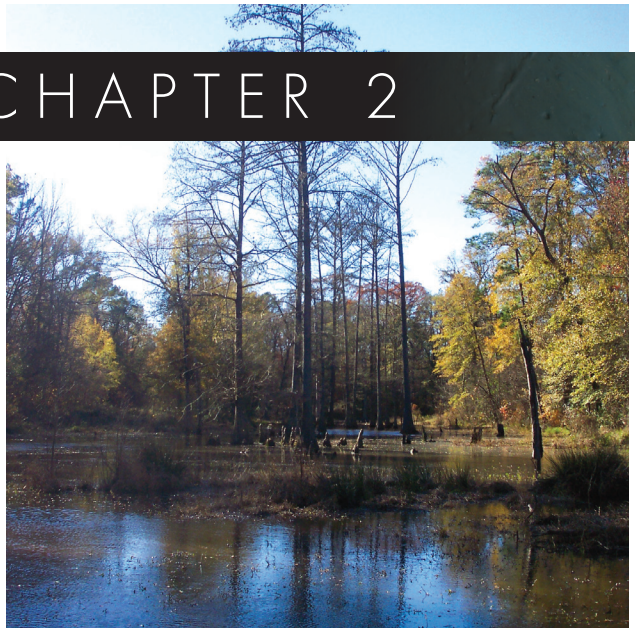


photo by Lee Thomas of the Northeast Texas Municipal Water District

Progress in Improving Water Quality

Section 319(h) of the CWA requires that state NPS annual reports include, "…to the extent that appropriate information is available, reductions in nonpoint source pollutant loading and improvements in water quality… resulting from implementation of the management program." This specifically applies to the water bodies of the state that have previously been identified as requiring NPS pollution control actions in order to "…attain or maintain applicable water quality standards or the goals and requirements of the Clean Water Act."

The two primary ways of measuring improvement in water quality are:

- reductions in pollutant loadings resulting from management measures implemented, estimated with the help of models or other calculations
- water quality improvements measured by changes in pollutant concentrations before and after implementation of management measures

Other indicators of progress toward water quality improvements include land use or behavioral changes that are associated with reductions in loadings or pollutant concentrations in water bodies. Examples include restored riparian or aquatic vegetation and reduced use of fertilizers and pesticides.

Measuring the Effectiveness of Best Management Practices

Assessing Water Quality Management Plan Implementation in the Middle and South Bosque River and Hog Creek Watersheds

The Middle and South Bosque Rivers, Segment 1246, have concerns for elevated nitrates, as does Lake Waco, the receiving water body for the Middle and South Bosque Rivers and Hog Creek. While nitrogen is an essential nutrient for aquatic life,

excessive nitrates can lead to conditions that make it difficult for aquatic insects and fish to survive due to excessive algal growth. High nitrate levels can also lead to human health problems, particularly for infants, if used as drinking water. However, for the Middle and South Bosque Rivers and Hog Creek, aquatic life issues are the concern.

To address this concern, the TSSWCB and McLennan County Soil and Water Conservation District (SWCD) are providing technical and financial assistance to aid landowners in the development and implementation of Water Quality Management Plans (WQMP). A WQMP is a site-specific plan developed through and approved by SWCDs that includes appropriate land treatment practices, production practices, management measures, and technologies that prevent and abate agricultural NPS pollution.

Water quality monitoring is being conducted to evaluate the impact of best management practices (BMP) implemented along the Middle and South Bosque Rivers and Hog Creek on decreasing NPS contributions of nitrates. This monitoring comprises both routine grab sampling and measurement of storm water runoff for nutrients and total suspended solids (TSS) as well as chlorophyll *a* and bacteria monitoring with routine grab samples. Chlorophyll *a* is monitored as an indicator of the amount of algae in the water.

While the project is not yet complete, a preliminary review of the data indicates lower concentrations of nitrates in recent years compared to historical data. These decreases coincide with landowner efforts to implement BMPs in the watersheds.

Reductions in Pollutant Loadings

Lower Colorado River Authority's Creekside Conservation Program

The Creekside Conservation Program, administered by the Lower Colorado River Authority (LCRA), is a partnership between LCRA, private landowners, the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), and local SWCDs. The Creekside Conservation Program provides a cost-share incentive to help reduce soil erosion and agricultural NPS pollution on privately owned land. The Creekside Conservation Program is being conducted in Bastrop, Blanco, Burnet, Colorado, Fayette, Lampasas, Llano, Matagorda, San Saba, Travis, and Wharton Counties.

In fiscal year 2010, this effort placed 39,124 acres under conservation management. BMPs installed in the last year included 321 acres of rangeland reseeding, seven acres of pasture planting, nine ponds or grade stabilization structures, 59,456 linear feet of cross fencing, 1,571 acres of brush management, and a water well. According to the Spreadsheet Tool for Estimating Pollutant Loads (STEPL) modeling, these BMPs achieved the following load reductions:

Sediment	6,616 tons
Phosphorus	22,147 lbs
Nitrogen	207,798 lbs

In addition to technical and financial assistance, LCRA hosted five field days and over 20 presentations. The Creekside Conservation Program was also selected as a finalist in the agricultural category for the TCEQ's 2010 Texas Environmental Excellence Award Program.

Implementing Agricultural Best Management Practices in the Arroyo Colorado Watershed

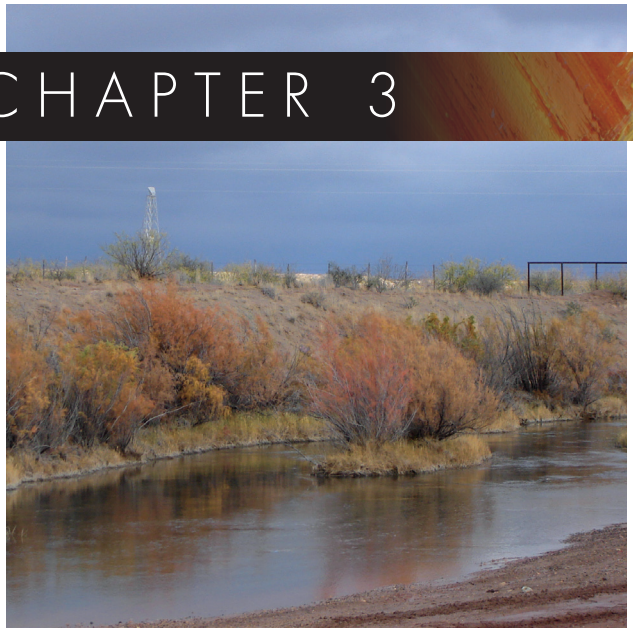
The Arroyo Colorado flows through Hidalgo, Cameron, and Willacy Counties in the Lower Rio Grande Valley of Texas into the Laguna Madre. Flow in the Arroyo Colorado is sustained by wastewater discharges, agricultural irrigation return flows, urban runoff, and base flows from shallow groundwater. To address the Arroyo Colorado's bacteria and dissolved oxygen (DO) impairments as well as nutrient concerns, the Arroyo Colorado Watershed Partnership developed *A Watershed Protection Plan for the Arroyo Colorado–Phase I*. For more information regarding the Arroyo Colorado WPP, please see Chapter 4 of this report.

The Arroyo Colorado WPP calls for the voluntary adoption of agricultural BMPs on 33 percent of the irrigated cropland within the watershed by 2010 and 50 percent by 2015. In response, the Southmost and Hidalgo SWCDs received a CWA Section 319(h) grant through the TSSWCB to provide technical and financial assistance to implement BMPs on agricultural land in the Arroyo Colorado.

Over the past year, nine WQMPs were developed covering 1,018 acres. The BMPs being implemented include irrigation land leveling, residue management, conservation crop rotation, nutrient management, pasture planting, and prescribed grazing. According to the STEPL modeling, these BMPs provided the following load reductions:

Sediment	122 tons
Phosphorus	724 lbs
Nitrogen	5,711 lbs

CHAPTER 3



Pecos River near Imperial

Progress toward Meeting the Goals and Objectives of the Texas Nonpoint Source Management Program

The TCEQ and TSSWCB have established goals and objectives for guiding and tracking the progress of NPS management in Texas. The goals describe high-level guiding principles for all activities under the *Texas NPS Management Program*. The objectives specify the key methods that will be used to accomplish the goals. Successes in achieving the goals and objectives are reported annually in this report, which is submitted to the U.S. Environmental Protection Agency (EPA) in accordance with CWA requirements. Although not comprehensive, this chapter reports on a variety of programs and projects that directly support the goals and objectives of the *Texas NPS Management Program*.

Clean Water Act Section 319(h) Grant Program

Section 319(h) of the CWA established a grant that is awarded annually by Congress to the EPA. The EPA allocates these funds to the states to implement activities supporting the congressional goals of the CWA. The TCEQ and the TSSWCB target these grant funds toward NPS activities consistent with the long- and short-term goals defined in the *Texas NPS Management Program*.

Status of Clean Water Act Section 319(h) Grant-Funded Projects

In fiscal year 2010, the TCEQ had 45 active multi-year CWA Section 319(h) grant-funded projects which had a total budget of approximately $15.1 million

in federal funds, addressing a wide range of NPS issues (Figure 3.1). These projects focus on the development and implementation of WPPs and TMDLs where the primary sources of NPS pollution are not agricultural or silvicultural. General implementation project types include urban storm water retrofits, on-site sewage facility (OSSF) upgrades, public education and outreach projects, demonstration projects, and a variety of other BMPs chosen on the basis of local water quality needs.

In fiscal year 2010, the TSSWCB had 52 active multi-year CWA Section 319(h) grant-funded projects which had a total budget of approximately $15 million in federal funds addressing a wide array of agricultural and silvicultural NPS issues (Figure 3.2). Specific project actions include developing and implementing WPPs and TMDLs, supporting targeted educational programs, and implementing BMPs to abate NPS pollution from dairy and poultry operations, silvicultural activities, grazing operations, and row crop operations.

Figure 3.1.
TCEQ Current Nonpoint Source Grant-Funded Projects

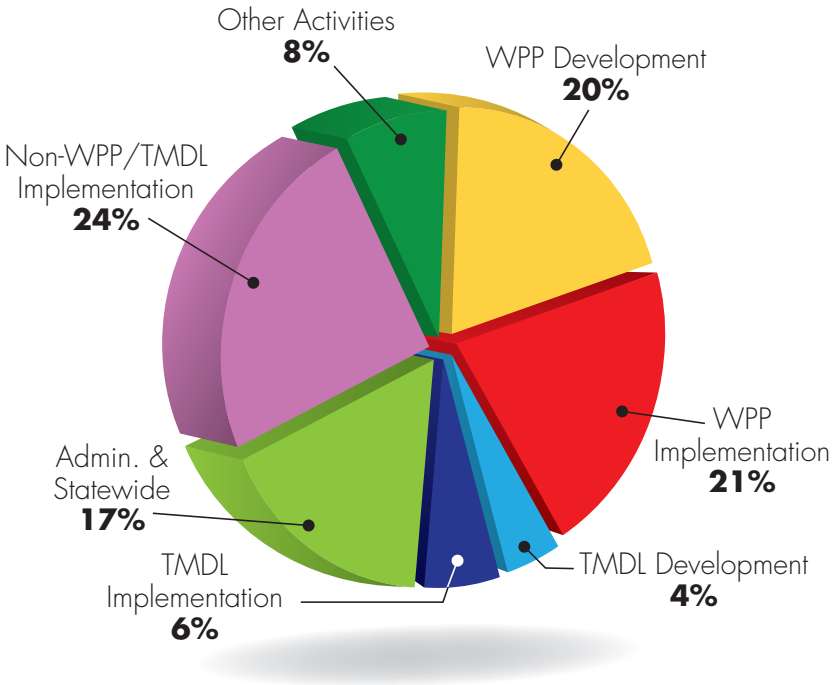
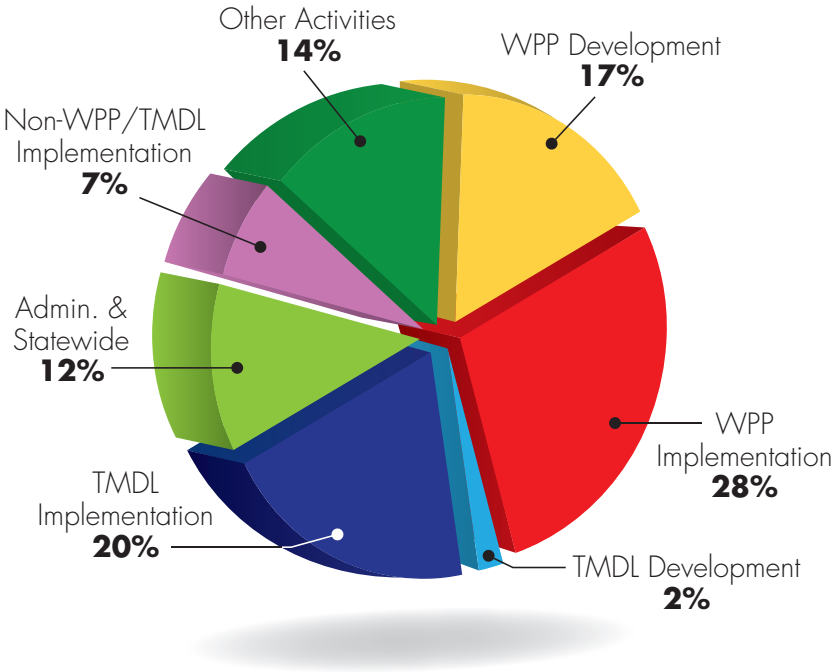


Figure 3.2.
TSSWCB Current Nonpoint Source Grant-Funded Projects



Short-Term Goals and Milestones of the Texas Nonpoint Source Management Program

Goal One—Data Collection and Assessment

One of the goals of the *Texas NPS Management Program* is to collect

and assess water quality data. Data collection requires the coordination of appropriate federal, state, regional, and local entities as well as private sector and citizen groups. The TCEQ's Surface Water Quality Monitoring (SWQM) program, operating from the central office and 16 regional offices, conducts both routine ambient monitoring and special studies. In addition, the Clean Rivers Program (CRP), a collaboration between the TCEQ and 15 regional water agencies, collects surface water quality data throughout the state in response to both state needs and local stakeholder interests. Furthermore, the TCEQ acquires water quality data from other state and federal agencies, river authorities, and municipalities after assuring the quality of the data are comparable to that of data collected by the TCEQ's programs.

Data are assessed by the TCEQ to determine if a water body meets its designated use(s) or if water quality improvement activities are achieving their intended goals. For impaired waters, water quality data can be used in the development of WPPs and TMDLs. Data are also used to determine sources of pollution and the adequacy of regulatory measures, watershed improvements, and restoration plans. The data collection primarily guides the distribution of CWA Section 319(h) grant funds toward water quality assessment activities in high priority, NPS-impacted watersheds, vulnerable and impacted aquifers, or areas where additional information is needed.

Texas Integrated Report

Section 305(b) of the CWA requires all states to assess the quality of surface waters every two years. The 2010 Draft *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)* (IR) describes the status of surface water bodies of the state evaluated for the given assessment period. To accomplish this, the TCEQ uses data collected during the most recent seven to ten-year period. The descriptions of water quality present a snapshot of conditions during the limited time period considered in the assessment. Water bodies identified as impaired by NPS pollution are given priority for CWA Section 319(h) grants and other available funding. Guidance for developing the assessment is based on a set of methods that apply the Texas Surface Water Quality Standards (TSWQS), or goals for water quality. These methods are developed by the TCEQ with the advice of a diverse group of stakeholders, and are detailed in the *Draft 2010 Guidance for Assessing and Reporting Surface Water Quality in Texas* (available online at <www.tceq.state.tx.us/assets/public/compliance/monops/water/10twqi/2010_guidance.pdf>).

The 303(d) List is an important management tool produced as part of the assessment. It identifies waters for which the existing preventative measures, such as permits that limit discharge of wastewater and the technology used by the dischargers, are not sufficient to meet TSWQS. The Draft 2010 IR is subject to review and approval by the EPA.

Categories Indicate Water Quality Status

The Draft 2010 IR assigns each assessed water body segment to one of five categories in order to report water quality status and management information to the public, the EPA, state agencies, federal agencies, municipalities, and environmental groups. These categories indicate the status of a water body segment and describe how the state will approach identified water quality problems. Table 3.1 defines the five categories and shows the number of water bodies assigned to each assessment category in 2010.

Water bodies on the 303(d) List (Category 5 of the IR) are those water bodies that require remedial action by the state to restore water quality. For water bodies in Category 5a, the state must develop a TMDL and a plan to implement it. Water bodies in Category 5b require a review against TSWQS and those in Category 5c require additional monitoring to further define the impairment. Table 3.2 shows the total number of impairments in the water bodies requiring remedial action.

The categories must be applied to each combination of designated use and criteria, or parameter, for determining support. The combination of the use with the pollutant or condition of concern is called an *impairment*. For example, the concentration of DO is one of the criteria used to determine the support of the aquatic life use. If DO concentrations are too low, the water body being evaluated will have an aquatic life use impairment. Since a water body has multiple uses, it may fall into different categories for different uses. In that case, the overall category for the water body is the one with the highest category number.

Table 3.1.
Number of Water Body Segments Assigned to Each Assessment Category in the Draft 2010 Integrated Report

Category	Definition	Water Body Classification		Number of Water Bodies
		Classified	Unclassified	
1	Attaining the water quality standard and no use is threatened.	10	23	33
2	Attaining some of the designated uses, no use is threatened, and insufficient information, or none, is available to determine if the remaining uses are attained or threatened.	184	221	405
3	Insufficient information, or none, to determine if any designated use is attained. Many of these water bodies are intermittent streams and small reservoirs.	14	267	281
4	The standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.	17	38	55
5	The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.	149	291	440
Totals		**374**	**840**	**1,214**

Table 3.2.
Number of Impairments in the Draft 2010 Integrated Report Requiring Remedial Action

Category	Definition	Water Body Classification		Total Number of Impairments
		Classified	Unclassified	
5	5a—TMDL scheduled or underway	89	96	185
	5b—Water Quality standards review scheduled or under way or undergoing use attainability analysis	74	174	248
	5c—Need additional monitoring	100	88	188
Total Number of Impairments in Category 5		**263**	**358**	**621**

Summary of the Draft 2010 Integrated Report

Beginning in 2009, the TCEQ assessed data from both classified and unclassified water bodies for the Draft 2010 IR in contrast to the 2008 IR where only unclassified waters were evaluated. The Draft 2010 IR included 1,214 (374 classified, 840 unclassified) water bodies. Enough data was available to determine at least one use attainment for 933 of these water bodies.

Of the 933 water bodies, 440 were included as Category 5 water bodies. This was a slight increase from the 2008 303(d) List which included 386 water bodies. The total number of impairments also increased from 516 to 621 (Table 3.3). Public

comment was solicited from February 8 through March 5, 2010 and the Draft 2010 IR was approved for submission to the EPA by the TCEQ on August 25, 2010.

Summary of 2010 Impairments

Impairments identified in the Draft 2010 IR have been grouped by the cause and the beneficial use of the water body affected (Table 3.3). Elevated levels of bacteria cause 52 percent of the listed impairments. Many of these bacteria impairments are the result of urban and agricultural NPS pollution. Low DO, impairing many of the same water bodies, results in an unhealthy environment for aquatic life. DO levels can be affected by both point source and NPS oxygen-demanding substances, including nutrients, which overfertilize aquatic plants and algae. Contaminants in fish tissue originate primarily from the landscape. For example, heavy metals and organic contaminants such as pesticides are often components of runoff from urban and agricultural land.

Continuous Water Quality Monitoring Network

In 2001, the TCEQ established a continuous water quality monitoring network (CWQMN). The purpose of the network is to use advanced technologies to enhance the state's SWQM program. CWQMN sites are designed to meet site-specific data needs. Most sites monitor conventional parameters such as temperature, pH, DO, and specific conductance. Several of the sites can also monitor nutrients, turbidity, and/or chlorophyll.

Table 3.3.
Summary of Impairments Identified on the 303(d) List for the Draft 2010 Integrated Report

Impairment Group	Media	2008 Number of Impairments	2010 Number of Impairments	Use
Bacteria	in water	274	303	Recreation
	in shellfish	21	15	oyster waters
	beaches	2	1	beach use
dissolved oxygen	in water	84	94	aquatic life
Toxicity	in ambient water	5	2	aquatic life
	in ambient sediment	6	6	
Organics	in water	0	0	fish consumption, aquatic life
	in fish or shellfish	34	94	
metals (except mercury)	in water	4	6	fish consumption, oyster waters, aquatic life
	in fish or shellfish	0	0	
Mercury	in water	1	1	fish consumption, oyster waters, aquatic life
	in fish or shellfish	17	23	
dissolved solids	chloride	16	13	General
	sulfate	6	9	
	total dissolved solids	8	13	
Temperature	in water	0	0	General
pH	in water	16	17	General
Nutrients	nitrogen	0	0	general, public water supply
Biological	habitat, macrobenthos community, or fish community	24	24	aquatic life
Totals		**516**	**621**	

The CWQMN collects and displays ambient water quality data in real time, meaning that the data collected in the field are reported almost immediately to the TCEQ. The stations, located throughout Texas, use a combination of *in situ* probes and automated analysis instruments. Data are transmitted from the stations to the TCEQ using phone modems, wireless modems, and satellite telemetry. Once data are transferred, they are stored in the Leading Environmental Analysis and Display System (LEADS) database. The data can be accessed by the public via the Web at <www.texaswaterdata.org>.

Figure 3.3 identifies the locations of 68 CWQMN sites in operation during fiscal year 2010. Three new sites were deployed in fiscal year 2010. The TCEQ worked to improve data return, data management, operator training, and instrument selection. TCEQ is in the early stages of incorporating measurement of bio-fouling and drift at selected sites. All these efforts will be continued in fiscal year 2011 and additional CWQMN sites may also be deployed.

The TCEQ maintains a prioritized list of continuous monitoring proposals for deployment in fiscal year 2011 and beyond. Personnel from water programs throughout the TCEQ, with input from cooperators outside the agency, base the list on the following criteria:

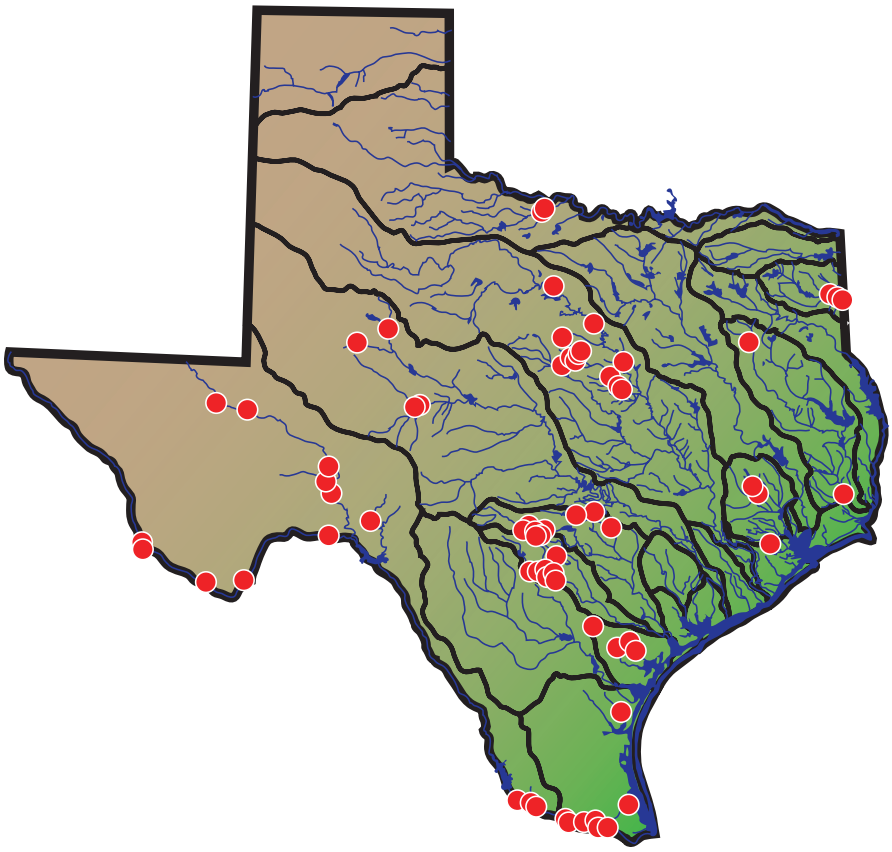
- demonstrated data needs
- availability of monitoring technology to address the specific data needs
- intended use of data
- availability of personnel—internal or external—for operation and maintenance (including data validation)

Numerous organizations have cooperated with the TCEQ in the CWQMN, including the following:

- Caddo Lake Institute
- Nueces River Authority
- San Antonio River Authority
- Bexar Metropolitan Water Supply
- City of San Antonio—Public Center for Environmental Health
- San Antonio Water Systems
- Toyota
- Waste Management, Inc.
- Colorado River Municipal Water District
- City Public Service Energy
- Water Monitoring Solutions
- Guadalupe Blanco River Authority
- United States Geological Survey
- Cow Creek Groundwater Conservation District
- South Texas Groundwater Alliance
- Barton Springs / Edwards Aquifer Conservation District
- Edwards Aquifer Authority
- United States International Boundary and Water Commission

Several of the CWQMN sites have been established based on a need to monitor NPS pollution. These include seven sites in the Bosque and Leon River watersheds, two Edwards Aquifer recharge monitoring sites, 18 sites in the Rio Grande Basin, and two sites in the Upper Colorado River watershed.

Figure 3.3.
Continuous Water Quality Monitoring Network Stations



Rio Grande Watermaster Continuous Water Quality Monitoring Network

Data from the CWQMN sites on the Rio Grande are used to assist with water use and agricultural production in the Rio Grande region. Mexico diverts irrigation water from the Rio Grande and San Juan River downstream of Falcon Reservoir. Agricultural return flows from these diversions reenter the river upstream of Anzalduas Reservoir.

The Anzalduas Reservoir is an important diversion point for irrigation water for both Texas and Mexico. When the agricultural return-flows from Mexico contain high concentrations of total dissolved solids (TDS) (> 1000 mg/L), Mexico can divert those flows around the Anzalduas Reservoir via a constructed bypass called the El Morillo Drain to a coastal lagoon and then to the Gulf of Mexico.

The TCEQ installed a CWQMN site on Anzalduas Reservoir at Hardwicke Farms in December 2006. The site monitors field parameters including temperature, pH, DO, and specific conductance. Water quality data are collected every 15 minutes and telemetered to the TCEQ database. Electronic notifications are automatically distributed when TDS concentrations are greater than 850 mg/L.

Based on these notifications, the Rio Grande Watermaster can request release of freshwater by the International Boundary and Water Commission (IBWC). The freshwater is released from upstream storage to dilute TDS to acceptable concentrations for irrigation purposes. The Watermaster also requests that the IBWC verify proper operation of the El Morillo Drain by Mexico. If Mexico does not release flows from the El Morillo Drain as scheduled, the waters released by IBWC are taken from Mexico's water allocation.

In fiscal year 2010, three additional sites were scheduled to be deployed, one site was scheduled to be relocated, and one site was scheduled to be upgraded. Two of the proposed new sites were deployed in June 2010. However, Hurricane Alex and subsequent flooding in July and August damaged or destroyed virtually all CWQMN sites in the Rio Grande Watermaster CWQMN. Reconnaissance of damage, repairs and deployments is tentatively scheduled for fiscal year 2011.

North Bosque River Watershed Assessment

Excessive nutrients, elevated chlorophyll *a* concentrations, and indicator bacteria levels exceeding TSWQS have been a concern in the North Bosque River watershed for over a decade. The TCEQ approved two TMDLs for phosphorus in the North Bosque River for Segments 1226 and 1255 on February 9, 2001. The TMDLs were subsequently submitted to and approved by the EPA. The TMDL I-Plan for the two North Bosque River segments was approved by the TCEQ in late 2002 and the TSSWCB in early 2003. Bacteria concerns continue in Segment 1255, which has resulted in that segment, and several of its tributaries, being listed on the Texas 303(d) list since 2002. The two approved phosphorus TMDLs and subsequent I-Plan focus on contaminants originating from municipal wastewater treatment facilities (WWTF), animal feeding operations (AFO), and animal waste application fields (WAF).

The North Bosque River Effectiveness Monitoring project is designed to obtain necessary water quality and stream flow data to allow assessment of the effectiveness of various BMPs and nutrient control activities that are either ongoing or scheduled for implementation in the North Bosque River watershed. Water quality monitoring, laboratory analysis, and statistical analysis of the data are all conducted by the Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University. Additional monitoring in the watershed is conducted by the TCEQ Regional staff and Brazos River Authority (BRA) staff under the CRP.

In the approved I-Plan, a number of efforts are presented to reduce phosphorus levels in the North Bosque River watershed. The four basic elements of phosphorus control identified in the plan are:

- phosphorus application rates on dairy WAFs
- reduced phosphorus diets for dairy cows to decrease phosphorus content of dairy waste
- removal of approximately half of the dairy-generated manure from the North Bosque River watershed for use or disposal outside the watershed
- effluent limits on phosphorus for municipal WWTFs

The monitoring activities of this project have consisted of automated storm water sampling at seven stream stations, bi-weekly ambient grab sampling at nine locations, and continuous stream flow measurement at eight stream stations. Both storm water and routine sampling are needed to evaluate NPS loadings as well as ambient stream concentrations.

The *Assessment of Water Quality Trends for the North Bosque River through 2009* report was completed by TIAER in August 2010 as part of this project. The report includes a review of the historical water quality data at each station and analyses of the data in terms of existing BMPs and land use practices within the watershed. The report also provides an evaluation of the data with respect to the phosphorus reduction goals specified in the approved TMDLs.

The statistical analyses indicate whether significant trends in water quality can be determined for a variety of water quality constituents that are related to the pollutant sources in the watershed. Trend analyses were conducted on data collected from 1993 through 2009 and included the following parameters: nitrite+nitrate-nitrogen, orthophosphate phosphorus, total kjeldahl nitrogen, total phosphorus, TSS, ammonia-nitrogen, total nitrogen, specific conductance, chlorophyll *a*, and *Escherichia coli (E. coli)* bacteria.

The "Summary and Discussion" section of the TIAER report states that, "…Trend results based on data through 2009 indicated several statistically significant, but relatively small (commonly less than one percent per year) decreasing trends in nutrients at stations within the North Bosque River watershed. …" In addition, the data analysis for 2009 shows that orthophosphate phosphorus concentrations are meeting the TMDL goals at four of the five TMDL Index sites. The only TMDL Index site not meeting the goal is the site upstream of Stephenville. The sites directly downstream of Stephenville show a significant reduction in phosphorus concentrations since the installation of phosphorus controls at the WWTF. Even though there was a reduction in phosphorus concentrations downstream of Stephenville, the sites located at the mid-point of the watershed, and those in the downstream portions of the watershed near Clifton and Valley Mills, actually showed a "…general increase in chlorophyll *a* concentrations in 2006 through 2009…" The report goes on to say, "While decreasing trends in nutrients and particularly ortho-phosphate phosphorus are being observed within the North Bosque River watershed, it is still unclear whether long-term weather patterns or changes in land management are the primary driving factors causing these trends with regard to nonpoint source contributions." To further clarify this relationship, continued effectiveness monitoring is needed.

Assessment of Nonpoint Source Pollutant Contributions from the City of Killeen Urbanized Area within the Lampasas River Watershed

The City of Killeen conducted a water quality assessment program in the Lampasas River watershed to identify priority sub-basins where pollutant concentrations exceed TSWQS and target these areas for implementation of BMPs. Water quality monitoring for this project was conducted from January 2008 through March 2009. Watershed pollutant sources were identified, mapped, and used in conjunction with the water quality data to identify priority areas for implementation of BMPs. This project addressed water quality parameters that are typically associated with urban NPS pollution including: *E. coli* bacteria, nutrients, biochemical oxygen demand (BOD) oil/grease, metals, suspended solids and physical properties such as water temperature, pH, DO, and specific conductance. Ambient monitoring was conducted at two main stem stream sites on the Lampasas River. Wet-weather monitoring was conducted at three sites on tributaries that receive urban runoff from the City of Killeen to characterize pollutant event mean concentrations. Two wet-weather monitoring sites were located on Reese Creek and one site was located on Trimmier Creek. Ten storm events were monitored during the study.

Assessment monitoring conducted on the Lampasas River/photo courtesy of the City of Killeen

Monitoring data indicated that *E. coli* concentrations at both Lampasas River sampling sites met TSWQS and no exceedances were observed. The maximum concentration that was

observed during this time period was 60 most probable number (MPN) per 100mL. Geometric mean concentrations of 7.89 and 13.9 MPN/100 mL were computed for the downstream and upstream sites, respectively. Geometric means were well below the TSWQS criteria of 126 MPN/100 mL. The results of a paired T-test indicated that the *E. coli* concentrations were statistically similar upstream and downstream of the Reese Creek confluence indicating that bacteria inputs from Reese Creek are not contributing to the bacteria impairment for Lampasas River Above Stillhouse Hollow.

All sites monitored during this study met TSWQS and no exceedances of water quality criteria or screening levels were observed. While not currently causing a use impairment, urbanization in the Trimmier Creek sub-basin is contributing to elevated concentrations of pollutants during storm events as compared to the more rural Reese Creek sub-basin. In general, event mean concentrations for sediment, nutrients, and BOD were higher in the Trimmier Creek sub-basin as compared to the Reese Creek sub-basins. Mean event mean concentrations for BOD, ammonia, and total kjeldahl nitrogen were 20 to 50 percent higher in the Trimmier Creek sub-basin. The mean event mean concentrations for soluble nutrients, nitrate+nitrite, and orthophosphorus were approximately three times greater in the Trimmier sub-basin. Higher sediment and nutrient loads may become an issue as future development occurs in the southern portions of Killeen's extraterritorial jurisdiction including the Trimmier, Onion, and Rock Creek watersheds, which drain to Lake Stillhouse Hollow.

Implementation of BMPs in Killeen's Storm Water Management Program that relate to construction and post-construction minimum control measures will begin in 2011 and will address some of the potential issues identified in this study.

Double Bayou Watershed Characterization

The West Fork of Double Bayou has been listed on the 2008 303(d) List due to DO and bacteria impairments. The goal of this project is to develop a Watershed Characterization Report for the East and West Forks of Double Bayou, focusing on water quality. The future goal is to use this characterization report for a WPP for Double Bayou.

The objectives of this project are to establish a baseline data set for the Double Bayou watershed, identify gaps in the baseline data set, implement additional data monitoring, perform data and model analysis, and conduct stakeholder processes. Water quality data will be evaluated to determine if data are adequate for evaluating annual and seasonal trends, spatial patterns, flow analyses and other relationship patterns. Land use-land cover (LULC) analysis of the watershed will also be conducted as part of this project to help identify gaps. A data monitoring plan will be developed and implemented with the USGS Texas Water Science Center - Gulf Coast Program to provide sufficient data for evaluating annual and seasonal trends, spatial patterns, flow analyses, and other relationship patterns. The monitoring plan's goals will be to define water quality problems, assess critical areas, and analyze data trends.

The initial baseline data inventory was completed in the fall of 2009, and the ensuing data gap analysis in early spring of 2010. Due to the small population present in the watershed, this watershed has only been featured in a handful of studies, and as a result has a very small initial baseline data set. Land use is mainly pasture, with

some agricultural crops, mostly in the form of rice farming. The watershed has an extensive network of rice irrigation canals as well as some channelized waterways that greatly alter the natural drainage pattern of the watershed. Oil and gas wells are scattered through the area, with a concentration of oil and gas wells situated near Monroe City. Land in the watershed is generally very flat.

Using the data collected from the baseline data set and the resulting gap analysis findings, a data monitoring plan was developed in spring of 2010. A total of four sites were selected for this project. Two sites are located on the West Fork Double Bayou with one of those sites located in an area of tidal influence. The other two sites are located on the East Fork Double Bayou with one site located in an area of tidal influence and the other site located in the northern most part of the watershed. The locations of the sites were determined based on initial land use analysis to optimize representative sampling of both bayous working within the scope of the project. It was determined that sampling would occur during two three-month seasonal periods: fall of 2010 and spring 2011.

An initial inventory list of stakeholders has been created, and several on the initial list have been contacted to discuss the project. Two of the stakeholders met with team members in the fall of 2009 to aid and direct in site selection for water quality monitoring. Lab results from the initial water quality sampling event will be completed towards the end of 2010, and these will be analyzed and presented at the first stakeholder workshop in 2011.

Highland Bayou Watershed Characterization

The Highland Bayou Coastal Basin refers to an area of bayous and waterways in southern mainland Galveston County. The basin covers almost 120 square miles and many of its waterways are influenced by the tides. Urbanized communities within the basin include Texas City, La Marque, Hitchcock, Santa Fe, Bayou Vista, and Tiki Island. Around these communities are sizeable areas of industrial activity, agriculture, rangeland, and recreational areas, as well as extensive estuaries, marshes, and coastal prairies.

The basin discharges into the Galveston Bay system via several bayous: Highland, Marchand, Moses, Basford, and the Carancahua Bayous. The Highland Bayou is the largest of these. The receiving waters of Galveston Bay and West Bay are impaired for elevated levels of bacteria in oyster-producing waters. The Highland and Marchand Bayous are listed on the 2008 303(d) list due to decreased levels of DO and for elevated levels of bacteria. The Highland Bayou runs 12.5 miles before it flows into the Bay. The Marchand Bayou is a tributary that joins the Highland. This project is designed to provide a coordinated framework for prioritizing protection and restoration strategies guided by environmental data and public concerns.

This project will establish a baseline data set for water quality and initiate several elements of a WPP. The project includes additional monitoring, sampling, analysis, and evaluation of water quality within the basin. A public participation process will be established to work with stakeholders and members of the public from the project area.

The project began in the spring of 2010 and will produce the Highland Bayou Coastal Basin Watershed Characterization Report. Water quality data is being evaluated against geospatial land data to identify possible pollutant sources, pollutant loads, and to determine data gaps. These gaps will be used to design and conduct a water quality monitoring program to provide sufficient data for evaluating seasonal trends, spatial patterns, flows, and other relationships around the bayous. A water quality model will be identified and used to examine and evaluate these relationships. Participation from the public will be critical to this planning process. Stakeholders will be identified to include community leaders, elected representatives, landowners, private citizens, not-for-profit organizations, and officials from governing agencies. The completed Watershed Characterization Report is an important step for restoring water quality within the coastal basin.

Watershed Protection Plans

The TCEQ and the TSSWCB apply the watershed approach to managing NPS pollution by supporting the development and implementation of WPPs. These plans are developed through local stakeholder groups who coordinate activities and resources to manage water quality. In Texas, WPPs facilitate the restoration of impaired

water bodies and/or the protection of threatened waters before they become impaired. These stakeholder-driven plans give the decision-making power to the local groups most vested in the goals specified in the plans. Bringing groups of people together through watershed planning efforts combines scientific and regulatory water quality factors with social and economic considerations. While WPPs can take many forms, the development of plans funded by CWA Section 319(h) grants must follow guidelines issued by the EPA. These guidelines can be found at: Nonpoint Source Program and Grants Guidelines for States and Territories, <www.epa.gov/fedrgstr/EPA-WATER/2003/October/Day-23/w26755.htm>.

In 2010, the TCEQ and the TSSWCB facilitated the development and implementation of WPPs (Table 3.4) throughout Texas by providing technical assistance and/or funding through grants to regional and local planning agencies and, thereby, to local stakeholder groups. A significant portion of the funding for preventing NPS pollution under the federal CWA is dedicated to the development and implementation of WPPs where NPS pollution has contributed to the impairment of water quality.There are also WPPs being developed or that have been developed in Texas independently of those listed in the table. The following list is not intended to be a comprehensive list of all the WPP efforts currently underway in Texas.

The following web link provides an overview and summary of WPPs in progress or completed in Texas by the TSSWCB, <www.tsswcb.state.tx.us/en/wpp>, and the TCEQ, <www.tceq.state.tx.us/goto/wpp>. Specific WPP activities are described in Chapter 4 of this report.

Table 3.4.
Texas Watershed Protection Plans

TCEQ WPPs	LINKS
Armand Bayou	www.armandbayou.org/
Arroyo Colorado	www.arroyocolorado.org/
Bastrop Bayou	www.h-gac.com/community/water/watershed_protection/bastrop/default.aspx
Brady Creek	www.ucratx.org/NPSBrady.html
Caddo Lake	www.netmwd.com/Caddo%20Lake%20Protection%20Plan/Caddo_index.html
Cypress Creek	www.cypresscreekproject.org/
Dickinson Bayou	www.dickinsonbayou.org/
Halls Bayou-Westfield Estates	www.h-gac.com/community/water/watershed_protection/westfield/default.aspx
Hickory Creek	www.cityofdenton.com/index.aspx?page=162
Lake Granbury	www.brazos.org/gbWPP.asp
San Bernard River	www.h-gac.com/community/water/watershed_protection/sanbernard/
Upper Cibolo Creek	www.ci.boerne.tx.us/index.aspx?nid=147
Upper San Antonio River	www.sara-tx.org/public_resources/library.php#water_quality_report/
TSSWCB WPPs	**LINKS**
Attoyac Bayou	attoyac.tamu.edu/
Buck Creek	buckcreek.tamu.edu /
Concho River	www.ucratx.org/CRiverRest_UCRA.html
Geronimo Creek	geronimocreek.org/
Granger Lake	www.tsswcb.state.tx.us/en/managementprogram/granger
Lampasas River	www.lampasasriver.org/
Leon River	www.brazos.org/LeonRiverWPP.asp
Pecos River	pecosbasin.tamu.edu/
Plum Creek	pcwp.tamu.edu/

Pet waste management in the Plum Creek Watershed/photo by the City of Kyle

Goal Two—Implementation

Texas Nonpoint Source Management Program Implementation

The second goal of the *Texas NPS Management Program* involves the management of CWA Section 319(h) grant funds and the leveraging of additional funds to efficiently and effectively target implementation activities to areas identified as impacted or at risk for being impacted by NPS pollution. Implementation activities are conducted with the goal of preventing and reducing NPS pollution in surface water, groundwater, wetlands, and coastal areas, through the execution of TMDL I-Plans, WPPs, recommendations from the *Joint Groundwater Monitoring and Contamination Report*, the Texas Groundwater Protection Strategy, the TSSWCB-certified WQMPs on agricultural and silvicultural lands, and other identified priorities. The following sections provide an update on various programs and projects that involve NPS implementation activities and are examples of additional funding that target NPS pollution.

Total Maximum Daily Loads and Implementation Plans

The state's TMDL program works to improve water quality in impaired or threatened water bodies in Texas. This program is a major component of the state's strategy for managing the quality of water in Texas streams, lakes, bays, and other surface waters. The federal mandate for state TMDL programs is contained in the Water Pollution Control Act and its amendments, also known as Section 303(d)(1)(C) of the CWA. The EPA's implementing regulations in Title 40, Code of Federal Regulations, Part 130, require states to identify waters where effluent limitations alone are not sufficient to meet water quality standards. The CWA further requires that, where point source controls are not sufficient to attain water quality standards, a TMDL must be established to account for and allocate loadings from point, nonpoint, and natural sources of pollution.

The TCEQ and TSSWCB are both responsible for developing TMDLs for Texas' water bodies. The TCEQ develops most TMDLs in Texas; however, the TSSWCB is involved in and may take the lead in developing TMDLs in watersheds where agriculture or silviculture are a significant percentage of land uses. The TCEQ and the TSSWCB coordinate closely on all TMDLs in which agricultural or silvicultural NPS pollutants are involved, no matter which agency leads TMDL development. Regardless of who develops a TMDL, the TCEQ has jurisdiction for managing the overall quality of surface waters in Texas. The TCEQ must therefore adopt all TMDLs developed for Texas and is responsible for submitting adopted TMDLs to the EPA for concurrence.

The state is committed to developing TMDLs in a timely manner and implementing all approved TMDLs. Implementation of TMDLs may require the TCEQ to impose new or revised limitations on the discharge of some pollutants in the permits issued under the Texas Pollutant Discharge Elimination System (TPDES). Where NPS pollution is identified, the state will work through the NPS Programs at the TSSWCB and TCEQ to encourage local implementation of voluntary actions that reduce the amount of pollutants entering waters.

It is essential to engage stakeholders in the watershed when developing plans to reduce pollution. Stakeholders—anyone whose interests may be affected by a TMDL project—provide the local expertise for identifying site-specific problems, targeting those areas for cleanup, and determining what measures will be most effective.

Stakeholders include, among others, permitted wastewater dischargers, municipal and county governments, regional or state governmental agencies, agricultural producers, recreational clubs, homeowners associations, environmental groups, industry groups and lobbyists, and interested individuals. Experts from local, regional, state, and federal agencies and universities also participate by giving technical and scientific support.

As of August 2010, the TCEQ had approved TMDL I-Plans for several streams, reservoirs, and estuaries that are impaired in part due to NPS pollution. Table 3.5 lists each I-Plan and its progress toward reaching the environmental goals defined in the corresponding TMDLs. The table also shows the project name, basins, and segment numbers, the designated use that has been affected, and the geographic extent of the impairment.

Table 3.5.
Total Maximum Daily Load Implementation Status

Implementation Plan	Basin and Segment(s)	Use Affected	Year Begun	Area of Impairment	Status
Aquilla Reservoir: atrazine	Brazos River; 1253	source for drinking water	2002	3,943 lake acres	Goals met; source water use restored; removed from the state's 303(d) List
Arroyo Colorado: legacy pollutants* and organics	Nueces–Rio Grande Coastal; 2202, 2202A	safety of fish consumption	2001	504 stream miles; 333 lake acres	Underway; some consumption advisories rescinded
Clear Creek: dissolved solids	San Jacinto–Brazos Coastal; 1102	general (not tied to a specific use)	2006	60 stream miles	General uses restored; removed from the state's 303(d) List
Colorado River below E.V. Spence Reservoir: dissolved solids	Colorado River; 1426	general (not tied to a specific use)	2007	66 stream miles	Some goals met
Dallas and Tarrant counties waterways: legacy pollutants*	Trinity River; 0805, 0841, 0841A	safety of fish consumption	2001	18,970 lake acres; 127 stream miles	Fish consumption use restored related to legacy pollutants, but use still restricted due to PCBs.
E.V. Spence Reservoir: dissolved solids	Colorado River; 1411	general (not tied to a specific use)	2001	29,000 lake acres	Some goals met
Fort Worth waterways: legacy pollutants*	Trinity River; 0806, 0806A, 0806B, 0829, 0829A	safety of fish consumption	2001	101 lake acres; 47 stream miles	Underway; Some goals met
Lake O' the Pines: low dissolved oxygen	Cypress Creek; 0409	support of aquatic life	2006	18,700 lake acres	Underway
North Bosque River: soluble reactive phosphorus	Brazos River; 1226, 1255	general (not tied to a specific use)	2002	121 stream miles	Underway; some goals met
Petronila Creek above tidal: dissolved solids	Nueces–Rio Grande Coastal; 2204	general (not tied to a specific use)	2007	44 stream miles	Some goals met

**Legacy pollutants* are chemicals that persist in the environment long after their use has been banned or severely restricted.

Bacteria Total Maximum Daily Loads

Bacteria from human and animal waste can indicate the presence of disease-causing microorganisms that pose a threat to public health. People who swim or wade in waterways with high concentrations of bacteria risk contracting gastrointestinal illnesses. High bacteria concentrations can also affect the safety of oyster harvesting and consumption. NPS pollution often contributes some of the bacteria loading to surface waters.

Of the 621 impairments listed in the Draft 2010 303(d) List for surface water segments in Texas, about half are for bacteria impairments to recreational water uses. The TCEQ has TMDLs under way, scheduled, or approved for most of the impaired segments in urban areas, and for about 40 percent of all recreational impairments.

Bacterial impairments are widespread in the Houston metropolitan area. By the end of September 2010, the TCEQ adopted 52 TMDLs in this area; all have been approved by the EPA. An additional 15 TMDLs are proposed for adoption in the metro area by December 2010. Together, the adopted and proposed TMDLs address about 21 percent of the state's impairments for contact recreation use.

The board and staff of the Houston–Galveston Area Council (H-GAC) formed the Bacteria Implementation Group (BIG) to develop an I-Plan for the Houston-area TMDLs. The BIG has wide and diverse regional participation, including participation by the TCEQ, and expects to discuss a draft I-Plan in December 2010. The TCEQ worked very closely with the BIG in developing the bacteria TMDLs for the Houston Metropolitan area and has also participated in developing the I-Plan. The BIG is the largest group formed so far to implement TMDLs; because of the size and population of the Houston Metropolitan Area, the I-Plan may affect a significant percentage of the state's residents.

Total Maximum Daily Load for Carters and Burton Creeks

Carters Creek and Burton Creek encompass a 57 square mile watershed located in central Brazos County that is rapidly changing due to the expanding urban-rural interface. Carters Creek is the larger of the two creeks; its headwaters begin just north of the City of Bryan and flow approximately 17 miles in a southeasterly direction to its confluence with the Navasota River. Burton Creek begins in the center of Bryan and flows east approximately four miles before its confluence with Carters Creek. Land uses in these watersheds differ in that the Burton Creek watershed is almost exclusively urbanized while Carters Creek is roughly 50 percent urban and 50 percent rural. Water quality monitoring indicates that these water bodies do not meet TSWQS due to elevated levels of bacteria and as a result have been included in recent 303(d) Lists.

With funding from the TCEQ TMDL Program, efforts to restore water quality in these water bodies include numerous agencies and local watershed stakeholders. Using data and information collected over the past several years, the TIAER developed and completed a technical support document that describes the water quality impairment in these watersheds, assesses the current pollutant loading, and sets allowable limits

for future pollutant loading. Concurrent with the development of the technical support document, the Texas Water Resources Institute (TWRI) has been working with local watershed stakeholders to foster an understanding of the water bodies' impairments and to advance the creation of an effective decision making group with the ultimate goal of developing a TMDL I-Plan for Carters and Burton Creeks. Efforts to engage stakeholders in the I-Plan development process over the past year have included two general stakeholder meetings, two urban source contributor meetings, and two coordination team meetings. Meetings focused on accomplishing primary goals in this first partial year of stakeholder engagement. These goals included informing the public of the water quality impairments and the process to restore water quality, along with organizing stakeholder groups into effective decision making teams or work groups. These work groups will develop management measures appropriate for their designated focus areas that will serve as content for the TMDL I-Plan.

Texas Coastal Nonpoint Source Pollution Control Program

Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) of the Coastal Management Act created a requirement for states and territories with federally approved Coastal Zone Management Programs to develop and implement a coastal NPS control program. The program is unique in that it establishes a set of management measures for states to use in addressing polluted runoff. The program is jointly administered by the National Oceanic and Atmospheric Administration (NOAA) and the EPA. Twenty-nine coastal states and territories (including Texas) are required to develop Coastal Nonpoint Pollution Control Programs. Section 6217 envisions a two-tiered management approach for NPS:

(1) implementation of management measures to protect coastal waters generally (i.e., technology-based approach)

(2) implementation of additional management measures needed to attain and maintain applicable surface water quality standards (i.e., water quality-based approach, TMDLs)

State coastal NPS programs must provide for implementation of management measures in conformity with guidance published by EPA and NOAA. Management measures are defined as economically achievable measures for addressing NPS pollution that reflect the greatest degree of pollutant reduction achievable through the application of the BMPs. BMP guidance has been developed for six main categories of NPS pollution: agriculture, forestry, hydromodification, marinas, urban areas and wetlands.

The Texas Coastal NPS program has been approved for all management measures except for the measures for operating on-site disposal systems, and for four urban measures: new development, existing development, watershed protection, and site development. The state continues to implement programs and projects in an effort to

gain full approval of its coastal NPS program. TCEQ has funded, or is actively seeking funding for, various projects that specifically address the remaining conditions of the state's coastal NPS program, including:

- CWA Section 319(h) grants totaling $1.9 million to address the inspection of on-site disposal systems.
- CWA Section 319(h), CWA Section 604(b), and Coastal Impact Assistance Program (CIAP) grants totaling $4.5 million to implement urban management measures in the coastal zone. Texas has also applied for an additional $1.8 million CWA Section 319(h), CWA Section 604(b), and CIAP grants to implement urban management measures in the coastal zone.

In addition, TCEQ expects that low impact development (LID) projects will benefit the coastal zone by documenting the costs and benefits of LID practices. It is anticipated that the favorable demonstration of the costs and benefits of LID practices will increase implementation of these practices in the state and the coastal zone in particular. Funding will also be provided for educational activities, technical assistance, and legal analyses needed to support the goal of widespread use of LID practices in urban areas of Texas.

The Galveston Bay Estuary Program

The Galveston Bay Estuary Program (GBEP) is part of a network of 28 National Estuary Programs in the United States working with local stakeholders to restore and protect estuaries that are threatened by pollution, development, and overuse. The GBEP is a partnership of stakeholders, which includes a 41 member advisory committee, the Galveston Bay Council, and its six standing subcommittees. The GBEP and its stakeholders implement a Comprehensive Conservation Management Plan, the *Galveston Bay Plan*. One of the highest priorities of the plan is controlling or eliminating NPS pollution. The *Nonpoint Source Pollution Action Plan* is the portion of the plan that was developed in order to reduce and eliminate NPS pollution entering Galveston Bay, including toxins, nutrients, pathogens, sediment, and oxygen-depleting substances. The specific goals of this action plan are to reduce NPS pollutant loads from industry, agriculture, construction, sewage, and marinas.

The GBEP provides technical and financial assistance through workshops, conferences, and grants to Galveston Bay area municipalities. GBEP encourages the use of storm water management initiatives that include public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site storm water runoff control, post construction storm water management in new developments, and pollution prevention for municipal operations. As an example, the GBEP provides financial and technical support to locally driven, watershed-wide management planning efforts to improve water quality, including streams listed as impaired for aquatic life use, contact recreation, and public health. Each plan focuses on solutions to NPS pollution problems, including the development of BMPs that will be implemented by local governments and citizens. Since 2005, non-regulatory, watershed management planning efforts have been initiated in the Galveston Bay area for Armand Bayou, Clear Creek, Dickinson Bayou, West Bay, Bastrop Bayou, Double Bayou, and Highland Bayou.

The WPPs for Armand and Clear Creek watersheds are pending completion of other monitoring and planning efforts in the watersheds. Additional bacteria data is being collected to evaluate the need to complete a TMDL for Armand Bayou. The Clear Creek WPP activities may continue after the completion of the bacteria TMDL and the development of the Houston area Bacteria I-Plan being coordinated by the H-GAC.

Projects in the watersheds of Highland and Marchand Bayous in Galveston County and Double Bayou in Chambers County are currently characterizing land uses, reviewing historic data, collecting new data, and initiating contact with local stakeholders. After this characterization phase, stakeholders in these watersheds will determine whether to complete the WPPs. American Recovery and Reinvestment Act (ARRA) funding is being used to complete the characterization phase of the projects.

West Bay is a unique watershed approach that is looking to protect the water quality of Chocolate Bayou, through preservation by acquisition or conservation easements. The Bastrop Bayou watershed is adjacent to West Bay. GBEP is a supporting partner through match funding and technical assistance to the H-GAC and the TCEQ in the development and implementation of the Bastrop Bayou WPP.

The Bastrop Bayou WPP draft was completed in fiscal year 2010 and is available on the H-GAC website at <www.h-gac.com/community/water/watershed_protection/bastrop/default.aspx>.

GBEP supports direct water quality implementation projects to improve water quality and encourage local governments to adopt water quality BMPs. Currently, GBEP is supporting the creation of a storm water treatment wetland on the University of Houston at Clear Lake campus. This fully monitored project will treat runoff from the university's parking lot. Additionally the project will test the feasibility of treating ambient water from an adjacent impaired bayou through a solar pump system. Also, GBEP has initiated two BMPs, a storm water treatment wetland and low water use project, in the City of League City.

In addition to developing WPPs, GBEP continues to support the region's annual Rivers, Lakes, Bays 'N Bayous Trash Bash, <www.trashbash.org/>, through funding and coordinating assistance. Trash Bash (Table 3.6) is an annual litter clean up event on local waterways that encourages voluntary public clean up and provides opportunities to educate the public about NPS pollution.

The Texas Groundwater Protection Committee and Pesticide Management

The Texas Groundwater Protection Committee (TGPC) was created by the Texas Legislature in 1989. It was formed as an interagency committee with representatives from nine state agencies and the Texas Alliance of Groundwater Districts. The TGPC strives to identify areas where new groundwater programs can be implemented or where existing programs can be enhanced. It works to protect groundwater as a vital resource by bridging the gaps between existing state groundwater programs and by improving coordination between member agencies. Specific management measures to which the TGPC focuses attention are described in *The Texas Groundwater Pesticide Management Plan* (*PMP*, 2001) and the *Texas NPS Management Program*.

Table 3.6.
2010 Trash Bash Results

Number of Cleanup Locations:	17
Total Number of Participants: Number of Participants under 18 years of age:	5,566 2,928
Total Number of Volunteer Hours: (H-GAC planning time not included)	15,899
Total pounds of trash collected: Total tons of trash collected:	208,555 104
Number of tires picked up and hauled away for proper disposal:	841
Total pounds of material recycled:	700
Miles of Shoreline Cleaned:	122

The focus of the *PMP* is on the implementation of management practices that prevent groundwater degradation by the use of pesticides or help to recover groundwater degraded by the use of pesticides. One useful tool for pesticide management is the TCEQ's *Interagency Pesticide Database (IPD)* which is an endeavor to compile groundwater pesticide monitoring data for the whole state. The *IPD* at its last update included data for more than 173,308 pesticides or other chemical analytes, from analyses on 8,294 groundwater samples, collected from 5,204 wells. Data was provided by 12 agencies and other entities.

Pesticide information is now also being included in the EPA's *Pesticides-Of-Interest Tracking System (POINTS)*, which is an on-line system for entering information on pesticides assessed by each state and tribe. The assessment process includes pesticide monitoring. 16 pesticides were assessed on the website in December 2008. 19 more were assessed in 2009, with another 22 scheduled to be assessed by the end of December 2010. During the 2010 monitoring period, a total of 22 wells were sampled in the Panhandle region. Another ten wells and one spring were sampled in the greater Dallas-Fort Worth metropolitan area, and one spring in Austin. Ten wells were also sampled at golf courses in and around Travis County and three counties to the east of Travis County. Additionally, 218 wells were sampled by the Texas Water Development Board (TWDB) and analyzed by the TCEQ by immunoassay analytical methods. Immunoassay analyses included five pesticides,

while laboratory analyses included up to four methods for 49 pesticides. A combined total of nearly 251 groundwater samples were collected, 801 immunoassay analyses, and 31 laboratory analyses were completed for pesticides in 2010.

Agricultural Chemicals Subcommittee

The Agricultural Chemicals Subcommittee (ACS) of the TGPC was created to be the primary vehicle for interagency coordination and communication regarding pesticide groundwater issues. The ACS provides guidance for the implementation of the PMP by suggesting avenues of investigation, by reviewing monitoring plans and reports, providing assessment materials, and by making response recommendations. Groundwater pesticide monitoring, which is a big part of pesticide management, has been carried out in the Texas Panhandle and urban areas. Specific monitoring in these areas included cotton crop areas, Public Water Supply wells with known atrazine detections, general urban wells, and golf course wells. This pesticide monitoring has primarily been performed by the TCEQ. Additional pesticide monitoring has been carried out through the Cooperative Monitoring Program primarily with the TWDB. In this program, immunoassay analytical methods are used to screen for pesticides across the state.

The ACS and TCEQ, supported by a recent EPA initiative, continue to focus on the management of pesticides by first assessing and classifying them as pesticides of interest (POIs) or pesticides of concern (POCs). Under this course the *PMP* still acts as the foundational guide, and groundwater pesticide monitoring still serves as a primary component in making assessments. The remaining 22 pesticides to be assessed in 2010 largely have no water quality standard or affordable analytical methods, thus TCEQ will utilize chemical characteristics to assess these pesticides. The PMP Task Force of the ACS continues to coordinate the assessment activities based on the EPA pesticide assessment initiative.

Clean Water State Revolving Fund Loans for Nonpoint Source Projects

The TWDB provides loans for NPS pollution abatement projects through the Clean Water State Revolving Fund (CWSRF) at interest rates lower than the market offers. Loans can be made to private organizations (only for NPS or estuary management projects) and to governmental organizations and Indian tribes that have authority to dispose of sewage, industrial waste, or other waste. The program includes mainstream and disadvantaged community funds.

Loans can be used for planning, designing, and constructing WWTFs, wastewater recycling and reuse facilities, collection systems, storm water pollution control, NPS pollution control, and estuary management projects.

Activities that were undertaken by the CWSRF Program related to NPS pollution in fiscal year 2010 include:

- increased meetings and coordination with the TCEQ and the TSSWCB NPS Program
- opened a re-solicitation period for submitting applications for NPS projects
- enacted a policy that sets aside seven percent of total funds available for NPS projects

Texas Waterway Cleanup Event in the Arroyo Colorado watershed/photo by TCEQ

Featherlake II Basin

After the storms of 2006, an evaluation identified extensive damage to the City of El Paso's drainage system. Many of the drainage canals were no longer functioning properly and areas near Interstate 10 in the Mission Valley Watershed were subjected to increased flooding. The impacted water body, the Rio Grande River, has been included on the 303(d) List since 1996 for exceeding standards due to bacteria and TDS.

To address these issues, a project was funded under the ARRA CWSRF and conducted during fiscal year 2010 with the El Paso Water Utilities. Along with improving the drainage, a goal of the project was the excavation of Featherlake II Basin. The holding capacity and retention time were increased to provide an opportunity to form a flora and fauna wetland habitat similar to the one found at the Feather Lake Wildlife Sanctuary. A spillway was constructed between Mesa Drain and the Featherlake II Basin that allows it and the Feather Lake Wildlife Sanctuary to be interconnected and function as one basin.

top left: *Wetland creation at Featherlake II/photo by the TWDB*
top right: *Agricultural waste brought for an Agricultural Waste Pesticide Cleanup event/photo by the TCEQ*
above: *City of Kyle Storm Drain Marker/photo by Matt Berg of the Texas AgriLife Extension Service*
left: *Household Hazardous Waste cleanup event in Wharton/photo by the TCEQ*

Texas Waterway Cleanup Program

The Texas Waterway Cleanup Program assists communities and organizations with establishing freshwater waterway cleanups and litter-prevention activities to improve and maintain the quality of surface water. As part of a contract partnership with the TCEQ, Keep Texas Beautiful has managed the Texas Waterway Cleanup Program since 1999. Participants in the Texas Waterway Cleanup Program receive assistance with event planning and publicity, as well as necessary cleanup materials at no cost.

A minimum of 120 total cleanups are held each year throughout the state as part of the Texas Waterway Cleanup Program. Keep Texas Beautiful actively solicits cleanups in areas that are part of the TCEQ's TMDL Program. Throughout fiscal year 2010, over 229 cleanups were held around the state. During these cleanups, 16,295 volunteers collected more than 375,238 pounds of debris from 660.9 miles of waterways.

Additionally, the Texas Waterway Cleanup Program provided educational resources to participants that include information on improving water quality through reducing litter and NPS pollution. In fiscal year 2010, Keep

Texas Beautiful provided educational information on the Texas Waterway Cleanup Program at more than 19 events, conferences, or trainings.

Household Hazardous Waste Collection Program

The TCEQ Household Hazardous Waste Collection Program gives local governments an opportunity to offer Texans an alternative disposal option for household waste that would otherwise be considered hazardous. Household Hazardous Waste Collections are most commonly funded and organized by municipalities and county governments, with assistance on program requirements provided by the TCEQ.

Results from Household Hazardous Waste Collections, including one-day events as well as permanent collection facilities, are reported annually to the TCEQ. In calendar year 2009, over 190 collection events were held throughout the state, resulting in the collection of more than 4,879 tons of hazardous household waste.

Agricultural Waste Pesticide Collection Program

The Agricultural Waste Pesticide Collection Program is a collaborative effort between the Texas AgriLife Extension Service, the Texas Department of Agriculture (TDA), and the TCEQ, which provides funding for the program. The Agricultural Waste Pesticide Collection Program organizes regional collections of waste pesticides, giving agricultural producers who use pesticides in Texas a free opportunity to properly dispose of unwanted products.

The program strives to prevent the unauthorized disposal of pesticide wastes on farms and ranches, with an annual goal of collecting at least 125 tons of agricultural pesticide and other related waste each year. A series of collections are conducted each fall; participation is strictly voluntary, and collections are free for participants. Eleven cleanups were held throughout Texas during state fiscal year 2010, resulting in the collection of more than 160 tons of waste.

Plum Creek Implementation in the City of Kyle

The City of Kyle completed the first year of a CWA Section 319(h) grant partnership with the TCEQ and the EPA. Through the implementation of BMPs, the City of Kyle has worked to actively implement the Plum Creek WPP. BMPs included in the project consist of mapping and marking of the storm drainage system, monitoring and upgrading of detention facilities, installation of dog waste stations, city street sweeping, and the implementation of storm sewer education and awareness initiatives throughout the community.

An education initiative that has proven successful for the City of Kyle is the installation of dog waste stations in two area parks. In 2009 at the City of Kyle's clean up day, held at Steeplechase Park, 550 dog droppings were flagged and properly disposed. At the February 2010 clean up day, only 128 dog droppings were marked and cleaned. This clearly shows the installation of the dog waste stations has been embraced by the residents and they are taking great interest in their local watershed. Another success for this partnership has been the completion of mapping and marking the city's storm drain system. The city was able to purchase Geographic Information System (GIS) equipment which enabled them to locate storm drain inlets, outlets, and manholes using Global Positioning System (GPS) technology. With this information the city can create the maps needed to manage the storm drain system much more effectively, which ultimately allows tracking and addressing the source of the pollutants directly. For more information regarding protection efforts in the Plum Creek Watershed, please visit <www.plumcreektamu.edu>.

Monitoring Effectiveness of Nonpoint Source Nutrient Management in the North Bosque River Watershed

As part of the I-Plan for the North Bosque River (NBR) TMDLs addressing phosphorus, a microwatershed approach to monitoring is being implemented. Monitoring at the microwatershed or subwatershed level allows the impact of agricultural NPS implementation activities to be assessed separately from urban runoff and WWTF contributions. This approach is likely to show improvements quickly in the subwatersheds. Monitoring at several microwatersheds was initiated in 2001 through the TSSWCB project, "Technical and Financial Assistance to Dairy Producers and Landowners of the NBR Watershed within the Cross-Timbers and Upper Leon SWCDs." This monitoring has continued under a series of related projects funded through the TSSWCB. The current monitoring is conducted at 13 sites under a

CWA Section 319(h) grant project, "Monitoring Effectiveness of Nonpoint Source Nutrient Management of the North Bosque River Watershed." Data collected from these microwatersheds has been used to help the TSSWCB direct technical and financial assistance to property owners and to better characterize the effects of implemented management activities. This project also complements monitoring along the mainstem of the North Bosque River conducted via a TCEQ project, "North Bosque River Watershed Water Quality Assessment" (highlighted earlier in this chapter).

One component of the I-Plan that has shown reductions in the amount of instream phosphorus based on microwatershed data is the manure hauling and composting program. While financial support for the Composted Manure Incentive Project (CMIP) by TCEQ ended in August 2006 and TSSWCB funding for the Dairy Manure Export Support (DMES) program ended in February 2007, continuing microwatershed monitoring through this project will help assess the long-term effectiveness of these programs. While the public funding support for these projects has ceased, a goal of CMIP and DMES was to aid in the establishment of a self-sustaining composting industry. Within the watershed, six composting facilities are still active and many amended concentrated animal feeding operation (CAFO) permits note the use of composting for manure disposal. While specific tracking of manure haul-off data is not available, indirect measures based on general information from permits and composting facilities should allow linkage of changes in water quality at the microwatershed level to the effectiveness of overall manure management including the use of composting.

Large-Scale Composting System as a Means of Managing Water Hyacinth

Water hyacinth is an invasive species worldwide. The main objective of this CWA Section 319(h) project funded by the TCEQ and conducted by the River Systems Institute (RSI) is to determine if large-scale composting is an effective means of managing water hyacinth from the Spring Lake, the headwaters of the San Marcos River, along with other hyacinth inundated waterbodies in the state. The goal is to render the seeds non-viable while producing a quality compost product for the horticultural industry.

Seed mortality tests conducted in ovens held at 120, 135, and 150 degrees Fahrenheit indicated that no seeds were found to be viable in compost held at 135 and 150 degrees Fahrenheit. However, using tetrazolium tests, two water hyacinth seeds were found to be viable of the seeds maintained in the compost sample held at 120 degrees Fahrenheit. Therefore, compost pile temperatures needed to be maintained at temperatures of 135 degrees Fahrenheit or more in order to render water hyacinth seeds non-viable.

A large scale composting system was developed at the Texas State University Muller Farm. Of the five acres allocated for the compost site, approximately 2.3 acres were transformed into a catchment pond that could withstand a 25 year/24 hour rain event. The remaining 2.7 acres were cleared and graded so that any water runoff from the compost piles would be captured by the retention pond. Eleven compost piles were built containing feedstocks at the following percentages: food waste from the cafeterias (10%), poultry litter (15%), water hyacinth plants (25%), and wood chips (50%). In total, piles contained 22,000 pounds of water hyacinth, 25,000 pounds of poultry litter, 20,000 pounds of food waste, and 38,500 pounds of wood chips.

Preliminary laboratory screening tests at the Ladybird Johnson Wildflower Center have screened 50 of 100 sample gallons of cured compost to two millimeter-sized particles. Visual tests, screening and use of an aspirator that separates heavy particles from lightweight particles have shown no indication of water hyacinth seed remaining in the finished and cured compost. Other compost quality tests from the certified compost testing agency are still being analyzed for criteria such as pH, nutrient availability, pathogens, organic matter content, etc.

Quality Recharge for a Karst Aquifer using Continuous Water Quality Monitoring

The Edwards Aquifer, located in south-central Texas, is one of the most prolific karst aquifers in the United States and is an important groundwater resource for municipal, industrial, domestic, agricultural, recreational, and ecological needs. The aquifer extends about 270 miles from the Rio Grande along the Mexico/United States border at Del Rio, east to San Antonio, then northeast through Austin to Salado. Hydrologic divides separate the Edwards Aquifer into three major segments: the San Antonio

(southern unit), Barton Springs, and Northern segments. The Edwards Aquifer is a karst aquifer with numerous direct recharge features including sinkholes and caves which provide the conduit for high volumes of rainfall runoff to enter the aquifer. Owing to rapid recharge, the Edwards Aquifer is highly susceptible to NPS pollution during rainfall runoff events. Because of its hydrogeologic character, the Edwards Aquifer is ranked by the TCEQ as the most vulnerable major aquifer in the state and more susceptible to pollution from contaminants deposited on or flowing over the recharge zone than other aquifers in the state. The Edwards Aquifer Authority (EAA) and the Barton Springs/Edwards Aquifer Conservation District (BSEACD) have successfully modified major recharge features and have applied new technology which allows continuous monitoring of certain water quality parameters as a means to reduce the potential for contamination of the Edwards Aquifer from "first flush" runoff in two of the three major segments of the aquifer.

The projects goals were to improve water quality in the Edwards Aquifer by excluding "first flush" flows of storm water into recharge features: Hollywood Park Sinkhole located in Lorence Creek, a tributary to the Salado Creek near the City of San Antonio and Antioch Cave in Onion Creek near the City of Austin. The exclusion of the "first flush" flow of storm water was accomplished by modifications to the recharge feature including installation of a valve that automatically opens after the initial storm water pulse has passed the recharge feature to allow recharge of better quality water. The valve is automated to open based on turbidity and flow data collected by the CWQMN system installed at the site. The valve controls can be programmed to open or close at predetermined values of turbidity or water level.

Although the number of rainfall events was limited during the monitoring phase of the projects, the two automated sites successfully operated using the data from the continuous monitoring equipment to control the recharge of storm water. The studies showed valves successfully closed at the predetermined settings ranging between 100 and 200 Nephelometric Turbidity Units (NTU) and automatically reopened when the turbidity improved to predetermined levels. With the completion of these projects, EAA and BSEACD have committed resources to continue to test and improve the systems, including to test and ensure the operation of the controlled recharge, to evaluate water quality for quantification of pollutant load reductions, and to make needed adjustments to ensure most efficient operation of the two sites.

Goal Three–Education

The third goal of the *Texas NPS Management Program* is to conduct education and technology transfer activities to help raise awareness of NPS pollution and prevent activities contributing to the degradation of water bodies, including aquifers, by NPS pollution.

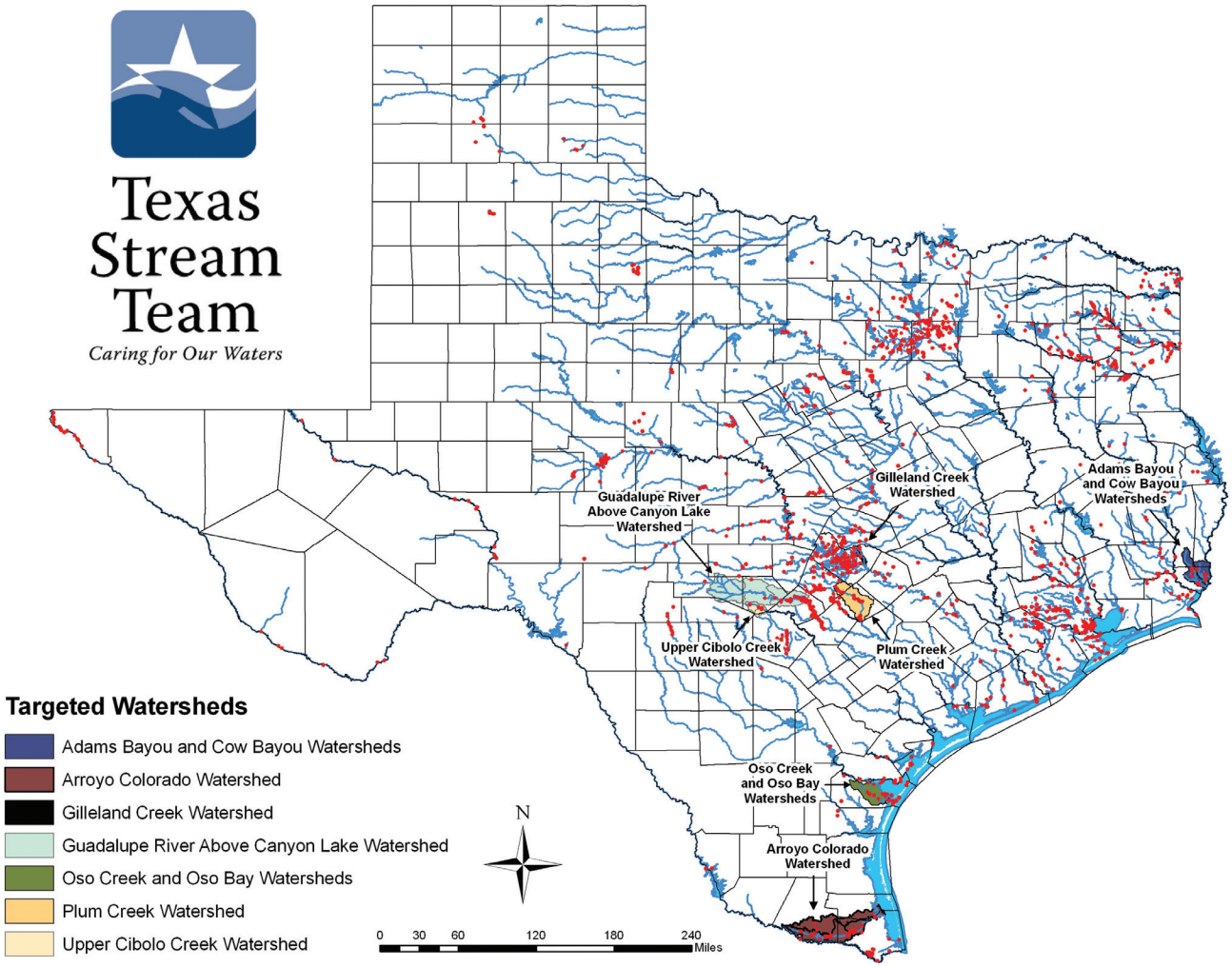
Education is a critical aspect of managing NPS pollution. Public outreach and technology transfer are integral components of every NPS grant project, WPP, TMDL, and I-Plan. This section highlights some of the NPS education and public outreach activities conducted in Texas in fiscal year 2010.

Texas Stream Team

Texas Stream Team is a statewide organization committed to improving water quality through citizen water quality data collection, stakeholder engagement, and watershed education. The program is based at the RSI at Texas State University-San Marcos, and Texas Stream Team is administered primarily through a cooperative CWA Section 319(h) grant-funded partnership between the RSI, the TCEQ, and the EPA.

In fiscal year 2010 Texas Stream Team citizen monitors sampled streams, reservoirs, and tidal areas for *E. coli*, DO, specific conductivity, pH,

Figure 3.4.
Texas Stream Team Citizen Water Quality Monitoring Locations and Project Areas



secchi depth, temperature, and various field observations including flow severity. Data are collected utilizing a quality assurance project plan (QAPP) and a four-phase training certification process. Intended data uses include problem identification, understanding background conditions, education, research, local decisions, and other uses deemed appropriate by the end user. Data summary reports and a data forum are available for viewing and download at the program website. There are over 43 data summary reports available for water resource managers, stakeholders, and others. The data forum provides water quality data from the last ten years from every major river basin.

In addition to statewide programmatic activities, the Texas Stream Team also focused efforts in several targeted watersheds (Figure 3.4). These included the Upper Cibolo Creek, Plum Creek, Gilleland Creek, Arroyo Colorado, Oso Bay/Oso Creek, and Orange County. Activities with the upper Guadalupe River are also planned. A suite of watershed services such as NPS pollution outreach, monitor trainings, outreach internships, community clean-up coordination assistance, data summary reports, and other initiatives were provided to assist in the development and implementation of TMDL and WPP projects. Texas Stream Team

intends to continue supporting these areas and to expand efforts into additional watersheds in fiscal year 2011.

Fiscal year 2011 brings interesting developments for the Texas Stream Team with an on-line dataviewer and database where monitors, partners, and the general public can access citizen monitoring information. This resource will bring on-line data entry, graphing, analysis, and data query capabilities. Other new resources include a citizen monitoring iPhone application, a suite of training and quality control videos, a communications plan, new nutrients, turbidity, and flow monitoring methods, and new outreach tools to help reduce NPS pollution. The Texas Stream Team watershed outreach program focuses on teaching participants about watershed functions and how NPS pollution impacts water quality. Watershed outreach services are delivered in myriad ways including curriculum distribution, NPS watershed model demonstrations, hands-on student scenario investigations, creek-side lessons, watershed bacteria monitoring events, water quality monitoring trainings, and hosting booths at special events. Texas Stream Team continues to provide outreach to hundreds of teachers and thousands of students each year. By providing customized watershed information and new ways to engage teachers and students, participants learn about local issues, factors influencing water quality, and ways to improve watershed health. Teacher workshops took place at universities, community education centers, partner offices, and at local creeks and reservoirs. Additional information about the Texas Stream Team can be found at <txstreamteam.rivers.txstate.edu/>

City of Austin Lawn and Garden Chemical Education

The City of Austin, in conjunction with its partner, Texas AgriLife Extension Service, is working to reduce landscape chemicals in Austin's waterways through Grow Green, a water quality education program. The CWA Section 319(h) grant from the TCEQ and EPA, with matching funds from the city's Watershed Protection Department, has enabled the program to provide expanded educational outreach and enhanced monitoring for pesticides and other gardening chemicals, particularly in the environmentally-sensitive Edwards Aquifer Recharge Zone.

The education program takes a multi-faceted approach that includes Public Service Announcements (PSAs) on Austin's major television stations featuring The Big Three, cartoon characters that promote the use of fewer fertilizers and pesticides. The PSAs can be viewed at <www.ci.austin.tx.us/growgreen/advertisement.htm>. These messages are reinforced by direct mailings to pilot neighborhoods, an expanded website, and an on-line survey. A new pilot neighborhood received pre- and post-surveys to identify landscaping habits and behavior change, as well as an educational piece that specifically addressed findings from chemical monitoring in the pilot neighborhood. A "reminder" card was also sent to 6,000 people in former pilot neighborhoods to reinforce the message of using chemicals appropriately. Hits to the website, <www.growgreen.org>, increased from less than 15,000 per month before the television spots aired to 58,000 per month during the television campaign. The online survey showed that 33 percent of respondees had seen the spots and 50 percent said the television spots had helped them reduce chemical and water use.

City of Austin Lawn and Garden Chemical Educational Campaign

Monitoring of fertilizers and pesticides continues at five springs and four storm water monitoring sites, including one at Stillhouse Hollow spring in the Northern Edwards Aquifer Recharge Zone. To date, there have been no detections of carbaryl at any of the sites, but atrazine continues to be observed at low concentrations. Groundwater concentrations were observed in 2010 in the month of May, where levels of contaminants generally peak, and it appears that atrazine has decreased at two of five spring sites following education. While the city assesses the data regularly, statistically valid conclusions at this time are prevented by the divergent rainfall conditions between 2009 and 2010, the low concentrations at or below detection limits, and the limited timeframe of the monitoring.

Texas Watershed Coordinator Roundtable

Proper training of watershed coordinators and water professionals is needed to ensure that watershed protection efforts are adequately planned, coordinated, and implemented. To provide this training, the Texas Watershed Planning Short Course was developed through a coordinated effort led by the TWRI and funded by a CWA Section 319(h) grant through the TCEQ.

The TWRI partnered with the Texas AgriLife Extension Service, Texas AgriLife Research, TSSWCB, TCEQ, EPA, RSI, and the TIAER to develop and conduct this short course.

Since 2008, four week-long Watershed Planning Short Courses have been hosted, providing training to over 160 watershed professionals on sustainable proactive approaches to managing water quality throughout the state. The Watershed Planning Short Course provides guidance on stakeholder coordination, education, and outreach; meeting the EPA nine key elements of a watershed-based plan; data collection and analysis; and the tools available for plan development.

Along with the Watershed Planning Short Courses, water professionals were invited to attend Texas Watershed Coordinator Roundtables to provide a forum for establishing and maintaining dialogue between watershed coordinators, facilitate interactive solutions to common watershed issues faced throughout the state, and add to the fundamental knowledge conveyed at the short courses. More than 220 water professionals attended the three Texas Watershed Coordinator Roundtables held in Temple, Georgetown, and Dallas. Topics of discussion included sustainable organizational structure for long-term WPP implementation, the EPA's Region 6 review guide of watershed-based plans, strategies and expectations for demonstrating successful implementation, and financing WPPs.

Additional workshops also offered to further familiarize watershed coordinators with watershed management tools provided by the EPA included Getting In Step Workshops and Key EPA Internet Tools for Watershed Management courses. The Getting In Step Workshop aims to improve the effectiveness of NPS outreach in Texas and the internet tools course familiarizes users with online watershed management tools provided by the EPA.

More than 100 watershed professionals participated in four Getting In Step Workshops offered in Houston, Austin, Dallas, and Georgetown. Nearly 40 watershed professionals participated in the two Key EPA Internet Tools for Watershed Management courses offered in San Marcos and Dallas. Also, the TWRI coordinated with Wildland Hydrology to provide an Applied Fluvial Geomorphology Short Course with 40 water resource professionals participating to better understand the fundamentals and general principles of river behavior.

To assist watershed professionals in searching for funding programs, the TWRI worked with the Environmental Finance Center at Boise State University to update the Directory of Watershed Resources to include Texas-specific funding programs. The Environmental Finance Center Network is an EPA-sponsored, university-based program providing financial outreach services. The Directory of Watershed Resources is an on-line, searchable database for watershed restoration funding. The database includes information on federal, state, private, and other funding sources and assistance and allows Texas users to query information in a variety of ways including by agency sponsor or keyword, or by a detailed search.

In total, the combined courses, workshops, and meetings have reached out to more than 350 watershed coordinators and water professionals and will continue to do so through bi-annual Watershed Coordinator Roundtable meetings and training opportunities.

Concho River Basin Aquatic Research and Education Center

The Upper Colorado River Authority (UCRA) Water Education Center is

above: *Concho River Water Education Center Volunteers, the "Aqua Squad" providing education and outreach services at a public event/photo courtesy of the UCRA*

below: *Concho high school students in the Water Chemistry Program*

housed in a renovated building adjacent to both the Concho River and the San Angelo Museum of Fine Arts. It began as a joint venture between the UCRA and the San Angelo Museum of Fine Arts and was made possible with funding from a CWA Section 319(h) grant through the TCEQ. The mission of the Center is to educate the community of the Concho River basin on the importance of watershed protection, preservation of water quality, and water conservation. Since opening in the fall of 2008, the Center has accomplished these goals through both in-house and outreach programs aimed at school aged children, in addition to teacher workshops, adult trainings and family events. In fiscal year 2010, the Water Education Center served over 2,800 community members through these program offerings. The demand for programs has grown substantially over the last year. For example, in May of 2009, the Water Education Center served 85 students and adults through in-house programs alone. In May of 2010, that number was up to 374. The demand for outreach has also increased with regular Family Science Nights at two different elementary schools with attendance by over 400 people at each event, and regular in–class visits to several others. There are several factors that contributed to this growth that are worth highlighting.

The first is that the UCRA has focused on establishing the Water Education Center through continued strengthening of relationships with other community organizations. For example, through their partnership with the San Angelo Museum of Fine Arts, they initiated the first year of "Art of Nature" Camps in the summer of 2010. These all-day, week-long camps focused on the intersection of environmental science and art and revolved around the Concho River. Campers participated in activities such as conducting water quality tests, canoeing and fishing the river, creating landscape collages, learning about native aquatic plants, and pressing flowers. Through a partnership with the San Angelo Museum of Fine Arts, Texas Parks and Wildlife Department (TPWD), Angelo State University, and the Girl Scouts of the USA, Water Education Center activities created an opportunity for young people to learn more about their local river and protecting their watershed through activities at the North Concho River water front. These camps served 60 children, and will be expanded in summer 2011.

Texas Watershed Stewards

Texas Watershed Stewards (TWS) is a highly successful one-day training program designed to increase citizen understanding of watershed processes and foster increased local participation in watershed management and WPP activities across the state. Funded by the TSSWCB under CWA Section 319(h), the program is tailored to and delivered in target watersheds undergoing TMDL or WPP development or implementation.

The program curriculum is comprised of five units including a program introduction, an overview of watershed systems, identification of watershed impairments, watershed management and regulation, and community-driven watershed protection strategies. The curriculum is compiled into a full-color handbook that also includes a comprehensive glossary of terms, and three appendices providing detailed information on federal, state, and local water quality agencies and organizations, important websites pertaining to water quality projects, management, and regulation, and a list of important activities for communities to engage in to help protect their local water resources. The program is delivered through interactive training events conducted by a team of professionals using high quality visual aids and hands-on teaching stations.

To date, 24 workshops have been conducted in watersheds across

the state. In all, more than 1,350 citizens including landowners, agricultural producers, city personnel, business owners, state environmental agency staff, students from public schools and universities, and other watershed residents have become trained TWS.

Results from pre- and post-test evaluations indicate that knowledge regarding watershed function, pollutant sources, BMPs, water quality, and regulatory agency responsibilities has increased by 31 percent. More than 99 percent of participants report the program has enabled them to be better stewards of their water resources. Furthermore, results from six-month delayed post-test evaluations indicate that 80 percent of workshop attendees have more closely monitored individual actions that could impair water quality, 80 percent have adopted and/or maintained water quality BMPs on their property, and 65 percent have encouraged others in their community to attend a TWS workshop.

In addition, the preliminary draft of the online TWS training course has been completed and is currently under review. Upon release, the online course materials will be available on the program website and will enable more flexible and widespread access to the training program. For more information on the TWS program, please visit <tws.tamu.edu>.

Texas Silviculture Nonpoint Source Pollution Prevention

"The Texas Silvicultural NPS Pollution Prevention" project, funded under CWA Section 319(h) by the TSSWCB, continues to have a tremendous impact on Texas' water resources. A recently published monitoring report by Texas Forest Service (TFS) (December 2008) documented that 92 percent of all forestry operations implemented BMPs, one of the highest utilization rates in the South. Based on this rate of implementation, computer models predict annual soil savings of 100,000 tons across East Texas, including 12,000 tons of which would otherwise enter our streams, lakes, and rivers.

During fiscal year 2010, personnel coordinated numerous landowner workshops and educational outreach events, reaching more than 4,000 people with the message of sustainable forestry and water quality protection. Participation in the inaugural Texas Woodland and Wildlife Expo in Conroe, a joint effort between TFS, TPWD, Texas Agrilife Extension Service, the United States Forest Service, and the Texas Forest Family Fun Day are just two of the events that allowed this project to connect with many potential cooperators.

The TFS is always looking for innovative ways to promote BMPs to the forestry sector. Focused training workshops on stream crossings and forest roads were again conducted for logging professionals, and a new and improved online training course was released. This new course will provide participants with greater flexibility to receive training on their own time, allowing for a much larger audience to be targeted. Project staff developed specific guidance on applying BMPs and firebreak rehabilitation measures during wildfire suppression activities, and incorporated these concepts into the TFS's fire operations plan.

The effectiveness of the education project is primarily measured through BMP implementation monitoring. While the eighth round will be completed in fiscal year 2011, evaluations have been conducted on approximately one third of the target samples and initial results show a 93 percent implementation rating. Based on this rate, computer models predict annual load reductions of 92,000 tons across East Texas, including 12,000 tons of which would otherwise enter our streams, lakes, and rivers.

Maintaining a proactive approach to addressing water quality issues is one of the foundations of this project. *The Texas Forest Resource Strategy*, a comprehensive strategic plan published in June 2010, outlines the specific actions the program will focus on over the next five years to address the threats to our forest resources. The Wetland / Best Management Practices Coordinating Committee meets annually, most recently in March 2010, to share information and plan efforts and actions that relate to wetlands, water quality and Texas forests. This group consists of members from various agencies, organizations, and industries in Texas. As new research, technology, and operational methods arise, so does the need to update the forestry BMP handbook. This stakeholder driven process resulted in a new BMP manual being published in August 2010.

Education Program for Improved Water Quality in Copano Bay

The Copano Bay watershed drains approximately 2,652 square miles and includes portions of Aransas, Bee, Goliad, Refugio, San Patricio, and a small part of Karnes County in the coastal bend region of South Texas. Data assessed in 2002 showed that Copano Bay was not suitable for harvesting oysters for consumption because of elevated bacteria levels. Two years later the two main tributaries of Copano Bay, and the Mission and Aransas Rivers were placed on the 303(d) List for bacteria levels exceeding TSWQS for contact recreation use.

The TCEQ started the Copano Bay TDML project in 2003 to determine the sources of bacteria. The results of bacterial source tracking (BST) indicated that horses and livestock were a large contributor of bacteria to the bay.

As a result of this impairment and TMDL, the TSSWCB partnered with TWRI and AgriLife Extension Service to develop the "Education Program for Improved Water Quality in Copano Bay" which conducts educational programs for horse and livestock owners, coordinating with the "Urban Rancher" program for small landowners, and "Lone Star Healthy Streams" program for cattlemen. These programs are working to increase awareness of the water quality issues throughout the watershed and provide educational programs and demonstrations for landowners and livestock owners in the watershed on practices to decrease or prevent bacteria from entering waterways.

In fiscal year 2010, nine programs were presented in Aransas, San Patricio, Goliad, Refugio, and Bee counties located in the Copano Bay watershed reaching 898 agricultural producers, residents, and school children.

The TWRI coordinates the project and maintains a website at <copanobay-wq.tamu.edu>.

Feral Hog Management Education in the Plum Creek Watershed

During development of the Plum Creek WPP, feral hogs were identified as a key potential contributor of bacteria and nutrients. As part of the "Implementing Agricultural Nonpoint Source Components of the Plum Creek Watershed Protection Plan" project of the TSSWCB, the Texas AgriLife Extension Service developed tools to engage and assist landowners in feral hog management across the watershed. The project includes the delivery of landowner educational and training programs, development of a feral hog management website, and the development and dissemination of publications.

An AgriLife Extension Assistant stationed in the watershed helped build rapport with stakeholders by providing information and technical assistance regarding feral hog management. This relationship has resulted in the exchange of valuable information, as landowners are able to provide first-hand knowledge of feral hog distribution, diet, and daily and seasonal behavior. The Extension Assistant had 846 individual contacts with landowners in 2009, representing over 960 contact hours, including five presentations. In addition, he led coordination and mapping efforts with individual ranches representing over 40,000 acres where abatement

Successful feral hog trapping in the Plum Creek Watershed
below: *trap assembly*
bottom: *feral hog trail*

by Texas Wildlife Services removed 372 feral hogs.

The annual Feral Hog Management Workshop was held in February of 2010 and had approximately 279 participants. Approximately 1,000 individuals from Caldwell and Hays Counties and surrounding areas have participated in education events since the program began.

In 2009, AgriLife Extension launched a feral hog management education website specifically crafted for the Plum Creek Watershed. It houses an online feral hog reporting system designed to accumulate data for observed feral hog activity and impacts in the region. Residents and travelers in Caldwell and Hays Counties are encouraged to report sightings of feral hogs and their damage. The location of sightings can be used to target feral hog hotspots. A core group of selected landowners was contacted to participate in an effort to track management efforts on private lands. Landowners were asked to provide estimates of negative impacts, number of feral hogs taken, and economic losses from feral hog activity on their properties. Although the approach is novel and may help develop a broader management strategy, there has been some reluctance among landowners to utilize the online reporting system <plumcreek.tamu.edu/feralhogs>. The Extension Assistant has served as a point of contact to respond to reports of recent feral hog activity, documenting damage, and converting these observations to a Geographical Information System for focusing management attention. In addition, the Extension Assistant has coordinated efforts with all of the project partners including Hays and Caldwell County Extension Agents and Texas Wildlife Services personnel.

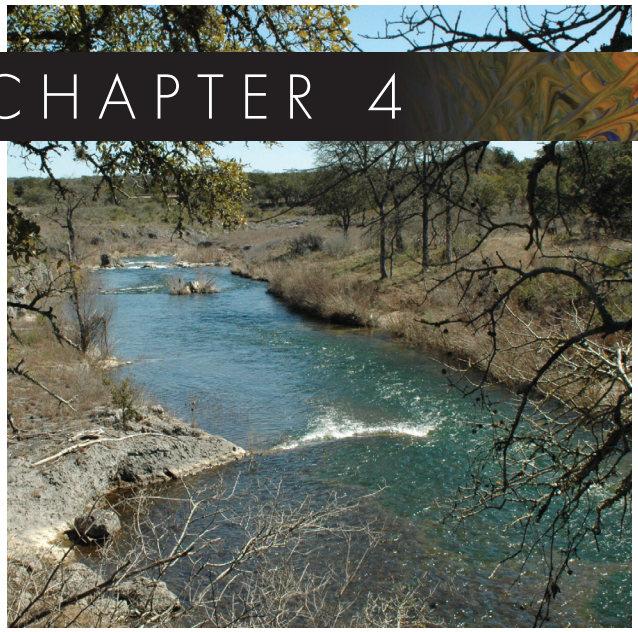
As another component of the outreach strategy, a series of six feral hog management factsheets was developed for landowners including, *Recognizing Feral Hog Signs, Corral Traps for*

Capturing Feral Hogs, Box Traps for Capturing Feral Hogs, Placing and Baiting Feral Hog Traps, Snaring Feral Hogs, and Building a Feral Hog Snare. All of the factsheets are available at <pcwp.tamu.edu/feral-hogs/capture-techniques>. Though created for the Plum Creek Watershed, the information in these publications is transferable to any watershed where feral hogs cause water quality concerns. The publications have been well received by landowners, and in addition to being viewed by website visitors from 49 states plus the District of Columbia, online versions of the factsheets have been downloaded by viewers from several other countries. In addition, blog articles were written and posted to the *Wild Wonderings Blog* at <wild-wonderings.blogspot.com> which had 4,865 unique visitors and 8,090 page views.

For more information about the Plum Creek WPP see Chapter 4 of this report.

Plum Creek watershed sunset/photo by Matt Berg of Texas AgriLife Extension Service

CHAPTER 4



Upper Cibolo Creek/photo courtesy of the City of Boerne

Progress in Developing and Implementing Watershed Protection Plans

In Texas, WPPs are locally developed water quality plans that coordinate activities and resources to manage water quality. They facilitate the restoration of impaired water bodies and/or the protection of threatened waters before they become impaired. These stakeholder-driven plans give the decision-making power to the local groups most vested in the goals specified in the plans. Bringing groups of people together through watershed planning efforts combines scientific factors with social and economic considerations.

While WPPs can take many forms, the development of plans funded by CWA Section 319(h) grants must follow guidelines issued by the EPA. These guidelines can be found at: *Nonpoint Source Program and Grants Guidelines for States and Territories*, <www.epa.gov/fedrgstr/EPA-WATER/2003/October/Day-23/w26755.htm>.

In fiscal year 2010, the TCEQ and the TSSWCB facilitated the development of WPPs throughout Texas by providing technical assistance and/or funding through grants to local partners. There are also WPPs that are being developed or have been developed in Texas independently of this grant funding.

Texas State Soil and Water Conservation Board Watershed Protection Plans

Attoyac Bayou

The Attoyac Bayou is a sub-watershed within the Upper Neches River Watershed extending approximately 82 miles through Rusk, Nacogdoches, San Augustine,

and Shelby counties before emptying into Sam Rayburn Reservoir. Several rural communities can be found throughout the area, with the majority of the land in the watershed being used for cattle and poultry operations, along with forestry, recreational and wildlife uses.

The Attoyac Bayou is one of many rural watersheds listed as an impaired water body on the 303(d) List due to elevated levels of *bacteria* and was first listed in 2004. Data collected at three monitoring stations provided water quality data that illustrated excessive levels of *E. coli bacteria* concentrations in the water body along with elevated levels of ammonia at two of the three monitoring sites.

To address these water quality concerns, the "Development of a Watershed Protection Plan for the Attoyac Bayou" is being conducted to assess the water quality, watershed characteristics, and appropriate designated uses for the bayou. The project, which began in November 2009, involves working with local entities to conduct water quality monitoring at ten stream sites and four WWTFs throughout the watershed, developing an up-to-date GIS of the watershed, and updating LULC maps. Additionally, project members are providing technical support to local watershed entities to conduct Load Duration Curve (LDC) analysis, BST, and Spatially Explicit Load Enrichment Calculation Tool (SELECT) modeling that will assist local watershed stakeholders in developing their WPP.

Accomplishments during the first year of the project include coordinating with local stakeholders to establish a local watershed partnership and providing education on watershed stewardship. The project also set-up an expanded network of watershed monitoring stations, along with an intensified sampling scheme that will yield two years of bi-monthly water quality data and automatic storm-flow monitoring. The project website <attoyac.tamu.edu/> hosted by the TWRI is a resource for education and outreach efforts in the watershed. The website will also serve as a project database and will house meeting agendas, presentations, minutes, quarterly progress reports, maps, technical reports, and other pertinent information in the watershed.

Anticipated work in fiscal year 2011 will focus on the collection of watershed and water quality data, the development of an updated GIS, as well as LULC layers for the watershed, and assessment of the appropriate uses of the Attoyac Bayou and its tributaries. Project members will evaluate potential sources of bacterial pollution through a sanitary survey of the watershed and by conducting BST analysis. The continued engagement of watershed stakeholders and the development of a watershed partnership are critical steps that will be taken and will influence the future development of the Attoyac Bayou WPP.

Attoyac Bayou downstream of Hwy 59/photo by Castilaw Environmental

Buck Creek

Buck Creek is a small intermittent water body in the southeastern corner of the Texas Panhandle. The creek flows in an east-southeast direction 68 miles before entering Oklahoma and joining the Lower Prairie Dog Town Fork to form the Red River. The creek is encompassed by a rural watershed. Weather cycles and connection to underlying groundwater greatly influence the flow in the creek and result in significant variations in flow across spatial and temporal scales.

In 2000, water quality data collected from Buck Creek resulted in its

Buck Creek

listing on the 303(d) List for *bacteria* levels exceeding TSWQS. As a result of this listing, Texas AgriLife Research in Vernon and the TWRI received a CWA Section 319(h) grant from the TSSWCB to collect additional water quality data and further evaluate the impairment. Data indicated that periodically elevated *E. coli* levels exist in portions of the creek and warrant further investigation. TSSWCB provided further CWA Section 319(h) funding to explore these variations and facilitate the development of a WPP for Buck Creek that collectively approaches the management of water quality concerns in the watershed.

Work in fiscal year 2010 has focused on the conclusion of water quality monitoring, watershed modeling, and the development of the Buck Creek WPP. Stakeholder meetings were held to discuss BST results, LDC results, and SELECT model results. Stakeholders used this information in the decision-making process when deciding what BMPs to include into the draft Buck Creek WPP.

BST work indicated that major sources of bacteria in Buck Creek are feral hogs, livestock, and wildlife. Human influences, including OSSFs, were also identified and were quite surprising considering the limited human presence in the watershed. Further investigation of the human pollution signature is needed along with evaluation of potential cross-reaction with wildlife sources. LDCs developed for the water body indicate that water quality continues to improve since the initiation of the project. Watershed landowners used SELECT model outputs to help in developing a BMP implementation prioritization schedule through its predictions of potential loading contributions from individual pollutant sources in each subwatershed.

Increased awareness and educational programming delivered through this project have led to changes in practices applied by watershed landowners and has resulted in *E. coli* loading reductions in the watershed. The implementation of these practices by local landowners and the subsequent reductions in measured *E. coli* concentrations resulted in the recommended removal of Buck Creek from the Draft 2010 303(d) List. Although Buck Creek does meet TSWQS, watershed protection and planning remains critical for the long-term health of Buck Creek and its watershed.

Work on the WPP will continue into fiscal year 2011 and will culminate with the completion of the WPP. This plan will include management strategies desired by landowners to mitigate *E. coli* and nitrate loading to the creek and result in decreased loads of each constituent in the watershed.

Concho River

The Concho River basin lies within 13 West Texas Counties and encompasses a watershed of approximately 4.5 million acres. Four major reservoirs, O.H. Ivie, O.C. Fisher, Twin Buttes, and Lake Nasworthy are located within the watershed boundaries. These reservoirs provide potable water, either wholly or in part, to approximately 500,000 residents. In addition, the streams and reservoirs of the Concho basin are utilized for agriculture. The Concho River itself lies below San Angelo and enters O.H. Ivie Reservoir near Paint Rock, Texas. In the San Angelo area, several major streams converge to form the Concho River. These include the North, South, and Middle Concho Rivers, Spring Creek, and Dove Creek. Many historical springs feed into the tributaries of the Concho River. It is at these locations that the more environmentally sensitive aquatic habitats are commonly found. In 2002, the Concho River was placed on the 303(d) List for having impaired macrobenthos communities. The O.C. Fisher Reservoir was also listed for TDS and chlorides affecting general uses of the water body.

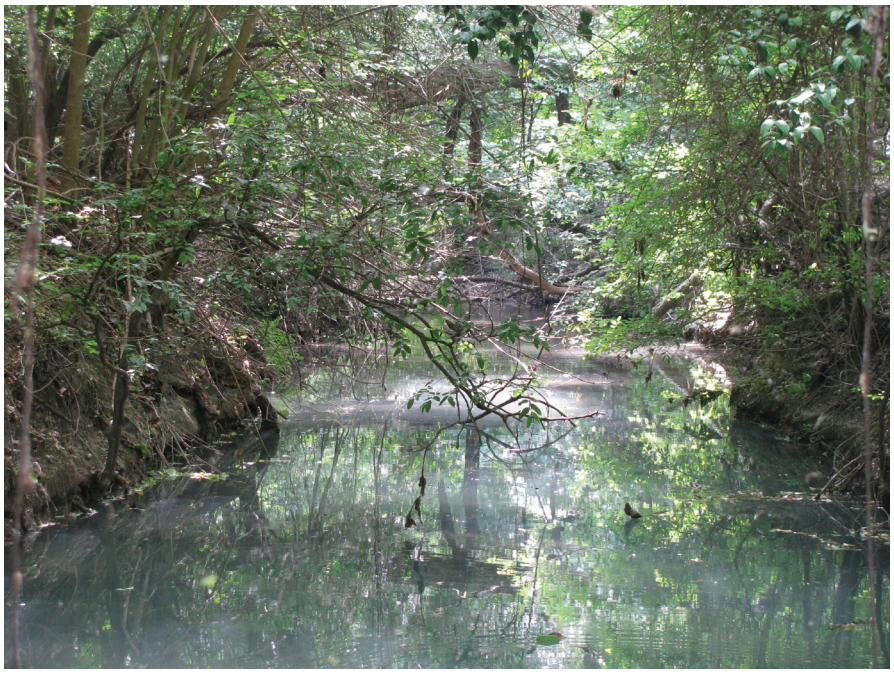
In 2004, the UCRA received a CWA Section 319(h) grant from the

TSSWCB to facilitate the development of a WPP. In July 2008, the UCRA submitted a stakeholder-approved WPP for state and federal review.

Currently, WPP implementation activities are ongoing in the Concho River Basin. Implementation activities include education/outreach efforts (see Chapter 3), targeted brush control, bank stabilization, and sludge dredging. Additionally, the City of San Angelo recently completed their Stormwater Management Plan to implement the Municipal Separate Storm Sewer System permit. The UCRA, with foresight to the new permit, recommended certain BMPs to be included as a part of the City of San Angelo's program. The City of San Angelo Comprehensive Stormwater Ordinance was one of the recommendations. The ordinance was passed in 2010 and is currently being implemented. Another recommendation was to update the Concho River NPS Master Plan, which is currently underway. Data being used to update and track progress of the Master Plan, a comprehensive montoring and response system, is being funded under the CRP.

Geronimo and Alligator Creeks

In 2008, the Guadalupe Blanco River Authority (GBRA) received a CWA Section 319(h) grant from the TSSWCB to develop a WPP for Geronimo and Alligator Creeks. After receiving the grant award, GBRA subcontracted with the Texas AgriLife Extension Service to aid in facilitation of the WPP. After holding two successful public meetings and a TWS training in the fall of 2009, a Geronimo and Alligator Partnership meeting was held in January 2010. As a part of the partnership, a steering committee of local entities, landowners, and educators was formed.



Geronimo Creek/photo by Brian Koch of the TSSWCB

With substantial stakeholder input, the potential source loads were modeled using the SELECT. LDCs were developed in order to determine the load reductions needed to bring the stream back into compliance with TSWQS for bacteria and nitrate-nitrogen. Topical work groups that focused on urban, agricultural, and wastewater impacts met a total of nine times to evaluate and recommend BMPs to address potential agricultural, urban, and wastewater sources of the pollutants. The partnership toured the upper watershed to see retention structures in a highly-urbanized area and heard presentations on water quality issues caused by feral hogs and how agricultural producers use practices designed to protect water quality in the watershed.

Stream water quality monitoring data is available to stakeholders on the project webpage, along with meeting presentations and resource information at <www.geronimocreek.org>.

Granger Lake

Granger Lake is located on the San Gabriel River in Williamson County, about 7.1 miles east of Granger, Texas. Originally constructed for flood control and recreation, the lake serves as a drinking water supply reservoir for residents of Williamson County, which has one of the highest rates of population growth in the state. While the demand for water from Granger Lake is increasing, its storage capacity is decreasing due to sedimentation. Volumetric surveys suggest Granger Lake has lost more than 12,000 acre-feet of storage since its initial construction in 1980 and continues to lose between 200 and 300 acre-feet

of storage per year, on average. It is estimated that by the year 2067 there will be no storage capacity left with the current lake level. Water quality monitoring also detected elevated levels of nutrients in the lake and several of its tributaries.

The TSSWCB, BRA, Little River-San Gabriel SWCD, and Texas AgriLife Research have partnered together to quantify sediment loadings and develop a WPP for Granger Lake and the San Gabriel River. In June 2010, Texas AgriLife Research completed its second bathymetric survey of the lake.

In an effort to reduce sedimentation to Granger Lake, the Little River-San Gabriel SWCD is providing technical and financial assistance to agricultural producers for the development and implementation of WQMPs.

Lampasas River

The Lampasas River watershed encompasses 1,250 square miles and lies within Bell, Burnet, Coryell, Hamilton, Lampasas, Mills, and Williamson counties. The Lampasas River begins in western Hamilton County and flows southeast for 76 miles through a primarily rural landscape before it drains into Stillhouse Hollow Lake in Bell County. Above Stillhouse Hollow Lake, the Lampasas River is listed as impaired for contact recreation use due to elevated bacteria levels. As a result of this impairment, the TSSWCB partnered with Texas AgriLife Research–Blackland Research and Extension Center to collaborate with local watershed stakeholders to develop a WPP for the Lampasas River Watershed to improve and protect water quality within the basin.

The Lampasas River Watershed Partnership was formed in November 2009. The Partnership includes a Steering Committee, the decision-making body, Work Groups which discuss specific issues facing the watershed, and general partners that are interested in protecting the watershed. A Technical Advisory Group was also formed with members from state and federal agencies, including TCEQ, TPWD, NRCS, and the United States Geological Survey, among others to offer technical expertise. To date there have been over 180 local stakeholders, city and county officials, and state and federal agencies actively involved in the watershed planning efforts. Stakeholders participate in monthly Steering Committee or Work Group meetings to discuss various needs of the WPP. The Steering Committee has set water quality goals for the Partnership as well as the necessary load reductions needed to reach those goals.

LDCs were developed for seven monitoring stations within the watershed to aid in determining pollutant sources. The Steering Committee has approved an updated LULC analysis that has been used in conjunction with estimated source population densities, 911 addresses, soils data, and other data layers in the SELECT to estimate potential *E .coli* loadings from specific sources and subwatersheds. Based upon the SELECT results, stakeholders will be able to choose and rank BMPs to efficiently address pollutant sources.

Lampasas River at Maxdale/photo by Lisa Prcinr of Texas AgriLife Research

Leon River

The Leon River Watershed encompasses approximately 1,340 square miles in Bell, Coryell, Hamilton, Comanche, and Erath counties. In 1998, the Leon River was placed on the 303(d) List for having bacteria concentrations that exceeded TSWQS for contact recreation, prompting the TCEQ to commence a TMDL project for bacteria in 2002. To take a more proactive role in developing management strategies to reduce bacteria loadings to the

Leon River, local TMDL stakeholders initiated a WPP in 2006.

Over the past year, the BRA and Parsons, Inc. have received and included input from local stakeholders and the technical advisory group into the Leon River WPP. The working committee met in June 2010 to provide initial comment on the draft WPP. The Leon River WPP will be available for public comment, finalized, and submitted to EPA in fiscal year 2011.

Pecos River

The Pecos River meanders 418 miles through one of the driest regions of west Texas in a south-southeast direction before joining the Rio Grande at the International Amistad Reservoir. Along the river's journey southward, the surrounding watershed changes from a relatively flat, short-brush dominated rangeland interspersed with short grasses above Interstate 10 to one that is filled with plateaus, valleys, steep cliffs and is dominated by larger brush species and sparse short grasses below Interstate 10.

Pecos River irrigation canal/photo by Allen Berthold of TWRI

During fiscal year 2010, work in the Pecos River watershed evolved from the development of the Pecos River WPP to the implementation of the WPP. The WPP was completed and distributed to watershed landowners in December 2009. At the same time, WPP implementation funding and planned activities were presented to watershed landowners at a series of meetings throughout the watershed. Work conducted under the implementation project has focused on further cultivating landowner relationships and establishing agreements for implementation of BMPs throughout the watershed. In an effort to increase awareness about upcoming implementation programs, the local watershed coordinator and two field technicians employed by local SWCDs have attended numerous meetings to present information on program availability and project timelines, and to provide general information on the implementation program.

Planned implementation activities include the additional treatment of invasive saltcedar through herbicide application in previously untreated areas along the river and the expansion of the saltcedar leaf beetle release program at multiple sites along the river and throughout the watershed. Also included in the implementation portion of the program is the development and implementation of WQMPs, the removal of saltcedar debris along the river through controlled burns, and the continued development and maintenance of water quality databases that house Pecos water quality data. Additionally, the development and application of a DO model for the river that will aid in identifying the source(s) of the DO impairment and the construction and installation of another continuous water quality monitoring station on the river are underway.

Planned activities in fiscal year 2011 include the continued efforts to implement activities initiated in the past fiscal year. This project will continue to facilitate relationships with local watershed landowners, work cooperatively with them to implement BMPs recommended in the Pecos River WPP, and help secure additional funding for future watershed management activities.

Plum Creek

The Plum Creek Watershed was selected as the first WPP pilot project by the TSSWCB's Regional Watershed Coordination Steering Committee in December 2005. Plum Creek is a 400 square mile watershed with headwaters north of Kyle in Hays County. The watershed also drains much of Caldwell County and a small portion of Travis County. The creek has been included on the 303(d) List due to high levels of bacteria since 2002 and concerns for nutrient enrichment since 1998. Plum Creek was moved on the Draft 2010 IR to Category 4b. The Plum Creek

Plum Creek educational brochure cover

WPP was completed in 2008 and is in its second year of implementation.

During the past year, significant progress toward achieving a number of WPP components has been made. Public involvement and education continues to be a key focus of implementation. Over 30 meetings, workshops, and trainings have been conducted in fiscal year 2010 including: four steering committee meetings, four work group meetings, 13 public and local-government meetings, and 11 educational events. Three press releases, four Plum Creek Current quarterly Newsletters and three project brochures were developed and distributed. The Plum Creek Watershed partnership website has had 8,867 page views and 3,480 unique visitors. The webpage that hosts the surface water quality data and the four online modules has had over 10,023 page views. The outreach and education efforts of the "Taking Charge of Water Quality in the Plum Creek Watershed" coordinated by GBRA and Texas AgriLife Extension Service received the 2010 Envision Central Texas Community Stewardship Award for Raising Public Awareness. The Plum Creek Current Newsletter has been recognized by the American Society of Agronomy through its educational materials excellence program. The Partnership has conducted meetings to discuss the long-term sustainability of the Partnership. Through all of these efforts, Texas AgriLife Extension Service, in collaboration with the GBRA, has engaged personnel and officials with each of the municipalities and counties within the watershed to build strong cooperative partnerships.

The Caldwell-Travis and Hays County SWCDs are providing technical and financial assistance to agricultural producers for the development and implementation of WQMPs in the Plum Creek watershed. A district technician has been promoting the WQMP program at workshops, civic organizations, and in the newspaper. To date, nine producers have applied for a WQMP and four have begun implementation. The BMPs being installed include grass planting, cross-fencing, pipelines, and watering facilities. The feral hog education program in the Plum Creek watershed includes the delivery of landowner education and training programs, development of a feral hog management website (< pcwp.tamu.edu/feralhogs/>), and the development and dissemination of publications.

Implementation efforts also continued in the urban sector in the City of Kyle, where TCEQ funds through the CWA Section 319(h) grant are being used to implement a variety of pollution prevention strategies. In addition to structural modifications such as the reengineering of regional detention facilities, a few key outreach measures engaged local stakeholders to play a role in water resource protection. Ten pet waste stations have been installed in public parks, with more planned for remaining high-use areas. More than 400 volunteers participated in the annual Plum Creek Watershed Clean-Up, removing 1,720 pounds of trash and collecting 1,740 pounds of recyclable materials. City staff installed 1,000 bright blue markers on the city's storm water drains, to remind the public that pollutants that flow into the drain are headed straight into local creeks and streams. The City of Lockhart began implementation of a CWA Section 319(h) grant through funding from the TCEQ in the summer of 2010. The City of Lockhart will continue the Annual Town Branch Cleanup in City Park which has been a very successful event with over 350 volunteers each year removing trash, recycling, and conducting park beautification projects.

In support of the WPP, the GBRA continued to conduct intensive surface water quality monitoring on Plum Creek and its tributaries through funding from the TSSWCB. As part of the sampling protocol, targeted routine ambient, stormflow, wastewater effluent, and springflow samples are collected at 43 sites throughout the watershed. As rainfall returned to the watershed, many monitoring locations that had been dry for the previous two years experienced measurable flow, allowing for the collection of valuable water quality data. The data collection efforts were extended through October 2010. Additional funds are being sought to extend monitoring for at least three more years in order to assess implementation efforts and to increase the level of understanding of local streamflow and water quality trends. This additional monitoring will prove vital to responding to changing water conditions as part of an adaptive management strategy.

San Antonio River Walk/photo courtesy of SARA

Texas Commission on Environmental Quality Watershed Protection Plans

Arroyo Colorado

The Arroyo Colorado, an ancient distributary channel of the Rio Grande, extends about 90 miles from Mission, Texas to the Laguna Madre in the Lower Rio Grande Valley. Flow in the Arroyo Colorado is sustained by wastewater discharges, agricultural irrigation return flows, urban runoff, and base flows from shallow groundwater. To address the Arroyo Colorado's water quality impairments for bacteria and depressed DO, as well as nutrient concerns, the Arroyo Colorado Watershed Partnership developed a phase-one WPP for the Arroyo Colorado.

Following the release of the WPP in 2006, the "Arroyo Colorado Watershed Protection Plan Implementation" project began putting the strategies and objectives listed within the plan into action. The Arroyo Colorado Watershed Partnership has grown to over 700 members. Through this project, the Partnership leveraged local dollars and time from the Lower Rio Grande Valley TPDES Stormwater Task Force and citizens to host a watershed-wide event in conjunction with Earth Day to install more than 1,000 storm drain markers, reading "No Dumping, Drains to Laguna Madre." The task force hopes to fund an additional 20,000 markers in the future. Over 21,000 individuals have experienced the physical watershed model, a hands-on educational tool that teaches youth and adults about their local watershed, their impact on water quality, and how they can be better stewards of the land. Currently, the Partnership tracks activities from at least 16 projects working to implement the WPP. Over $3.9 million federal and $2.2 million local funds support the implementation of the Arroyo Colorado WPP.

The "Arroyo Colorado Watershed: Construction of Wetland Treatment Systems" project provided financial assistance to the cities of San Juan, San Benito, and La Feria to improve water quality through the design, construction, maintenance, operation, and monitoring of wetlands that will receive treated effluent from municipal WWTFs and storm water runoff. Recreational ammenitites such as boardwalks, all-weather paths, signage, and kiosks are being developed. The City of La Feria completed construction of its wetlands in November 2009 with a grand opening on December 6, 2009. San Juan completed construction on its wetlands

in March of 2010 and had a grand opening on April 22, 2010. San Benito has just recently completed the construction phase of its wetland. The city will set a date for the grand opening after the plants are established.

The primary focus of the "Arroyo Colorado Agricultural Nonpoint Source Assessment" project is to better characterize agricultural runoff in the Arroyo Colorado, assess and demonstrate the effects of BMP implementation at the field and sub-watershed level, and measure progress towards meeting WPP goals. Scientists monitored water quality in agricultural drainage ditches to assess potential mitigation and attenuation within the drainage way and also collected irrigation return water to gain better data on the quality of tailwater leaving the fields currently using BMPs. Agricultural BMPs installed throughout the watershed were inventoried and mapped to better target future education efforts and cost-share programs. Impacts of BMPs on water quality and potential mitigation effects of drainage ditches will continue to be monitored during the next year. Also, this project uses the Soil and Water Assessment Tool (SWAT) model and GIS to simulate the current sediment, BOD, and nutrient loadings in the Arroyo Colorado watershed. Data was collected for input through the LULC map and the model has been calibrated and validated. By spring 2011, scientists will simulate load reduction scenarios based on a suite of potential BMPs.

The WQMP Implementation "Assistance in the Arroyo Colorado Watershed" project provides technical and financial assistance to local watershed landowners to develop WQMPs. This project is featured in Chapter 2.

The "Pesticide Education in the Coastal Zone of the Arroyo Colorado Watershed" project is funded by the General Land Office (GLO) and is helping fulfill two of the goals of the Texas Coastal Management Program. Agricultural and turfgrass producers in the Coastal Zone of the Arroyo Colorado watershed are educated on water quality issues and how the proper application of pesticides meets current laws and regulations and can improve water quality and fish communities in the coastal natural resources area (CNRA). This is done through the Pesticide Applicator Safety Training and Continuing Education program. Pesticide disposal signs are currently being designed and will be distributed at a pesticide applicator safety training held quarterly. Secondly, the Sports Athletic Field Education (SAFE) Program addresses a host of issues such as economic nutrient application, reduced pesticide management techniques, and maintenance of turf health for proper playing surface, reduced water use and efficient irrigation. Also, included in this project is the Soil Testing Campaign where it has been anticipated that at least 700 producers will have participated by the end of the campaign. Estimates of nutrient (nitrogen and phosphorus) reduction will be provided as a result of the campaign. The overall impact of this project will be that it will provide landowners with accurate, technically sound information that they can use to reduce the potential for NPS pollution caused by improper use of land management techniques and to maintain and improve water quality in the Arroyo Colorado Watershed.

Funded by the EPA as part of the Strategic Agricultural Initiative Program, the Integrated Farm Management Education Program is a program that will meet three of the six goals identified by the Strategic Agricultural Initiative Program by using demonstration projects to increase the adoption of reduced risk/Integrated Pest Management (IPM) practices, implementing education programs to encourage a partnership between individual producers and local, state, or federal governments agencies, and encouraging producers to adopt an integrated farm management approach or whole-farm management system. During the last year, Texas AgriLife Extension Service has been hosting programs promoting the adoption of an integrated farm management system where agricultural producers have learned how to better manage their land and resources through the adoption of IPM, including nutrient, irrigation, and production practices that reduce the potential for NPS pollution.

The PSAs for the Arroyo Colorado Watershed is a project funded by the GLO that supports the development and distribution of two television PSAs, which will educate watershed residents about local water quality and NPS pollution issues. These educational pieces will be broadcasted via television in both English and Spanish to raise community involvement in the activities of the Arroyo Colorado WPP. The PSAs are anticipated to be complete in the fall of 2010 and will be aired in 2011.

"Enhancing Water Quality and Dredged Material for the Port of Harlingen (Phase I)," a project funded by the GLO, will focus efforts in the heart of the impaired tidal segment

of the Arroyo Colorado. This part of the water body is classified as a CNRA and a coastal wetland in the Coastal Coordination Act. The project addresses two major categories and goals within the Coastal Management Programs, which included water quality and quantity improvements and enhancement of critical areas. Water quality issues associated with the Arroyo Colorado and the Lower Laguna Madre are being addressed through the construction of an approximate 35 acre wetland that will be designed and built to protect critical habitat and provide nutrient removal from dredge spoils from the turning basin of the Port of Harlingen. The spoils contain nutrients from two sources, including NPS pollution associated with port activities (loading, unloading, storm water runoff) and detachment from upstream sediment that settles out of the water column in the turning basin (a wider, deeper segment of the stream that has slower flow). By removing these nutrients, the spoils can be sold and used as beneficial amendments in other areas of the watershed, which will provide revenue for sustaining the sediment basin and wetland system, as well as improving the water quality. This Phase I of the project is the assessment phase where permit coordination, an ecological assessment, available hydrological, soils, and topographic data is being gathered for a conceptual layout of the wetland to be developed. A conceptual design report will be developed for Phase II.

Bastrop Bayou

The Bastrop Bayou watershed is located entirely within Brazoria County. Ambient water quality monitoring began for the watershed in August 2004 under the CRP. A risk assessment was completed for the watershed in June 2006. The assessment revealed that although the watershed is not currently on the 303(d) List, rapid population growth in the area is a significant risk to water quality. By 2025, the watershed is expected to have a 50 percent growth in households. Because of the risk assessment, the TCEQ, the GBEP, and the H-GAC began the WPP in 2006. In 2010, modeling of bacteria loading and tidal dynamics was completed and incorporated into the draft WPP.

Brady Creek

Brady Creek is an intermittent to perennial stream that originates in Concho and Menard Counties, flows through Concho and McCulloch Counties, and finally joins with the San Saba River in San Saba County, east of Brady, Texas. Since construction of Brady Lake in the early 1960s, Brady Creek from below the dam through the City of Brady has primarily consisted of flows from urban runoff. Since this time, the creek through the City of Brady has experienced significant algae blooms and fish kills. The creek was first identified on the 2004 303(d) List for not supporting the designated aquatic life use due to low DO. Concerns have also been identified for chlorophyll a and nutrients.

In fiscal year 2009, the UCRA completed the initial watershed characterization portion of a WPP for Brady Creek, in which existing data and new monitoring data were assessed to determine overall water quality and potential sources and causes of pollution. During fiscal year 2010, a new project for the completion of the WPP was initiated by the UCRA and TCEQ utilizing CWA Section 319(h) funding. During fiscal year 2010, the monitoring plan for the new project was developed to include urban and rural ambient and storm water montoring. The implementation of the monitoring plan, development and implementation of the modeling

Brady Creek near Melvin/photo by Lauren Bilbe of the TCEQ

plan, and the stakeholder process will occur in fiscal year 2011.

Overall, the WPP is an expansion of the Brady Creek Master Plan that addresses the entire Brady Creek watershed. The WPP includes a focus on NPS pollution in the downtown Brady portion of the watershed, sources and potential sources of pollution in the greater watershed, and other water quality and quantity issues of interest identified by stakeholders. The WPP project will include refining the Brady Creek Watershed Characterization by conducting additional monitoring and modeling; further identifying and quantifying pollutant loading sources; prioritizing BMPs identified in the Master Plan for the City of Brady; identifying additional BMPs for the watershed, along with associated costs and load reductions to be achieved; creating a schedule of implementation with measurable milestones; and involving stakeholders throughout the WPP process.

Caddo Lake

Stakeholders within the Caddo Lake/Cypress Basin have expressed concern over issues that include NPS pollution affecting water quality. To address some of these issues related to NPS pollution, stakeholders have embarked on the development of a WPP. The WPP project encompasses not only Caddo Lake but also the contributing Cypress Creek Basin. Specific water quality issues addressed in the WPP project include bacteria and nutrient loading.

Modeling activities were performed to predict pollutant loadings. The modeling efforts focused on understanding the processes involved in pollution generation, migration, and kinetics from the Cypress Creek Basin into Caddo Lake. The driving force for pollutant transport from watersheds to water bodies is excess precipitation in the form of runoff. The physical nature of the watershed plays a fundamental role in the quantity and quality of water in the watercourses. Only a fraction of precipitation that falls across a watershed is actually available for runoff to the drainage systems. Many waterborne constituents introduced into the water can affect how the receiving water responds to pollutants as a consequence of the processing by the watershed.

Four models, including SELECT, SWAT, the Environmental Fluid Dynamics Computer Code (EFDC), and Water Quality Analysis Simulation Program (WASP) were used to characterize different issues evident within the basin. SELECT and SWAT were used to model the watershed while EFDC and WASP were used to model Caddo Lake itself. The SELECT watershed tool was used to evaluate bacteria and which sources of bacteria contribute the highest potential bacteria load in different areas within the basin. The SWAT watershed model was used to evaluate nutrient and sediment loads contributed by watershed sources to receiving streams. The Caddo Lake model consists of two linked models: the EFDC hydrodynamic model and the WASP water quality model. The combined lake model was used to evaluate changes to lake water quality resulting from changes in watershed loading (i.e., SWAT model outputs).

The major sources of bacteria and nutrients in the watershed were preliminarily determined to be livestock, wildlife, pets, OSSFs, poultry (lagoon wastes and dry litter), and WWTFs. To the extent possible, protocols used to characterize sources were consistent with other WPP projects in Texas. Additional work will be required before the analysis can be used as a guide for BMP implementation and water quality restoration.

Cypress Creek

Cypress Creek originates in western Hays County and flows into the Blanco River. This perennial stream is 15 miles long and emanates from the middle Trinity Aquifer at a place known as Jacob's Well near Wimberley, Texas. The Cypress Creek watershed is home to a unique set of rural and urban communities and distinctive ecosystems. The area has a long-standing reliance on groundwater for drinking supply, recreational activity, and in maintaining aquatic life uses. Stakeholders have determined that a WPP is one of the many tools they will use to keep Cypress Creek clean, clear, and flowing. The RSI at Texas State University–San Marcos is helping to guide the development of the WPP.

Issues of concern include excess sediment in the creek, high bacteria concentrations, and occasionally very high nutrient levels. Characterization results show that flow is a critical factor for maintaining adequate oxygen levels and a highly functioning aquatic community. Analysis indicates the upper portions of the watershed tend to be highly influenced by inflow of groundwater in terms of the water chemistry, while downstream sites show more of an influence by local

stream conditions and runoff from contributing subwatersheds.

Through a series of 58 meetings, stakeholders worked to help identify concerns, set priorities, and to answer many pressing questions associated with the watershed characterization process. Their efforts are documented within the *Cypress Creek Characterization Report* located at <www.cypresscreekproject.org>. Through the development and delivery of a decision support system, stakeholders were trained to utilize this tool to process land use change scenarios and to analyze the results. Two trainings took place in July 2010 and the decision support system was delivered to the Watershed Committee in August 2010. The decision support system will bring scientifically based information into consideration and will aid decision makers in determining how land use decisions impact water resources.

Funding for this project comes from the TCEQ, RSI, and stakeholder contributions. Active partners collaborating to develop the WPP include: the City of Wimberley, the City of Woodcreek, Hays County, the Wimberley Valley Watershed Association, Hays-Trinity Groundwater Conservation District, Texas State University–San Marcos, the GBRA, the Watershed Science Lab, Texas Stream Team, the TWDB, The Nature Conservancy, and the Way Family Foundation.

Dickinson Bayou

The Texas AgriLife Extension Service, with funding from the TCEQ CWA Section 319(h) grant program, is working to implement BMPs identified as necessary in the Dickinson Bayou WPP. The primary goal of this project is to implement and demonstrate effective BMPs through the Dickinson Bayou Watershed Partnership. Dickinson Bayou is on the 303(d) List for DO and bacteria affecting aquatic life and contact recreation uses. Texas AgriLife Extension Service and TCEQ facilitated the formation of a watershed partnership and a WPP was completed in the spring of 2009. This plan is under revision to incorporate information from a draft bacteria TMDL. This project will develop BMPs for the area and the planning and ordinance tools to be used by local officials to implement these practices within the watershed.

Dickinson Bayou/photo by Charriss York of Texas AgriLife Extension Service

During fiscal year 2010, much progress has been made on this project. Four fact sheets on topics important to the watershed were written titled: *Dickinson Bayou Pet Waste and Water Quality, Dickinson Bayou WPP at a Glance, Stormwater Runoff Pollution, and Neighborhood Friendly Landscapes.* Also, a pet waste education campaign was initiated with the City of League City encouraging watershed residents to "bag it for your bayou." Two posters and one print ad for community newsletters were produced and distributed and a new pet waste station was installed at the League City Sportsplex Park. Another aspect of this project is youth education. Texas AgriLife Extension Service worked with elementary school students using a watershed model and high school students to complete hands-on citizen water quality testing, as well as creating their own watershed model demonstrating water and pollutant runoff. Lesson plans for these activities are all available on the Dickinson Bayou website <www.dickinsonbayou.org>.

Finally, the Texas Agrilife Extension Service began working with the Clear Creek Independent School District on a storm water detention basin retrofit project. Leveraging an additional $90,000 in funding from the GBEP, this project will retrofit an existing detention basin into a storm water wetland at the school district's new Education Village, a site with an elementary school, middle school and high school all on one campus. This site will provide education opportunities for multiple grade levels and their parents as well as improving water quality. This ten acre wetland project is still in the design phase with ground breaking expected in the spring of 2011.

Illicit discharge in the Westfield Estates neighborhood/ photo by Justin Bower of H-GAC

Halls Bayou–Westfield Estates

The Westfield Estates Watershed is a small urban area that contributes drainage to the Halls Bayou Watershed. The Westfield Estate Watershed is composed of a series of urban residential streets and open drainage ditches located in an unincorporated portion of northeast Harris County. The sanitary sewer needs of the community are served entirely by OSSFs, many of which are failing due to design, maintenance or operational issues made worse by a general lack of available funding. As a result, this historically underserved neighborhood of 700 households was identified by Harris County in a previous study as the community most in need of adequate wastewater treatment. Combined with bacterial contamination from domestic animals (primarily dogs and chickens) and other wildlife, the failing OSSFs have led to elevated bacteria levels (greater than 100,000 MPN/100ml) in the watershed's drainage ditches. These conditions far exceed the state's criteria for contact recreation and pose direct human health risks.

To alleviate these risks, the Westfield Estates WPP was developed through a stakeholder involvement process, led by an interdisciplinary Stakeholders Advisory Group (SAG) comprised of members from local political jurisdictions, water quality professionals, and interested community members. The SAG met several times over the last year and provided resources, technical assistance, and expertise throughout the planning process. Additionally, project staff worked with community outreach groups and key governmental stakeholders during the year to develop outreach program elements and strategies, and to further refine procedures for structural measures.

The goals of the Plan are to reduce bacteria levels, institute BMPs to maintain improved water quality, and raise awareness of water quality issues in the watershed. These aims will be achieved by reducing the human and non-human bacteria load through both structural and behavioral BMPs. Structural measures include targeted maintenance, repair, and replacement of malfunctioning OSSFs, installation of low-flow water devices to reduce flows to OSSFs, and a pet waste reduction incentive program potentially including waste disposal facilities and waste recycling. Behavioral measures will include developing and implementing a series of educational materials and meetings regarding OSSF maintenance and pet waste disposal, fostering a permanent community watershed management group to insure continued stakeholder commitment to implementation activities, and public informational meetings. The draft Plan is currently under EPA review.

Hickory Creek

The Hickory Creek arm of Lake Lewisville has been identified as a water body of concern for ammonia nitrogen. Lake Lewisville is not currently identified on the 303(d) List as impaired. However, significant development is anticipated for the area within the next several years. This growth has the potential to threaten designated uses of the creek. In fiscal year 2009, the City of Denton completed the Hickory Creek WPP. The goals of the WPP are to identify sources and causes of pollution and to determine which management strategies are best suited to maintain water quality in the watershed. These strategies are being targeted with the goal of being in compliance with current and anticipated future TSWQS, along with protecting the city's drinking water supply. The WPP is designed to prevent net increases in sediment and nutrient loading. The WPP provides an in-depth cost analysis of the BMPs versus their effectiveness at removing pollutant loads. The WPP also proposes a pilot program that can be used for trading nutrient and sediment loads. During fiscal year 2010, a new project was initiated by Denton and TCEQ utilizing CWA Section 319(h) funding. This project will implement BMPs as recommended in the WPP and prioritized by stakeholders.

Lake Granbury

Lake Granbury in Hood County serves as a water supply for more than 250,000 people in North Central Texas. While bacteria problems are not exhibited within the main body of the lake, elevated bacteria levels are exhibited in specific coves and canal water bodies attached to the lake. For the last several years, regular water quality testing has found elevated concentrations of *E. coli* in the coves of Lake Granbury, resulting in water quality not meeting TSWQS for contact recreation use due to elevated bacteria levels. A substantial portion of the developed area around Lake Granbury, which lies wholly within Hood County, consists of unincorporated subdivisions that do not have sewage collection systems and centralized sewage treatment facilities. Small lot sizes and soils make on-site sewage treatment problematic.

The Lake Granbury WPP Project provided an assessment of existing and potential water quality threats from ongoing NPS pollution within the Lake Granbury watershed. Historical data analysis was completed and a water quality characterization report with trend analysis was produced. The results of the BST data were presented in fiscal year 2009 and stakeholders chose to rely on the modeling process as the primary source of information to support decision-making for the plan.

Finalization of the plan occurred in fiscal year 2010 with a highly-defined plan of stakeholder-vetted BMPs. Major findings and outcomes of the stakeholder-driven WPP development process will follow.

Of numerous areas identified and 21 areas studied in detail by the stakeholders, 13 subdivision areas adjacent to the lake are targeted for specific future strategies to reduce bacteria loads. Implementation strategies include maintaining a watershed coordinator to oversee implementation, regional collection and treatment of wastewater, and area-targeted education programs. Targeted education programs are to include septic maintenance, pet waste management, greywater management, fertilizer application, and other landowner/association activities.

San Bernard River

The H-GAC is guiding the WPP process for the rural and developing watershed of the San Bernard River. The San Bernard River Watershed includes portions of Austin, Colorado, Fort Bend, Wharton, and Brazoria Counties. The watershed is approximately 900 square miles and the river flows about 125 miles from the headwaters near New Ulm in Austin County to the Gulf of Mexico.

The San Bernard River was placed on the 303(d) List in 2002 for contact recreation due to bacteria. The tidally influenced portion of the river has also experienced low levels of DO. Recently however, the DO levels have returned to normal due to the reopening of the mouth of the river. The TCEQ funded the H-GAC under an ARRA grant for three major tasks to maintain and improve the river's water quality: a WPP, incorporation of BMPs in local jurisdictions, and an analysis of NPS pollution through the use of GIS.

The project to complete these tasks was initiated in September 2009. Three kickoff meetings and watershed tours were conducted in fall 2009. Starting in January 2010, stakeholder meetings have been held every other month. The meetings have been well attended by the Stakeholder Committee and the public. At these meetings, a map showing causes and sources of pollution and a Watershed Characterization and Inventory report were created based on participant input. In January 2010, a TWS training hosted by Texas AgriLife Extension Service was held in the watershed, it was well attended by local stakeholders. In May 2010, a Texas Stream Team training session was held to train citizen water monitors. Quarterly ambient water quality monitoring continues at eight sites in the watershed. Throughout the project, the H-GAC has worked in coordination with the TSSWCB and the NRCS to identify stakeholders and gather information about the watershed. A website has been set up for the project at <www.h-gac.com/go/sanbernard>. The website contains links to model ordinances to reduce NPS pollution and information about BMPs along the urban to rural transect.

Upper Cibolo Creek

The Upper Cibolo Creek originates in southern Kendall County and flows for 23 miles from the headwater springs to the confluence of Balcones Creek near the Comal and Kendall County line. The Upper Cibolo Creek Watershed contains 76 square miles and lies within the San Antonio River Basin. The majority of Upper Cibolo Creek is perennial with the lower reach supplemented by the City of Boerne WWTF discharge. Despite its perennial nature, the extreme lower reach of the creek remains dry throughout most of the year due to groundwater recharge.

The Upper Cibolo Creek was initially placed on the 1999 303(d) List for aquatic life and recreational uses due to depressed DO and bacteria excedences. From 2002-2004 the

Upper Cibolo Creek/photo courtesy of the City of Boerne

creek was impaired for low DO and from 2006-2010 the creek has been listed as impaired for elevated bacterial levels. A push for action occurred after the TCEQ completed aquatic life monitoring in 2008 on the lower reach of the creek and determined it contained borderline exceptional aquatic life use.

The City of Boerne received a CWA Section 319(h) grant from the TCEQ to develop a WPP in August 2009. During the past year, work has focused on project initiation, stakeholder development and watershed characterization. The Upper Cibolo Creek Watershed Partnership was formed and stakeholders have participated in three public meetings to provide input and discuss details of local water quality concerns. Topical Work Groups have been created and recently met to start working on specific aspects of the WPP. A TWS training was held in Boerne to increase public awareness and participation in the watershed planning process. Stakeholders had an opportunity to attend a watershed tour where guest speakers provided information on the unique natural resources found within the watershed. A monitoring plan has been formed to identify sources and causes contributing to bacteria levels and provide data for watershed modeling. Work on the WPP will continue through fiscal year 2011 with a primary focus on data collection and modeling.

Upper San Antonio River

In 2006, the San Antonio River Authority (SARA) along with the Bexar Regional Watershed Management partnership completed a WPP for the Upper San Antonio River which was identified on the 1996 303(d) List for contact recreation due to elevated levels of bacteria. One of the BMPs identified in this document was the need to reduce wildlife (mainly birds) in the Upper San Antonio River, particularly along the historic River Walk commonly known as Paseo Del Rio. The river walk district in the heart of San Antonio consists of restaurants, shops, and hotels that are frequented by tourists and residents.

The SARA received a CWA Section 319(h) grant from the TCEQ to reduce bacteria in the River Walk portion of the Upper San Antonio River by 50 percent. A community approach was taken and the River Walk Watershed Alliance (RWWA) was formed to tackle the problem of changing people's behavior to reduce bacteria in the river. The RWWA consists of staff from Bexar County, the City of San Antonio, the SARA and San Antonio Water Systems, along with representatives from Downtown Alliance/Centro San Antonio, Downtown Residence Association, and the Paseo Del Rio Association.

The RWWA held seven meetings with stakeholders, partner organizations, and staff from local government to determine the outreach theme, messages, and type. Through education and outreach to the community, the project received free monthly ads in the local *Rio* Magazine. As part of an improvement project, new signs were posted along the River Walk with maps and the following statement, "Don't feed the ducks, pigeons and other wildlife." With the new signage and additional outreach using the materials developed under this grant, it is anticipated that the *E. coli* levels will be reduced further. Recent comparisons of *E. coli* data collected prior to the project and after implementation of the education campaign indicate that greater than 25 percent reduction has been attained.

Third-Party Watershed Protection Plans

The North Central Texas Water Quality Project

Watershed planners with the North Central Texas Water Quality Project

(NCTWQP) have worked diligently to continue the momentum established with watershed planning efforts for the Cedar Creek and Eagle Mountain reservoir watersheds. The two reservoirs are owned and operated by the Tarrant Regional Water District (TRWD) and are in various stages of project development. The NCTWQP was created to develop watershed plans for the two reservoirs and is working to perfect a template for watershed planning in the region emphasizing the use of computer modeling, prioritization of targeted sub-basins, and economic analysis of conservation practices to allow for strategic use of funds.

The NCTWQP is a partnership of the TRWD, the TWRI, and the Texas AgriLife Research and Extension Urban Solutions Center at Dallas. Funding for the project is provided by the NRCS, the EPA, the TSSWCB, the TCEQ, and TRWD.

Cedar Creek Reservoir Watershed

The Cedar Creek Reservoir appears on the 2006 and 2008 303(d) List due to DO and pH, as well as on the Draft 2010 303(d) List for pH. WPP efforts are focused on the reduction of chlorophyll a through the limitation of phosphorus and sediment entering the reservoir.

Featured in the WPP is extensive and collaborative modeling utilizing the SWAT for watershed level modeling, Enhanced Stream Water Quality Model (QUAL2E) for in channel processes, and the WASP model for the reservoir. Additionally, completion of a conservation practice economic performance analysis model by Texas A&M University economists has provided project leadership and stakeholders with several scenarios of conservation practice implementation integrating cost figures and pollutant reduction performance. Utilization of this tool has determined that the strategic placement of filter strips, grassed waterways, grade stabilization structures, terracing, and a 2,000 foot buffer strip surrounding the reservoir will achieve the previously determined goal of 35 percent phosphorus reduction. This effort will work in conjunction with ongoing efforts of the Kaufman Van Zandt SWCD to develop WQMPs for individual landowners within priority subbasins.

A stakeholder work group led by the Texas AgriLife Extension Service and the Kaufman County Environmental Co-op has determined a list of targeted audiences for informational and outreach programming, as well as catered messages to foster watershed awareness and stewardship among sportsmen, homeowners, agricultural producers, and schoolchildren. To supplement these planned outreach efforts, demonstration sites funded by the TCEQ for selected conservation practices such as rainwater harvesting and bioswales have been installed or have been planned within watershed communities.

In addition, reporting of pollutant contributions associated with WWTF discharges has been coupled with recommended upgrades for each facility currently discharging within the watershed.

The implementation protocol for BMPs and interim milestones for progress will be based upon the number of practices installed and advancement of educational programming. Monitoring of pollutant reduction will be conducted with the same methodology of computer modeling and ambient water quality testing utilized to analyze current and past watershed and reservoir conditions.

Eagle Mountain Lake Watershed

Watershed planning for the Eagle Mountain Lake watershed is moving forward with the use of computer modeling and subbasin analysis of conservation practices for both pollutant reduction and economic performance.

Planning efforts are driven by a rising trend of chlorophyll *a* observed within the reservoir. Stakeholder interest in the plan has increased substantially as reflected by attendance at local meetings, media attention, and the prospect of partnerships with entities such as Save Eagle Mountain Lake, The Trust for Public Land, and the LBJ National Grasslands. SWAT and WASP modeling of the watershed and reservoir are currently in progress and will be followed by the advancement of planning efforts in targeted areas where BMPs will be strategically proposed for areas of highest priority. Reporting of pollutant loadings and recommended upgrades to watershed WWTFs have been conducted to account for point sources within the watershed. Development of an economic performance analysis by Texas A&M University of conservation practices is currently in progress to guide project leadership and stakeholders toward the most efficient use of project funds.

The NCTWQP participants are cooperating with Texas AgriLife Research in Stephenville as they conduct a recreational use attainability analysis for portions of the upper Trinity River basin including portions of the Eagle Mountain Lake Watershed for bacterial impairments.

ABBREVIATIONS

Lake Buchanan/photo by Lauren Bilbe of the TCEQ

Abbreviations

ACS	Agricultural Chemicals Subcommittee
AFO	Animal Feeding Operation
ARRA	American Recovery and Reinvestment Act
BMP	Best Management Practice
BRA	Brazos River Authority
BOD	Biochemical Oxygen Demand
BSEACD	Barton Springs/Edwards Aquifer Conservation District
BST	Bacterial Source Tracking
CAFO	Concentrated Animal Feeding Operation
CMIP	Composted Manure Incentive Program
CNRA	Coastal Natural Resources Area
CRP	Clean Rivers Program
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund (of the TWDB)
CWQMN	Continuous Water Quality Monitoring Network
CZARA	Coastal Zone Act Reauthorization Amendments
DMES	Dairy Manure Export Support
DO	Dissolved Oxygen
E. coli	*Escherichia Coli*
EAA	Edwards Aquifer Authority

EFDC	Environmental Fluid Dynamics Computer Code
EPA	U.S Environmental Protection Agency
GBEP	Galveston Bay Estuary Program
GBRA	Guadalupe Blanco River Authority
GIS	Geographic Information System
GLO	General Land Office
GPS	Global Positioning System
H-GAC	Houston-Galveston Area Council
IBWC	International Boundary and Water Commission
IPD	Interagency Pesticide Database
IPM	Integrated Pest Management
I-Plan	Implementation Plan for a TMDL
IR	Texas Integrated Report
Lbs	Pounds
LCRA	Lower Colorado River Authority
LDC	Load Duration Curve
LEADS	Leading Environmental Analysis and Display System
LID	Low Impact Development
LULC	Land Use–Land Cover
mL	Milliliters
MPN	Most Probable Number
NBR	North Bosque River
NCTWQP	North Central Texas Water Quality Project
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Units
OSSF	On-Site Sewage Facility
PMP	Texas Groundwater Pesticide Management Plan
POC	Pesticide of Concern
POI	Pesticide of Interest
POINTS	Pesticide of Interest Tracking System
PSA	Public Service Announcement
QAPP	Quality Assurance Project Plan
QUAL2E	Enhanced Stream Water Quality Model
RSI	River Systems Institute at Texas State University-San Marcos
RWWA	River Walk Watershed Alliance
SAFE	Sport and Athletic Field Education
SAG	Stakeholder Advisory Group
SARA	San Antonio River Authority
SELECT	Spatially Explicit Load Enrichment Calculation Tool
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
SWQM	Surface Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TFS	Texas Forest Service
TGPC	Texas Groundwater Protection Committee
TIAER	Texas Institute for Applied Environmental Research
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TRWD	Tarrant Regional Water District
TSS	Total Suspended Solids
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
TWS	Texas Watershed Stewards
UCRA	Upper Colorado River Authority
USDA	U.S. Department of Agriculture
WAF	Waste Application Field
WASP	Water Quality Analysis Simulation Program
WPP	Watershed Protection Plan
WQIP	Water Quality Improvement Projects
WQMP	Water Quality Management Plan
WWTF	Wastewater Treatment Facility

left: *West Caney Creek in Trinity County/ photo by the Texas Forest Service*

below: *Pecos River north of Pecos/ photo by Allen Berthold of TWRI*

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