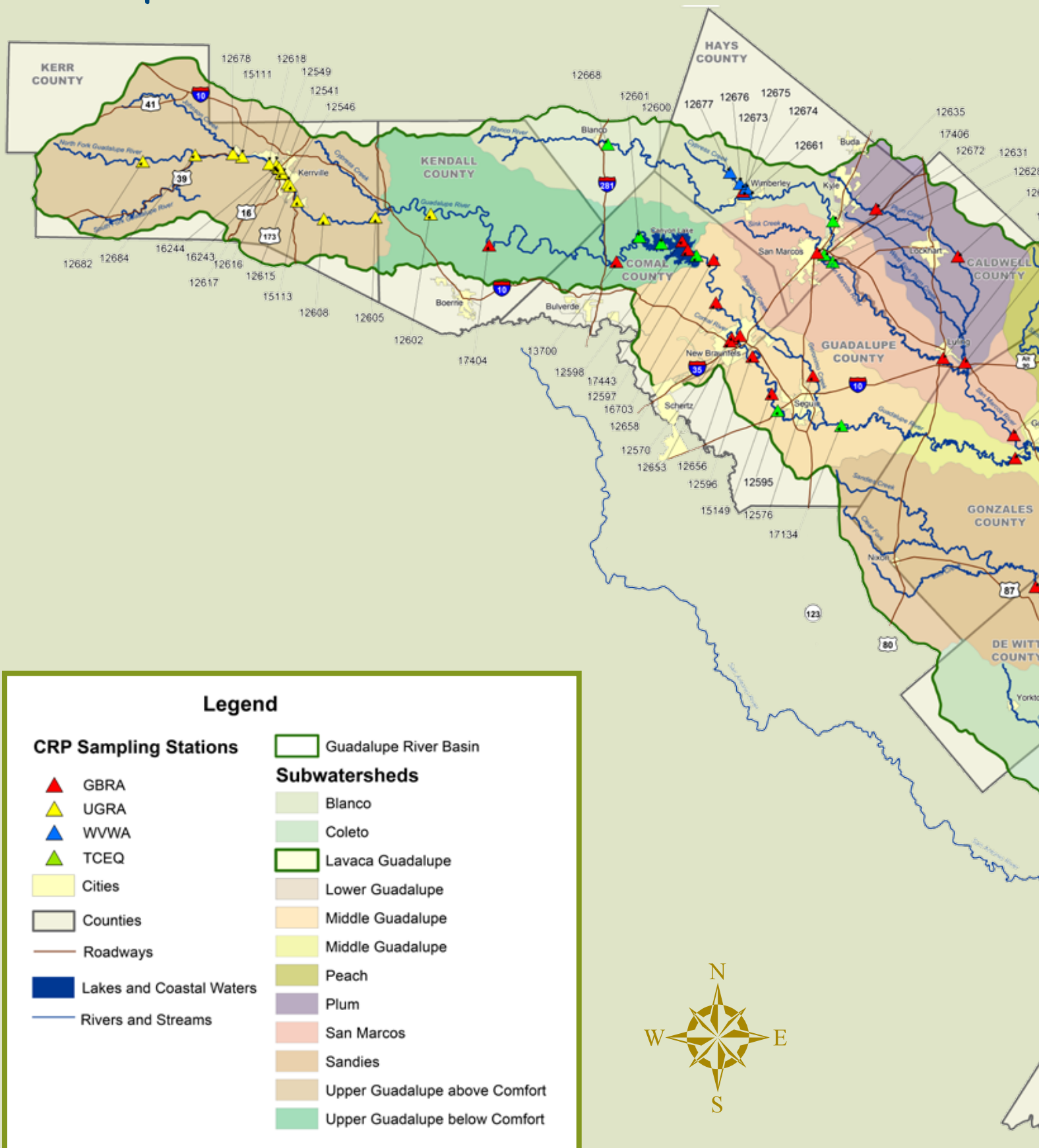
2013
Clean Rivers Program Basin Summary Report

Guadalupe River and Lavaca-Guadalupe Coastal Basins

Guadalupe River Basin



Legend

CRP Sampling Stations

- GBRA
- UGRA
- WVWA
- TCEQ

Cities

Counties

Roadways

Lakes and Coastal Waters

Rivers and Streams

Guadalupe River Basin

Subwatersheds

- Blanco
- Coleto
- Lavaca Guadalupe
- Lower Guadalupe
- Middle Guadalupe
- Middle Guadalupe
- Peach
- Plum
- San Marcos
- Sandies
- Upper Guadalupe above Comfort
- Upper Guadalupe below Comfort

N
W E
S

Table of Contents

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Photo by Janet Thome

The Basin Summary report is designed to provide a comprehensive review of water quality data and related information for the Guadalupe River and Lavaca Coastal Basin. The report serves to develop a greater understanding of water quality conditions in the river basin. It also serves to enhance the ability to make decisions regarding water quality issues. The report is compiled every five years. In addition to the water quality data review, the report contains highlights on activities in the Guadalupe River Basin and Lavaca Coastal Basin under the Clean Rivers Program (CRP) and opportunities for the public to have input into the program. The CRP is managed by the Texas Commission on Environmental Quality and funded through the consolidated water quality fees, which include but not limited to fees assessed to wastewater and water rights permit holders. The Guadalupe-Blanco River Authority (GBRA), together with the Upper Guadalupe River Authority (UGRA), carry out the water quality management efforts in these basins under contract with the Texas Commission on Environmental Quality (TCEQ).

Executive Summary

The 2013 Basin Summary Report for the Guadalupe River Basin and Lavaca-Guadalupe Coastal Basin summarizes the monitoring and watershed protection activities, and water quality conditions of the watersheds in the respective basins. Historical data was reviewed for possible trends that would indicate degrading or improving conditions.

Basin Description

The Guadalupe River Basin varies from the steep, limestone Hill Country that is prone to flash flooding, to the flat, rolling terrain of the lower basin. As a result of the turbulent flows of the upper watershed streams, the substrates are primarily composed of bedrock and large gravel and the streams are shallow and swift. The lower basin substrates are silty, and the streams carry logs and debris from upstream which often collect in log jams at the lower end of the river. The middle portion of the river basin is made up of water bodies that are referred to as lakes but are really run-of-river impoundments. Four years out of five respond like rivers with short residence times, rather than true lakes or reservoirs with long residence times and stratification. The Guadalupe River Basin has two primary reservoirs, Canyon Reservoir and Coleto Creek Reservoir. Canyon Reservoir will stratify in most years, with one "turnover" that occurs in the fall. Coleto Creek Reservoir is used for cooling water for a power plant which creates excellent habitat for aquatic vegetation and fish. The tributaries of the middle and lower Guadalupe River have sandy substrates.

The Guadalupe River Basin is home to several endangered species. The Texas Wild Rice and the fountain darter are found in the Comal and San Marcos Springs and Rivers along with other species unique to springs and underground caves. Water quality, quantity and consistency of spring flow are critical to their habitat. The whooping crane that winters in the Aransas National Wildlife Refuge, along San Antonio Bay, is making a comeback. Freshwater inflows, or the lack of inflows due to diversions of water upstream, impact the habitat and biology of this species that is considered the poster child for protection of endangered species. The Senate Bill 3 stakeholder process has recommended instream flows for the Guadalupe River and inflows into the bays and estuaries in the lower basin. TCEQ considered these recommendations when setting the environmental flow requirements for the river.

The land use of the basin includes: Hill Country ranches, primarily used for hunting; farms and ranches; raising row crops; cattle, goats and poultry; and urbanized areas around the growing cities of Kerrville, Boerne, New Braunfels, Seguin, San Marcos, Lockhart, Luling, Gonzales, Cuero, Victoria, and Port Lavaca. The highest population growth is occurring along the major thoroughfares, US 281, IH 35 and SH 130, located in the central portion of the basin. Most of the industrial facilities are located in the lower basin, near the Victoria Barge Canal and ports along the coast. Recreation is an important "industry" in the upper basin and reservoirs, utilizing the clear water

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Photo by Alvin Schuerg



Photos by Janet Thome

and flows for swimming, tubing, canoeing, kayaking, and fishing. Numerous summer camps can also be found along the banks of the upper Guadalupe River. Utilization of the surface water for cooling occurs at power plants in Victoria and Goliad counties.

Watershed Concerns

The watershed segment summaries found in this report include discussions on stakeholders concerns. Those concerns may vary somewhat from watershed to watershed, but most have common issues. Stakeholders are concerned about the impact of human activities on water quality, and how those activities will influence both the recreational, and aesthetic value of the watershed. The human activities range from recreational pressure, to waste discharges and disposal, or lack thereof, to urban development. Recreational activities produce trash that, if not disposed of properly, floats downstream and becomes a nuisance. The wastewater discharges that exist throughout the river basin range in level of treatment, and in permitted volume. The permits are issued to municipalities for domestic waste treatment, to industries for their waste streams, and to power plants that use surface water for cooling. More and more new permits are being issued with nutrient limitations. Wastewater reuse is beneficial because it turns treated wastewater into a resource. This helps conserve water resources, but an unintended consequence of reuse is the reduction in return flows to the river, which can be a factor in water quality and quantity of the river, bay, and estuary. Improperly installed, poorly maintained, or failing septic tanks can be a source of bacteria, and nutrient pollution in the watershed. Additionally, control of illegal dumping at stream crossings is a high priority to stakeholders.

Impacts from urban development are concerns up and down the basin. The impervious cover associated with new houses and roads increases rainfall runoff. This runoff can be a source of "nonpoint source pollution" (pollution not associated with a permitted discharge pipe). Pollutants which soils can readily capture and biodegrade instead wash over cement and pavement, and flow directly into surface waters. Additionally, impervious cover reduces groundwater recharge and in turn, reduces the base flow of the streams.

In Kerr County, stakeholders are concerned about dense stands of ashe juniper and its propensity to intercept rainwater and prevent it from reaching the soil surface. This reduces groundwater recharge, which is critical to the base flow of the river in Kerr County. In Goliad County, the stakeholders are concerned about impacts from oil and gas production, and most recently, the in-situ mining for uranium.

The Eagle Ford Shale underlies much of south Texas, including DeWitt and Gonzales counties, which are located in the heart of the Guadalupe River Basin. The Eagle Ford Shale is a hydrocarbon-producing formation capable of producing both gas and oil. Hydraulic fracturing is a process to stimulate wells, and recover natural gas and oil from unconventional reservoirs of shale gas, and coal beds. Landowners in these counties are concerned with possible impacts of hydraulic fracturing on groundwater, and potential surface water pollution form runoff, or spills.

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Monitoring Water Quality

Most sampling locations have been routinely monitored for quite a number of years, and provide an excellent historical perspective of water quality. Only consistently collected, long term data was used for the trend analysis presented in this document. Monitoring entities include the TCEQ, the GBRA, the UGRA, the WVWA and the USGS The Hays County Development Services Department initiated a monitoring program within their jurisdiction in 2012. Because of economic reasons, funding for the Hays County program has been diverted to other projects. Their monitoring program will be discontinued until funding can be restored.

Trends in Water Quality

Water quality in most locations does not appear to be degrading. Most historical data confirmed the impairments or concerns that were listed in the 2012 Texas Water Quality Inventory. The concentration of total suspended solids, turbidity and *E. coli* bacteria continue to be of concern at most locations throughout the basin. The increase in concentration of these parameters closely correlates with high flows as a result of rainfall runoff. When the opposite conditions occur, like the droughts of 2009-2011, water quality is also impacted; base flow can become higher in dissolved solids, and effluent-dominated streams may have higher concentrations of nutrients.

The Upper Guadalupe River in Kerr County remains listed as impaired for bacteria in a small section in Kerrville. In 2011, the Upper Guadalupe River Authority partnered with the City of Kerrville, Kerr County, and the Texas Department of Transportation to implement the Bacteria Reduction Plan for the Upper Guadalupe River. The plan includes strategies to address the primary sources of bacteria pollution that have been identified in this section of the Guadalupe River, including birds nesting on bridges, large flocks of domestic waterfowl congregating in the lakes, septic systems, and pollution from general urban runoff. Other segments in the Upper Guadalupe River basin are also impaired for bacteria, and there is a concern for depressed dissolved oxygen, and habitat.

Canyon Reservoir remains listed as impaired due to a fish consumption advisory for mercury in fish tissue of the striped bass and long-nosed gar.

There is a concern for ammonia-nitrogen in Plum Creek, at a station downstream of Kyle, Buda, and other small wastewater treatment plants. The magnitude of the concentrations added to the concern. Sources of the ammonia nitrogen could be the wastewater effluent that dominates the flow at this location, but septic tanks and fertilizer can also be sources. Plum Creek is listed with an impairment for bacteria, and thus does not support its contact recreational use. Plum creek also has concerns for nitrate and total phosphorus.

Peach, Sandies and Elm Creeks are in various stages of total maximum daily load (TMDL) development. The Peach Creek TMDL has been completed, but no implementation plan has been initiated. The TMDL found that the impairment was most likely coming from non-point sources, such as failing septic tanks, livestock, and wildlife. Sandies and Elm Creeks have completed the majority of the data collection, but models have not been developed that would establish the sources of the impairments or the recommended total maximum daily loads. Stakeholders in these watersheds are concerned that the contact recreation standard is inappropriate for this stream because of the low potential for exposure to bacteria by swimmers immersed in water in these small tributaries. TCEQ has developed a process to assess the applicability of the recreational standards on these small creeks. A Recreational Use Attainability Assessment (RUAA) can be performed to determine which contact recreational use category (primary contact, secondary contact 1, secondary contact 2, or noncontact recreation) is appropriate for the water body and how it is used. The use category determines the appropriate assessment criteria. Evidence of primary recreation on these water bodies (i.e., swimming) exists. No RUAAs are planned for Elm, Sandies or Peach Creeks.

Overall, the quality of the Guadalupe River and its tributaries is good. The involvement of stakeholders and the ongoing water quality protection efforts in the basin indicate the extensive commitment to maintaining the health of the Guadalupe basin.

Objectives and Goals of the Clean Rivers Program

The Texas Legislature passed the Clean Rivers Act in 1991, which requires water quality assessments for each river basin in Texas. In accordance with the Act, the TCEQ administers the Clean Rivers Program, in partnership with river authorities, municipal water authorities, councils of governments, and other regional entities. The goal of the program is to maintain and improve water quality within each river basin through these partnerships.

The TCEQ, GBRA and UGRA gather data from the Guadalupe River, its sub-watersheds and coastal basins in a watershed management approach, in order to identify and evaluate water quality issues, establish priorities for corrective action, work to implement those actions, and adapt to changing priorities. Examination of long-term data allows comparison between current and historical water quality data, and statistical analysis can indicate any trends in improvement or deterioration of water quality parameters.

Coordination and Cooperation with Other Entities in the Basin

GBRA and UGRA coordinate with other entities interested in monitoring in the Guadalupe River Basin. Those entities include the TCEQ, United States Geologic Survey (USGS), Texas Parks and Wildlife Department (TPWD), Texas State Soil and Water Conservation Board (TSSWCB), the Wimberley Valley Watershed Association (WVWA) and Texas Stream Team. Annually, all cooperators monitoring in the basin meet to coordinate their activities. This coordination minimizes duplication, focuses monitoring and resources where needed, and helps prevent voids in coverage across the basin.

Another important partner in the river basin is the WVWA. The WVWA determined that managing water resources is of paramount importance for the continued health and welfare of the local citizens and economy. WVWA funds the Blanco River – Cypress Creek Water Quality Monitoring Program. The purpose of their program is to protect the water resources in the Wimberley area. The objectives of the monitoring program are to detect and describe spatial and temporal changes, determine impacts of point and nonpoint sources, and assess compliance with established water quality standards for Cypress Creek and the Blanco River. The monitoring program is done under the Guadalupe River Basin Clean Rivers Program Quality Assurance Project Plan (QAPP). By following the strict quality control guidelines spelled out in the QAPP, the data can be contributed to the TCEQ Surface Water Quality Database for use in stream assessments.

The Guadalupe River Basin Clean Rivers Program supports Texas Stream Team monitoring groups in the basin. GBRA provides the Stream Team Citizen Monitors with supplies, replacement chemicals, monitoring training, and quality assurance support. Currently there are monitoring groups on the Guadalupe River near Seguin, the Cyprus Creek in Wimberley, the Geronimo Creek near Seguin, Lake Placid near Seguin, the San Marcos River, the Blanco River and its tributaries, Canyon Reservoir, and Plum Creek and its tributaries.

CRP also provides quality-assured data for use in watershed planning efforts in the river basin. The TCEQ uses water quality data collected by the CRP to assess surface waters to determine if they are meeting the standards for their designated uses. Four watershed protection plans are in various stages of development in the Guadalupe River Basin.

The Plum Creek Watershed Protection Plan (PCWPP) was accepted by the U. S. Environmental Protection Agency in 2008. The PCWPP was the result of a stakeholder driven process, and provides the foundation for ecological restoration of Plum Creek, and its tributaries. Plum Creek is located in Hays and Caldwell counties in one of the most rapidly growing areas in the state. Based on routine water quality sampling, TCEQ listed portions of Plum Creek for high *E. coli* bacteria in 2004. The elevated bacteria concentrations indicated that the creek no longer supported the designated use for contact recreation. Additional segments of the creek were identified as having

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Butterfly photos by John Snyder

high nutrient concentrations. The Plum Creek Watershed Partnership developed a watershed protection plan. Based on the pollutant sources in the watershed, the plan listed both the management measures, as well as the timeline that will help meet the goal of restoring the water quality of the stream. GBRA continues to monitor three routine stations on the main stem as a part of the Clean Rivers Program. The data generated for these stations can be used to assess the success of the implementation of the management measures identified in the plan.

The Geronimo and Alligator Creeks Watershed Partnership was successful in having a watershed protection plan accepted by the EPA in 2012. Like the Plum Creek plan, the Geronimo and Alligator Creek Watershed Protection Plan can be used to restore the environmental health of the creeks. Geronimo Creek and its tributary, Alligator Creek, are located in Comal and Guadalupe Counties, in an area, like many in our basin, that is transitioning from a rural to an urban landscape. The Watershed Protection Plan outlines a series of implementation measures that will reduce nonpoint source pollutant loading from urban storm water sources, such as pet waste, and from wildlife and non-domestic animals, such as feral hogs. The plan recommends the development of water quality management plans on the agricultural operations in the watershed. GBRA continues to monitor monthly at the CRP station that originally identified the bacterial impairment of the stream and collects data to assess the effectiveness of implementation measures.

Two other watershed protection plans are being developed in the Guadalupe River Basin. The Meadows Center for Water and the Environment at Texas State University is facilitating stakeholder development of the Cypress Creek Watershed Protection Plan. The goal of the plan is to protect and preserve the water quality of Cypress Creek that flows through the City of Wimberley for present and future generations. Routine monitoring conducted by the WVWA under the CRP revealed a concern for depressed dissolved oxygen and impacted habitat for macro-invertebrates and fish communities. The Meadows Center facilitates the project and a Clean Water Act Section 319(h) grant from the TCEQ, through the EPA Region VI finances the project.

The Upper San Marcos River is included on the 2012 List of Impaired Water Bodies (303(d) List) due to elevated concentrations of total dissolved solids (TDS). There are significant interactions between the San Marcos River and the Edwards Aquifer, and both are experiencing pressures related to development, and land use changes. This project presents the opportunity to explore ways to manage impacts to surface and groundwater resources through a voluntary, stakeholder driven watershed protection plan for the upper San Marcos River watershed. The WPP will address the listed impairment for TDS. The plan will also be proactive in that it will address *E.coli*, nutrients, sediment, items identified by stakeholders in future growth scenarios (Meadows Center for Water and the Environment -Upper San Marcos Watershed Initiative, 2013). The CRP station located on the San Marcos River at IH 35, in the City of San Marcos, provided the data for the TCEQ stream assessment process. Total dissolved solids were not analyzed directly, rather, the assessment calculates the TDS by multiplying the specific conductance by a factor of 0.65. GBRA is collecting TDS at this station monthly in hopes that when sufficient TDS data is collected the stream can be reassessed for exceedence of the stream standard.

Photo by Elizabeth Aguilar

Photo by LaMarriol Smith

Photo by Janet Thome

Overview of the Guadalupe River Basin

The Guadalupe River Basin is located in south Central Texas, with the headwaters in southwestern Kerr County. The river is 432 miles long and flows southeastward through a drainage area of 6,061 square miles. The Balcones Escarpment divides the basin into two distinct regions. The northern region consists of the Edwards Plateau of the Great Plains Province. Limestone-walled valleys divide the rough area with rolling hills. The southern region is referred to as the Gulf Coastal Plains area, and consists of gently sloping prairie. The basin's principle tributaries are the North and South Fork, Johnson Creek, the Comal River, the Blanco River, the San Marcos River, Geronimo Creek, Plum Creek, Peach Creek, Sandies Creek, and Coleto Creek. The springs that feed the Comal and San Marcos Rivers have an average monthly discharge of 302 cubic feet per second and 187 cubic feet per second, respectively. The Comal River is more subject to drought conditions and has stopped flowing during the severe drought of the 1950's. The San Marcos River is much more environmentally stable.

The geology of the area consists primarily of sedimentary material that was deposited during the latter Mesozoic and Cenozoic Eras. The principle geologic structures in the basin are the Balcones and Luling fault zones. The Balcones Fault Zone consists of a series of semi-parallel faults, about 14.9 miles, extending from Hays County southwestward to Bexar County. The Luling Fault Zone extends from Caldwell County to Medina County and is 9.9 to 19.8 miles southeast of the Balcones Fault Zone. The displacement varies from less than three feet to a combined displacement of over 1500 feet. Edwards limestone covers the Edwards Plateau.

The Guadalupe River Basin and Lavaca-Guadalupe Coastal Basin are located within four ecoregions. The delineation of ecoregions is based on geographic conditions that cause or reflect differences in ecosystem patterns. These conditions include geology, physiography, vegetation, climate, soils, land use, wildlife and hydrology. The basin lies within the Edwards Plateau (Ecoregion 30), the Texas Blackland Prairie (Ecoregion 32), East Central Texas Plains (Ecoregion 33) and the Western Gulf Coastal Plains (Ecoregion 34). In the technical section of this report, specific information on the land use, climate, soil, and key factors that impact water quality are described on the sub-watersheds of the basin.

Spring-fed, perennial streams characterize the Edwards Plateau Ecoregion, and it is predominantly rangeland. The Texas Blackland Prairie Ecoregion has timber along the stream, including oak, pecan, cedar elm and mesquite. In its native state, it was largely a grassy plain, but most of the area has been cultivated and only small areas of meadowland remain. Subtropical dryland vegetation made up of small trees, shrubs, cacti, weeds, and grasses characterize the East Central Texas Plains Ecoregion. Principal plants include mesquite, live oak, post oak, blackbrush acacia, and huisache. Long-continued grazing contributes to the dense cover of brush. The gulf coast and marshes of the Western Gulf Coastal Plains are divided into two subunits: marsh and salt grasses at the tidewater and bluestems and tall grasses more inland. Oaks, elms

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and other hardwoods grow along the streams. The area is abundant with fertile farmland.

The climate of the region is mild and normal temperatures seldom fall below 32°F in the winter. The basin averages 32 inches of rainfall per year. However, in 2011, the state, as a whole, received about 11 inches of rain, about 16 inches less than normal. The rainfall amounts vary with season, with the minimum occurring in the winter, and the maximum in the late spring and early fall. The cool season begins in November, and extends through March. According to the USGS Water-Data Report for 2011, the annual average runoff in the northern part of the river basin is 164,700 acre-feet per year, 1,362,000 acre-feet per year in the middle portion, and 1,420,000 acre-feet in the lower basin. These discharge volumes represent the annual amount of water reaching the stream, in the form of runoff, at the cities of Comfort, Gonzales, and Victoria, respectively.

The region is subject to wide swings in weather and rainfall patterns. The northern part of the basin is known for flash floods, with the lower portion under the threat of tropical storms and hurricanes from mid-June through the end of October. The region has experienced several prolonged droughts, including that of 2011. According to Texas climatologists, the ongoing dry spell covering most of 2011 is the worst single-year drought since Texas rainfall data started being recorded in 1895. That is a significant occurrence. The annual average runoff in 2011 at Comfort was 36,230 acre-feet, less than 22% of the annual average runoff in the water years of 1939 through 2011. The annual average runoff in 2011 at the gages in Gonzales and Victoria were 29% of the annual average runoff recorded at those locations.

Photo by Tammy Beutnagel

However, the 2011 drought is not unprecedented in every way. Much longer droughts have occurred in the past. The Texas "drought of record," or its worst extended drought, is considered to be the 1950s drought in which the state suffered drought conditions for 10 years from the late 1940s to the late 1950s. Tree ring studies have shown even worse and more extended droughts have occurred historically. Some water resource managers predict that, if 2013 is a repeat of recent years, a new "drought of record" could be established.

The mainstream impoundments located in the river basin include Nimitz Lake, Flat Rock Lake, Canyon Reservoir, Lakes Dunlap, McQueeney, Placid, Meadow, Gonzales and Wood, and Coleto Creek Reservoir. Canyon Reservoir, built in the 1960s, is the largest impoundment in the river basin and has 8,230 surface acres. It is a multipurpose reservoir designed to serve flood control and water supply functions. It is also used for recreation. Nimitz Lake, Flat Rock Lake and Lakes Dunlap, McQueeney, Placid, Meadow, Gonzales and Wood are run-of-river impoundments. The physical characteristics of the run-of-river impoundments are given in Table 1.

As populations in the basin grow, the potential for associated anthropogenic impacts increase. Along with urbanization comes increases in impervious cover, larger

Table 1. Physical characteristics of run-of-river impoundments in the Guadaupe River Basin.

Impoundment	Volume (acre-ft)	Surface Area (acres)	Mean Depth (feet)	Elevation (feet msl)	Median Flow (cfs)	Median Residence Time (days)
Nimitz Lake	840	105	8.0	1621	91	4.65
Flat Rock Lake	793	104	7.6	1564	91	4.39
Lake Dunlap	5,900	410	14.4	575.2	583	5.10
Lake McQueeney	5,050	400	12.6	528.7	583	4.37
Lake Placid	2,624	248	10.6	497.5	583	2.27
Meadow Lake	1,460	144	10.1	457.6	583	1.3
Lake Gonzales	4,620	495	9.4	332	583	3.3
Lake Wood	4,000	488	8.2	290.9	583	3.46

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volumes of wastewater discharged to the stream, and greater demands on water supplies, reducing the base flow of the river. The 2010 estimated county population was 673,944, with the heaviest concentrations in Victoria, Comal, Hays, Kendall and Guadalupe Counties. The fastest growing counties in the region are located in the Guadalupe River Basin: Hays, Guadalupe, Kendall and Caldwell Counties. These counties are experiencing explosive growth as the populations of the cities of San Antonio and Austin spill over to the communities in the river basin. Additionally, other significant changes occurred in the watershed that caused the population and the landscape to change.

The oil and gas exploration in DeWitt and Gonzales Counties caused the population and construction activities to rise in these counties. According to the UTSA Center for Community and Business Research, the increased revenue from the Eagle Ford Shale will lead to the creation of approximately 117,000 full-time jobs by 2021. State Highway 130, the tollway that gives traffic an alternative to Interstate Highway 35, connecting Austin and San Antonio, is predicted to see a large amount of commercial and residential growth over the next ten years.

The Eagle Ford Shale, located in DeWitt and Gonzales counties, has become one of the richest oil and gas deposits in Texas because of the exploration technology called hydraulic fracturing or "fracking." Fracking is the process to stimulate wells and recover natural gas and oil by creating fractures that extend from a well bore into formations and allow the product to travel more easily. Agriculture, in the form of crops and livestock production, was the primary industry in the basin, with the manufacture of steel, gravel, plastics and chemicals contributing to the economy of the basin, as well. Oil and gas production can be found in all counties, but especially in the mid-Basin. See pg. 99 for a map of the Eagle Ford Schale Play.

Photos by Elizabeth Aguilar

Summary of Water Quality Characteristics

The groundwater that makes up baseflow highly influences the water quality of the Guadalupe River. The largest contribution to the baseflow is the Edwards Aquifer, with additional volume from the Cow Creek, Trinity, Leona, Carrizo, and Gulf Coast Aquifers. Each aquifer has unique water quality, discharge points and volume. The headwaters of the Guadalupe are located in Kerr County, and originate from springs in the North and South Forks. The discharge of the Edwards Aquifer at the Comal Springs and San Marcos Springs form two small, crystal clear lakes. Landa Lake and Spring Lake, respectively, support aquatic vegetation and wildlife, including the fountain darter and Texas Wild Rice, two endangered species. Springs that come from the Leona formation, which is high in nitrate-nitrogen, are thought to be, in part, the source of the nutrient concern and dissolved solids in Plum and Geronimo Creek.

The Guadalupe River flows through Kerr and Kendall counties and into Canyon Reservoir, the largest reservoir in the basin, located in Comal County. Canyon Reservoir impounds water for water supply, flood control, and recreation. The water exits the reservoir through a bottom penstock and is used for hydroelectric generation. A more complete description of the releases from the reservoir is given in the technical section. In most years, the lake stratifies in the late summer months and, after the first strong cold front of the winter, usually in October, the lake will experience a lake "turnover". During times of lake stratification, the bottom release from the reservoir is low in temperature and dissolved oxygen. The water is aerated as it leaves either the hydroelectric plant or penstock. The cold water conditions of Canyon Reservoir's bottom release have been utilized by TPWD and Trout Unlimited for a put and take trout sport fishery.

Downstream of Canyon Reservoir, the Guadalupe River flows over bedrock substrate and through swift water runs. The river is shallow, with few pools until it nears the City of New Braunfels, where it confluences with the Comal River and enters the first of six hydroelectric impoundments. The flow through the impoundments is diverted through turbines to generate hydroelectric power. A description of the operation of the hydroelectric lakes is given in the technical section. These impoundments are nutrient-rich, with nitrogen and phosphorus contributions from wastewater discharges, and organic sediments. The impoundments exhibit the water quality conditions of a flowing stream in years of high flow. In years of medium to high flows, the impoundments have low chlorophyll concentrations and no stratification. In years of low flow conditions, the impoundments provide the residence time needed for the assimilation of nutrients that promote higher chlorophyll production. Also during periods of low flow, the impoundments exhibit weak temporal stratification. Historically, these impoundments have been subject to infestations of non-native aquatic vegetation, and algal blooms.

From Kerr County to Refugio County, the Guadalupe River receives treated wastewater discharges. The cities of Kerrville, Boerne, Buda, New Braunfels, Kyle, San Marcos, Lockhart, Luling, Seguin, Gonzales, Cuero, and Victoria, along with other small wastewater treatment plants, discharge treated wastewater, most of which provide up to secondary treatment. Secondary wastewater treatment uses biological or chemical processes to remove 80-90% of the suspended matter and oxygen demanding materials. In several locations the Guadalupe River or one of its tributaries is used for cooling water. In the upper part of the watershed, a power plant diverts flow from the Guadalupe River to mix with treated wastewater, and use as cooling water. This is a zero discharge facility, and no water is returned to the stream. A power plant diverts a portion of the flow of the Guadalupe River north of the City of Victoria, and returns it to the stream. The Coleto Creek Reservoir also serves as cooling water for the power plant located in Goliad County. The return water from these two locations is warmer than the receiving water. Coleto Creek Reservoir was designed to hold the water long enough to dissipate the heat. The warm water conditions are conducive for the growth of aquatic vegetation. The volume and temperature of the release from the power plant near Victoria is regulated by a discharge permit that is protective of the receiving stream.

At the lower end of the basin, the Guadalupe River confluences with the San Antonio River. The Guadalupe River Diversion Canal and Fabridam are located below the confluence with the San Antonio River. The fabridam is made up of two large inflatable bags that are used to prevent salt water intrusion from the bay during times of low river flows. The canal system diverts fresh water for irrigation and municipal water supply.

Water Quality Monitoring

The Guadalupe-Blanco River Authority and the Upper Guadalupe River Authority have been monitoring under the Clean Rivers Program since 1996. Prior to the partnership with TCEQ through the CRP, both entities had routine monitoring programs. Other entities contributing data to the historical database include the Wimberley Valley Watershed Association, the Texas Commission on Environmental Quality's Surface Water Quality Monitoring and Total Maximum Daily Load divisions, and USGS.

Table 2 is the summary of water quality sampling currently being performed in the basin. The sections in this report are divided by sub-watershed or segment and will discuss the historical trends observed in the data review, and factors that may be impacting water quality within each sub-watershed.

The Texas State Soil and Water Conservation Board is funding water quality monitoring programs on Plum Creek, and Geronimo and Alligator Creeks in support of the implementation of the watershed protection plans developed on these creeks. The plans were developed using data collected by the Clean Rivers Program and the TCEQ's Surface Water Quality Monitoring Program and, in the case of the Geronimo Creek plan, with additional monitoring done in advance of the plan development. Using the existing monitoring of the three stations on Plum Creek and one station on the Geronimo Creek by TCEQ and GBRA's CRP as match, TSSWCB has funded additional monitoring in these watersheds with Clean Water Act Section 319(h) funds. GBRA, under an EPA-approved QAPP, is performing routine and targeted stream monitoring, and monitoring of springs and storm water within the watersheds. GBRA will submit the data to the TCEQ for inclusion in the biennial assessments.

These monitoring programs are executed under QAPPs. A QAPP is used to plan, organize and define the quality assurance process for the program. Quality assurance is the integrated system of management activities that ensures that data generated is of the type and quality needed for its uses. Those uses include planning, assessment and water quality management. Elements of the program that are controlled by the QAPP include measurement performance specifications, appropriate methods, field and laboratory quality control, data management, and data verification and validation. Additionally, oversight of the laboratory quality system and process of corrective actions are described in the QAPP. The current QAPP is available for review on the GBRA CRP webpage.

Photos by Janet Thome

Table 2. Summary of water quality sampling in the Guadalupe River Basin. DO = dissolved oxygen.

FY 2013 (September 2012 through August 2013)

Sampling Entity	Field	Conventional	Bacteria	Biological and Habitat	24 Hr DO	Metals in Water	Metals in Sediment	Organics in Water	Organics in Sediment
GBRA	18 stations monthly; 8 stations quarterly	18 stations monthly; 8 stations quarterly; 1 station monthly TDS and conductivity	18 stations monthly; 8 stations quarterly	2 stations 2X per year	2 stations 2X per year	1 station 2X per year; 1 station annually	1 station annually	2 stations annually	4 stations annually
UGRA (Kerr Co)	11 stations quarterly; 9 stations - monthly	11 stations quarterly	11 stations quarterly; 9 stations monthly						
TCEQ	10 stations quarterly	10 stations quarterly	10 stations quarterly			2 stations 2X per year	1 station 2X per year	1 station 2X per year	1 station 2X per year
WVWA	5 stations 8 X per year	5 stations 8 X per year	5 stations 8 X per year		1 station annually				
TSSWCB-Plum Creek	5 stations monthly; 40 stations Targeted for wet and dry weather quarterly; 3 stations quarterly for storm water; 7 wastewater effluents monthly; 3 springs quarterly	5 stations monthly; 40 stations targeted for wet and dry weather quarterly; 3 stations quarterly for storm water; 7 wastewater effluents monthly; 3 springs quarterly	5 stations monthly; 40 stations targeted for wet and dry weather quarterly; 3 stations quarterly for storm water; 7 wastewater effluents monthly; 3 springs quarterly		8 stations monthly during index period				
TSSWCB Geronimo Creek	7 stations monthly; 14 stations targeted for wet and dry weather quarterly; 3 springs quarterly	7 stations monthly; 14 stations targeted for wet and dry weather quarterly; 3 springs quarterly	7 stations monthly; 14 stations targeted for wet and dry weather quarterly; 3 springs quarterly		8 stations monthly during index period				

Description of the Water Quality Assessment Process

In compliance with sections 305(b) and 303(d) of the federal Clean Water Act, the TCEQ evaluates water bodies in the state and identifies those that do not meet the uses and criteria defined in the Texas Surface Water Quality Standards. EPA has established guidance that directs TCEQ to document and submit the assessment results to EPA biennially, in even numbered years. The 2012 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) summarizes the condition of the state's surface waters, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources (TCEQ, 2013). It describes the status of water quality in all surface water bodies in the state that were evaluated for the assessment period. The data used in the assessment comes from various sources, including the Guadalupe River Basin CRP partners, TCEQ's Surface Water Quality Monitoring program, and other contributors. Given the regulatory implications associated with the use of the water quality data, the data used in the assessment process must have been collected using consistent and scientifically rigorous sampling and laboratory methods. Data collected under an accepted quality assurance project plan that describes the integrated system of management activities that ensures that data generated is of the type and quality needed for its uses is assessed. Data that are not collected under a TCEQ-approved quality assurance plan, if submitted, must be accompanied by documentation of quality assurance for evaluation by TCEQ water quality staff. Data without appropriate quality assurance documentation is considered as anecdotal evidence to support or refute assessment results, but is not to be used in statistical evaluations. On July 1, 2008 requirements regarding laboratory accreditation went into effect. Data analyzed after that date must comply with the National Environmental Laboratory Accreditation Conference (NELAC) standard to be used to generate the Integrated Report (See 30 TAC, Chapter 25). Both the GBRA and UGRA laboratories are accredited by the Texas Environmental Laboratory Accreditation Program administered by the TCEQ.

The quality of the water described in the assessment report is a snapshot of conditions during the specific time period considered in the assessment. The 2012 assessment covers the period of record from Dec. 1, 2003 to Nov. 30, 2010. Assessors have the option of including more recently collected data than Dec. 1, 2010, if available. The TCEQ develops the assessment methodology through a stakeholder process. River authorities and CRP partners are invited to participate in the development and review of the assessment guidance.

Photo by Janet Thome

Photo by John Snyder

Water quality standards are comprised of two parts, designated uses, and the associated criteria for stream conditions necessary to support that use. The uses of a water body include aquatic life use, providing a suitable environment for fish and other aquatic organisms; and contact recreation use, providing water that is safe for swimming and other recreational activities. The criteria for each use may be described numerically or expressed in terms of desirable conditions.

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Uses and criteria are assigned to a segment. A segment is a water body or a portion of a water body with a specific location, defined dimensions, and designated or presumed uses. If the criterion of a segment are not met, then the segment is designated as impaired. If nonattainment of the criterion is imminent, then the segment is designated with a concern. If there is insufficient data to determine if the standard is attained, but what data is available points to a concern, the segment is noted with a concern in the Texas Water Quality Inventory. Also, a screening level concern may be assigned if no numeric criteria is assigned.

After assessments are completed, water bodies are designated as impaired if the stream exceeds the numeric stream standard or as a concern if the conditions exceed the screening levels established by the assessment team. Overall, the quality of the Guadalupe River Basin is good. According to the 2012 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d), 11 water bodies are impaired (Table 3). Five water bodies have concerns for nutrient concentrations or depressed dissolved oxygen.

Table 3. 2012 Texas Water Quality Inventory and 303(d) List (Guadalupe River Basin) (assessed using data collected in 12/1/2003 through 11/30/2010)

Segment Number	Water Body	Impairment	Concern
1801	Guadalupe River Tidal		Depressed Dissolved Oxygen; Nitrate-Nitrogen
1802	Guadalupe River below the San Antonio River		Nitrate-Nitrogen
1803	**Guadalupe River below the San Marcos River**		**Bacteria**
1803A	Elm Creek	Depressed Dissolved Oxygen	
1803B	Sandies Creek	Depressed Dissolved Oxygen; Impaired Macrobenthic and Fish Communities; Bacteria	Impaired Habitat
1803C	Peach Creek	Depressed Dissolved Oxygen; Bacteria;	Chlorophyll *a*
1804A	Geronimo Creek	Bacteria	Nitrate-Nitrogen
1805	Canyon Lake	Mercury in Edible Fish Tissue	
1806	Guadalupe River above Canyon Reservoir	Bacteria	**Impaired Habitat**
1806D	Quinlan Creek	Bacteria	
1806E	Town Creek	Bacteria	**Depressed Dissolved Oxygen**
1810	Plum Creek	Bacteria	Depressed Dissolved Oxygen; **Impaired Habitat**; Nitrate-Nitrogen; Orthophosphorus; Total Phosphorus
1811A	Dry Comal Creek	Bacteria	
1813	Upper Blanco River	**Depressed Dissolved Oxygen**	
1814	Upper San Marcos River	Total Dissolved Solids	
1815	Cypress Creek		Depressed Dissolved Oxygen; **Impaired Habitat; Impaired Fish and Macrobenthic Communities**

Bold text indicates additions as of 2012 assessment.

Index of Biotic Integrity

Run - Guadalupe River at Split Rock Dam

Glide - Geronimo Creek

Riffle - Guadalupe River at Split Rock Dam

Pool - Guadalupe River at Split Rock Dam

Photos by Lee Gudgell

The index of biotic integrity (IBI) has been developed in order to assess the health of a biological system, like a stream, river or lake. Assessments are done at selected stream locations, collecting data on fish and invertebrate populations and the condition of the stream and riparian habitat. Data is then put into metrics that result in a score that describes the quality of the stream to support aquatic life. The IBI consists of these metrics, or criteria, that reflect nekton species (aquatic organisms that live in the water column and swim independent of the current, such as fish) richness and composition, number and abundance of indicator invertebrate species, trophic organization and function, reproductive behavior, and the types and availability of habitat. Each metric is scored based on a range of conditions. The score for each element of the biotic index will fall into one of four ranges: limited, intermediate, high and exceptional. Together the combined indices will determine if the stream is meeting its designated uses for aquatic life support. Biological and habitat assessment must be conducted during the critical period that runs from July 1 to September 30.

Stations on the stream are selected to represent conditions of the entire water body. The "reach" of the stream that is assessed should have a variety of habitats such as a run, a pool, glide and a riffle, and should not be impacted by a tributary or discharge within the reach. During a biological assessment, measurements are taken to assess the availability and types of habitat at each station. Measurements include stream width and depth, bank slope, stream type, instream cover, substrate type, percent erosion, and the natural buffer and vegetation along the stream bank. The metrics used to assess habitat quality compare the availability of different types of habitat, bank and substrate stability and changes, and impacts of flow.

To assess the benthic quality of a stream, benthic organisms (aquatic organisms that live on the river or lake substrate) are collected using a kick net sampling method. In this method, an area of substrate is disturbed for five minutes with a net positioned downstream to capture the organisms that are carried to the net by the current. Field staff cut portions of snags, or submerged woody debris exposed to the current, and collect the invertebrates in a sieve. Field staff separate invertebrates by type of feeding method (gatherers, predators, or collectors), and by tolerant and intolerant species. The number of invertebrate species, along with the ratio of the different invertebrate types found at each station, are put into the benthic metrics to determine the benthic index.

To assess a stream's ability to support fish, depending on the applicability of the method to the location, fish are collected using seining and electro-shocking methods. Fish that are collected during the assessment are separated by species categories, method of feeding, natives and non-natives, and those with diseases and anomalies.

Since the 2008 Basin Summary Report, GBRA and UGRA have performed biological assessments at the stations listed in Table 4. Table 4 summarizes the results of those assessments, and possible reasons for why the station is not be meeting its designated uses for supporting of aquatic life. Over the last four years, the Guadalupe River Basin has experienced two prolonged periods of extreme drought, broken by periods of flash flooding. These extreme weather conditions are the most likely causes of the difference between the current aquatic life designation and the measured IBI score at these stations. Limited funding, drought conditions, flood conditions, and other causes have led to a reduction in frequency and the number of available locations for biological assessments.

Table 4. Biological Assessments (assessed using data collected in 2008 through 2011)

Sampling Station (Segment No.)	Sampling Date	Current Aquatic Life Use Designation	Measured Aquatic Use Designation			Meeting Designaged Use?	Known or Potential Causes of Nonsupport
			Nekton (No. of Species Found)	Benthos (No. of Species or Subclass Found)	Habitat		
Guadalupe River at Split Rock (1806)	9/23/2008	Exceptional	High (17)	High (21)	High	No	Severe drought conditions bracketed by periodic pulses of high flow may wash away biological habitat
	9/2/2009	Exceptional	High (14)	High (19)	High	No	Severe drought conditions bracketed by periodic pulses of high flow may wash away biological habitat
	8/10/2010	Exceptional	Exceptional (18)	Exceptional (24)	High	Yes	
	7/28/2011	Exceptional	Exceptional (22)	Exceptional (17)	High	Yes	
Guadalupe River at Riverview Park (1806)	9/22/2008	Exceptional	Exceptional (16)	High (17)	High	Yes	
	9/1/2009	Exceptional	High (15)	High (23)	High	No	Severe drought conditions bracketed by periodic pulses of high flow may wash away biological habitat
	8/17/2010	Exceptional	High (16)	Exceptional (19)	High	Yes	
Dry Comal Creek (1811A)	7/15/2008	High	High (13)	High (16)	High	Yes	
	8/24/2009	High	High (10)	Intermediate (15)	High	No	Severe drought conditions throughout the index period
Peach Creek (1803C)	7/21/2008	High	High (11)	High (19)	High	Yes	
	8/21/2009	High	Intermediate (8)	High (18)	Intermediate	No	Insufficient biological habitat due to impacts of periodic high flow pulses on sandy substrate; extreme low flows due to extended drought
Cypress Creek (1815)	7/18/2008	Exceptional	High (13)	High (16)	High	No	Insufficient biological habitat due to impacts of periodic high flow pulses on bedrock substrate
	9/2009	Exceptional				No	Stream dried up due to drought
	8/20/2010	Exceptional	High (16)	High (15)	Intermediate	No	Insufficient biological habitat due to impacts of periodic high flow pulses on bedrock substrate
	7/14/2011	Exceptional	Intermediate (11)	Limited (0)	Intermediate	No	Insufficient biological habitat due to impacts of periodic high flow pulses on bedrock substrate

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Table 4. Biological Assessments (assessed using data collected in 2008 through 2011) (cont.)

Sampling Station (Segment No.)	Sampling Date	Current Aquatic Life Use Designation	Measured Aquatic Use Designation			Meeting Designaged Use?	Known or Potential Causes of Nonsupport
			Nekton (No. of Species Found)	Benthos (No. of Species or Subclass Found)	Habitat		
Plum Creek at Plum Creek Road (1810)	9/30/2008	High	High (10)	High (19)	High	Yes	
	8/23/2010	High	High (11)	Intermediate (18)	High	Yes	
Plum Creek at CR 202 (1810)	8/8/2008	High	High (11)	Intermediate (15)	Intermediate	No	Insufficient biological habitat due to impacts of periodic high flow pulses on clay substrate; downstream of four major wastewater discharges; frequent illegal dumping at road crossings upstream
	8/27/2009	High	Intermediate (14)	Intermediate (20)	Intermediate	No	Insufficient biological habitat due to impacts of periodic high flow pulses on clay substrate; downstream of four major wastewater discharges; frequent illegal dumping at road crossings upstream
	8/24/2010	High	Intermediate (8)	Intermediate (15)	Intermediate	No	Insufficient biological habitat due to impacts of periodic high flow pulses on clay substrate; downstream of four major wastewater discharges; frequent illegal dumping at road crossings upstream
	7/13/2011	High	High (10)	Intermediate (25)	Intermediate	No	Insufficient biological habitat due to impacts of periodic high flow pulses on clay substrate; downstream of four major wastewater discharges; frequent illegal dumping at road crossings upstream
Geronimo Creek (1804A)	8/16/2010	High	High (12)	Exceptional (23)	High	Yes	
	7/25/2011	High	High (15)	High (25)	High	Yes	

Public Partnerships

Guadalupe-Blanco River Authority

The GBRA sustains a number of communication mechanisms to support the CRP in the Guadalupe Basin, striving to maintain active communication with the public to pursue the goals of public involvement and education in water quality issues. GBRA develops opportunities for direct public participation to ensure that community concerns are addressed. These include producing quarterly *GBRA River Run* magazines, updating the GBRA website, issuing press releases about water topics, and presenting to the public.

Guadalupe River Basin Steering Committee

A major communication vehicle for the CRP is the Basin Steering Committee. Composed of community leaders and interested citizens from throughout the basin, this group meets annually to review activities, and advise the program on priorities for monitoring and special studies. The Steering Committee membership includes; representation from municipalities, counties, industries, homeowner organizations, Texas State Soil and Water Conservation Board, Texas Parks and Wildlife Department, Texas Department of Agriculture, Railroad Commission of Texas, League of Women Voters, chambers of commerce, and local/regional environmental organizations. Steering Committee meetings are open to the public. The committee reviews and approves achievable basin water quality objectives, defines priorities, considers available technologies, considers economic impacts, guides work plans, and guides resource allocation. Notice of the Steering Committee meetings is made available by mail and on the meeting page of the GBRA website (www.gbra.org).

Special Sub-committees for Local Water Quality Issues

In addition to the Basin Steering Committee for the CRP, the GBRA has established the Hydroelectric Lake Citizens Advisory Committee, and the Coleto Creek Reservoir Advisory Committee. Yearly, these groups can learn, question, and provide input on activities that control nuisance, non-native aquatic vegetation, and lake operations and safety. The committees have representatives from homeowners associations, potable water systems, bass clubs, boating sales companies, industries, as well as the Texas Parks and Wildlife Department, and Texas Department of Agriculture. These committees also receive invitations to the CRP Steering Committee meetings.

Regional Lab

The Regional Laboratory located at the General Offices of GBRA in Seguin provides technical assistance and support to GBRA's operations, municipalities, water districts, industries, engineering firms, and other organizations as they comply with federal, state, and local regulatory requirements that protect water quality. The Regional Laboratory has received its accreditation from the Texas Environmental Laboratory Accreditation Program. The Regional Laboratory is equipped to perform physical, chemical, and biological analyses of water from natural streams, potable water and wastewater treatment plants, groundwater wells and treatment residuals. The Regional Laboratory serves as a contract laboratory for the CRP. In addition to its broad water quality planning initiatives, and participation in environmental and water quality monitoring programs within the river basin, the laboratory also sponsors and trains Texas Stream Team. The lab also conducts presentations for schools, civic and other organizations on water quality, environmental issues, Texas Stream Team, and other water-related subjects. The laboratory maintains strong working relationships with federal, state, and local government agencies responsible for water quality, as well as corporations and individuals capable of affecting water quality.

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Public Education Efforts

GBRA's award-winning fourth-grade program, Journey through the Guadalupe River Basin, maintains a strong presence in schools throughout the river basin. This TEKS-correlated program takes an interdisciplinary approach to the subject of water, placing an emphasis on watersheds and water quality, specific to the Guadalupe River Basin. In addition, the curriculum touches on the water cycle, water uses in the basin, population growth, and water conservation. GBRA offers teacher trainings for this program.

Waters to the Sea, Guadalupe River is a new multi-media middle school program that GBRA will introduce during 2013-14 school year. Education staff developed this new program with the Center for Global Environmental Education (Hamline University, St. Paul, Minnesota). This new interactive learning program highlights relationships between human activities and water resources within the Guadalupe River watershed, from the river's headwaters to San Antonio Bay. The program addresses Texas science and social studies education standards through numerous short videos, animations, simulations, and multimedia interactives that draw from the region's rich history. Modules focus on themes ranging from traditional Native American uses of natural resources, to the importance of water for agriculture, to the impacts of urban growth on surface water runoff, to the importance of wetlands at the bay. GBRA expects the program's completion in summer 2013, and teacher trainings will begin immediately.

Education staff makes a concerted effort in both the Plum Creek and Geronimo Creek watersheds. Water quality education and monitoring are introduced to fourth and fifth grade students in these target watersheds. GBRA Environmental Education Administrator Cinde Thomas-Jimenez led efforts in nine public schools in the Plum Creek watershed for the sixth consecutive school year in 2011-2012. Working side by side with teachers and students, Jimenez spent two weeks in classrooms presenting information using a tabletop watershed model to discuss watersheds, nonpoint source pollution, and the Plum Creek project directly with the students. All needed supplies were donated to the schools including water monitoring test kits, watershed map posters and student workbooks. A total of 1,000 students and 32 teachers conducted two rounds of water quality testing. Using the Texas Stream Team methods as a model for their monitoring, students tested water from Plum Creek for the following parameters: temperature, dissolved oxygen, pH, turbidity, nitrates, and phosphates. *E. coli* bacteria was also an option. The results of the student monitoring indicate a slight decrease in dissolved oxygen, and increases in phosphates and nitrates as the creek moves from the urban area in the northern portion of the watershed to the more rural southern area. This effort will continue in 11 Plum Creek schools during 2012-2013. In spring of 2011, this same model was introduced in Geronimo Creek schools at both the elementary and secondary levels.

Upper Guadalupe River Authority

As the lead water resource planning agency for the Upper Guadalupe River Basin, UGRA partners with municipal and county governments, communities, civic groups, and citizens to preserve and protect the water quality in all Kerr County surface water bodies.

As an active partner in the Texas Clean Rivers Program, UGRA performs routine, quarterly sampling at ten stations in Kerr County. In 2008, UGRA launched the County Wide Goal Based Monitoring Program to increase the number of stations that are monitored routinely in the Upper Guadalupe River so that water quality concerns can be addressed proactively. The program concentrates on the main tributaries to the Guadalupe River, and monitors the same parameters as the Clean Rivers Program.

UGRA's Summer Swimability Program provides information on current water quality conditions for local citizens. Samples for *E. coli* bacteria analysis are taken at 21 stations on a weekly basis from Memorial Day to Labor Day. The results are compared to state standards for contact recreation, and are posted on the UGRA website.

UGRA provides opportunities for citizen stewardship and community involvement in protecting the water resources of Kerr County. A popular activity is the UGRA Volunteer Summer Study. Interested members of the community who collect samples for E. coli bacteria analysis support the program each summer. The information collected by the volunteers provides important data and helps identify areas in need of further investigation while including the community in water quality monitoring.

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Photo by Travis Linscomb

Central to these varied water monitoring programs is the nationally accredited UGRA Environmental Laboratory, a full service laboratory serving the entire Hill Country. The Laboratory's analytical services include bacteriological, chemical, and biological testing of drinking water, wastewater, and surface water. The Laboratory is accredited according to the National Environmental Laboratory Accreditation Program and is one of the largest microbiological laboratories in the region.

Preservation and Conservation Efforts

UGRA is committed to the elimination of trash from the river, and actively solicits and promotes community involvement in its Trash-Free Initiative. UGRA arranges for and funds routine clean ups at fifteen low water crossings across the county. Over 15,000 pounds of trash was removed from these low water crossings in 2012.

Another cornerstone of the Trash-Free Initiative is UGRA's Annual River Clean Up, a county wide event to promote awareness of the importance of the Guadalupe River to the community and its proper stewardship. In 2012, more than 11,000 pounds of garbage was collected by 270 participants, working along the river from above Hunt, all the way to Center Point.

UGRA partners with other local entities for hazardous material spill containment and clean up. Absorbent hazmat socks and pillows are provided to area fire departments and the environmental health department to aid them in their efforts to contain and clean up oil and gas spills in and near the Guadalupe River.

Through a grant from TCEQ, UGRA was able to facilitate the installation of seven pet waste stations in Flat Rock Park along the Guadalupe River in Kerrville. An effectiveness monitoring program was also initiated and in 2012 over 1,100 pounds of pet waste was collected as a result of these stations.

UGRA promotes landowner practices that have the potential to enhance groundwater and surface water resources. Studies have indicated that brush control, primarily ashe juniper removal, can help increase Edwards Plateau Aquifer recharge, enhance springflow, and improve range and pasture land productivity. Financial assistance is available for eligible landowners to aid their brush management efforts.

UGRA recently launched a rebate program promoting water conservation and watershed stewardship through rainwater harvesting. The Rainwater Catchment System Rebate Program is available to residents with a Kerr County address and reimburses eligible applicants up to $50; contact UGRA for more information.

Public Education to Raise Awareness

Part of UGRA's mission is to actively facilitate the understanding of water issues and engage the community in maintaining and promoting the health and enjoyment of the Upper Guadalupe River Basin.

UGRA has an active education program designed to give Kerr County residents a better understanding of the Upper Guadalupe River and its watershed. UGRA staff prepares presentations for area schools, clubs, organizations, and summer camps to teach about water quality, conservation, the water cycle, and the importance of the Guadalupe River to the community. UGRA publishes a monthly column in the local newspapers about water quality and the aquatic environment, and has an active public awareness campaign to keep the community informed on water issues. The Major Rivers water education program is distributed to 4th and 5th grade teachers in Kerr County to aid their lessons on the water cycle, conservation, and Texas water resources through a joint effort by UGRA and Headwaters Groundwater Conservation District.

Above all, UGRA is a resource and advocate for the community on water quality, surface water, and the Guadalupe River. Please contact UGRA with comments, questions or concerns at (830) 896-5445 or visit www.ugra.org.

Water Quality Parameters

Field Parameters are water quality constituents that can be obtained on-site and generally include: dissolved oxygen, conductivity, pH, temperature, stream flow (not in reservoirs), and secchi disc depth.

Dissolved Oxygen (DO) indicates the amount of oxygen available in the stream to support aquatic life. DO can be reduced by the decomposition of organic matter.

Conductivity is a measure of the water body's ability to conduct electricity and indicates the approximate levels of dissolved salts, such as chloride, sulfate and sodium. Elevated concentrations of dissolved salts can impact water as a drinking water source and aquatic habitat.

pH is a measure of the hydrogen ion concentration in an aqueous solution. It is a measure of the acidity or basic property of the water. Chemical and biological processes can be affected by the pH. The pH can be influenced by dissolved constituents, such as carbon dioxide and by point and nonpoint source contributions to the stream.

Temperature of the water affects the ability of the water to hold dissolved oxygen. It also has an impact on the biological functions of aquatic organisms.

Stream Flow is an important parameter affecting water quality. Low flow conditions common in the warm summer months create critical conditions for aquatic organisms. Under these conditions, the stream has a lower assimilative capacity for waste inputs from point and nonpoint sources.

Secchi Disc transparency is a measure of the depth to which light is transmitted through the water column, and thus the depth at which aquatic plants can grow.

Conventional Parameters are typical water quality constituents that require laboratory analysis and generally include: nutrients, chlorophyll *a*, total suspended solids, turbidity, hardness, chloride, and sulfate.

Nutrients include the various forms of nitrogen and phosphorus. Elevated nutrient concentrations may result in excessive aquatic plant growth and can make a water body unfit for its intended use(s).

Chlorophyll *a* is a plant pigment whose concentration is an indicator of the amount of algal biomass and growth in the water.

Turbidity is a measure of water clarity or light transmitting properties. Increases in turbidity are caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms.

Total Suspended Solids indicate the amount of particulate matter suspended in the water column.

Hardness is a composite measure of certain ions in water, primarily calcium and magnesium. The hardness of the water is critical due to its effect on the toxicity of certain metals. Typically, higher hardness concentrations in the receiving stream can result in reduced toxicity of heavy metals.

Chloride and Sulfate are major inorganic anions in water and wastewater. Numeric stream standards for chloride and sulfate have been set on all of the classified stream segments in the basin. Both of these inorganic constituents can impact the designated uses, and can come from point and nonpoint sources, such as wastewater discharges, oil field activities, and abandoned flowing wells from groundwater with elevated concentrations of dissolved solids.

Other Parameters

Bacteria, specifically *E. coli*, is used as an indicator of the possible presence of disease-causing organisms. *E. coli* concentrations are reported as Most Probable Number per 100 milliliters (MPN/100mL). MPN/100mL is directly relatable to the units used in the contact recreation standard (126 colonies per 100mL).

Biological and Habitat assessments include collection of fish community data, benthic macroinvertebrate (insects) data, and measurement of physical habitat parameters. This information is used to determine whether the stream adequately supports a diverse and desirable biological community. The physical, chemical, and biological data are used together to provide an integrated assessment of aquatic life support.

24-Hour DO studies perform measurements of DO in frequent intervals (e.g., one hour) in a 24-hour period. The average and minimum concentrations in the 24-hour period are compared to corresponding criteria. This type of monitoring takes into account the diurnal variation of DO and avoids the bias in samples taken only at certain times of the day.

Metals in Water, such as mercury or lead, typically exist in low concentrations, but can be toxic to aquatic life or human health when certain levels are exceeded. To obtain accurate data at low concentrations, the GBRA uses special clean methods that minimize the chance for sample contamination and provide high quality data.

Organics and Metals in Sediment could be a source of toxicants for the overlying water, though currently there are no numeric sediment standards.

Organics in Water, such as pesticides or fuels, can be toxic to aquatic life or human health when certain levels are exceeded.

Overview of the Technical Summary



Photos by Travis Linscomb

The technical summary section provides a review of the water quality conditions in the Guadalupe River Basin. Also included in this section is a discussion of the latest biennial assessment of the surface water quality done by TCEQ. In an evaluation of the water quality data, stations and parameters for which the data met sample number and sampling duration criteria were examined statistically to identify and verify trends. Also considered in the evaluation of the data were land uses, soils and vegetation, and point source discharges. The factors at play in each sub-watershed are considered in order to identify and prioritize concerns or impairments and their most probable causes, recommend future monitoring activities, implementation of control or remediation actions, public outreach, or other appropriate measures. The origin of the data and the analytic procedures used to evaluate the data are explained in the section, *Description of Water Quality Assessment Process*. The **Watershed Summaries** section provides an overview of existing data, a discussion on the water quality concerns identified during the screening process and an assessment of the trends seen in the water quality data.

The screening and assessment of water quality conditions in this Basin Summary Report is organized by watershed, segment and station. A watershed is the total area that drains to a particular point in a stream. The Guadalupe River basin is broken into 12 watersheds for this report. For assessment and trend analysis, the watersheds were broken down further into sub-watersheds and then further by segment. Segments are contiguous reaches that exhibit similar physical, chemical or biological characteristics and which an uniform set of standards applies. Most segments have one monitoring location. But in those cases where there are multiple sampling locations, the data sets were combined to observe differences within the segment, and/or to strengthen the analyses by increasing the number of data points used in the assessment. If two or more stations within one segment were statistically different for any water quality data type, the data was not combined for more than a comparison between stations and the difference was noted.

For evaluation of trends over time, water quality data available from the TCEQ's Surface Water Quality Monitoring Information System was divided by station and then by parameter. For a given station and parameter the number of data points used in the initial trend analyses was at least 20 points over the historical period, with at least three measurements per year, in five or more years. The data sets that met the data criteria were compared over time to observe any trends. If a trend was observed the data was further evaluated using statistical tools. Linear regressions were performed to confirm the significance of the trend. Additionally, a graph and narrative were created to explain any significant trends.

When looking for potential changes in water quality conditions, water quality parameters are compared over time. The statistical comparisons and graphs of these comparisons can show if there are overall upward or downward trends at a location or in a segment. The graphed data can be represented with or without a line that connects the data points. The line may make it easier to see seasonal patterns in the water quality data. It should be recognized that if the data points are connected by a line in time comparisons, the line between the points does not represent the true conditions of the stream between the times that the data was actually collected.

Inventory of Events
January - December 2012

Event	Segment	Comments
Ban the Can	1811, 1804	The ordinance adopted by the city of New Braunfels that established a ban on disposable containers was in place over the 2012 recreational season and there has been a noticable difference in the amount of trash that floats down to the hydroelectric lake downstream of the city. The ordinance imposes a $500 fine on any disposable food or beverage container used on the Comal River or the portions of the Guadalupe River that flows through the city.
Habitat Conservation Plan signed by USFW	1811, 1808, 1804	After more than seven years and rigorous negotiations between 26 stakeholders and a dedicated program manager, the U.S. Fish and Wildlife Service has approved the Edwards Aquifer Recovery Implementation Program (EARIP) Habitat Conservation Plan (HCP) and issued an incidental take permit under the Endangered Species Act to protect most users of aquifer water. The EARIP process began in 2006 with an "ad hoc" effort and progressed in 2007 with the passage of Senate Bill 3, Article 12, by the Texas Legislature. The efforts of those 26 stakeholders and another 60 participants resulted in the Edwards Aquifer HCP designed to protect endangered species that depend on spring flow emanating from the Edwards Aquifer springs.
BBASC Work Plan Submitted	All	The Work Plan for Adaptive Mangement from the Guadalupe, San Antonio, Mission and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Stakeholder Committee (BBASC) was submitted to TCEQ on May 25, 2012. The work plan followed the submittal of an environmental flow analyses and a recommended environmental flow regime for the river basin and bay system completed in 2011. The work plan is a comprehensive list of study efforts and activities that will provide additional information for future environmental flow rule-making as well as expand knowledge on the ecosystems of the rivers and bays within our basin.
Drought Persists	All	Drought conditions across the river basin continue to persist in 2012.
Hydraulic Fracturing in the Eagle Ford Shale in DeWitt and Gonzales Counties	1803	The Eagle Ford Shale in DeWitt and Gonzales Counties continues to be one of the richest oil and gas deposits in the U.S. The exploration technology of hydraulic fracturing is used to recover oil and gas deposits. Concerns about the impacts of these operations continue to be raised. These concerns include potential for contamination of groundwater by fracking fluids and drilling activities, spills, that could enter the surface water resources and demand on the stressed water resources of the area.
Meadows Center for Water and the Environment	All	Texas State University - San Marcos established the Meadows Center for Water and the Environment, formerly the River Systems Institute, as a leadership initiative to coordinate and further university-wide efforts in the field of aquatic resource management. The Meadows Center started out as the International Institute for Sustainable Water Resources in January 2002, and was renamed the River Systems Institute in 2005.

Inventory of Events
January - December 2012

Event	Segment	Comments
Cypress Creek Watershed Protection Plan	1815	Phase II of the Cypress Creek Project is being facilitated by the Meadows Center for Water and the Environment. The main goal for the Cypress Creek Project is to ensure that the long-term integrity and sustainability of the Cypress Creek Watershed is preserved and that water quality standards are maintained for present and future generations.
Upper San Marcos, Sink Lake and Sink Creek Project	1814	The Upper San Marcos River is included on the 2012 Texas Water Quality Inventory and 303(d) list due to elevated concentrations of total dissolved solids (TDS). This project will develop a WPP for the San Marcos River to reduce TDS in the river, and also proactively address concerns related to bacteria, nutrients and sediment in the river and in Spring Lake. The project is being facilitated by the Meadows Center for Water and the Environment.
Texas Instream Flow Program to Begin in 2013	1803, 1804	The Texas Instream Flow program was created in 2001 by the state legislature to study Texas rivers and streams in an effort to determine the amount of water required to maintain a healthy river (sound ecological environment). The study on the Lower Guadalupe River will begin in 2013, and end in December 2016.
GBRA Funds Environmental Flow Study in Mid-Basin	1803	GBRA is funding a study to characterize the flow-habitat and flow-ecological relationships in this reach to provide a means of assessing biological impacts or benefits of various flow regimes relative to the Mid-Basin project. The study is being conducted on the Gonzales reach, the Lower Guadalupe River below confluence with the San Marcos River to near the City of Cuero. The study will be concluded in 2014.
UGRA Bacteria Reduction Plan	1806	In the second year of the grant from TCEQ, the groundwork has been laid for implementing numerous bacteria reduction strategies and UGRA is coordinating with the City of Kerrville, TXDOT, and Kerr County to put those strategies in place. The strategies will address the primary souces of bacteria pollution that have been identified in the Guadalupe River in Kerrville including birds nesting on the SH16 bridge, large flocks of domestic waterfowl congregating on the lakes, septic systems and pollution from general urban runoff. The ultimate goal of the project is to reduce the bacteria levels in the Guadalupe River to a concentration that does not represent a health risk to swimmers and will allow this segment to be removed from the impaired water body list. Construction of the bird deterrents on the SH16 bridge in Kerrville was completed in January 2013.
Kyle WWTP Spill	1810	Aqua-TX reported a spill of at least 100,000 gallons of partially treated sewage containing solids from a final clarifier into Plum Creek from the Kyle WWTP on November 21, 2012. TCEQ and TPWD investigations continue.

Inventory of Events

January - December 2012

Event	Segment	Comments
City of Buda and Hays County Partner to Remove Failing Septic Systems and Treat at City's WWTP	1810	The City of Buda and Hays County have partnered to submit an application for the planning and design of the Hillside Terrace Project through the Texas State Revolving Fund Loan Forgiveness Program. The project will design a collection system and lift station to remove over 260 homes off of failing septic systems and process the wastewater at the City of Buda's WWTP. Due to the economic status of Hillside Terrace residents, the project qualified for 70% loan forgiveness (highest available). This area was identified in the Plum Creek Watershed Protection Plan as a potential source of E. coli bacteria in the creek.
Feral Hog Task Force to form in Caldwell, County	1810	Caldwell County, landowners, SH130 and others have formed a task force to control populations of feral hogs in the county. Feral hogs have established themselves across Texas and pose a variety of challenges, including direct depositon of bacteria; streambank destabilization; agricultural damage; predation of livestock, pets and wildlife; transmission of disease and parasites; and environmental damage to both urban and rural environments.
Geronimo and Alligator Creeks Watershed Protection Plan Accepted by EPA	1804A	The WPP was accepted by EPA on September 13, 2012 as meeting their guidance requirements for watershed protection plans. It is only the third WPP developed for Texas waters that has this designation. Since that time, implementation of the WPP has been underway. All implementation activities are voluntary, and are dependent upon a combination of factors such as stakeholder participation, financial and technical resources, and political will.

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Guadalupe-Blanco River Authority

flowing solutions