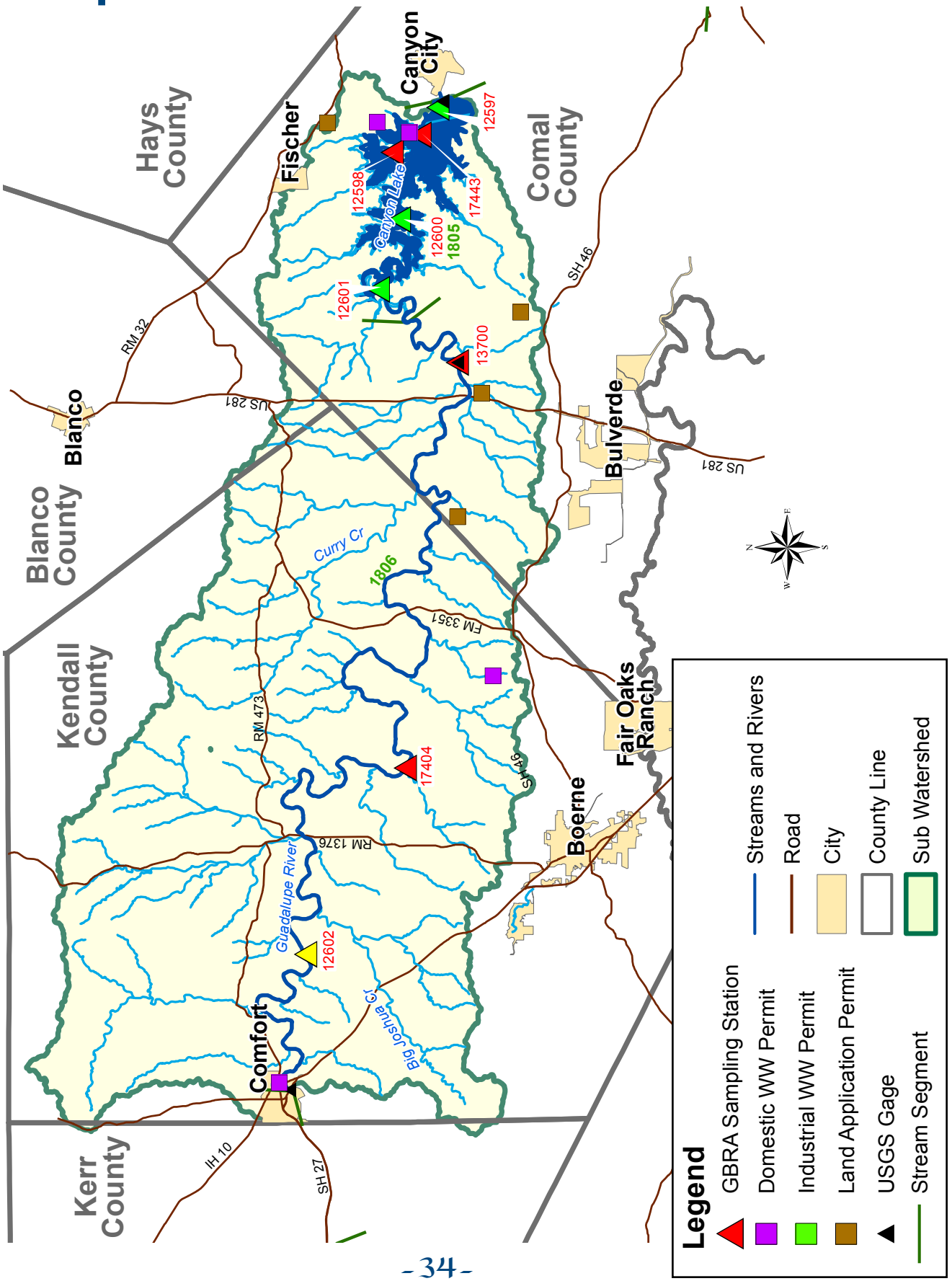
Guadalupe River Watershed below Comfort



Guadalupe River Watershed below Comfort

River Segments, Descriptions and Concerns

Segment 1806: (Guadalupe River above Canyon Lake): From a point (1.7 miles) downstream of Rebecca Creek Road in Comal County to the City of Comfort in Kendall County.

Segment 1805: (Canyon Lake): From Canyon Dam in Comal County to a point (1.7 miles) downstream of Rebecca Creek Road in Comal County, including Canyon Reservoir. Canyon Reservoir is a flood control and water supply reservoir, impounding the Guadalupe River with a conservation pool elevation of 909 feet mean sea level (msl).

Drainage Area: 596 square miles

Streams and Rivers: Guadalupe River from Comfort to Canyon Lake, Joshua Creek, Flat Rock Creek, Rebecca Creek, Block Creek, West Sister Creek

Lake: Canyon Lake

Aquifer: Trinity, Edwards Plateau

River Segments: 1805, 1806

Cities: Comfort, Kendalia, Bergheim, Bulverde, Canyon City, Spring Branch, Startzville

Counties: Kerr, Comal, Kendall, Blanco

EcoRegion: Edwards Plateau

Vegetation Cover: Evergreen Forest 43.6%, Shrublands 11.0%, Grass/Herbaceous 31.3%

Climate: Average annual rainfall 32 inches, Average annual temperature January 38°, July 95°

Land Uses: urban, unincorporated suburban sprawl, cattle, goat and sheep production, light and heavy industry, and recreational

Water Body Uses: aquatic life, contact recreation, general use, fish consumption, and public water supply

Soils: Dark and loamy over limestone to loam with clay subsoils

Permitted Wastewater Treatment Facilities: Domestic 4, Land Application 4, Industrial 0

Photo by courtesy of US Army Corps of Engineers

Guadalupe River Watershed below Comfort

River Segments, Descriptions and Concerns

Guadalupe River above Canyon Lake

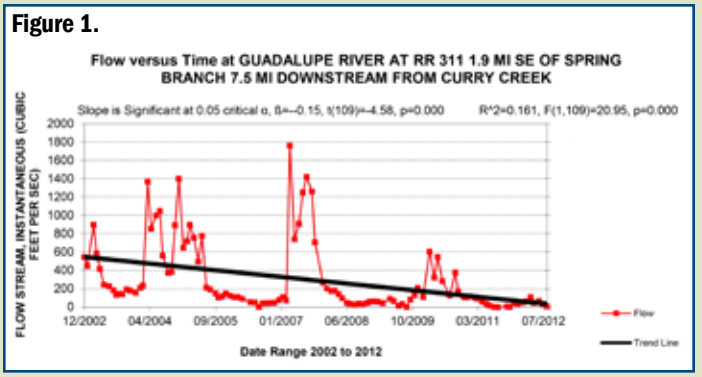
Segment 1806, the ***Guadalupe River above Canyon Lake***, extends from the lake in Comal County, through Kendall County, to the confluence with the North and South forks of the Guadalupe River in Kerr County. For ease in discussing the historical data and understanding the contributing watershed, the segment is separated into two parts in this report. The lower subsegment, which begins below the City of Comfort is separated into three assessment units: the lower 25 miles in Comal County; from the lower 25 miles to the confluence with Big Joshua Creek in Kendall County; and, from the confluence with Big Joshua Creek to the monitoring station near the City of Comfort. (Refer to the Upper Guadalupe River above Comfort for discussion on the water quality of the upper portion of Segment 1806.)

Several entities have been monitoring the lower portion of Segment 1806 since the 1990s. GBRA has two monitoring stations within the lower subsegment, the Guadalupe River at FM 311 in Spring Branch (station no. 13700), which has been monitored monthly since 1996 and the Guadalupe River at FM 474 (station no. 17404), in Kendall County, which has been a quarterly monitoring location since October 2001. Each of the monitoring stations is located in the two lower assessment units. TCEQ has a routine station in the upper assessment unit, located at the Guadalupe River at Waring (station no. 12602) that they have been monitoring quarterly since 1999. In the fall of 2012, the Upper Guadalupe River Authority took over the quarterly monitoring at that station.

The average instantaneous **flow** at the Spring Branch station during the data record used for this trends analysis was 295 cubic feet per second (cfs) and 162 cfs at the FM 474 station. At Waring, the median flow was 359 cfs. The area has suffered under drought conditions for four out of the last five years. The flow in the river was recorded as zero, referred to as "dry with pools", on August 3, 2011. To illustrate the prolonged period of low flows, the flow at the Spring Branch station in the last five years (2008 – 2012) was 106 cfs, 36% of the average flow over the entire 10 year period. Figure 1 shows the decline in flow over time at the Spring Branch station on the Guadalupe River.

The Kendall County Water Control and Improvement District operates the wastewater treatment plant for the

Figure 1.



City of Comfort. The plant is the only wastewater discharge to this portion of Segment 1806, and is located at the most upstream part of the subsegment. The permitted discharge is for 0.35 million gallons per day, with high quality effluent standards of 5 milligrams per liter (mg/L) biochemical oxygen demand, 5 mg/L total suspended solids, 2 mg/L ammonia-nitrogen and 1 mg/L total phosphorus. The plant has been operating under a 210 authorization for beneficial reuse of the effluent on a nearby golf course since 2002.

The 2012 Texas Water Quality Inventory lists the middle assessment unit as impaired for bacteria because the geometric mean for ***E. coli*** at the FM 474 station was 150 MPN/100 mL. The stream standard for contact recreation is a geometric mean of 126 colonies/100 mL. A review of the data set from 2003 through 2012, shows a reduction in the geometric mean at this station to 123 MPN/100 mL. The area has been under significant drought four out of the last five years. One positive aspect of drought, if there is one, is the lack of runoff that would be a source of nonpoint source bacterial loading into the stream. The stream standard exceedence is isolated to the middle assessment unit. Further downstream, the geometric mean for *E. coli* at the Spring Branch station was 61 MPN/100 mL. The TCEQ station, located at Waring, upstream of the FM474 station, had a geometric mean for *E. coli* of 42 MPN/100 mL.

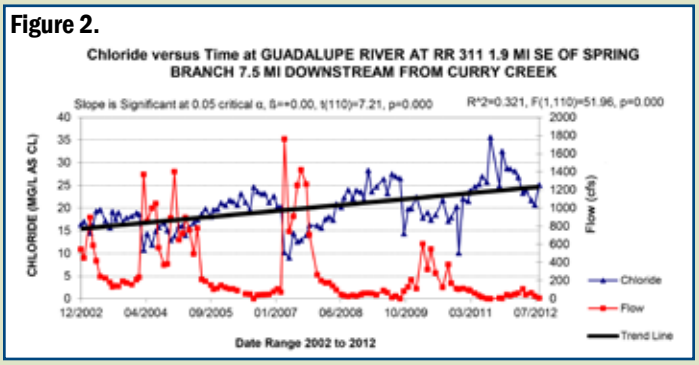
The median concentrations for **dissolved oxygen**, beginning at the downstream station at Spring Branch and moving upstream to the Comfort station are 9.4 mg/L, 9.4 mg/L and 8.9 mg/L, respectively, ranging from a minimum of 5.2 mg/L at the Spring Branch station to a maximum of 14.9 mg/L at the Spring Branch station. At

Continued on next page

no time in the period of record did the dissolved oxygen drop below the standard for the minimum dissolved oxygen concentration (4.0 mg/L). The **temperature** varied between 5.3°C to 32.7°C, with median temperatures of 21.8 °C, 20.6°C and 22.3°C at the three monitoring locations, from downstream to upstream. The **specific conductance** ranged between 277 umhos/cm to 990 umhos/cm, with median conductivities of 516 umhos/cm, 537 umhos/cm and 526 umhos/cm, respectively. The median **pH** of the three monitoring stations, from downstream to upstream, were 8.1, 7.9 and 8.1 respectively, ranging from 7.5 to 8.6 standard pH units, never falling outside the stream standard range of 6.5 to 9.0 standard units.

The median concentrations for **chloride** and **sulfate**, from downstream to upstream, were 19.8 mg/L, 20.4 mg/L and 23 mg/L and 23.6 mg/L, 23.8 mg/L and 23 mg/L respectively. At no time did the concentration of these dissolved constituents exceed the stream standard of 50 mg/L. A slight upward trend was seen in the chloride concentration at the Spring Branch station (Figure 2).

Figure 2.



Nutrients (Total Kjeldahl Nitrogen (TKN), nitrate nitrogen, ammonia nitrogen and total phosphorus) were analyzed at the three main stream stations. The median concentrations for **nitrate nitrogen** ranged from 0.28 mg/L to 0.58 mg/L, with the highest median being seen at the upstream station at Waring. The nitrate nitrogen concentration never exceeded the screening criteria of 1.95 mg/L. The median **ammonia nitrogen** concentration at all three stations was below the detection limit of 0.1 mg/L. The concentration of ammonia nitrogen measured at the main stem stations exceeded the screening concentration of 0.33 mg/L one time (0.35 mg/L). This event occurred at the station at FM474 during the lowest flow recorded in the data period (7.6 cfs). The detection levels for total phosphorus changed from 0.05 mg/L to 0.02 mg/L in FY 2012. The median **total phosphorus** concentrations were at or below the limit of quantification for the method at the FM474 station. **TKN** was added to the suite of nutrients being monitored at the stations within this segment in 2007. The maximum concentration of 0.95 mg/L occurred at the Spring Branch station when station went dry with standing pools, at the height of the drought of 2011.

The substrate in the main stem transitions from a gravel to bedrock substrate. The water is clear and shallow in the majority of locations along the segment, with very few pools. The **suspended solids** ranged from less than 1 mg/L to 236 mg/L, with median concentrations ranging from 4.3 mg/L to 5.5 mg/L at the main stem stations.

The median **chlorophyll *a*** concentration is less than detection and there was never a measured value above the screening concentration of 14.1 micrograms per liter.

Canyon Reservoir

Canyon Reservoir, also known as Canyon Lake, Segment 1805, is located in Comal County, north of the City of New Braunfels. The multipurpose reservoir, built by the US Army Corp of Engineers (COE) and the Guadalupe-Blanco River Authority (GBRA) and impounded in the mid-1960's, is designed to serve flood control and water supply functions. It is also used for recreation. Canyon Lake has 8,230 surface acres and over 80 miles of shoreline, seven public parks, two military recreational areas and two marinas. The lake is divided up into four assessment units: the cove around Jacob's Creek Park, the north end of Crane's Mill Park to the south end of Canyon Park, the upper end of the segment and the lower end of the reservoir near the dam. The lake has designated uses of contact recreation, exceptional aquatic life use, domestic water supply and aquifer protection.

The reservoir is monomictic, stratifying in the summer and having one turnover per year, usually with the first strong cold front in the fall. The reservoir can be divided into three zones, moving down the reservoir, toward the dam. Those zones include the riverine zone, the transitional zone and the lacustrine zone. The **riverine zone** does not routinely stratify because it is flow-dominated, keeping the waters in this zone mixed. The conditions are often turbid because it

is in this zone that sediments carried by stormwater from upstream enter the reservoir. The **transitional zone** is the zone where the river reacts with the reservoir. As the flow from the river slows and spreads, the sediment carried by the river begins to drop out and settles to the bottom. Studies done on the Canyon Reservoir have found that in years of high runoff and sediment loading, the reservoir's anoxic zone can develop in this zone where the decay of the organic deposition depletes the oxygen. The lacustrine zone is located near the dam. The **lacustrine zone** is clear and deep. It is in this area that thermal stratification occurs as well as the development of an anoxic layer. In years of low incoming flow the lake will strongly stratify with "layers" called the epilimnion at the surface and the hypolimnion at the bottom, separated by a thermocline (area of rapid thermal change). In years with heavy spring rains and incoming flows, the lake will be more weakly stratified because of high volume coming into the reservoir, coupled with the bottom releases that are used to evacuate the flood pool. In times where the reservoir is strongly stratified the thermocline is strong enough to keep the waters of the epilimnion and hypolimnion from mixing, creating distinctly different density and oxygen differences through the water column.

The reservoir operates as two parts. The lower portion from elevation 800 to 908 mean sea level (msl) is operated by GBRA for conservation storage. GBRA was granted the original water right for 50,000 acre-feet of water per year to be made available for customers through water purchase contracts. GBRA releases water from the conservation pool as it is called for by downstream customers.

The upper portion of Canyon Reservoir from 909-948 msl, is referred to as the "flood pool" and is controlled by the COE. This part of the reservoir captures floodwaters that are usually released at rates sufficient to empty the flood pool without contributing to downstream flooding.

The land use in the watershed is made up of residential and business development, resorts, parks and recreational facilities, and ranches with unimproved brush, used for cattle and hunting. Comal County has been experiencing a high level of growth and a large portion of that growth is occurring in the Canyon Lake watershed. The watershed contains a relatively small amount of urbanized area. The town of Sattler and the City of Bulverde are in the watershed, both of which are not currently served by a domestic wastewater treatment facility. There is one small package plant that serves a strip center in Bulverde but that facility only serves the businesses in the center.

The COE has one development regulation that affects the area immediately around the reservoir. There can be no on-site septic systems or major buildings with plumbing or electricity built within the 948 mean sea level elevation. Any other construction must be reviewed and approved by the COE.

There are two wastewater treatment plants that discharge directly to the reservoir. The Canyon Park Estates Wastewater Treatment Facility is operated by

GBRA and is permitted to treat 260,000 gallons per day. The facility must treat the domestic wastewater to high quality standards of 5 milligrams per liter (mg/L) of biochemical oxygen demand, 5 mg/L total suspended solids, 2 mg/L ammonia nitrogen and 1 mg/l total phosphorus. The facility discharges to a cove on the north side of the lake. The other wastewater treatment plant that discharges to the lake is operated by the US Department of Army and serves a small recreational facility available to military personnel. The plant is permitted to discharge 12,500 gallons per day. The remaining area around the reservoir is served by septic tanks, with Comal County being the designated representative for enforcement of septic tank rules.

All four assessment units were listed on the 2012 Texas Water Quality Inventory as impaired due to mercury in fish tissue. The listing came as a result of a fish consumption advisory issued by the Texas Department of State Health Services (DSHS) in 2006. In 2003, a tier one fish tissue survey was conducted by TCEQ, DSHS and Texas Parks and Wildlife Department. A follow-up tier two survey was conducted in 2005. In the follow-up survey 30 fish were collected and analyzed for heavy metals. The species of fish collected in the survey included striped bass, long-nosed gar, largemouth bass, blue catfish, flathead catfish and white bass. The action level for mercury in fish tissue is 0.7 mg/kg. The two species identified in the advisory were striped bass and long-nosed gar. These two species contained a mean mercury concentration of 1.149 mg/kg and 0.772 mg/kg respectively. These species are high-end predators that are long-lived and voracious eaters. The mercury bioaccumulated in their tissue as methylmercury, the organometallic form, which is the most toxic form. Because there are only two domestic wastewater discharges to the reservoir, the most likely mechanism for mercury to enter the reservoir is by atmospheric deposition. Possible sources of mercury in the area of the reservoir include emissions from coal-fired power plants and cement plants. Other sources include naturally-occurring sources, volcanoes and industrial emissions. There are 18 other water bodies in Texas that have fish consumption advisories due to mercury. Most are found in East Texas and the Panhandle. These water bodies have low pH, high dissolved organic material or are shallow wetlands, making it very unusual for Canyon Reservoir to be included on that list. Canyon Lake has hard water and very low dissolved organic content.

TCEQ has developed standards for nutrients in reservoirs. Nutrient enrichment from nitrogen and phosphorus can cause excessive growth of macrophytes, algal blooms in the open waters as well as attached to the substrate and floating in mats. The Texas Water Quality Standards have numeric nutrient criteria for chlorophyll *a* in Texas reservoirs. Canyon Reservoir is listed in the Appendix F (Chapter 301.10) of the Texas Water Quality Standards that lists site-specific nutrient criteria for reservoirs and lakes in Texas. The table lists the chlorophyll concentration for each water body. Criteria formulations were based on selected sampling stations that represent the deep pool near the dam for each reservoir, represent average conditions with an allowance for statistical variability, and are calculated as the upper confidence interval of the median with the assumption that a sample size of 10 is used. Based on these assumptions, the nutrient criteria for Canyon Reservoir is 5.0 microgram per liter (ug/L) chlorophyll. When the calculated chlorophyll criterion is below 5.0 ug/L, then the criterion is set at the minimum default criterion of 5.0 ug/L. The calculated value for Canyon Reservoir is 4.11 ug/L.

In order to review the historical data and look for trends that would indicate changes in water quality, the data was separated into two areas in the reservoir, the main pool stations and stations located in coves. The main pool stations and the associated depth profiles were reviewed individually and in comparison with other pool monitoring stations.

Main Pool - Canyon Reservoir

TCEQ has three monitoring stations located in the reservoir, one in the upper portion of the reservoir, located at Cranes Mill Park (station no. 12601), one in the mid-reservoir at Potter's Creek Park (station no. 12600) and one at the dam (station no. 12597). TCEQ Surface Water Quality Monitoring teams collected water quality data from these two stations from two to four times per year. The data set evaluated for trends cover 2002 through 2012. The TCEQ data sets were used in the trend analysis because of the availability of the most recent data.

Guadalupe River Watershed below Comfort

River Segments, Descriptions and Concerns

Photo by Alvin Schuerg

Photo by Janet Thome

Canyon Reservoir at Crane's Mill Park

The Crane's Mill Park station is located in the upper assessment unit and in the riverine zone of the reservoir. The average depth at the upstream location at Crane's Mill Park was 8.6 meters. The reservoir depth fluctuates the most at this location, as the flow from the river upstream varies between wet and dry years. The change in **temperature** from surface to bottom averaged 7.0°C, ranging from median temperature at the surface of 21.4°C to and a median temperature at the bottom of 16.3°C. There was no thermal stratification at this location. The **conductivity** changed an average of 43 umhos/cm at the surface to bottom profiles. In normal to wet years the conductivity is lower at the surface than at the bottom. The surface conductivities at this station ranged from a median of 396 umhos/cm at the surface to a median conductivity at the bottom of 433 umhos/cm.

The difference in **dissolved oxygen** between the surface to bottom averaged 1.75 mg/L. The median surface dissolved oxygen at the Crane's Mill Park station was 8.3 mg/L and a median bottom dissolved oxygen of 6.6 mg/L. The oxygen was depleted to less than 5.0 mg/L from surface to bottom 56 times during the 10 year data set. The difference in **pH** from surface to bottom at this reservoir location averaged a change of 0.4 pH units. No surface or profile sample fell outside the pH standard range of 6.5 to 9.0.

Nutrients, dissolved constituents, suspended solids and chlorophyll *a* were analyzed in the surface samples only. **Nitrate nitrogen** had a median concentration of 0.06 mg/L, ranging from the limit of quantification (LOQ) to 0.63 mg/L. The concentrations measured at the station exceeded the reservoir screening concentration of 0.37 mg/L four times or 12.5 % of the time. **Ammonia nitrogen** had a median concentration of 0.05 mg/L, ranging from the LOQ to 0.08 mg/L, never exceeding the reservoir screening concentration of 0.11 mg/L. The **total phosphorus** concentrations ranged from the LOQ to 0.06 mg/L, with a median concentration of less than method detection.

Chloride and **sulfate** had median concentrations of 16 mg/L and 21.5 mg/L, respectively and ranged from 11 mg/L to 19 mg/L chloride and 18 mg/L to 25 mg/L sulfate, both well below the stream standard of 50 mg/L for each. The **total suspended solids** had a median concentration of 4 mg/L, ranging from 4 mg/L to 8 mg/L, the highest recorded concentrations occurring with high inflows into the reservoir. The high solids content is typical of the riverine zone of the reservoir. All **chlorophyll *a*** concentrations were less than 10 ug/L, the LOQ used by the TCEQ laboratory until May of 2006. At this point, the LOQ for the method was changed to 3 ug/L. Although many of the subsequent data points were found above the new LOQ, all data was well below the screening concentration of 26.7 ug/L for the assessment unit.

TCEQ also collected mercury in water and mercury in sediment at this reservoir location. There were only four data points in each data set. All **mercury in water** data was found below the LOQ of 0.001 ug/L and all **mercury in sediment** was found below the LOQ of 0.045 mg/kg. The analysis for metals in sediment is important in a reservoir, especially in those like Canyon Reservoir, because metals

will be released from the sediment when the hypolimnion becomes anoxic. The metal oxides that are bound in the sediment then become a source of oxygen for bacteria. The metal ions released diffuse into the water column and can be dispersed throughout the volume of the reservoir as the lake turns over in the fall. As the metals enter the water column, the ions can combine with the available oxygen and become oxides again, be diluted by the large volume in the reservoir, and/or possibly bioaccumulate in the food chain. This source of heavy metals could be an explanation for the mercury in fish tissue impairment in Canyon Reservoir.

The low flows associated with the extraordinary drought conditions from 2008 to 2012 in the Guadalupe River basin have driven several trends in Canyon Reservoir. In general, nutrient levels such as TKN are significantly declining (Figure 3), while dissolved salts such as chloride are significantly increasing over time (Figure 4).

Figure 3.

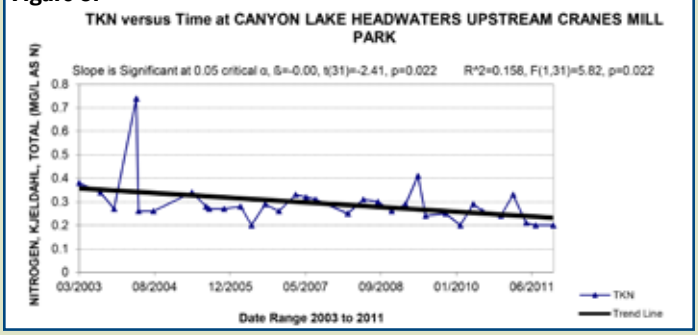
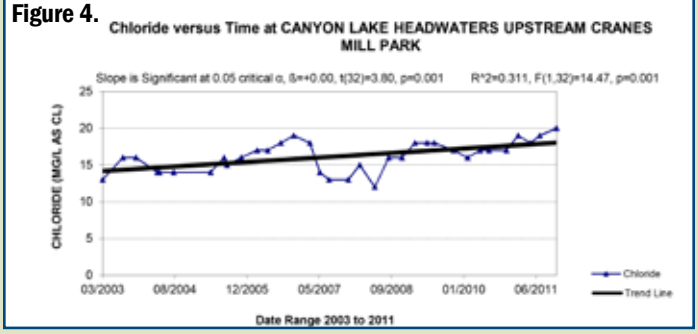


Figure 4.



Canyon Reservoir at Potter's Creek Park

Moving into the transition zone of the reservoir, the TCEQ samples a station at Potter's Creek Park that has an average depth of the sampling events of 15.2 meters. The station weakly stratified in the summer months and was uniform in **dissolved oxygen** and **temperature** in the fall and winter samples. The change in dissolved oxygen in the fall and winter months averaged 1.2 mg/L, with the largest difference of 4.1 mg/L seen in August of 2005. In comparison, the spring and summer months averaged 1.8 mg/L change from surface to bottom profiles. None of the 33 sampling events found less than 1.0 mg/L at the bottom.

As was the case at the Crane's Mill station, the Potter's Creek station profiles had lower **conductivities** at the surface than at the bottom. In all of the 33 profiles taken at the Potter's Creek station, only three were the inverse. The average difference between the surface and bottom profile samples was 51 umhos/cm. The pH change averaged 0.5 pH units from surface to bottom and no individual sample in the profiles exceeded the 6.0 to 9.5 pH standard.

Nutrients, dissolved constituents, suspended solids and chlorophyll *a* were analyzed in the surface samples only. **Nitrate nitrogen** had a median concentration of 0.06 mg/L, ranging from the LOQ to 1.01mg/L. The concentrations measured at the station exceeded the reservoir screening concentration of 0.37 mg/L 5 times or, less than 15.6% of the time. **Ammonia nitrogen** had a median concentration of less than the LOQ, ranging from the LOQ to 0.18 mg/L, exceeding the reservoir screening concentration of 0.11 mg/L only one time. The **total phosphorus** concentration ranged from the LOQ to 0.08 mg/L, with a median concentration at the LOQ.

Chloride and **sulfate** had median concentrations of 16 mg/L and 22 mg/L, respectively and ranged from 12 mg/L to 19 mg/L chloride and 18 mg/L to 25 mg/L sulfate, both well below the stream standard of 50 mg/L for each. The **total suspended solids** had a median concentration of 6.0 mg/L, ranging from 4.0 mg/L to 123 mg/L. The high concentrations associated with high inflows into the reservoir seen in the riverine zone on the reservoir are not seen at the Potter's Creek station, in the transition zone. The **chlorophyll *a*** concentrations were less than 10 ug/L, the LOQ used by the TCEQ laboratory, and well below the screening concentration of 26.7 ug/L for the assessment unit.

TCEQ also collected **mercury in water** and **mercury in sediment** at this reservoir location. There were only four data points in each data set. All mercury in water data was found below the LOQ of 0.001 ug/L and all mercury in sediment was found below the LOQ of 0.045 mg/kg.

The low flows associated with the extraordinary drought conditions from 2008 to 2012 in the Guadalupe River basin have driven several trends in Canyon Reservoir. Total phosphorus may show a significant decline (Figure 5) but it can be attributed to a change in the LOQ from 0.06 mg/L to 0.02 mg/L (as indicated by the red line), while dissolved salts such as sulfate are significantly increasing over time (Figure 6).

Figure 5.

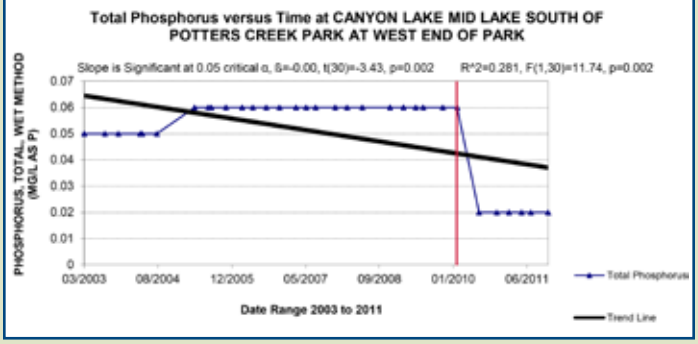
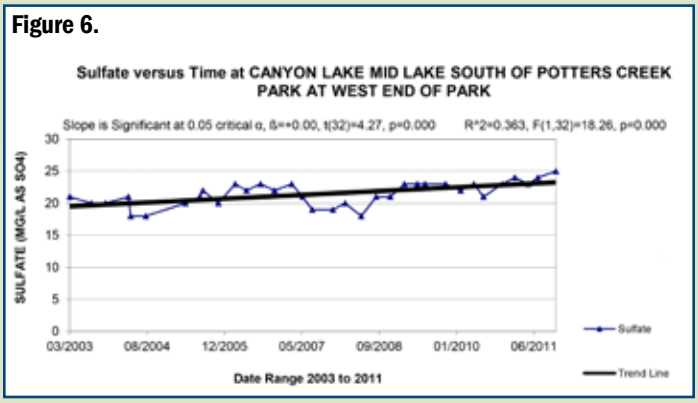


Figure 6.



Canyon Reservoir at the Dam

The TCEQ has been monitoring the location at the dam, in the lacustrine zone, since the summer of 2001. The average depth at the dam was 27.4 meters. The reservoir depth fluctuates as the volume varies between wet and dry years. The change in **temperature** from surface to bottom averaged 7.0°C, ranging from median temperature at the surface of 21.°C to and a median temperature at the bottom of 14.0°C. Thermal stratification occurred in the summer months in most years. As seen at the upstream stations, the **conductivity** gained an average of 28 umhos/cm from surface to bottom profiles. The surface conductivities at this station ranged from a median of 383 umhos/cm at the surface to a median conductivity of 411 umhos/cm at the bottom.

The difference in **dissolved oxygen** between the surface to bottom averaged 3.5 mg/L. The median surface dissolved oxygen at the dam was 8.4 mg/L and a median bottom dissolved oxygen of 1.0 mg/L. The oxygen was depleted to less than 1.0 mg/L from surface to bottom 14 times during the period of record at this station (out of 40 sampling events), with the most recent being in October of 2011.

The difference in **pH** from surface to bottom at both reservoir locations averaged a change of 0.5 pH units. The median surface pH was 8.3 and the median pH at the bottom was 7.8. No surface or profile sample fell outside the pH standard range of 6.5 to 9.0.

Nutrients, dissolved constituents, suspended solids and chlorophyll *a*, were analyzed in the surface samples only. **Nitrate nitrogen** had a median concentration of 0.08 mg/L, ranging from LOQ to 0.32 mg/L. No concentrations measured at the station exceeded the reservoir screening concentration of 0.37 mg/L. **Ammonia nitrogen** had a median concentration at the LOQ, never exceeding the reservoir screening concentration of 0.11 mg/L. The median concentration for **total phosphorus** was also at the LOQ.

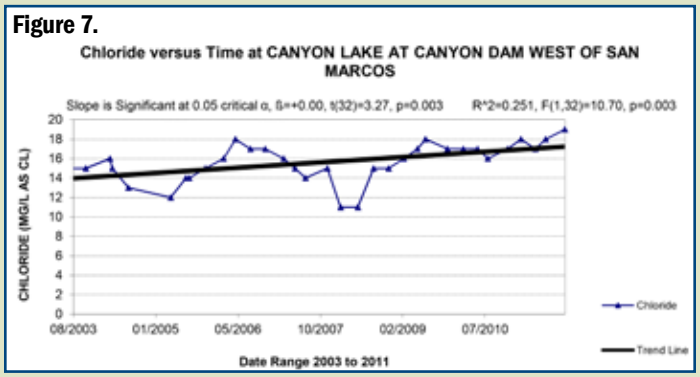
Chloride and **sulfate** had median concentrations of 16 mg/L and 21 mg/L, respectively and ranged from 11 mg/L to 19 mg/L chloride and 16 mg/L to 25 mg/L sulfate, both below the stream standard of 50 mg/L for each. The **total suspended solids** always had concentrations less than the LOQ of 4 mg/L. The **chlorophyll *a*** concentrations were less than 10 ug/L, the LOQ used by the TCEQ laboratory until May 2006, when the LOQ was changed to 3 ug/L. All values were well below the screening concentration of 26.7 ug/L for the assessment unit.

TCEQ also collected **mercury in water** and mercury in sediment at this reservoir location. There were only four data points in each data set. All mercury in water data was found below the LOQ of 0.001 ug/L and all **mercury in sediment** was found below the LOQ of 0.045 mg/kg.

The historical data for the main pool of the reservoir was reviewed for trends over time that may be indicative of a degradation in water quality. The low flows associated with the extraordinary drought conditions from 2008 to 2012

in the Guadalupe River basin have driven several trends in the main pool of Canyon Reservoir. In general, nutrient levels are significantly declining, while dissolved salts such as chlorides are significantly increasing over time (Figure 7).

Figure 7.



Cove Stations – Canyon Reservoir

GBRA has two monitoring locations in coves on Canyon Reservoir. The station located near the Canyon Lake Marina (station no. 12598) was established in 1987 as part of the GBRA historical monitoring program aimed at looking at water quality for contact recreation. The parameter list was expanded in 1996 when GBRA joined the Clean Rivers Program. The TCEQ has also monitored at this location and their data is part of this review. GBRA monitors this station monthly and samples are collected from the first third of a meter.

The other GBRA monitoring station was established in 2001 at the request of the Comal County Judge. He and the Commissioner's Court were concerned about the wastewater discharge to the cove and wanted a monitoring station closer to the discharge. The station near the Jacob's Creek Park is approximately two miles from the discharge. The station is monitored quarterly.

Both coves are relatively shallow as compared to the main pool of the reservoir. The sample stations are located in the assessment unit that refers to the coves around Jacob's Creek Park. There were no concerns noted for this assessment unit other than the mercury in fish tissue impairment previously mentioned.

Looking at the water quality at the Jacob's Creek Park station, the median **temperature** is 21.6°C, ranging from 11.8°C to 30.7°C. The median **specific conductance** was 400 umhos/cm, ranging from 328 umhos/cm to 461 umhos/cm. The **dissolved oxygen** ranged from 6.8 mg/L to 12.5 mg/l, with a median concentration of 9.7 mg/L and never exceeded the screening concentration of 6.0 mg/L. The **pH** of the water at the Jacob's Creek Park station ranged from 7.8 pH units to 8.4 pH units, with a median pH of 8.2.

Nitrates, ammonia and total phosphorus were analyzed at the Jacob's Creek Park station. The median concentration for **nitrate nitrogen** was 0.08 mg/L, ranging from the LOQ

Photo by Connie Rothe

to 0.39 mg/L, exceeding the screening concentration for this assessment unit two times. The ammonia nitrogen was always measured above the screening concentration of 0.11 mg/L 7 times and the median concentration was at the LOQ of 0.1 mg/L. The median concentration for total phosphorous was below detection.

Chlorophyll *a* concentrations were very low and never approached the screening concentration of 26.7 micrograms per liter (ug/L). The median concentration was 1.3 ug/L, and the highest concentration measured in the historical data set was 10.8 ug/L. ***E. coli*** concentrations are also very low, with the highest concentration measured being 61 MPN/100 mL. The geometric mean for the station was 3 MPN/100 mL.

The historical data for this cove of the reservoir was reviewed for trends over time that may be indicative of a degradation in water quality. The low flows associated with extraordinary drought conditions from 2008 to 2012 in the Guadalupe River basin have also driven several significant trends in the Jacob's Creek Park cove of the reservoir. Currently, dissolved oxygen levels are significantly declining (Figure 8), while pH levels are significantly increasing over time (Figure 9). Ammonia nitrogen levels are significantly increasing as well, but this trend may be partially caused by the rise in the analysis LOQ from 0.02 mg/L to 0.10 mg/L in September 2007.

The GBRA station in the cove near the Canyon Lake Marina has an extensive historical data set. The median **temperature** is 24.2°C, ranging from 10.9° to 32.0°C. The median **specific conductance** was 398 umhos/cm, ranging from 325 umhos/cm to 526 umhos/cm. The **dissolved oxygen** ranged from 6.1 to 12.8 mg/L, with a median concentration of 9.0 mg/L and never exceeded the screening concentration of 6.0 mg/L. The pH of the water at the Marina station ranged from 7.5 to 8.5 pH units, with a median pH of 8.2.

Nitrates, ammonia and total phosphorus were analyzed at the GBRA Marina station. The median concentration for **nitrate nitrogen** was 0.08 mg/L, ranging from the LOQ to 1.22 mg/L, exceeding the screening concentration of 0.37 mg/L for this assessment unit 5 out of 126 measurements (4.0%). The median concentration for **ammonia nitrogen** was 0.1 mg/L and ranged from the LOQ to 0.30 mg/L. Ammonia nitrogen appears to be significantly increasing over time (Figure 10). The increase in ammonia nitrogen levels may be partially caused by low flow conditions from 2008 to 2012 and also by a change in the LOQ from 0.02 mg/L to 0.10 mg/L in late 2007.

Chlorophyll *a* concentrations were very low and never exceeded the screening concentration of 26.7 ug/L. The median concentration was 1.6 ug/L. The highest concentration measured in the historical data set was 7.5 ug/L.

Figure 9.

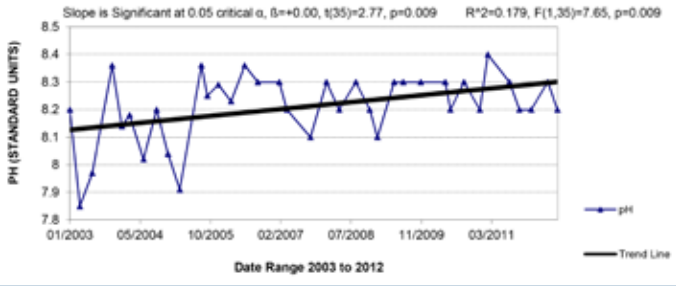


Figure 8.

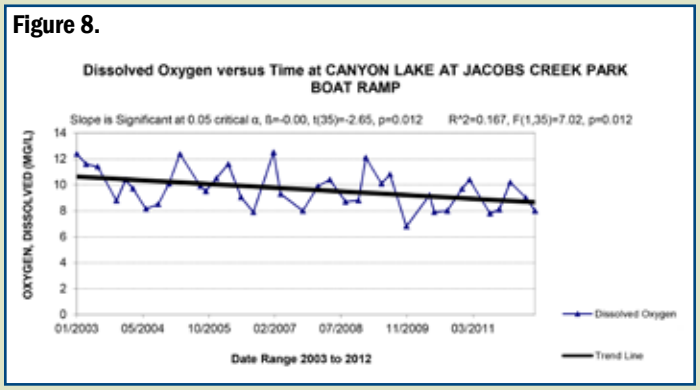
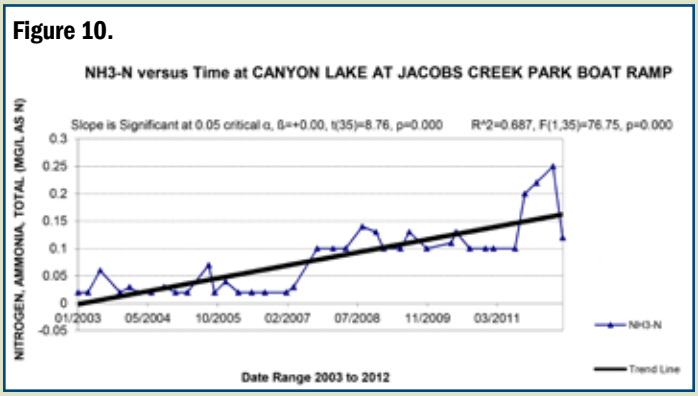


Figure 10.



The geometric mean for ***E. coli*** at the GBRA Canyon Lake Marina station was 5 MPN/100 mL.

The historical data was reviewed for trends over time that may be indicative of degradation in water quality at the Canyon Park Marine location. The majority of the trends discovered appeared to be driven primarily by the low flows and associated extraordinary drought conditions present from 2008 to 2012. The pH at this station appears to be slightly increasing (Figure 11). The nutrient concentrations such as TKN are decreasing (Figure 12), while dissolved salts continue to increase (Figure 13).

Figure 11.

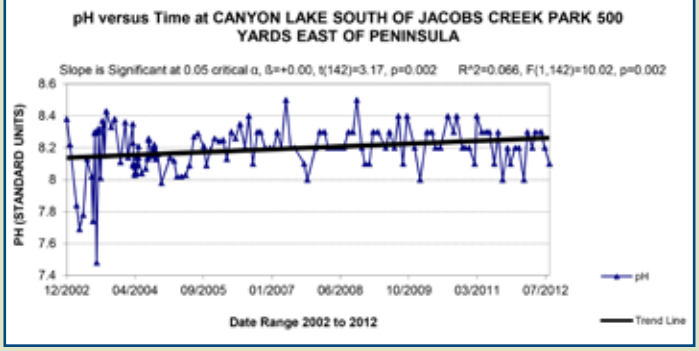


Figure 12.

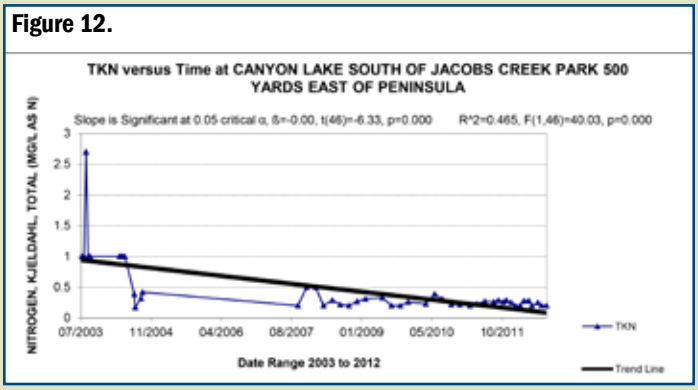
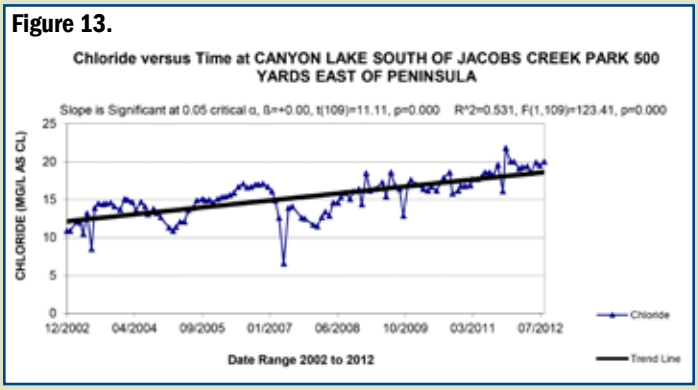


Figure 13.



Guadalupe River below Comfort Issues and Concerns			
Water Quality Issue	**Affected Area**	**Possible Influences/Concerns**	**Possible Actions Taken/to be Taken**
Mercury in Fish Tissue	Canyon Reservoir	Air deposition (volcanoes, coal-fired plants, cement plants)	TMDL; EPA's 5M Strategy (identify air and multi-media sources, adoption of statewide reduction goals, coordination across states); watershed protection plan