

BLANCO RIVER WATERSHED DATA REPORT

March 2021



THE MEADOWS CENTER
FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

TEXAS STREAM TEAM



Photo credit: Sandra Arismendez



TEXAS  STATE
UNIVERSITY
The rising STAR of Texas

This report was prepared in cooperation with, and financed through, grants from the U.S. Environmental Protection Agency through the Texas Commission on Environmental Quality.

TABLE OF CONTENTS

LIST OF TABLES.....	3
LIST OF FIGURES.....	3
ACKNOWLEDGEMENTS.....	4
INTRODUCTION.....	5
Texas Stream Team.....	5
WATERSHED DESCRIPTION.....	6
Location and Climate.....	6
Physical Description.....	7
Land Use.....	8
History.....	9
Endangered Species and Conservation Needs.....	9
Texas Water Quality Standards.....	10
Watershed Protection Plans and TMDLs.....	11
Water Quality Impairments.....	11
WATER QUALITY PARAMETERS.....	12
Water Temperature.....	12
Specific Conductance and Salinity.....	12
Dissolved Oxygen.....	13
pH.....	13
Water Transparency and Total Depth.....	13
<i>E. coli</i> and Enterococci Bacteria.....	14
Orthophosphate.....	14
Nitrate-Nitrogen.....	15
DATA COLLECTION, MANAGEMENT AND ANALYSIS.....	15
Data Collection.....	15
Data Management.....	16
Data Analysis.....	16
DATA RESULTS.....	17
Site Analysis.....	18

Air and water Temperature	18
Conductivity	19
Dissolved Oxygen	19
pH.....	19
Transparency.....	19
Total Depth	19
WATERSHED SUMMARY	24
REFERENCES	25
Appendix I: Endangered and Threatened Species	26

LIST OF TABLES

Table 1. Land use and land cover for Blanco River watershed (USGS, 2016).....	8
Table 2. State and federally listed species in the Blanco River watershed (TPWD, 2020).	10
Table 3. State water quality criteria in the Blanco River Watershed (TCEQ, 2018).	11
Table 4. Blanco River watershed Texas Stream Team monitoring sites.....	17
Table 5. Texas Stream Team data summary in the Blanco River watershed (May 2011 - December 2020). Mean±SD (range); ND = no data.	20

LIST OF FIGURES

Figure 1. Blanco River watershed in Central Texas Hill Country.....	6
Figure 2. Long-term (1971-2000) monthly average precipitation (in) and air temperature (°C) from San Marcos, Texas (NOAA Climate Data, 2020).	7
Figure 3. Land cover for Blanco River watershed (USGS, 2016).	9
Figure 4. Blanco River watershed active Texas Stream Team citizen scientist monitoring sites.	18
Figure 5. Air temperature (°C) for sites in the Blanco River watershed (May 2011-January 2021).	21
Figure 6. Water temperature (°C) for sites in the Blanco River watershed (May 2011-January 2021).	21
Figure 7. Total dissolved solids for sites in the Blanco River watershed (May 2011-January 2021).	22
Figure 8. Dissolved oxygen (mg/L) for sites in the Blanco River watershed (May 2011-January 2021).	22
Figure 9. pH (s.u.) for sites in the Oso Creek/Bay watershed (May 2011-January 2021).	23
Figure 10. Secchi disk transparency (m) in Blanco River watershed (May 2011-January 2021)..	23
Figure 11. <i>E. coli</i> bacteria geometric means for sites in the Blanco River watershed (May 2011- January 2021).....	24

ACKNOWLEDGEMENTS

The Texas Stream Team encourages life-long learning about the environment and people's relationship to the environment through its multidisciplinary citizen science programs. We also provide hands-on opportunities for Texas State University students and inspire future careers and studies in natural resource related fields. Preparation of this report fulfills a contract deliverable for the granting entity, but it also serves as a valuable educational experience for the students that assisted in preparing the report. The Texas Stream Team staff values the student contributions and recognizes each individual for their role. The following staff and student workers assisted in the preparation of this report and are acknowledged for their contributions:

Sandra S. Arismendez, Water Quality Monitoring Coordinator

Desiree Jackson, Student Research Assistant

Aspen Navarro, Program Coordinator

Laura M. Parchman, GIS and Data Management Associate

Daniel Vasquez, Student Research Assistant

INTRODUCTION

Texas Stream Team

Texas Stream Team is a volunteer-based citizen science water quality monitoring program. Citizen scientist water quality monitoring occurs at predetermined monitoring sites, at approximately the same time of day each month. Information collected by Texas Stream Team citizen scientists is covered by a Texas Commission on Environmental Quality (TCEQ)-approved Quality Assurance Project Plan (QAPP) to ensure that a standard set of methods are used. The citizen scientist data may be used to identify surface water quality trends, target additional data collection needs, identify potential pollution events and sources of pollution, and to test the effectiveness of water quality management measures. Texas Stream Team citizen scientist data are not used by the state to assess whether water bodies are meeting the designated surface water quality standards. The data collected by Texas Stream Team provide valuable records, often collected in portions of a water body that professionals are not able to monitor frequently or monitor at all.

For additional information about water quality monitoring methods and procedures, including the differences between professional and volunteer citizen science monitoring, please refer to the following sources:

- [Texas Stream Team Core Water Quality Citizen Scientist Manual](#)
- [Texas Stream Team Advanced Water Quality Citizen Scientist Manual](#)
- [Texas Stream Team Program Volunteer Water Quality Monitoring Program Quality Assurance Project Plan](#)
- [Texas Commission on Environmental Quality \(TCEQ\) Surface Water Quality Monitoring Procedures](#)

The purpose of this report is to provide a summary of the data collected by Texas Stream Team citizen scientists. The data presented in this report should be considered in conjunction with other relevant water quality reports for a holistic view of water quality in the Blanco River watershed. Such sources include, but are not limited to, the following:

- Texas Surface Water Quality Standards
- Texas Water Quality Inventory and 303(d) List (Integrated Report)
- Texas Clean Rivers Program (CRP) partner reports, such as Basin Summary and Highlight Reports
- TCEQ Total Maximum Daily Load (TMDL) reports
- TCEQ and Texas State Soil and Water Conservation Board Nonpoint Source Program funded reports, including watershed protection plans (WPPs)

To get involved with Texas Stream Team or for questions regarding this watershed data report contact us at TxStreamTeam@txstate.edu or at (512) 245-1346. Visit our website for more information on our programs at www.TexasStreamTeam.org.

WATERSHED DESCRIPTION

Location and Climate

The Blanco River originates from springs in northeastern Kendall County and flows across the Hill Country of Texas for 87 miles through Kendall, Blanco, Hays, and Comal Counties until it converges with the San Marcos River in San Marcos, Texas (GBRA, 2008). The watershed lies over the Edwards-Trinity and Trinity aquifers and drains approximately 400 square miles of land. The watershed is part of the Guadalupe River basin in the Edwards Plateau ecoregion (Jasinski, 2021).

The Texas Commission on Environmental Quality (TCEQ) delineates the Blanco River into two segments, the Upper Blanco River (Segment 1813) and the Lower Blanco River (Segment 1809) (Figure 1) (TCEQ, 2018). The spring-fed Upper Blanco River is classified as a freshwater stream and extends from a point 0.3 km (0.2 mi) upstream of Limekiln Road in Hays County to the confluence of Meier Creek in Kendall County. The Lower Blanco River is also classified as a freshwater stream and extends from the confluence with the San Marcos River in Hays County to a point 0.3 km (0.2 mi) upstream of Limekiln Road in Hays County. Several tributaries flow into the Upper Blanco River including the unclassified segments of Falls Creek (Segment 1813E), Crabapple Creek (Segment 1813G), Big Creek (Segment 1813D), McKinney Creek (Segment 1813C), Cottonwood Creek (Segment 1813F), and Koch Creek (Segment 1813B), and the classified segment of Cypress Creek (Segment 1815) near Wimberley. The study area for this report includes both the Upper and Lower Blanco River segments within the Blanco River watershed.

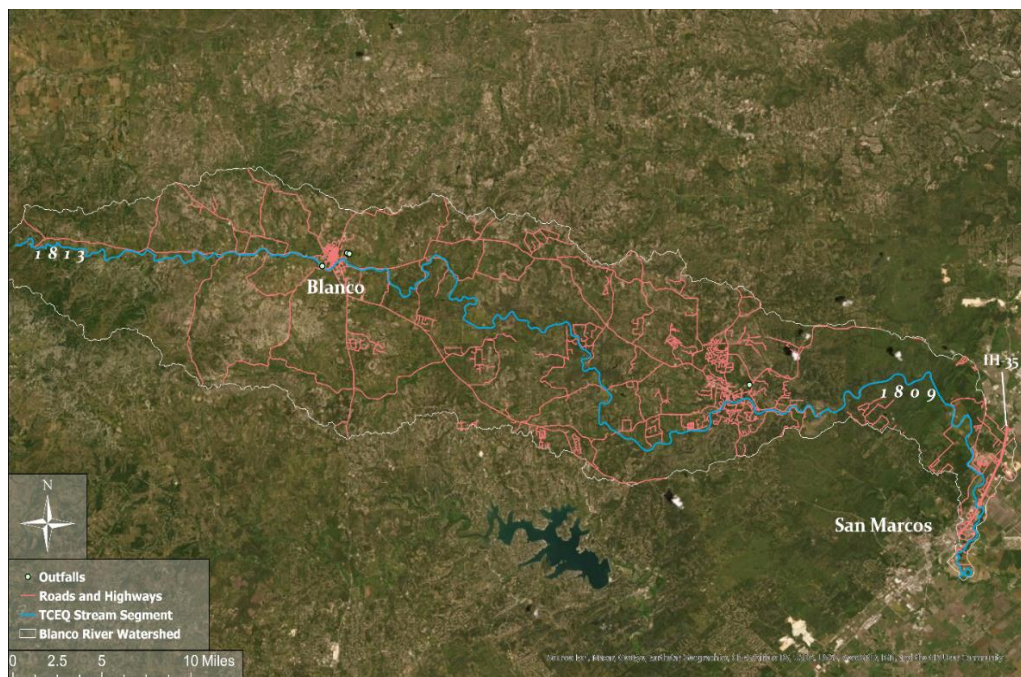


Figure 1. Blanco River watershed in Central Texas Hill Country.

National Oceanic and Atmospheric Administration (NOAA) climate data from San Marcos, Texas was acquired from the National Data Center (NOAA, 2020). Precipitation averaged 35.7 inches annually and occurs year-round (Figure 2). Monthly precipitation has a bimodal distribution with peaks occurring in June and October. Average rainfall in June and October was 4.6 and 4.3 inches, respectively. The least amount of rainfall occurred in August, which coincides with the warmest time of the year (29.7 °C).

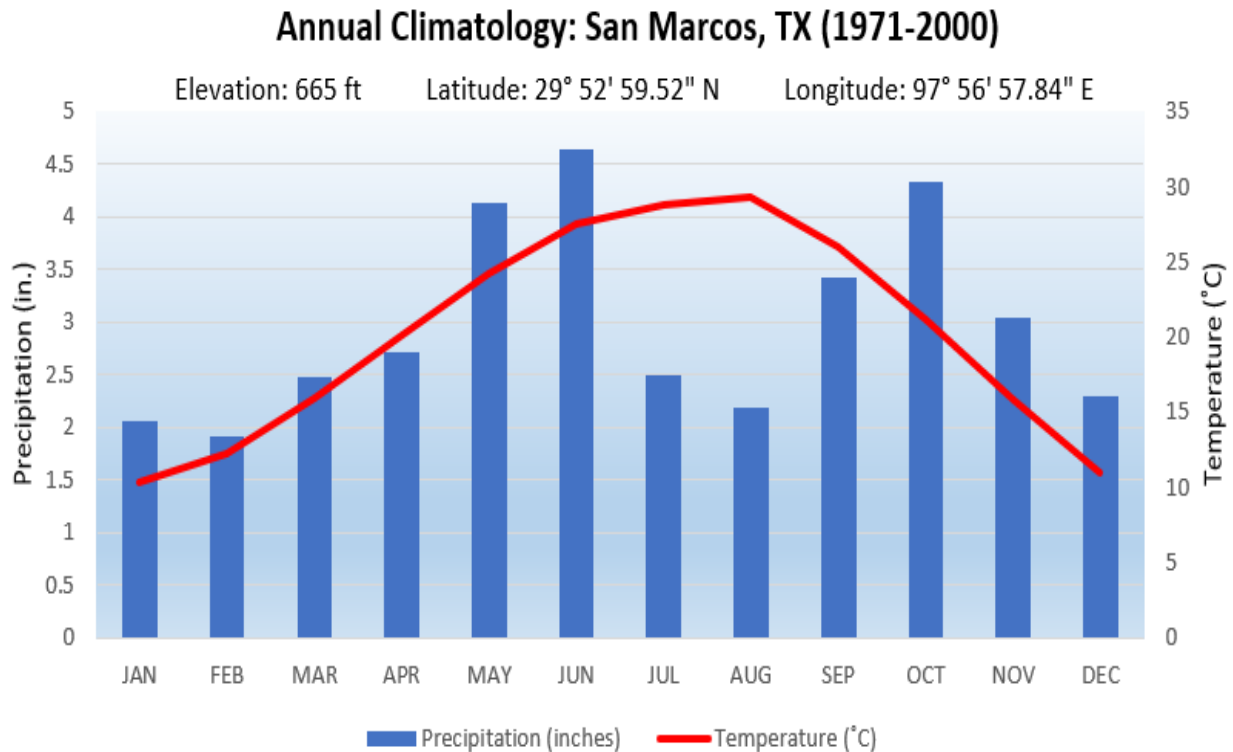


Figure 2. Long-term (1971-2000) monthly average precipitation (in) and air temperature (°C) from San Marcos, Texas (NOAA Climate Data, 2020).

Physical Description

The Blanco River watershed is located within the Central Texas Hill Country. This region is known for stony clays and clay loams with limestone outcroppings (Jasinski, 2021). The area is further described as having limestone substrate containing gypsum deposits with occasional gravel, silt, or clay strata (GBRA, 2008). The limestone-lined river has flowing, clear water that attracts water enthusiasts. This region is prone to frequent and prolonged droughts, which affect the flow rates of rivers and streams located in the Edwards Plateau (TPWD, 2021). The river is relatively shallow in depth for most of its length, but it is accessed for recreational use in deeper pools created by low water dams.

The Blanco River watershed is diverse with respect to its geology and vegetation. The upper portions of the watershed contain historic Indian mounds which are described as unusual

geologic formations, while the lower portion of the watershed is described to have bald cypress lined banks of notable scenic beauty (TPWD, 2021). Two additional landmarks include "the narrows" and "Devil's Backbone". The area referred to as the narrows is an area where the river becomes narrowly constricted between steep bluffs downstream of the City of Blanco. The area referred to as the Devil's Backbone is a scenic area of rugged, hill country adjacent to the river with a beautiful scenic overlook along HWY 32.

Three major municipalities are located within the Blanco River watershed and include the cities of Blanco, Wimberley, and San Marcos from the headwaters to the terminus. Blanco State Park is located on the banks of the Blanco River in Blanco, Texas.

Land Use

Land cover types were calculated for the Blanco River watershed (Table 1) using USGS National Land Cover Data (NLCD,2016). The Blanco River watershed predominantly consists of shrub (46%) and forest (41.5%) land, followed by grassland (6%), developed land (4.6%), then planted and cultivated land (1.1%), open water (0.3%), woody wetlands (0.3%), bare (0.1%) and herbaceous wetlands (0.01%) (NLCD, 2016).

Shrub, forest, and grassland comprise approximately 94 percent of the watershed, while developed and planted/cultivated land comprise less than 6 percent. The composition of the land cover types in the watershed are a testament to the historically exceptional surface water quality and clarity in the river. However, the concerns about increased urbanization and associated nonpoint sources of pollution are warranted since one of the most densely populated areas in the watershed is in Hays County, which is one of the fastest growing counties in the region. This explosive growth is attributed to the overflow of population growth in the neighboring cities of San Antonio and Austin (GBRA, 2008).

Table 1. Land use and land cover for Blanco River watershed (USGS, 2016).

Land Use	Acres	Hectares	Percent (%)
Shrub	128,752.20	52,104.17	46.13%
Forest	115,844.20	46,880.48	41.51%
Grassland	16,600.42	6,717.95	5.95%
Developed	12,886.43	5,214.95	4.62%
Planted & Cultivated	3,041.69	1,230.93	1.09%
Open Water	919.82	372.24	0.33%
Woody Wetland	727.90	294.57	0.26%
Bare	306.68	124.11	0.11%
Herbaceous Wetlands	25.35	10.26	0.01%
Total	279,104.70	112,949.66	100

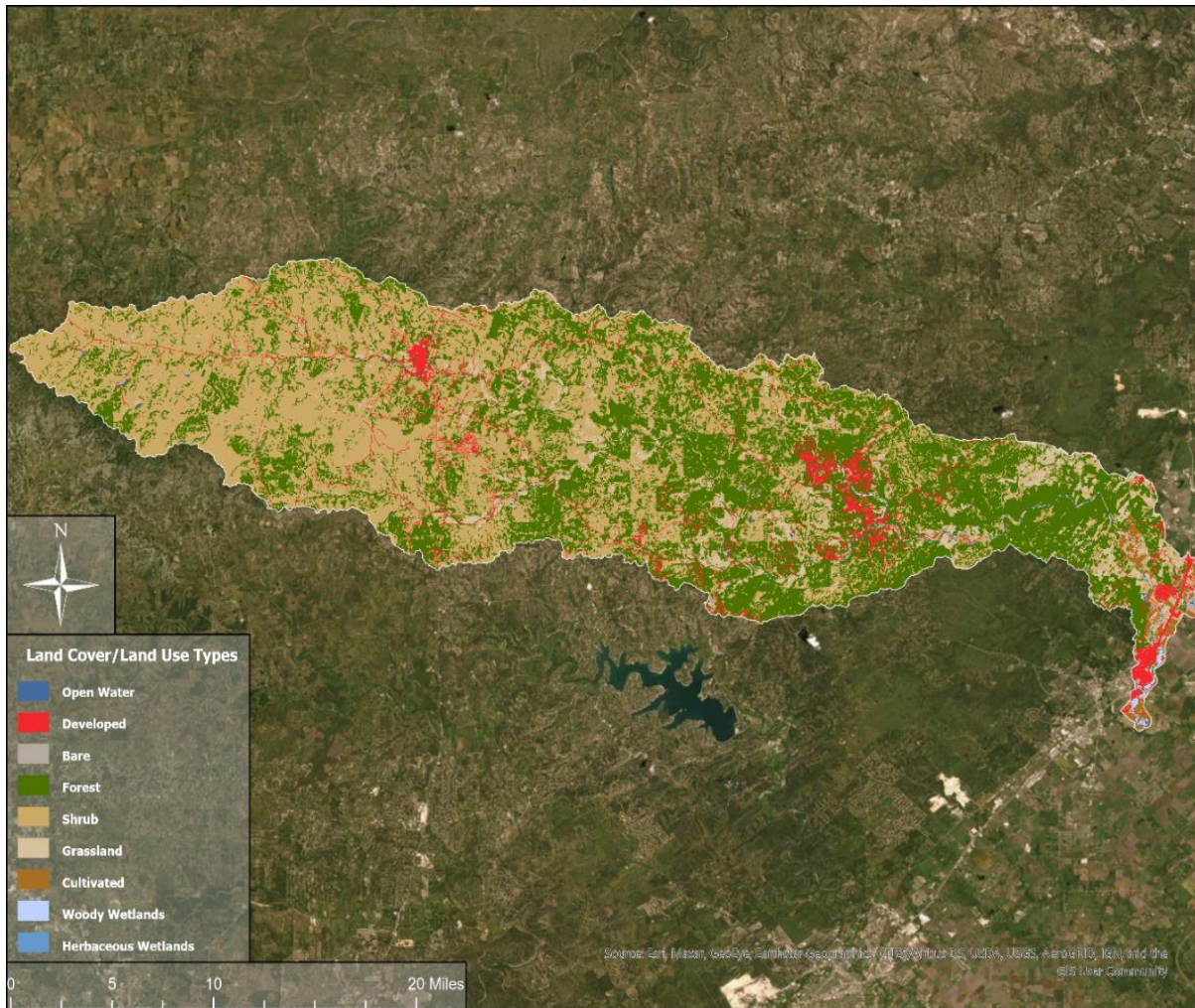


Figure 3. Land cover for Blanco River watershed (USGS, 2016).

History

The Blanco River was originally named by members of the Aguayo expedition in 1721 for its clear water and white limestone banks and streambed (Jasinski, 2021). Several Native American tribes, including Comanches and Apaches, inhabited the region around the Blanco River until the 1850s (Jasinski, 2021). Blanco County was established in 1858 as more settlers moved to the area (Jasinski, 2021).

Endangered Species and Conservation Needs

The common names of 32 species listed as threatened or endangered (under the authority of Texas state law and/or under the US Endangered Species Act) within the Blanco River watershed are included in Appendix I at the end of this report. Table 2 provides a summary of the number of species per taxonomic group listed as endangered, threatened, G1 or G2, species of greatest conservation need, and endemic.

Table 2. State and federally listed species in the Blanco River watershed (TPWD, 2020).

Taxon	Endangered (Federal or State)	Threatened (Federal or State)	G1 or G2 (Critically Imperiled or Imperiled)	Species of Greatest Conservation Need (TPWD) (S1 or S2)	Endemic
Amphibians	2	4	6	7	9
Birds	3	6	2	9	14
Fish	1	2	1	3	7
Mammals	0	1	1	6	18
Reptiles	0	3	0	6	13
Crustaceans	1	1	9	9	11
Insects	2	0	17	17	22
Arachnids	0	0	11	11	11
Mollusks	0	5	17	17	16
Arthropods	0	0	0	0	1
Plants	1	0	7	11	37
Total Count	10	22	71	96	159

Texas Water Quality Standards

The Texas Surface Water Quality Standards (TSWQS) establish explicit goals for the quality of streams, rivers, lakes, and bays throughout the state. The standards are developed to maintain the quality of surface waters in Texas so that they support public health and protect aquatic life, consistent with the sustainable economic development of the state. Water quality standards identify appropriate uses for the state’s surface waters, including aquatic life, recreation, and sources of public water supply (drinking water). The criteria for evaluating support of those uses in the Blanco River segments included in this report are listed in Table 3.

The Texas Surface Water Quality Standards also contain narrative criteria (verbal descriptions) that apply to all waters of the state and are used to evaluate support of applicable uses. Narrative criteria include general descriptions, such as the existence of excessive aquatic plant growth, foaming of surface waters, taste- and odor-producing substances, sediment build-up, and toxic materials. Narrative criteria are evaluated by using screening levels, if they are available, as well as other information, including water quality studies, occurrences of fish kills or contaminant spills, photographic evidence, and local knowledge. Screening levels serve as a reference point to indicate when water quality parameters may be approaching levels of concern.

Table 3. State water quality criteria in the Blanco River Watershed (TCEQ, 2018).

Segment	TDS (mg/L)	Dissolved Oxygen (mg/L)	pH Range (SU)	E. coli Bacteria (#/100 mL)	Temperature (°C)
1813 - Upper Blanco River (Exceptional Aquatic Life Use)	400	*Mean: 6.0 Minimum: 4.0	6.5-9.0	Primary Contact Recreation1: 126 geometric mean, 399 single sample	33.3
1809 - Lower Blanco River (High Aquatic Life Use)	400	Mean: 5.0 Minimum: 3.0	6.5-9.0	Primary Contact Recreation 1: 126 geometric mean, 399 single sample	33.3

*The dissolved oxygen mean is applied as a minimum average over a 24-hour period. The 24-hour minimum is not to extend beyond eight hours per 24-hour day.

Watershed Protection Plans and TMDLs

No watershed protection plans (WPPs) are currently underway on the Blanco River. However, in April 2014, a WPP was approved by the United States Environmental Protection Agency (EPA) and TCEQ for the Cypress Creek Watershed, a tributary to the Blanco River. The WPP targets point and nonpoint sources of *E. coli* bacteria and other pollutants through monitoring and best management practices geared toward improving water quality and restoring the contact recreation use. The Cypress Creek WPP aims to ensure the integrity of the creek for generations to come.

Water Quality Impairments

The TCEQ determines a water body to be impaired if more than 10-percent of samples, provided by professional monitoring from the last seven years, exceed the standard for each parameter, except for bacteria (see enterococci bacteria below for standards assessment methodology). When the observed sample value does not meet the standard, it is referred to as an exceedance of the water quality standard.

The Blanco River historically has had exceptional water quality (GBRA, 2008). The river water in this area is extremely clear with most water quality concerns being linked to the highly variable streamflow and the potential for reduced surface water quality from the rapidly growing population in this area. Other concerns have arisen over the available water supply to support the growing population. Increases in population result in urbanization and subsequent increases in nonpoint sources of pollution from impervious cover, more wastewater discharges to streams and rivers, and larger demands for clean, safe drinking water.

The 2020 Texas Integrated Report assessed the Upper and Lower Blanco River segments. Results of the assessment did not result in any impairments or concerns. Both river segments were either fully supporting their designated uses or had no identified concerns.

WATER QUALITY PARAMETERS

Water Temperature

Water temperature influences the physiological processes of aquatic organisms, and each species has an optimum temperature for survival. High water temperatures increase oxygen-demand for aquatic communities and can become stressful for fish and aquatic insects. Water temperature variations are most detrimental when they occur rapidly, leaving the aquatic community no time to adjust. Additionally, the ability of water to hold oxygen in solution (solubility) decreases as temperature increases. This effect is exacerbated in coastal water bodies influenced by tidal, saline waters.

Warm water temperatures occur naturally with seasonal variation, as water temperatures tend to increase during summer and decrease in winter in the Northern Hemisphere. Daily (diurnal) water temperature changes occur during normal heating and cooling patterns. Man-made sources of warm water include power plant effluent after it has been used for cooling or hydroelectric plants that discharge warmer water. Citizen scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases because of the sampling frequency. While citizen scientist data do not show diurnal temperature fluctuations, they may demonstrate the fluctuations over seasons and years when collected consistently at predetermined monitoring sites and monthly frequencies.

Specific Conductance and Salinity

Salinity is a measure of the saltiness or the dissolved inorganic salt concentration in water. Salinity is often measured in ocean, estuarine or tidally-influenced waters, but in Texas there are some streams that have a high salt content due to the local geology and require salinity measurements. Some common ions measured as salinity include sodium, chloride, magnesium, sulfate, calcium and potassium. Seawater typically has a salt content of 35 parts per thousand (ppt or ‰). Like other water quality parameters, salinity affects the homeostasis or the balance of water and solutes within both plants and animals. Too much or too little salt can affect plant and animal cell survival and growth, therefore salinity is an important measurement.

Specific conductivity is a measure of the ability of a body of water to conduct electricity. It is measured in microsiemens per cubic centimeter ($\mu\text{S}/\text{cm}^3$). A body of water is more conductive if it has more total dissolved solids (TDS) such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lower the level of dissolved oxygen (DO), leading to eutrophication. High concentrations of salt can inhibit water absorption and limit root growth for vegetation, leading to an abundance of more drought tolerant plants, and can cause dehydration of fish and amphibians. Sources of TDS can include

agricultural runoff, domestic runoff, or discharges from wastewater treatment plants. Specific conductivity values are typically converted to TDS using a conversion factor of 0.65 and are reported as mg/L.

Dissolved Oxygen (DO)

Oxygen is necessary for the survival of organisms like fish and aquatic insects. The amount of oxygen needed for survival and reproduction of aquatic communities varies according to species composition and adaptations to watershed characteristics like stream gradient, habitat, and available streamflow.

The DO concentrations can be influenced by other water quality parameters such as nutrients and temperature. High concentrations of nutrients can lead to excessive surface vegetation and algae growth, which may starve subsurface vegetation of sunlight and, therefore, reduce the amount of oxygen they produce via photosynthesis. This process is known as eutrophication. Low DO can also result from high groundwater inflows (which have low DO due to minimal aeration), high temperatures, or water releases from deeper portions of dams where DO stratification occurs. Supersaturation typically only occurs underneath waterfalls or dams with water flowing over the top.

pH

The pH scale measures the concentration of hydrogen ions on a range of zero to 14 and is reported in standard units (s.u.). The pH of water can provide information regarding acidity or alkalinity. The range is logarithmic; therefore, every one-unit change is representative of a 10-fold increase or decrease in acidity or alkalinity. Acidic sources, indicated by a low pH level, can include acid rain and runoff from acid-laden soils. Acid rain is mostly caused by coal powered plants with minimal contributions from the burning of other fossil fuels and other natural processes, such as volcanic emissions. Soil-acidity can be caused by excessive rainfall leaching alkaline materials out of soils, acidic parent material, crop decomposition creating hydrogen ions, or high-yielding fields that have drained the soil of all alkalinity. Sources of high pH (alkaline) include geologic composition, as in the case of limestone increasing alkalinity and the dissolving of carbon dioxide in water. Carbon dioxide is water soluble, and as it dissolves it forms carbonic acid. A suitable pH range for healthy organisms is between 6.5 and 9.0 s.u.

Water Transparency and Total Depth

Two instruments can be used by Texas Stream Team Citizen scientist to measure water transparency, a Secchi disk or a transparency tube. Both instruments are used to measure water transparency or to determine the clarity of the water, a condition known as turbidity. The Secchi disk is lowered into the water until it is no longer visible, then raised until it becomes visible, and the average of the two depth measurements is recorded. A transparency tube is filled with sample water and water is released using the release valve until the black and white pattern at the bottom of the tube can be seen. The tube is marked with two-millimeter increments and is used to measure water transparency. Transparency measurements less than

the total depth of the monitoring site are indicative of turbid water. Readings that are equal to total depth indicate clear water. Highly turbid waters pose a risk to wildlife by clogging the gills of fish, reducing visibility, and carrying contaminants. Reduced visibility can harm predatory fish or birds that depend on good visibility to find their prey. Turbid waters allow very little light to penetrate deep into the water, which, in turn, decreases the density of phytoplankton, algae, and aquatic plants. This reduces the DO in the water due to reduced photosynthesis. Contaminants are most commonly transported in sediment rather than in the water. Turbid waters can result from sediment washing away from construction sites, erosion of farms, or mining operations.

E. coli and Enterococci Bacteria

E. coli bacteria originate in the digestive tract of endothermic organisms. The United States Environmental Protection Agency has determined *E. coli* to be the best indicator of the degree of pathogens in a freshwater system. A pathogen is a biological agent that causes disease.

Enterococci bacteria are a subgroup of fecal streptococci bacteria (mainly *Streptococcus faecalis* and *Streptococcus faecium*) that is present in the intestinal tracts and feces of warm-blooded animals. It is used by TCEQ as an indicator of the potential presence of pathogens in saltwater along the Texas Gulf coast.

The Blanco River is designated a primary contact recreation 1 (PCR1) use. This means that recreation activities on the Blanco River are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, handfishing as defined by Texas Parks and Wildlife Code, §66.115, and the following whitewater activities: kayaking, canoeing, and rafting).

The standard for a bacteria impairment is based on the geometric mean (geomean) of the bacteria measurements collected. A geometric mean is a type of average that incorporates the high variability found in parameters such as *E. coli* and enterococci which can vary from zero to tens of thousands of CFU/100 mL. The standard for contact recreational use of a water body is 126 CFU/100 mL for *E. coli* in freshwater or 35 CFU/100 mL for enterococci in saltwater. A water body is considered impaired if the geometric mean is higher than the corresponding water quality standard.

Texas Stream Team does not monitor water quality for enterococci in coastal waters, instead citizen scientists can get certified in *E. coli* bacteria monitoring, the indicator used by TCEQ for freshwater streams.

Orthophosphate

Orthophosphate is the phosphate molecule all by itself. Phosphorus almost always exists in the natural environment as phosphate, which continually cycles through the ecosystem as a nutrient necessary for the growth of most organisms. Testing for orthophosphate detects the amount of phosphate in the water itself, excluding the phosphate bound up in plant and animal

tissue. There are other methods to retrieve the phosphate from the material to which it is bound, but they are too complicated and expensive to be conducted by citizen scientists. Testing for orthophosphate provides an idea of the degree of phosphate in a water body. It can be used for problem identification, which can be followed up with more detailed professional monitoring, if necessary. Phosphorus inputs into a water body may be caused by the weathering of soils and rocks, discharge from wastewater treatment plants, excessive fertilizer use, failing septic systems, livestock and pet waste, disturbed land areas, drained wetlands, water treatment, and some commercial cleaning products. The effect excess orthophosphate has on a water body is known as eutrophication and is described above under the “Dissolved Oxygen” section.

Nitrate-Nitrogen

Nitrogen is present in terrestrial or aquatic environments as nitrate-nitrogen, nitrites, and ammonia. Nitrate-nitrogen tests are conducted for maximum data compatibility with TCEQ and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most organisms. Nitrogen inputs into a water body may be from livestock and pet waste, excessive fertilizer use, failing septic systems, and industrial discharges that contain corrosion inhibitors. The effect excess nitrogen has on a water body is known as eutrophication and is described previously in the “Dissolved Oxygen” section. Nitrate-nitrogen dissolves more readily than orthophosphate, which tend to be attached to sediment, and, therefore, can serve as a better indicator of the possibility of sewage or manure pollution during dry weather.

DATA COLLECTION, MANAGEMENT AND ANALYSIS

Data Collection

The field sampling procedures implemented by trained citizen scientists are documented in the Texas Stream Team Core Water Quality Citizen Scientist Manual and the Texas Stream Team Advanced Water Quality Citizen Scientist Manual. The sampling protocols in both manuals adhere closely to the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012). Additionally, all data collection adheres to Texas Stream Team’s approved QAPP.

Procedures documented in Texas Stream Team Water Quality Citizen Scientist Manuals or the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012) outline the necessary steps to prevent contamination of samples, including direct collection into sample containers, when possible. Field quality control samples are collected and analyzed to detect whether contamination has occurred.

Field sampling activities are documented on field data sheets. For all field sampling events the following items are recorded: station ID, location, sampling time, date, depth, sample collector’s name/signature, group identification number, meter calibration information, and reagent expiration dates.

For all *E. coli* sampling events, station ID, location, sampling time, date, depth, sample collector's name/signature, group identification number, incubation temperature, incubation duration, *E. coli* colony counts, dilution aliquot, field duplicates and blank, and media expiration dates are recorded.

Values for all measured parameters are recorded. If reagents or media are expired, it is noted, and data are flagged and communicated to Texas Stream Team staff. Sampling is not permitted with expired reagents and bacteria media; the corresponding values will be flagged in the database and excluded from data reports. Detailed observational data recorded include water appearance, weather, field observations (biological activity and stream uses), algae cover, unusual odors, days since last significant rainfall, and flow severity. Comments related to field measurements, number of participants, total time spent sampling, and total round-trip distance traveled to the sampling site are also recorded for grant reporting and administrative purposes.

Data Management

The citizen scientists collect field data and report the measurement results to Texas Stream Team, either by submitting a hard copy of the form or by entering the data directly to the online Waterways Dataviewer. All data are reviewed to ensure they are representative of the samples analyzed and locations where measurements were made, and the data and associated quality control data conform to specified monitoring procedures and project specifications as stated in the approved QAPP.

Data review and verification is performed using a data management checklist and self-assessments, as appropriate to the project task, followed by automated database functions that will validate data as the information is entered into the database. The data are verified and evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Potential errors are identified by examination of documentation and by manual and computer-assisted examination of corollary or unreasonable data. Issues that can be corrected are corrected and documented. Once entered, the data can be accessible through the online [Texas Stream Team Datamap](#).

Data Analysis

Data were compiled, analyzed, summarized, and compared to state water quality standards and screening criteria to provide readers with a reference point for parameters that may be of concern. The assessment performed by TCEQ involves more stringent monitoring methods and oversight than those used by citizen scientists and staff in this report. The citizen scientist water quality monitoring data are not currently used in the TCEQ assessments mentioned above but are intended to inform stakeholders about general characteristics and assist professionals in identifying areas of potential concern to plan future monitoring efforts.

All data collected by citizen scientists from the watershed and its tributaries were exported from the Texas Stream Team database and grouped by site. Once compiled, data were sorted,

summary statistics were generated and reviewed, and results were graphed in JMP Pro 14.0.0 (SAS Institute Inc., 2018) using standard methods. Best professional judgement was used to verify outliers. Statistically significant trends were analyzed further. R-squared is a statistical measure of how close the data are to the fitted regression line. Zero indicates that the model explains none of the variability of the response data around its mean. The p-value is the level of marginal significance within a statistical hypothesis test representing the probability of the occurrence of a given event. Statistical significance was set to a p-value of ≤ 0.05 . A p-value of ≤ 0.05 means that the probability that the observed data matches the actual conditions found in nature is 95-percent. As the p-value decreases, the confidence that it simulates actual conditions in nature increases.

DATA RESULTS

Water quality data from eight Texas Stream Team monitoring sites on the Blanco River were acquired for this report (Figure 4). One site (81105) is located on the Lower Blanco River, while the remaining seven sites (80587, 81106, 80233, 81308, 81008, 80539 and 80479) are on the Upper Blanco River. Between 15 and 113 sampling events occurred at each site, for a total of 319 sampling events (Table 4). The period of record for the sampling events ranged from May 2011 to January 2021, with some sites experiencing temporal intermittent sampling.

Table 4. Blanco River watershed Texas Stream Team monitoring sites.

Site ID	Description	Number of Samples (n)	Period of Record
80587	BLANCO RIVER @ BLANCO STATE PARK, 200 M DOWNSTREAM OF HWY 281	24	May 2011 – Feb 2015 Aug 2020
81006	BLANCO RIVER @ GW HASCHKE	31	Jun 2014 – Mar 2015 May 2018 – Apr 2020
80233	CARPERS CREEK TRIBUTARY TO BLANCO RIVER	113	Feb 2006 – Jan 2021
81308	Bendigo low water crossing	15	May 2018 – Nov 2020
81007	BLANCO RIVER @ RIVER OAKS WATER PARK	19	May 2018 – Apr 2020
80539	BLANCO RIVER @ PARADISE VALLEY RIVER PARK	22	May 2018 – Feb 2020
80479	BLANCO RIVER @ RMR (River Mountain Ranch) WATER PARK	48	May 2008 – Sep 2010 Mar 2018 – Feb 2020
81105	Blanco River at 5 Mile Dam Boat Launch	47	May 2019 – Dec 2020



Figure 4. Blanco River watershed active Texas Stream Team citizen scientist monitoring sites.

Site Analysis

The period of record for data analyzed for this report intermittently spanned from May 2011 to January 2021. Data from 319 monitoring events conducted at eight sites were acquired from the Waterways Dataviewer (Table 4). Water quality monitoring data for the eight sites in the Blanco River were analyzed and summarized in Table 5 including the number of samples, mean, standard deviation, and range of values. Citizen scientists monitored eight sites for core and *E. coli* bacteria water quality monitoring parameters. The total number of sampling events for the Texas Stream Team core and *E. coli* bacteria water quality monitoring parameters (air and water temperature, conductivity, TDS, dissolved oxygen, pH, Secchi disk transparency, total depth, and e. coli) remained somewhat consistent for the period of record.

Air and water Temperature

Average air temperature for all sites ranged from 19.2 to 24.4 °C (Table 5). The lower overall mean air temperature (19.2 °C) was observed at the RMR Water Park (80479) in the lower reach of the Upper Blanco River. The higher mean air temperature (24.4 °C) was observed at the 5 mi. Dam site (81105) on the Lower Blanco River. The distribution of air temperatures for each site are displayed in Figure 5 from upstream to downstream with the highest median temperature reported at 5-mile Dam (81105) and the lowest median temperature reported at Paradise valley (80539).

Water temperatures at all sites were well below the water quality standard (WQS) of 33.3°C. Average water temperature for all eight sites ranged from 18.6°C at the RMR Water Park (80479) in the lower reach of the Upper Blanco River to 22.4°C at the Bendigo (81308) site (Table 5). The distribution of water temperatures for each site are displayed in Figure 6 from upstream to downstream with the highest median temperature reported at 5-mile Dam (81105) and the lowest median temperature reported at Paradise valley (80539).

Conductivity

Conductivity measurements were converted to total dissolved solids for all sites (Table 5). Average TDS values at all sites were below the water quality standard (WQS) of 400 mg/L. Average TDS values for all eight sites ranged from 280 to 389 mg/L (Table 5). The distribution of TDS measurements for each site from upstream to downstream are displayed in Figure 7 with the highest median TDS reported at Bendigo (81308) in the Upper Blanco River and the lowest median TDS reported at 5-mile Dam (81105) in the Lower Blanco River.

Dissolved Oxygen

Average dissolved oxygen values at all sites were above the TSWQS of 6.0 mg/L in the Upper Blanco River and 5.0 mg/L in the Lower Blanco River (Table 5). The range of average DO values for all sites spanned from 6.2 to 7.9 mg/L. The distribution of DO measurements for each site from upstream to downstream are displayed in Figure 8. The highest median DO was reported at Carpers Creek (80233) and the lowest at Blanco State Park (80587) in the Upper Blanco River.

pH

The pH values at all sites were well within the TSWQS of 6.5 to 9.0 s.u. (Figure 9). Average pH for all sites ranged from 7.5 to 8.4 s.u. (Table 5). River Oaks (81007) in the Upper Blanco River had the highest median pH, while Blanco State Park (80587) had the lowest (Figure 9).

Transparency

Secchi disc transparency was measured and reported at all sites (Table 5). The average range of Secchi disc transparency values reported was from 0.3 to 1.2 m. The largest median transparency was reported at Carpers Creek (80233), while the smallest was reported at Paradise Valley (80539) and River Oaks (81007) in the Upper Blanco River (Figure 10).

Total Depth

Total depth at each site was also measured and reported (Table 5). The deepest average total depth was reported at 5-mile Dam (1.2 m), while the shallowest average total depth was reported at Paradise Valley (0.3 m).

E. coli

E. coli bacteria was measured and reported at six of the eight sites on the Blanco River (Table 5). No bacteria data was available from the site in the Lower Blanco River, but bacteria data was available at six of the seven sites in the Upper Blanco River. The *e. coli* geometric means met the TSWQS (126 cfu/100 ml) at all sites where measurements were collected (Figure 11).

Table 5. Texas Stream Team data summary in the Blanco River watershed (May 2011 - December 2020). Mean±SD (range); ND = no data.

Parameter	Blanco S.P. 80587 n=24	GW Haschke 81006 n=31	Carpers Crk. 80233 n=113	Bendigo 81308 n=15	River Oaks 81007 n=19	Paradise Valley 80539 n=22	RMR Water Park 80479 n=48	5 mi. Dam 81105 n=47
Air Temp. (°C)	20.4±7 (22.5)	21.1±7 (30.8)	22.7±7 (29.5)	19.5±6 (22.0)	22.0±4 (15.4)	19.7±6 (19.0)	19.2±7 (29.5)	24.4±9 (39.0)
Water Temp. (°C)	22.2±6 (22.4)	20.6±5 (17.7)	19.3±6 (22.0)	22.4±5 (14.0)	21.1±5 (17.4)	19.1±7 (19.5)	18.6±7 (29.0)	22.1±6 (26.9)
Cond. (µS/cm)	447±47 (240)	536±46 (220)	505±52 (438)	598±13 (40)	491±38 (170)	481±46 (140)	473±64 (210)	430±53 (306)
*TDS (mg/L)	291±31 (156)	348±30 (143)	328±34 (285)	389±8 (26)	319±25 (111)	313±30 (91)	307±42 (137)	280±34 (199)
Dissolved Oxygen (mg/L)	6.2±1 (4.5)	7.3±1 (5.4)	7.9±2.2 (9.7)	6.9±1 (4.3)	7.3±1 (4.6)	7.5±1 (4.5)	7.7±1 (5.5)	7.1±2 (6.5)
pH (s.u.)	7.5±0.2 (0.7)	8.0±0.5 (1.55)	7.6±0.3 (2.2)	7.7±0.7 (3)	8.4±0.2 (0.8)	8.2±0.2 (0.5)	8.1±0.3 (1.2)	7.7±0.3 (1.4)
Secchi Disk Transp. (m)	0.6±0.3 (0.9)	0.7±0.5 (1.9)	1.0±0.4 (1.4)	0.7±0.1 (0.2)	0.4±0.3 (0.8)	0.3±ND (0)	0.8±1.2 (4)	0.9±0.4 (1.3)
Total Depth (m)	0.8±0.2 (0.7)	0.7±0.5 (1.4)	1.0±0.5 (1.3)	0.6±0.1 (0.2)	0.4±0.3 (0.8)	0.3±0 (0)	0.6±0.5 (2.1)	1.2±0.4 (1.3)
**E. coli (cfu/100ml)	94.3	61.5	34.7	ND	116.7	94.5	69.4	ND

*TDS was calculated from specific conductance (TDS = specific conductance * 0.65)

**Geometric means were calculated for *E. coli*.

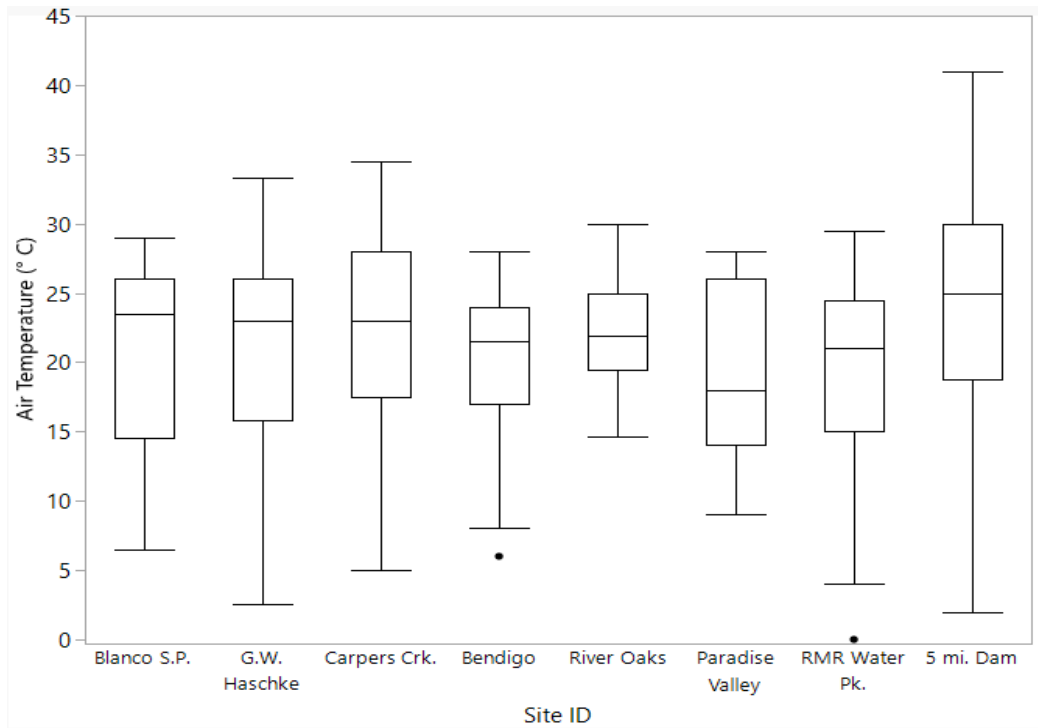


Figure 5. Air temperature (°C) for sites in the Blanco River watershed (May 2011-January 2021).

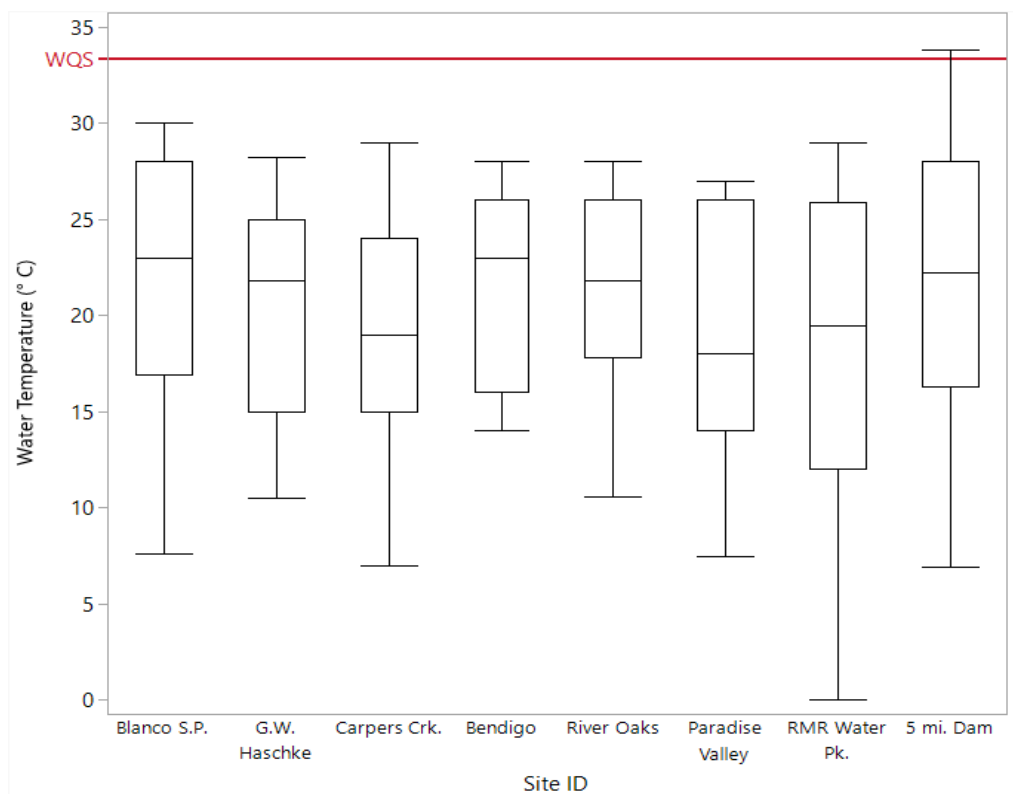


Figure 6. Water temperature (°C) for sites in the Blanco River watershed (May 2011-January 2021).

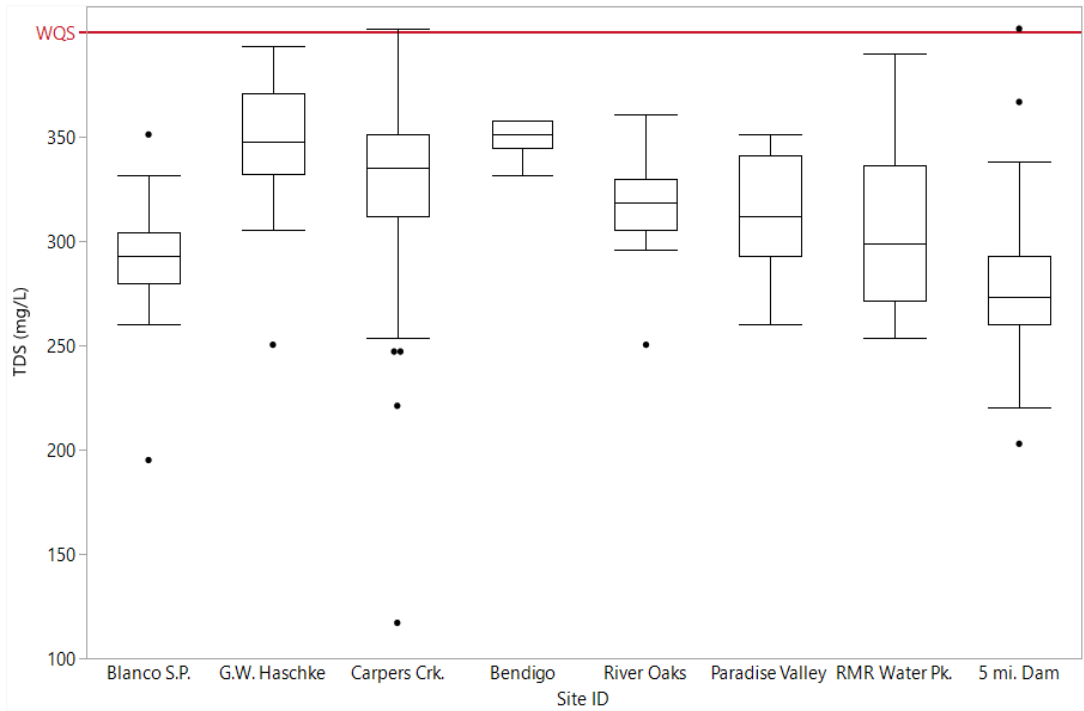


Figure 7. Total dissolved solids for sites in the Blanco River watershed (May 2011-January 2021).

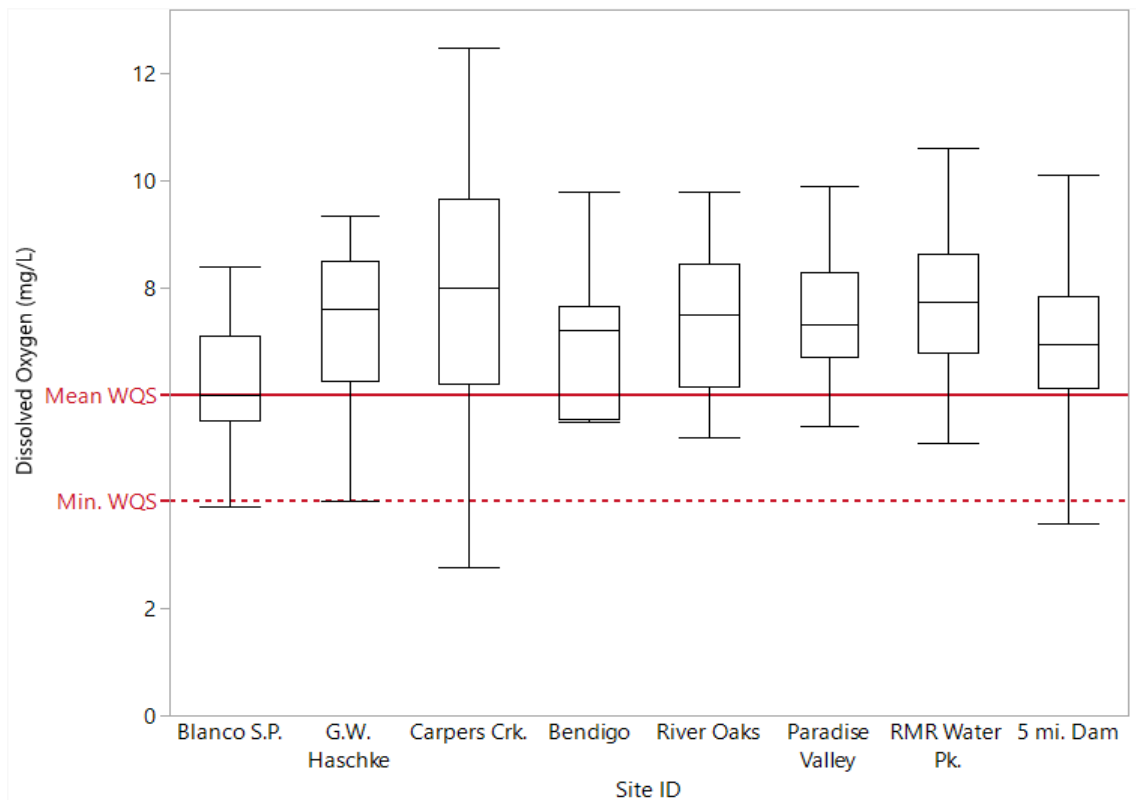


Figure 8. Dissolved oxygen (mg/L) for sites in the Blanco River watershed (May 2011-January 2021).

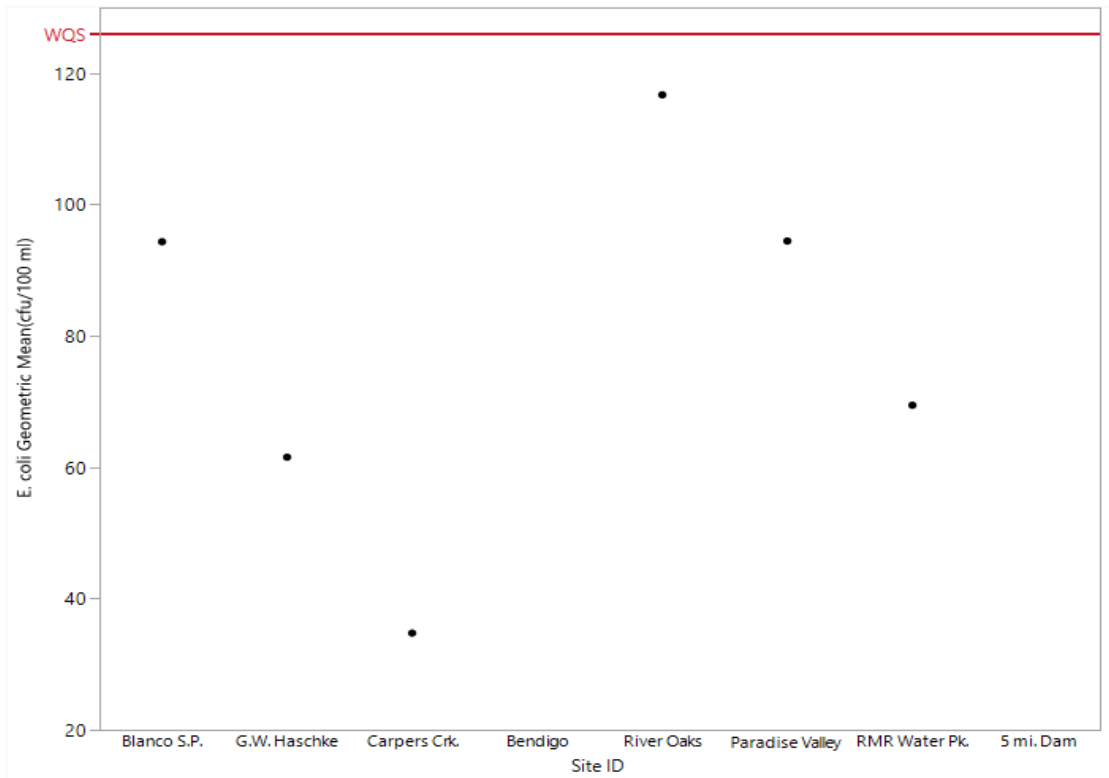


Figure 11. *E. coli* bacteria geometric means for sites in the Blanco River watershed (May 2011-January 2021).

WATERSHED SUMMARY

Texas Stream Team citizen scientists monitored standard core water quality parameters at eight sites in the Blanco River watershed from May 2011 to January 2021. Parameters monitored included water and air temperature, conductivity, TDS, DO, pH, transparency, total depth, and *E. coli* bacteria. Monitoring for the Advanced Texas Stream Team parameters nitrate-nitrogen and orthophosphate did not take place in the Blanco River watershed during the period of record. Data from the eight monitoring sites were analyzed and summarized for this report.

Water quality standards for all measured parameters were met at all sites in both the Upper and Lower Blanco River. The 2020 Texas Integrated Report (IR), prepared biennially by TCEQ, also reported no water quality impairments on the Blanco River. Historically, water quality in the Blanco River has been exceptional. Findings in this data summary report coincide with the historical account and the Texas IR, therefore the primary concern for this area involves nonpoint sources of pollution associated with urbanization and demands from future population growth.

The Texas Stream Team citizen scientists monitoring water quality in the Blanco River watershed are encouraged to continue monitoring and consider pursuing the Advanced water quality monitoring trainings. There is a need for this type of monitoring to continue for the development of long-term water quality data sets. The information gathered thus far has been useful to describe current water quality conditions. Continuation of this monitoring will allow future trend analysis to capture changes in water quality over time as the area grows. Texas Stream Team will continue to support current citizen scientists as needed by providing technical support, creating new monitoring sites and re-activate existing sites, and we look forward to training new citizen scientists to expand and grow the water quality monitoring efforts in this area and beyond. For more information about Texas Stream Team and upcoming trainings contact us at txstreamteam@txstate.edu or visit the calendar of events on our website at www.TexasStreamTeam.org.

REFERENCES

- Guadalupe-Blanco River Authority (GBRA). 2008. Guadalupe-Blanco River Authority Basin Summary Report. Guadalupe-Blanco River Authority, Seguin, Texas. 26 pgs.
- Jasinski, Laurie E. 2021. "Blanco River," Handbook of Texas Online, <https://www.tshaonline.org/handbook/entries/blanco-river>. Published by the Texas State Historical Association. Accessed March 9, 2021.
- National Land Cover Data (NLCD). 2016. NLCD Conus Land Cover. U.S. Geological Survey. <https://www.mrlc.gov/data/nlcd-2016-land-cover-conus>. Accessed December 7, 2020.
- National Oceanic and Atmospheric Administration (NOAA). 2020. NOAA National Climate Data Center: <http://www.ncdc.noaa.gov/>. Accessed on March 5, 2021.
- Texas Commission on Environmental Quality (TCEQ). 2014. Texas Surface Water Quality Standards. Austin: Texas Commission on Environmental Quality.
- Texas Parks & Wildlife Department (TPWD). 2021. "An Analysis of Texas Waterways." Accessed March 10, 2021. http://www.tpwd.state.tx.us/publications/pwdpubs/pwd_rp_t3200_1047/13_c_tx_blanco_bosque.phtml.
- Texas Parks and Wildlife Department (TPWD), Wildlife Division. 2020. TPWD County Lists of Protected Species and Species of Greatest Conservation Need: Blanco, Comal, and Hays Counties. Accessed March 3, 2021.
- United States Geological Survey (USGS). 2016. National Land Cover Database, 2011-01-01. Web accessed 12-16-2020. TNRS DataHub.

Appendix I: Endangered and Threatened Species

Endangered species located within the Blanco River watershed

Taxonomic Group	Common Name	Federal/State Listing
Amphibians	Barton Springs salamander	Federally Listed as Endangered/State Listed as Endangered
Amphibians	Texas Blind salamander	Federally Listed as Endangered/State Listed as Endangered
Birds	Whooping crane	Federally Listed as Endangered/State Listed as Endangered
Birds	Interior least tern	Federally Listed as Endangered/State Listed as Endangered
Birds	Golden-cheeked warbler	Federally Listed as Endangered/State Listed as Endangered
Fish	Fountain darter	Federally Listed as Endangered/State Listed as Endangered
Crustacean	Peck's Cave amphipod	Federally Listed as Endangered/State Listed as Endangered
Insects	Comal Springs riffle beetle	Federally Listed as Endangered/State Listed as Endangered
Insects	Comal Springs dryopid beetle	Federally Listed as Endangered/State Listed as Endangered
Plants	Texas wild-rice	Federally Listed as Endangered/State Listed as Endangered

Threatened species located within the Blanco River watershed

Taxonomic Group	Common Name	Federal/State Listing
Amphibians	San Marcos salamander	Federally Listed as Threatened/State Listed as Threatened
Amphibians	Texas salamander	State Listed as Threatened

Amphibians	Blanco blind salamander	State Listed as Threatened
Amphibians	Cascade Caverns salamander	State Listed as Threatened
Birds	Reddish egret	State Listed as Threatened
Birds	White-faced ibis	State Listed as Threatened
Birds	Wood stork	State Listed as Threatened
Birds	Zone-tailed hawk	State Listed as Threatened
Birds	Piping plover	Federally Listed as Threatened/State Listed as Threatened
Birds	Tropical parula	State Listed as Threatened
Fish	Headwater catfish	State Listed as Threatened
Fish	Guadalupe darter	State Listed as Threatened
Mammals	White-nosed coati	State Listed as Threatened
Reptiles	Cagle's map turner	State Listed as Threatened
Reptiles	Texas tortoise	State Listed as Threatened
Reptiles	Texas horned lizard	State Listed as Threatened
Crustaceans	Texas troglobitic water slater	State Listed as Threatened
Mollusks	Texas Fatmucket	State Listed as Threatened
Mollusks	Guadalupe Fatmucket	State Listed as Threatened
Mollusks	Texas Pimpleback	State Listed as Threatened
Mollusks	Guadalupe Orb	State Listed as Threatened
Mollusks	False Spike Mussel	State Listed as Threatened