PLUM CREEK WATERSHED DATA REPORT

December 2023

Photo Credit: Plum Creek Watershed Partnership

United States Environmental Protection Agency

Texas Commission on Environmental Quality

Texas State University
The rising STAR of Texas

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ACKNOWLEDGEMENTS

The Texas Stream Team encourages life-long learning about the environment and people's relationship to the environment through its multidisciplinary community 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:

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INTRODUCTION

Texas Stream Team

Texas Stream Team is a volunteer community science water quality monitoring program. Community scientist monitoring occurs at predetermined monitoring sites, at approximately the same time of day each month. Information collected by Texas Stream Team is covered by a Texas Commission on Environmental Quality-approved Quality Assurance Project Plan to ensure data quality. Community scientist data may be used to determine water quality trends, identify data gaps, identify pollution events and sources, and to test the effectiveness of management measures. Texas Stream Team data are not used by the state to assess whether water bodies are meeting the designated surface water quality uses and standards. Data collected by Texas Stream Team provide valuable information, often collected in water bodies professionals are not able to monitor frequently or monitor at all.

For additional information about water quality monitoring methods and procedures refer to the following sources:

- Texas Stream Team Core Water Quality Community Scientist Manual
- Texas Stream Team Advanced Water Quality Community Scientist Manual
- Texas Stream Team Program Volunteer Water Quality Monitoring Program Quality Assurance Project Plan
- Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures

The purpose of this report is to provide a summary of the data collected by Texas Stream Team community 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 Plum Creek Watershed within the Guadalupe River Basin. Such sources may include the following:

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

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 Plum Creek Watershed (watershed) spans approximately 397 square miles (1028 km^2) and is located within the Guadalupe River Basin. The watershed lies within Hays, Travis, Caldwell, and Gonzales counties (Figure 1). Plum Creek rises two miles north of Kyle before flowing southeast for 52 miles to its confluence with the San Marcos River three miles southeast of Luling (Texas State Historical Association, 1995). This area is important locally for aesthetics, recreation, and for the ecosystem it supports (City of Kyle, 2023a).

It is unclear how Plum Creek got its name, but the area was primarily inhabited by Tonkawa and Comanche indigenous peoples until settlement began in the late 19th century (Cecil and Greene, 2020; Strom, 1995). Ranching and farming would contribute to the county population and economic growth throughout the late 19th and 20th centuries, and tourism related to cave and spring systems would become a popular industry in the late 20th century (Cecil and Greene, 2020).

The Texas Commission on Environmental Quality designates classifications for streams, rivers, lakes, and bays throughout Texas including the watershed (Table 1). Three streams within the watershed were monitored by Texas Stream Team community scientists and are included in the study area for this summary report. Plum Creek (Segment 1810) is a classified stream and begins from the confluence with the San Marcos River in Caldwell County to FM 2770 in Hays County. As such, Plum Creek is the focus of this report and is recognized as a freshwater stream and classified segment. Town Branch (Segment 1810A) is an unclassified perennial stream in the watershed that extends from the confluence with Plum Creek upstream to the headwaters at SH 130 northwest of Lockhart. A third stream, Clear Fork Creek, also lies within the watershed, and it is an unclassified intermittent stream with no designated segment number.

The climate in this part of the state is described as semi-humid subtropical with hot summers and mild winters (Berg et al., 2008). National Oceanic and Atmospheric Administration climate data from one weather station in Luling, Texas was acquired from the National Data Center (National Oceanic and Atmospheric Administration, 2021). Average annual precipitation is 35.4 inches and typically occurs year-round (Figure 2). Long-term monthly average precipitation has a bimodal distribution with peaks occurring in May and October. Average rainfall during these months is 4.2 inches. The least amount of rainfall (1.85 inches) occurs in July. The warmest and coldest months of the year are August (29.8°C) and January (10.8°C), respectively.

Table 1. Texas Commission on Environmental Quality segment classifications (Texas Commission on Environmental Quality, 2022).

Segment Number	Segment Name	Segment Description
1810	Plum Creek	From the confluence with the San Marcos River in Caldwell County to FM 2770 in Hays County
1810A	Town Branch	Perennial stream from the confluence with Plum Creek upstream to the headwaters at SH 130 northwest of the City of Lockhart
NA	Clear Fork Creek	Unclassified intermittent stream

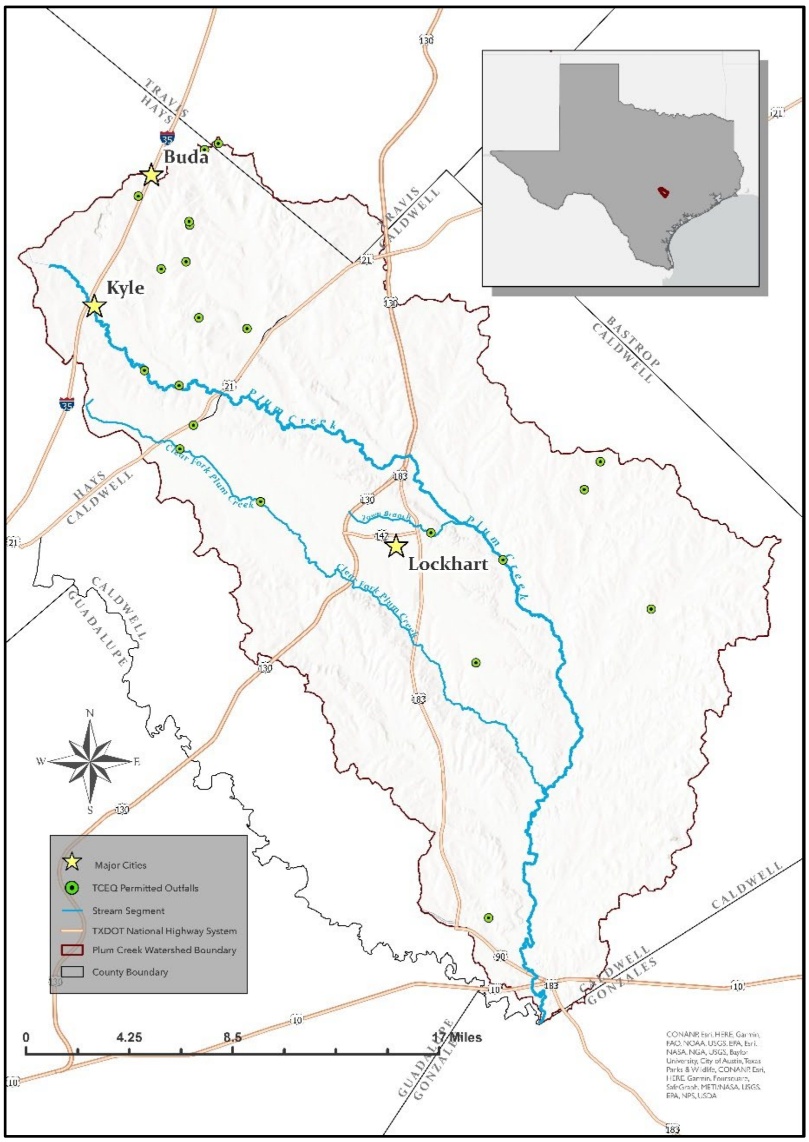

Figure 1. Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas.

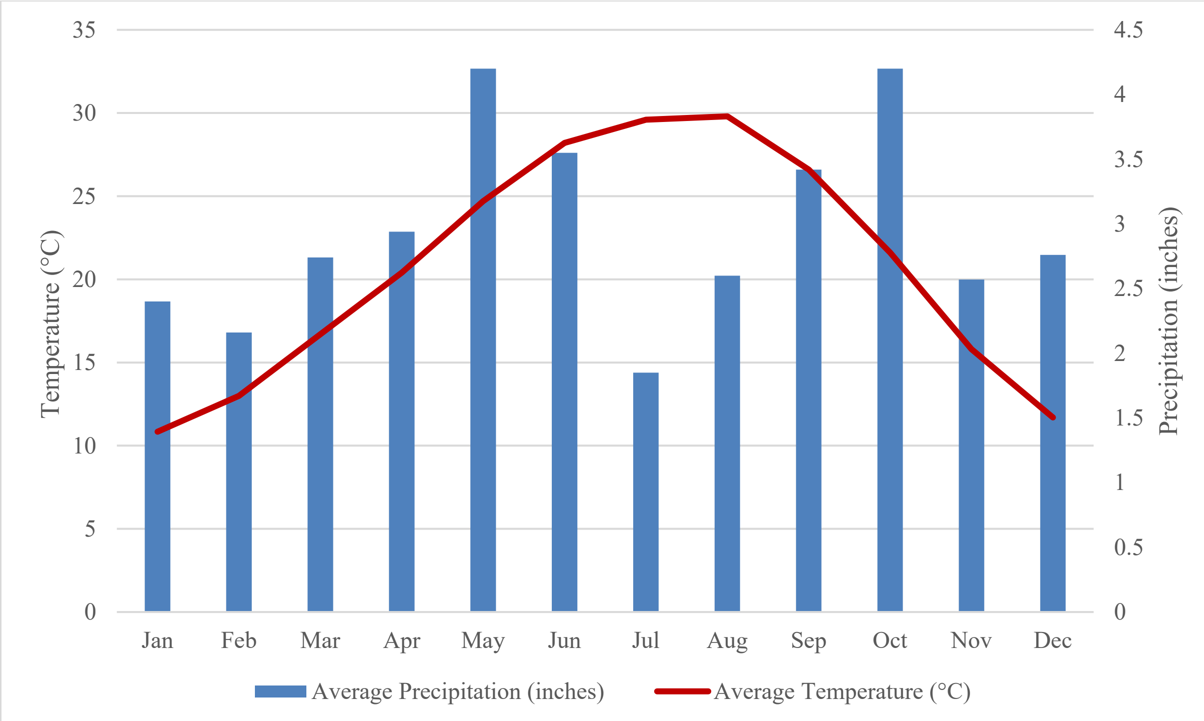

Figure 2. Long-term (1991-2020) monthly average precipitation (inches) and air temperature (°C) from Luling, Texas (National Oceanic and Atmospheric Administration Climate Data, 2021).

Physical Description

The watershed is contained within Hays, Travis, Caldwell, and Gonzales counties. Located along the Balcones Escarpment, the landscape is described as hilly to gently rolling to nearly level terrain. The Edwards Plateau vegetation in the northern portion of the watershed is comprised of oak, juniper, mesquite, hardwoods, conifers, and grasses (Texas Parks and Wildlife Department, 2023). The Blackland Prairie vegetation in the southeastern portion of the watershed is comprised mostly of food and forage crops but also includes grasses such as big bluestem, little bluestem, Indiangrass, and switchgrass (Texas Parks and Wildlife Department, 2023). Soils that support the landscape include shallow to moderately deep clays and loams. Mineral resources found in the area include limestone. This area supports diverse wildlife including deer, raccoons, rabbits, nutria, coyotes, turtles, fish, snakes, waterfowl, and more (City of Kyle, 2023b).

Land Use

Land cover types were determined from spatial data sets processed in geographic information systems for the watershed (Figure 3). Eighty percent of the land cover in the area consists of pasture/crops (45%), shrub/scrub (20%), and forest (15%) (Table 2). The remaining twenty percent is comprised of land use types including developed (10%), wetlands (3%), open water (<1%), and barren land (<1%).

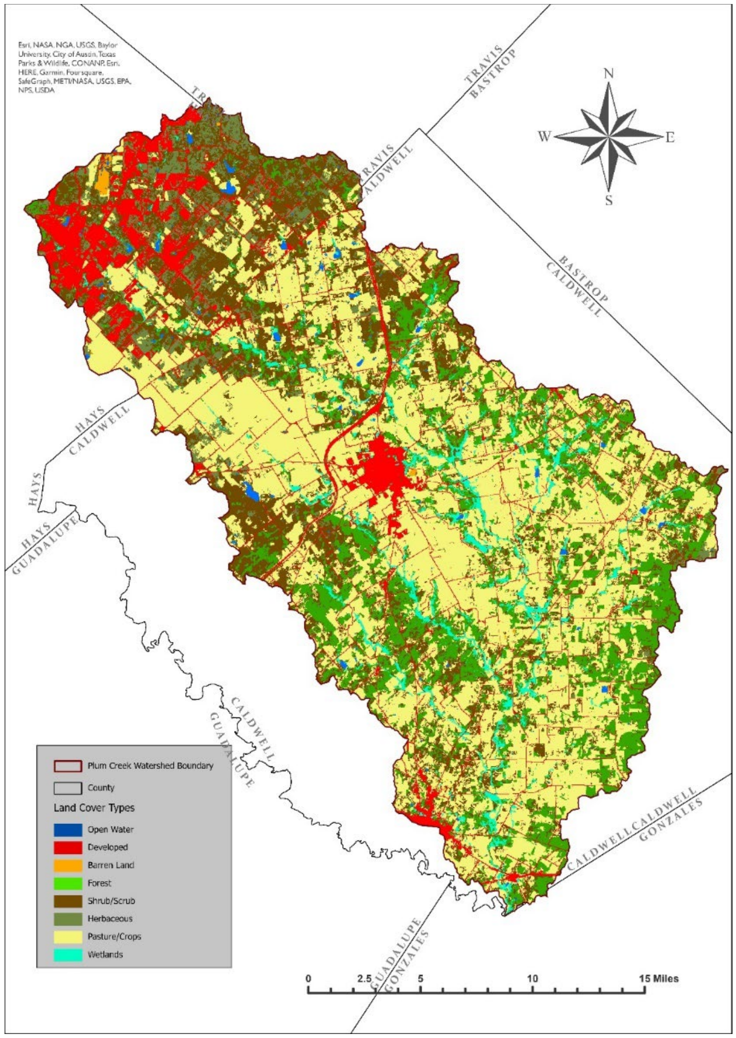

Figure 3. Land cover for the Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas (National Land Cover Data, 2019).

Table 2. Land use in the Plum Creek Watershed in Hays County, Texas (National Land Cover Data, 2016).

Land Use Type	**Acres (ac)**	**Hectares (ha)**	**Percent (%)**
Pasture/Crops	111,266	45,028	44.7
Shrub/Scrub	49,026	19,840	19.7
Forest	37,963	15,363	15.2
Developed	25,979	10,513	10.4
Herbaceous	15,386	6,227	6.2
Wetlands	7,194	2,911	2.9
Open Water	1,547	626	0.6
Barren Land	593	240	0.2
	248,954	100,748	100

History

The area was first settled by Paleo-Indians at least 10,000 years ago and primarily inhabited by Tonkawa, Karankawas, and Comanche indigenous peoples (Smyrl, 2020). Spanish explores would pass through the area in the 18th century but failed to permanently settle. Colonization of the area would not occur until the early-19th century by Anglo settlers.

The fertile soil gave rise to ranching and farming industries, making the watershed largely agricultural. Oil became a popular and lucrative industry throughout the 20th century and modern county population growth was largely a result of the expanding metropolitan areas in Austin and San Antonio (Smyrl, 2020).

Endangered Species and Conservation Needs

The common names of 43 species listed as threatened or endangered (under the authority of Texas state law and/or under the United States Endangered Species Act) within the watershed are included in Appendix A. A summary of the number of species per taxonomic group listed as state or federally endangered, threatened, G1, or G2 (critically imperiled or imperiled), species of greatest conservation need, and/or endemic are provided in Table 3.

Table 3. State and federally listed species in the Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties Texas.

Taxon	Endangered (Federal or State)	Threatened (Federal or State)	G1 or G2 (Critically imperiled or imperiled)	Species of Greatest Conservation Need (NPWD) (S1 or S2)	Endemic Total Count
Amphibians	4	4	9	9	9
Birds	2	6	2	9	0
Fish	1	2	1	3	3
Mammals	0	0	0	5	1
Reptiles	0	2	0	3	4
Crustaceans	0	1	8	7	8
Insects	4	0	20	20	17
Arachnids	4	0	21	19	20
Mollusks	5	6	12	12	11
Plants	1	1	7	11	31
Total Count	**21**	**22**	**80**	**98**	**104**

Texas Water Quality Standards

The Texas Surface Water Quality Standards 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 to 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 as drinking water. The criteria for evaluating support of those uses at monitoring sites in Plum Creek (Segment 1810) included in this report are provided in Table 4. The dissolved oxygen criteria are for dissolved oxygen means at any site within the segment, the minimum and maximum values for pH apply to any site within the segment, the *E. coli* indicator bacteria for freshwater is a geometric mean, and the temperature criteria is a maximum value at any site within the segment.

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, and other information, including water quality studies, existence of fish kills or contaminant spills, photographic evidence, and local knowledge. Screening levels serve as a reference to indicate when water quality parameters may be approaching levels of concern.

Water Quality Impairments

The *2022 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Integrated Report) includes an index of water quality impairments. The classified segment, Plum Creek (Segment 1810), currently has no impairments. However, in the late 1990s and early 2000s Plum Creek showed signs of nutrient and bacteria impairments prompting the development of a voluntary watershed protection plan. The plan was adopted in 2009 and remains in effect at the present time.

Table 4. State water quality criteria for the Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas (Texas Commission on Environmental Quality, 2022).

Segment	**Dissolved Oxygen (mg/L)**	**pH Range (s.u.)**	**Total Dissolved Solids (mg/L)**	***E. coli* Bacteria (#/100 mL)**	**Temperature (°C)**
Plum Creek (1810)	Grab screening level: 5.0 Grab min.: 4.0	6.5-9.0	1,120	Primary Contact Recreation 1: 126 geometric mean, 399 single sample	32.2

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 warm water. Community scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases because of the monthly sampling frequency. While community scientist data may not show diurnal temperature fluctuations, they could demonstrate the fluctuations over seasons and years when collected consistently at predetermined monitoring sites and monthly frequencies.

Specific Conductance and Salinity

Specific conductance is a measure of the ability of a body of water to conduct electricity. It is measured in microsiemens per centimeter (µS/cm). A body of water is more conductive if it has more total dissolved solids such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lead to eutrophication, which results in lower levels of dissolved oxygen. 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 total dissolved solids can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants.

Salinity is a measure of saltiness or the dissolved inorganic salt concentration in water. Salinity is often measured in ocean, estuarine, or tidal influenced waters, but in Texas there are some inland 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.

Dissolved Oxygen

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 dissolved oxygen 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 dissolved oxygen can also result from high groundwater inflows (which have low dissolved oxygen due to minimal aeration), high temperatures, or water releases from deeper portions of dams where dissolved oxygen stratification occurs. Supersaturation typically occurs underneath waterfalls or dams with water flowing over the top where aeration is abundant.

pH

The pH scale measures the concentration of hydrogen ions in a range from 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 predominantly 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 community scientists to measure water transparency, a Secchi disc 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 disc 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 until the Secchi 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 less light to penetrate deep into the water, which, in turn, decreases the density of phytoplankton, algae, and other aquatic plants. This reduces the dissolved oxygen in the water due to reduced photosynthesis. Contaminants are mostly transported in sediment rather than in the water. Turbid waters can result from sediment runoff 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 are present in the intestinal tracts and feces of warm-blooded animals. It is used by the Texas Commission on Environmental Quality as an indicator of the potential presence of pathogens in tidally-influenced saltwater along the Texas Gulf Coast.

Plum Creek (segment 1810) is designated a primary contact recreation 1 use. This means that recreation activities are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, hand fishing 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 colony forming units per 100 milliliters (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 currently monitor water quality for enterococci in coastal waters. Instead, community scientists can get certified in *E. coli* bacteria monitoring, the indicator used by the Texas Commission on Environmental Quality for freshwater streams.

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 the Texas Commission on Environmental Quality and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most living 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 attach to sediment, and, therefore, can serve as a better indicator of possible sewage or manure pollution during dry weather.

Phosphate

Phosphorus almost always exists in the natural environment as phosphate and continually cycles through the ecosystem as a nutrient necessary for the growth of most organisms. Testing for phosphate in the water excludes the phosphate bound up in plant and animal tissue. There are other methods to retrieve phosphate from the material to which it is bound, but they are too complicated and expensive to be conducted by community scientists. Testing for phosphate provides an idea of the degree of phosphorus 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 phosphate has on a water body is known as eutrophication and is described above in the “Dissolved Oxygen” section.

DATA COLLECTION, MANAGEMENT AND ANALYSIS

Data Collection

The field sampling procedures implemented by trained community scientists are documented in the Texas Stream Team Core Water Quality Community Scientist Manual and the Texas Stream Team Advanced Water Quality Community Scientist Manual. The sampling protocols in the manuals adhere closely to the Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012). Additionally, all data collection adheres to Texas Stream Team’s Texas Commission on Environmental Quality-approved Quality Assurance Project Plan.

Procedures documented in Texas Stream Team Water Quality Community Scientist Manuals or the Texas Commission on Environmental Quality 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 and to ensure data accuracy and precision.

Field sampling activities are documented on Environmental Monitoring Forms. The following items are recorded for each field sampling event: station ID, location, sampling time, date, depth, sample collector's name/signature, group identification number, meter calibration information, and reagent expiration dates. Specific conductance values are converted to total dissolved solids using a conversion factor of 0.65 and are reported as mg/L.

Values for 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 or 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 community scientists collect field data and report the measurement results to Texas Stream Team, by submitting a hard copy of the Environmental Monitoring Form, entering the data directly into the online Waterways Dataviewer, or by using the electronic Environmental Monitoring Form. All data are reviewed to ensure they are representative of the samples analyzed and locations where measurements were made. The measurements and associated quality control data are also reviewed to ensure they conform to specified monitoring procedures and project specifications as stated in the approved Quality Assurance Project Plan.

Data review and verification is performed using a quality control checklist and self-assessments, as appropriate to the project task, followed by automated database functions that 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 accessed publicly through the online Texas Stream Team Datamap.

Data Analysis

Data were compiled, analyzed, summarized, and compared to state water quality standards and/or criteria to provide readers with a reference point for parameters that may be of concern. The statewide, biennial assessment performed by the Texas Commission on

Environmental Quality involves more stringent monitoring methods and oversight than those used by community scientists and staff in this report. The Texas Stream Team community scientist water quality monitoring data are not currently used in the Texas Commission on Environmental Quality assessments mentioned above. However, the Texas Stream Team data is 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 community scientists in the study watersheds were exported from the Texas Stream Team database and grouped by site. Sites with 10 or more monitoring events were maintained in the dataset for analysis. Sites with fewer than 10 monitoring events were excluded from the analysis for this report but may be used in future data summary reports. 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. Outlier box or scatter plots were prepared to provide a compact view of the distribution of the data for each parameter and site(s). The horizontal line within the box plot represents the median sample value, while the ends of the box represent the 25th and 75th quantiles or the interquartile range. The lines extending from each end of the box, or whiskers, are computed using the 25th/75th quartiles ± 1.5 x (interquartile range). Outliers are plotted as points outside the box plot.

DATA RESULTS

Water quality data from 10 Texas Stream Team monitoring sites in the watershed were acquired for this report (Figure 4). The 10 sites were monitored sporadically during the past 17 years from December 2006 through September 2023. Trained community scientists conducted between 11 and 61 monitoring events at each site, for a total of 331 monitoring events (Table 5). The period of record for the sampling events ranged from December 2006 through September 2023, with all sites experiencing temporal intermittent sampling.

Site Analysis

Water quality monitoring data from sites with 10 or more sampling events were analyzed and summarized including the number of samples, mean, standard deviation, and range of values (Table 6). Community scientists monitored the sites for standard core parameters, including air and water temperature, specific conductance, total dissolved solids, dissolved oxygen, pH, Secchi disc transparency, and total depth. The site at Lockhart State Park (site 80451) was monitored five times for *E. coli* bacteria in 2012 and 2013.

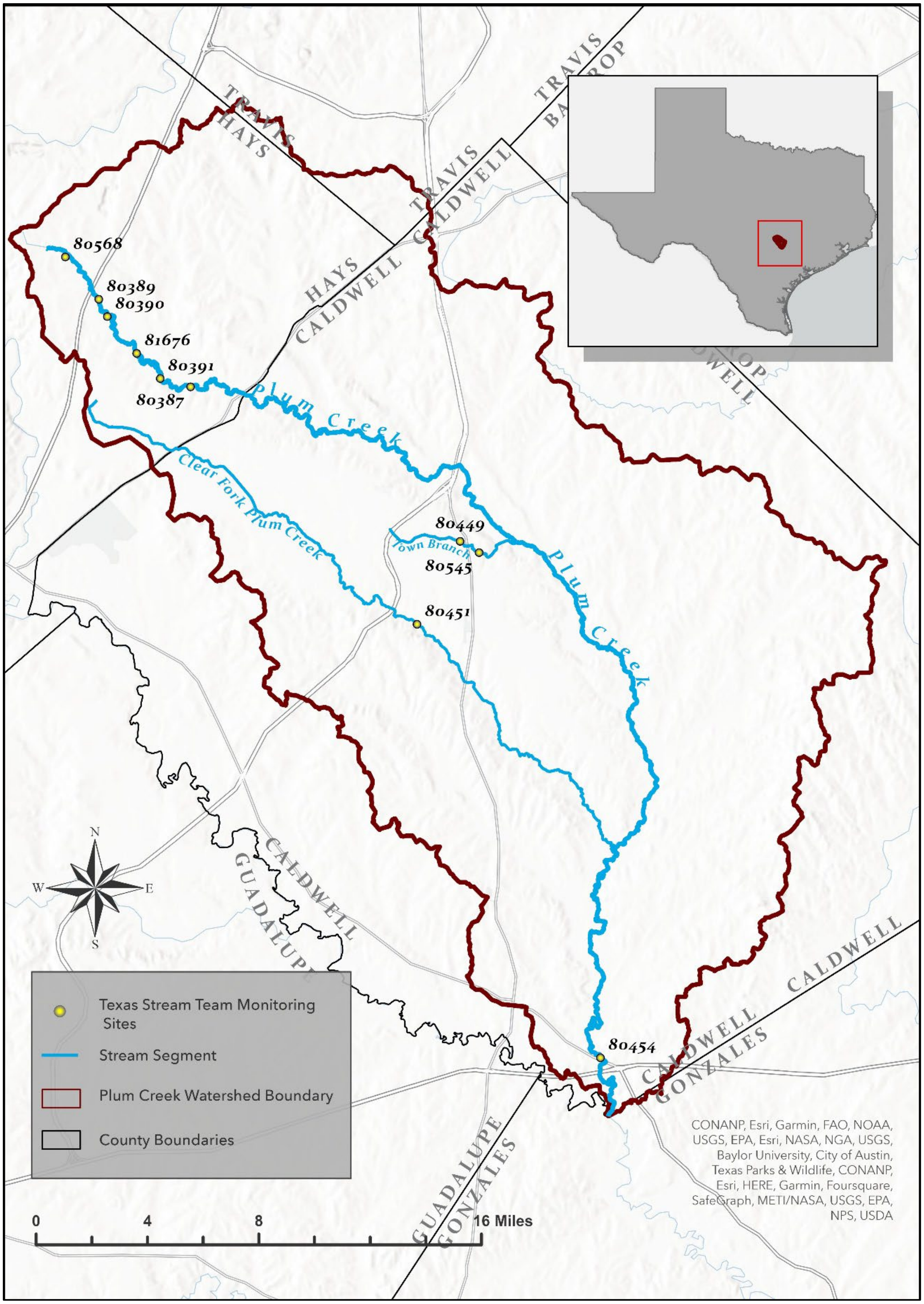

Figure 4. Texas Stream Team monitoring sites in Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas.

Table 5. Texas Stream Team monitoring sites in Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas.

Site ID	**Description**	**Number of Monitoring Events (n)**	**Period of Record**
80568	PLUM CREEK @ GOLF COURSE RESERVOIR OFF FAIRWAY ST	41	2/22/2010 – 1/18/2013
80389	PLUM CREEK @ GOFORTH ROAD (CR 157)	19	3/5/2007 – 4/29/2010
80390	PLUM CREEK @ LEHMAN RD (CR 204)	42	2/10/2007 – 4/16/2023
81676	PLUM CREEK AT PEDESTRIAN FOOTBRIDGE NEAR BUNTON CREEK PARK	10	11/11/2021 – 8/6/2022
80391	PLUM CREEK @ HEIDENREICH LN. (CR-152)	38	12/17/2006 – 8/6/2022
80387	PLUM CREEK @ GRIST MILL ROAD (CR 153)	19	4/26/2007 – 8/6/2022
80449	TOWN BRANCH @ NORTH BLANCO STREET	61	12/30/2007 – 9/1/2023
80451	CLEAR FORK @ LOCKHART STATE PARK	49	5/2/2009 – 11/4/2017
80454	PLUM CREEK ON 135	41	11/25/2007 – 8/31/2023
80545	TOWN BRANCH @ E. MARKET ST. (UPSTREAM FROM LOCKHART WWTP #1)	11	7/9/2009 – 7/13/2012
	TOTAL	**331**	

Table 6. Texas Stream Team data summary for sites in the Plum Creek Watershed, Hays, Travis, Caldwell, and Gonzales counties, Texas. (December 2006 to September 2023).

Parameter	80568 Fairway St.	80389 Goforth Rd.	80390 Lehman Rd.	81676 Bunton Creek	80391 Heidenreich Ln.	80387 Grist Mill Rd.	80454 CR 135	80449 N. Blanco St.	80545 E. Mkt. St.	80451 Lockhart S. P.
Number of events	n = 41	n = 19	n = 42	n = 10	n = 38	n = 19	n = 40	n = 61	n = 11	n = 49
Air Temperature (°C)	26.0±8.0 (29.9)	19.7±4.1 (14)	21.8±5.8 (24)	20.3±8.9 (26)	24.0±7.5 (31)	20.2±8.0 (28)	21.6±8.0 (33.5)	19.7±7.6 (30)	26.9±5.6 (15)	22.1±8.4 (43.5)
Water Temperature (°C)	22.6±6.8 (23.5)	17.7±4.9 (17.5)	18.7±4.9 (17)	13.2±9.3 (26.5)	22.6±5.3 (21.5)	20.2±5.8 (17.5)	20.5±7.0 (22.6)	18.9±4.9 (19)	23.3±4.1 (11.5)	19.8±6.6 (26)
Specific Conductance (µS/cm)	351±131 (480)	634±57 (260)	691±141 (650)	743±199 (570)	1,000±226 (790)	1,113±389 (1,105)	1,057±274 (1,240)	859±114 (675)	809±76 (230)	649±196 (900)
***Total Dissolved Solids (mg/L)**	228±85 (312)	412±37 (169)	449±92 (423)	483±130 (371)	649±147 (514)	723±253 (718)	687±178 (806)	558±74 (439)	526±49 (150)	422±127 (585)
Dissolved Oxygen (mg/L)	7.0±2.3 (9.2)	8.3±1.9 (8.5)	7.0±2.4 (10.8)	6.0±3.0 (9.7)	5.3±2.2 (8.8)	6.0±1.7 (6.3)	6.2±1.6 (6.6)	5.8±1.8 (10.1)	6.5±1.2 (4.5)	6.4±2.3 (9.9)
pH (s.u.)	7.7±1.0 (4.8)	7.7±0.4 (1.6)	7.7±0.5 (1.5)	7.6±0.3 (1.0)	7.5±0.6 (3.5)	7.3±0.7 (3.2)	7.5±0.2 (0.8)	7.7±0.5 (1.7)	7.4±0.2 (0.8)	7.4±0.3 (1.0)
Secchi Disk (m)	1.2±0.6 (3.1)	0.5±0.4 (0.9)	0.8±0.4 (1.3)	0.2 (0)	0.5±0.2 (1.0)	0.5±0.2 (0.5)	0.6±0.2 (1.3)	0.1±0.03 (0.1)	0.5±0 (0)	0.5±0.2 (1.0)
Total Depth (m)	1.3±0.7 (3.1)	0.5±0.4 (0.9)	0.8±0.4 (1.5)	0.3±0.2 (0.8)	0.6±0.6 (1.9)	0.7±0.4 (1.9)	0.8±0.3 (1.5)	0.3±0.4 (2)	0.5±0 (0)	0.8±0.3 (2)
*******E. coli*** **(CFU/100 ml)**	ND	ND	ND	ND	ND	ND	ND	ND	ND	54

*Total dissolved solids were calculated from specific conductance (TDS = specific conductance * 0.65).

**The geometric mean was calculated for *E. coli* bacteria and only 5 monitoring events were conducted at site 80451.

ND = no data available.

Air and Water Temperature

Average air temperature for all sites ranged from 19.7 to 26.9°C (Table 6). The lowest mean air temperature (19.7°C) was observed on Plum Creek at N. Blanco Street (site 80449), while the highest mean air temperature (26.9°C) was observed on Town Branch at E. Market Street (site 80545).

Average water temperature for all sites ranged from 17.7 to 23.3°C (Table 6). The lowest mean water temperature (17.7°C) was observed on Plum Creek at Goforth Rd. (site 80389), while the highest mean water temperature (23.3°C) was observed on Town Branch at E. Market Street (site 80545). Discreet water temperature measurements from all sites met the water quality standard (32.2°C) throughout the period of record of this report except for one occurrence in June 2011 at the Plum Creek golf course reservoir off Fairway Street (site 80568) (Figure 5).

Specific Conductance and Total Dissolved Solids

Total dissolved solid values were calculated from specific conductance measurements. The average total dissolved solids from all sites ranged from 228 mg/L to 723 mg/L (Table 6). The lowest mean total dissolved solids value (228 mg/L) was observed at the Plum Creek golf course reservoir off Fairway Street (site 80568), while the highest mean total dissolved solids value (723 mg/L) was observed at the Plum Creek Grist Mill Road (site 80387). No water quality standard exceedances (> 1,120 mg/L) were measured at any of the sites (Figure 6).

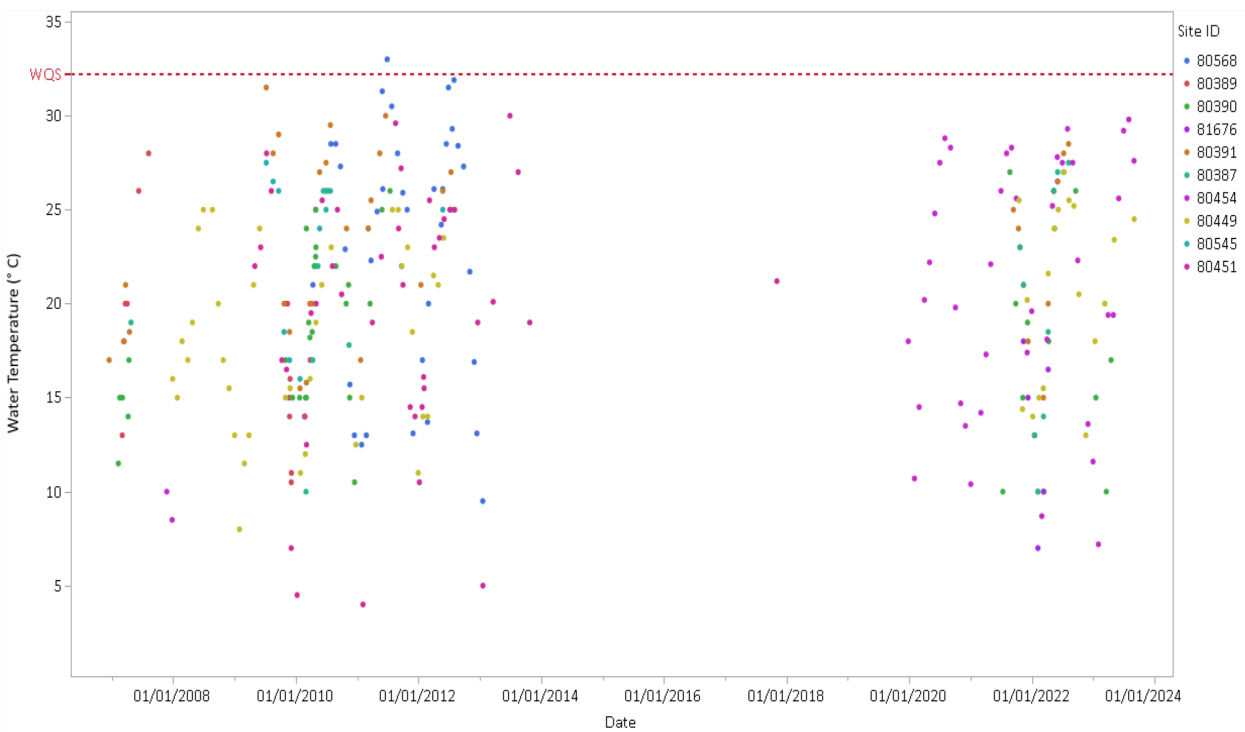

Figure 5. Water temperature for Texas Stream Team sites in the Plum Creek Watershed, Hays, Travis, Caldwell, and Gonzales counties, Texas. (December 2006 to September 2023). WQS = Water Quality Standard.

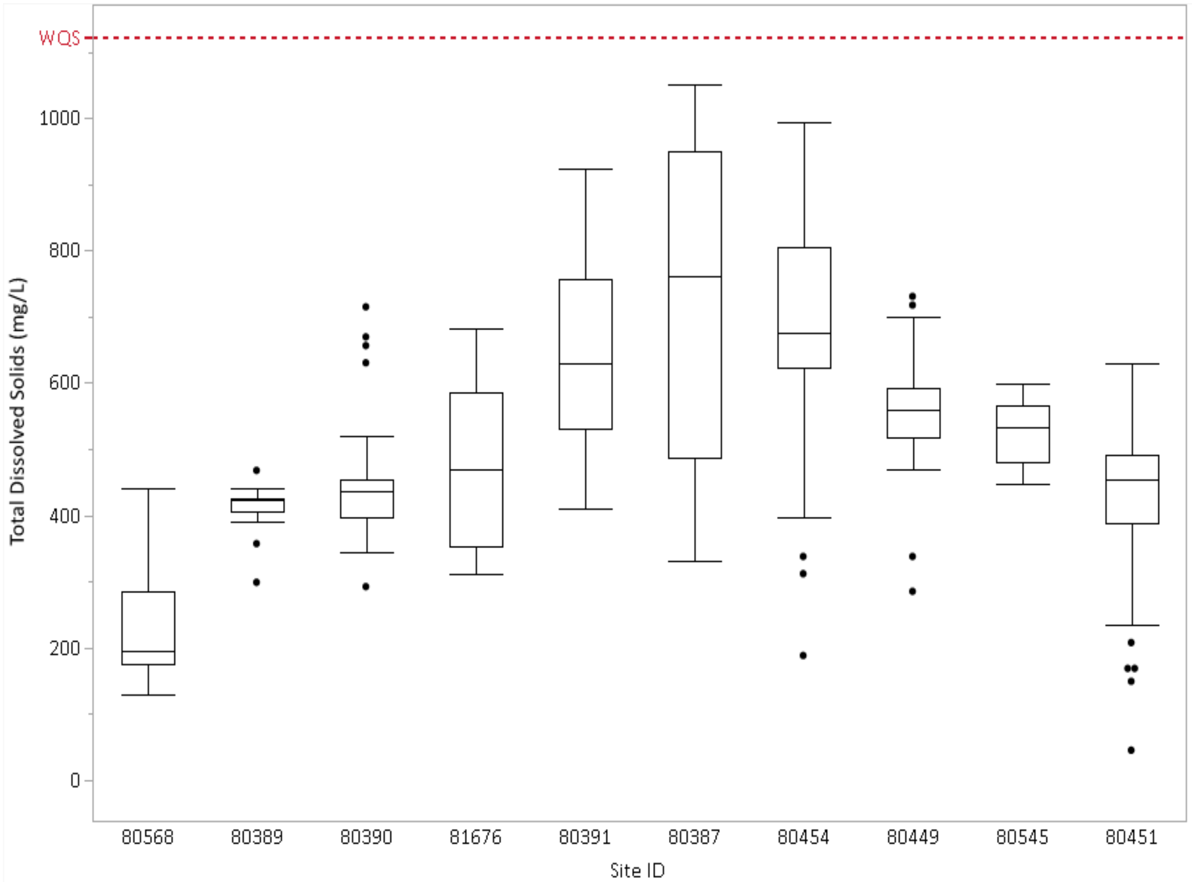

Figure 6. Total dissolved solids (mg/L) for Texas Stream Team sites in the Plum Creek Watershed, Hays, Travis, Caldwell, and Gonzales counties, Texas. (December 2006 to September 2023). WQS = Water Quality Standard.

Dissolved Oxygen

The range of average dissolved oxygen values for all sites spanned from 5.3 to 7.0 mg/L (Table 6). The average dissolved oxygen value at each site was above the average water quality standard of 5.0 mg/L. Although the average water quality standard was achieved at all sites, there were discreet measurements recorded below the standard at all sites except the Plum Creek site on Goforth Rd. (site 80389) (Figure 7).

Discreet dissolved oxygen measurements at most sites fell below the minimum standard of 4.0 mg/L except for the Plum Creek site at Goforth Road (site 80389) and the Town Branch site at E. Market Street (site 80545) (Figure 7).

pH

The average range of values at all sites was between 7.3 and 7.7 s.u. (Table 6). Average pH values at all sites were within the range of the minimum and maximum WQS (6.5 to 9.0 s.u.)

(Figure 8). However, discreet measurements above and below the range were collected on Plum Creek at the golf course reservoir off Fairway Street (site 80568).

Transparency and Total Depth

Secchi disks were used to measure transparency at the sites monitored in the watershed. The average transparency values measured at all sites ranged from 0.1 to 1.2 meters (Table 6). The largest variability in Secchi disk measurements was observed on Plum Creek at the golf course reservoir off Fairway Street (site 80568) (Figure 9).

Total depth was measured at all sites monitored (Table 6). The average range of depths for all sites was 0.5 to 1.5 meters.

E. coli Bacteria

E. coli bacteria was measured at one site on Plum Creek at Lockhart State Park (80451) five times in 2012 and 2013. The geometric mean for the limited data set was 54 CFU/100 ml, which was below the water quality standard for the primary contact recreation use (124 CFU/100 ml).

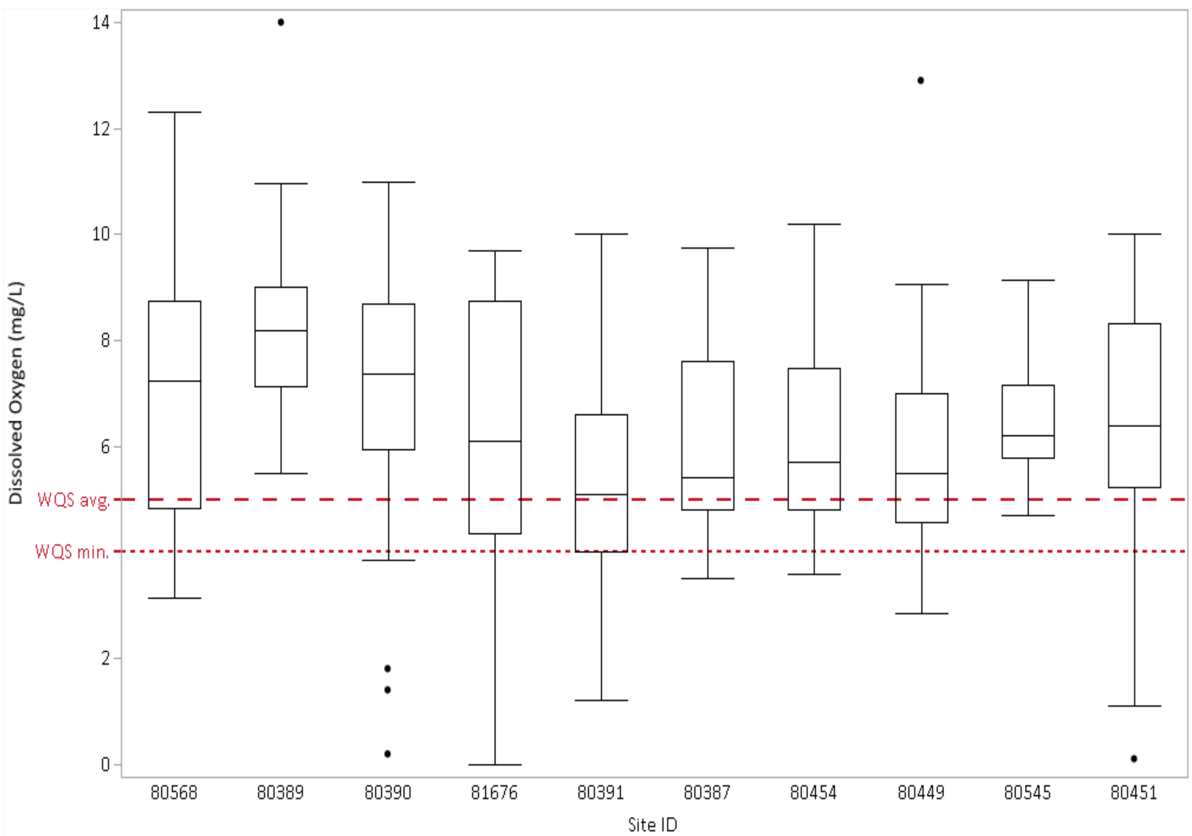

Figure 7. Dissolved oxygen in water for Texas Stream Team sites in the Plum Creek Watershed, Hays, Travis, Caldwell, and Gonzales counties, Texas. (December 2006 to September 2023). WQS avg = average water quality standard; WQS min = minimum water quality standard.

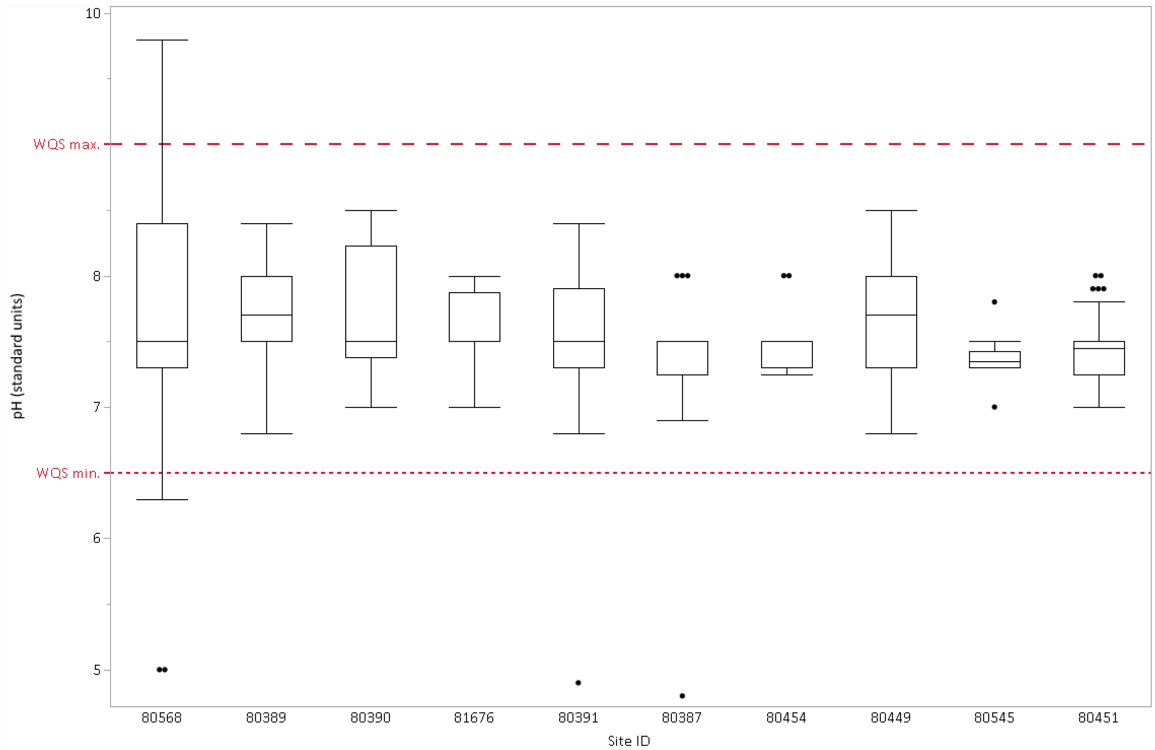

Figure 8. pH (s.u.) for Texas Stream Team sites in the Plum Creek Watershed, Hays, Travis, Caldwell, and Gonzales counties, Texas. (December 2006 to September 2023). WQS max= maximum pH water quality standard; WQS min = minimum pH water quality standard.

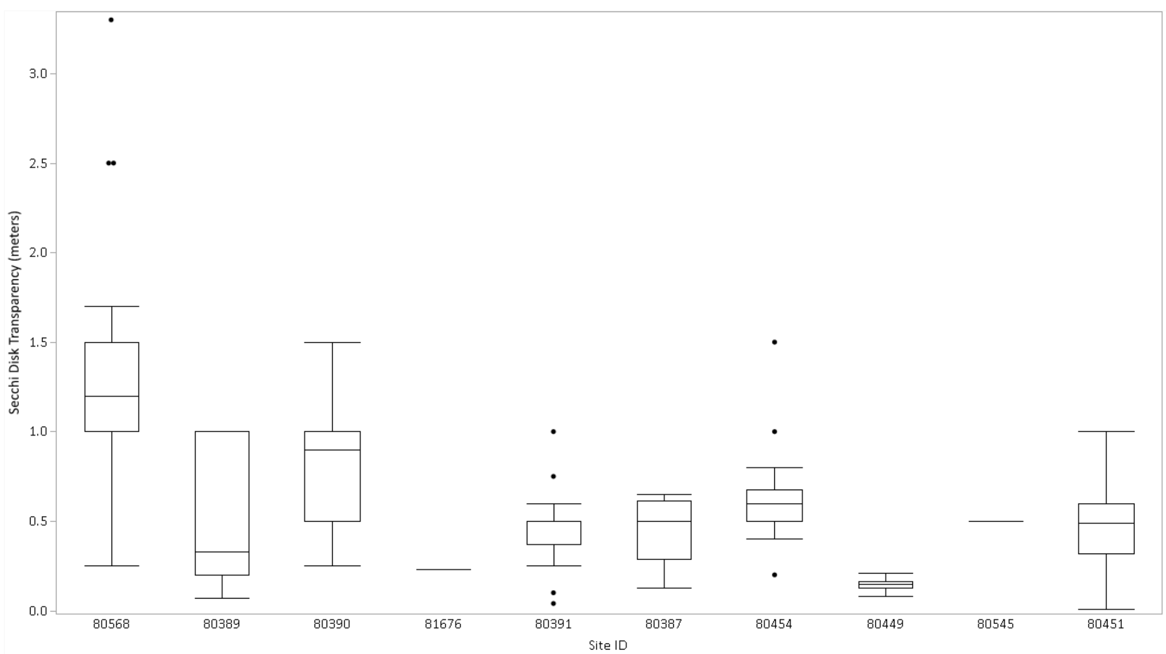

Figure 9. Secchi disk transparency measurements for Texas Stream Team sites in the Plum Creek Watershed, Hays, Travis, Caldwell, and Gonzales counties, Texas. (December 2006 to September 2023).

WATERSHED SUMMARY

Texas Stream Team community scientists monitored Standard Core and *E. coli* Bacteria parameters intermittently at 10 sites in the Plum Creek Watershed from December 2006 to September 2023. A total of 331 monitoring events were conducted during that period of record with all 10 sites having 10 or more monitoring events. Of the 10 sites monitored, seven were on Plum Creek (segment 1810), two were on Town Branch (segment 1810A) and one was on Clear Fork Creek (no segment number assigned). The Plum Creek Watershed has diverse land uses from highly urbanized areas at the headwaters to predominantly agriculture in the lower reaches with only 10% of the land cover categorized as developed. Collectively all sites included in this report were monitored by Texas Stream Team trained community scientists.

Parameters monitored by community scientists included water and air temperature, specific conductance, total dissolved solids, dissolved oxygen, pH, transparency, total depth, and *E. coli* bacteria.

The 2022 Integrated Report prepared by the Texas Commission on Environmental Quality did not identify any impairments in Plum Creek (segment 1810). However, nutrient and bacteria concerns were identified in the late 1990s and early 2000s. Nutrients were not monitored by community scientists, therefore no nutrient data was available for this summary report. *E. coli* bacteria was only monitored at one site five times, therefore only a limited historical data set was included in this report.

Water quality standards associated with designated uses in the watershed were compared to the results of this analysis to evaluate water quality. Discreet measurements from all sites evaluated met the water quality standard for temperature (32.2°C), total dissolved solids (1,120 mg/L), and pH (6.5 and 9.0 s.u.) during the period of record for this report. However, discreet measurements for temperature and pH exceeded the corresponding water quality standard at the Plum Creek site located at the golf course on Fairway Street (80568) at least once.

The average dissolved oxygen values for all sites in the watershed met the average water quality standard of 5.0 mg/L for the period of record of this study. However, the minimum standard of 4.0 mg/L was not attained at some point during the period of record at all sites but two, one on Plum Creek (site 80389) and one on Town Branch (89545). Although no impairments for dissolved oxygen were identified in the 2022 Integrated Report prepared biennially by TCEQ, the area appears to be showing signs of concern based on these results. Dissolved oxygen levels are affected by nutrient enrichment resulting in eutrophication. Plum Creek was impaired for nutrients in the late 1990s, therefore it is imperative to monitor nutrients to better understand the interaction between nutrient loadings and dissolved oxygen. With the growing human population and increased development in the headwaters of the watershed and throughout the central Texas Hill Country, these findings should be of concern to residents and decision-makers alike.

The Texas Stream Team community scientists monitoring Standard Core water quality parameters in the watershed are encouraged to continue monitoring and consider adding the advanced parameters of nutrients and bacteria to their current monitoring efforts. Continuation of the ongoing monitoring is crucial due to the results presented here and the increased development in the watershed and the surrounding central Texas Hill Country. Continued water quality monitoring is important for the development of long-term data sets that describe current water quality conditions and for historical and future trends to capture changes in water quality as the area grows. Texas Stream Team will continue to support community scientists by providing technical support, creating new monitoring sites, and re-activating existing sites. We look forward to training new community scientists to expand, grow, and sustain 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.

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Appendix A.

Table 7. Endangered species located within the Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas.

Species Type	Common Name	Federal/State Listing
Amphibians	Barton Springs salamander	Federally Listed as Endangered, State Listed as Endangered
	Texas blind salamander	Federally Listed as Endangered, State Listed as Endangered
	Austin blind salamander	Federally Listed as Endangered, State Listed as Endangered
	Houston toad	Federally Listed as Endangered, State Listed as Endangered
Birds	Whooping crane	Federally Listed as Endangered, State Listed as Endangered
	Golden-cheeked warbler	Federally Listed as Endangered, State Listed as Endangered
Fish	Fountain darter	Federally Listed as Endangered, State Listed as Endangered
Insects	Comal Springs riffle beetle	Federally Listed as Endangered, State Listed as Endangered
	Tooth Cave ground beetle	Federally Listed as Endangered
	Kretschmarr Cave mold beetle	Federally Listed as Endangered
	Comal Springs dryopid beetle	Federally Listed as Endangered, State Listed as Endangered
Arachnids	Tooth Cave spider	Federally Listed as Endangered
	Reddell harvestman	Federally Listed as Endangered
	Bone Cave harvestman	Federally Listed as Endangered

	Tooth Cave pseudoscorpion	Federally Listed as Endangered
Mollusks	Texas fatmucket	Federally Proposed as Endangered
	Guadalupe fatmucket	Federally Proposed as Endangered
	Texas pimpleback	Federally Proposed as Endangered
	Guadalupe orb	Federally Proposed as Endangered
	False spike	Federally Proposed as Endangered
Plants	Texas wild-rice	Federally Listed as Endangered, State Listed as Endangered

Table 8. Threatened species located within the Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas.

Species Type	Common Name	Federal/State Listing
Amphibians	San Marcos salamander	Federally Listed as Threatened, State Listed as Threatened
	Texas salamander	State Listed as Threatened
	Jollyville Plateau salamander	Federally Listed as Threatened, State Listed as Threatened
	Blanco blind salamander	State Listed as Threatened
Birds	White-faced ibis	State Listed as Threatened
	Wood stork	State Listed as Threatened
	Swallow-tailed kite	State Listed as Threatened
	Black rail	Federally Listed as Threatened, State Listed as Threatened
	Piping plover	Federally Listed as Threatened, State Listed as Threatened
	Rufa red knot	Federally Listed as Threatened, State Listed as Threatened
Fish	Headwater catfish	State Listed as Threatened
	Guadalupe darter	State Listed as Threatened
Reptiles	Cagle's map turtle	State Listed as Threatened
	Texas horned lizard	State Listed as Threatened
Crustaceans	Texas troglobitic water slater	State Listed as Threatened
Mollusks	Texas fatmucket	State Listed as Threatened
	Guadalupe fatmucket	State Listed as Threatened
	Texas pimpleback	State Listed as Threatened
	Guadalupe orb	State Listed as Threatened
	False spike	State Listed as Threatened
	Texas fawnsfoot	Federally Proposed as Threatened, State Listed as Threatened
Plants	Bracted twistflower	Federally Listed as Threatened, State Listed as Threatened

Table 8. State and federally listed species located within the Plum Creek Watershed in Hays, Travis, Caldwell, and Gonzales counties, Texas.

Taxon	**Endangered (Federal or State)**	**Threatened (Federal or State)**	**G1 or G2 (Critically imperiled or imperiled)**	**Species of Greatest Conservation Need (NPWD) (S1 or S2)**	**Endemic Total Count**
Amphibians	4	4	9	9	9
Birds	2	6	2	9	0
Fish	1	2	1	3	3
Mammals	0	0	0	5	1
Reptiles	0	2	0	3	4
Crustaceans	0	1	8	7	8
Insects	4	0	20	20	17
Arachnids	4	0	21	19	20
Mollusks	5	6	12	12	11
Plants	1	1	7	11	31
Total Count	**21**	**22**	**80**	**98**	**104**