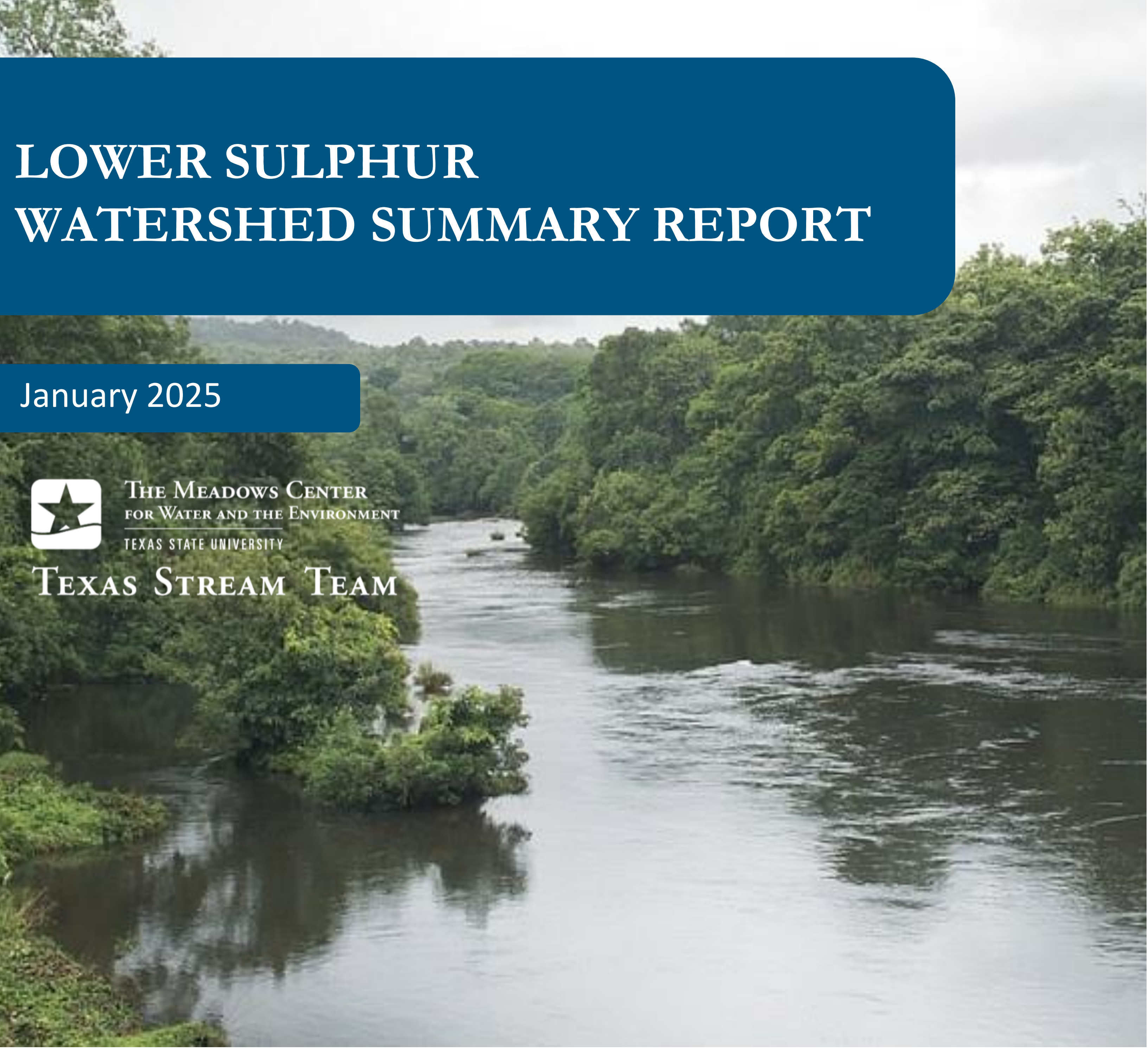
LOWER SULPHUR WATERSHED SUMMARY REPORT

January 2025



The Meadows Center for Water and the Environment
Texas State University
Texas Stream Team

Photo Credit: Nicholas Henderson

EPA United States Environmental Protection Agency

Texas Commission on Environmental Quality

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.

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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:

Delaney Hankins, Student GIS Assistant
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Kyla Perry, Student Research Assistant
Nicky Vermeersch, Water Quality Specialist

INTRODUCTION

Texas Stream Team

Texas Stream Team is a volunteer community science water quality monitoring program. Community scientist water quality monitoring occurs at predetermined monitoring sites, at approximately the same time of day each month. Information collected by Texas Stream Team community scientists is covered by a Texas Commission on Environmental Quality-approved Quality Assurance Project Plan to ensure a standard set of methods is used. Community 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 community scientist 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, including the differences between professional and volunteer community science monitoring, please 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 Wichita River watershed within the Red River Basin. Such sources may 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 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.

Recognition of Field Contribution

This report would not have been possible without the dedicated efforts of the Northeast Texas Texas Stream Team monitoring group. Their invaluable contributions have played a pivotal role in collecting water quality data for the Lower Sulphur watershed (the watershed). These dedicated community scientists have consistently monitored sites across the watershed, providing essential data that serves as the foundation for the analysis presented in this report.

The Northeast Texas Texas Stream Team group has been active since the program's inception. Over the years, they have reached more than 300 individuals through outreach events, trainings, and collaborations. Their reach extends to science teachers, college professors, and students from Paris Junior College, Wiley College, and Texarkana College, as well as members of the Cypress Basin Chapter of the Texas Master Naturalists, and more. Today, the group maintains eight active Core Monitoring sites, continuing their legacy of stewardship and community science.

Their sustained commitment to monitoring has offered critical insights into water quality trends and potential challenges within the watershed. The Texas Stream Team is deeply grateful for their dedication, which has not only made this report possible but also contributed to the overarching mission of safeguarding and preserving Texas waterways. The data they have gathered remains an indispensable resource, guiding ongoing conservation efforts and shaping informed policy decisions for the future.

WATERSHED DESCRIPTION

Location and Climate

The watershed covers 1,636 square miles, located within Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties (Figure 1). The Sulphur River, a tributary of the Red River, rises at the intersection of the North Sulphur River and South Sulphur River, flowing 183 miles until it reaches Arkansas. Dammed parts of the Sulphur River in Bowie and Cass counties serve as lake recreational areas (Texas State Historical Association, 1995).

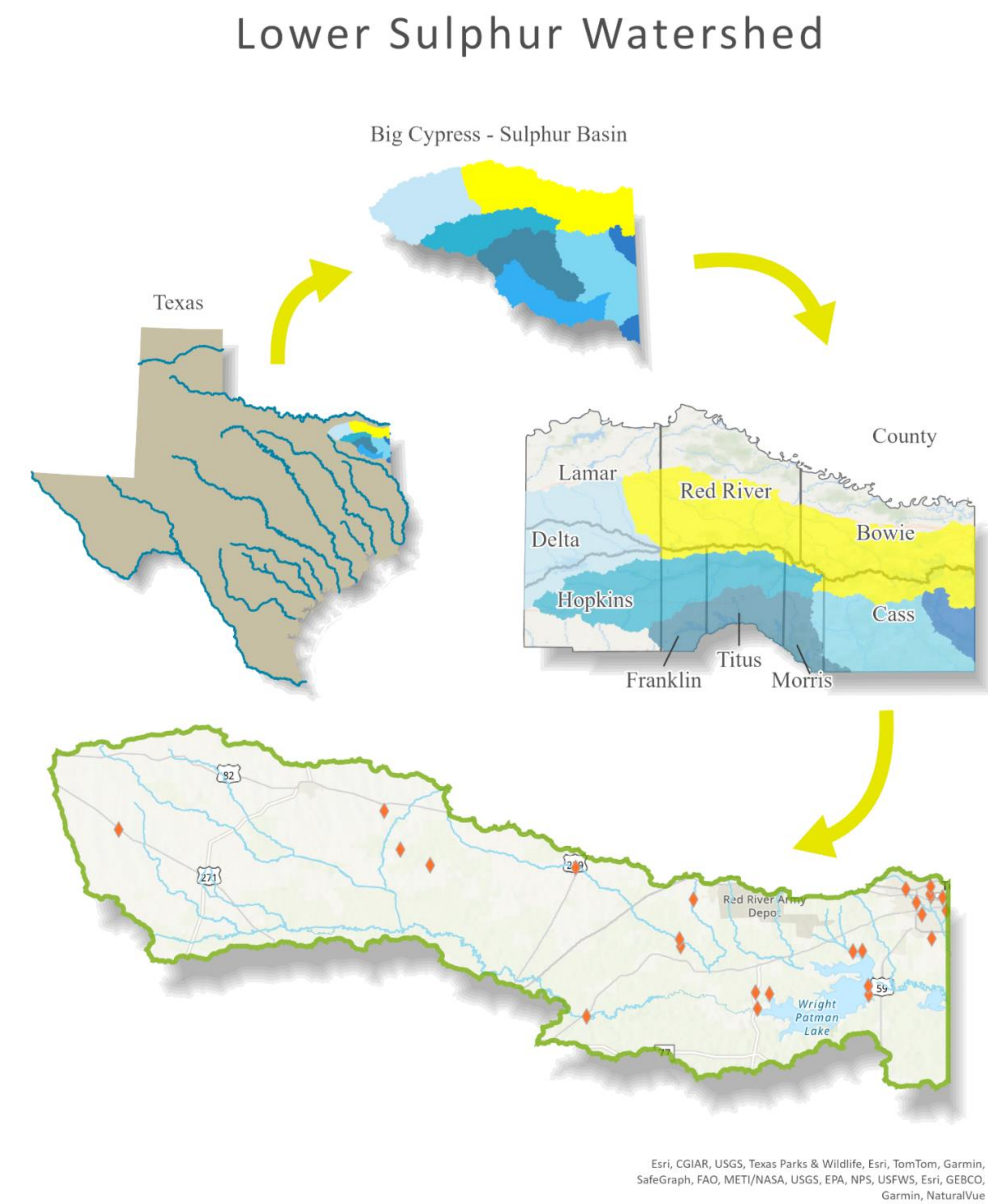

Figure 1. Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas.

The Sulphur River obtained its name from Sulphur Springs, a tributary of Sulphur River located in Hopkins County (Texas Water Development Board, n.d.). The river serves as a county line for several counties in Northeast Texas and flows through Wright Patman Lake, previously known as Lake Texarkana. The Sulphur River is dammed six miles east of Redwater, Texas, acting as the main water source for Lake Texarkana.

The Texas Commission on Environmental Quality designates classifications for streams, rivers, lakes, and bays throughout Texas, including those within the watershed (Table 1). Three classified freshwater streams, one classified reservoir, and 18 unclassified freshwater streams within the sub-watershed were monitored by Texas Stream Team community scientists and are included in this summary report. Sulphur River Below Wright Patman Lake (Segment 0301) is a classified freshwater stream and arises from the Arkansas State Line in Bowie/Cass County to Wright Patman Lake Dam in Bowie/Cass County. Wright Patman Lake (Segment 0302) is a classified reservoir and arises from Wright Patman Lake Dam in Bowie/Cass County to a point 1.5 km (0.9 mi) downstream of Bassett Creek in Bowie/Cass County, up to the normal pool elevation of 226.4 feet (impounds the Sulphur River). South Sulphur River (Segment 0303) is a classified freshwater stream and arises from a point 1.5 km (0.9 mi) downstream of Bassett Creek in Bowie/Cass County to Jim L. Chapman Dam (formerly Cooper Lake dam) in Delta/Hopkins County. Days Creek (Segment 0304) is a classified freshwater stream and arises from the Arkansas State Line in Bowie County to the confluence of Swampoodle Creek and Nix Creek in Bowie County. The remaining 18 unclassified segments are described in Table 1.

Table 1. Texas Commission on Environmental Quality surface water quality viewer (Texas Commission on Environmental Quality, 2022).

Segment Number	Segment Name	Segment Description
0301	Sulphur River Below Wright Patman Lake	From the Arkansas State Line in Bowie/Cass County to Wright Patman Lake Dam in Bowie/Cass County
0302	Wright Patman Lake	From Wright Patman Lake Dam in Bowie/Cass County to a point 1.5 km (0.9 mi) downstream of Bassett Creek in Bowie/Cass County, up to the normal pool elevation of 226.4 feet (impounds the Sulphur River)
0303	South Sulphur River	From a point 1.5 km (0.9 mi) downstream of Bassett Creek in Bowie/Cass County to Jim L. Chapman Dam (formerly Cooper Lake dam) in Delta/Hopkins County
0304	Days Creek	From the Arkansas State Line in Bowie County to the confluence of Swampoodle Creek and Nix Creek in Bowie County

0301A	Akin Creek	From the confluence with the Sulphur River in Bowie County below Lake Wright Patman to 1 km (.6 mi) south of US HWY 82
0302A	Big Creek	Intermittent stream with perennial pools from Wright Patman Lake upstream to I 30
0302B	Boone Creek	From the confluence with Wright Patman Lake upstream to approximately 3.5 mi north of highway 67 in Bowie County
0302C	Anderson Creek	From Lake Wright Patman upstream 88.6 km (55 mi) to the headwaters near US HWY 82
0302D	Caney Creek	From the confluence with Big Creek in Bowie County to approximately 1.5 km south of US HWY 82
0302E	Rice Creek	From the confluence with Anderson Creek in Bowie County upstream to the dam of TP Lake west of New Boston
0302F	Akin Creek	From the confluence with the Sulphur River in Bowie County below Lake Wright Patman to 1 km (.6 mi) south of US HWY 82
0302H	Elliott Creek	Elliott Creek from the confluence with Wright Patman Lake east of Redwater, upstream to the Elliott Creek Reservoir dam in Bowie County
0302I	East Fork Elliott Creek	East Fork Elliott Creek from the confluence with Elliott Creek east of Redwater, upstream to the headwaters 4.5 km (2.8 mi) south of Leary in Bowie County
0303C	Morrison Branch	Intermittent stream with perennial pools from the confluence with Little Mustang Creek upstream to headwaters approximately 0.2 km west of TX 37 and northeast of the City of Bogata
0303J	Cuthand Creek	From the confluence with the Sulphur River in Titus County to 2.5 km (1.7 mi) north of the intersection of Farm Road 196 and US HWY 82
0303K	Little Mustang Creek	From the confluence with the Sulphur River in Red River County to 1.3 km (0.8 mi) north of the intersection of US HWY 271 and HW 37
0303L	Kickapoo Creek	From the confluence with Cuthand Creek in Titus County to 1.6 km (1 mi) south of FM 114
0303O	Scatter Creek	Scatter Creek from the confluence with Cuthand Creek south of Clarksville, upstream to the headwaters northwest of Detroit, in Red River County

0303P	Mustang Creek	Mustang Creek from the confluence with the Sulphur River northeast of Talco upstream to the headwaters north of Deport
0304A	Swampoodle Creek	From the confluence of Days Creek in central Texarkana in Bowie County to the upstream perennial portion of the stream in northern Texarkana in Bowie County
0304B	Cowhorn Creek	From the confluence of Wagner Creek in southern Texarkana in Bowie County to the upstream perennial portion of the stream in northern Texarkana in Bowie County
0304C	Wagner Creek	Perennial stream from the confluence with Days Creek upstream to the headwaters 0.3 km west of Birdwell Davis Road

The climate in this area is described as humid and subtropical, characterized by hot, humid summers, and cool to mild winters (Köppen-Geiger climate classification). Climate data from the National Oceanic and Atmospheric Administration, was collected at a weather station in Dekalb, Texas and acquired from the National Data Center (National Oceanic and Atmospheric Administration, 2021). The average annual precipitation is 52.8 inches and typically occurs year-round (Figure 2). Long-term monthly average precipitation shows a binomial distribution, with peaks occurring in April and October, averaging 5.36 inches of rainfall during these months. The least amount of rainfall (3.03 inches) occurs in August. The warmest and coldest months of the year are July (27.6 °C) and January (6.4 °C), respectively.

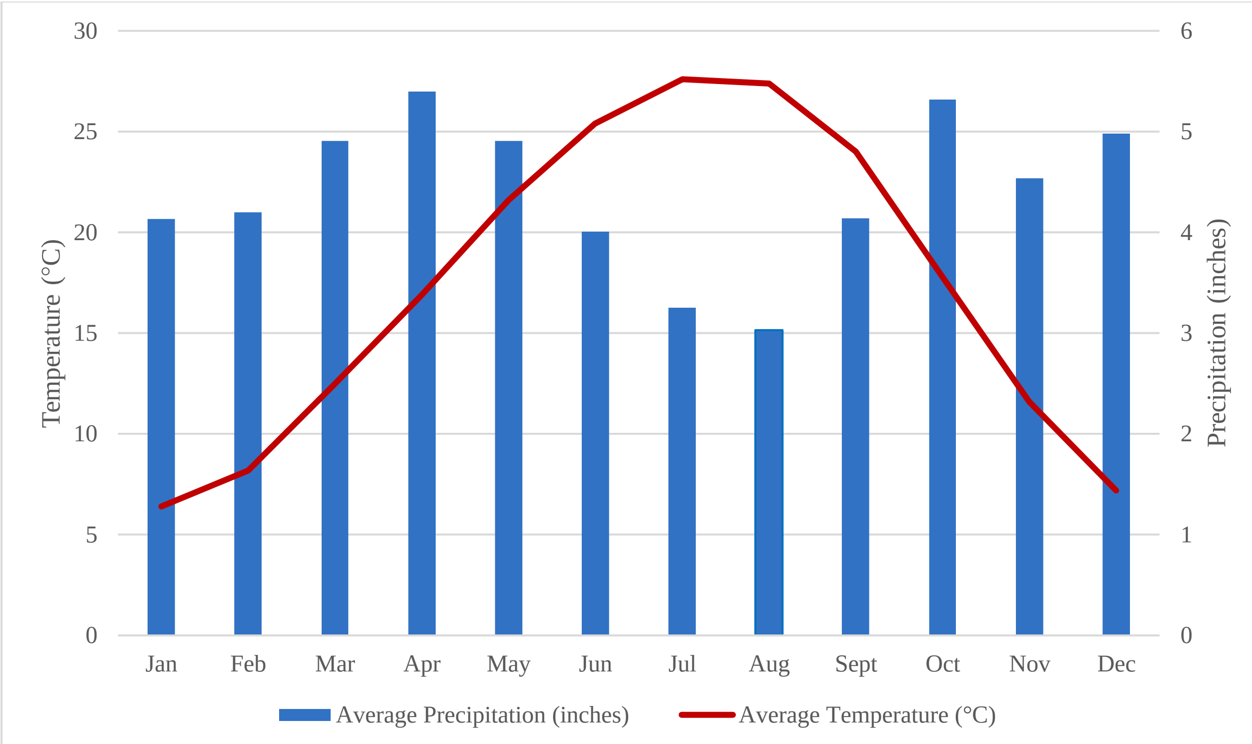

Figure 2. Long-term (1991-2020) monthly average precipitation (inches) and air temperature (°C) from Dekalb, Texas (National Oceanic and Atmospheric Administration, 2021).

Physical Description

The watershed is located in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties. The ecoregions in this area are described as Blackland Prairie and Post Oak Savanna. The vegetation in this region includes bluestem, switchgrass, prairie clover, post oak, sugar hackberry, elm, and cottonwood. This area has abundant clay and quartz sand decomposition with silty, clayey, and sandy substrates. This area supports various types of wildlife such as waterfowl, white-tail deer, otters, beavers, migratory birds, and paddlefish (Griffith et al., 2007; Texas Parks and Wildlife Department, n.d.).

Land Use

Land cover types were determined from spatial datasets processed in geographic information system for the watershed (Figures 3 and 4).

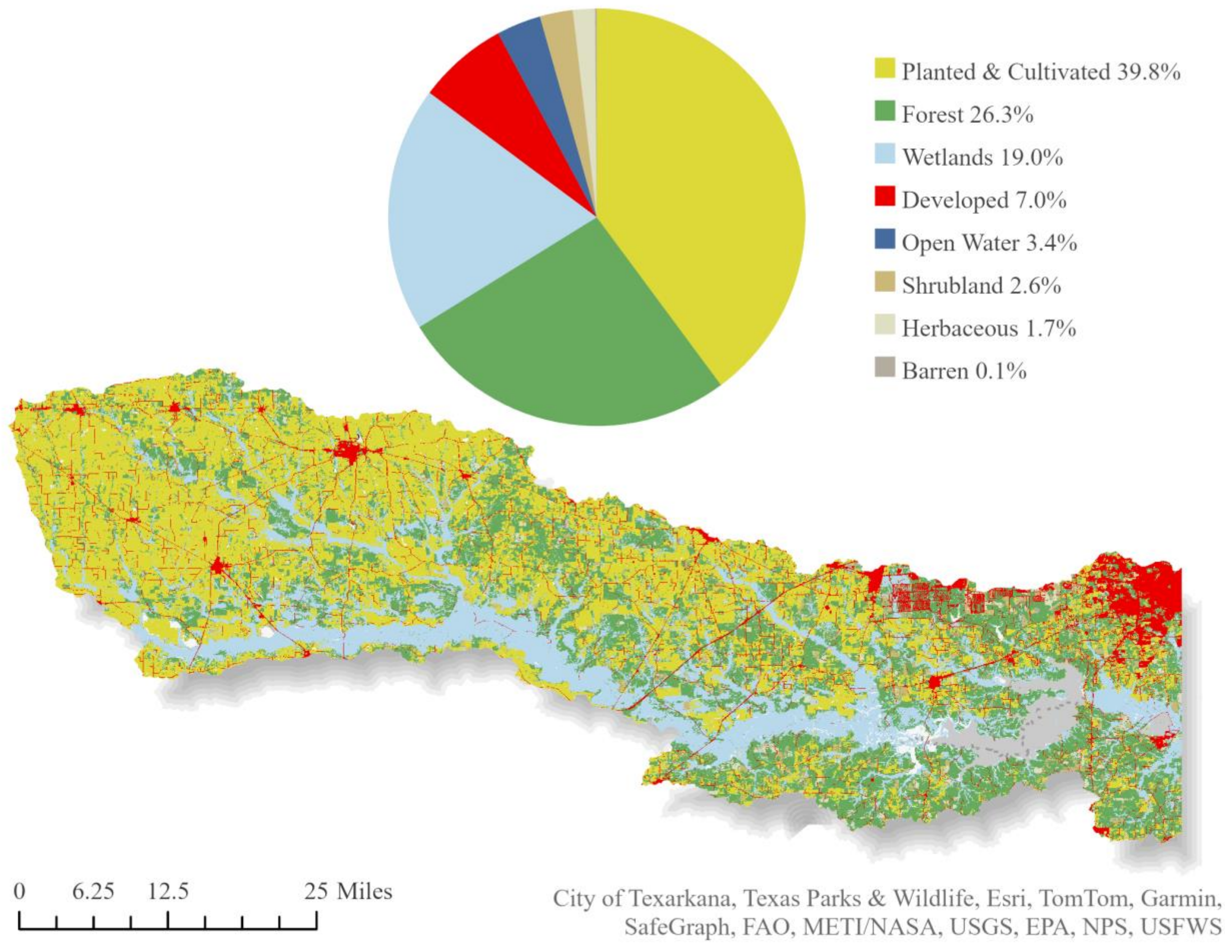

Figure 3. 2019 land use and land cover for the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas (National Land Cover Data, 2019).

Nearly 40% of the watershed consists of planted and cultivated land cover. The remaining land includes forest (26.3%), wetlands (19%), developed (7%), open water (3.4%), shrubland (2.6%), herbaceous (1.7%) and less than 1% of barren land.

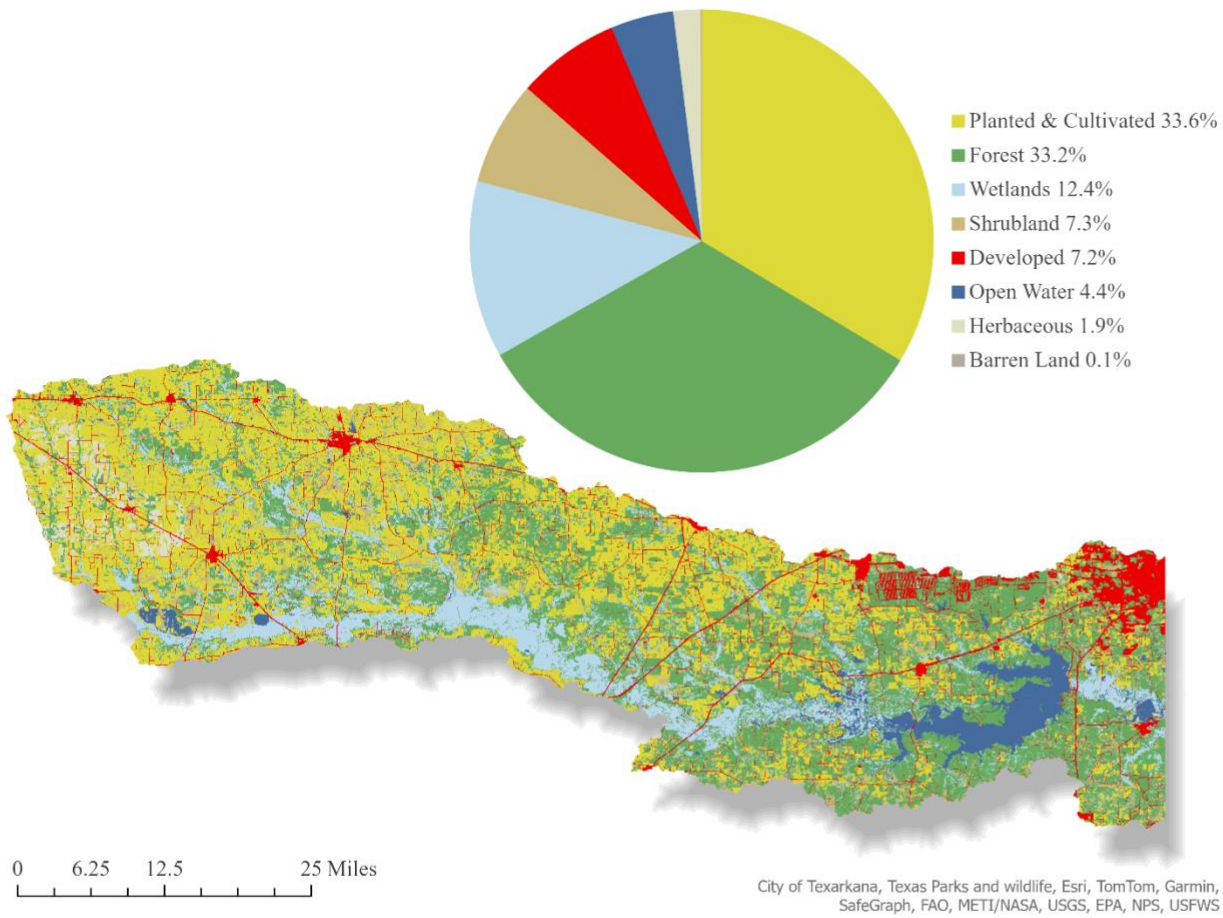

Figure 4. 2001 land use and land cover for the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas (National Land Cover Data, 2019).

Planted and cultivated land increased by 6% from 2001. The next largest category, forest, decreased 6% from 2001. The wetlands category increased more than 6% from 2001 to account for 19% of 2019 land cover. The developed category decreased 4% between 2001 and 2019, while open water, shrubland, and herbaceous decreased less than 2% each.

Table 2. 2001 land use land cover for the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas (National Land Cover Data, 2001).

Land Use	**Total Acreage**	**Percentage**
Planted & Cultivated	417330.6	39.85%
Forest	275738	26.33%
Wetlands	199038.2	19.00%

Developed	73123.76	6.98%
Open	36009.67	3.44%
Shrubland	26727.82	2.55%
Herbaceous	18010.4	1.72%
Barren	1361.499	0.13%
Total	**1047339.949**	**100.00%**

History

The land surrounding the watershed was first inhabited by the Caddoan peoples, but in the late eighteenth century they abandoned their villages due to tribe tensions and epidemics brought by Europeans. The land was soon settled by Anglo settlers, officially becoming part of the Republic of Texas in the mid nineteenth century. The addition of the Texas and Pacific Railway in the late 19th century brought the area a major economic and population boom, establishing this region as a highly productive sector. Today, this region relies on agriculture, lumber, and manufacturing businesses to maintain their economic prosperity (Harper, 2020; Harper, 2021).

Endangered Species and Conservation Needs

The common names of 25 species listed as threatened or endangered (under the authority of Texas state law and/or 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, federally endangered, threatened, G1 or G2 (critically imperiled or imperiled), species of greatest conservation need, and/or endemic is provided in Table 3.

Table 3. State and federally listed species in the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas.

Taxon	**Endangered (Federal or State)**	**Threatened (Federal or State)**	**G1 or G2 (Critically Imperiled/ Imperiled)**	**Species of Greatest Conservation Need (TPWD) (S1 or S2)**	**Endemic Total Count**
Amphibians	0	0	0	1	0
Birds	1	8	0	11	0
Crustaceans	0	0	0	1	0
Fish	0	6	0	6	0
Insects	1	0	1	2	1

Mammals	1	2	0	5	0
Mollusks	1	2	1	5	0
Plants	0	0	4	11	3
Reptiles	0	3	0	5	0
Total	**4**	**21**	**6**	**47**	**4**

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, while being consistent with the state's sustainable economic development. 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 these uses at monitoring sites on the Wright Patman Lake (Segment 0302) and Days Creek (Segment 0304), included in this report, are provided in Table 4. Unclassified water bodies are not defined in the state's standards but are associated with a classified water body because they are in the same watershed. 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 are a maximum value at any site within the segment.

Table 4. State water quality criteria for the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus 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)
0302 – Wright Patman Lake	5.00	6.5 – 9.5	400	126	32.2
0304 – Days Creek	4.00	6.0 – 8.5	850	126	32.2

For the purpose of this report, site 15254 will be analyzed based on the water quality standards for Segment 0304 Days Creek. The remaining five monitoring sites will be analyzed based on the water quality standards for Segment 0302 Wright Patman Lake. This was determined based on the location of the monitoring sites relative to the classified segments.

Water Quality Impairments

The *2024 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. Of the four classified water bodies and the 18 unclassified streams, six of the water bodies have impairments. Wright Patman Lake (Segment 0302) is impaired for pH. Alternatively, Big Creek (Segment 0302A), Elliot Creek (Segment 0302H), Mustang Creek (Segment 0303P) and Wagner Creek (Segment 0304C) are impaired for depressed dissolved oxygen. Additionally, Wagner Creek (Segment 0304C) and Days Creek (Segment 0304) are impaired for bacteria. Each of these impairments are listed as a Category 5, indicating at least one designated use is not being supported and a TMDL is needed.

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. 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 attaches 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 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) outlines 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 name, 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 database, 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 8 Texas Stream Team monitoring sites in the watershed were acquired for this report (Figure 4).

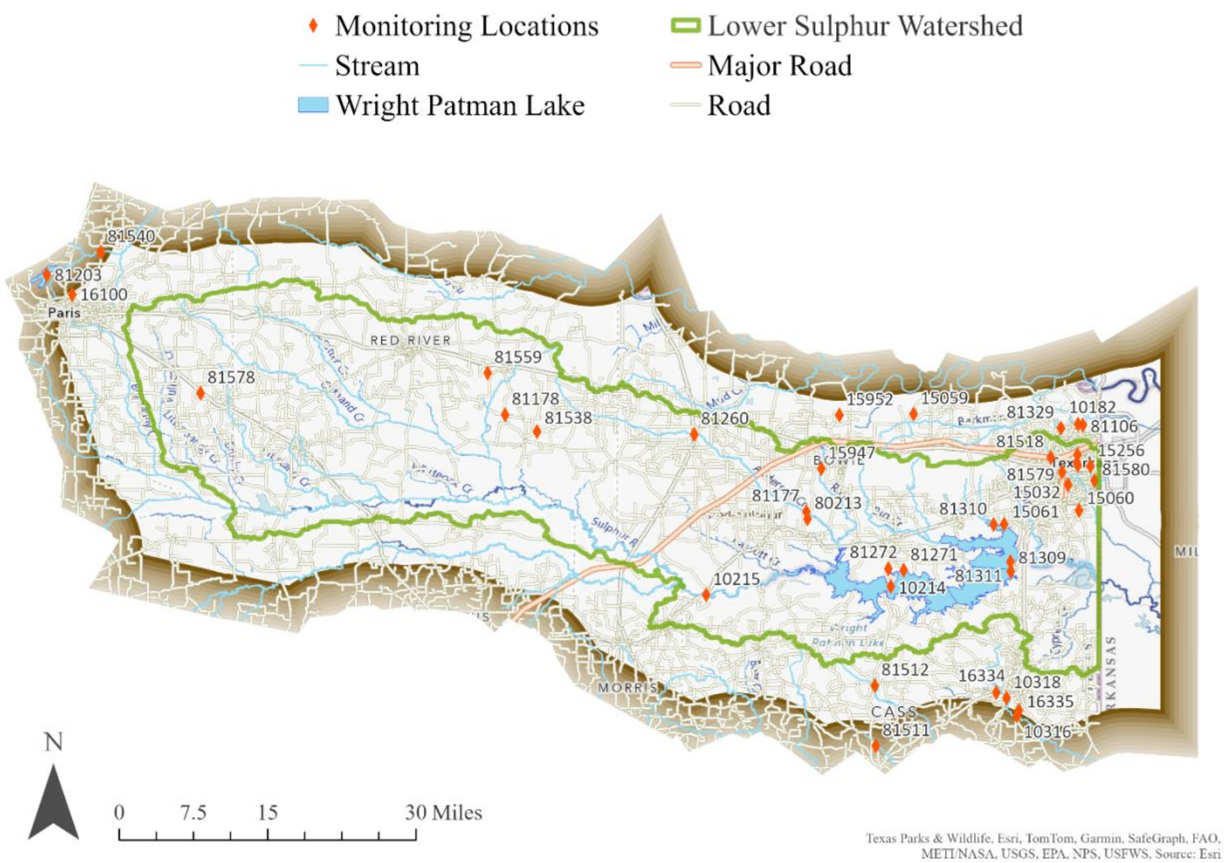

Figure 5. Texas Stream Team monitoring sites in Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas.

Six of the 8 sites had 10 or more monitoring events and were monitored sporadically from September 1994 through November 2024 (Table 5). Trained community scientists conducted between 2 and 89 monitoring events at each site, for a total of 488 events. The period of record for the sampling events ranged from September 1994 through November 2024, with some sites experiencing temporal intermittent sampling over time.

Table 5. Texas Stream Team monitoring sites in Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas.

Site ID	Description	Number of Events	Period of Record
15254	Cowhorn Creek @ Tucker Street	89	Sept 1994 – April 1999, Sept 2014 – Oct 2024
81177	Boat Ramp @ Scout Lake	83	Aug 2015 – Nov 2024
81260	Anderson Creek at Hwy 259	73	Nov 2016 – Oct 2024
81309	Rocky Point Pier @ Lake Wright Patman	77	Jan 2017 – Oct 2024
81310	Clear Springs Pier @ Lake Wright Patman	83	Jan 2017 – Oct 2024
81311	Piney Point Dock @ Lake Wright Patman	78	June 2017 – Oct 2024
81288	Fort Parker State Park Lake Springfield Spring	3	April 2017, April 2021, Feb 2023
81514	Ascarate Lake East Pier	2	Oct 2018-Nov 2018
	Total	**488**	

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). Sites 81288 (3 monitoring events) and 81514 (2 monitoring events) were excluded from the analysis due to the limited number of monitoring events that took place at each. Community scientists monitored all sites for standard core parameters, including air and water temperature, specific conductance (total dissolved solids were calculated based on conductance values), dissolved oxygen, pH, Secchi disk transparency, transparency tube, and total depth.

Table 6. Texas Stream Team data summary for sites in the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas. (September 1994 to November 2024).

Parameter	15254	81177	81260	81309	81310	81311
Number of events	n = 89	n = 83	n = 73	n = 77	n = 83	n = 78
Air Temperature (°C)	20.72 ± 7.51 (29)	18.22 ± 8.01 (31)	21.96 ± 8.56 (36)	19.90 ± 7.91 (28)	21.03 ± 9.05 (57)	19.02 ± 8.38 (33)
Water Temperature (°C)	19.96 ± 6.10 (22.5)	19.75 ± 7.46 (23)	17.25 ± 6.22 (22)	20.19 ± 7.59 (27)	21.19 ± 7.97 (28.5)	19.87 ± 7.70 (26.3)
Specific Conductance (µS/cm)	133.09 ± 29.04 (146.2)	155.41 ± 30.77 (164)	213.72 ± 85.63 (417)	190.59 ± 29.41 (137)	159.78 ± 37.72 (191)	184.73 ± 35.50 (218.8)
*Total Dissolved Solids (mg/L)	89.17 ± 19.46 (97.96)	104.13 ± 20.62 (109.88)	143.19 ± 57.37 (279.39)	127.69 ± 19.70 (91.79)	107.05 ± 25.27 (127.97)	123.77 ± 23.78 (146.60)

Dissolved Oxygen (mg/L)	6.61 ± 1.80 (6.9)	5.67 ± 2.62 (8.9)	7.11 ± 1.93 (7.95)	7.47 ± 1.90 (7.9)	7.72 ± 1.5 (4.95)	7.43 ± 1.98 (7.6)
pH (s.u.)	6.73 ± 0.59 (3.4)	6.78 ± 0.17 (1.2)	6.67 ± 0.10 (0.6)	6.81 ± 0.14 (1)	6.81 ± 0.32 (3.1)	6.84 ± 0.23 (1.42)
Secchi Disk Transparency (m)	0.36 ± 0.16 (0.92)	0.34 ± 0.20 (0.35)	0.18 ± 0.15 (0.76)	0.27 ± 0.12 (0.43)	0.33 ± 0.15 (0.39)	N.D.
Transparency Tube (m)	N.D.	0.98 ± 0.30 (0.8)	0.30 ± 0.14 (0.43)	0.28 ± 0.12 (0.44)	0.25 ± 0.13 (0.55)	0.31 ± 0.12 (0.46)
Total Depth (m)	0.38 ± 0.19 (1.24)	0.55 ± 0.46 (1.09)	0.28 ± 0.37 (1.3)	1.50 ± 0.72 (3.13)	1.49 ± 0.51 (1.97)	0.47 ± 0 (0)

*Total dissolved solids were calculated from specific conductance (TDS = specific conductance * 0.65).
ND = no data available.

Air and Water Temperature

Average air temperature for all sites ranged from 18.22 to 21.96°C (Table 6). The lowest mean air temperature (18.22°C) was observed at the Boat Ramp on Scout Lake (site 81177) while the highest mean air temperature (21.96°C) was observed on Anderson Creek at Highway 259 (site 81260).

Average water temperature for all sites ranged from 17.25 to 21.19°C (Table 6). The lowest mean water temperature (17.25°C) was observed on Anderson Creek at Highway 259 (site 81260) whereas the highest mean water temperature (21.19°C) was observed at Clear Springs Pier at Lake Wright Patman (site 81310). Discrete water temperature measurements from all sites met the water quality standard (32°C) throughout the period of record for this report, except for two separate sampling events (Figure 5). Both of these occurrences took place at site 81310 on July 27, 2023, and June 25, 2024, with a temperature reading of 32.5°C (Figure 5).

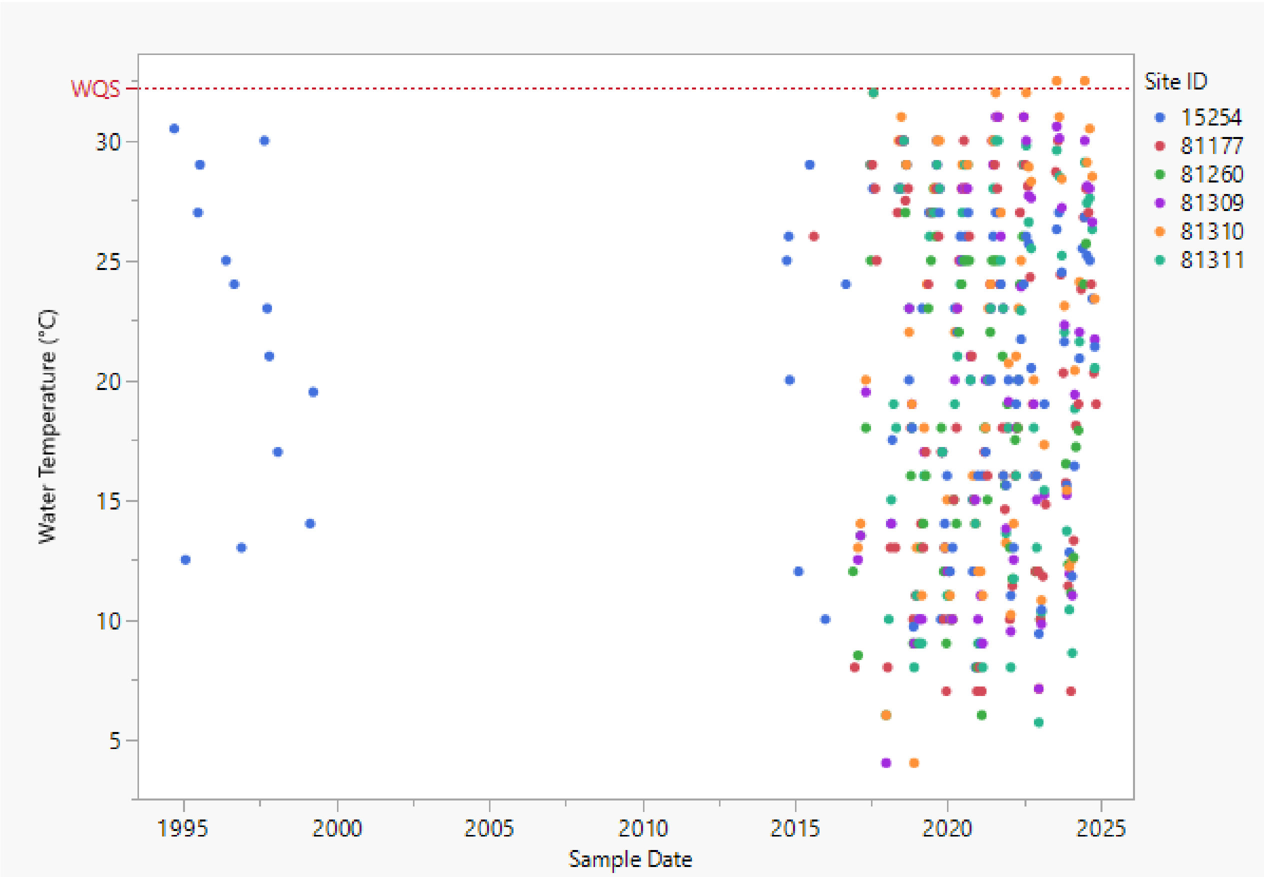

Figure 6. Water temperature for Texas Stream Team sites in the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas (September 1994 to November 2024). WQS = Water Quality Standard.

Specific Conductance and Total Dissolved Solids

Total dissolved solids values were calculated from specific conductance measurements. The average total dissolved solids from all sites ranged from 89.17 to 143.19 mg/L (Table 6). The lowest mean total dissolved solids value (89.17 mg/L) was observed on Cowhorn Creek at Tucker Street (site 15254) whereas the highest mean total dissolved solids value (143.19 mg/L) was observed on Anderson Creek at Highway 259 (site 81260). All discrete measurements for total dissolved solids met the water quality standard for both segment 0302 and segment 0304.

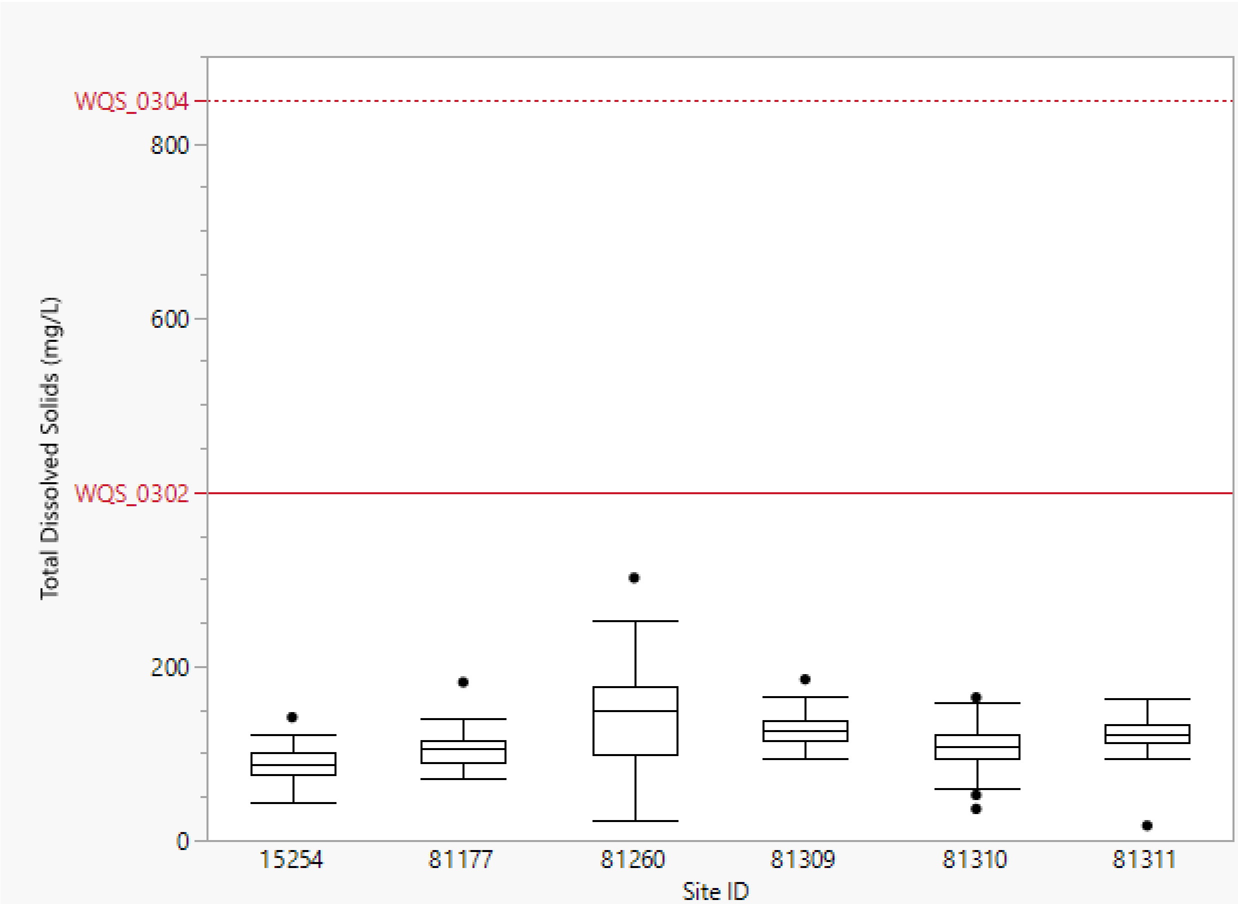

Figure 7. Total dissolved solids (mg/L) for Texas Stream Team sites in the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas (September 1994 to November 2024). WQS_0302 = Water Quality Standard for Segment 0302; WQS_0304 = Water Quality Standard for Segment 0304.

Dissolved Oxygen

The range of average dissolved oxygen values for all sites spanned from 5.67 to 7.72 mg/L (Table 6). The lowest mean dissolved oxygen value (5.67 mg/L) was observed at the Boat Ramp at Scout Lake (site 81177) whereas the highest mean dissolved oxygen value (7.72 mg/L) was observed at Clear Springs Pier at Lake Wright Patman. Although the dissolved oxygen averages for each site were above the water quality standards of 4.0 mg/L for segment 0304 and 5.0mg/L for segment 0302, discrete measurements that fell below the water quality standards were observed at all sites except site 81310 (Figure 7). Overall, there were four occurrences at site 15254, 35 at site 81177, eight at site 81260, seven at site 81309, and 11 at site 81311.

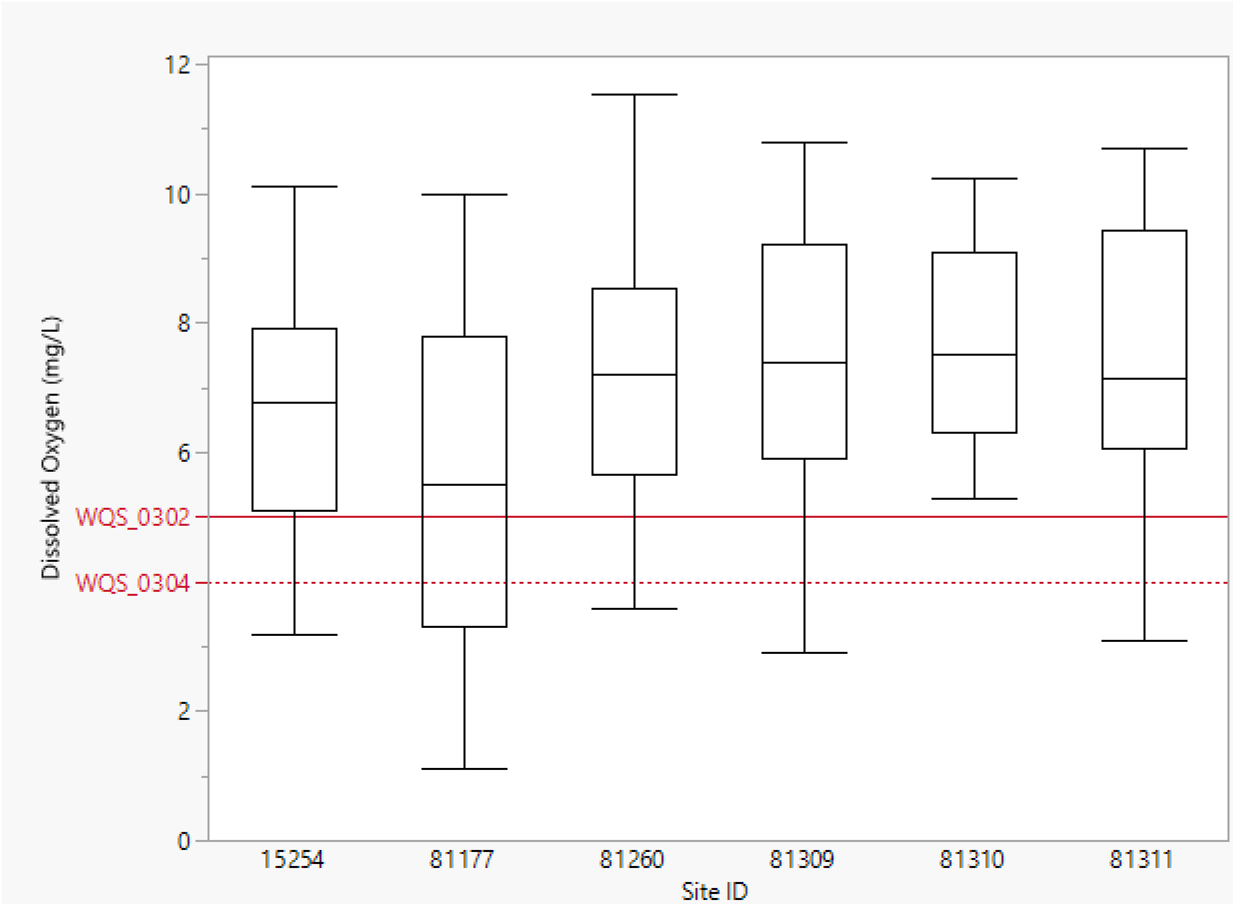

Figure 8. Dissolved oxygen in water for Texas Stream Team sites in the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas. (September 1994 to November 2024). WQS_0302 = Water Quality Standard for Segment 0302; WQS_0304= Water Quality Standard for Segment 0304.

pH

The average pH range of values at all sites was between 6.67 and 6.84 s.u. (Table 6). The lowest mean pH value (6.67 s.u.) was observed on Anderson Creek at Highway 259 (site 81260) whereas the highest mean pH value (6.84 s.u.) was observed at Piney Point Dock at Lake Wright Putman (site 81311). Average pH values at all sites were within the range of the minimum and maximum water quality standards (WQS) for both segment 0302 (6.5 – 9.5) and segment 0304 (6.0 – 8.5). However, both Cowhorn Creek at Tucker Street (site 15254) and Clear Springs Pier at Lake Wright Patman (site 81310) had discrete measurements that exceeded or fell below the respective WQS. There was one occurrence at site 15254 where the pH (9.4 s.u.) was above the WQS and one occurrence at site 81310 where the pH (5.5 s.u.) was below the WQS (Figure 9)

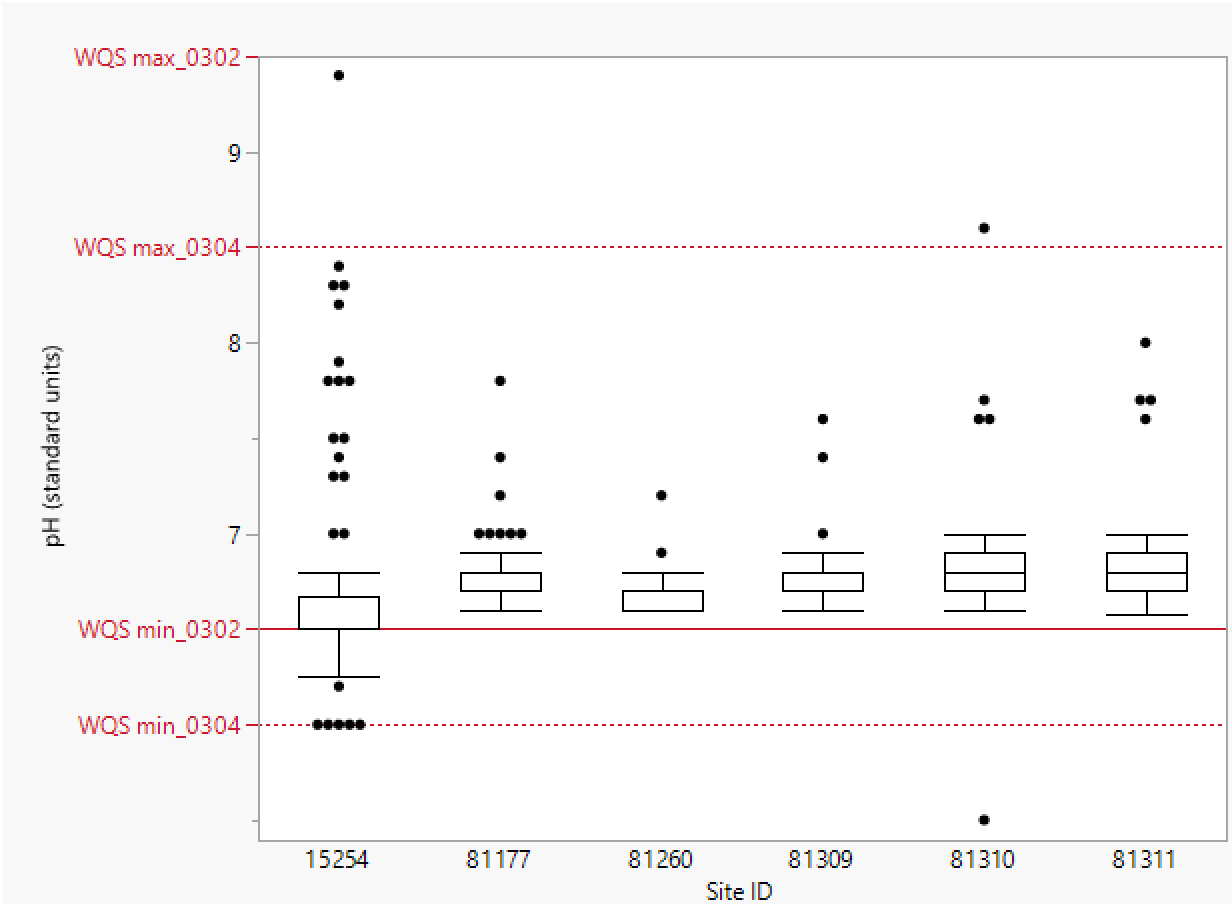

Figure 9. pH (s.u.) for Texas Stream Team sites in the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas (September 1994 to November 2024). WQS max_0302= Maximum pH Water Quality Standard for segment 0302; WQS min_0302 = Minimum pH Water Quality Standard for Segment 0302; WQS max_0304= Maximum pH Water Quality Standard for Segment 0304; WQS min_0304 = Minimum pH Water Quality Standard for Segment 0304.

Transparency and Total Depth

Secchi disks and/or transparency tubes were used to measure transparency at all monitoring sites within the watershed. Secchi disks were used at five out of the six sites with average transparency ranging from 0.18 to 0.36 m, whereas transparency tubes were used at five out of the six sites with average transparency ranging from 0.25 to 0.98 m. Out of the four sties where both transparency tubes and Secchi disks were used, monitoring site at the Boat Ramp at Scout Lake (site 81177) had the greatest variability in Secchi and transparency tube averages.

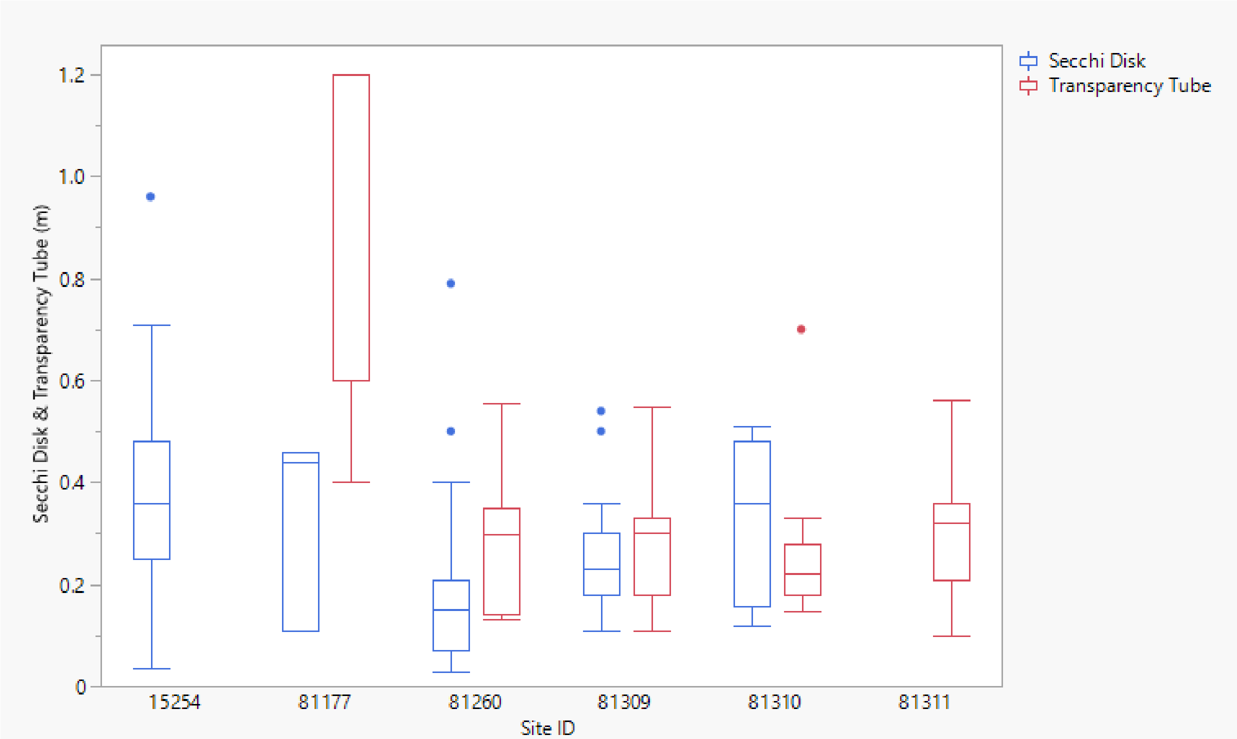

Figure 10. Secchi disk transparency measurements for Texas Stream Team sites in the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas (September 1994 to November 2024).

WATERSHED SUMMARY

The Lower Sulphur watershed is primarily composed of planted and cultivated land, covering nearly 40% of the area. Other land uses include forest (26.3%), wetlands (19%), developed areas (7%), open water (3.4%), shrubland (2.6%), herbaceous cover (1.7%), and less than 1% barren land.

According to the 2024 Integrated Report by the Texas Commission on Environmental Quality, six water bodies in the watershed have impairments. Wright Patman Lake (segment 0302) is impaired for pH. Big Creek (segment 0302A), Elliot Creek (segment 0302H), Mustang Creek (segment 0303P), and Wagner Creek (segment 0304C) are impaired for depressed dissolved oxygen, while Wagner Creek (segment 0304C) and Days Creek (segment 0304) are impaired for bacteria. These impairments are categorized as 5, indicating that at least one designated use is not being supported.

Texas Stream Team community scientists monitored eight sites in the watershed intermittently from September 1994 to November 2024, recording 488 monitoring events. Six sites with 10 or more monitoring events were analyzed for water quality, including the number of samples, mean, standard deviation, and range of values (Table 6). Core parameters monitored included air and water temperature, specific conductance, total dissolved solids, dissolved oxygen, pH, Secchi disk transparency, transparency tube readings, and total depth. All sites were monitored by Texas Stream Team-trained community scientists.

Water quality standards for designated uses in the watershed were compared to the monitoring results to evaluate overall water quality. Major findings include the following:

- Average water quality standards were met at all sites; however, several discrete measurements failed to meet standards.
- Temperature (32°C) exceeded standards twice at site 81310.
- Dissolved oxygen fell below standards at all sites except 81310, with exceedances at sites 15254 (4 times), 81177 (35 times), 81260 (8 times), 81309 (7 times), and 81311 (11 times).
- pH was outside the acceptable range at site 15254 (once) and site 81310 (once).

Although average standards were met, periodic exceedances suggest potential areas of concern.

Texas Stream Team community scientists are encouraged to maintain core monitoring while expanding efforts to include consistent *E. coli* bacteria monitoring. Given the bacteria impairment in the watershed, such monitoring is essential to identify sources over time and prevent further degradation. Ongoing monitoring is vital for building long-term data sets, tracking water quality changes, and addressing potential impacts from population growth and development.

This report would not have been possible without the dedicated efforts of the Northeast Texas monitoring group, whose work has been pivotal in collecting water quality data for the Lower Sulphur watershed. These community scientists have consistently monitored sites across the watershed, contributing valuable data that underpins this report. Texas Stream Team will continue to support these efforts by providing technical assistance and training new community scientists to expand, grow, and sustain water quality monitoring 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 Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas.

Species Type	Common Name	Federal/State Listing
Bird	Interior least tern	State Listed as Endangered
Insect	American burying beetle	State Listed as Endangered
Mammal	Tricolored bat	Federally Proposed as Endangered
Mollusk	Ouachita rock pocketbook	State Listed as Endangered

Table 8. Threatened species located within the Lower Sulphur watershed in Bowie, Cass, Delta, Franklin, Hopkins, Lamar, Morris, Red River, and Titus counties, Texas.

Species Type	Common Name	Federal/State Listing
Bird	White-faced ibis	State Listed as Threatened
	Wood stork	State Listed as Threatened
	Swallow-tailed kite	State Listed as Threatened
	Black rail	State Listed as Threatened
	Piping plover	State Listed as Threatened
	Rufa red knot	State Listed as Threatened
	Yellow-billed cuckoo	State Listed as Threatened
	Bachman’s sparrow	State Listed as Threatened
Fish	Shovelnose sturgeon	State Listed as Threatened
	Paddlefish	State Listed as Threatened

	Chub shiner	State Listed as Threatened
	Bluehead shiner	State Listed as Threatened
	Western creek chubsucker	State Listed as Threatened
	Backside darter	State Listed as Threatened
Mammal	Rafinesque’s big-eared bat	State Listed as Threatened
	Black bear	State Listed as Threatened
Mollusk	Southern hickorynut	State Listed as Threatened
	Louisiana pigtoe	Federally Proposed as Threatened, State Listed as Threatened
Reptiles	Alligator snapping turtle	Federally Proposed as Threatened, State Listed as Threatened
	Texas horned lizard	State Listed as Threatened
	Northern scarlet snake	State Listed as Threatened