LAKE TRAVIS WATERSHED DATA REPORT

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The Meadows Center for Water and the Environment
Texas State University

Texas Stream Team

EPA United States Environmental Protection Agency

Texas State University San Marcos
The rising STAR of Texas

TCEQ

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INTRODUCTION

Texas Stream Team (TST) is a volunteer-based citizen science water quality monitoring program. Citizen scientists collect surface water quality data that may be used in the decision-making process to promote and protect a healthy and safe environment for people and aquatic inhabitants. Citizen scientist water quality monitoring occurs at predetermined monitoring sites, at roughly the same time of day each month. Citizen scientist water quality monitoring data provides a valuable resource of information by supplementing professional data collection efforts where resources are limited. The data may be used by professionals to identify 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. TST citizen scientist data is not used by the state to assess whether water bodies are meeting the designated surface water quality standards. Citizen scientists use different methods than the professional water quality monitoring community. TST does not utilize those methods due to higher equipment costs, training requirements, and stringent laboratory procedures that are required of the professional community. However, the data collected by TST provides valuable records, often collected in portions of a water body that professionals are not able to monitor frequently or monitor at all. This long-term data set is available and may be considered by the surface water quality professional community to facilitate management and protection of Texas water resources. For additional information about water quality monitoring methods and procedures, including the differences between professional and volunteer monitoring, please refer to the following sources:

- Texas Stream Team Volunteer Water Quality Monitoring Manual
- Texas Commission on Environmental Quality (TCEQ) Surface Water Quality Monitoring Procedures

The information that TST citizen scientists collect is covered under a TCEQ-approved Quality Assurance Project Plan (QAPP) to ensure that a standard set of methods are used. All data used in watershed data reports are screened by TST for completeness, precision, and accuracy, in addition to being scrutinized for data quality objectives and with data validation techniques.

The purpose of this report is to provide analysis of data collected by TST citizen scientists. The data presented in this report should be considered in conjunction with other relevant water quality reports in order to provide a holistic view of water quality in this water body. Such sources include, but are not limited to, the following potential resources:

- Texas Surface Water Quality Standards
- Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)
- Texas Clean Rivers Program (CRP) partner reports
- TCEQ Total Maximum Daily Load (TMDL) reports
- TCEQ and Texas State Soil and Water Conservation Board Nonpoint Source Programs funded reports, including Watershed Protection Plans (WPPs)

Questions regarding this watershed data report should be directed to TST at (512) 245-1346.

WATERSHED LOCATION AND PHYSICAL DESCRIPTION

Lake Travis Location and Physical Description

Located in the Texas Hill Country, the Lake Travis watershed, including the Pedernales River and lakes Travis and Marble Falls, is approximately 1,830 square miles. Mansfield Dam (originally Marshall Ford Dam) and Lake Travis are in the Colorado River Basin in Travis County, 12 miles northwest of Austin on the Colorado River at river mile 318.0. Lake Travis also extends into Burnet and Llano counties (Texas Water Development Board 1964). The watershed lies within the Edwards Plateau, a region distinguished by rocky terrain and clear perennial streams. Growth and development have dramatically changed the landscape in the region over the past 20 years. Runoff is partly regulated by Buchanan Reservoir and other reservoirs upstream (TWDB 1964). Mansfield Dam impounds Lake Travis on the Colorado and Pedernales rivers in western Travis County. The reservoir, which is about 18,929 surface acres, originally was designed to contain floodwaters. It is one of the clearest reservoirs in Texas and is a popular recreation destination.

Lake Marble Falls Location and Physical Description

Formed in 1951 by the construction of Max Starcke Dam, Lake Marble Falls is the 4th lake (and newest lake) in the Highland Lakes string of lakes on the Colorado River in the central Texas Hill Country near the town of Marble Falls about 45 miles northwest of Austin. With a surface area of 545 acres, it is the smallest reservoir in the chain of Highland Lakes. Lake Marble Falls is a normally constant level lake and is popular for recreation. Most of the property bordering Lake Marble Falls is privately owned. Lake Marble Falls is used for generating hydroelectric power.

Pedernales River Location and Physical Description

The Pedernales River flows 106 miles through Texas Hill Country, being an important tributary of the Colorado River. The headwaters of the Pedernales are spring-fed and originate in southeastern Kimble County. The river flows in an easterly direction through Gillespie County, into Blanco County and ultimately into the Colorado River in Travis County. Overall, the main channel of the river passes through four counties with a drainage area of more than 819,200 acres. The Pedernales catchment area extends into eight counties, with the river having a number of important tributaries along its reach. Most of the tributaries are highly intermittent, but there are several perennial streams that provide important surface water to the main stem (TNC 2007). There are 19 rare plant species found in the watershed, 34 fish species, at least six species of salamander and numerous other insects and larvae residing in and around the river (LCRA 2012). The region is home to a wide array of plant and wildlife species, including 118 species found nowhere else in the world (TNC 2007). The river consists of a mixture of riffles, pools and runs, providing an important variety of habitats for aquatic species. The Pedernales River is an important source of water to Lake Travis of the Highland Lakes chain of lakes. Lake Travis supplies the City of Austin and many other downstream municipalities along the Colorado River as the sole source of potable water. Approximately 23 percent of the annual inflow to Lake Travis is from the Pedernales River. Maintaining environmental flows down to the Gulf of Mexico from the Colorado River is dependent on inflows from the Pedernales River (Wierman et. al 2017).

Physiography and Topography (after LCRA, 2000)

The Edwards Plateau is a physiographic region occupying about 35,900 square miles of Central and West Central Texas. Combined with the High Plains to the northwest, it makes up the southernmost extent of the Great Plains physiographic province of the United States. The central and western portions of the Edwards Plateau exhibit little relief, except along major stream valleys, and the plateau merges almost imperceptibly into the High Plains region to the northwest. The prominent Balcones Escarpment, which rises several hundred feet above the West Gulf Coastal Plain, forms the arc-shaped southeastern margin of the Edwards Plateau. Headward erosion of the streams flowing across the Edwards Plateau toward the Balcones Escarpment has dissected the southeastern part of the plateau, forming the subregion known as the Balcones Canyonlands. The resulting terrain is generally known as the Texas Hill Country, being characterized by steep canyons, narrow divides, and high gradient streams. The Pedernales River valley is the northernmost watershed of the Balcones Canyonlands, being bounded on the north by the Llano Uplift region. Plateau elevations in the study area increase from about 900 feet msl (above mean sea level) at the southeast end of the Pedernales River valley to about 2,200 feet msl at the west end. Valley bottom elevations increase from about 700 feet msl at the Pedernales River's confluence with the Colorado River to about 2,100 feet msl at the river's headwaters.

Geology

The major geologic structure to make note of is the Llano Uplift. Perhaps the most well-known portion of the Llano Uplift is the Pedernales Falls, located in the Pedernales Falls State Park, where the river drops 15.24 meters over a 914.4 meter stretch of layered, step-down limestone formations (Texas Parks and Wildlife Department). The climate in this area is subtropical, which consists of hot summers and dry winters. The Pedernales River area flows through rocky, rugged terrain where the ground typically rises far above the river valley. Owing to this geomorphology, the Pedernales River is well-known for rapid flash flooding because of the steep sloping drainage. The upper reaches of the Pedernales River are often dry, with the majority of the water located in the lower reaches (Lower Colorado River Authority, 2000). The geologic units exposed in the study area range in age from Paleozoic to Quaternary. Pennsylvanian-age Marble Falls limestone crops out along both banks of the river upstream of PFSP and is the geologic unit underlying the falls at the park (Barnes, 1982; Barnes, 1982a; and Barnes, 1963). This unit generally dips to the southeast at approximately 10 degrees. The Marble Falls is dark-gray limestone containing large crinoid fossil columnar. Caves are present on both sides of the river near the western boundary of PFSP indicating some karst development. The main unit underlying the Marble Falls are the rocks of the Ordovician-age Ellenburger Group, a group of limestone and dolomite units. Numerous southwest/northeast trending parallel faults have been mapped, but do not appear to propagate up into the Marble Falls (Wierman et al. 2017).

Ecoregion and Climate

Lake Travis and the Pedernales River are located within the Edwards Plateau Woodland, Llano Uplift, and Balcones Canyonlands Ecoregions (USEPA 2004). For the most part, the area is characterized by juniper-oak savanna and mesquite-oak savanna, housing soils that are mostly mollisols (Griffith, Bryce, Omernik, & Rogers, 2007). The fine, sandy to clay loams of the surrounding watershed also supports the ashe juniper, bald cypress, mesquite, and grasses characteristic of the Hill Country. The watershed supports a

variety of fish and wildlife as well. According to Texas Parks and Wildlife, fish commonly caught in Pedernales River includes catfish, perch, carp, and bass. Common wildlife inhabitants include coyotes, armadillos, white-tailed deer, skunks, opossums, rabbits, and raccoons. Common birds sighted in the area include herons, ravens, doves, quail, roadrunners, western scrub jays, wild turkeys, owls, and the endemic rufous-crowned sparrow (Texas Parks and Wildlife Department). Lake Travis is located within the approximate boundary of the Subtropical Subhumid and Subtropical Humid climate zones (Larkin and Bomar, 1983). According to data collected from 1971 to 2000, Lake Travis receives an approximate average annual precipitation amount of 30.01-35.00 inches (NOAA 2002). Climate variability in this region is dramatic. During 1991, the annual precipitation was approximately 40-50 inches. During 1996, the annual precipitation was approximately 20-30 inches. The gross lake surface evaporation average annual rate, 1950-79, was approximately 63-65 inches. Lake Travis and the Pedernales River are at a cross-roads as rapid growth in the Austin region spreads west into the Hill Country and extended droughts and potential climate change reduce rainfall, recharge, and springflow, negatively affecting the river's character and health (Weirman et al. 2017). Parts of this biologically diverse region and its threatened karst ecosystems have been thoughtfully conserved by more Habitat Conservation Plans than any other part of the US (Roberts 2012).

Land Cover

Land cover, particularly developed land use, plays a role in determining water quality, and both storm flow and base flow. Increased impervious cover, septic systems, organized sewage treatment, and non-point source pollution can impact water quality. The basin was primarily forest and shrub land in 2011, with a lesser amount of grassland. Most land use within the Open Space category is classified as "commonly includ(ing) large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes" (MRLC 2011). As stated in the Regional Water Quality Plan (2005), "various published and unpublished reports and in unpublished data compilations, the City of Austin has indicated that physical and biological degradation of streams begins to occur at between five and eighteen percent (5-18 percent) impervious cover". Therefore, it is expected that there is some degradation occurring from the "Developed, Open Space" land use areas, but these areas make up a small portion of the watershed. Land use and surficial geology are closely linked in the watershed. Developed and cultivated crops areas closely mirror the areas of surficial Hensel Sand. The sandy nature of the soils developed on the Hensel are tillable and suitable for crops. The large areas of surficial carbonate rocks (Edwards and Glen Rose) contain very shallow rocky soils unsuitable for most cultivated crops and are generally left in shrub and forest lands (Weirman et al. 2017).

Lower Colorado River Authority (LCRA): Colorado River Watch Network (CRWN)

The LCRA Colorado River Watch Network (CRWN) is a partner program of Texas Stream Team. As such, CRWN has their own set of procedures and quality system for their citizen monitoring program. For more information on CRWNs data collection procedures please visit the LCRA website. As an independent entity, which does not receive funding from the TCEQ or Texas State University, CRWN manages volunteers, conducts trainings, manages data, and supplies equipment for volunteers within the Colorado River Watershed. However, Texas Stream Team has chosen to include CRWN data information in this Data Report based on the following points: CRWN is considered as a part of the Texas Stream Team

monitoring network, CRWN data is included in the Texas Stream Team database, and CRWN volunteers and state-funded staff are counted as match for the Texas Stream Team grant project.

Endangered Species and Conservation Needs

The Pedernales is valued as a relatively pristine river in Central Texas, with important intact habitats providing shelter for a number of threatened and endangered species. Common names of species listed as rare, threatened, or endangered, under the authority of Texas state law and/or under the US Endangered Species Act, within the counties of Blanco, Burnet, Gillespie, Hays and Travis, include:

Table 1: Rare, threatened and endangered species located within the study area

ARACHNIDS	Bandit cave spider
	Bee Creek Cave harvestman
	Bone Cave harvestman
	Tooth Cave pseudoscorpion
	Tooth Cave spider
	Warton's Cave meshweaver
AMPHIBIANS	Austin blind salamander
	Barton Springs salamander
	Blanco blind salamander
	Blanco River Springs salamander
	Jollyville Plateau salamander
	Pedernales River Springs salamander
	San Marcos salamander
	Texas blind salamander
BIRDS	American peregrine falcon
	Arctic peregrine falcon
	Bald eagle
	Baird's sparrow
	Black-capped vireo
	Golden-cheeked warbler
	Interior least tern
	Mountain plover
	Peregrine falcon
	Sprague's pipit
	Western burrowing owl
	Whooping crane
	Zone-tailed hawk
CRUSTACEANS	A cave obligate crustacean (*Monodella texana*)
	An anthropod (*Stygobromus russelli*)
	Balcones Cave amphipod
	Bifurcated Cave amphipod
	Ezell's Cave amphipod
	Texas cave shrimp
	Texas troglobitic water slater
FISHES	Fountain darter

	Guadalupe bass
	Headwater catfish
	Ironcolor shiner
	San Marcos gambusia
	Smalleye shiner
MAMMALS	Black bear
	Cave myotis bat
	Gray wolf
	Llano pocket gopher
	Red wolf
	Plains spotted skunk
MOLLUSKS	False spike mussel
	Golden orb
	Smooth pimpleback
	Texas fatmucket
	Texas fawnsfoot
	Texas pimpleback
REPTILES	Cagle's map turtle
	Concho water snake
	Spot-tailed earless lizard
	Texas garter snake
	Texas horned lizard
INSECTS	A mayfly (Allenhyphes michaeli)
	A mayfly (Baetodes alleni)
	Disjunct crawling water beetle
	Comal Springs dryopid beetle
	Comal Springs riffle beetle
	Edwards Aquifer diving beetle
	Flint’s net-spinning caddisfly
	Kretschmarr cave mold beetle
	San Marcos saddle-case caddisfly
	Texas austrotinodes caddisfly
	Tooth Cave blind rove beetle
	Tooth Cave ground beetle
PLANTS	Arrowleaf milkvine
	Basin bellflower
	Basin wild-buckwheat
	Big red sage
	Boerne bean
	Bracted twistflower
	Broadpod twistflower
	Buckley tridens
	Canyon rattlesnake-root
	Correll’s false dragonhead
	Edwards Plateau cornsalad
	Enquist’s sandmint

	Glass Mountains coral-root
	Granite spiderwort
	Gravelbar brickellbush
	Guadalupe beardtongue
	Hall's prairie clover
	Heller's marbleseed
	Hill Country wild-mercury
	Llano butterweed
	Low spurge
	Narrowleaf brickellbush
	Net-leaf bundleflower
	Osage Plains false foxglove
	Plateau loosestrife
	Plateau milkvine
	Rock grape
	Rock quillwort
	Scarlet leather-flower
	Small-headed pipewort
	Stanfield’s beebalm
	Sycamore-leaf snowbell
	Texabama croton
	Texas almond
	Texas amorpha
	Texas barberry
	Texas fescue
	Texas milk vetch
	Texas peachbush
	Texas Seymeria
	Texas wild rice
	Tree Dodder
	Warnock’s coralroot

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.

Natural sources of warm water are seasonal, 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 release warmer water. Citizen scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases. While citizen scientist data does not show diurnal temperature fluctuations, it may demonstrate the fluctuations over seasons and years.

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 stream flow. The TCEQ Water Quality Standards document lists daily minimum DO criteria for specific water bodies and presumes criteria according to flow status (perennial, intermittent with perennial pools, and intermittent), aquatic life attributes, and habitat. These criteria are protective of aquatic life and can be used for general comparison purposes.

Table 2: Daily minimum dissolved oxygen requirements for aquatic life

Aquatic Life Sub-category	Daily Minimum Dissolved Oxygen (mg/L)
Exceptional	4.0
High	3.0
Intermediate	3.0
Limited	2.0
Minimal	1.5

The DO concentrations can be influenced by other water quality parameters such as nutrients and temperature. High concentrations of nutrients can lead to excessive surface vegetation growth and algae, which may starve subsurface vegetation of sunlight, and, therefore, limit the amount of DO in a water body due to reduced photosynthesis. This process, known as eutrophication, is enhanced when the subsurface vegetation and algae die, and oxygen is consumed by bacteria during decomposition. Low DO levels may also result from high groundwater inflows due to minimal groundwater aeration, high temperatures that reduce oxygen solubility, or water releases from deeper portions of dams where DO

stratification occurs. Supersaturation typically only occurs underneath waterfalls or dams with water flowing over the top.

Specific Conductivity and Total Dissolved Solids

Specific conductivity is a measure of the ability of a body of water to conduct electricity. It is measured in microsiemens per cubic centimeter (µS/cm3). A body of water is more conductive if it has more Total Dissolved Solids (TDS) such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lower the level of DO, leading to eutrophication. High concentrations of salt can inhibit water absorption and limit root growth for vegetation, leading to an abundance of more drought tolerant plants, and can cause dehydration of fish and amphibians. Sources of TDS can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants. For this report, specific conductivity values have been converted to TDS using a conversion factor of 0.65 and are reported as mg/L.

pH

The pH scale measures the concentration of hydrogen ions on a range of 0 to 14 and is reported in standard units (su). The pH of water can provide useful information regarding acidity or alkalinity. The range is logarithmic; therefore, every 1-unit change is representative of a 10-fold increase or decrease in acidity. Acidic sources, indicated by a low pH level, can include acid rain and runoff from acid-laden soils. Acid rain is mostly caused by coal power 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. The most suitable pH range for healthy organisms is between 6.5 and 9.

Secchi Disk and Total Depth

The Secchi disk is used to determine the clarity of the water, a condition known as turbidity. The disk is lowered into the water until it is no longer visible, and the depth is recorded. Highly turbid waters pose a risk to wildlife by clogging the gills of fish, reducing visibility, and carrying contaminants. Reduced visibility can harm predatory fish or birds that depend on good visibility to find their prey. Turbid waters allow very little light to penetrate deep into the water, which, in turn, decreases the density of phytoplankton, algae, and other aquatic plants. This reduces the DO in the water due to reduced photosynthesis. Contaminants are most commonly transported in sediment rather than in the water. Turbid waters can result from sediment washing away from construction sites, erosion of farms, or mining operations. Average Secchi disk transparency (a.k.a. Secchi depth) readings that are less than the total depth readings indicate turbid water. Readings that are equal to total depth indicate clear water. Low total depth observations have a potential to concentrate contaminants.

E. coli Bacteria

E. coli bacteria originate in the digestive tract of endothermic organisms. The EPA has determined *E. coli* to be the best indicator of the degree of pathogens in a water body, which are far too numerous to be tested for directly, considering the amount of water bodies tested. A pathogen is a biological agent that causes disease. The standard for *E. coli* impairment is based on the geometric mean (geomean) of the *E. coli* measurements taken. A geometric mean is a type of average that incorporates the high variability found in parameters such as *E. coli* which can vary from zero to tens of thousands of CFU/100 mL. The standard for contact recreational use of a water body such as the Lake Travis Watershed is 126 CFU/100 mL. A water body is considered impaired if the geometric mean is higher than this standard.

Orthophosphate

Orthophosphate is the phosphate molecule all by itself. Phosphorus almost always exists in the natural environment as phosphate, which continually cycles through the ecosystem as a nutrient necessary for the growth of most organisms. Testing for orthophosphate detects the amount of phosphate in the water itself, excluding the phosphate bound up in plant and animal tissue. There are other methods to retrieve the phosphate from the material to which it is bound, but they are too complicated and expensive to be conducted by volunteer monitors. Testing for orthophosphate gives us an idea of the degree of phosphate in a water body. It can be used for problem identification, which can be followed up with more detailed professional monitoring, if necessary. Phosphorus inputs into a water body may be caused by the weathering of soils and rocks, discharge from wastewater treatment plants, excessive fertilizer use, failing septic systems, livestock and pet waste, disturbed land areas, drained wetlands, water treatment, and some commercial cleaning products. The effect orthophosphate has on a water body is known as eutrophication and is described above under the “Dissolved Oxygen” section.

Nitrate-Nitrogen

Nitrogen is present in terrestrial or aquatic environments as Nitrate-Nitrogen, nitrites, and ammonia. Nitrate-Nitrogen tests are conducted for maximum data compatibility with TCEQ and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most organisms. Nitrogen inputs into a water body may be livestock and pet waste, excessive fertilizer use, failing septic systems, and industrial discharges that contain corrosion inhibitors. The effect nitrogen has on a water body is known as eutrophication and is described previously in the “Dissolved Oxygen” section (page 14). Nitrate-Nitrogen dissolves more readily than orthophosphate, which tend to be attached to sediment, and, therefore, can serve as a better indicator of the possibility of sewage or manure pollution during dry weather.

Texas Surface 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 so that it supports public health and protects 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 (or drinking water). The criteria for evaluating support of those uses include DO, temperature, pH, TDS, toxic substances, and bacteria.

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

DATA ANALYSIS METHODOLOGIES

Data Collection

The field sampling procedures are documented in TST Water Quality Monitoring Manual and its appendices, or the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012). Additionally, all data collection adheres to TST's approved Quality Assurance Project Plan (QAPP).

Table 3: Sample storage, preservation, and handling requirements

Parameter	Matrix	Container	Sample Volume	Preservation	Holding Time
E. coli	Water	Sterile Polystyrene (SPS)	100	Refrigerate at 4ºC*	6 hours
Nitrate-Nitrogen/Nitrogen	Water	Plastic Test Tube	10 mL	Refrigerate at 4ºC*	48 hours
Orthophosphate/Phosphorous	Water	Glass Mixing Bottle	25 mL	Refrigerate at 4ºC*	48 hours
Chemical Turbidity	water	Plastic Turbidity Column	50 mL	Refrigerate at 4ºC*	48 hours

*Preservation performed within 15 minutes of collection.

Processes to Prevent Contamination

Procedures documented in TST Water Quality Monitoring Manual and its appendices, or the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012) outline the necessary steps to prevent contamination of samples, including direct collection into sample containers, when possible. Field quality control samples are collected to verify that contamination has not occurred.

Documentation of Field Sampling Activities

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

For all *E. coli* sampling events, station ID, location, sampling time, date, depth, sample collector's name/signature, group identification number, incubation temperature, incubation duration, *E. coli* colony counts, dilution aliquot, field blanks, and media expiration dates are checked and recorded if expired. Values for all measured parameters are recorded. If reagents or media are expired, it is noted and communicated to TST.

Sampling is not encouraged with expired reagents and bacteria media; the corresponding values will be flagged in the database and excluded from data reports. Detailed observational data is recorded, including 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 and administrative purposes.

Data Entry and Quality Assurance

Data Entry

The citizen scientists collect field data and report the measurement results on TST approved physical or electronic datasheets. The physical datasheet is submitted to the TST and local partner, if applicable. The electronic datasheet is accessible in the online Waterways Dataviewer and, upon submission and verification, is uploaded directly to the TST database.

Quality Assurance and Quality Control

All data is reviewed to ensure that they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to specified monitoring procedures and project specifications. The respective field, data management, and quality assurance officer (QAO) data verification responsibilities are listed by task in the Section D1 of the QAPP, available on the TST website. Data review and verification is performed using a data management checklist and self-assessments, as appropriate to the project task, followed by automated database functions that will validate data as the information is entered into the database. The data is verified and evaluated against project specifications and is 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. If there are errors in the calibration log, expired reagents used to generate the sampling data, or any other deviations from the field or *E. coli* data review checklists, the corresponding data is flagged in the database.

When the QAO receives the physical data sheets, they are validated using the data validation checklist, and then entered into the online database. Any errors are noted in an error log and the errors are flagged in the TST database. When a monitor enters data electronically, the system will automatically flag data outside of the data limits and the monitor will be prompted to correct the mistake or the error will be logged in the database records. The certified QAO will further review any flagged errors before selecting to validate the data. After validation, the data will be formally entered into the database. Once entered, the data can be accessible through the online Dataviewer.

Errors, which may compromise the program's ability to fulfill the completeness criteria prescribed in the QAPP, will be reported to the TST program manager. If repeated errors occur, the monitor and/or the group leader will be notified via email or telephone.

Data Analysis Methods

Data is compared to state standards and screening levels, as defined in the Surface Water Quality Monitoring Procedures, to provide readers with a reference point for amounts/levels of parameters that may be of concern. The assessment performed by TCEQ and/or designation of impairment involves more complicated monitoring methods and oversight than used by volunteers and staff in this report. The citizen water quality monitoring data is not used in the assessments mentioned above but are intended to inform stakeholders about general characteristics and assist professionals in identifying areas of potential concern.

Standards and Exceedances

The TCEQ determines a water body to be impaired if more than 10 percent of samples, provided by professional monitoring, from the last seven years, exceed the standard for each parameter, except for *E. coli* bacteria. When the observed sample value does not meet the standard, it is referred to as an exceedance. At least ten samples from the last seven years must be collected over at least two years with the same reasonable amount of time between samples for a data set to be considered adequate. The 2018 Texas Surface Water Quality Standards report was used to calculate the exceedances for the Lake Travis Watershed, as seen on page 20 in Table 4.

Methods of Analysis

All data collected from Lake Travis and its tributaries were exported from the TST database and were then grouped by site. Data was reviewed and, for the sake of data analysis, only one sampling event per day, per site was selected for the entire study duration. If more than one sampling event occurred per day, per site, the most complete, correct, and representative sampling event was selected.

Once compiled, data was sorted and graphed in Microsoft Excel 2010 using standard methods. Upstream to downstream trends and trends over time were analyzed using a linear regression analysis in Minitab v 15. Statistically significant trends were added to Excel to be graphed. R-squared is a statistical measure of how close the data is to the fitted regression line. 0 percent indicates that the model explains none of the variability of the response data around its mean. The p-value is the level of marginal significance within a statistical hypothesis test representing the probability of the occurrence of a given event. The cut off for statistical significance was set to a p-value of ≤ 0.05. A p-value of ≤ 0.05 means that the probability that the observed data matches the actual conditions found in nature is 95percent. As the p-value decreases, the confidence that it matches actual conditions in nature increases.

For this report, specific conductivity measurements, gathered by volunteers, were converted to TDS using the TCEQ-recommended conversion formula of specific conductivity 0.65. This conversion was made so that volunteer gathered data could be more readily compared to state gathered data. Geomeans were calculated for *E. coli* data for trends and for each monitoring site. Due to the variability, the geometric mean is used to summarize bacteria data.

Sub-segment No.	Segment Name	Description	Dissolved Oxygen (mg/L)	*E. coli* single sample (CFU/100mL)	*E. coli* geometric mean (CFU/100mL)	Water Temp (°C)	High pH (SU)	Low pH (SU)	TDS (mg/L)
1404	Lake Travis	From Mansfield Dam in Travis County to Max Starcke Dam on the Colorado River Arm in Burnet County and to a point immediately upstream of the confluence of Fall Creek on the Pedernales River Arm in Travis County, up to the normal pool elevation of 681 feet	6.0	394	126	32	9.0	6.5	400
1404A	Hamilton Creek	From the confluence with Lake Travis upstream to the headwaters near the intersection of CR 110 and Threadgill Ranch Road northwest of Burnet in Burnet County	4.0	394	126	32	9.0	6.5	400
1404B	Cow Creek	From the confluence with Lake Travis in Travis County upstream to the headwaters 3.2 km (2.0 miles) southwest of the intersection of CR 336 and CR 337 near the City of Oatmeal in Burnet County	6.0	394	126	32	9.0	6.5	400

1404C	Long Hollow Creek	From the confluence of the Cypress Creek arm of Lake Travis upstream to the headwaters 1 mile southeast of the intersection of Lime Creek Road and Fisher Hollow Trail in Travis County	6.0	394	126	32	9.0	6.5	400
1404D	Lick Creek	From the confluence with the Pedernales River arm of Lake Travis upstream to the headwaters 1.0 km (0.75 miles) northeast of the intersection of Reimers-Peacock Road and Hamilton Pool Road in Travis county	6.0	394	126	32	9.0	6.5	400
1405	Marble Falls Lake	From Max Starcke Dam in Burnet County to Alvin Wirtz Dam in Burnet County, up to normal pool elevation of 738 feet (impounds the Colorado River)	5.0	394	126	34	9.0	6.5	500
1414	Pedernales River	From a point immediately upstream of the confluence of Fall Creek in Travis County to FM 385 in Kimble County	5.0	394	126	33	9.0	6.5	525

1414A	Barons Creek	Perennial stream from the confluence with the Pedernales River up to the most northern crossing of US 87 northwest of Fredericksburg	5.0	394	126	33	9.0	6.5	525
1414B	Cypress Creek	From the confluence with the Pedernales River west of Austin to the upstream perennial portion west of Round Mountain in Blanco County	5.0	394	126	33	9.0	6.5	525
1414C	Live Oak Creek	From the confluence with the Pedernales River near Fredericksburg to the upstream perennial portion northwest of Fredericksburg in Gillespie County	5.0	394	126	33	9.0	6.5	525
1414D	Miller Creek	From the confluence with the Pedernales River near Pedernales Falls State Park to the headwaters, southwest of Johnson City in Blanco County	5.0	394	126	33	9.0	6.5	525
1414E	Heinz Creek	From the confluence with the Pedernales River in Travis County upstream to CR 962 in Blanco County	5.0	394	126	33	9.0	6.5	525

Table 4: TCEQ designated stream segments and standards, as applicable to citizen water quality data in this report (other standards may exist for these water bodies).

LAKE TRAVIS WATERSHED DATA ANALYSIS

Lake Travis Maps

Numerous maps were prepared to show spatial variation of the parameters. The parameters mapped include DO, pH, TDS, Nitrate-nitrogen, and *E. coli*. There is also a reference map showing the locations of all active sites.

Added reference points in all maps, layers showing monitoring sites, cities, counties, and major highways were included. All shapefiles were downloaded from reliable federal, state, and local agencies.

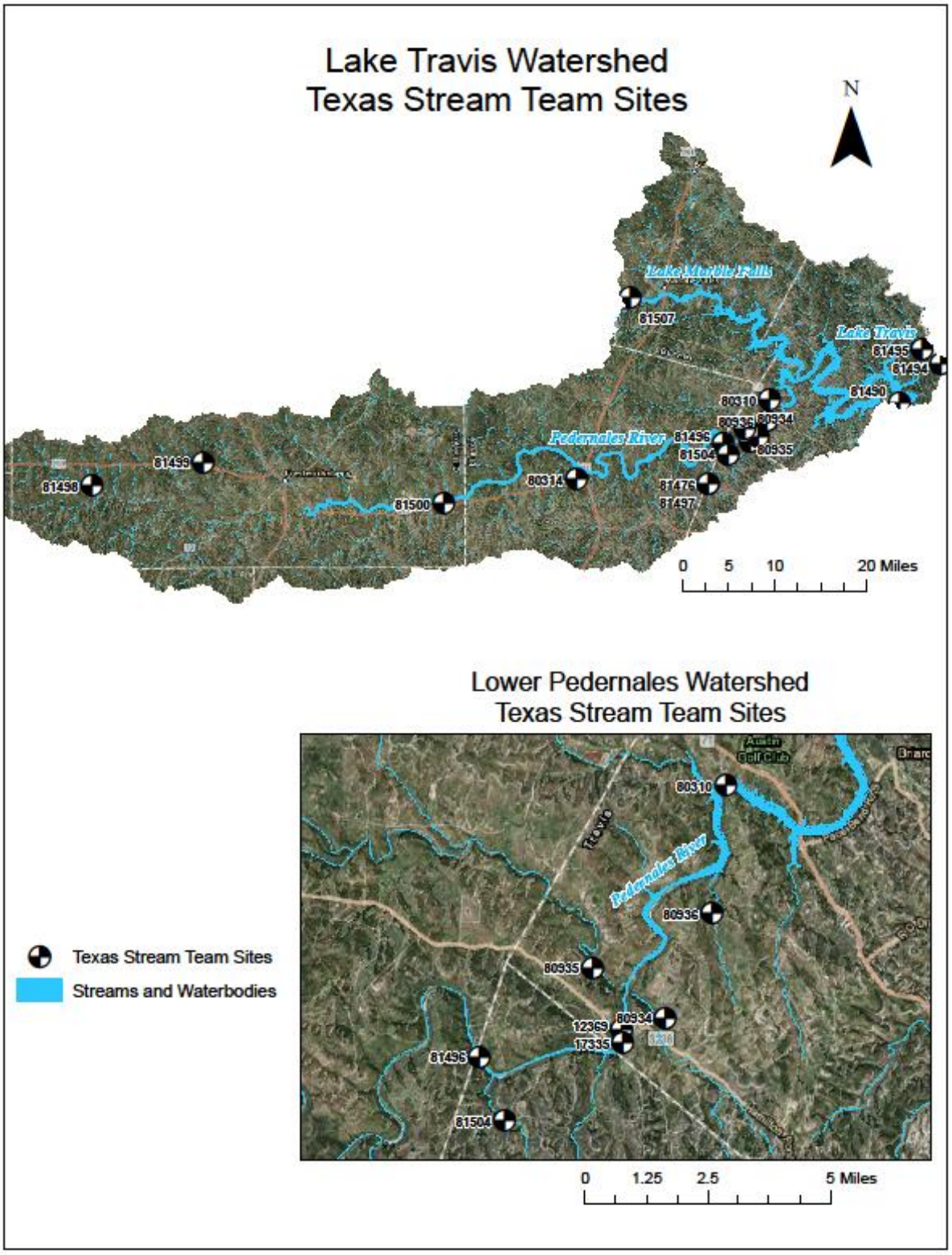

Figure 1: Lake Travis Watershed and active TST sites

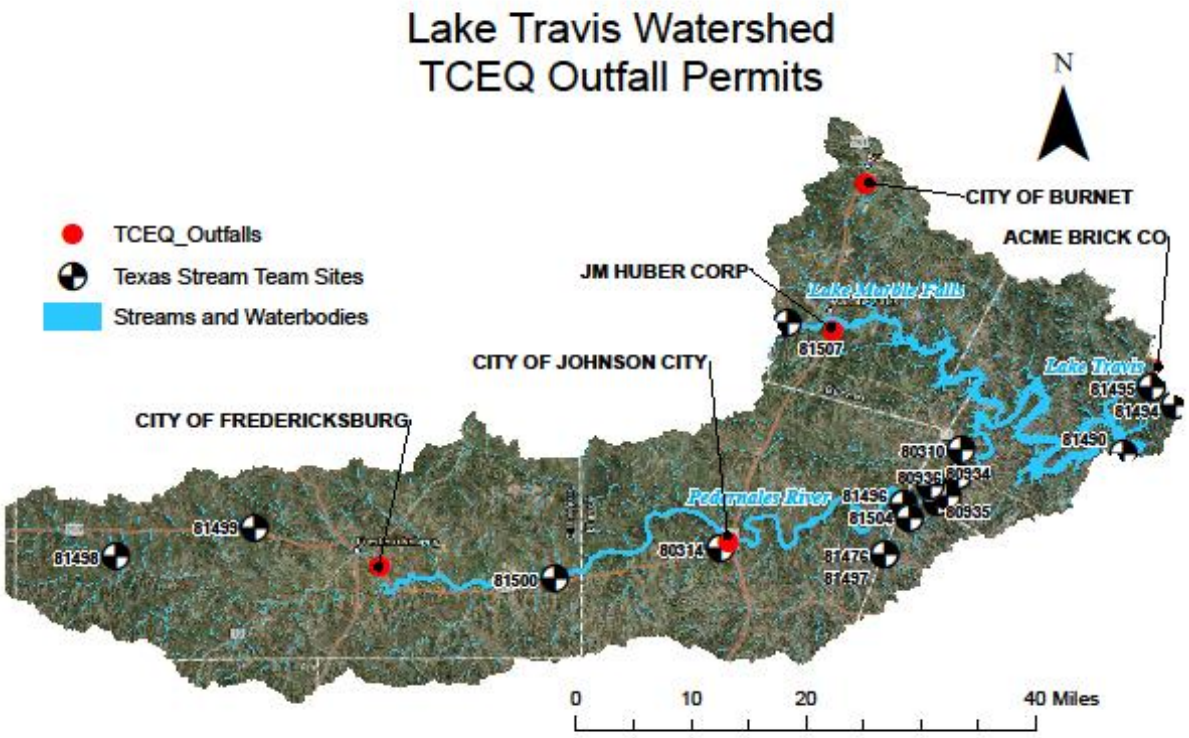

Figure 2: Lake Travis with TST sites and WWTP outfalls

Lake Travis Watershed Trends over Time

Sampling Trends over Time

Sampling within the Lake Travis Watershed began in January of 1996 and continues to this day. A total of 1715 individual monitoring events from 18 sites were analyzed. Monthly monitoring occurred on a consistent basis throughout the years.

Table 5: Descriptive parameters for all sites in the Lake Travis Watershed

Lake Travis Watershed January 1996 – September 2018				
Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	1594	356 ± 81	130	728
Water Temperature (°C)	1709	20.6 ± 6.1	1.0	39.0
Dissolved Oxygen (mg/L)	1705	6.9 ± 1.8	0.1	14.6
pH (su)	1678	7.7 ± 0.5	6.0	9.7
E. coli (CFU/100mL)	1173	16 ± 595	1	9707
Nitrate-Nitrogen (mg/L)	1346	0.86 ± 0.35	0.06	5.00
Orthophosphate (mg/L)	97	0.63 ± 0.37	0.25	1.00

There was a total of 1715 sampling events between 1/1/1996 and 9/7/2018. Mean is listed for all parameters except for *E. coli* which is represented as the geomean.

Trend Analysis over Time

Air and Water Temperature

A total of 1707 and 1709 air and water temperatures, respectively, were collected in the Lake Travis watershed between 1996 and 2018. Water temperature exceeded the TCEQ optimal temperature of 32.2°C on 18 occurrences during this time. Air temperature varied between 1.0°C and 41.5°C.

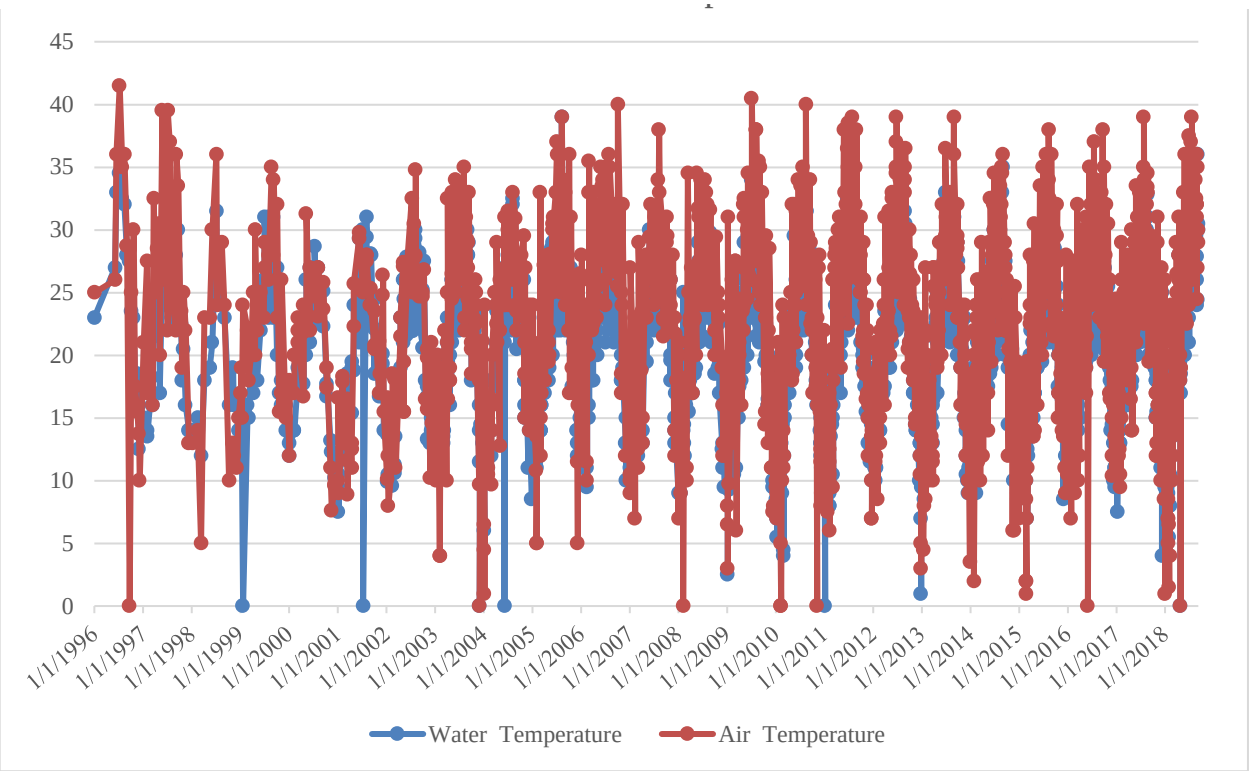

Figure 3: Air and water temperature over time at all sites within the Lake Travis Watershed

Total Dissolved Solids

Citizen scientists collected 1594 TDS samples within the watershed. The average TDS measurement for all sites was 356 mg/L.

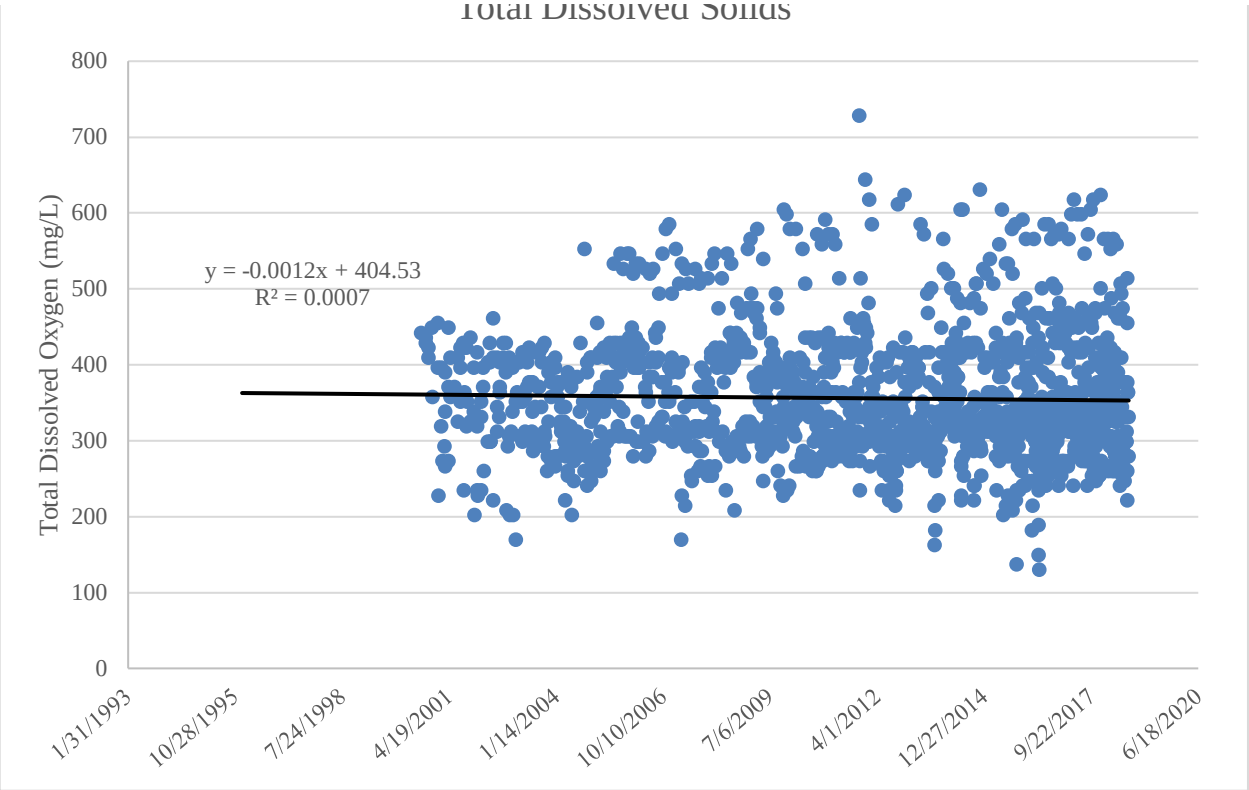

Figure 4: Total dissolved solids over time at all sites within the Lake Travis Watershed

Dissolved Oxygen

Citizen scientists collected a total of 1705 DO samples in the Lake Travis Watershed. The DO measurements were completed for 99percent of all monitoring sites. The mean DO was 6.9 mg/L and it ranged from a low of 0.07 mg/L in October and November of 2011, to a high of 14.6 mg/L in December of 2013.

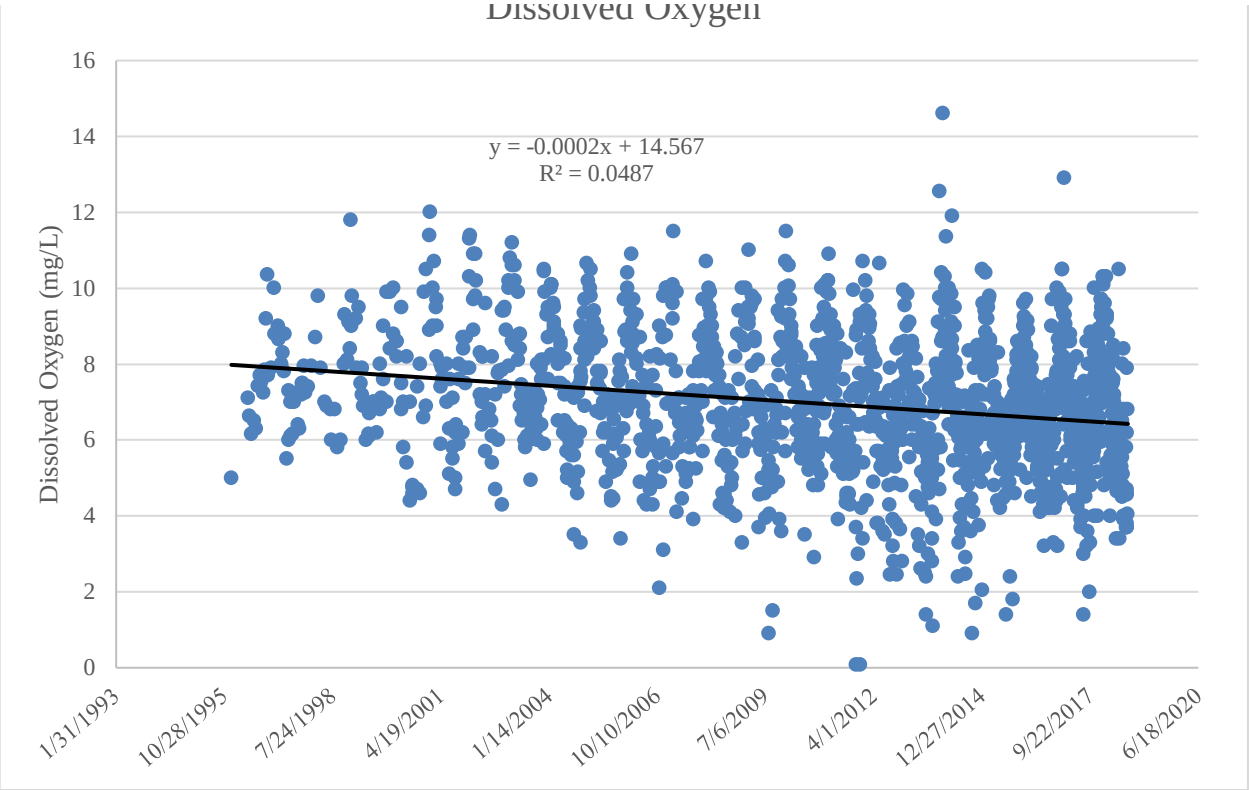

Figure 5: Dissolved oxygen and water temperature over time at all sites in the Lake Travis Watershed

pH

The pH was measured for 98 percent of all sampling events in the watershed. The mean pH was 7.7 and it ranged from 6.0 to 9.7 for all sites.

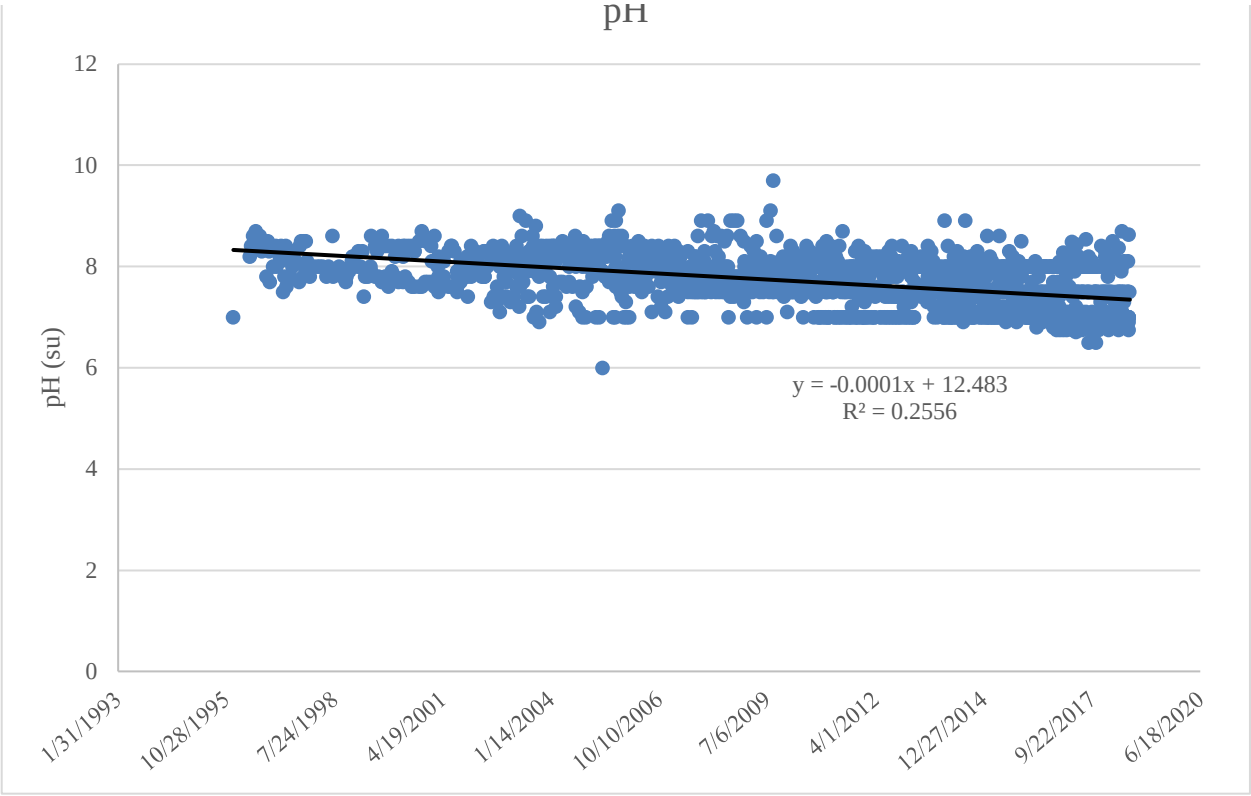

Figure 6: pH over time at all sites within the Lake Travis Watershed

E. coli Bacteria

E. coli samples were taken at over two-thirds of the selected sites in the Lake Travis Watershed. A total of 1173 *E. coli* samples were taken. The geomean for *E. coli* was 16 CFU/100 mL. The *E. coli* counts ranged from 0 CFU/100 mL to a high of 9707 CFU/100 mL in October of 2013.

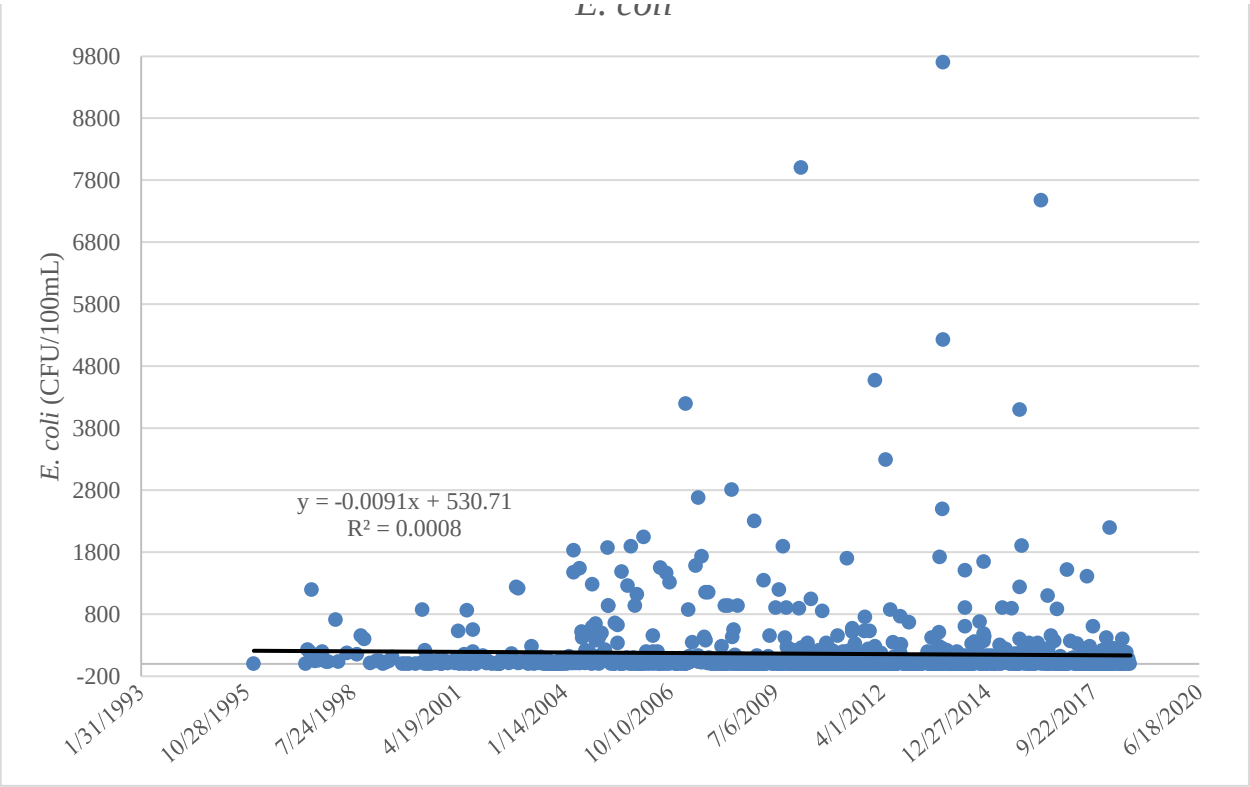

Figure 7: *E. coli* over time at all sites within the Lake Travis Watershed

Nitrate-Nitrogen

Nitrate-Nitrogen concentrations were taken at all of the selected sites in the Lake Travis Watershed except for Site 80934. A total of 1346 nitrate-nitrogen samples were taken. The mean nitrate-nitrogen concentration in the watershed was 0.86 mg/L and nitrate-nitrogen ranged from 0.0 mg/L to a high of 5.0 mg/L.

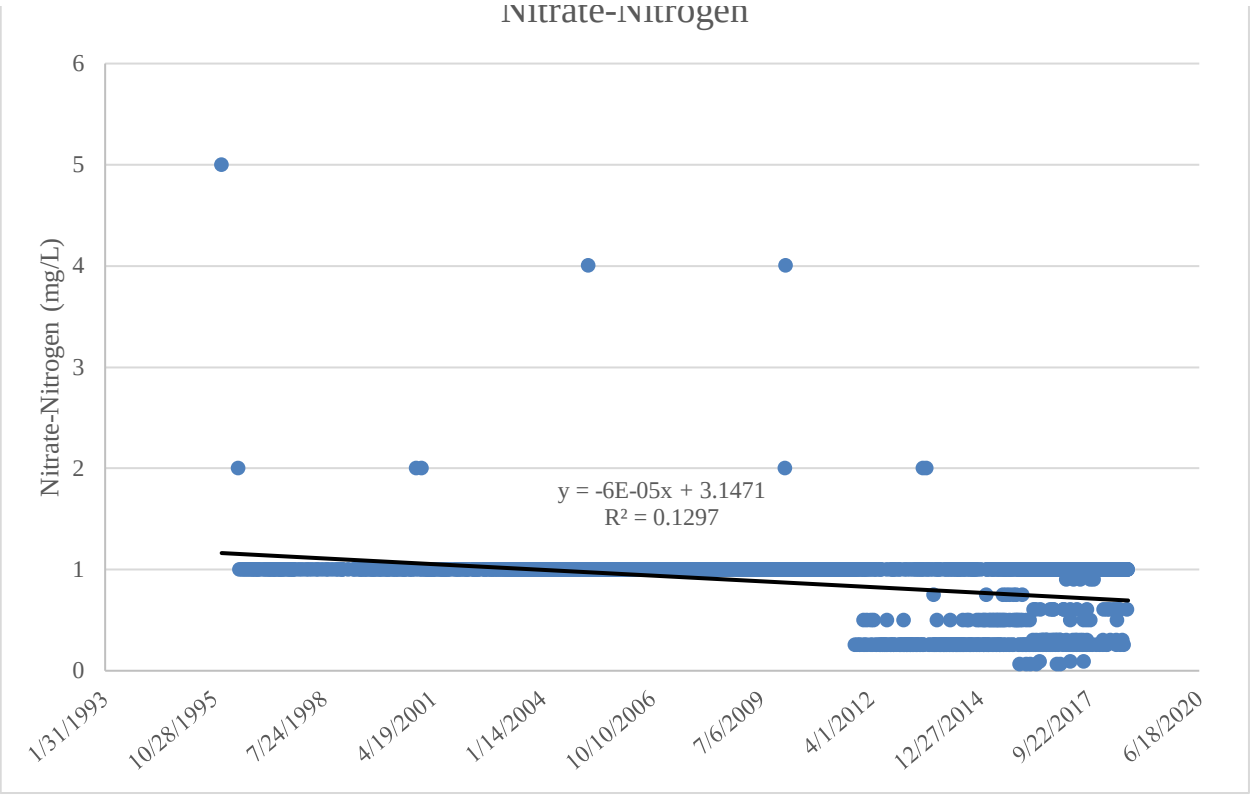

Figure 8: Nitrate-Nitrogen over time at all sites within the Lake Travis Watershed

Orthophosphate

A total of 97 orthophosphate samples were taken at just one of the selected sites, Site 80934. The mean concentration for orthophosphate in the watershed was 0.63 mg/L. Orthophosphate concentrations ranged from 0.25 mg/L to a high of 1.00 mg/L.

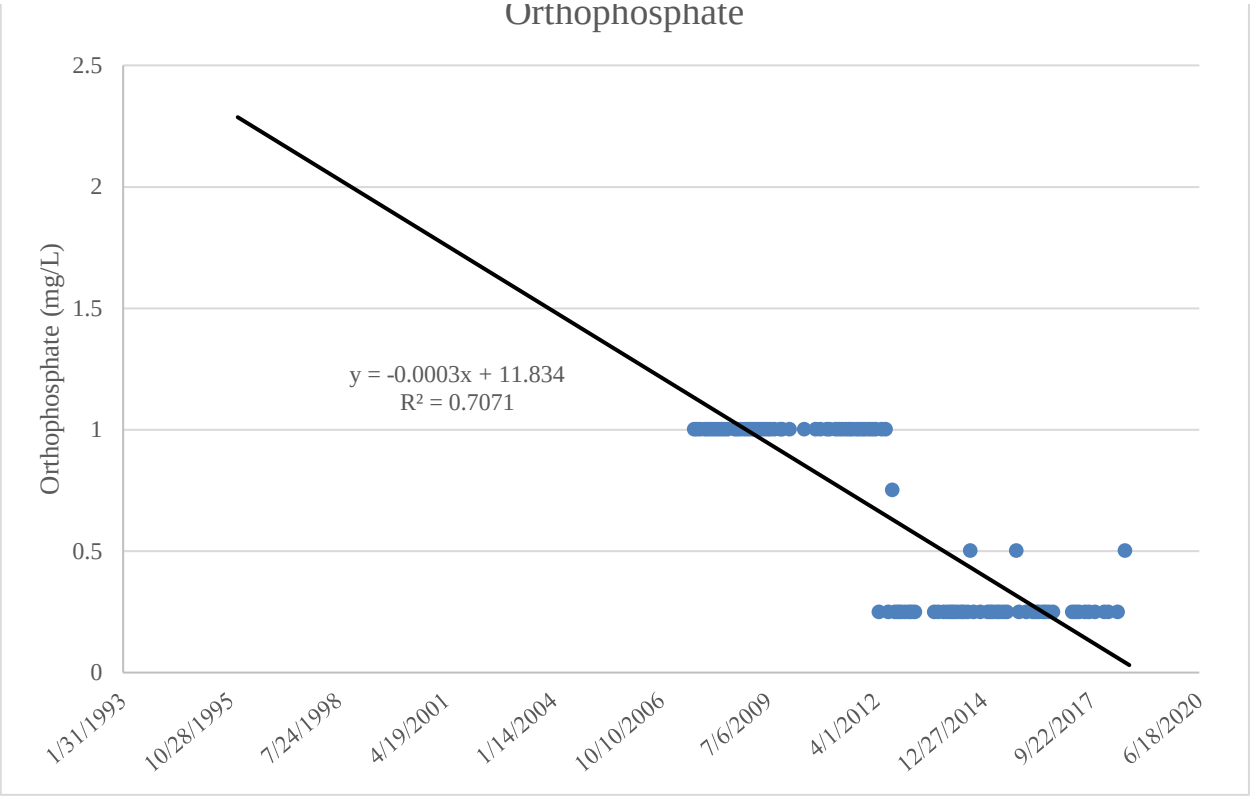

Figure 9: Orthophosphate over time at Site 80934

LAKE TRAVIS WATERSHED SITE BY SITE ANALYSIS

The following sections will provide a brief summarization of analysis by site. The average minimum and maximum values are reported in order to provide a quick overview of the watershed. The TDS, DO, and pH values are presented as an average, plus or minus the standard deviation from the average. The *E. coli* is presented as a geomean. Please see Table 6 for a quick overview of the average results.

As previously mentioned in the 'Water Quality Parameters' section, TDS is an important indicator of turbidity and specific conductivity. The higher the TDS measurement, the more conductive the water is. A high TDS result can indicate increased nutrients present in the water. Site 81494 had the highest overall average for TDS, with a result of 465 ± 43 mg/L. Site 81507 had the lowest average TDS, with a result of 261 ± 6 mg/L.

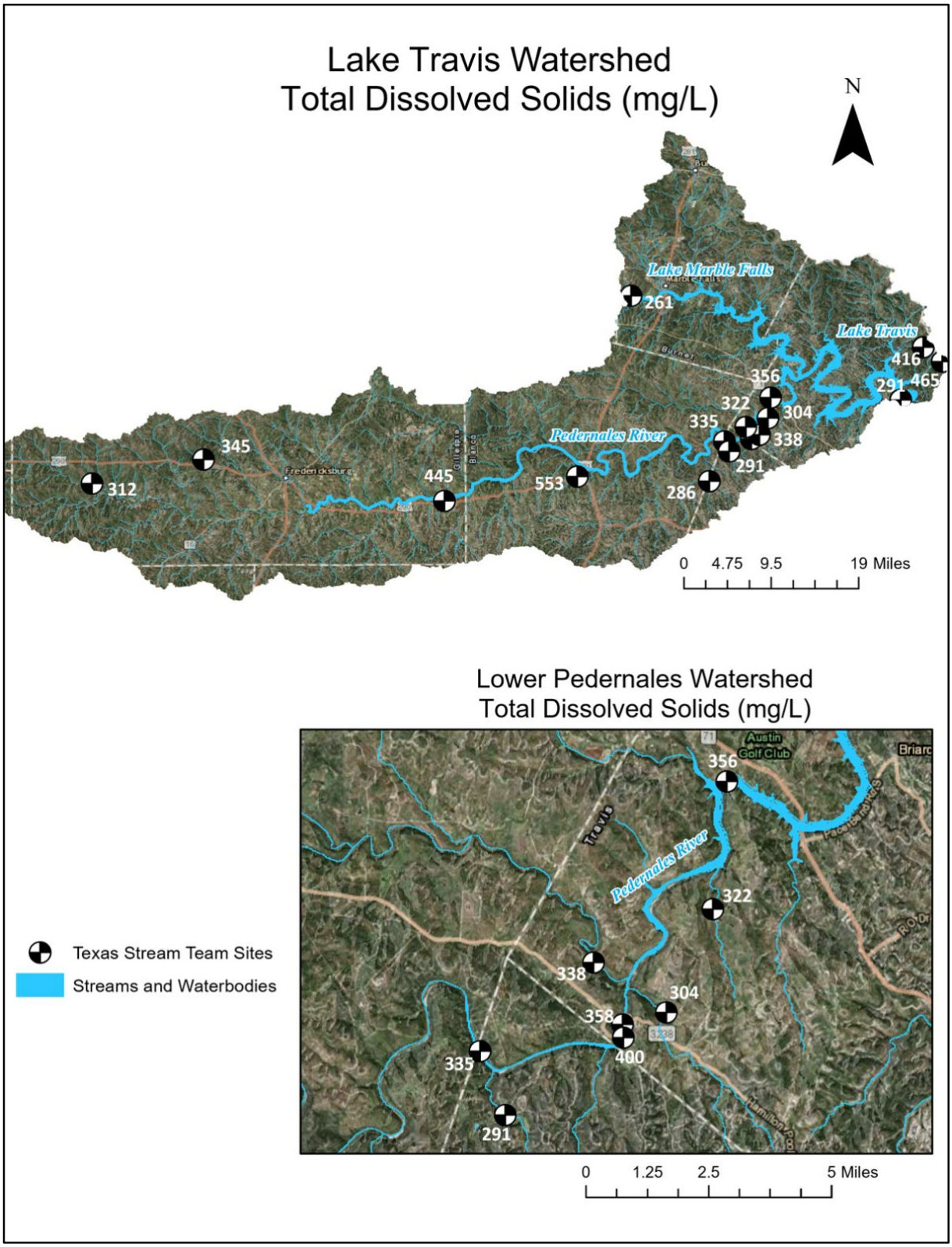

Figure 10: Map of the average total dissolved solids for sites in the Lake Travis Watershed

The DO measurement can help to understand the overall health of the aquatic community. If there is a large influx of nutrients into the water body then there will be an increase in surface vegetation growth, which can then reduce photosynthesis in the subsurface, thus decreasing the level of DO. Low DO can be dangerous for aquatic inhabitants, which rely upon the DO to breathe. The DO levels can also be impacted by temperature; a high temperature can limit the amount of oxygen solubility, which can also lead to a low DO measurement. Site 81494 had the lowest average DO reading, with a result of 5.4 ± 1.1 mg/L. Sites 12369 and 81498 both had the highest average DO reading, with a result of 7.9 ± 1.7 mg/L.

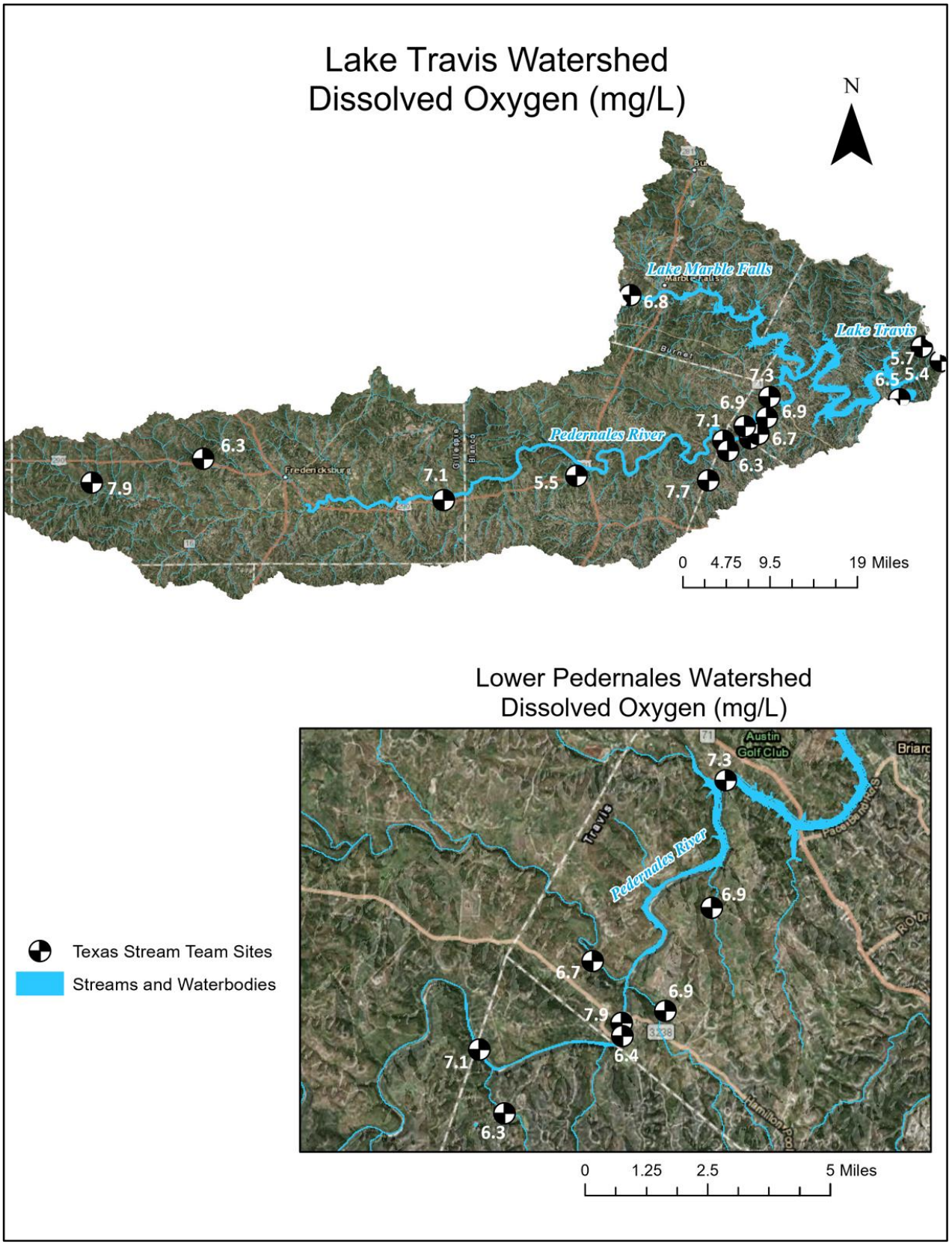

Figure 11: Map of the average dissolved oxygen concentration for sites in the Lake Travis Watershed

The pH levels are an important indicator for the overall health of the watershed as well. Aquatic inhabitants typically require a pH range between 6.5 and 9 for the most optimum environment. Anything below 6.5 or above 9 can negatively impact reproduction or can result in fish kills. There were no reported pH levels outside of this widely accepted range. Site 80904 had the highest average pH level, with a result of 8.2 ± 0.3. Site 80966 had the lowest average pH level, with a result of 7.3 ± 0.3.

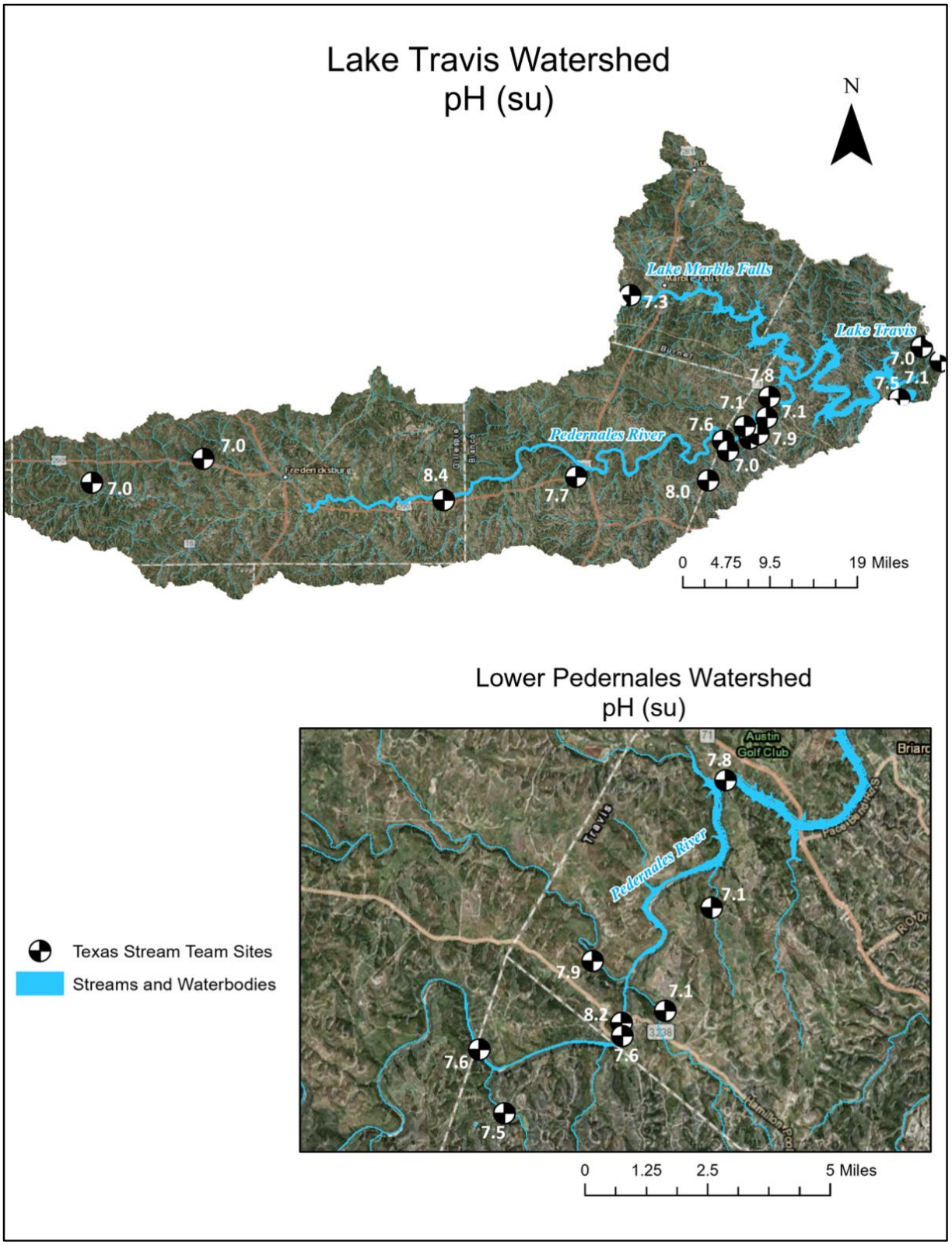

Figure 12: Map of the average pH for sites in the Lake Travis Watershed

E. coli can be used as an indicator of the degree of pathogens in a water body. Its presence above the TCEQ surface water quality standard for a single sample (394 CFU/100 mL) or geometric mean (126 CFU/100 mL) indicates a possible human health risk for primary contact recreation. Most of the selected sites exhibited some sampling events with elevated *E. coli* levels reported above the standard for a single sample. All sites had a geometric mean which satisfied the TCEQ surface water quality standard except for Site 80314. Site 80314 had an *E. coli* geomean of 391 ± 1027 CFU/100 mL.

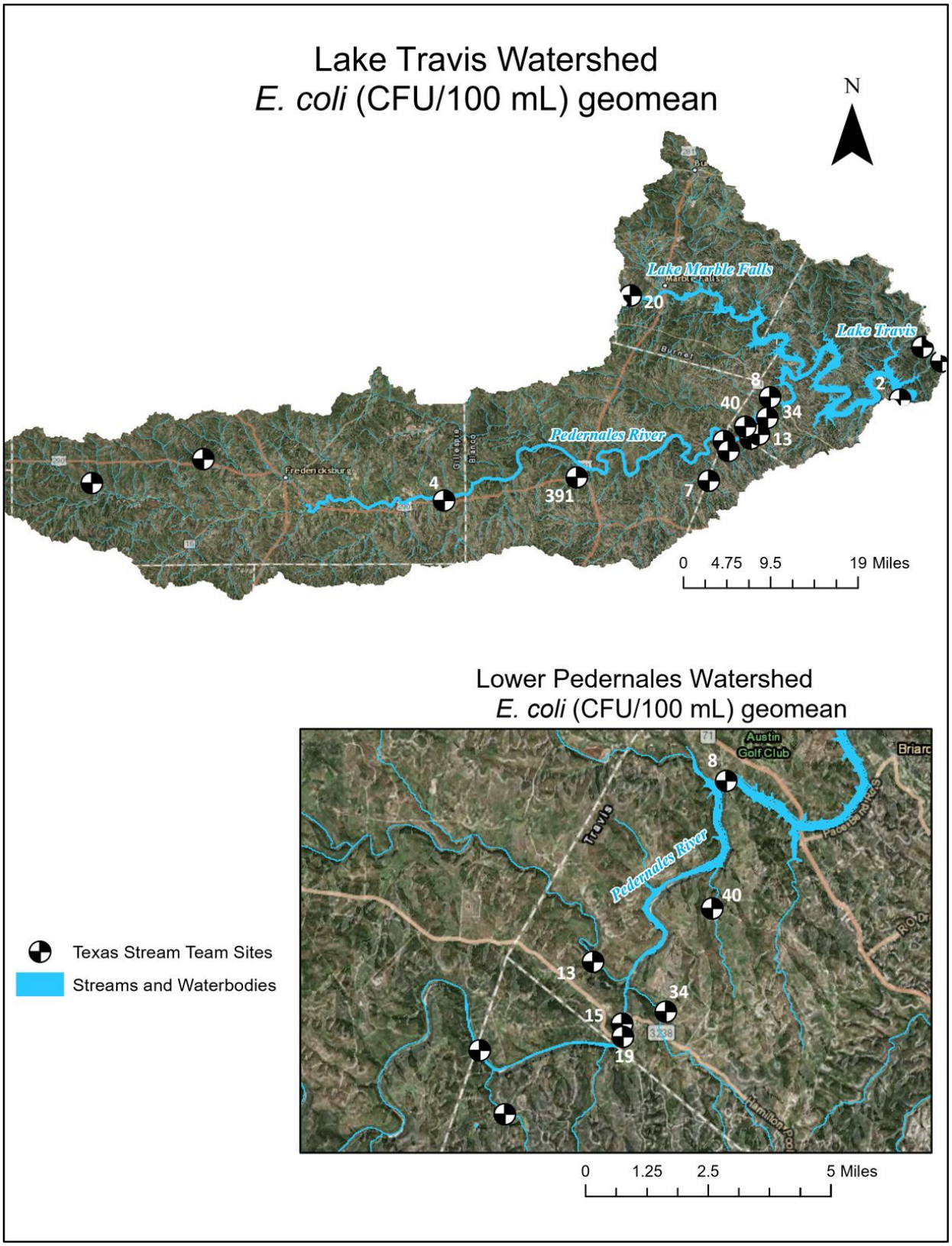

Figure 13: Map of the *E. coli* geomean for sites in the Lake Travis Watershed

Nitrates are essential plant nutrients, but in excess amount they can cause significant water quality problems. Excess nitrates can cause hypoxia (low DO) and can become toxic to warm-blooded animals at higher concentrations (10 mg/L or higher) under certain conditions. The natural level of ammonia or nitrate in surface water is typically low (less than 1 mg/L); in the effluent of wastewater treatment plants, it can range up to 30 mg/L. Sources of nitrates include wastewater treatment plants, runoff from fertilized lawns and cropland, failing on-site septic systems, runoff from animal manure storage areas, and industrial discharges that contain corrosion inhibitors. Site 81495 had the minimum average nitrate-nitrogen concentration with 0.50 mg/L. Site 81476 had the highest average nitrate-nitrogen concentration with 1.07 mg/L.

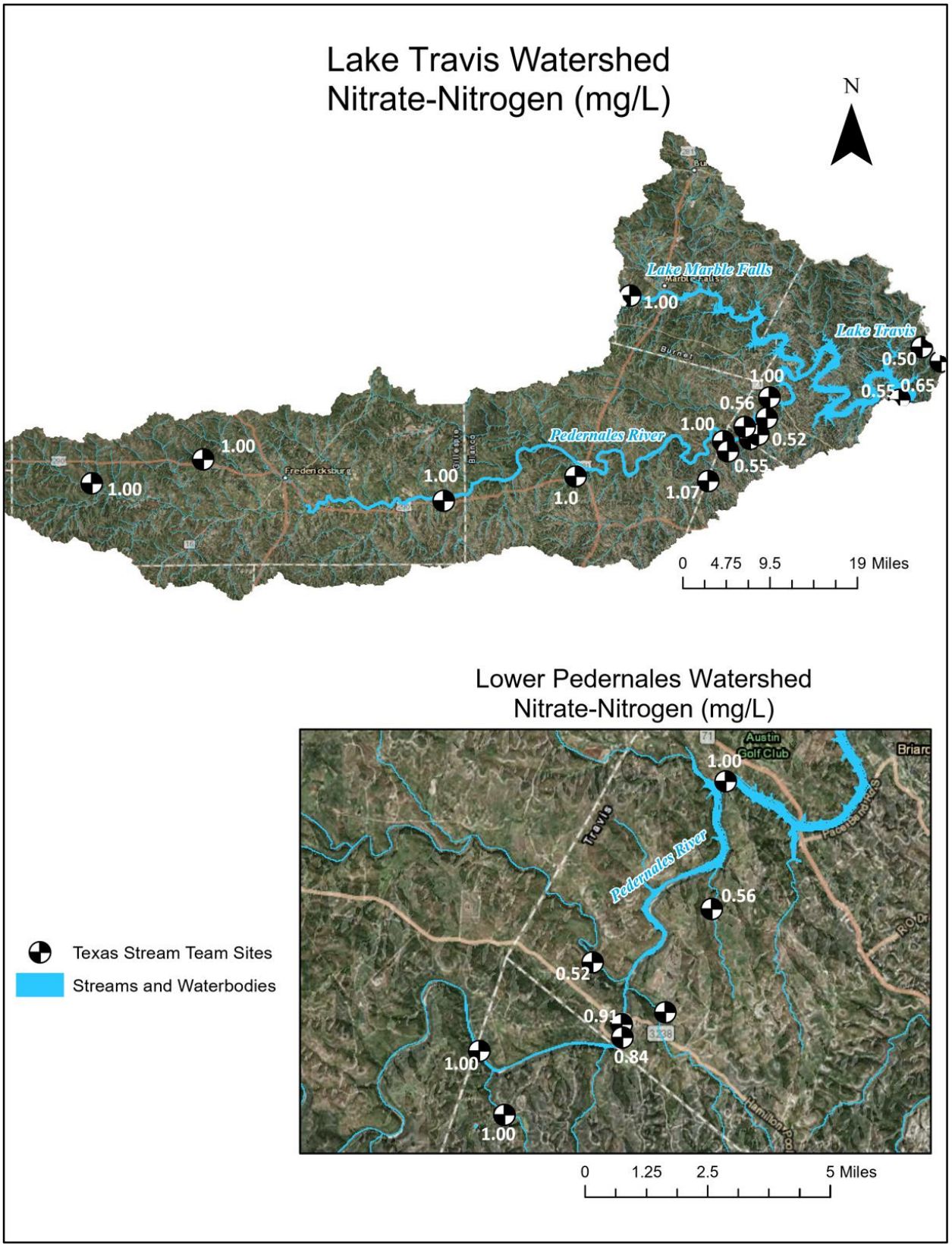

Figure 14: Map of the average nitrate-nitrogen for sites in the Lake Travis Watershed

Dense algal blooms or rapid plant growth can occur in waters rich in phosphorus, a limiting nutrient for eutrophication since it is typically in shortest supply. Sources are human and animal wastes and fertilizers. The EPA water quality criteria state that orthophosphates should not exceed 0.10 mg/L in streams or flowing waters not discharging into lakes or reservoirs to control algal growth. Site 80934, the only site monitored for orthophosphate concentrations, exceeded 0.10 mg/L in all its samples and demonstrated an average of 0.63 mg/L.

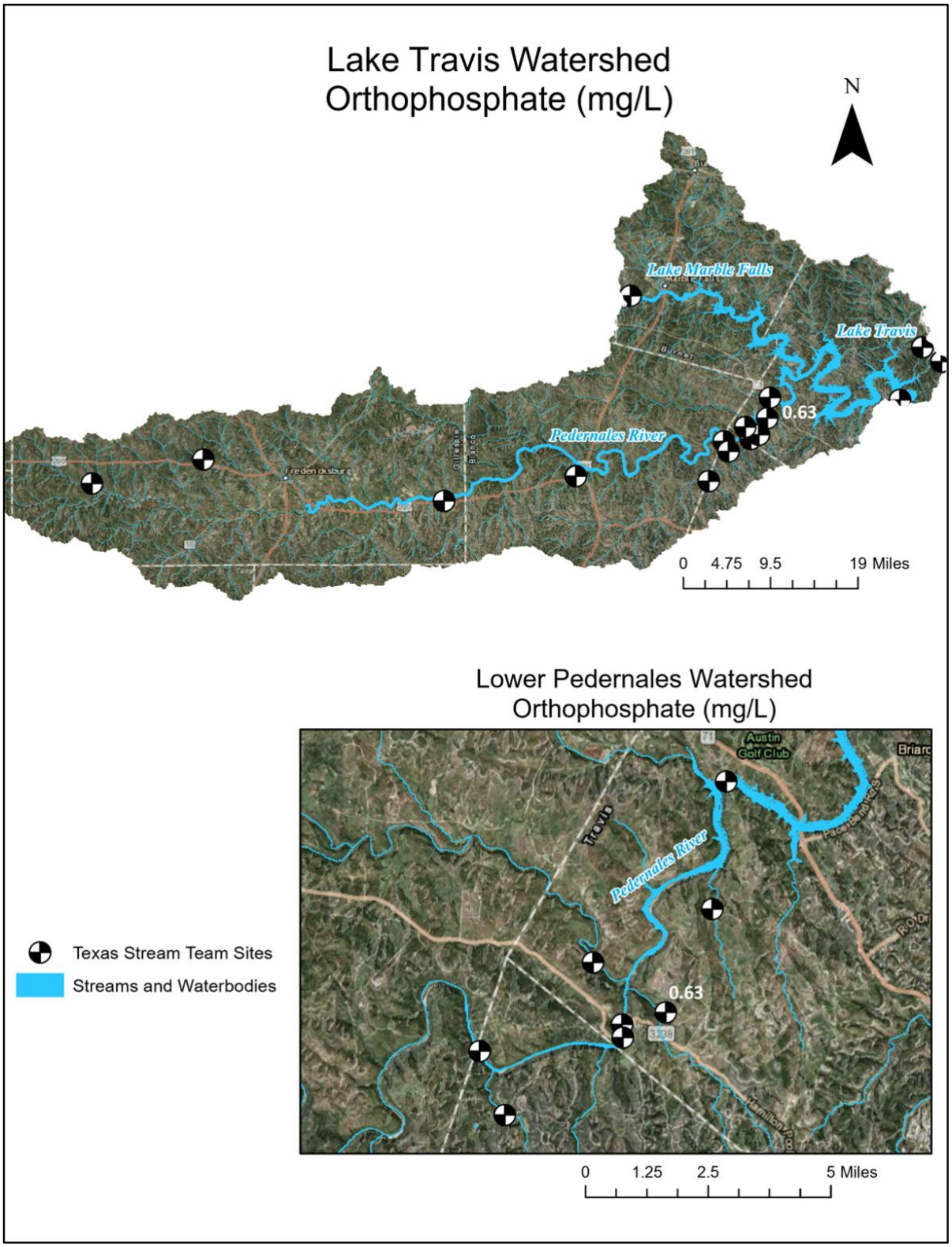

Figure 15: Map of the average orthophosphate for sites in the Upper Cibolo Creek Watershed

Please see Table 6 below for a summary of average results at all sites. It is important to note that there was variation in the number of times each site was tested, the time of day at which each site was tested, and the time of month the sampling occurred. While this is a quick overview of the results, it is important to keep in mind that there is natural diurnal and seasonal variation in these water quality parameters. TST citizen scientist data is not used by the state to assess whether water bodies are meeting the designated surface water quality standards.

Table 6: Average values for all Lake Travis Watershed sites

Site Number	TDS (mg/L)	DO (mg/L)	pH (su)	*E.coli* (CFU/100 mL) *geomean	Nitrate-Nitrogen (mg/L)	Orthophosphate (mg/L)
12369	358 ± 55	7.9 ± 1.7	8.2 ± 0.4	15 ± 409	0.91 ± 0.28	N/A
17335	400 ± 47	6.4 ± 1.8	7.6 ± 0.3	19 ± 991	0.84 ± 0.29	N/A
80310	356 ± 54	7.3 ± 1.4	7.8 ± 0.5	8 ± 239	1.00 ± 0.00	N/A
80314	553 ± 86	5.5 ± 2.0	7.7 ± 0.3	391 ± 1027	1.00 ± 0.00	N/A
80934	304 ± 30	6.9 ± 1.7	7.1 ± 0.2	34 ± 228	N/A	0.63 ± 0.37
80935	338 ± 50	6.7 ± 1.5	7.9 ± 0.2	13 ± 182	0.52 ± 0.36	N/A
80936	322 ± 38	6.9 ± 1.8	7.1 ± 0.2	40 ± 480	0.56 ± 0.54	N/A
81496	335 ± 42	7.1 ± 1.3	7.6 ± 0.3	N/A	1.00 ± 0.00	N/A
81497	321 ± 19	7.3 ± 1.5	7.5 ± 0.4	N/A	1.00 ± 0.00	N/A
81498	312 ± 51	7.9 ± 1.7	7.0 ± 0.0	N/A	1.00 ± 0.00	N/A
81499	345 ± 17	6.3 ± 1.4	7.0 ± 0.0	N/A	1.00 ± 0.00	N/A
81500	445 ± 53	7.1 ± 2.4	8.4 ± 0.2	4 ± 11	1.00 ± 0.00	N/A
81504	291 ± 9	6.3 ± 1.7	7.0 ± 0.0	N/A	1.00 ± 0.00	N/A
81490	291 ± 20	6.5 ± 1.2	7.5 ± 0.2	2 ± 8	0.55 ± 0.36	N/A
81476	286 ± 33	7.7 ± 1.6	8.0 ± 0.4	7 ± 119	1.07 ± 0.46	N/A
81507	261 ± 6	6.8 ± 1.5	7.3 ± 0.2	20 ± 31	1.00 ± 0.00	N/A
81494	465 ± 43	5.4 ± 1.1	7.1 ± 0.3	N/A	0.65 ± 0.40	N/A
81495	416 ± 22	5.7 ± 1.1	7.0 ± 0.2 (min)	N/A	0.50 ± 0.25	N/A

Site 12369 – Pedernales River at Hammett's Crossing

Site Description

This site is located on the western extreme of Travis County on a canyon of the Pedernales River and is situated immediately downstream of the Hamilton Pool Rd crossing and is approximately 900 meters upstream of the confluence with Hamilton Creek. The surrounding lands are mostly undeveloped, are predominantly rangeland, and include several notable protected areas including the Westcave Outdoor Discovery Center, Hamilton Pool Preserve, and Milton Reimers Ranch Park.

The exposed geologic formations at the site demonstrate the source for many water wells in the area: Glen Rose limestone, Hensel sand, Cow Creek limestone, Hammett Shale, Sycamore sand and Smithwick shale. The geology and groundwater-surface water interactions found at this site exhibit one of the most extensive and widely used groundwater resources in Texas: The Trinity aquifer (Lower Colorado River Authority 2012; George et al. 2011).

Sampling Information

This site was sampled 255 times between 6/15/1996 and 8/23/2018. The time of sampling for this site ranged from 6:46 to 19:26.

Table 7: Descriptive parameters for Site 12369

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	213	358 ± 55	221	514
Water Temperature (°C)	255	21.5 ± 6.9	4.5	34.5
Dissolved Oxygen (mg/L)	253	7.9 ± 1.7	4.1	14.6
pH (su)	252	8.2 ± 0.4	7.0	9.7
E. coli (CFU/100ml)	195	15 ± 409	1	5228
Nitrate-Nitrogen (mg/L)	241	0.91 ± 0.28	0.25	2

Site 12369 was sampled 255 times between 6/15/1996 and 8/23/2018.

Air and Water Temperature

Air temperatures were taken 253 times with water temperatures taken 255 times at this site. The air temperatures fluctuated in a seasonal pattern with the highest temperature of 41.5°C in July of 1996, and the lowest temperature of 3°C in January of 2009. The mean water temperature was 21.5°C and the water temperature ranged from a low of 4.5°C recorded in March of 2010 to a high of 34.5°C in July of 1996.

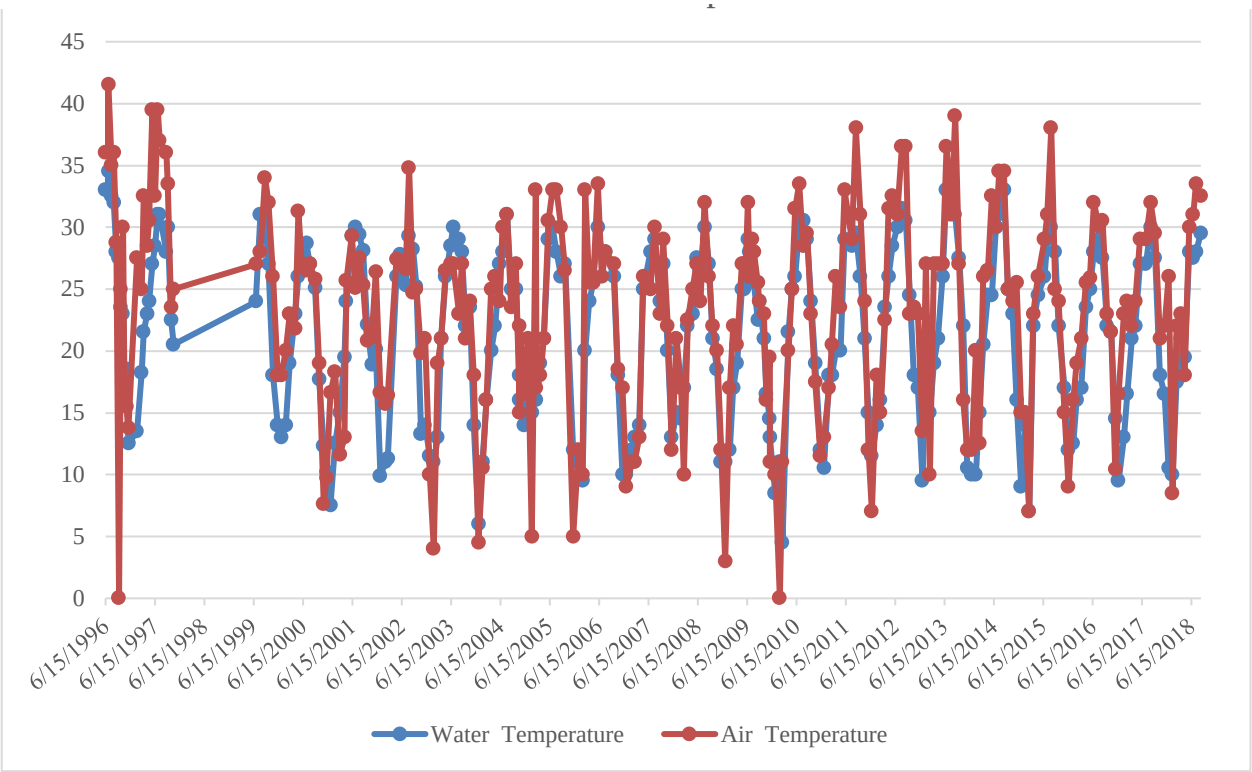

Figure 16: Air and water temperature at Site 12369

Total Dissolved Solids

Citizen scientists sampled TDS at this site 213 times between 8/4/2000 and 8/23/2018. The mean TDS concentration was 358 mg/L. The concentration of TDS ranged from a minimum of 221 mg/L in April of 2004 to a maximum of 514 mg/L in October of 2011.

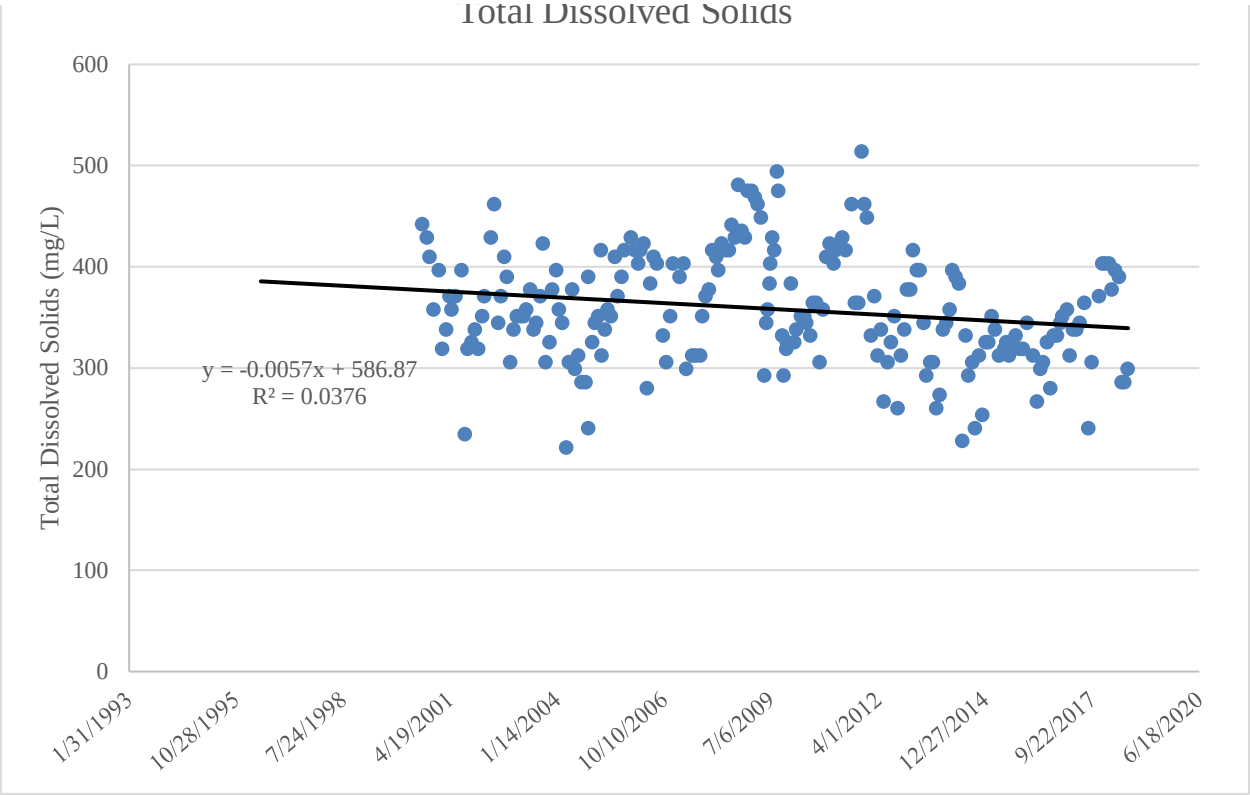

Figure 17: Total dissolved solids at Site 12369

Dissolved Oxygen

Citizen scientists took 253 DO samples at this site between 6/15/1996 and 8/23/2018. The mean DO concentration was 7.9 mg/L. DO concentrations ranged from a low of 1.7 mg/L in April of 2007 to a high of 14.6 mg/L in December of 2013.

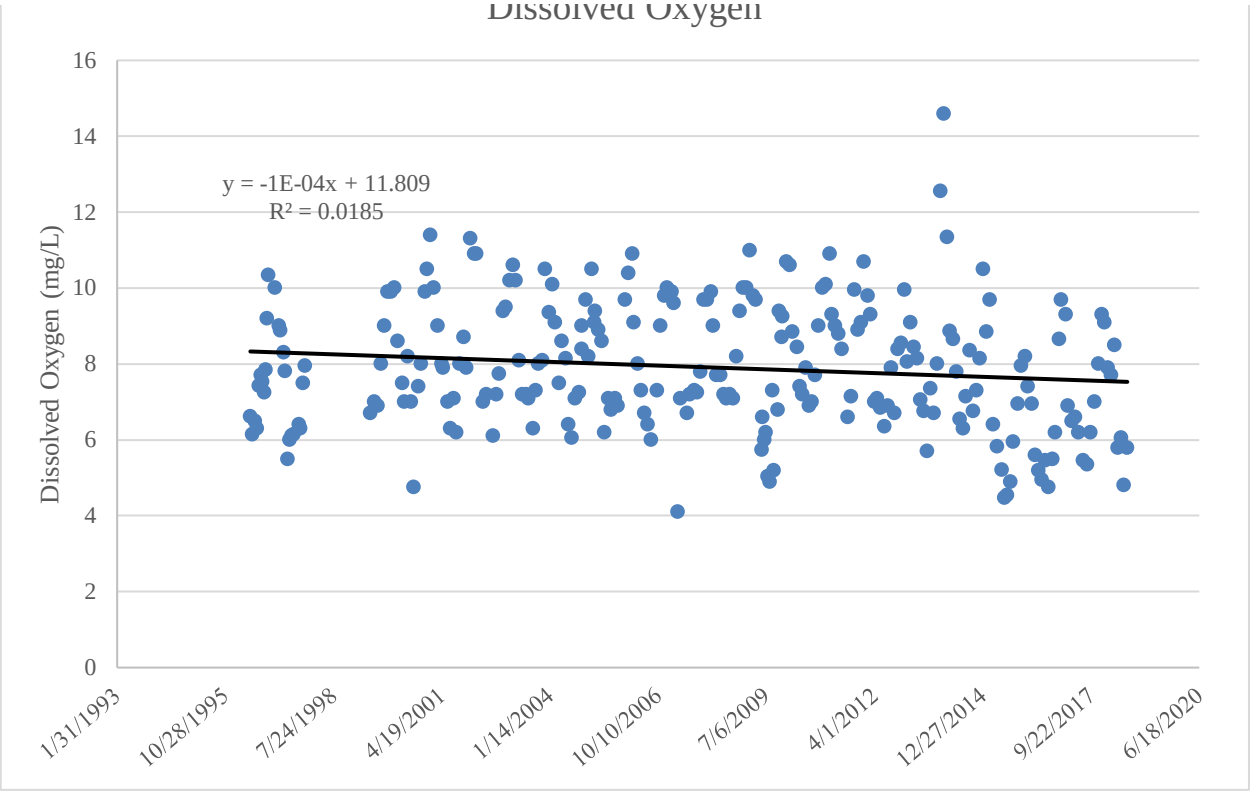

Figure 18: Dissolved oxygen at Site 12369

pH

There were 252 pH measurements taken at this site between 6/15/1996 and 8/23/2018. The mean pH was 8.2 and pH ranged from a low of 7.0 taken in January of 2009, February of 2016, and November of 2017 to a high of 9.7 taken in September of 2009.

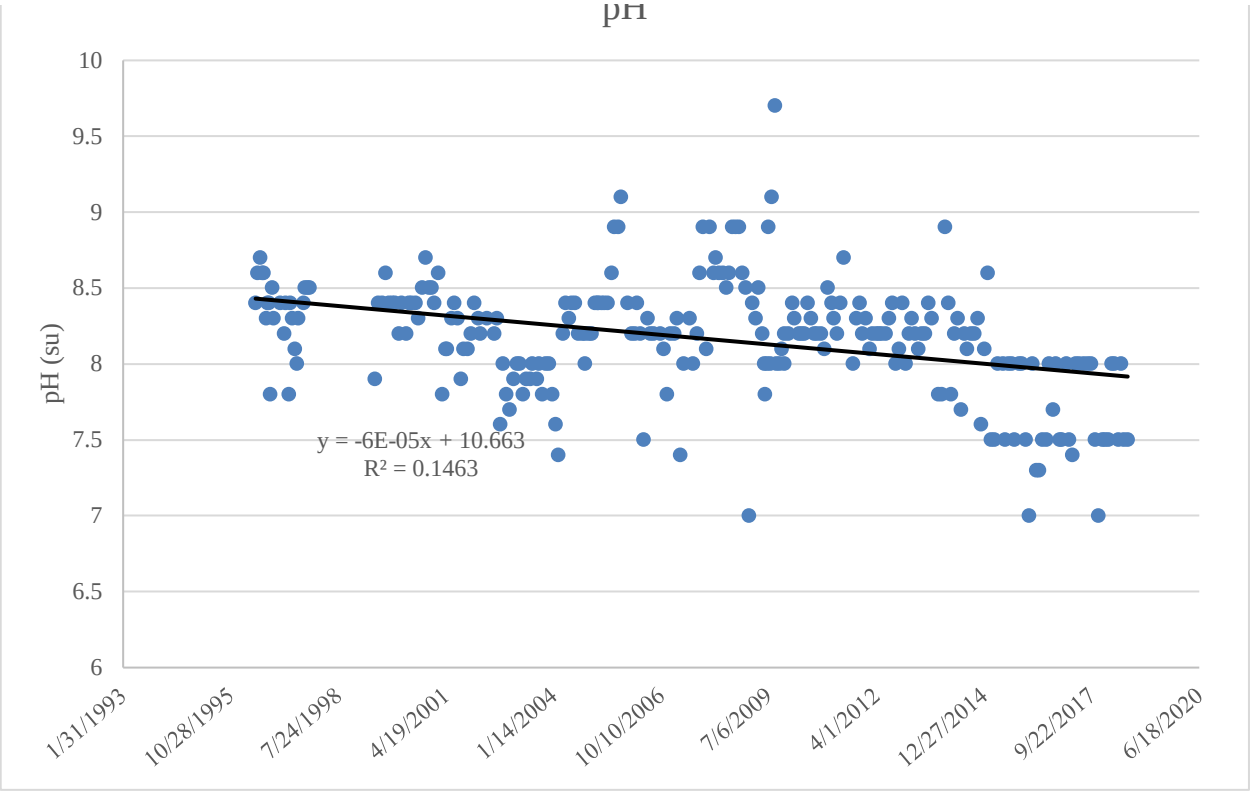

Figure 19: pH at Site 12369

E. coli

There were 195 *E. coli* measurements taken at this site between 5/25/1997 and 8/23/2018. The observed geomean was 15 CFU/100mL and ranged from 1 CFU/100mL taken on multiple occasions to a high of 5228 CFU/100mL taken in October of 2013.

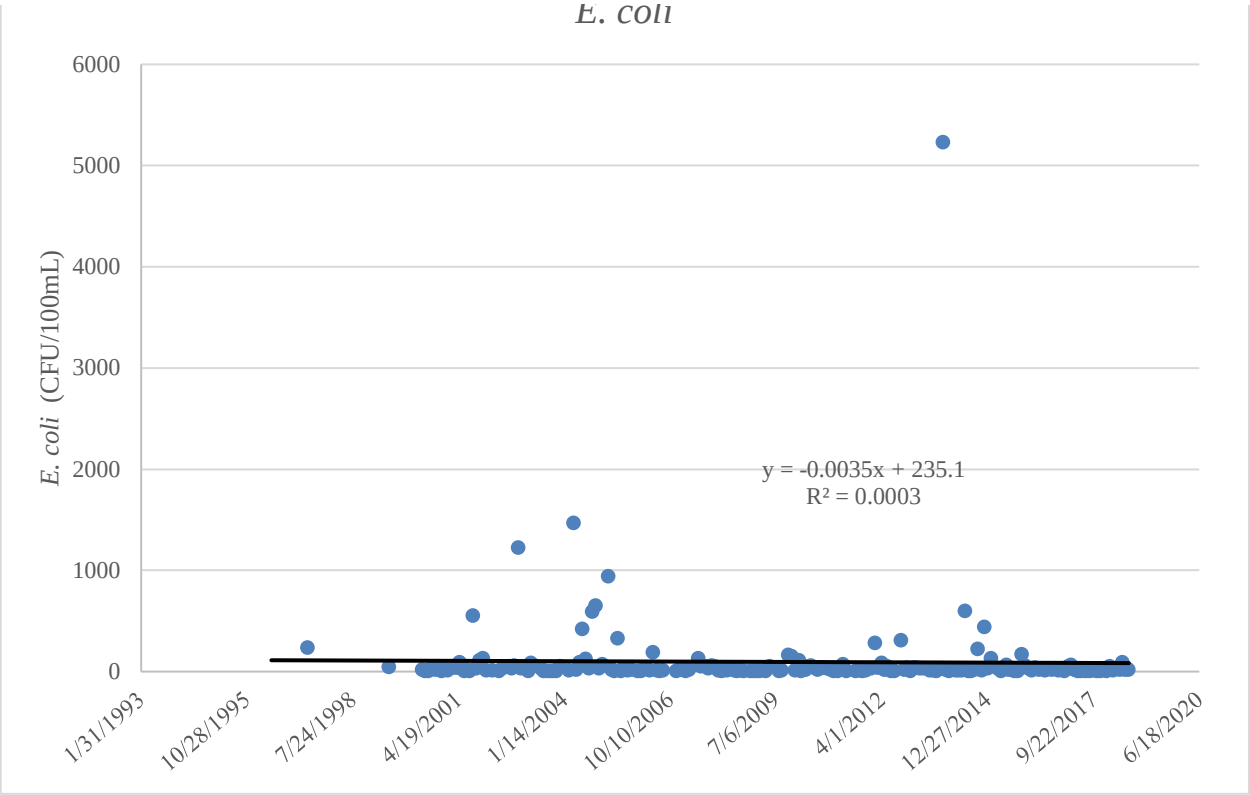

Figure 20: *E. coli* at Site 12369

Nitrate-Nitrogen

There were 241 nitrate-nitrogen measurements taken at this site between 6/15/1996 and 8/23/2018. The mean nitrate-nitrogen was 0.91 mg/L and nitrate-nitrogen ranged from a low of 0.25 mg/L taken multiple times to a high of 2.0 mg/L taken in November of 2000, January of 2001, and February of 2010.

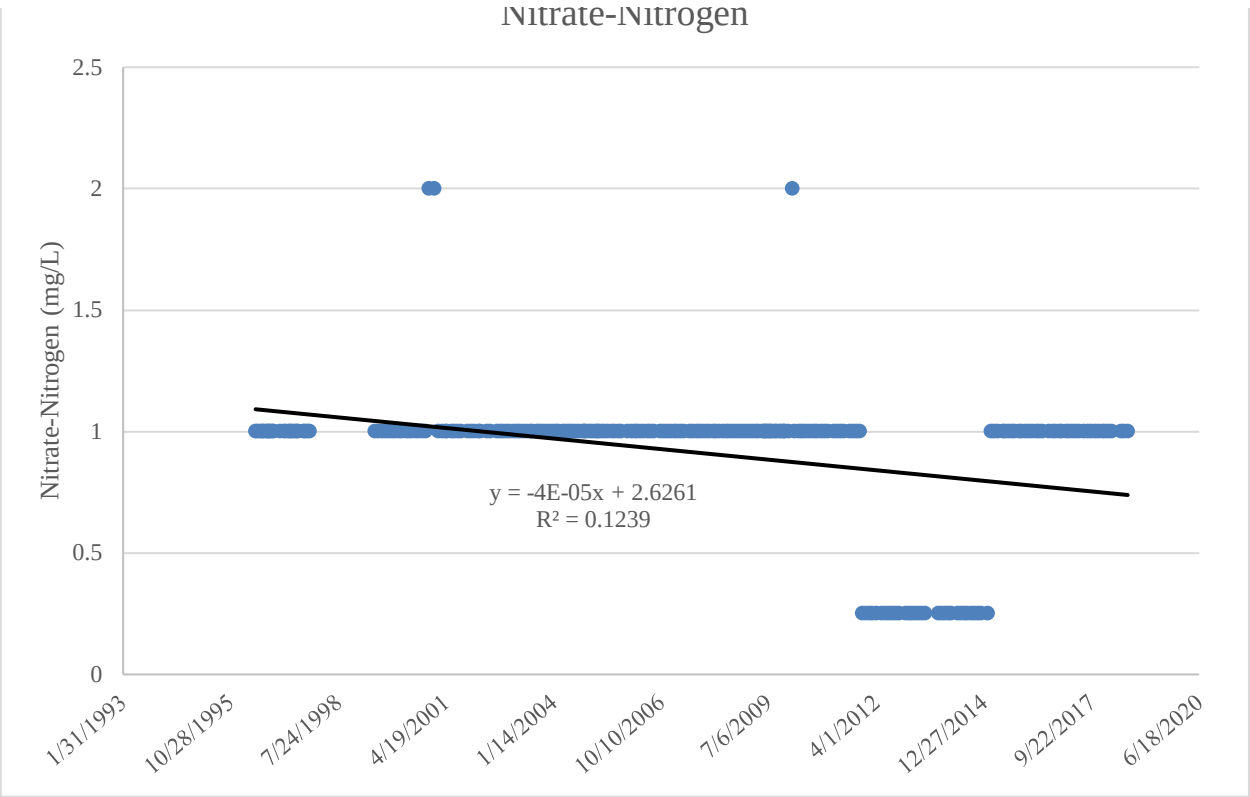

Figure 21: Nitrate-Nitrogen at Site 12369

Site 17335 – Heinz Creek in the Westcave Preserve

Site Description

The Heinz Branch Creek is located within the Westcave Preserve. This 5.8 kilometer, intermittent tributary of the Pedernales River is fed mostly by springs in grottos found along the Cow Creek limestone. The groundwater is recharged through the overlying Hensel sands found nearby which allow infiltration to the Trinity aquifer (Lower Colorado River Authority 2007).

Sampling Information

This site was sampled 255 times between 12/5/1996 and 6/30/2018. The time of sampling for this site ranged from 7:00 to 20:12.

Table 8: Descriptive parameters for Site 17335

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	213	400 ± 47	137	468
Water Temperature (°C)	255	18.1 ± 4.2	2.5	31.0
Dissolved Oxygen (mg/L)	253	6.4 ± 1.8	0.9	10.7
pH (su)	252	7.6 ± 0.3	6.7	8.6
E. coli CFU/100mL)	195	19 ± 991	1	9707
Nitrate-Nitrogen (mg/L)	241	0.84 ± 0.29	0.25	1

Site 17335 was sampled 255 times between 12/5/1996 and 6/30/2018.

Air and Water Temperature

Air temperature was taken 253 times and water temperature was taken 255 times at this site between 12/05/1996 and 6/30/2018. The mean water temperature was 18.1°C and ranged from a low temperature of 2.5°C in January of 2009 to a high 31°C in July of 1999. The air temperature ranged from a low of 1.0°C in December of 2017, to a high of 35.5°C in March of 2006.

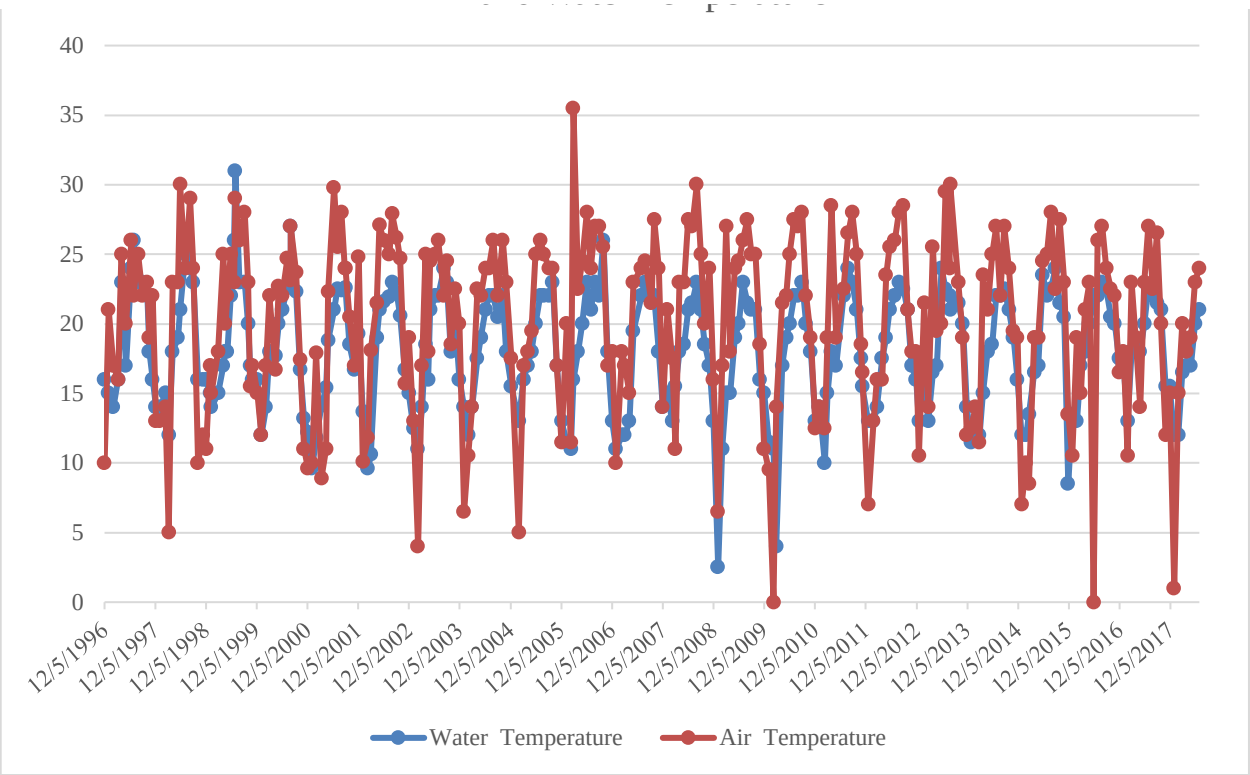

Figure 22: Air and water temperature at Site 17335

Total Dissolved Solids

Citizen scientists collected 213 TDS samples at this site between 9/13/2000 and 6/30/2018. The mean TDS concentration was 400 mg/L. The minimum TDS concentration was 136.5 mg/L and was taken in October of 2015. The maximum TDS concentration was 468 mg/L and was taken in October of 2017.

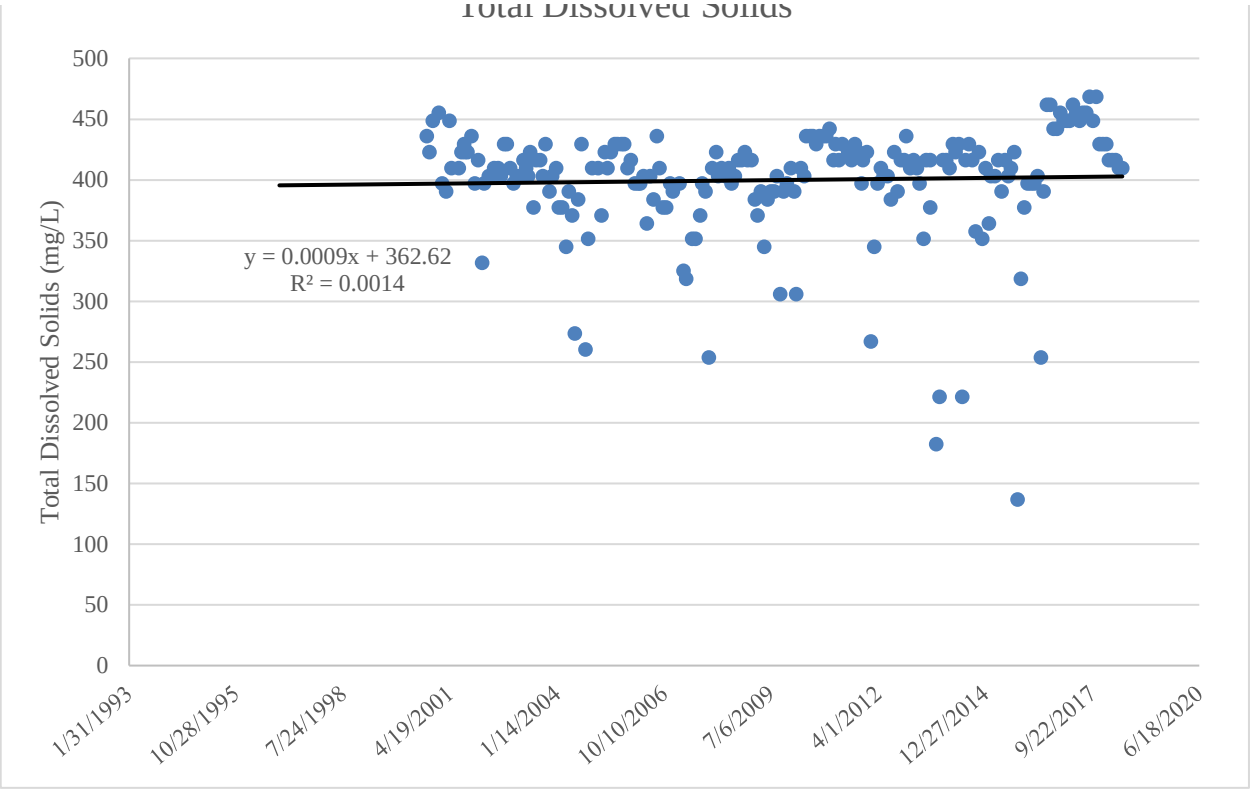

Figure 23: Total dissolved solids at Site 17335

Dissolved Oxygen

Citizen scientists collected 253 DO samples at this site between 12/5/1996 and 6/30/2018. The mean DO concentration was 6.4 mg/L. The minimum DO concentration was 0.9 mg/L and was taken in September of 2014. The maximum DO concentration was 10.7 mg/L and was taken in May of 2012.

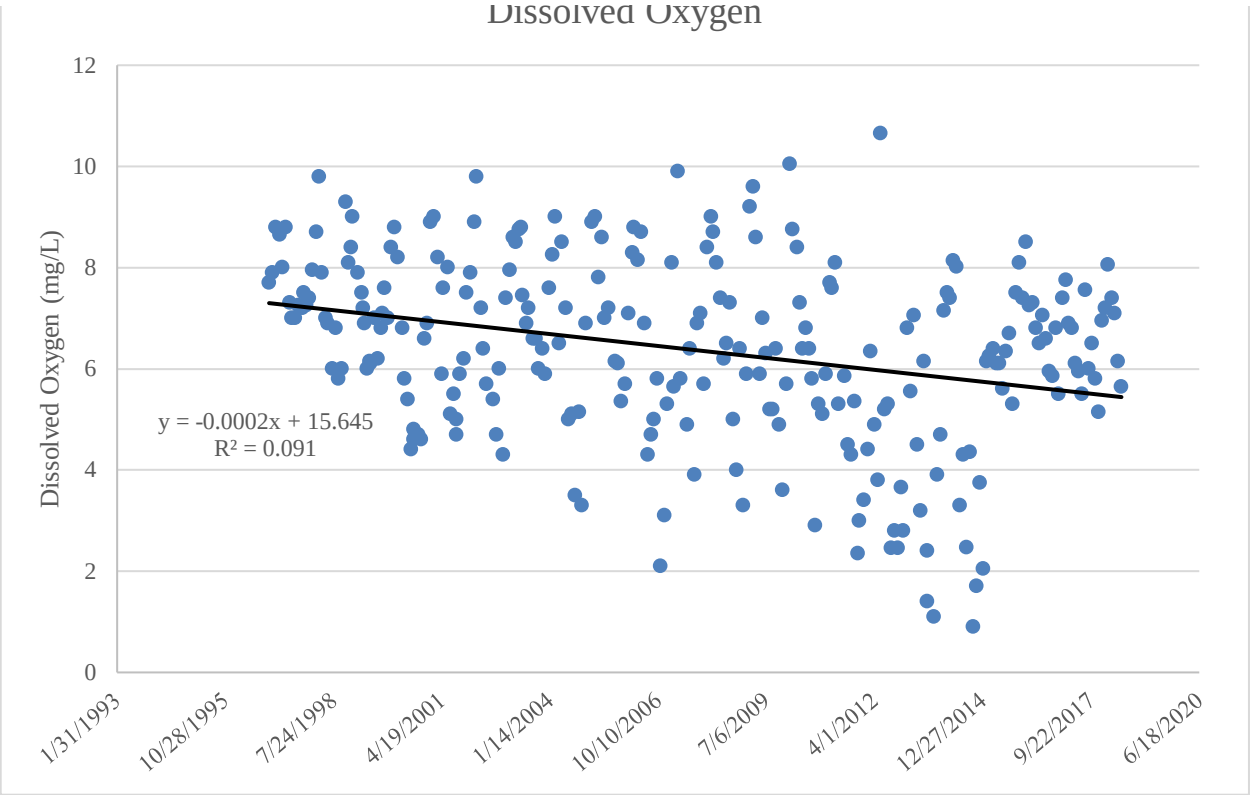

Figure 24: Dissolved oxygen at Site 17335

pH

A total of 252 pH measurements were taken at this site between 12/5/1996 and 6/30/2018. The mean pH was 7.6 and ranged from a low of 6.7 in April of 2017 to a high of 8.6 in July pf 1999 and October of 2009.

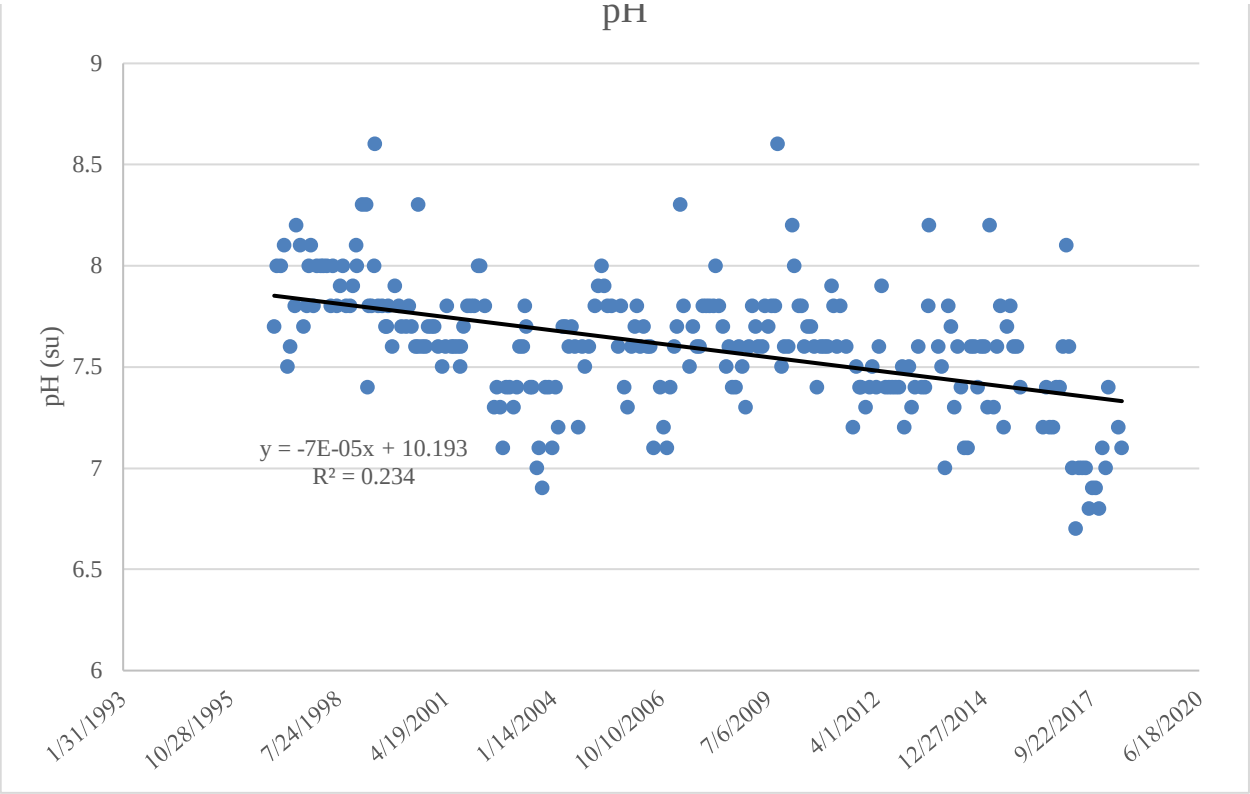

Figure 25: pH at Site 17335

E. coli

There were 195 *E. coli* measurements taken at this site between 5/6/1997and 2/28/2018. The observed geomean was 19 CFU/100mL and ranged from a low of 1 CFU/100mL taken on multiple occasions to a high of 9707 CFU/100mL taken in October of 2013.

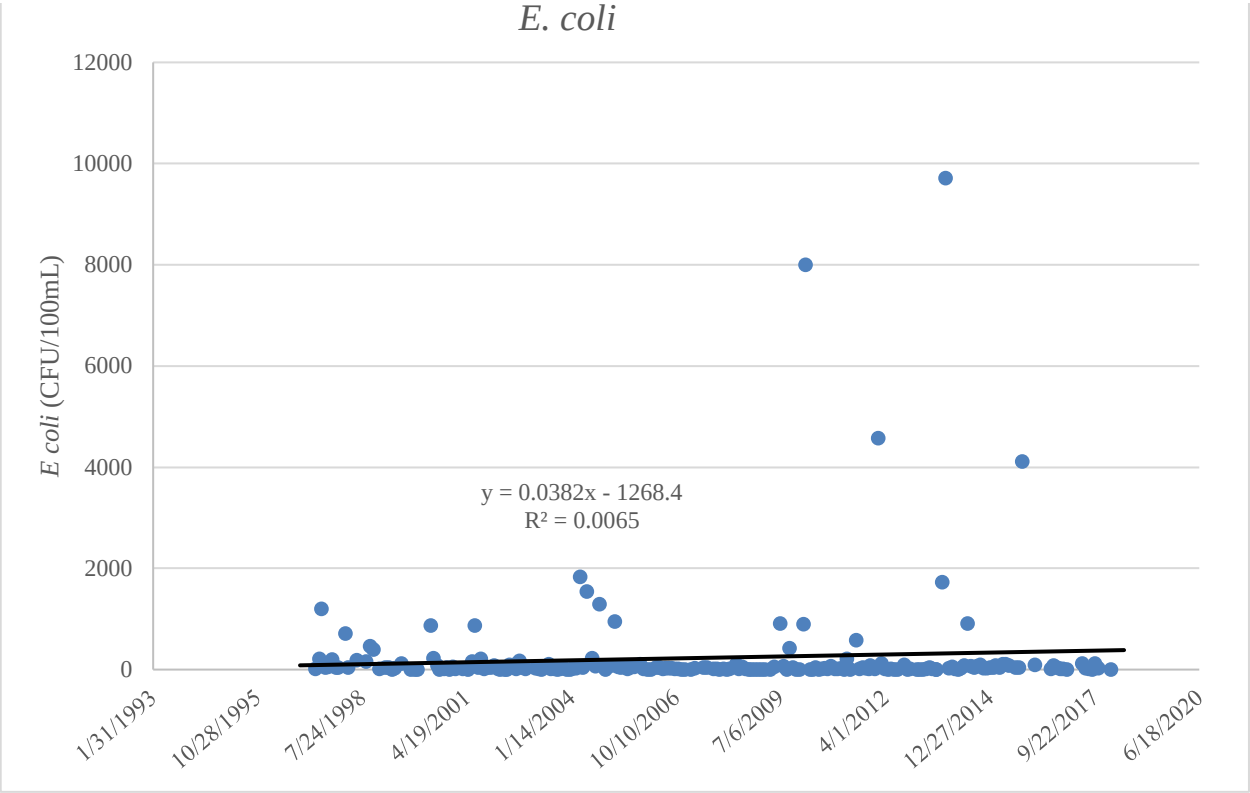

Figure 26: E. coli at Site 17335

Nitrate-Nitrogen

A total of 241 nitrate-nitrogen measurements were taken at this site between 12/5/1996 and 6/30/2018. The mean nitrate-nitrogen was 0.84 mg/L and ranged from a low of 0.25 mg/L on multiple instances and a high of 1mg/L on multiple instances.

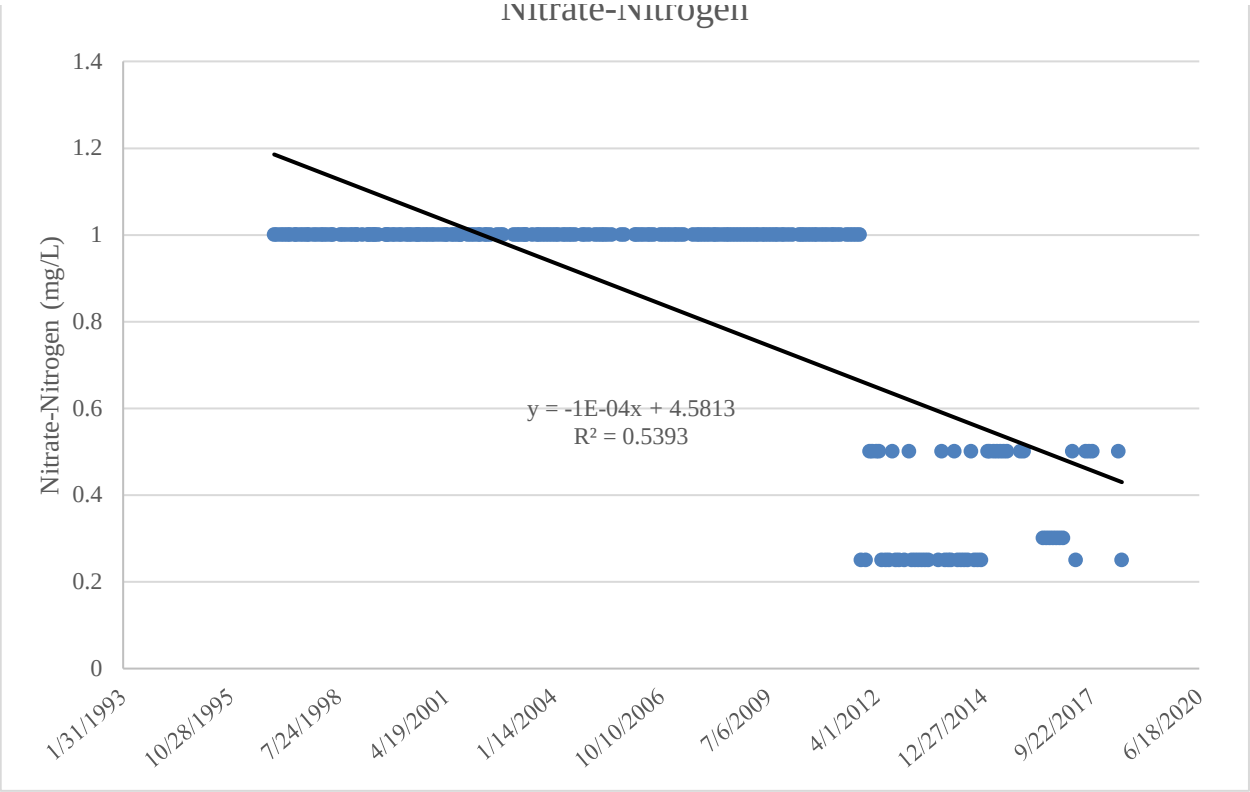

Figure 27: Nitrate-Nitrogen at Site 17335

Site 80310 – Pedernales River at Buffalo Crossing

Site Description

This site is located approximately 2.7 kilometers downstream of Texas State Highway 71 and is roughly where the Pedernales River begins to form its arm of Lake Travis. The sampling site is located on private property on a bend of the river roughly 500 meters downstream of an intermittent stream known as Fall Creek.

Sampling Information

This site was sampled 167 times between 10/21/2002 and 8/31/2018. Sampling times ranged between 8:30 and 14:50.

Table 9: Descriptive parameters for Site 80310

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	164	356 ± 54	169	494
Water Temperature (°C)	167	22.3 ± 6.8	7.0	36.0
Dissolved Oxygen (mg/L)	164	7.3 ± 1.4	4.3	10.8
pH (su)	165	7.8 ± 0.5	6.5	8.9
E. coli (CFU/100 mL)	163	8 ± 239	1	2680
Nitrate-Nitrogen (mg/L)	164	1 ± 0	1	1

Site 80310 was sampled 167 times between 10/21/2002 and 8/31/2018.

Air and Water Temperature

Both air and water temperatures were taken 167 times during this time period. The mean water temperature was 22.3°C and ranged from low of 7.0°C in January of 2010 to a high of 36.0°C in August of 2018. The mean air temperature was 24.9°C and ranged from a low of 7.0°C in January of 2008 to a high of 40.5°C taken in July of 2009.

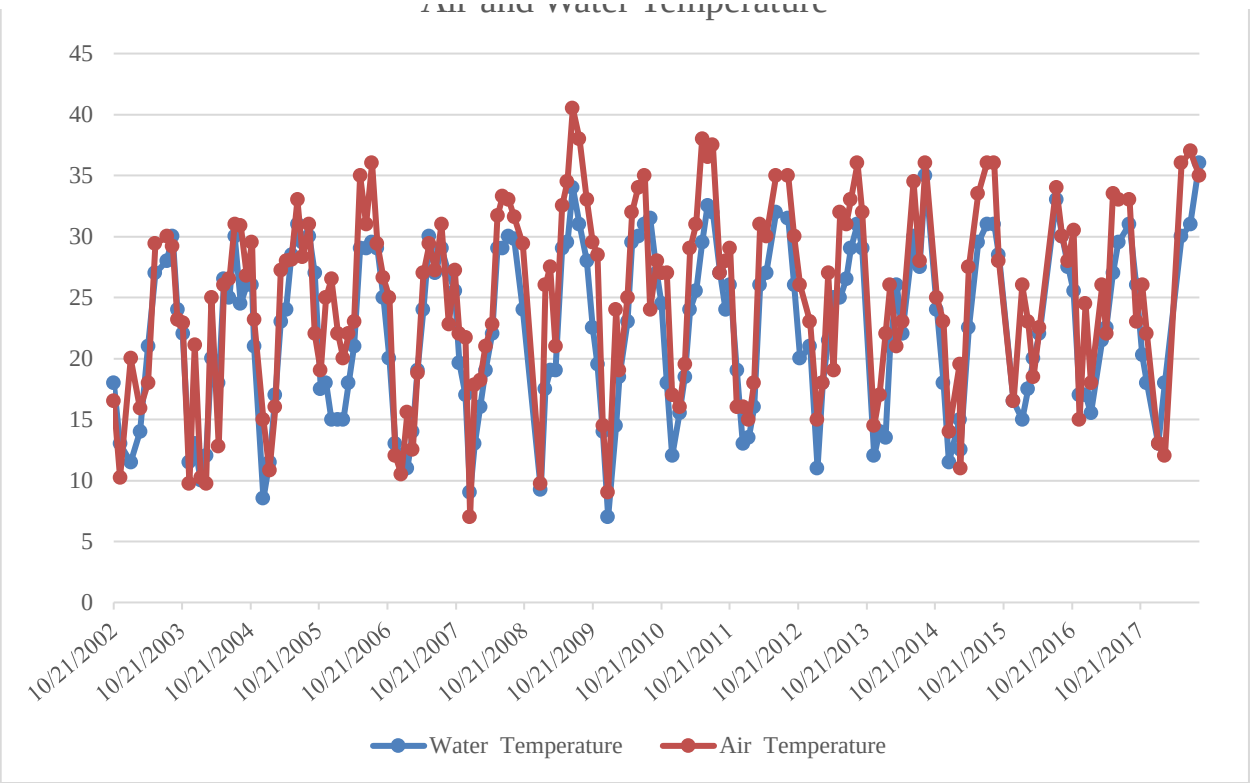

Figure 28: Air and water temperature at Site 80310

Total Dissolved Solids

Citizen scientists collected 164 TDS samples between 10/21/2002 and 8/31/2018. The mean TDS concentration was 356 mg/L and ranged from a minimum of 169 mg/L in March of 2007 to a maximum of 494 mg/L in January of 2009.

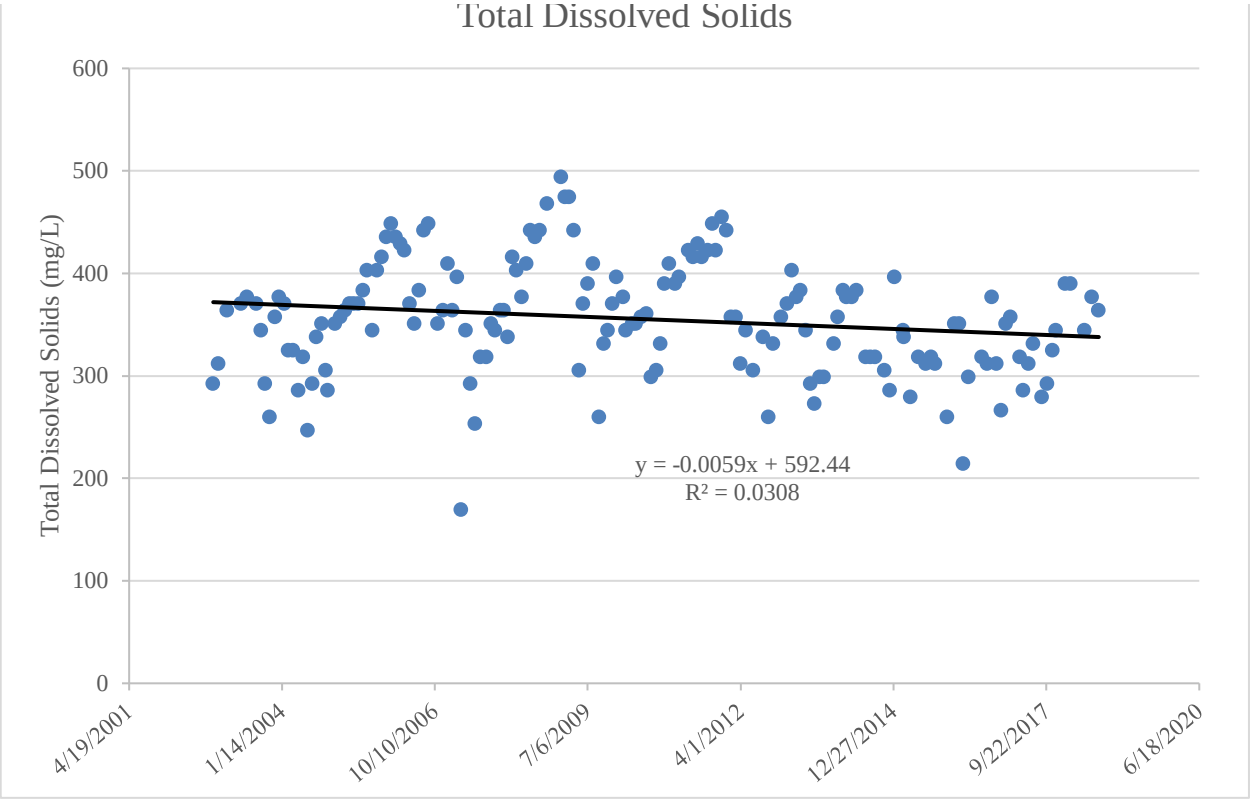

Figure 29: Total dissolved solids at Site 80310

Dissolved Oxygen

Citizen scientists collected 164 DO samples at this site between 11/25/2002 and 8/31/2018. The mean DO concentration was 7.3 mg/L. The minimum DO concentration was 4.3 mg/L and was taken in August of 2006. The maximum DO concentration was 10.8 mg/L and was taken in January of 2003.

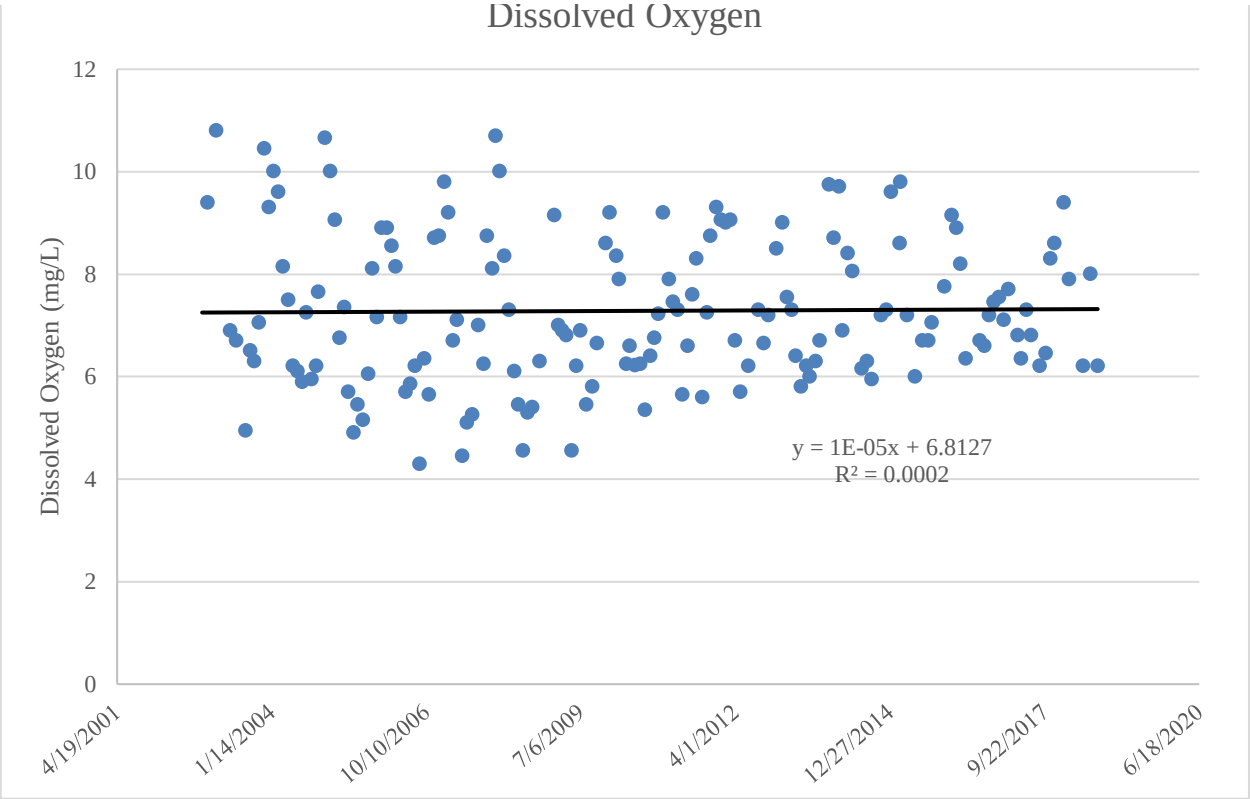

Figure 30: Dissolved oxygen at Site 80310

pH

Citizen scientists took 165 pH measurements at this site. The mean pH was 7.8 and ranged from a low of 6.5 in August and October of 2017 to a high of 8.9 in May of 2003.

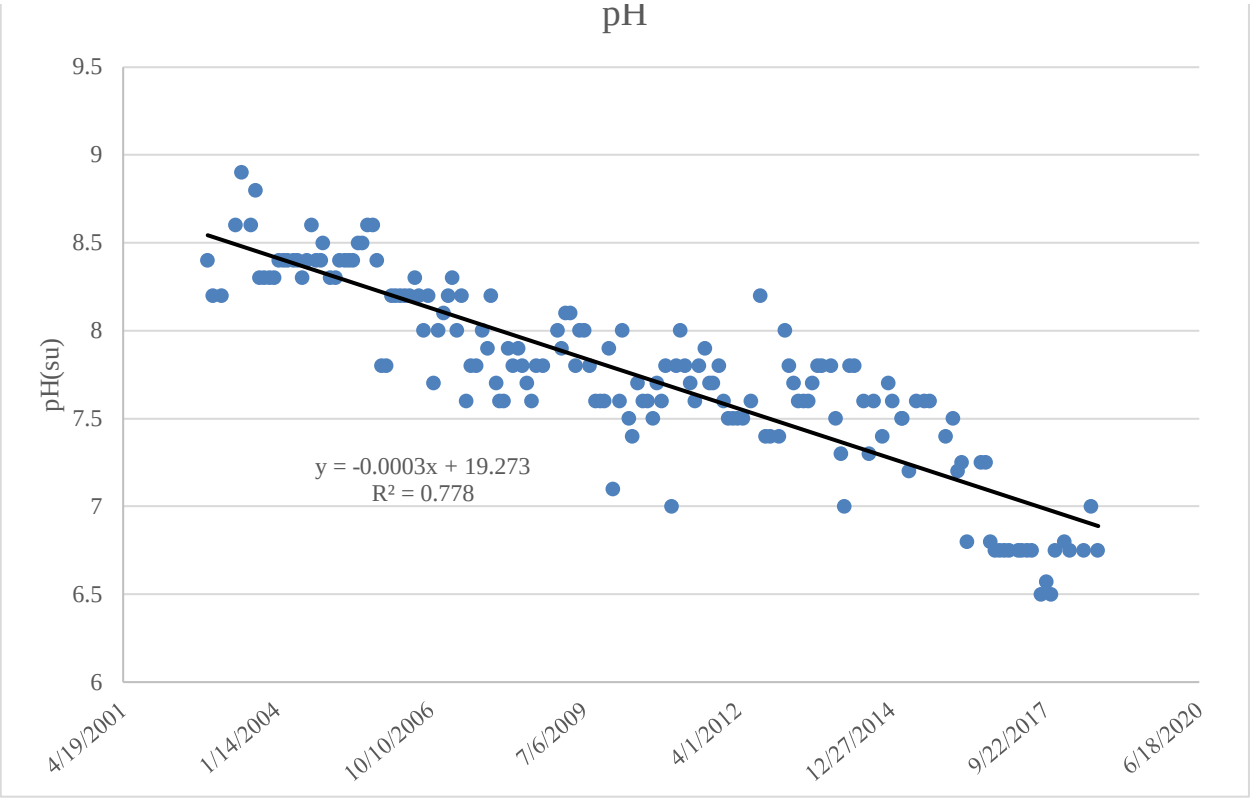

Figure 31: pH at Site 80310

E. coli

There were 163 *E. coli* measurements taken at this site between 10/21/2002 and 8/31/2018. The observed geomean was 8 CFU/100mL and ranged from a low of 1 CFU/100mL taken on multiple instances to a high of 2680 CFU/100mL taken in July of 2007.

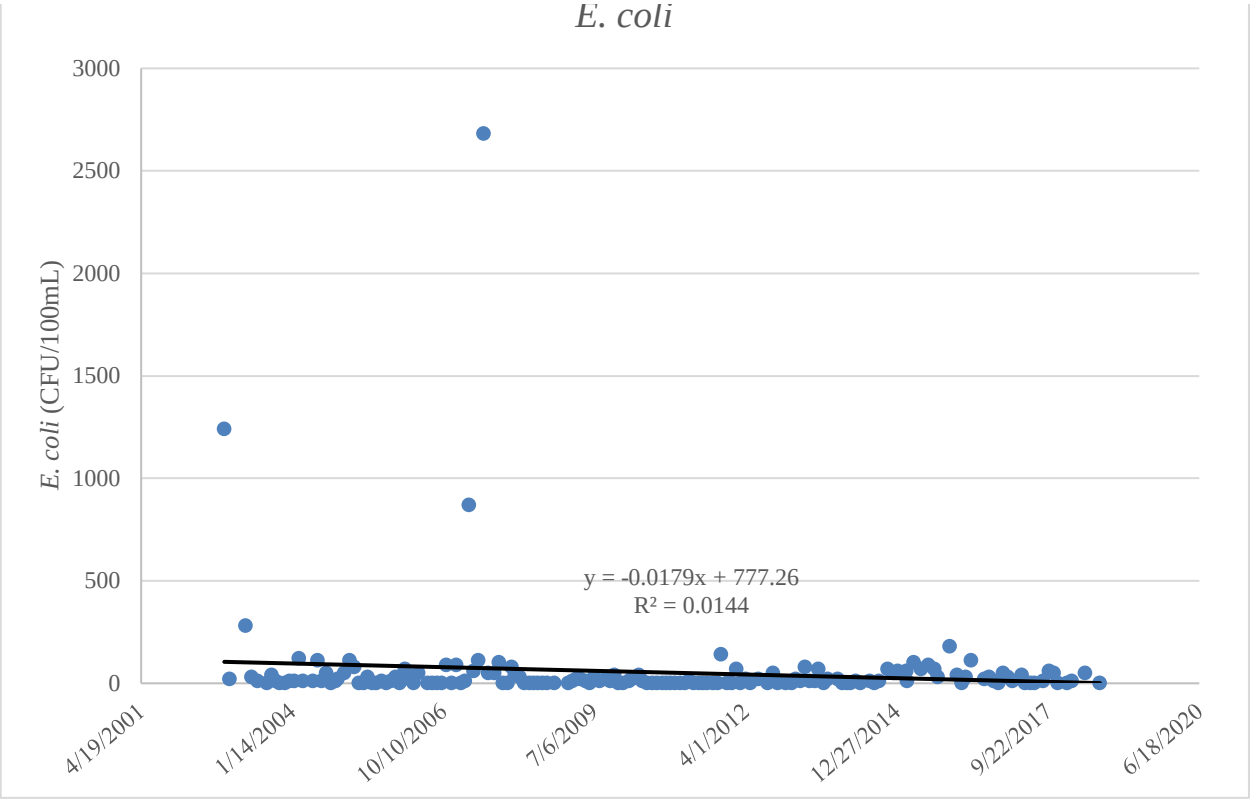

Figure 32: *E. coli* at Site 80310

Nitrate-Nitrogen

There were 164 nitrate-nitrogen measurements taken at this site between 11/25/2002 and 8/31/2018 all producing results of 1 mg/L.

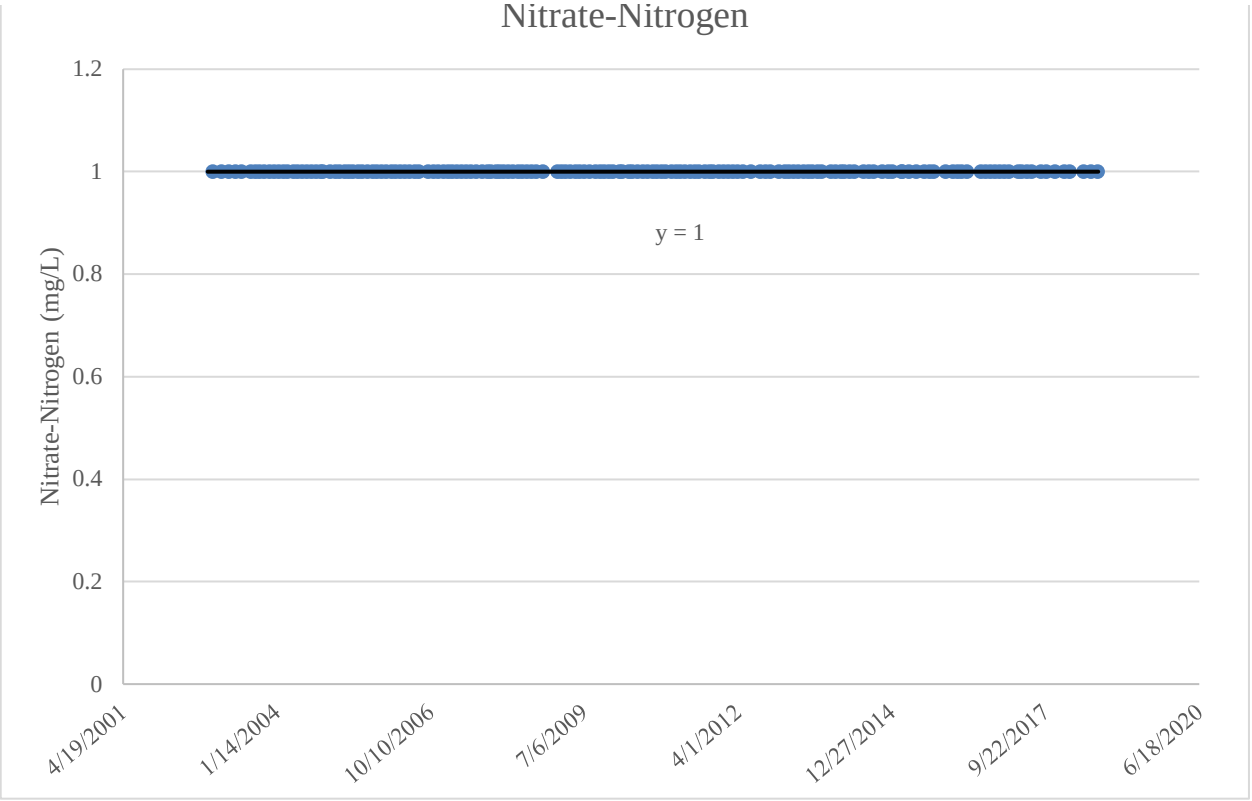

Figure 33: Nitrate-Nitrogen at Site 80310

Site 80314 – Town Creek @ Johnson Settlement

Site Description

This site is at the crossing of W Main Street in Johnson City at Town Creek. The creek continues approximately four kilometers northeast from this site until it empties out into the Pedernales River immediately downstream of the Lake Johnson City dam.

Sampling Information

This site has been sampled 108 times between 10/5/2004 and 6/25/2018. Sampling typically takes place in the morning after 8:45 and in two instances occurred in the afternoon as late as 17:30.

Table 10: Descriptive parameters for Site 80314

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	108	533 ± 86	150	728
Water Temperature (°C)	107	19.3 ± 5.0	9.0	27.0
Dissolved Oxygen (mg/L)	108	5.5 ± 2.0	0.9	11.5
pH (su)	106	7.7 ± 0.3	7.0	8.4
E. coli (CFU/100 ML)	94	391 ± 1027	1	7477
Nitrate-Nitrogen (mg/L)	105	1 ± 0	1	1

Site 80314 was sampled 108 times between 10/5/2004 and 6/25/2018.

Air and Water Temperature

Air temperatures were taken 108 times and water temperatures were taken 107 times at this site. The mean water temperature was 19.3°C, varying from a low of 9.0°C in February of 2011 to a high of 27.0°C in September of 2016. The air temperature varied from a low of 6°C in March of 2009 and February of 2011 to a high of 40.0°C in October of 2006.

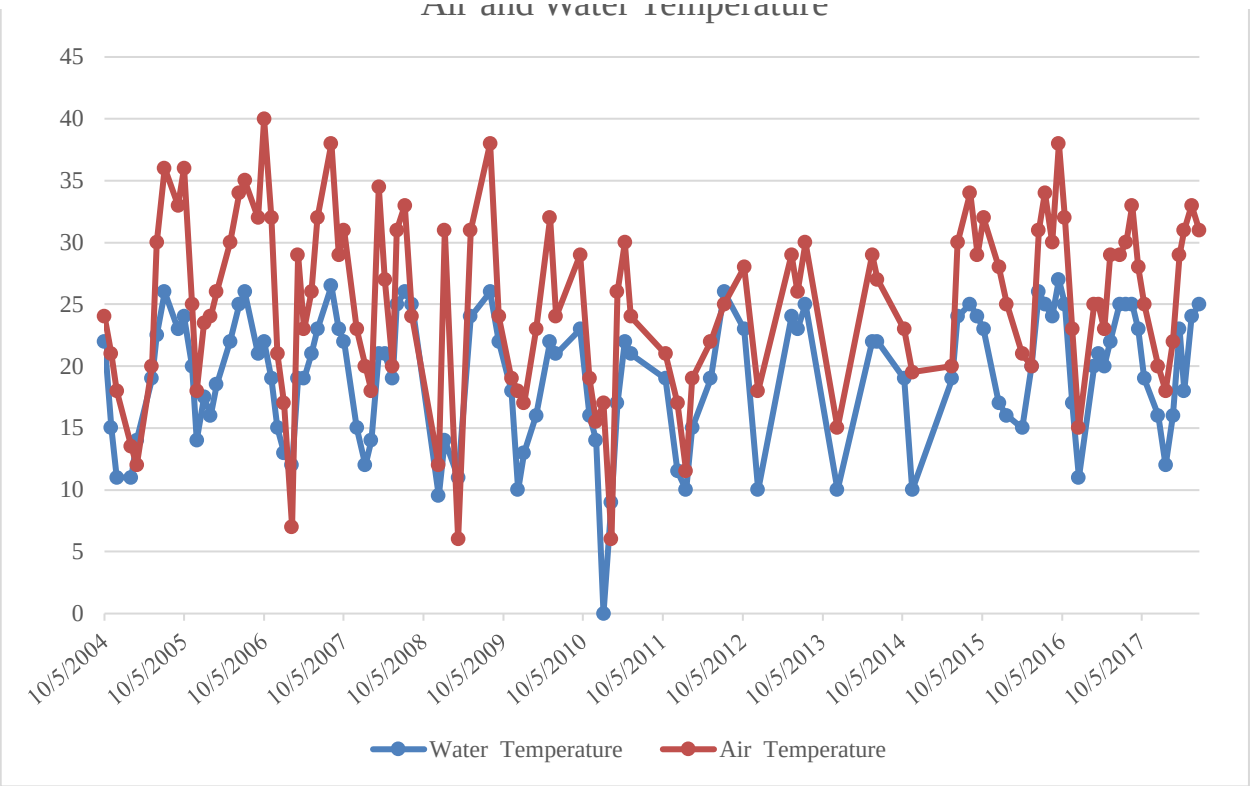

Figure 34: Air and water temperature at Site 80314

Total Dissolved Solids

Citizen scientists collected 108 TDS samples at this site between 10/5/2004 and 6/25/2018. The mean TDS concentration was 533 mg/L at this site. The minimum TDS concentration was 150 mg/L and was taken in May of 2016. The maximum TDS concentration was 728 mg/L taken in October of 2011.

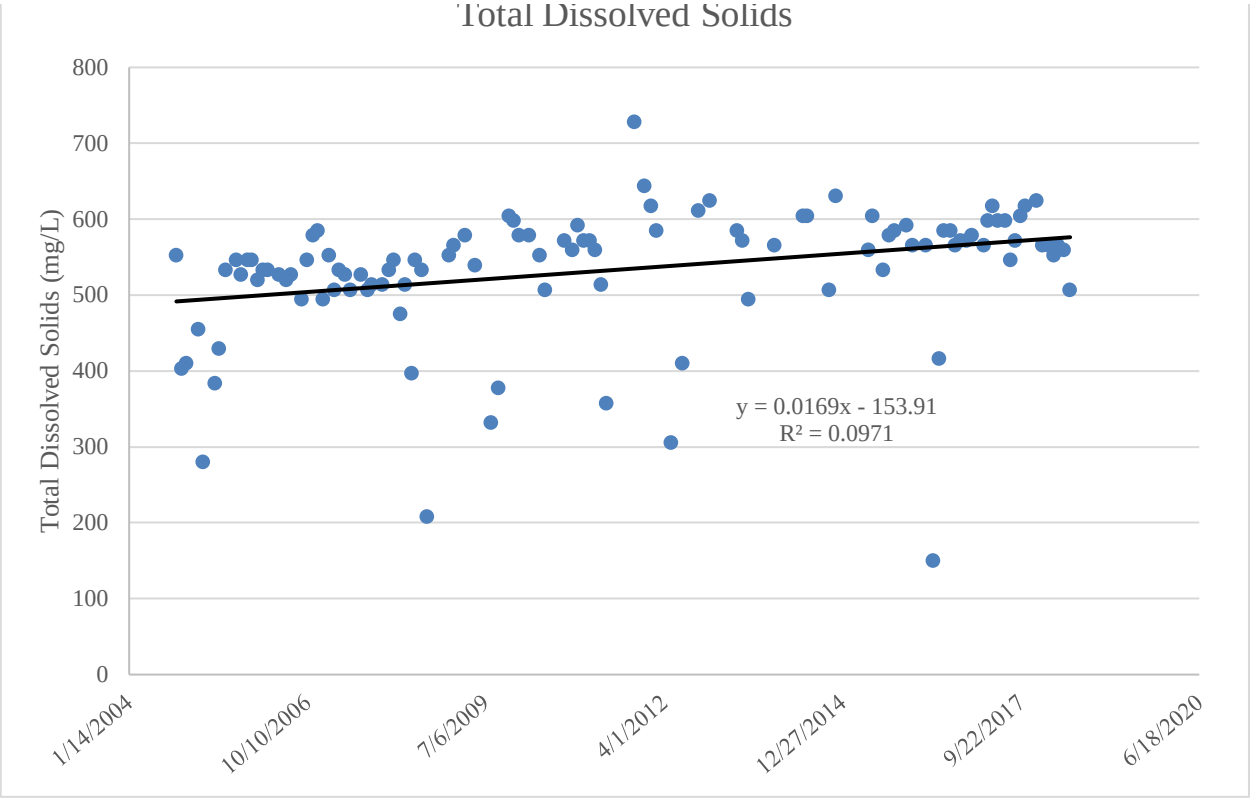

Figure 35: Total dissolved solids at Site 80314

Dissolved Oxygen

Citizen scientists collected 108 DO samples at this site between 10/5/2004 and 6/25/2018. The mean DO concentration was 5.5 mg/L. The minimum DO concentration was 0.9 mg/L and was recorded in August of 2009. The maximum DO concentration was 11.5 mg/L and was recorded in March 2007.

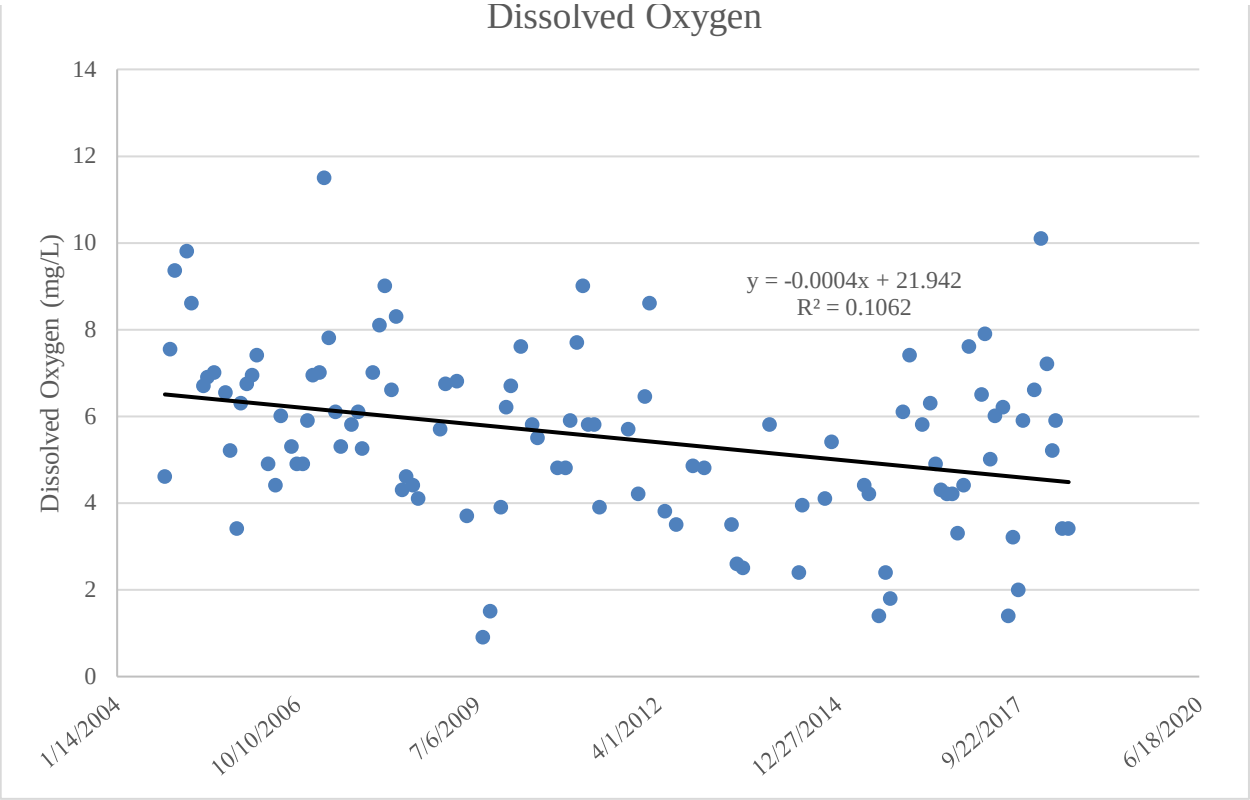

Figure 36: Dissolved oxygen at Site 80314

pH

Citizen scientists took 106 pH measurements at this site between 10/5/2004 and 6/25/2018. The mean pH was 7.7 and it ranged from a low of 7 on multiple instances and a high of 8.4 in December of 2010.

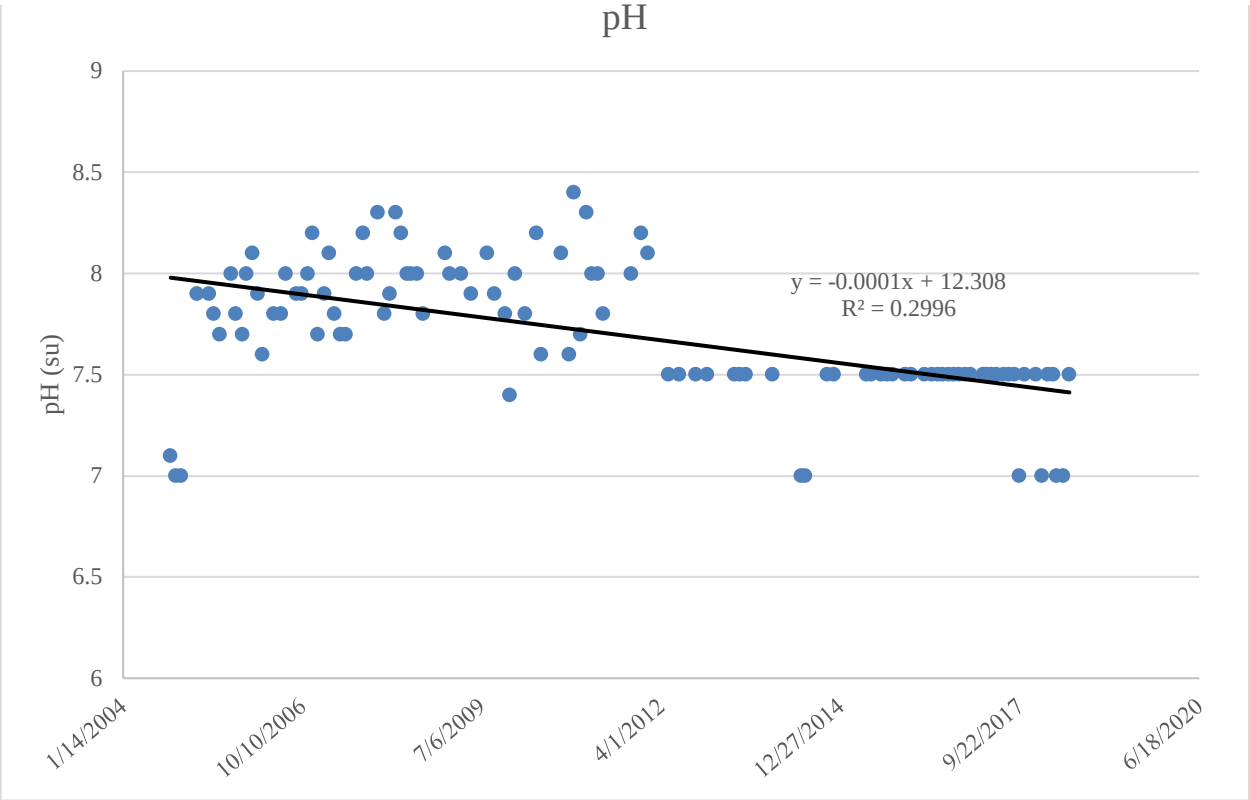

Figure 37: pH at Site 80314

E. coli

There were 94 *E. coli* measurements taken at this site between 11/4/2004 and 6/25/2018. The observed geomean was 391 CFU/100mL and ranged from a low of 1 CFU/100mL taken in March of 2010 to a high of 7477 CFU/100mL taken in May of 2016.

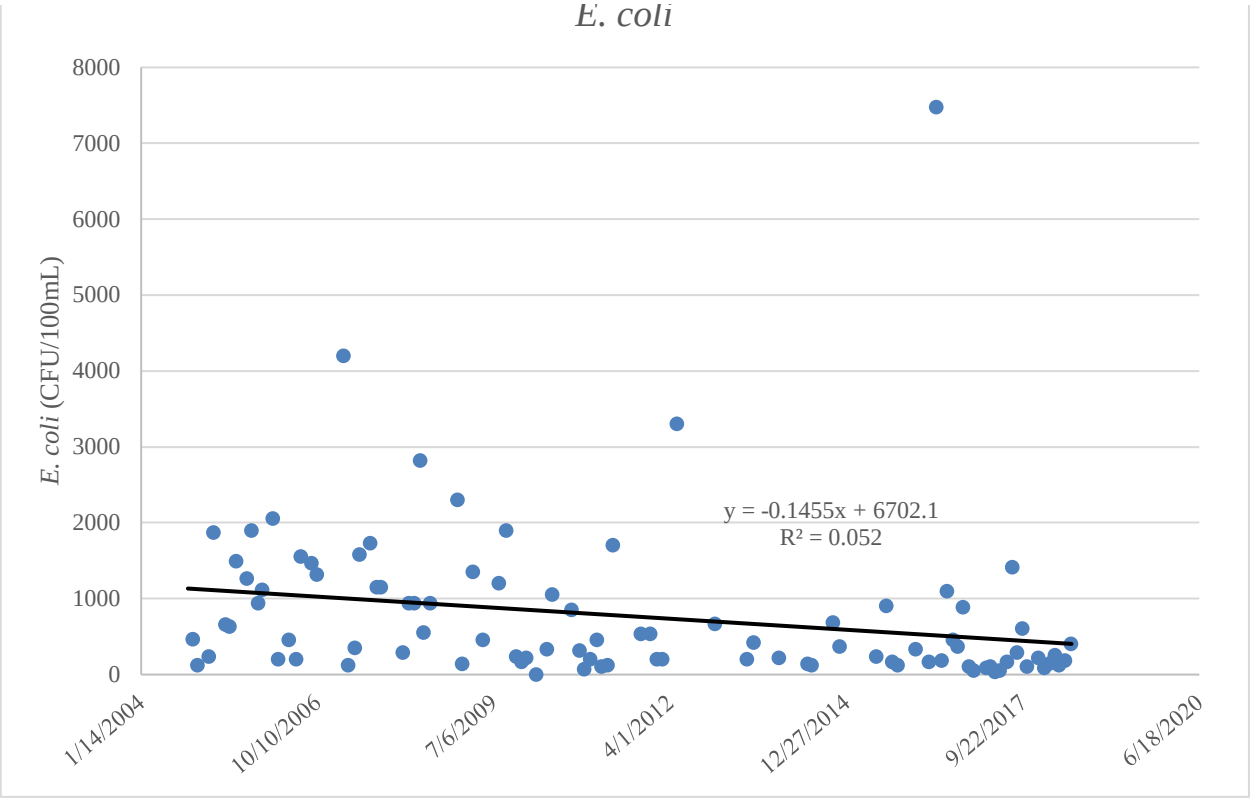

Figure 38: *E. coli* at Site 80314

Nitrate-Nitrogen

There were 105 nitrate-nitrogen measurements taken at this site between 10/5/2004 and 6/25/2018 all producing results of 1 mg/L.

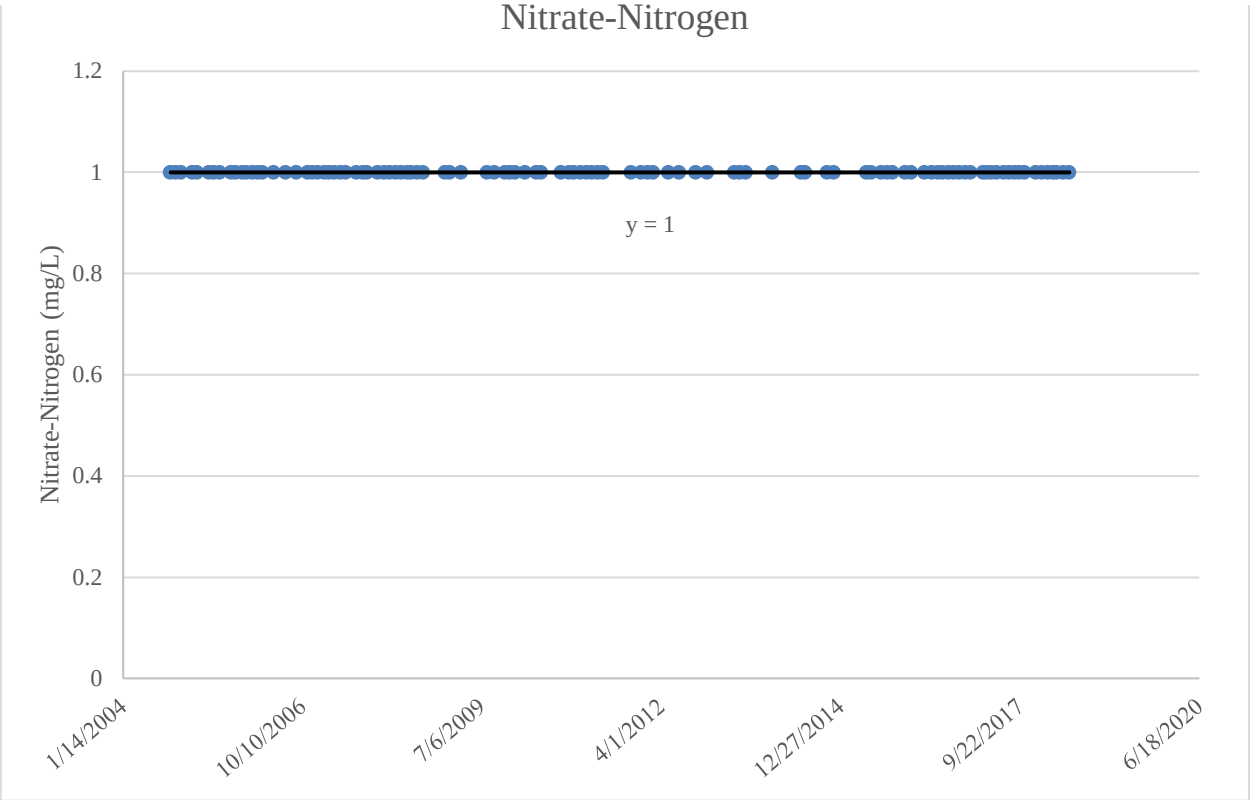

Figure 39: Nitrate-Nitrogen at Site 80314

Site 80934 – Hamilton Pool

Site Description

This site is located in Hamilton Pool Nature Preserve in a pool that has collected in a collapsed karst room that now forms a box canyon. The site, operated by Travis County Parks, is surrounded by a limestone canyon with thick riparian zones. While a waterfall feeds the pool, the pool itself is calm and has a small beach to one side.

Sampling Information

This site has been sampled 105 times between 8/13/2007 and 8/28/2018. Monitoring at this location took place between 10:00 and 18:20.

Table 11: Descriptive parameters for Site 80934

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	105	304 ± 30	163	364
Water Temperature (°C)	105	19.6 ± 5.9	1.0	28.0
Dissolved Oxygen (mg/L)	105	6.9 ± 1.7	2.8	10.0
pH (su)	103	7.1 ± 0.2	7.0	8.0
E. coli (CFU/100 ML)	97	34 ± 228	1	1900
Orthophosphate (mg/L)	97	1 ± 0	0.25	1

Site 80934 was sampled 105 times between 8/13/2007 and 8/28/2018.

Air and Water Temperature

There were 105 air and water temperatures taken at this site. The mean water temperature was 19.6°C. Water temperature varied from a low of 1.0°C in December of 2012, and a high of 28.0°C in August of 2007. The air temperature ranged from a low of 2.0°C in February of 2015 to a high of 37°C in June of 2012.

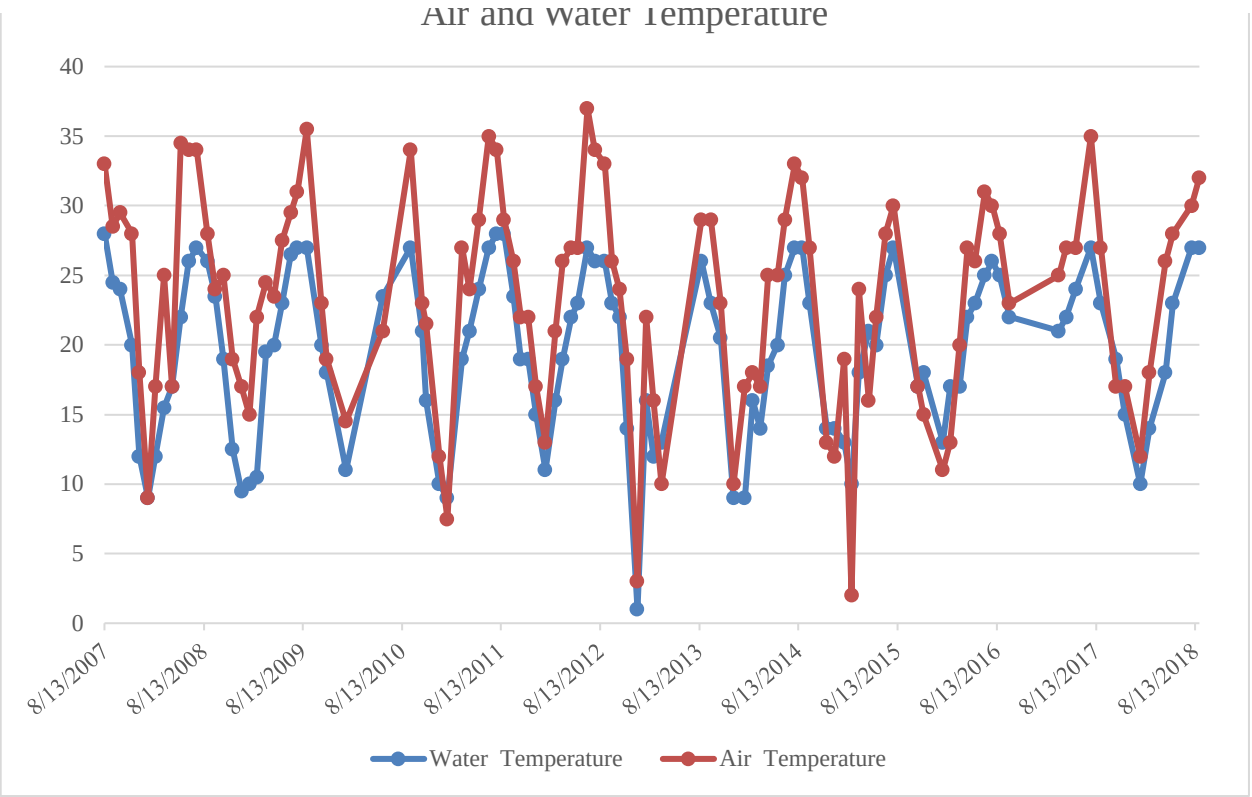

Figure 40: Air and water temperature at Site 80934

Total Dissolved Solids

Citizen scientists took 105 TDS samples at this site between 8/13/2007 and 8/28/2018. The mean TDS concentration was 304 mg/L. The minimum TDS concentration of 163 mg/L was recorded in September of 2013. The maximum TDS concentration was recorded in December of 2013 and was 364 mg/L.

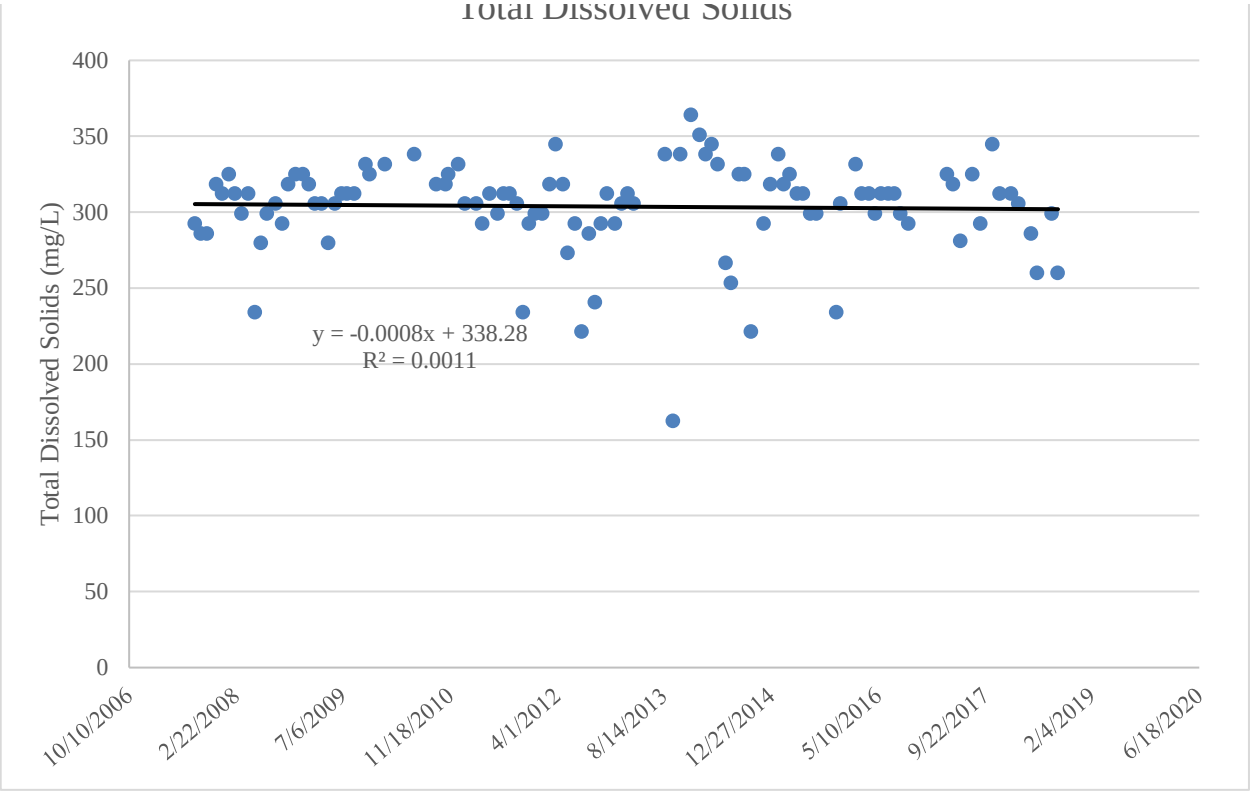

Figure 41: Total dissolved solids at Site 80934

Dissolved Oxygen

Citizen scientists collected 105 DO samples at this site between 8/13/2007and 8/28/2018. The mean DO concentration was 6.9 mg/L. The DO concentration varied from a low of 2.8 mg/L in September of 2013, to a high of 10.0 mg/L in January of 2014.

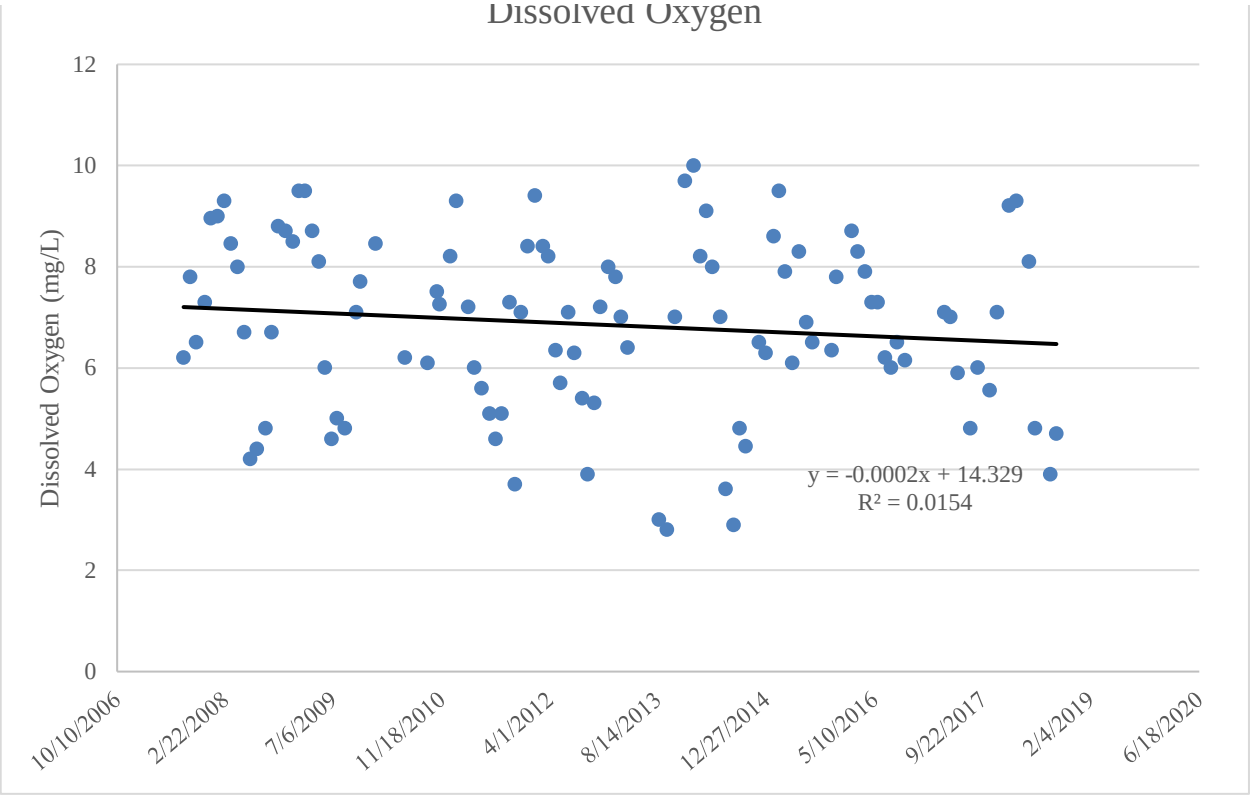

Figure 42: Dissolved oxygen at Site 80934

pH

A total of 103 pH measurements were taken at this site between 8/13/2007and 8/28/2018. The mean pH was 7.1 and it ranged from a high of 8.0 in April of 2012, to a low of 7.0 on multiple instances.

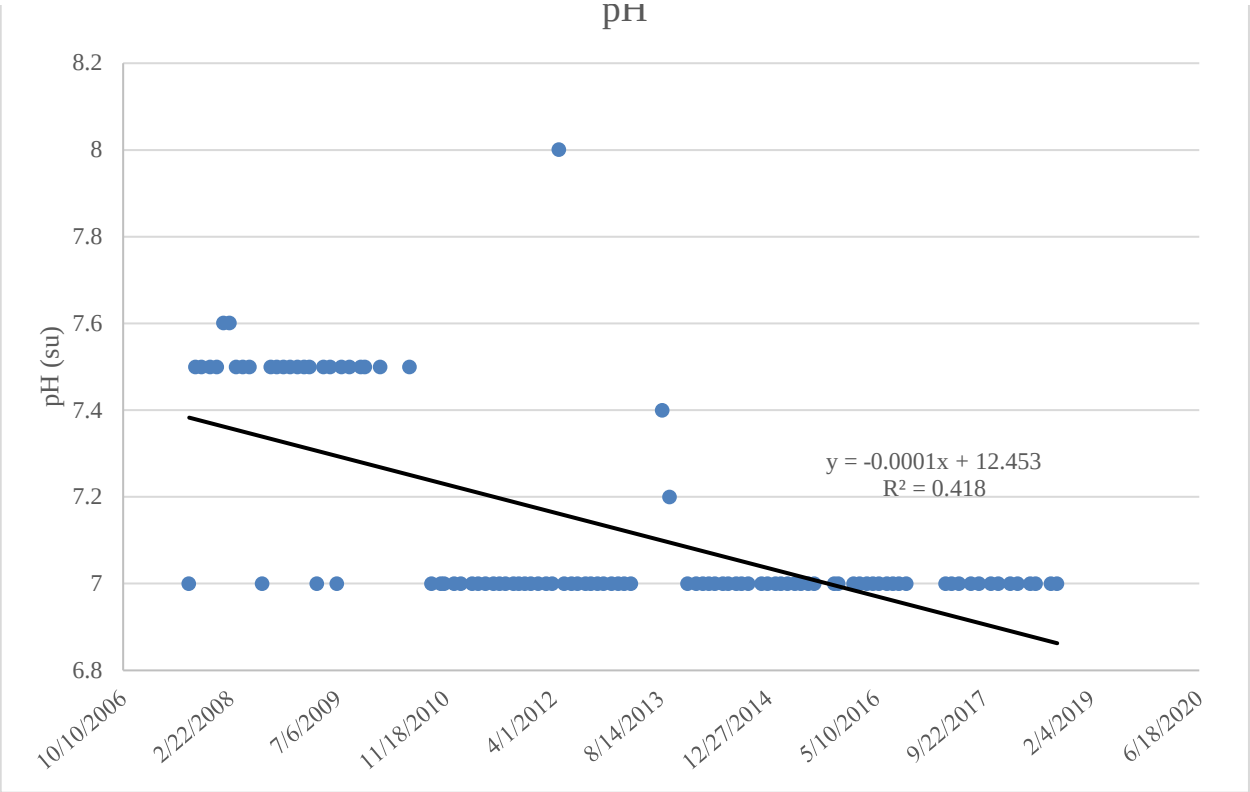

Figure 43: pH at Site 80934

E. coli

There were 97 *E. coli* measurements taken at this site between 8/13/2007 and 7/31/2018. The observed geomean was 834 CFU/100mL and ranged from a low of 1 CFU/100mL on multiple instances to a high of 1900 CFU/100mL taken in November of 2015.

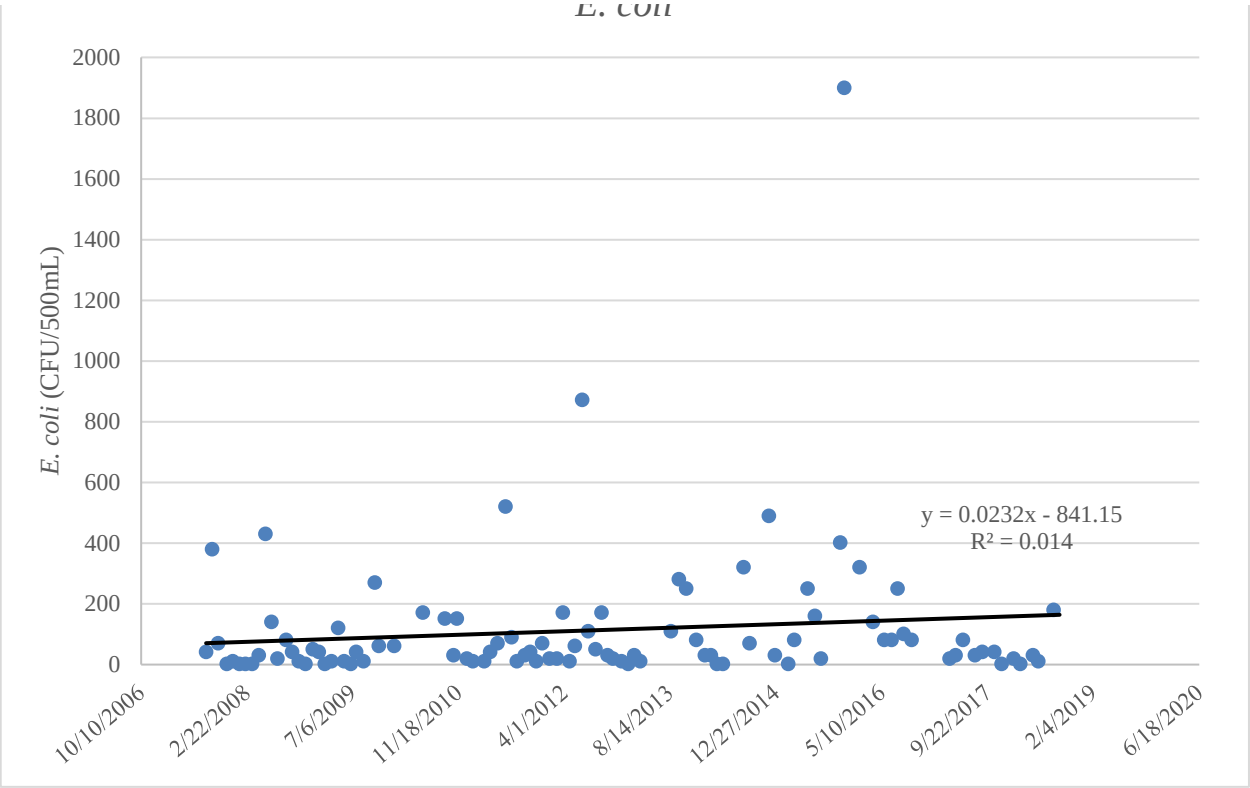

Figure 44: *E. coli* at Site 80934

Orthophosphate

Citizen scientists collected 97 orthophosphate samples at this site between 8/13/2007 and 7/31/2018. The mean orthophosphate concentration was 0.63 mg/L and ranged from a low of 0.25 mg/L to a high of 1 mg/L on multiple instances.

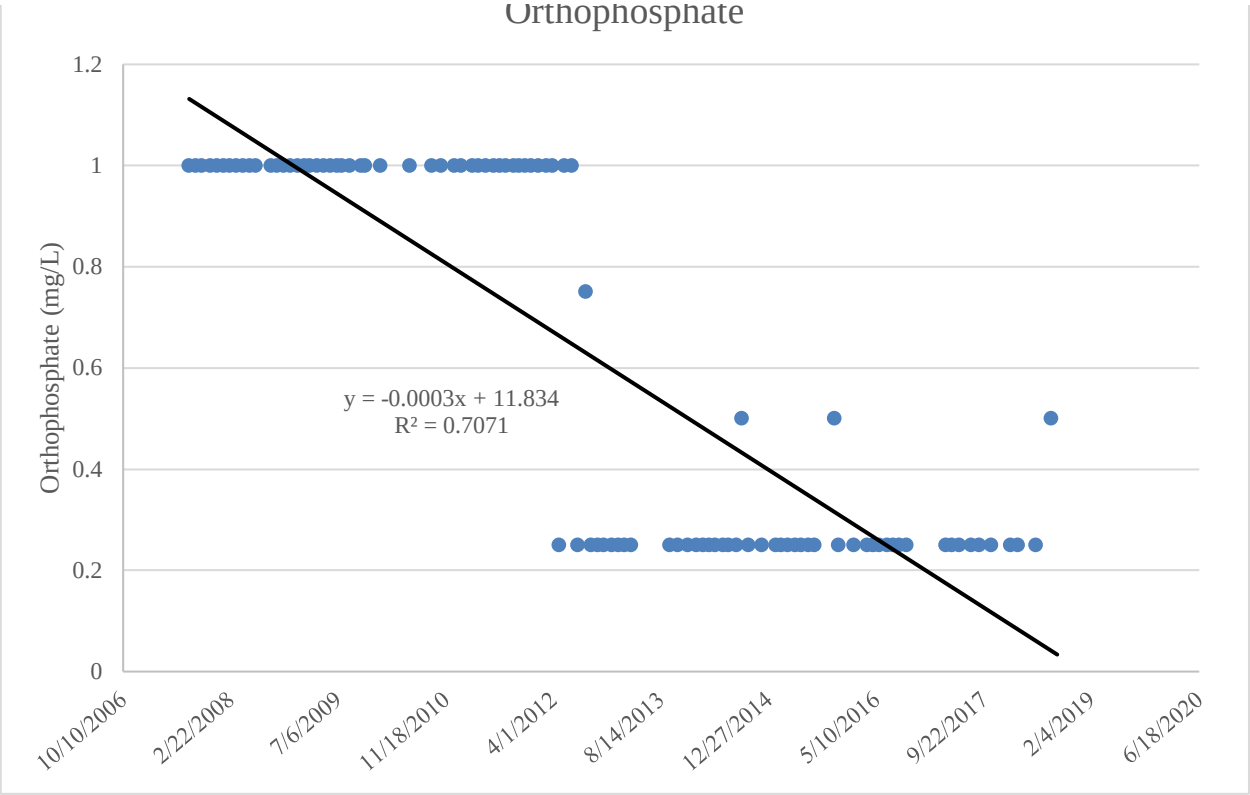

Figure 45: Orthophosphate at Site 80934

Site 80935 – Cypress Creek at Hammett's Crossing

Site Description

This site is located at a low water crossing of Cypress Creek off of Nicholson Bluff Road. This site features a small dammed area of the creek, with a riparian zone to the north and east sides of the creek. The land surrounding the site is predominantly rangeland with dense woodland immediately alongside the creek.

Sampling Information

This site was monitored 113 times between 3/5/2009 and 8/20/2018. Sampling times typically occur between 8:00 and 17:35.

Table 12: Descriptive parameters for Site 80935

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	110	338 ± 50	182	481
Water Temperature (°C)	113	20.4 ± 6.6	5.5	30.0
Dissolved Oxygen (mg/L)	113	6.7 ± 1.5	3.6	11.5
pH (su)	113	7.9 ± 0.2	7.5	8.3
E. coli (CFU/100mL)	104	13 ± 182	1	1520
Nitrate-Nitrogen (mg/L)	99	1 ± 0	0	1

Site 80935 was sampled 113 times between 3/5/2009 and 8/20/2018.

Air and Water Temperature

Air and water temperatures were taken 113 times at this site between 3/5/2009 and 8/20/2018. The mean water temperature was 20.4°C. Water temperature varied from a low of 5.5°C in January of 2010, to a high of 30.0°C in August of 2011. The air temperature varied from a low of 5.0°C in January 2018, to a high of 35.0°C in September of 2009.

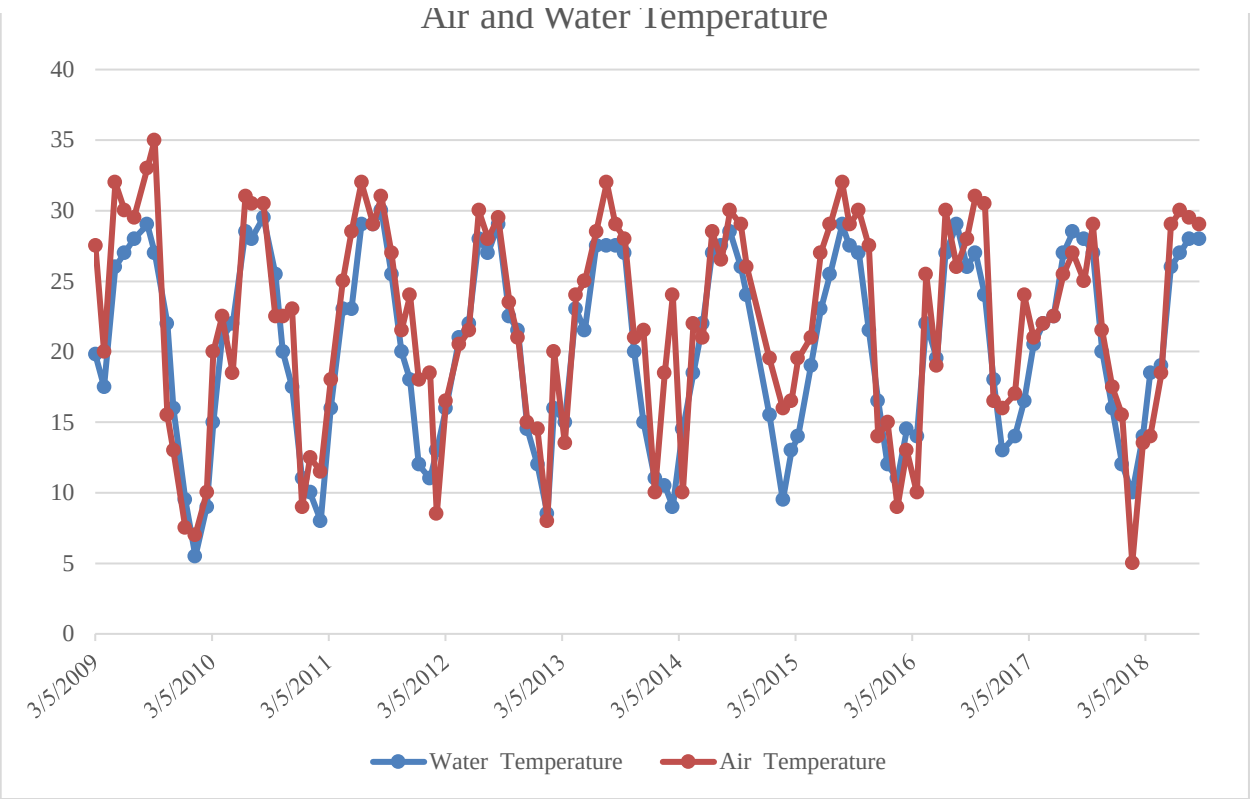

Figure 46: Air and water temperature at Site 80935

Total Dissolved Solids

Citizen scientists took a total of 110 TDS samples at this site between 3/5/2009 and 8/20/2018. The mean TDS concentration was 338 mg/L. The concentration of TDS varied from a low of 182 mg/L in March of 2016, to a high of 481 mg/L in January of 2012.

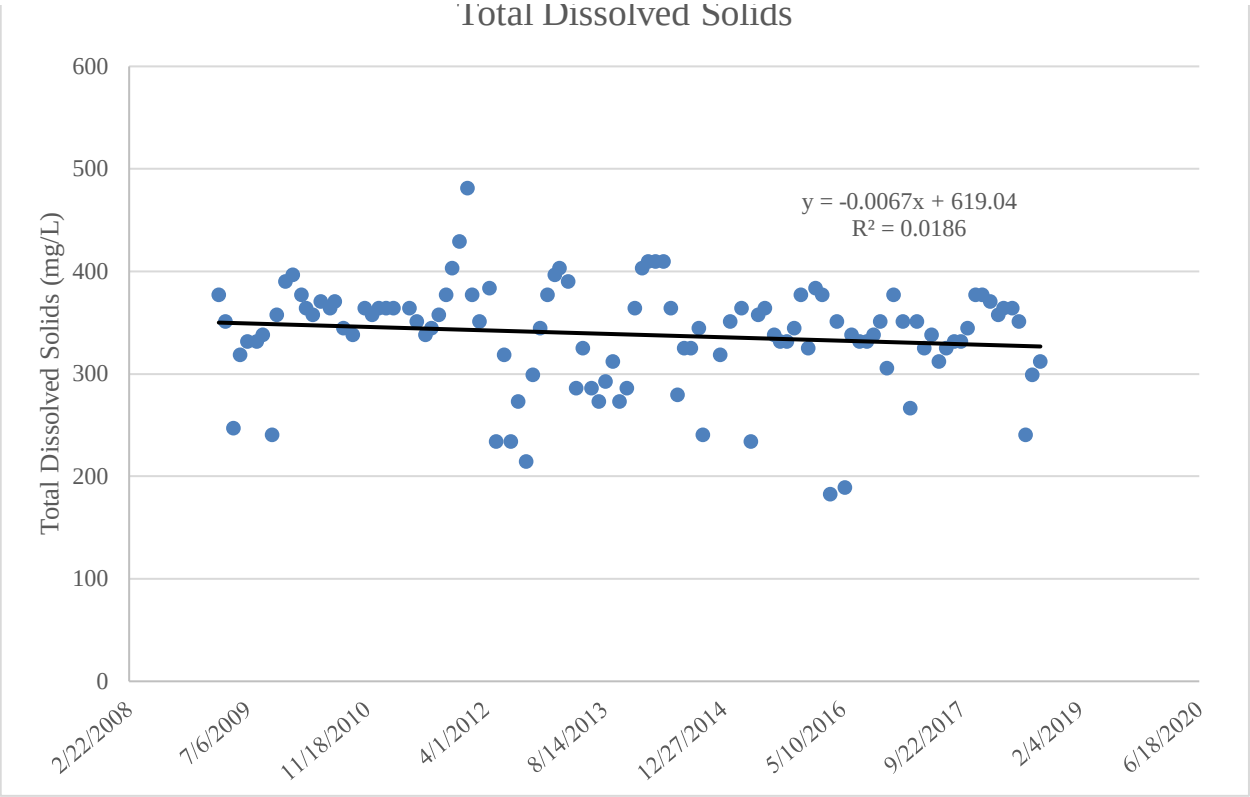

Figure 47: Total dissolved solids at Site 80935

Dissolved Oxygen

Citizen scientists took 113 DO samples at this site between 3/5/2009 and 8/20/2018. The mean DO concentration was 6.7 mg/L. The minimum DO concentration was 3.6 mg/L and was taken in September of 2014. The maximum DO concentration was 11.5 mg/L and was taken in January of 2010.

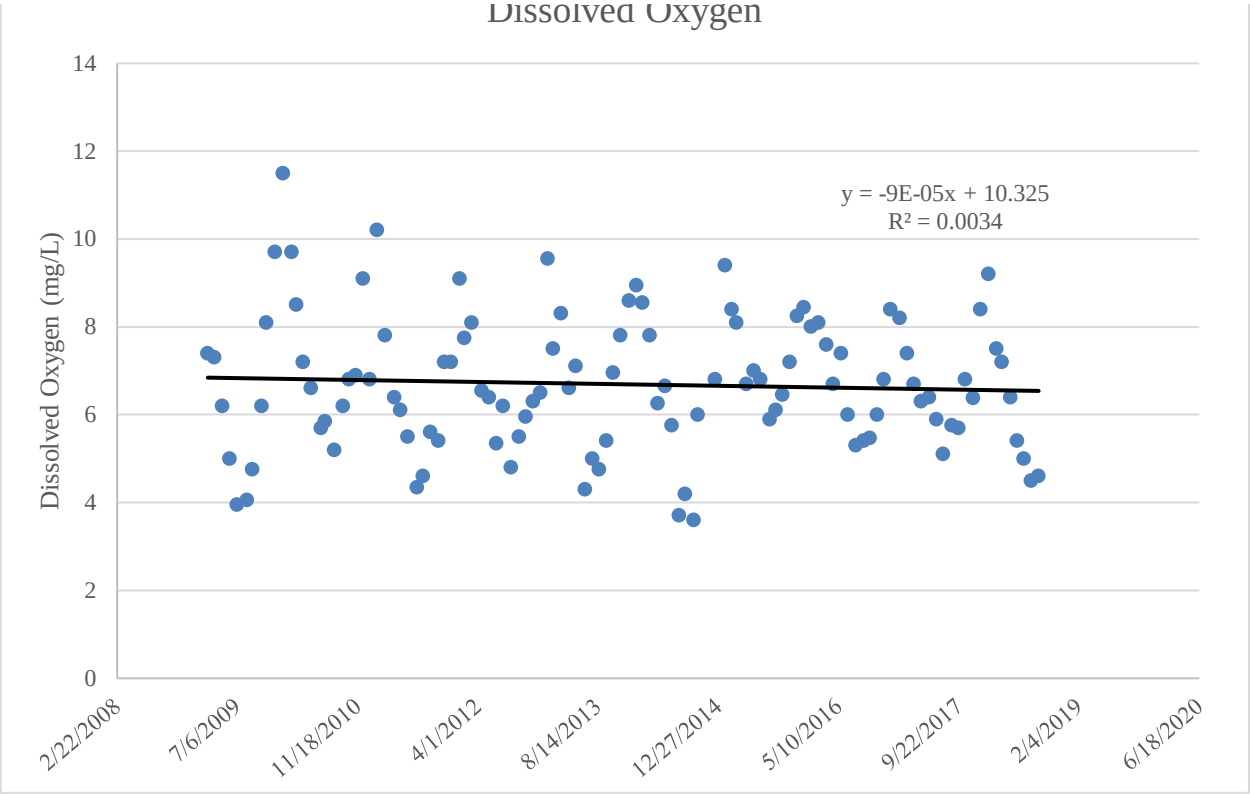

Figure 48: Dissolved oxygen at Site 80935

pH

Citizen scientists took 113 pH measurements at this site between 3/5/2009 and 8/20/2018. The mean pH was 7.9. The pH ranged from a low of 7.5 in April of 2015 to a high of 8.3 in August of 2015 and January of 2018.

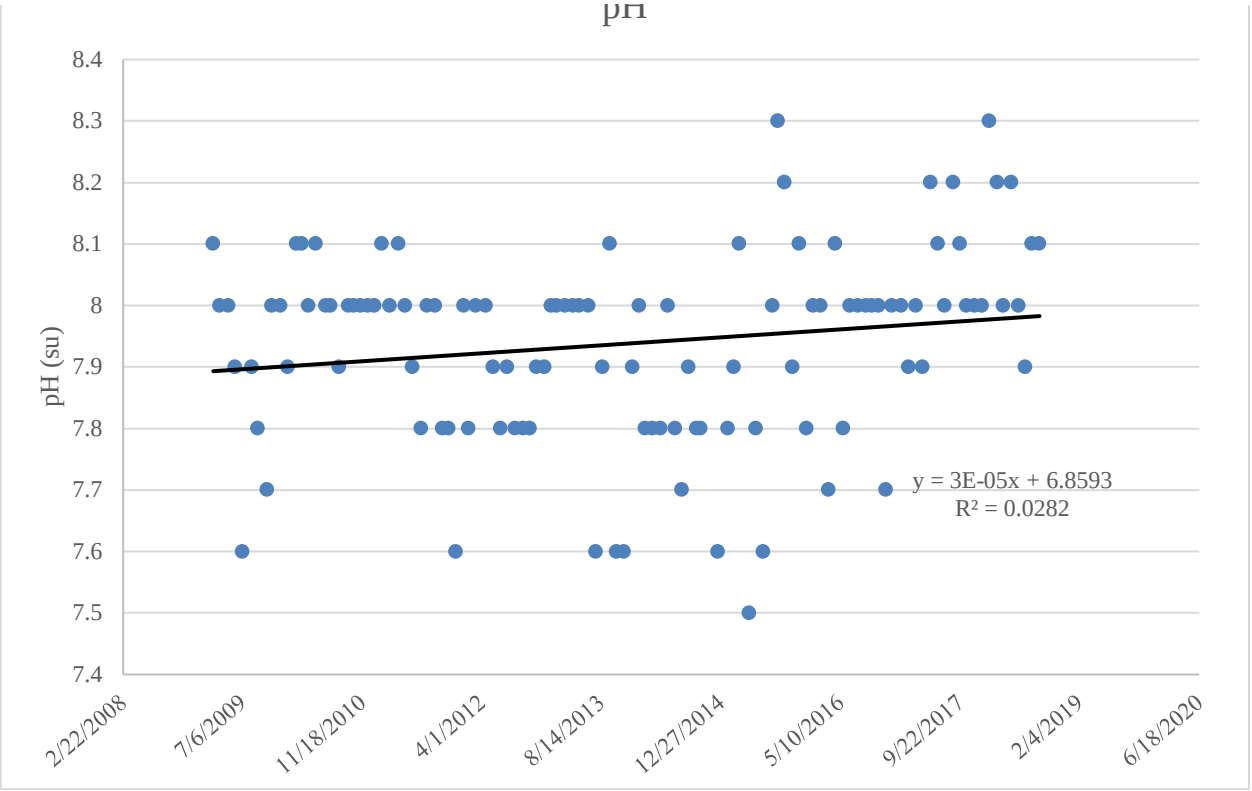

Figure 49: pH at Site 80935

E. coli

Citizen scientists collected 104 *E. coli* samples at this site between 3/5/2009 and 8/20/2018. The geomean for *E. coli* was 13 CFU/100 mL. The minimum *E. coli* count was 1 CFU/100 mL and was recorded on multiple occasions. The maximum *E. coli* count was 1520 CFU/100 mL and was collected in January of 2017.

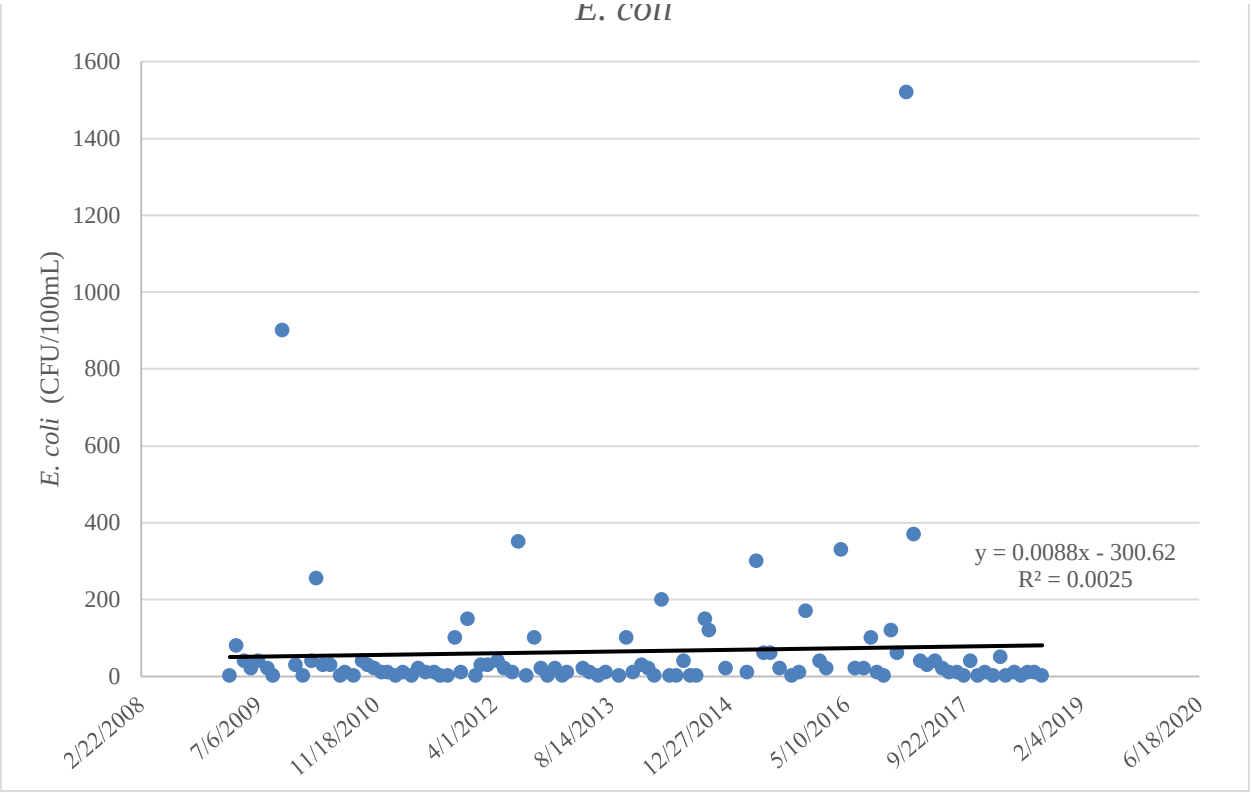

Figure 50: *E. coli* at Site 80935

Nitrate-Nitrogen

Citizen scientists collected 99 nitrate-nitrogen samples at this site between 3/5/2009 and 2/25/2018. The mean nitrate-nitrogen concentration was 0.52 mg/L. Nitrate-nitrogen ranged in concentration from 0.25 mg/L to a high of 1.0 mg/L taken on multiple occasions.

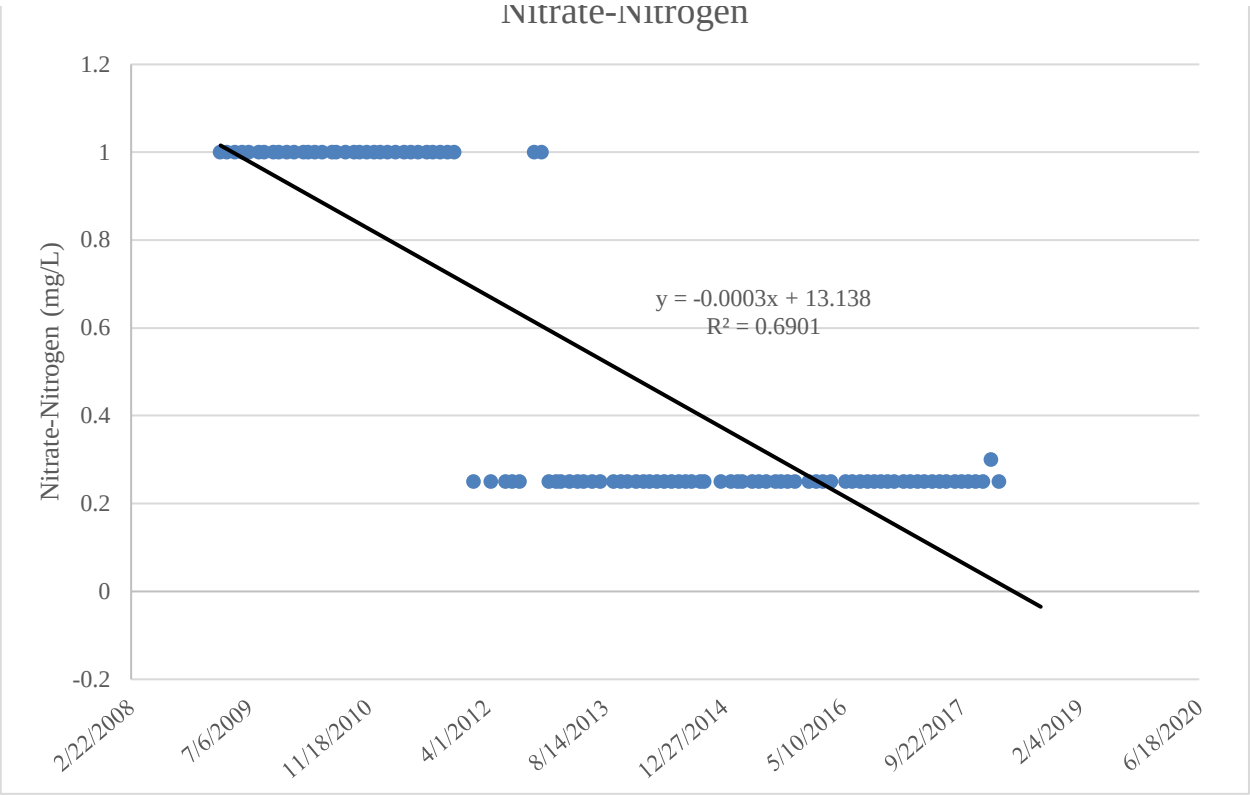

Figure 51: Nitrate-Nitrogen at Site 80935

Site 80936 – Pogue Springs

Site Description

This site is located at the Pogue Springs on Milton Reimers Ranch Park, which is operated by Travis County Parks. It is located on the Pogue Springs Preserve/Hogge Reserve component of the property and is accessible by foot only.

Sampling Information

This site was monitored 80 times between 1/19/2010 and 8/28/2018. Sampling times typically occur between 11:30 and 17:10.

Table 13: Descriptive parameters for Site 80936

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	80	322 ± 38	215	390
Water Temperature (°C)	80	20.3 ± 5.6	7.0	30.0
Dissolved Oxygen (mg/L)	80	6.9 ± 1.8	0.1	10.2
pH (su)	79	7.1 ± 0.2	6.9	7.9
E. coli (CFU/100mL)	71	40 ± 480	1	2500
Nitrate-Nitrogen (mg/L)	70	1 ± 1	0.25	4

Site 80936 was sampled 80 times between 1/19/2010 and 8/28/2018.

Air and Water Temperature

Air and water temperatures were taken 80 times at this site between 1/19/2010 and 8/28/2018. The temperature of the springs reflects a temperature similar to that of the average annual temperature in Austin, Texas of 20.8°C. Pogue Springs average 20.3°C year-round. Water temperature varied from a low of 7.0°C in December of 2012, to a high of 30.0°C in July of 2011. The air temperature varied from a low of 2.0°C in January 2014 and February of 2015, to a high of 40.0°C in August of 2010.

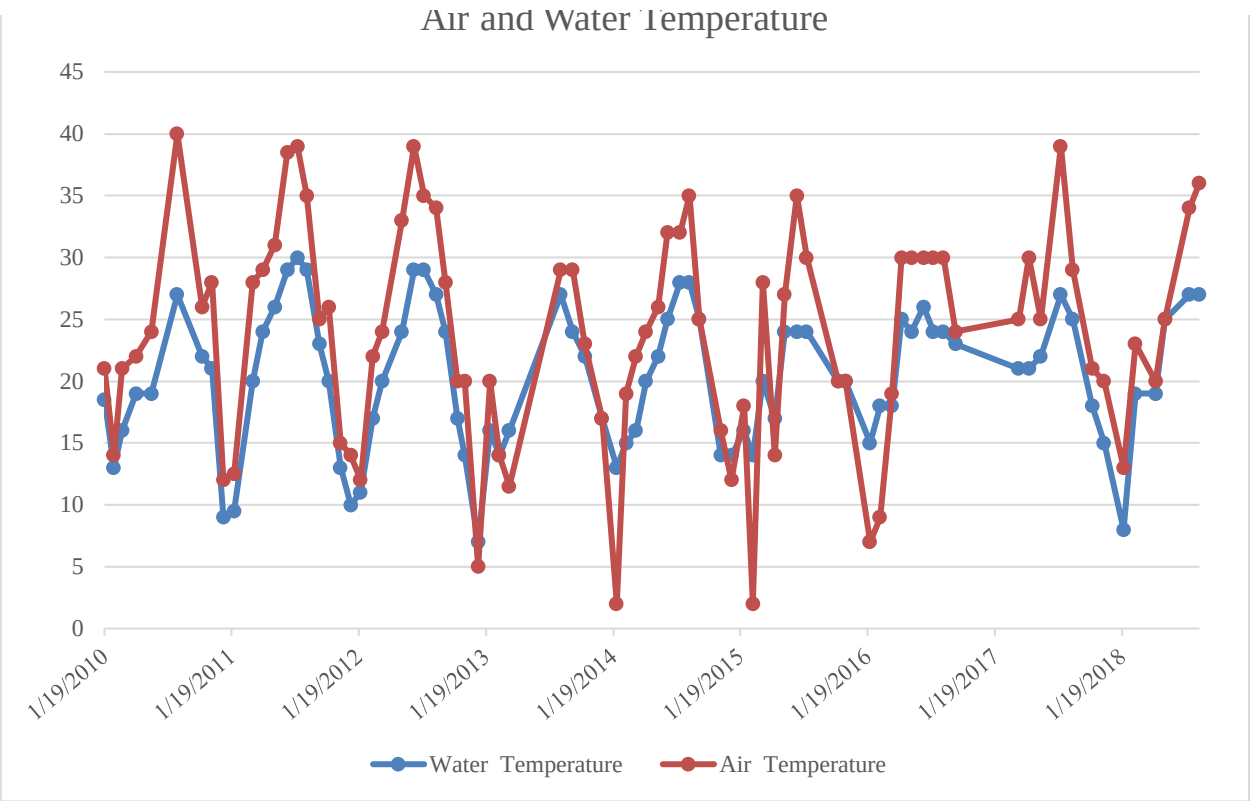

Figure 52: Air and water temperature at Site 80936

Total Dissolved Solids

Citizen scientists took a total of 80 TDS samples at this site between 1/19/2010 and 8/28/2018. The mean TDS concentration was 322 mg/L. The concentration of TDS varied from a low of 215 mg/L in September of 2013, to a high of 390 mg/L in May of 2017.

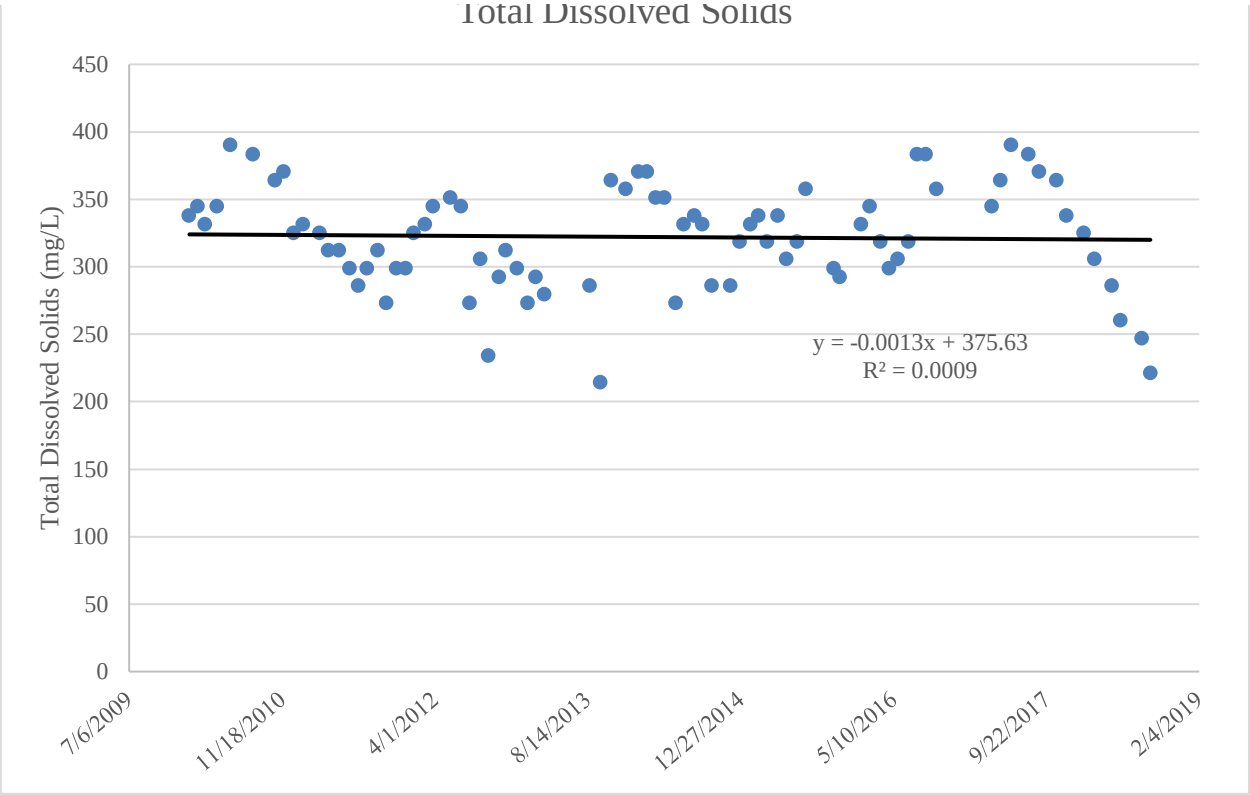

Figure 53: Total dissolved solids at Site 80936

Dissolved Oxygen

Citizen scientists took 80 DO samples at this site between 1/19/2010 and 8/28/2018. The mean DO concentration was 6.9 mg/L. The minimum DO concentration was 0.1 mg/L and was taken in October and November of 2011. The maximum DO concentration was 10.2 mg/L and was taken in January of 2018.

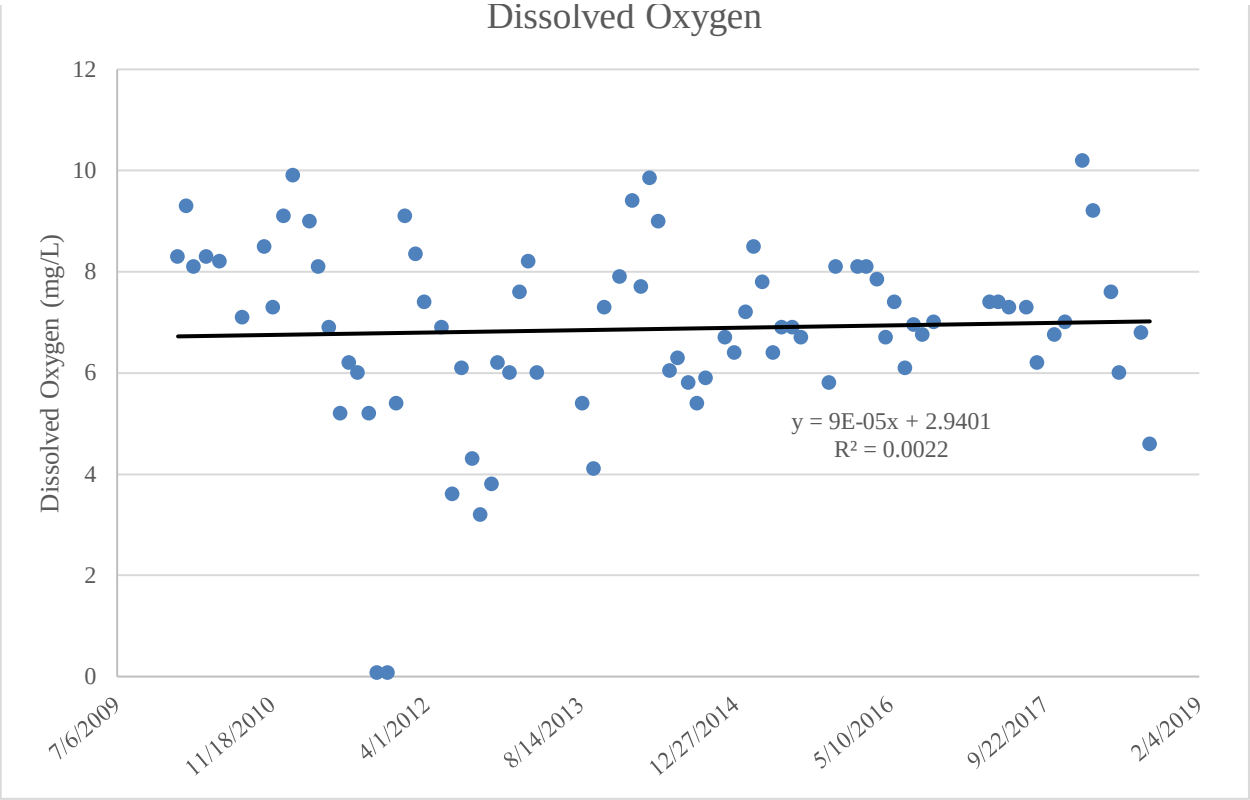

Figure 54: Dissolved oxygen at Site 80936

pH

Citizen scientists took 79 pH measurements at this site between 1/19/2010 and 8/28/2018. The mean pH was 7.1. The pH ranged from a low of 6.9 in November of 2017 to a high of 7.9 in September of 2013.

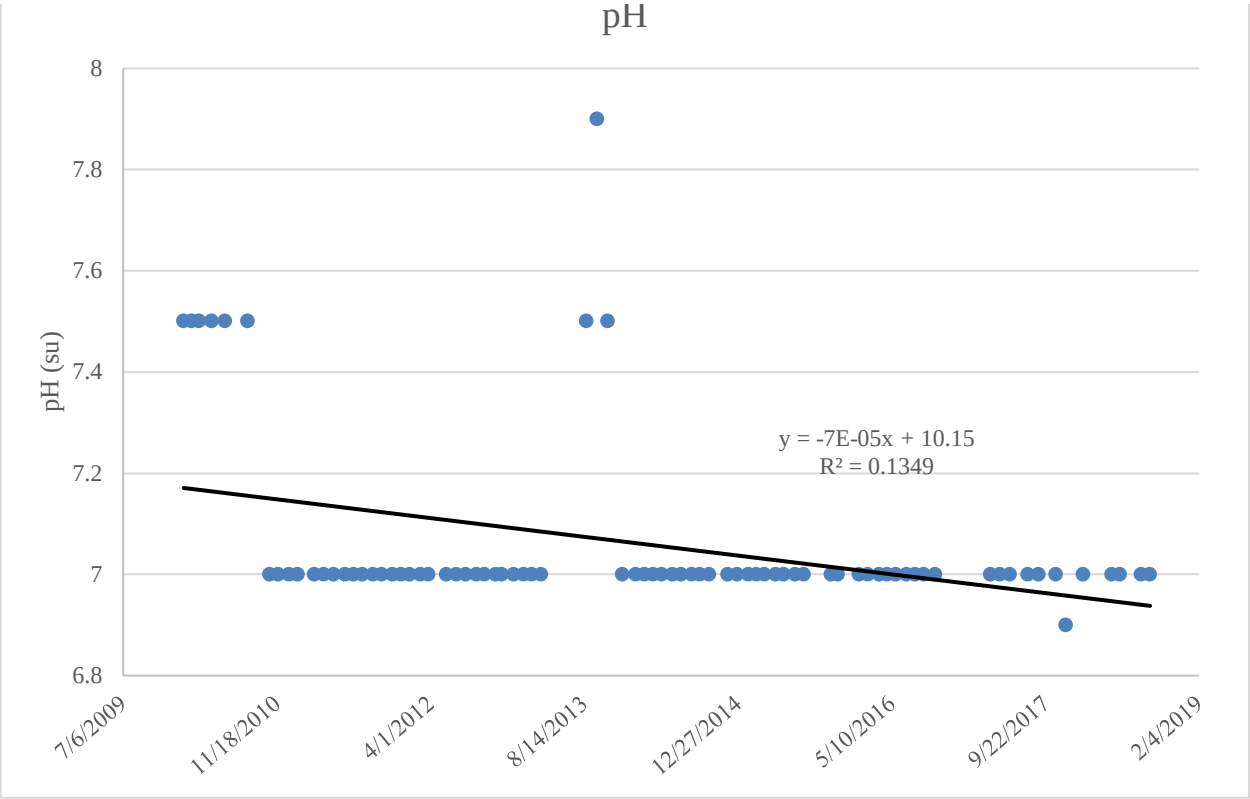

Figure 55: pH at Site 80936

E. coli

Citizen scientists collected 71 *E. coli* samples at this site between 1/19/2010 and 7/31/2018. The geomean for *E. coli* was 40 CFU/100 mL. The minimum *E. coli* count was 1 CFU/100 mL and was recorded on multiple occasions. The maximum *E. coli* count was 2500CFU/100 mL and was collected in October of 2013.

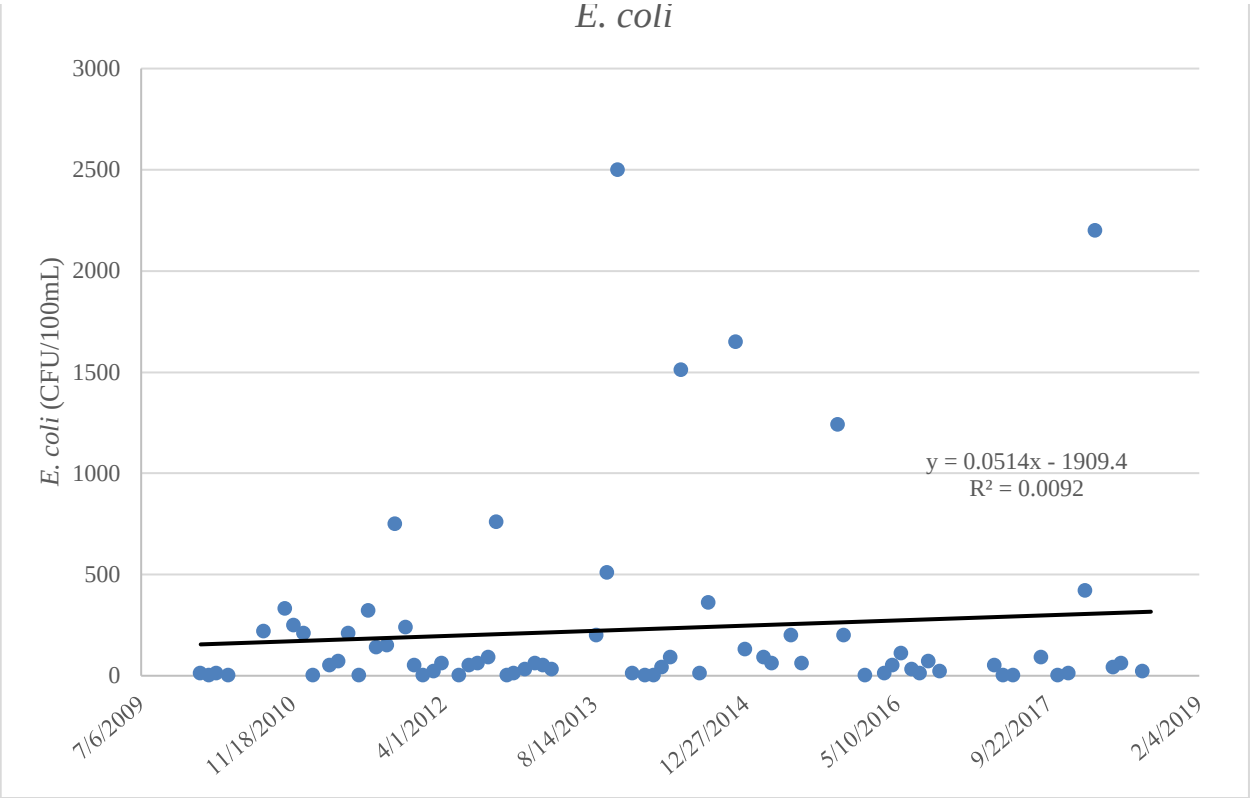

Figure 56: *E. coli* at Site 80936

Nitrate-Nitrogen

Citizen scientists collected 70 nitrate-nitrogen samples at this site between 1/19/2010 and 7/31/2018. The mean nitrate-nitrogen concentration was 0.56 mg/L. Nitrate-nitrogen ranged in concentration from 0.25 mg/L taken on multiple instances to a high of 4.0 mg/L taken in February of 2010.

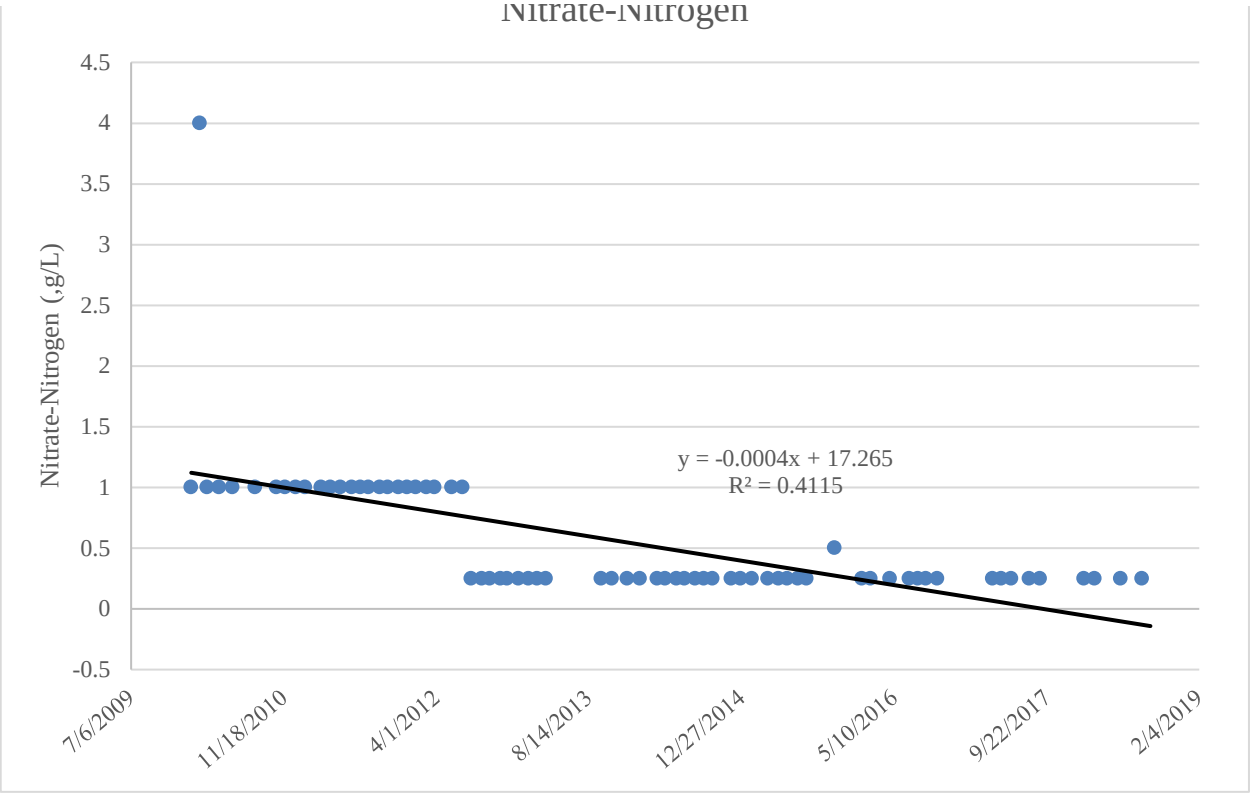

Figure 57: Nitrate-Nitrogen at Site 80936

Site 81496 – Pedernales River at Pedernales Place Park

Site Description

This site is located on the Pedernales River near the Blanco-Hays County line. The site is accessible through private property at the dead end of Liveoak Canyon Rd via the Pedernales Place Property Owners' Association and is approximately 600 meters upstream of the confluence of Dead Man's Creek. The river is surrounded by a thick woodland along this section and the surrounding uplands are predominantly rangeland.

Sampling Information

This site was monitored 34 times between 12/20/2015 and 9/7/2018. Sampling times typically occur between 8:45 and as late as 23:25.

Table 14: Descriptive parameters for Site 81496

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	34	355 ± 42	234	410
Water Temperature (°C)	34	22.8 ± 6.7	7.5	32.0
Dissolved Oxygen (mg/L)	33	7.1 ± 1.3	5.3	10.5
pH (su)	34	7.6 ± 0.3	7.0	8.0
Nitrate-Nitrogen (mg/L)	33	1 ± 0	1	1

Site 81496 was sampled 34 times between 12/20/2015 and 9/7/2018.

Air and Water Temperature

Air and water temperatures were taken 34 times at this site between 12/20/2015 and 9/7/2018. The mean water temperature was 22.8°C. Water temperature varied from a low of 7.5°C in January of 2017, to a high of 32.0°C in July of 2017. The air temperature varied from a low of 10.0°C in February of 2018, to a high of 34.0°C in August of 2018.

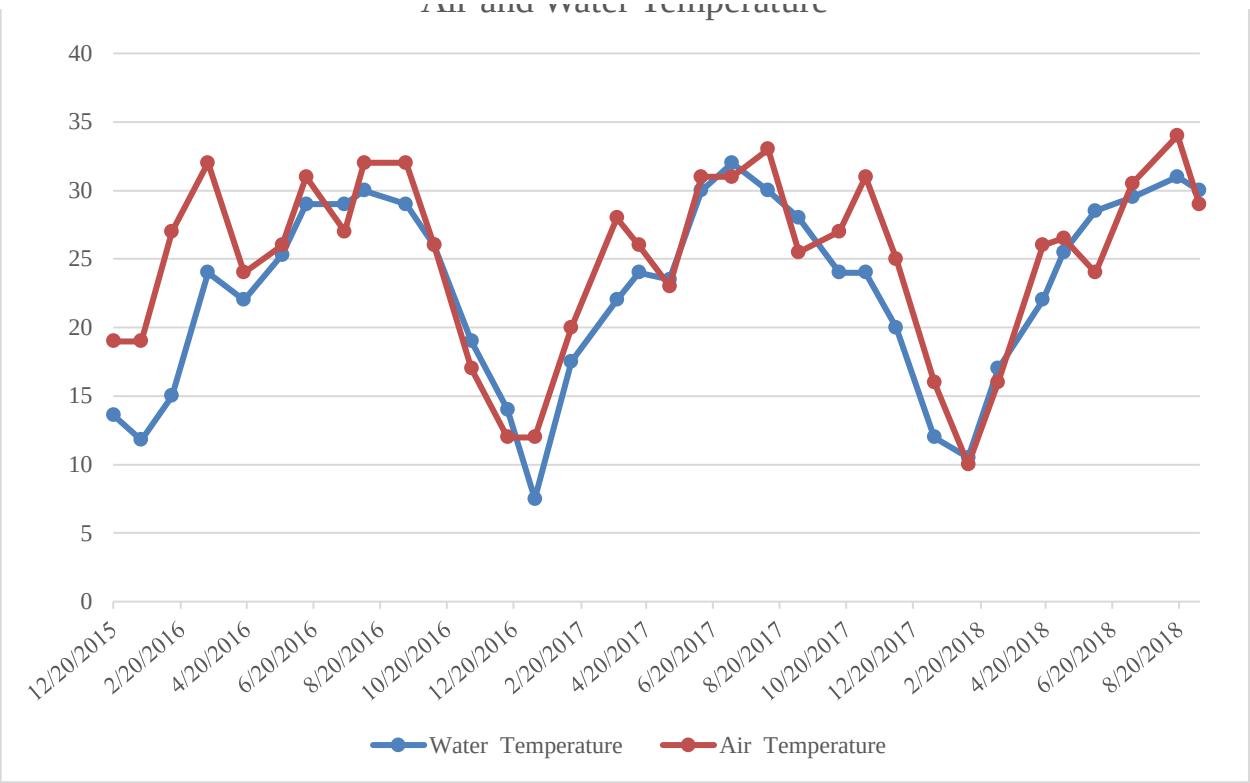

Figure 58: Air and water temperature at Site 81496

Total Dissolved Solids

Citizen scientists took a total of 34 TDS samples at this site between 12/20/2015 and 9/7/2018. The mean TDS concentration was 355 mg/L. The concentration of TDS varied from a low of 234 mg/L in May of 2016, to a high of 410 mg/L in January and March of 2018.

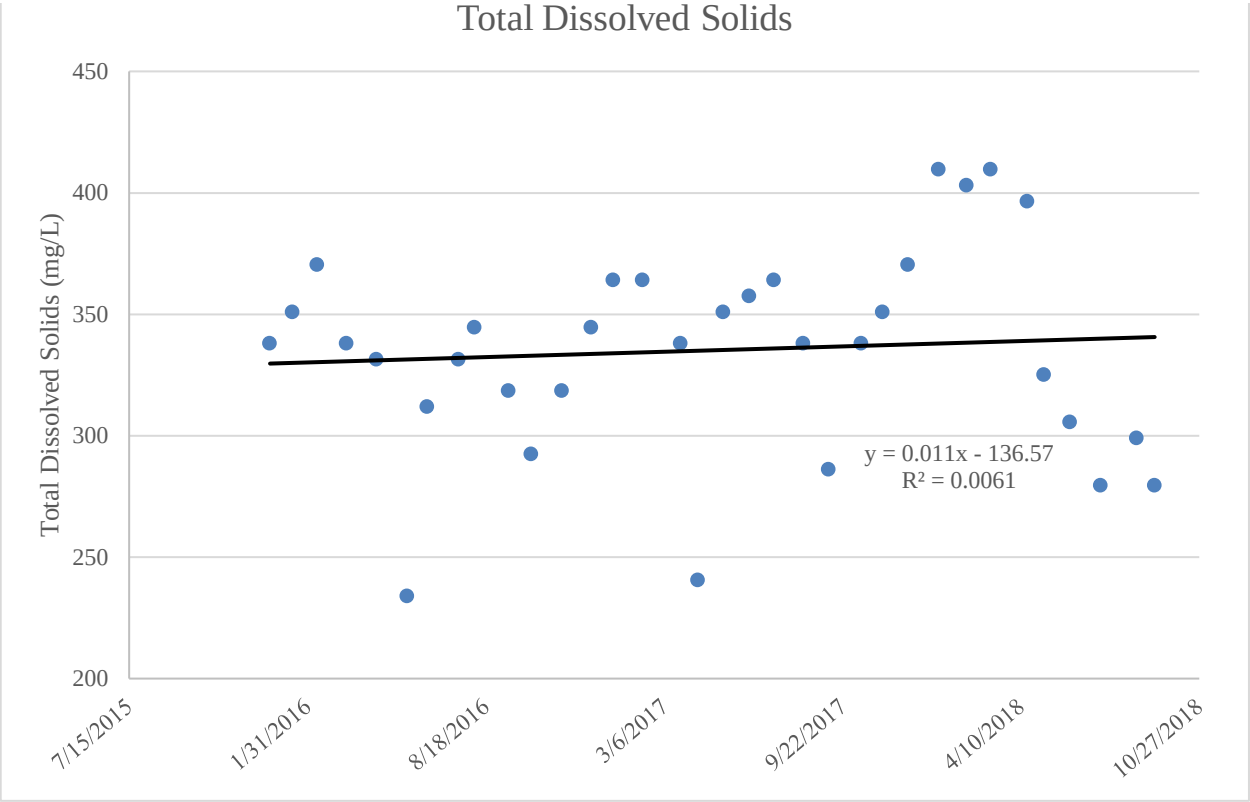

Figure 59: Total dissolved solids at Site 81496

Dissolved Oxygen

Citizen scientists took 33 DO samples at this site between 12/20/2015 and 9/7/2018. The mean DO concentration was 7.1 mg/L. The minimum DO concentration was 5.3 mg/L and was taken in July of 2016. The maximum DO concentration was 10.5 mg/L and was taken in January of 2017.

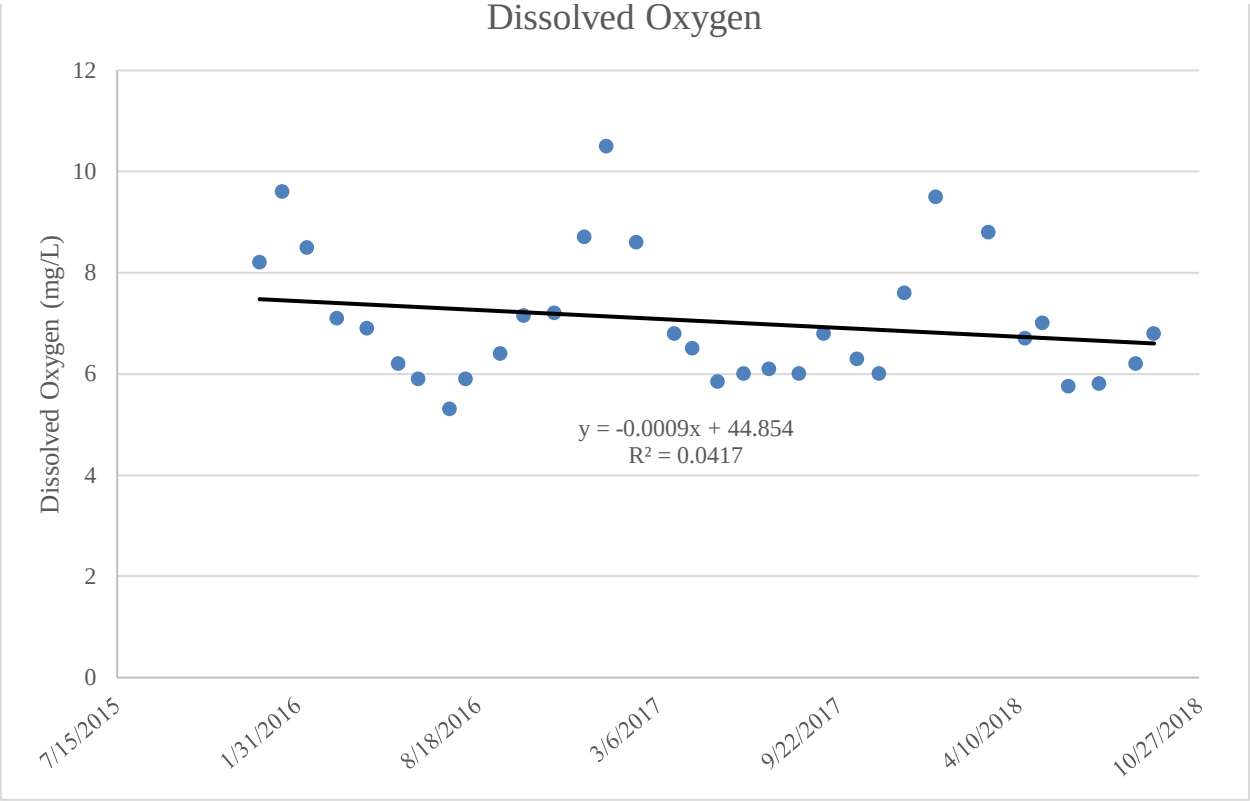

Figure 60: Dissolved oxygen at Site 81496

pH

Citizen scientists took 34 pH measurements at this site between 12/20/2015 and 9/7/2018. The mean pH was 7.6. The pH ranged from a low of 7.0 and a high of 8.0 on multiple occasions. The R_2 value of 0.0421 indicating that this relationship explained 4.21 percent of the variation in the data.

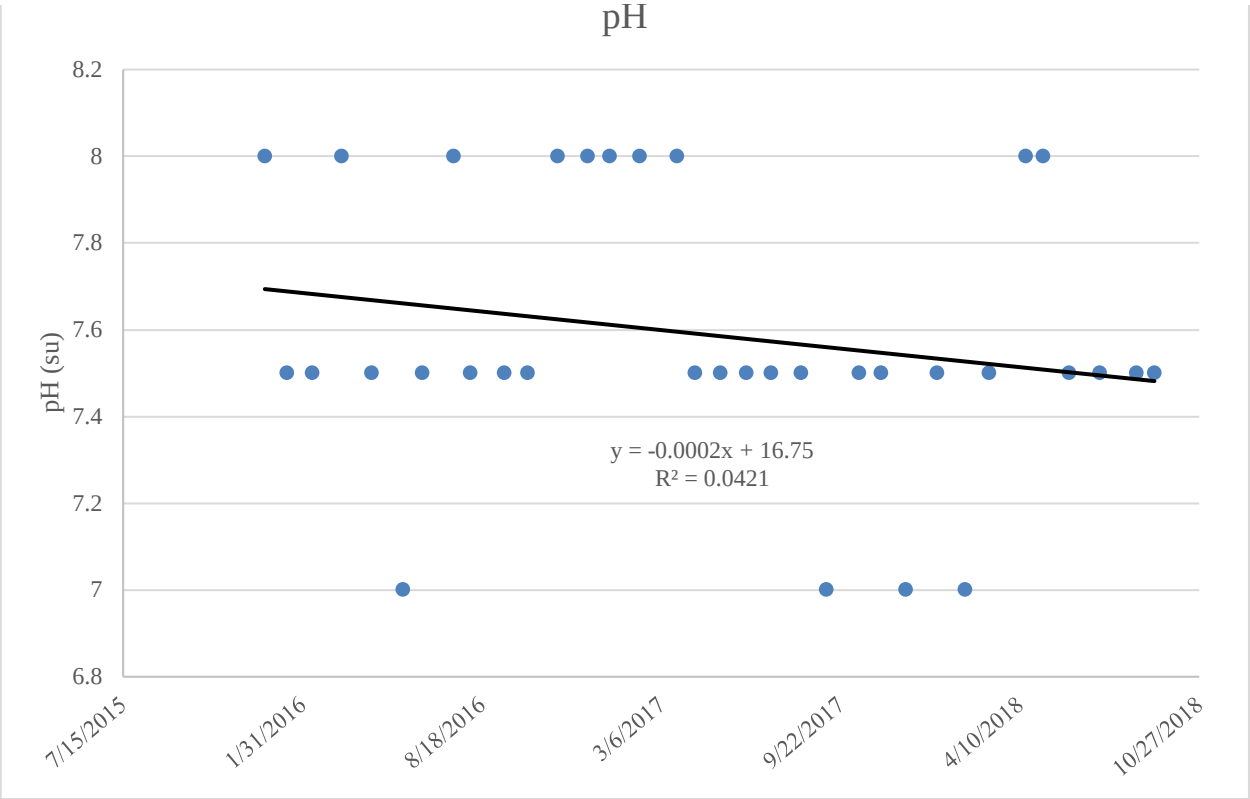

Figure 61: pH at Site 81496

Nitrate-Nitrogen

There were 33 nitrate-nitrogen measurements taken at this site between 12/20/2015 and 9/7/2018 all producing results of 1 mg/L.

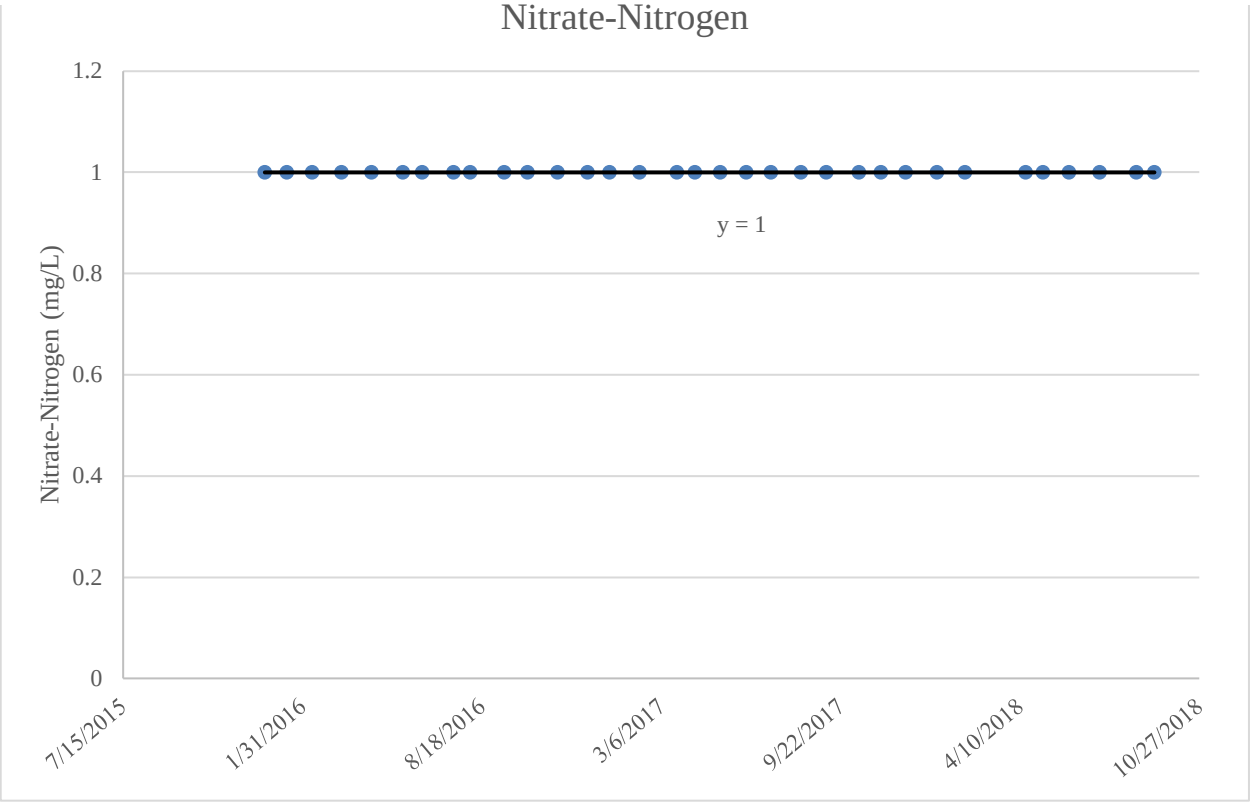

Figure 62: Nitrate-Nitrogen at Site 81496

Site 81497 – Flat Creek at FM 201

Site Description

This site is located at the crossing of FM 201 and Flat Creek, which is immediately downstream of the confluence of Sycamore and Flat Creeks. The site is approximately 21 kilometers east of Johnson City. The creek is an intermittent tributary of the Pedernales River and has a drainage basin that is mostly dominated by rangelands and some contiguous woodland. Some of the headwaters in the drainage here are dammed and have vineyards, some low impact residential development, and one rock quarry in the drainage basin.

Sampling Information

This site was monitored 33 times between 12/8/2015 and 9/7/2018. Sampling times typically occur between 8:45 and 16:50.

Table 15: Descriptive parameters for Site 81497

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	33	321 ± 19	273	351
Water Temperature (°C)	33	23.1 ± 6.1	8.0	33.0
Dissolved Oxygen (mg/L)	33	7.3 ± 1.5	4.1	10.5
pH (su)	32	7.5 ± 0.4	7.0	8.5
Nitrate-Nitrogen (mg/L)	33	1 ± 0	1	1

Site 81497 was sampled 33 times between 12/8/2015 and 9/7/2018.

Air and Water Temperature

Air and water temperatures were taken 33 times at this site between 12/8/2015 and 9/7/2018. The mean water temperature was 23.1°C. Water temperature varied from a low of 8.0°C in February of 2018, to a high of 33.0°C in July of 2016. The air temperature varied from a low of 4.0°C in February of 2018, to a high of 37.0°C in July of 2016.

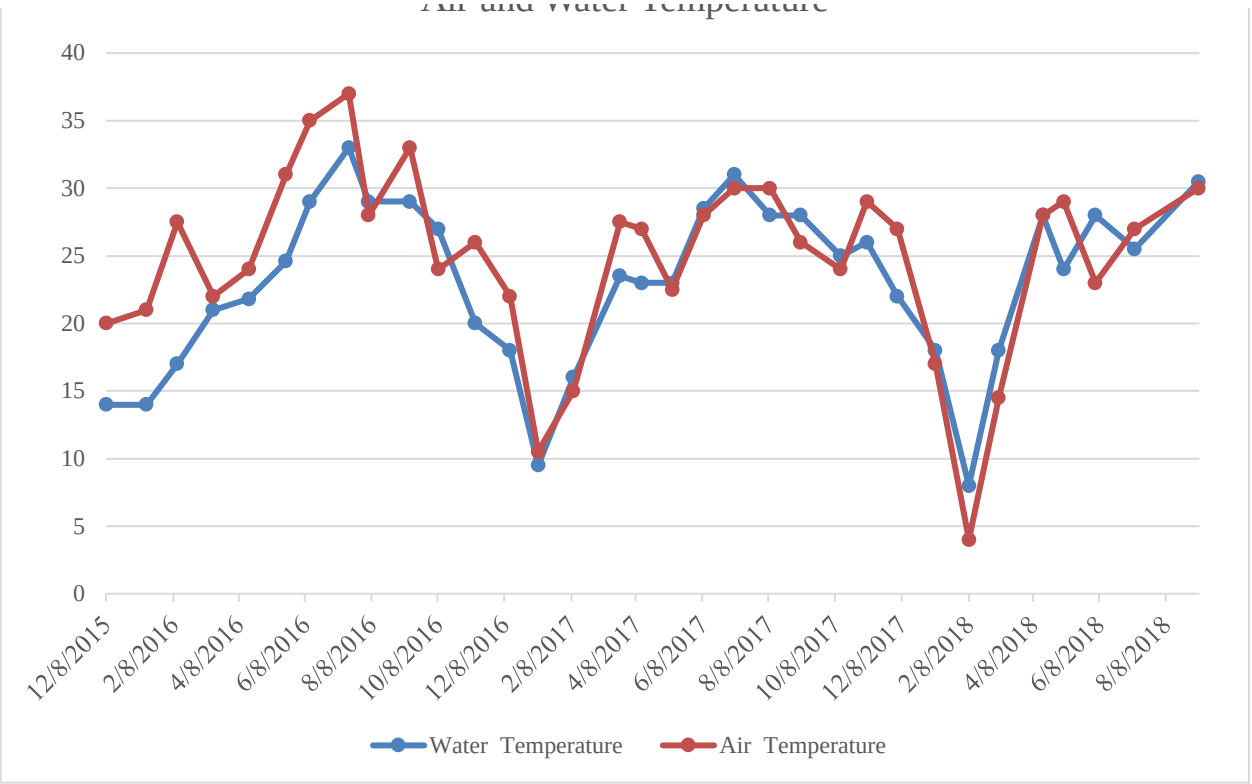

Figure 63: Air and water temperature at Site 81497

Total Dissolved Solids

Citizen scientists took a total of 33 TDS samples at this site between 12/8/2015 and 9/7/2018. The mean TDS concentration was 321 mg/L. The concentration of TDS varied from a low of 273 mg/L in August of 2017, to a high of 351 mg/L in June of 2018.

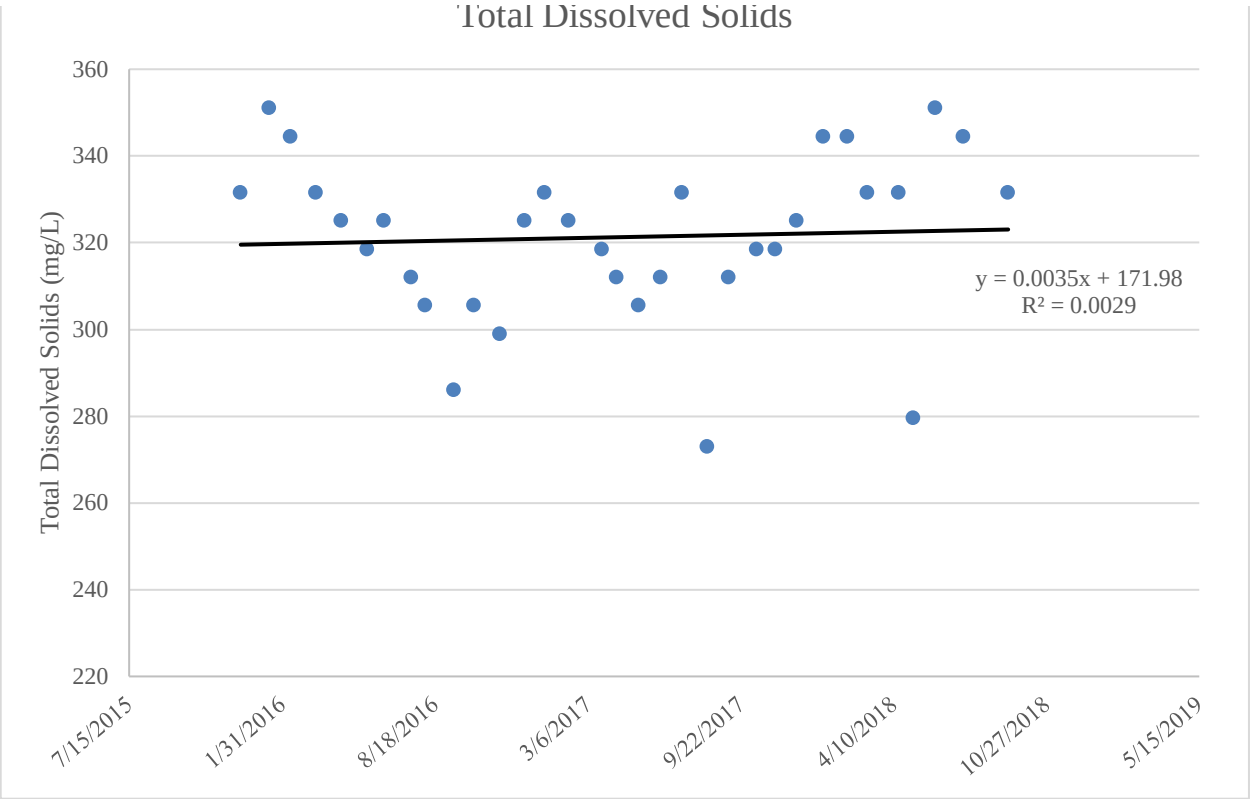

Figure 64: Total dissolved solids at Site 81497

Dissolved Oxygen

Citizen scientists took 33 DO samples at this site between 12/8/2015 and 9/7/2018. The mean DO concentration was 7.3 mg/L. The minimum DO concentration was 4.1 mg/L and was taken in September of 2018. The maximum DO concentration was 10.5 mg/L and was taken in January of 2017.

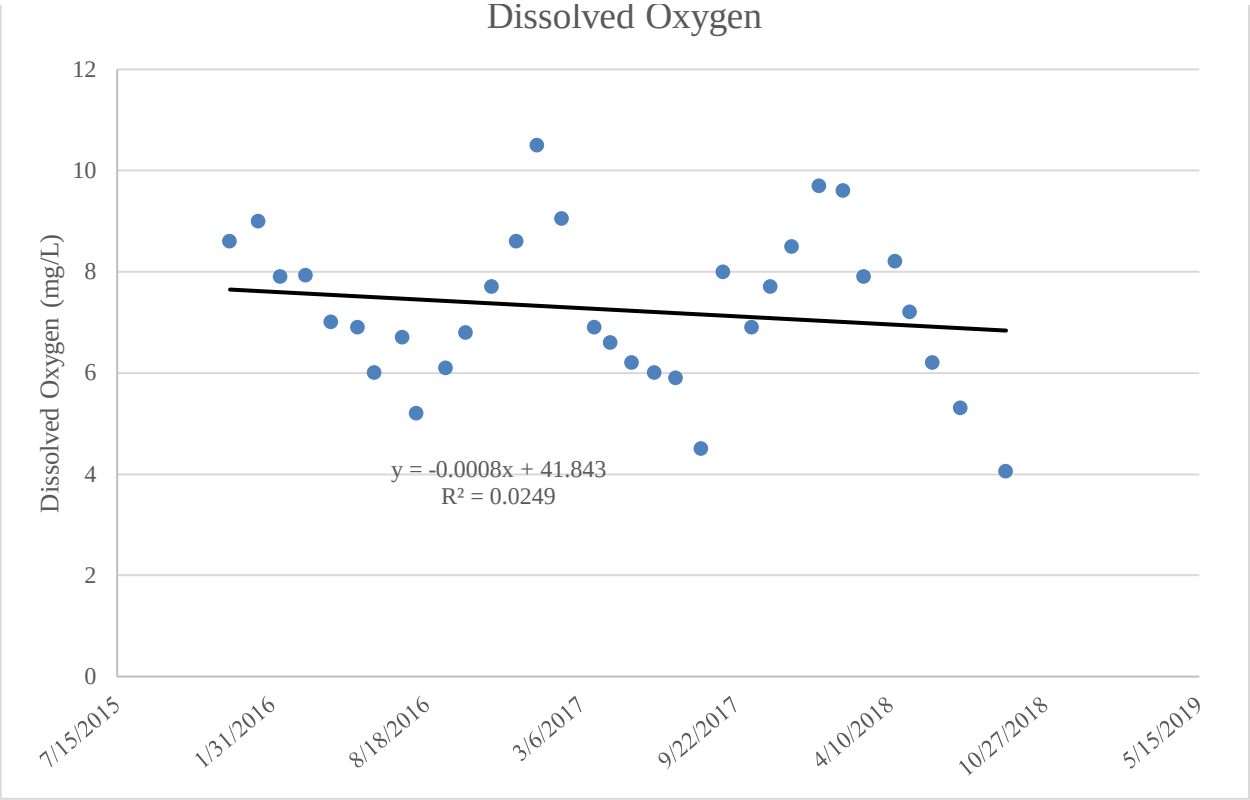

Figure 65: Dissolved oxygen at Site 81497

pH

Citizen scientists took 32 pH measurements at this site between 12/8/2015 and 7/10/2018. The mean pH was 7.5. The pH ranged from a low of 7.0 on multiple instances and a high of 8.5 in December of 2015.

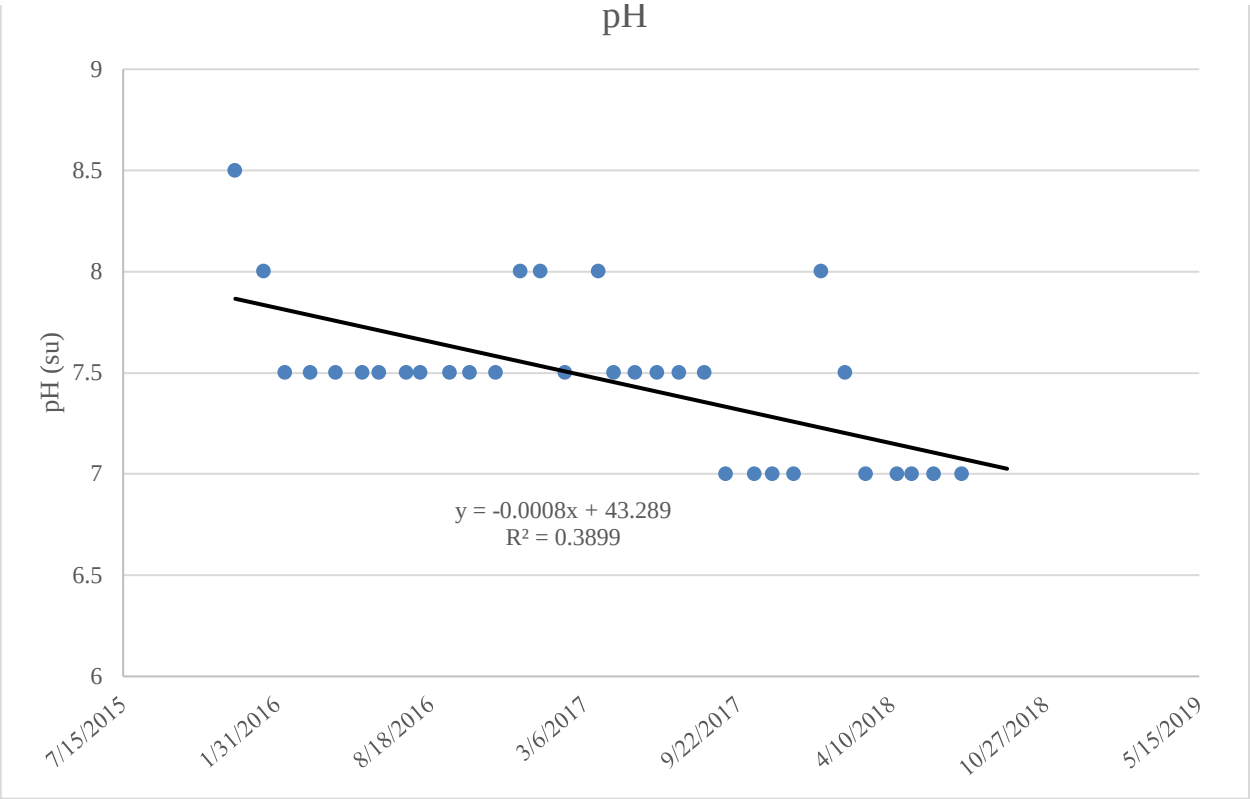

Figure 66: pH at Site 81497

Nitrate-Nitrogen

There were 33 nitrate-nitrogen measurements taken at this site between 12/8/2015 and 9/7/2018 all producing results of 1 mg/L.

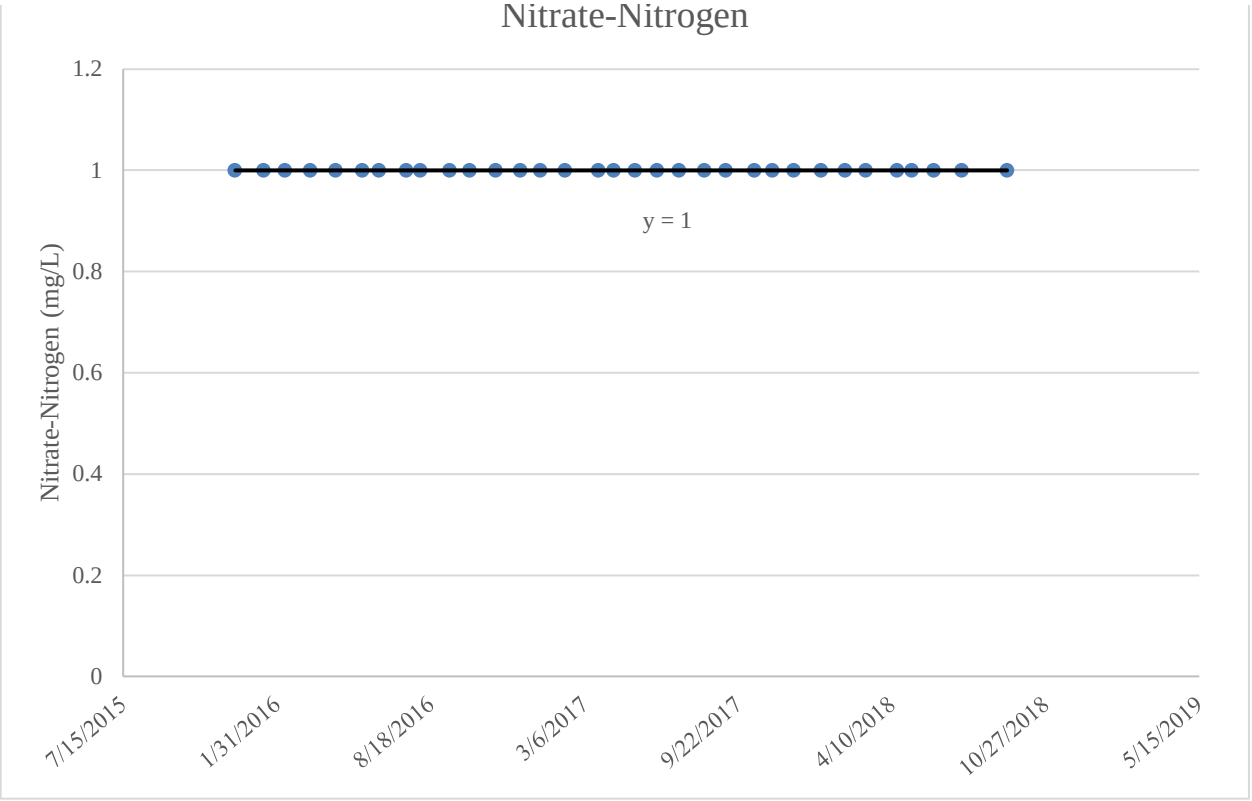

Figure 67: Nitrate-Nitrogen at Site 81497

Site 81498 – Pedernales Headwaters

Site Description

This Pedernales Headwaters site is located at a private low-water crossing of the Pedernales River found approximately 8 kilometers southeast of Harper, Texas. The river is held by numerous small dams up- and downstream of this site and experiences more farming activity along its banks here than in the previously mentioned sites that are further downstream in the middle and lower sections of the river.

Sampling Information

This site was monitored 31 times between 2/11/2016 and 8/30/2018. Sampling times typically occur between 10:00 and 18:20.

Table 16: Descriptive parameters for Site 81498

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	31	312 ± 51	130	436
Water Temperature (°C)	31	22.3 ± 6.5	11.5	33.0
Dissolved Oxygen (mg/L)	31	7.9 ± 1.7	4.7	10.3
pH (su)	29	7.0 ± 0.0	7.0	7.0
Nitrate-Nitrogen (mg/L)	31	1 ± 0	1	1

Site 81498 was sampled 31 times between 2/11/2016 and 8/30/2018.

Air and Water Temperature

Air and water temperatures were taken 31 times at this site between 2/11/2016 and 8/30/2018. The mean water temperature was 22.3°C. Water temperature varied from a low of 11.5°C in January of 2018, to a high of 33.0°C in July of 2018. The air temperature varied from a low of 15.0°C in October of 2017, to a high of 37.5°C in June of 2018.

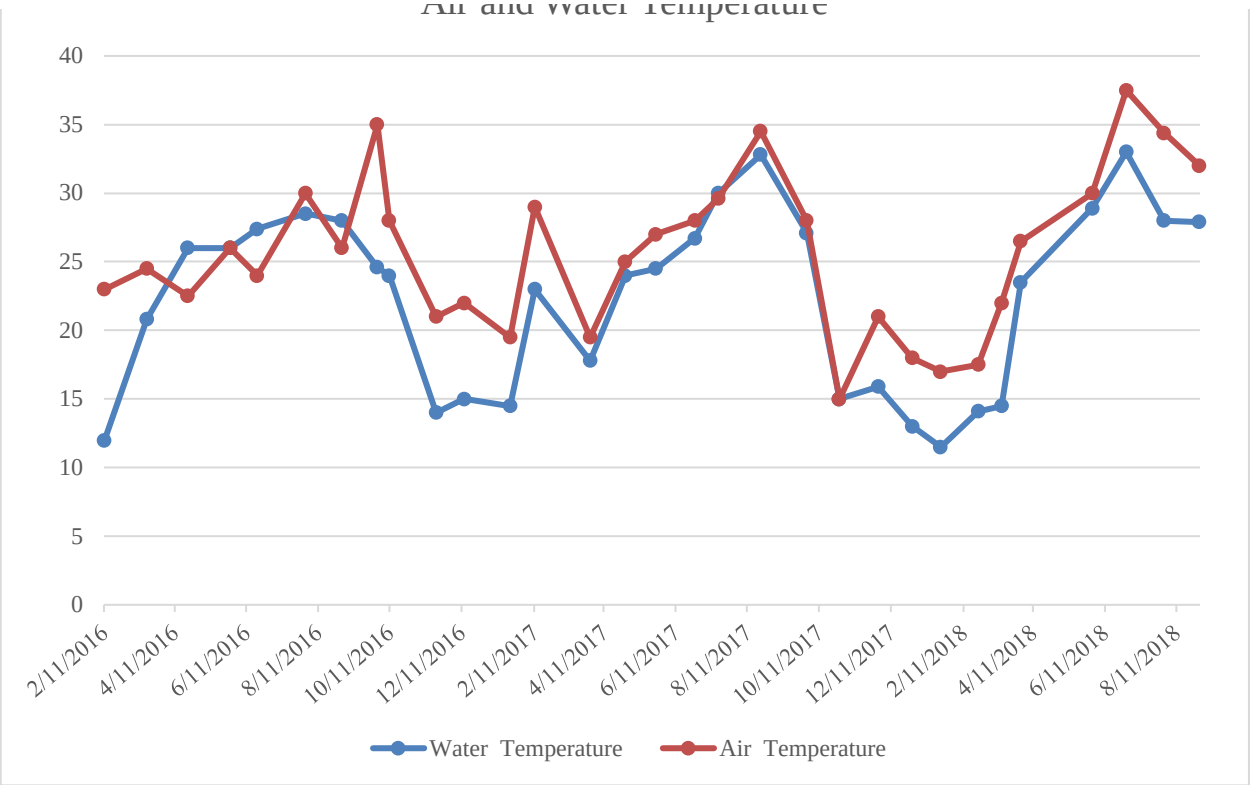

Figure 68: Air and water temperature at Site 81498

Total Dissolved Solids

Citizen scientists took a total of 31 TDS samples at this site between 2/11/2016 and 8/30/2018. The mean TDS concentration was 312 mg/L. The concentration of TDS varied from a low of 130 mg/L in May of 2016, to a high of 436 mg/L in February of 2018.

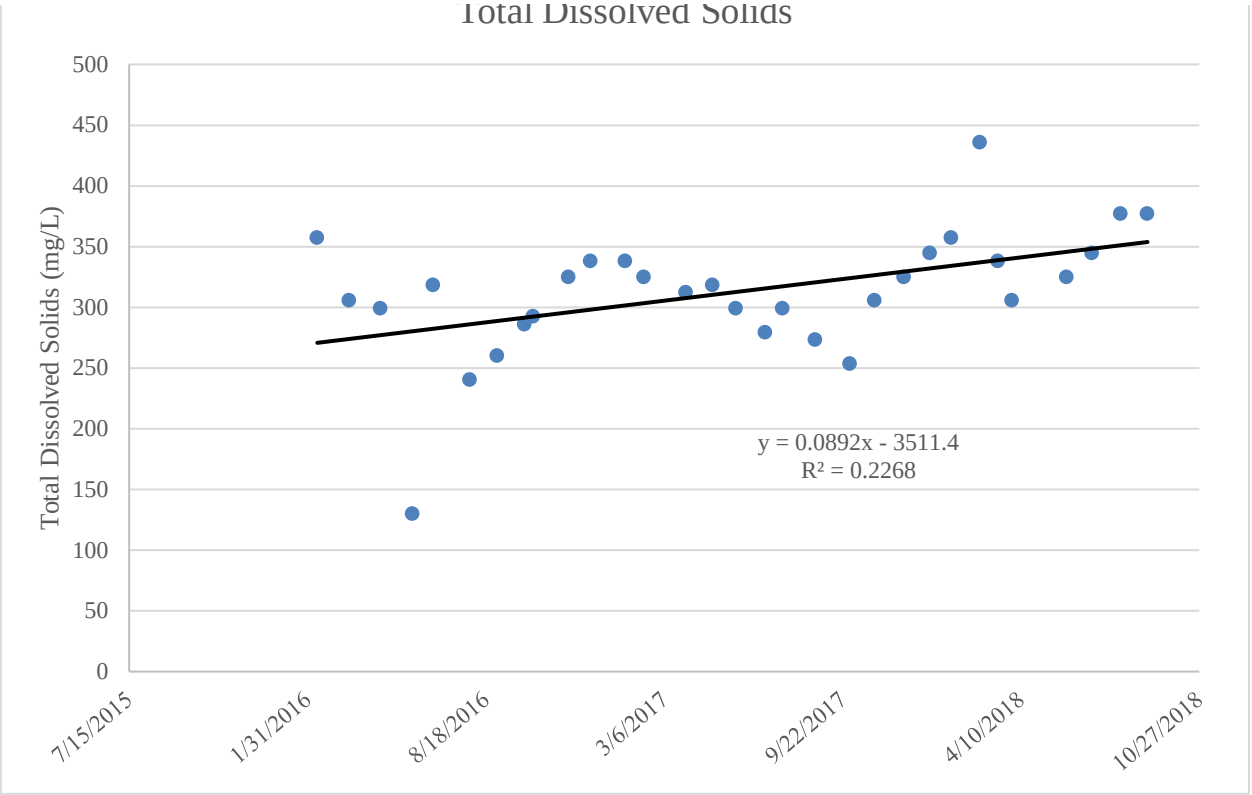

Figure 69: Total dissolved solids at Site 81498

Dissolved Oxygen

Citizen scientists took 31 DO samples at this site between 2/11/2016 and 8/30/2018. The mean DO concentration was 7.9 mg/L. The minimum DO concentration was 4.65 mg/L and was taken in May of 2018. The maximum DO concentration was 10.3 mg/L and was taken in January of 2018.

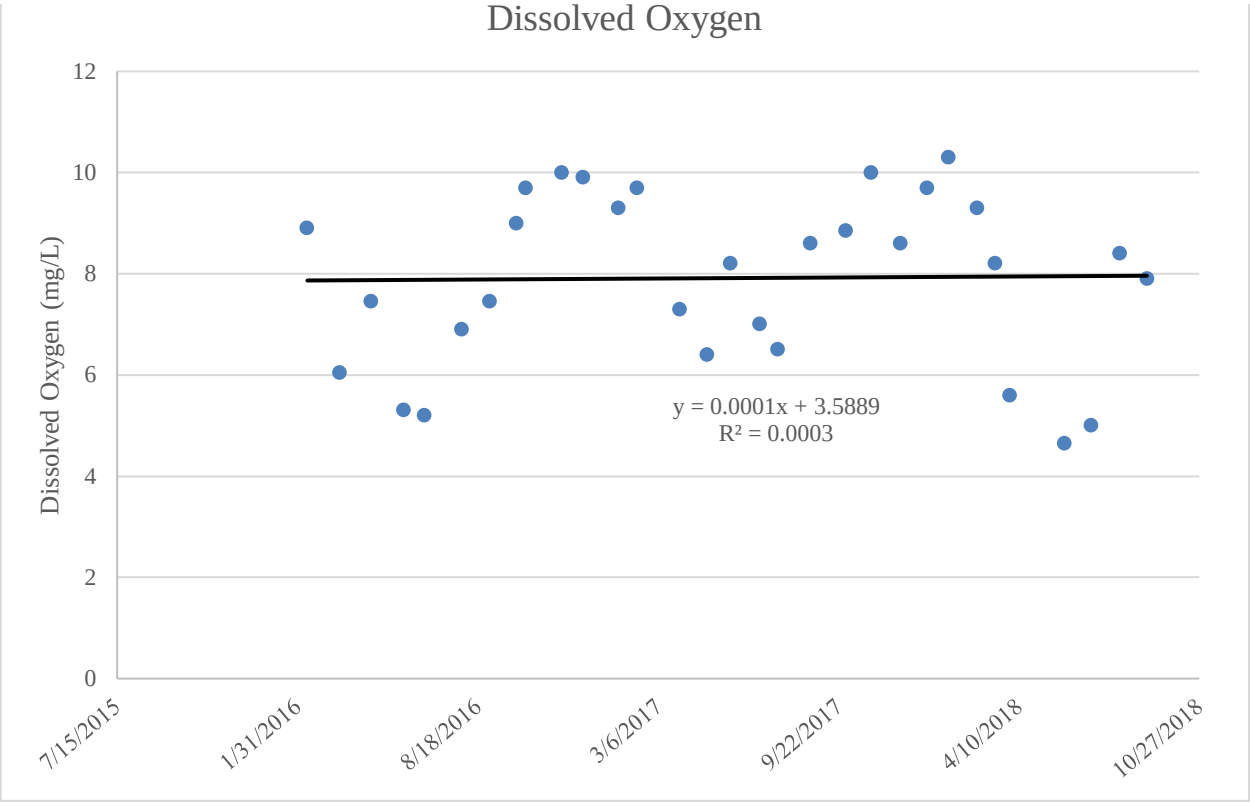

Figure 70: Dissolved oxygen at Site 81498

pH

Citizen scientists took 29 pH measurements at this site between 2/11/2016 and 8/30/2018. All measurements taken at this site resulted in a pH of 7.

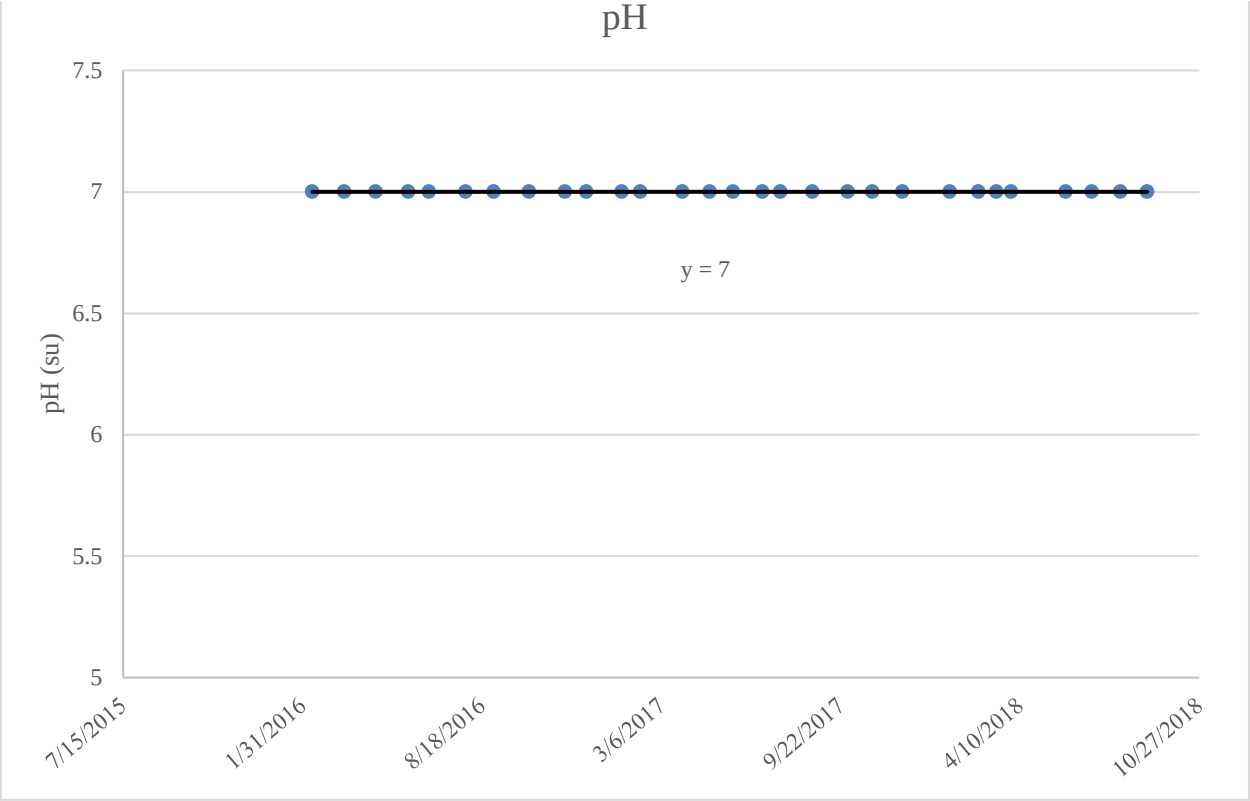

Figure 71: pH at Site 81498

Nitrate-Nitrogen

There were 31 nitrate-nitrogen measurements taken at this site between 2/11/2016 and 8/30/2018 all producing results of 1 mg/L.

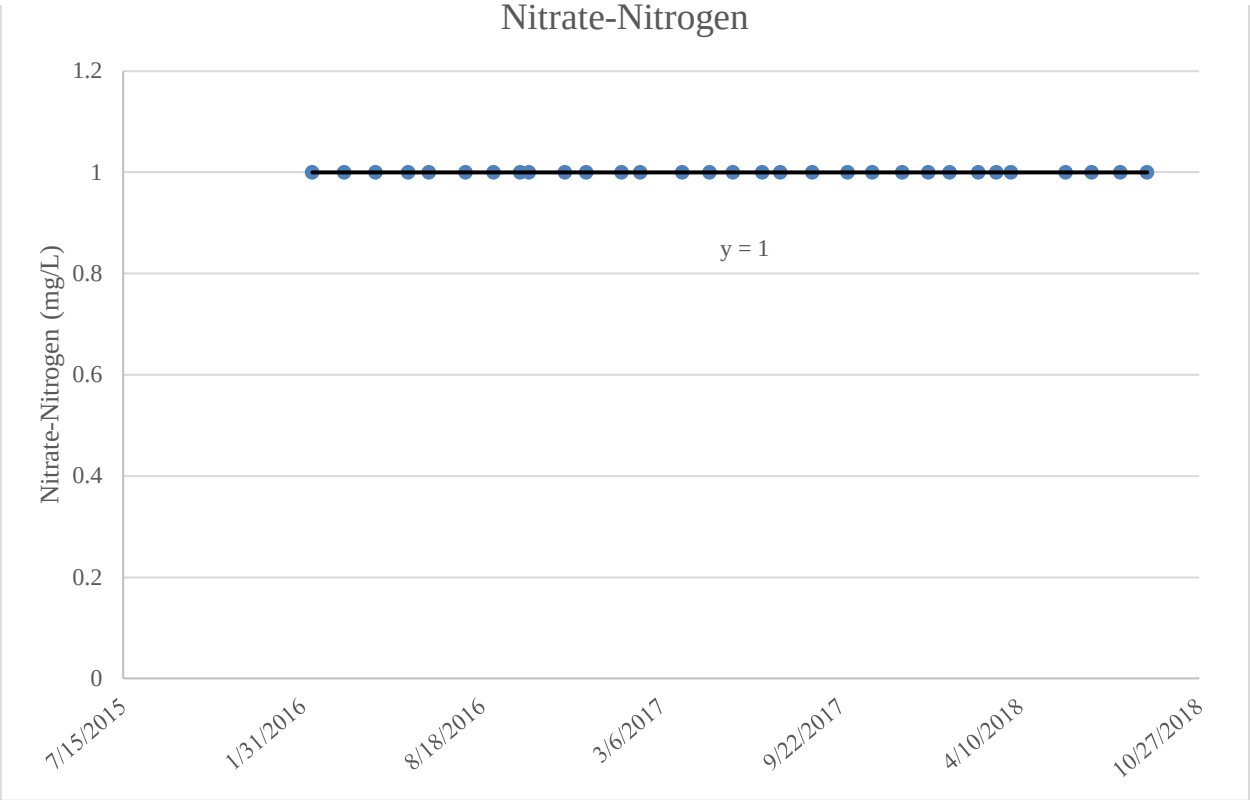

Figure 72: Nitrate-Nitrogen at Site 81498

Site 81499 – Honey Creek above US 290

Site Description

This site is located on a low-water crossing of Honey Creek on private property approximately 13 kilometers west of Fredericksburg, Texas. The creek is an intermittent tributary to the Pedernales River and has a drainage that is predominantly rangeland, although some farming operations exist nearby in its downstream reaches. Small dams exist upstream of the site.

Sampling Information

This site was monitored 31 times between 2/19/2016 and 8/31/2018. Sampling times typically occur between 9:30 and 20:00.

Table 17: Descriptive parameters for Site 81499

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	31	345 ± 17	306	397
Water Temperature (°C)	31	20.3 ± 5.7	9.5	27.0
Dissolved Oxygen (mg/L)	31	6.3 ± 1.4	3.7	8.8
pH (su)	30	7.0 ± 0	7.0	7.0
Nitrate-Nitrogen (mg/L)	31	1 ± 0	1	1

Site 81499 was sampled 31 times between 2/19/2016 and 8/31/2018.

Air and Water Temperature

Air and water temperatures were taken 31 times at this site between 2/19/2016 and 8/31/2018. The mean water temperature was 20.3°C. Water temperature varied from a low of 9.5°C in January of 2018, to a high of 27.0°C in July of 2016. The air temperature varied from a low of 11.0°C in January of 2018, to a high of 33.4°C in August of 2017.

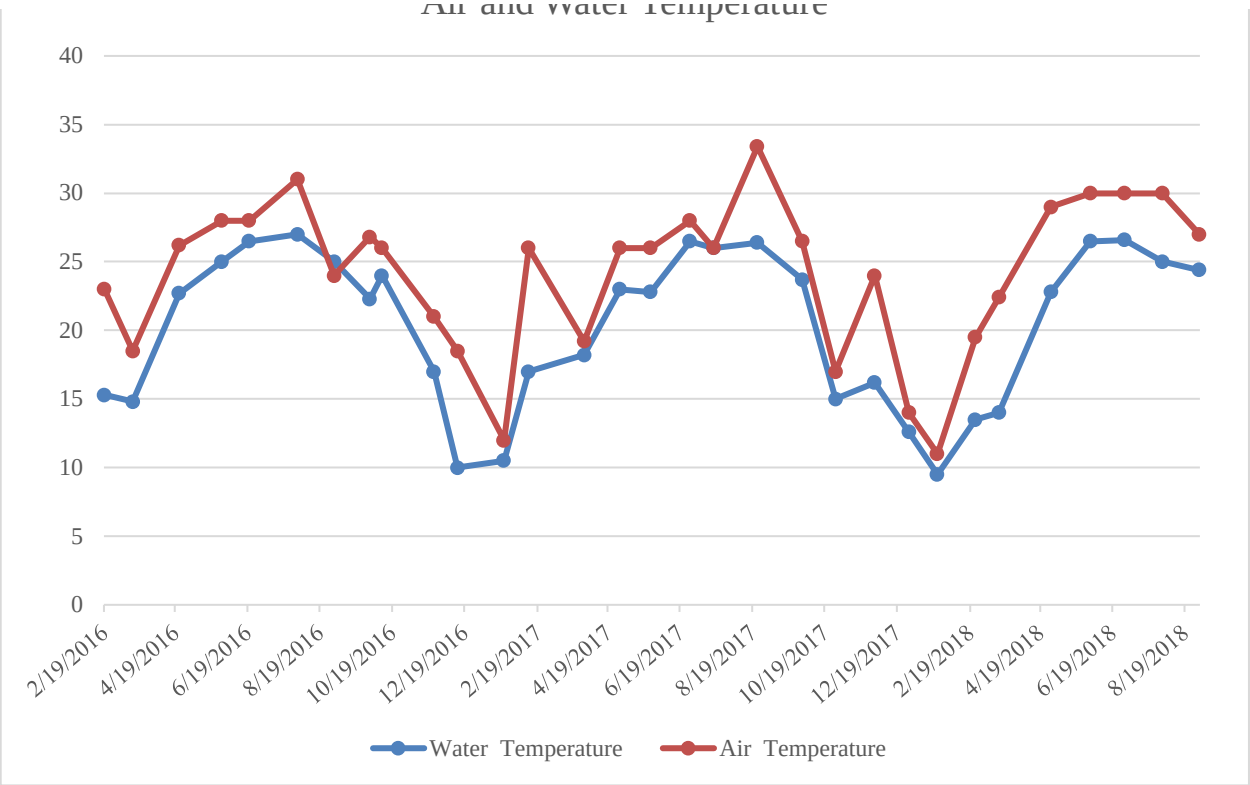

Figure 73: Air and water temperature at Site 81499

Total Dissolved Solids

Citizen scientists took a total of 31 TDS samples at this site between 2/19/2016 and 8/31/2018. The mean TDS concentration was 345 mg/L. The concentration of TDS varied from a low of 306 mg/L in June of 2017, to a high of 397 mg/L in March of 2018.

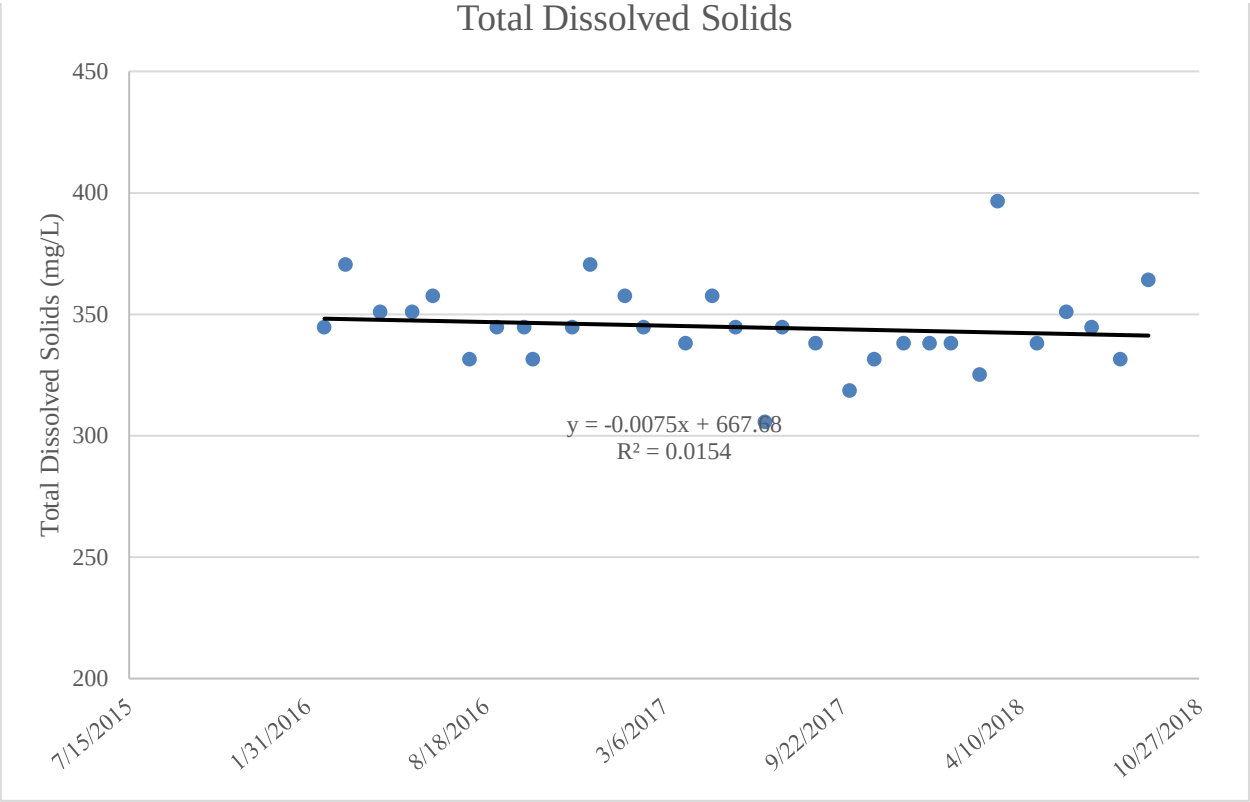

Figure 74: Total dissolved solids at Site 81499

Dissolved Oxygen

Citizen scientists took 31 DO samples at this site between 2/19/2016 and 8/31/2018. The mean DO concentration was 6.3 mg/L. The minimum DO concentration was 3.7 mg/L and was taken in August of 2018. The maximum DO concentration was 8.8 mg/L and was taken in December of 2017.

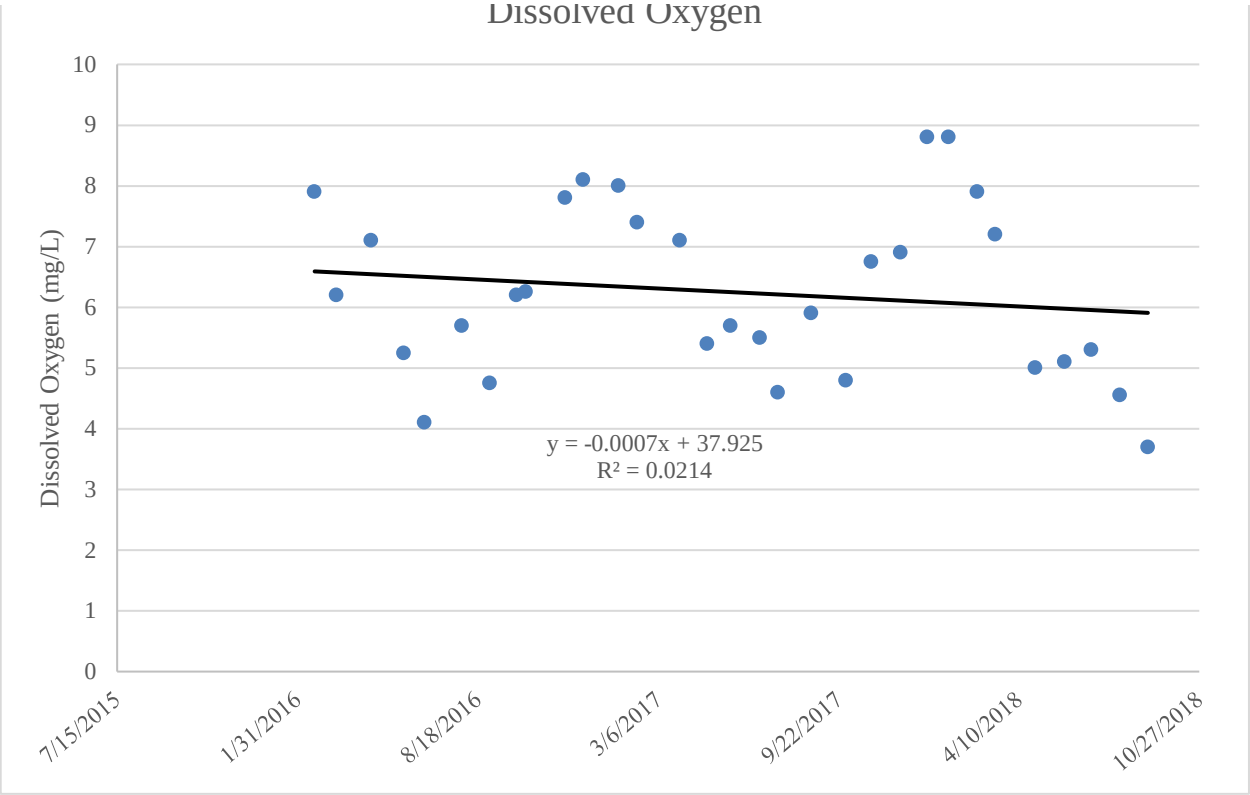

Figure 75: Dissolved oxygen at Site 81499

pH

Citizen scientists took 30 pH measurements at this site between 2/19/2016 and 8/31/2018. All measurements taken at this site resulted in a pH of 7.

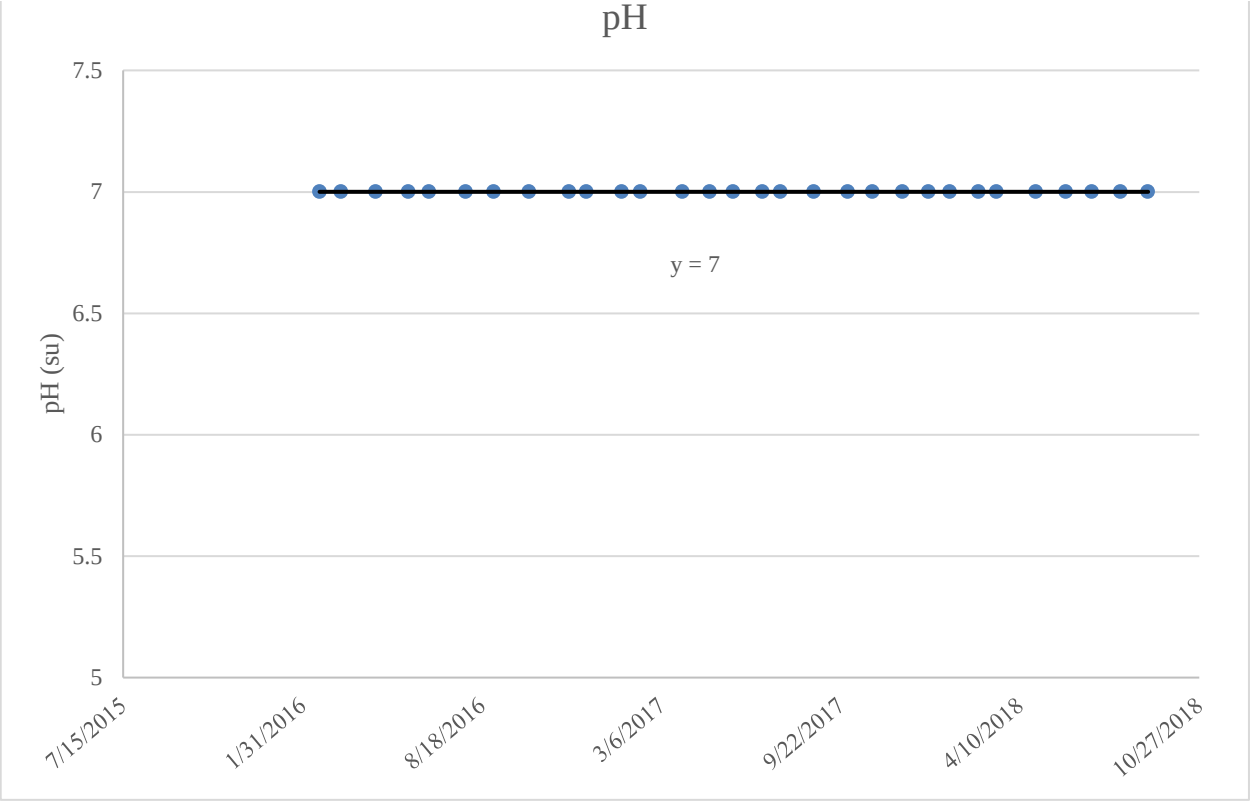

Figure 76: pH at Site 81499

Nitrate-Nitrogen

There were 31 nitrate-nitrogen measurements taken at this site between 2/19/2016 and 8/31/2018 all producing results of 1 mg/L.

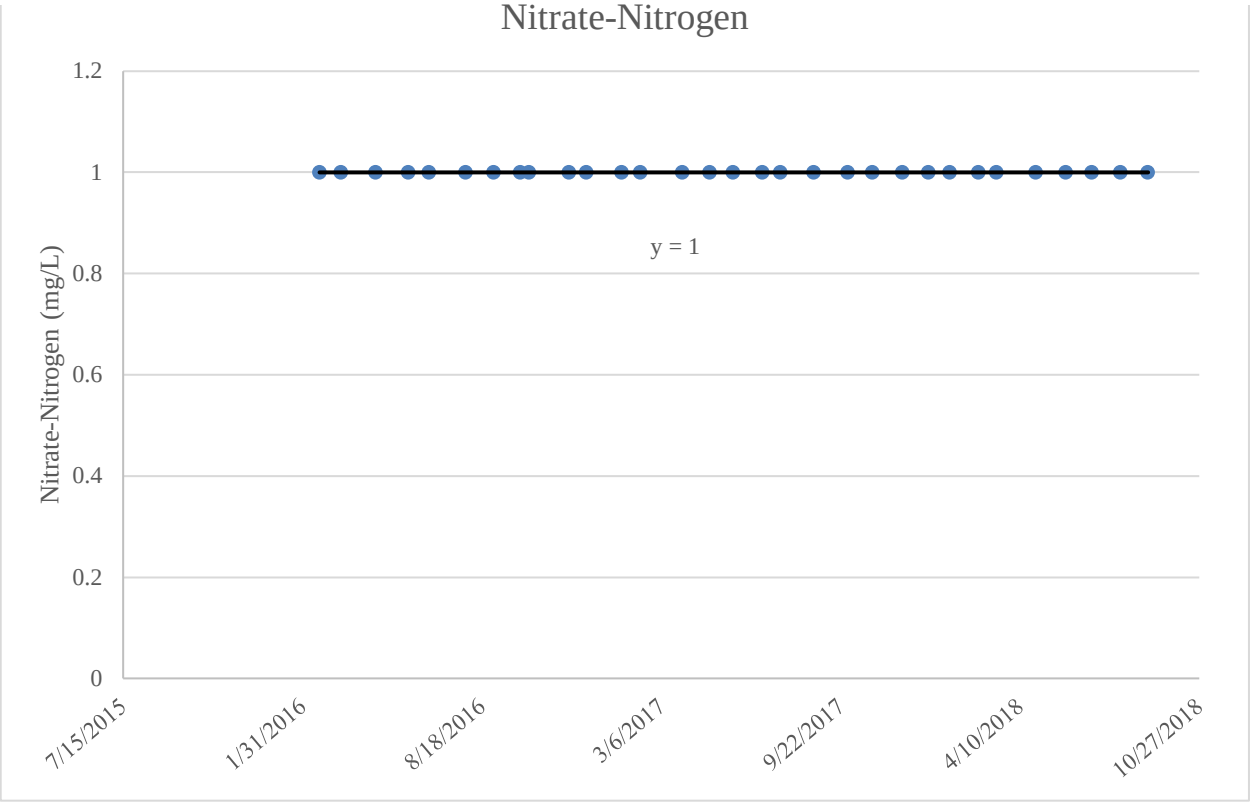

Figure 77: Nitrate-Nitrogen at Site 81499

Site 81500 – Pedernales River at LBJ Dam

Site Description

This site is located on a low-water crossing on public property at the Lyndon B. Johnson National Historical Park in Stonewall, Texas. Site 81500 is found on the second of three small dams that are on the river in the vicinity of park, and is accessible from Redstone Ranch Rd, on the north site of the river. The site is approximately 5 kilometers east and downstream of Stonewall and is mainly surrounded by a mix of farms and rangeland.

Sampling Information

This site was monitored 13 times between 11/29/2016 and 8/28/2018. Sampling times typically occur between 8:45 and 15:45.

Table 18: Descriptive parameters for Site 81500

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	13	445 ± 53	306	514
Water Temperature (°C)	13	23.0 ± 5.7	14.0	31.0
Dissolved Oxygen (mg/L)	13	7.1 ± 2.4	3.7	12.9
pH (su)	12	8.4 ± 0.2	7.8	8.7
E. coli (CFU/100mL)	8	4 ± 11	1	30
Nitrate-Nitrogen (mg/L)	11	1 ± 0	1	1

Site 81500 was sampled 13 times between 11/29/2016 and 8/28/2018.

Air and Water Temperature

Air and water temperatures were taken 13 times at this site between 11/29/2016 and 8/28/2018. The mean water temperature was 23.0°C. This is the highest mean water temperature for the selected sites on the Pedernales River in this report. Water temperature varied from a low of 14°C in January of 2017, to a high of 31.0°C in July of 2017. The air temperature varied from a low of 19.0°C in January of 2017, to a high of 34.0°C in July of 2017.

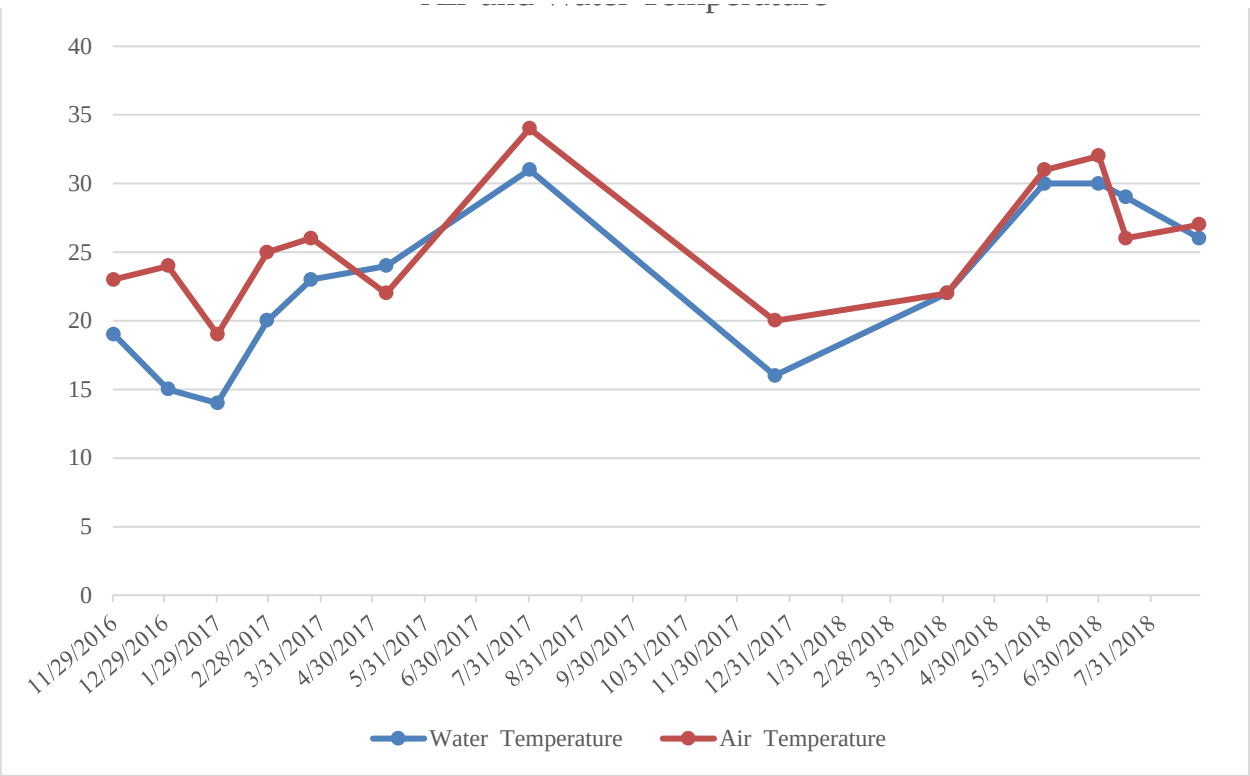

Figure 78: Air and water temperature at Site 81500

Total Dissolved Solids

Citizen scientists took a total of 13 TDS samples at this site between 11/29/2016 and 8/28/2018. The mean TDS concentration was 445 mg/L. The concentration of TDS varied from a low of 306 mg/L in May of 2018, to a high of 514 mg/L in August of 2018.

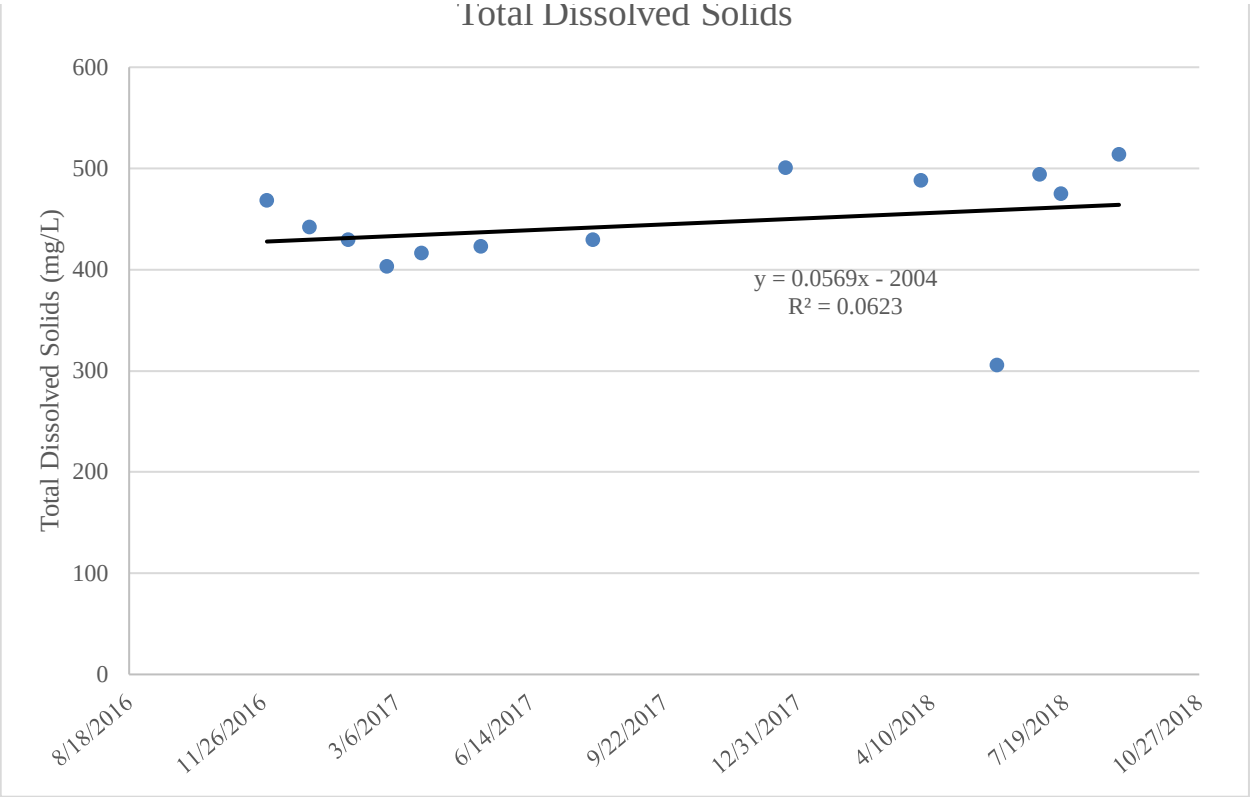

Figure 79: Total dissolved solids at Site 81500

Dissolved Oxygen

Citizen scientists took 13 DO samples at this site between 11/29/2016 and 8/28/2018. The mean DO concentration was 7.1 mg/L. The minimum DO concentration was 3.7 mg/L and was taken in August of 2018. The maximum DO concentration was 12.9 mg/L and was taken in January of 2017.

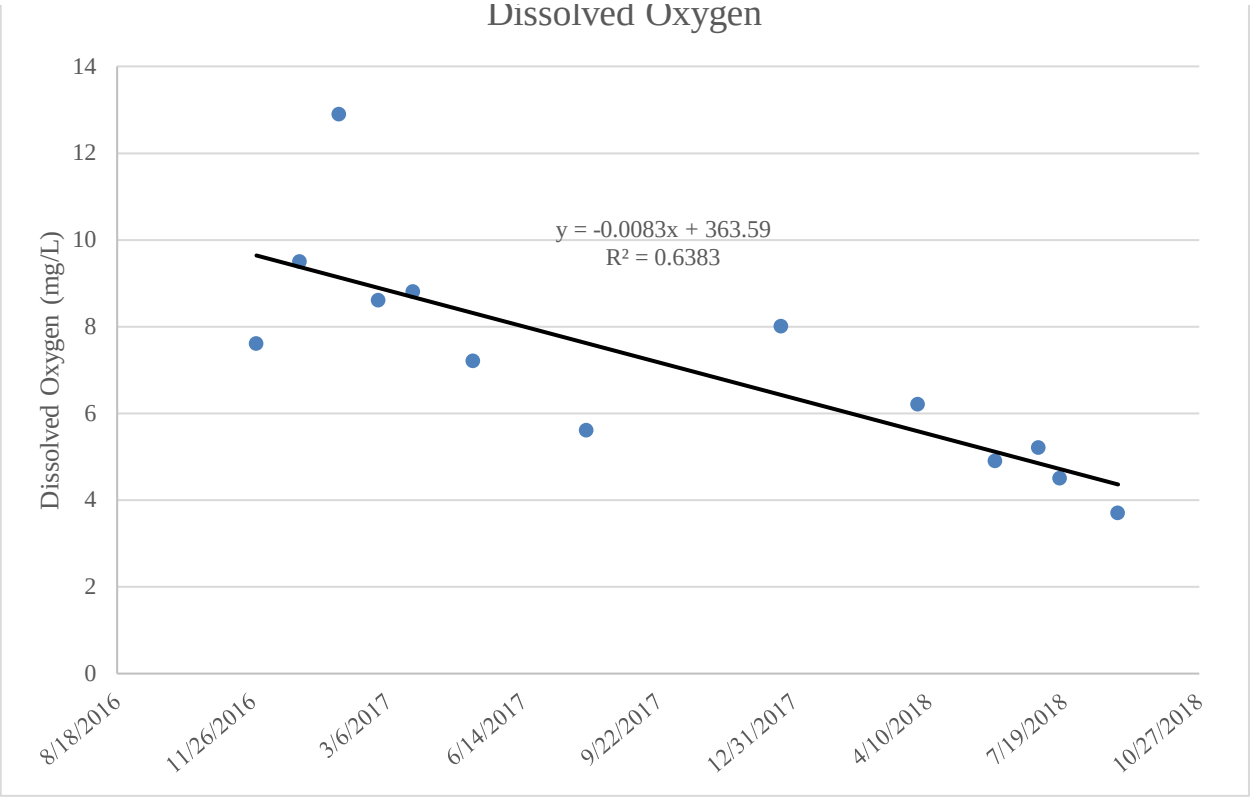

Figure 80: Dissolved oxygen at Site 81500

pH

Citizen scientists took 12 pH measurements at this site between 11/29/2016 and 8/28/2018. The mean pH was 8.4. The pH ranged from a low of 7.8 taken in January of 2017 and a high of 8.7 taken in June of 2018.

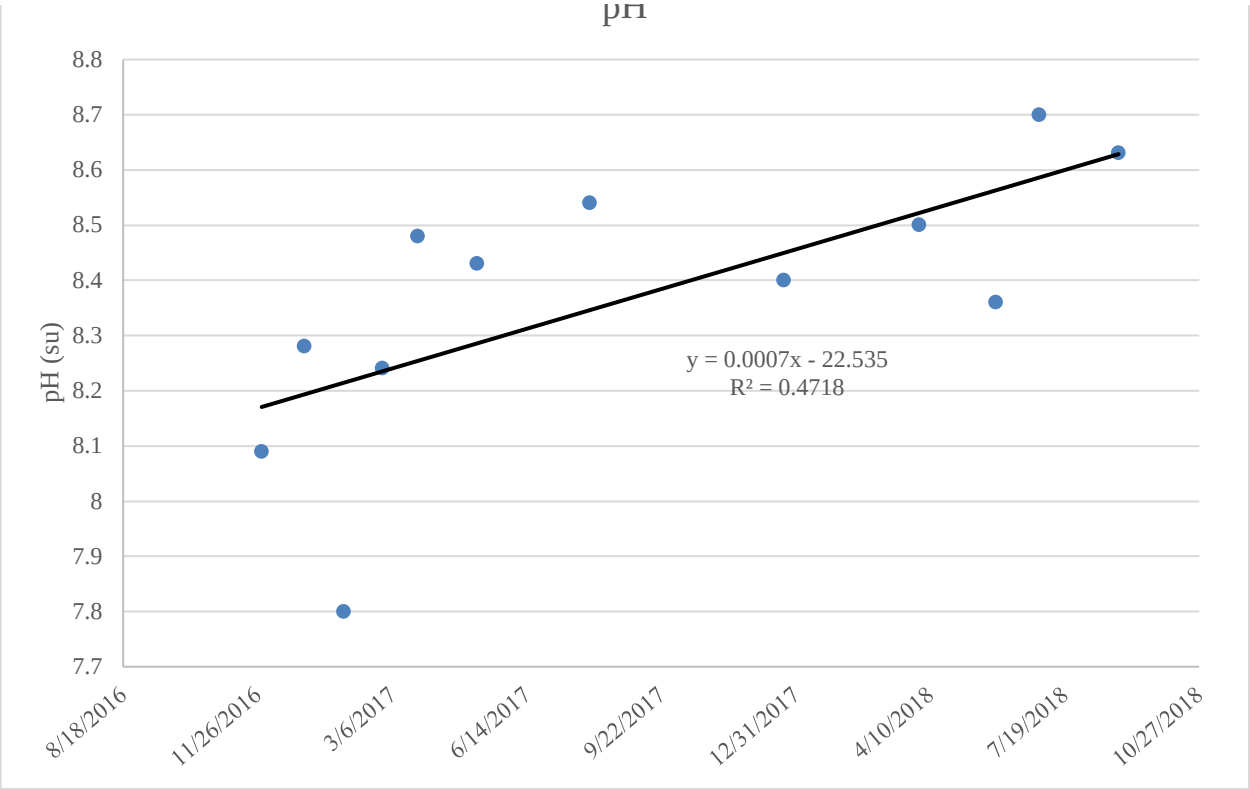

Figure 81: pH at Site 81500

E. coli

There were 8 *E. coli* measurements taken at this site between 11/29/2016 and 7/16/2018. The observed geomean was 4 CFU/100mL and ranged from a low of 1 CFU/100mL taken on several occasions to a high of 30 CFU/100mL taken in February of 2017.

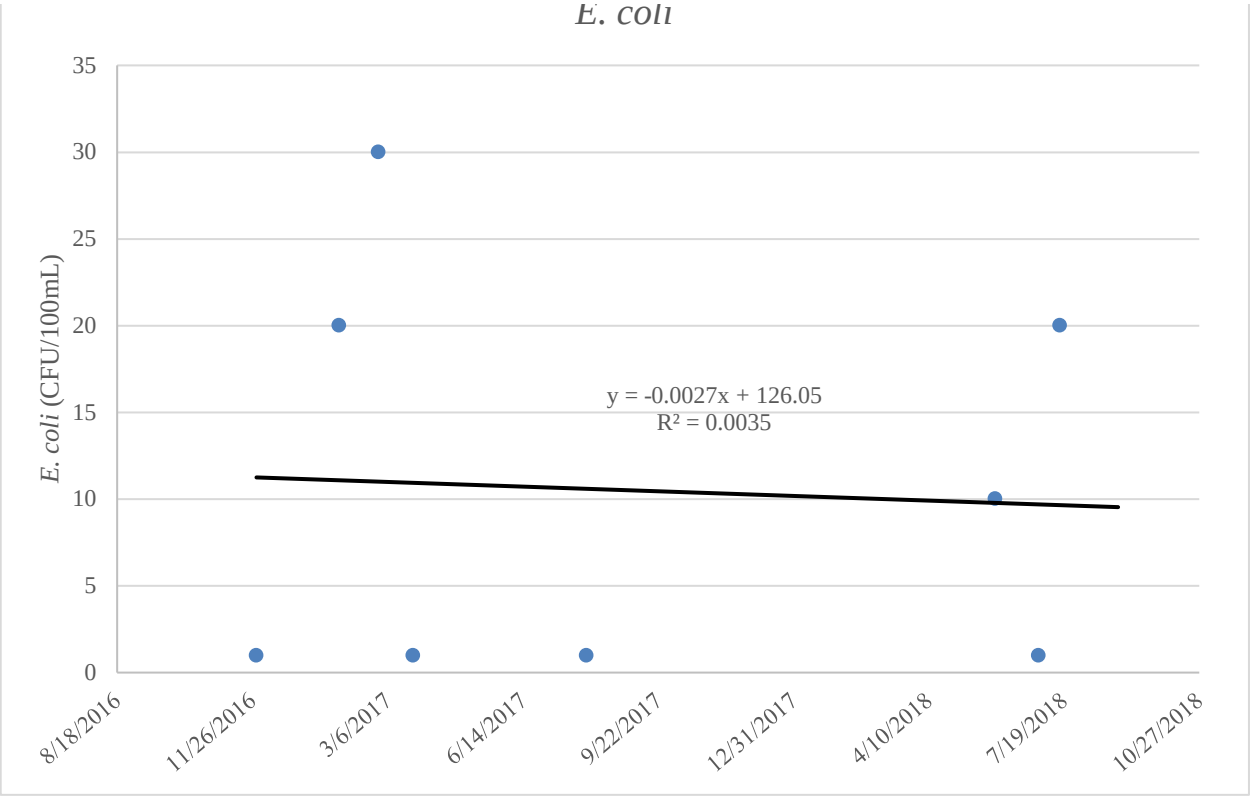

Figure 82: *E. coli* at Site 81500

Nitrate-Nitrogen

There were 11 nitrate-nitrogen measurements taken at this site between 11/29/2016 and 8/28/2018 all producing results of 1 mg/L.

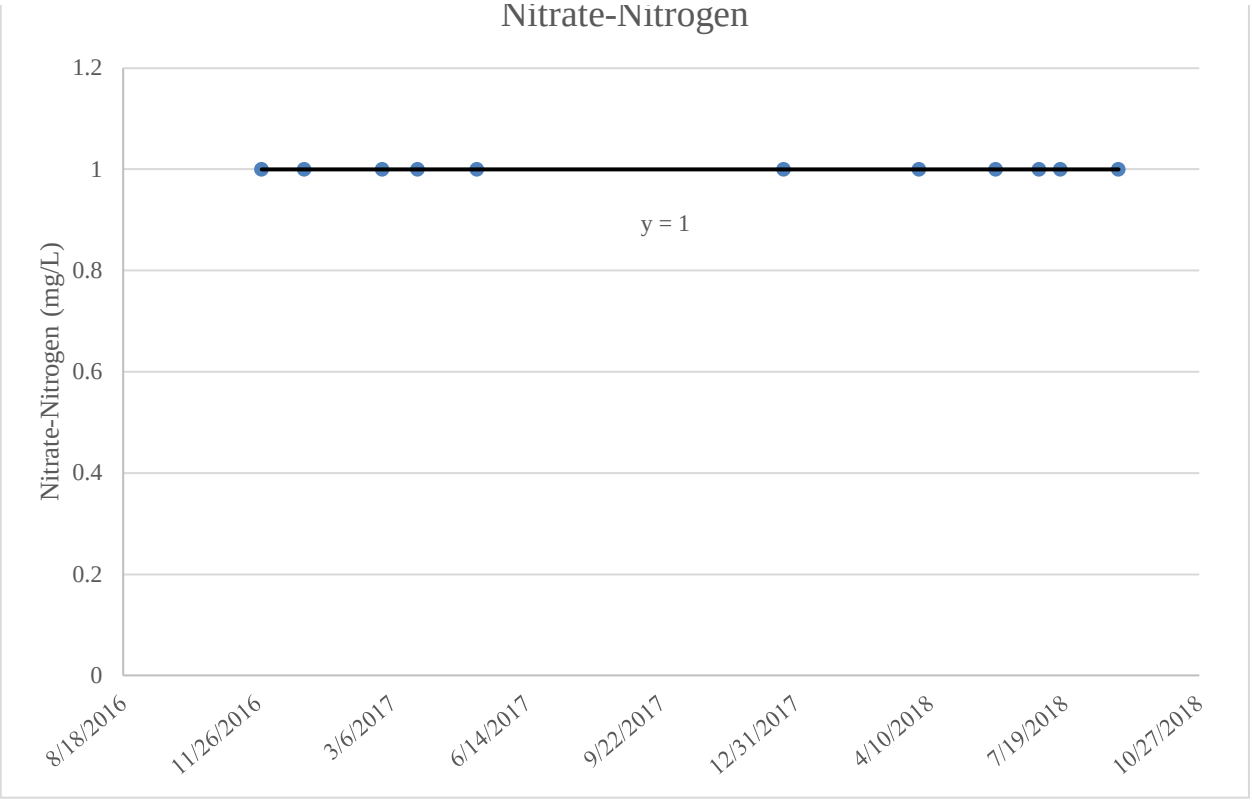

Figure 83: Nitrate-Nitrogen at Site 81500

Site 81504 – Dead Man's Hole

Site Description

This site is located at a deep, collapsed karst room on private property. The site is to be accessed through the permission of local residents only. Dead Man's Hole is on the middle section of Dead Man's Creek, downstream of small dams that eventually lead the creek to a near 40-foot drop off into Dead Man's Hole, which likely is spring-fed.

Sampling Information

This site was monitored 15 times between 6/9/2017 and 8/30/2018. Sampling times typically occur between 8:05 and 15:45.

Table 19: Descriptive parameters for Site 81504

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	15	291 ± 9	280	306
Water Temperature (°C)	15	21.7 ± 6.1	10.0	28.0
Dissolved Oxygen (mg/L)	15	6.3 ± 1.7	4.0	9.5
pH (su)	15	7.0 ± 0.0	7.0	7.0
Nitrate-Nitrogen (mg/L)	14	1 ± 0	1	1

Site 81504 was sampled 15 times between 6/9/2017 and 8/30/2018.

Air and Water Temperature

Air and water temperatures were taken 15 times at this site between 6/9/2017 and 8/30/2018. The mean water temperature was 21.7°C. Water temperature varied from a low of 10°C in January of 2018, to a high of 28°C in July of 2017. The air temperature varied from a low of 14.5°C in December of 2017, to a high of 30.0°C in June of 2018.

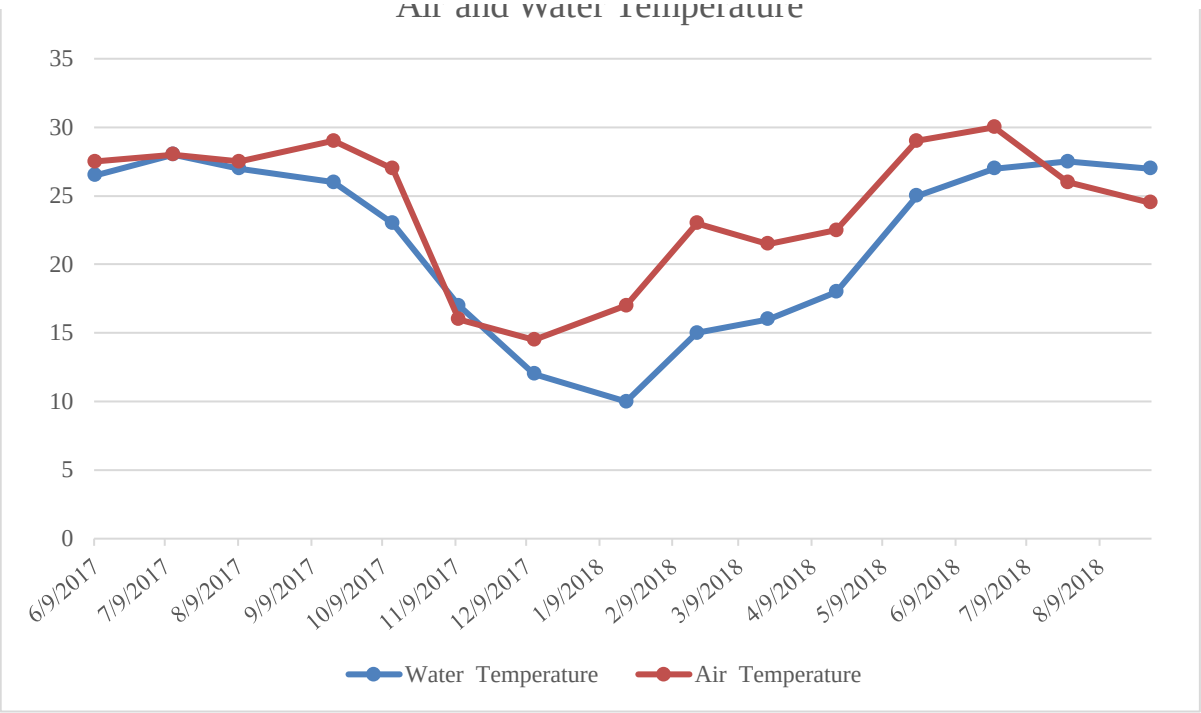

Figure 84: Air and water temperature at Site 81504

Total Dissolved Solids

Citizen scientists took a total of 15 TDS samples at this site between 6/9/2017 and 8/30/2018. The mean TDS concentration was 291 mg/L. The concentration of TDS varied from a low of 280 mg/L on multiple instances to a high of 306 mg/L in January of 2018.

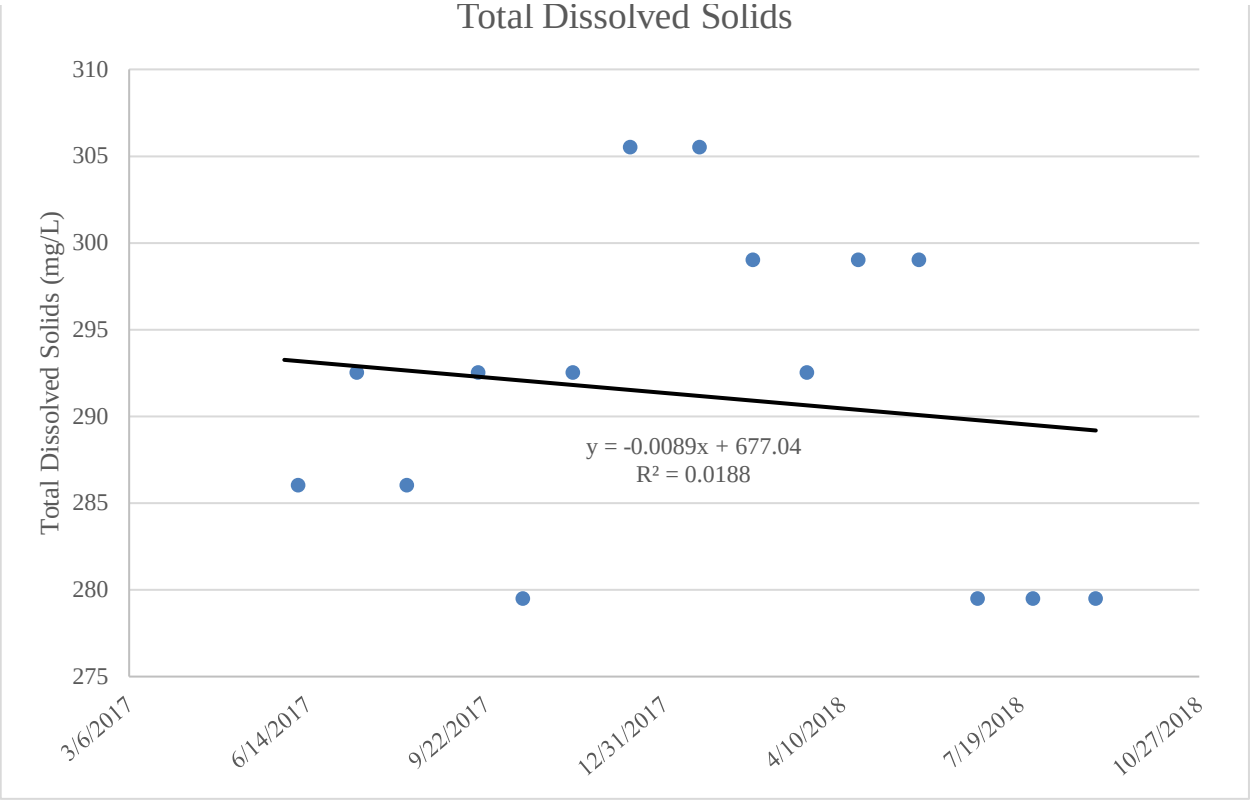

Figure 85: Total dissolved solids at Site 81504

Dissolved Oxygen

Citizen scientists took 15 DO samples at this site between 6/9/2017 and 8/30/2018. The mean DO concentration was 6.3 mg/L. The minimum DO concentration was 4.0 mg/L and was taken in July of 2018. The maximum DO concentration was 9.5 mg/L and was taken in January of 2018.

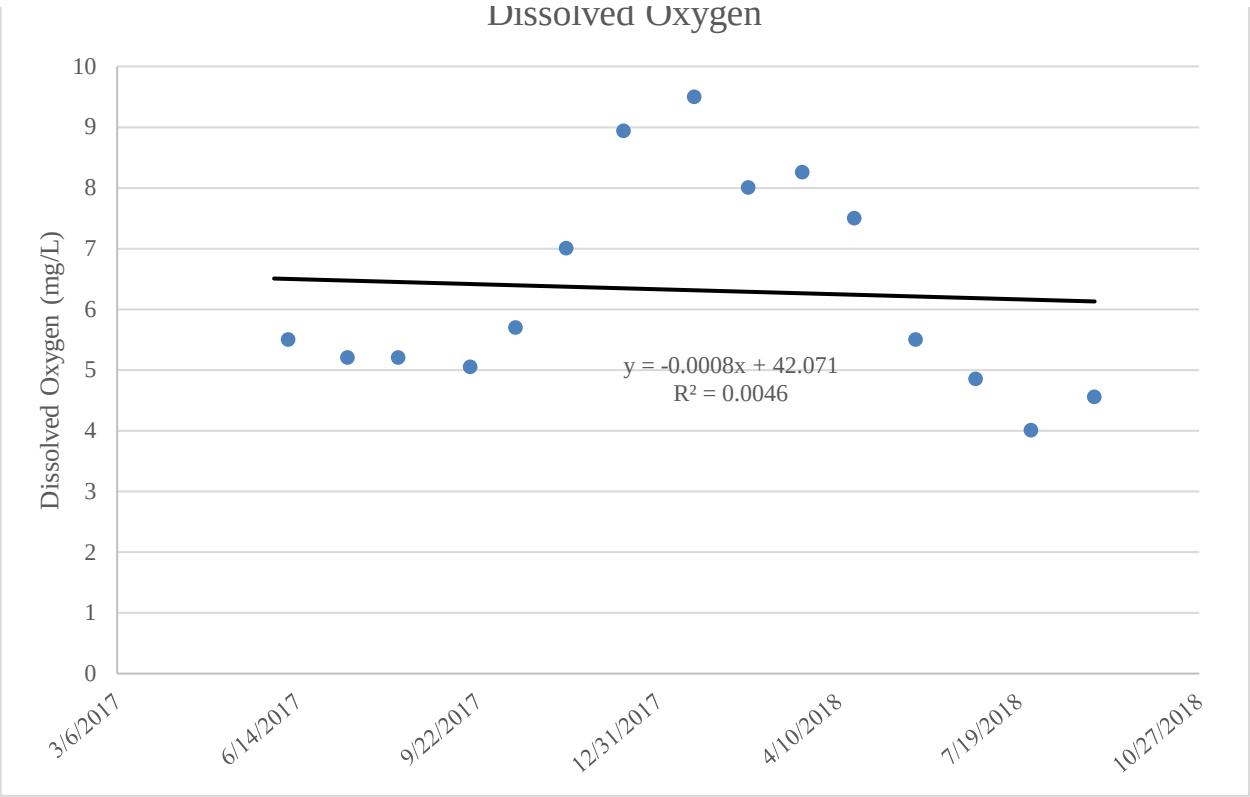

Figure 86: Dissolved oxygen at Site 81504

pH

Citizen scientists took 15 pH measurements at this site measurements at this site between 6/9/2017 and 8/30/2018. All measurements taken at this site resulted in a pH of 7.

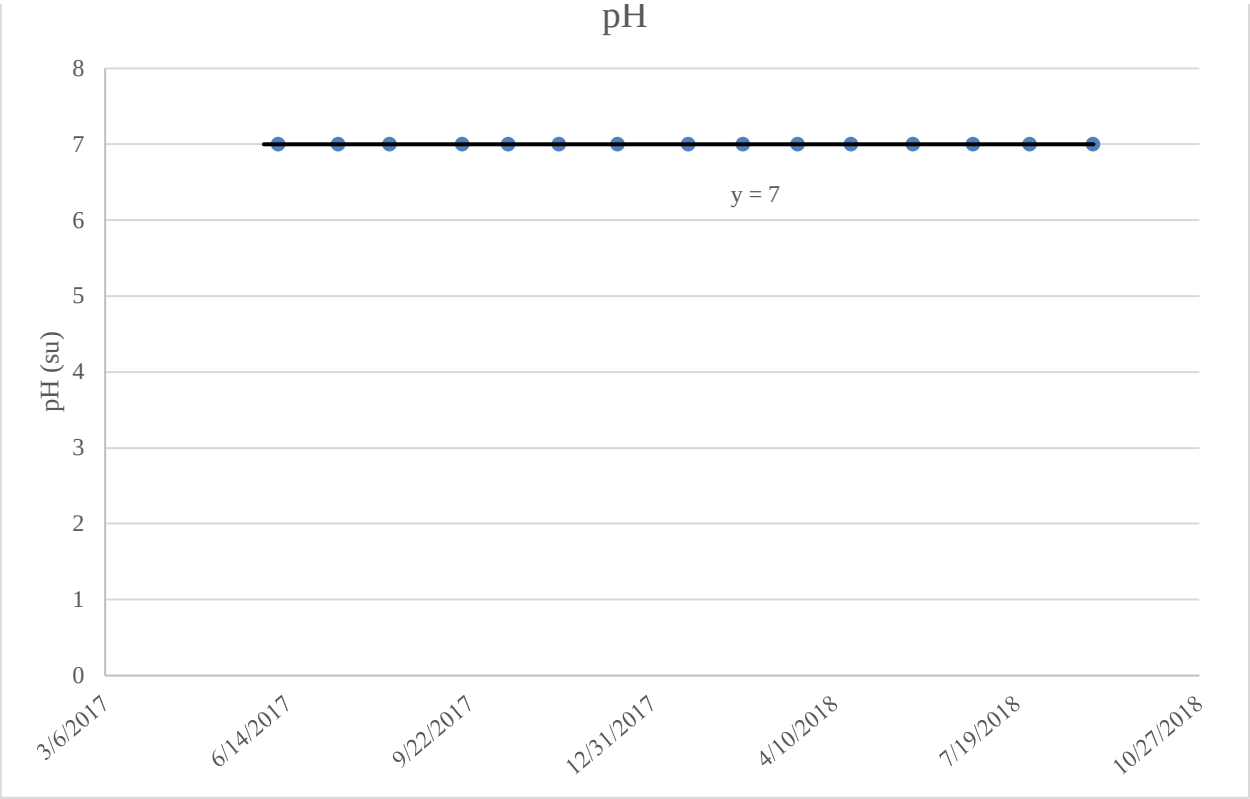

Figure 87: pH at Site 81504

Nitrate-Nitrogen

There were 14 nitrate-nitrogen measurements taken at this site between 6/9/2017 and 8/30/2018 all producing results of 1 mg/L.

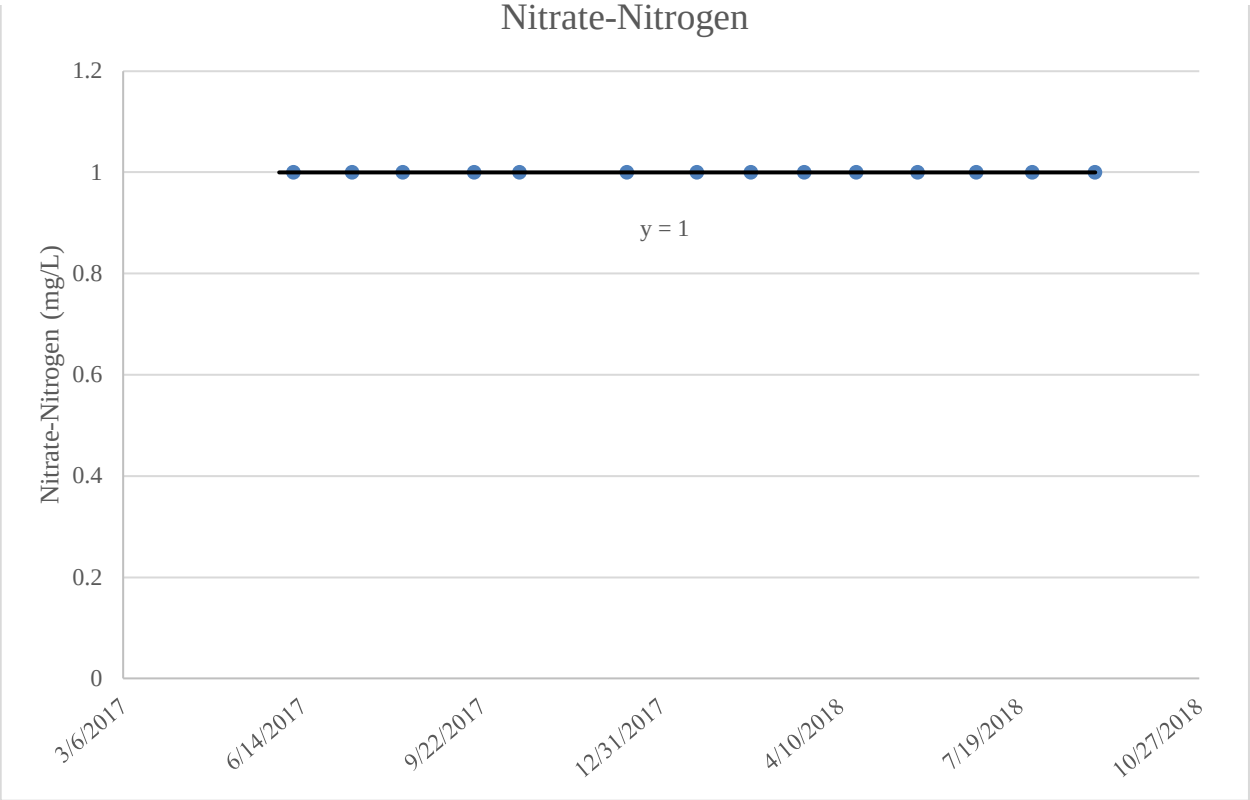

Figure 88: Nitrate-Nitrogen at Site 81504

Site 81490 – Lake Travis at Mansfield Dam Park

Site Description

This site is located at the Mansfield Dam Park. Mansfield Dam impounds Lake Travis on the Colorado and Pedernales rivers in western Travis County. Mansfield Dam Park offers beautiful views of Lake Travis where families can picnic, swim in our secluded cove, fish, and play and includes the largest public boat ramp on Lake Travis with an extensive scuba diving park.

Sampling Information

This site was monitored 91 times between 11/8/2010 and 7/16/2018. Sampling times typically occur between 9:00 and 14:08.

Table 20: Descriptive parameters for Site 81490

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	91	291 ± 20	254	325
Water Temperature (°C)	90	21.3 ± 5.7	10.0	30.0
Dissolved Oxygen (mg/L)	91	6.5 ± 1.2	4.6	9.2
pH (su)	90	7.5 ± 0.2	7.0	8.0
E. coli (CFU/100mL)	76	2 ± 8	1	60
Nitrate-Nitrogen (mg/L)	61	0.55 ± 0.36	0.25	1

Site 81490 was sampled 91 times between 11/8/2010 and 7/16/2018.

Air and Water Temperature

Air and water temperatures were taken 90 times at this site between 11/8/2010 and 7/16/2018. The mean water temperature was 21.3°C. Water temperature varied from a low of 10°C in January of 2014, to a high of 30.0°C in August of 2011. The air temperature varied from a low of 3.5°C in December of 2013, to a high of 37.0°C in July of 2011.

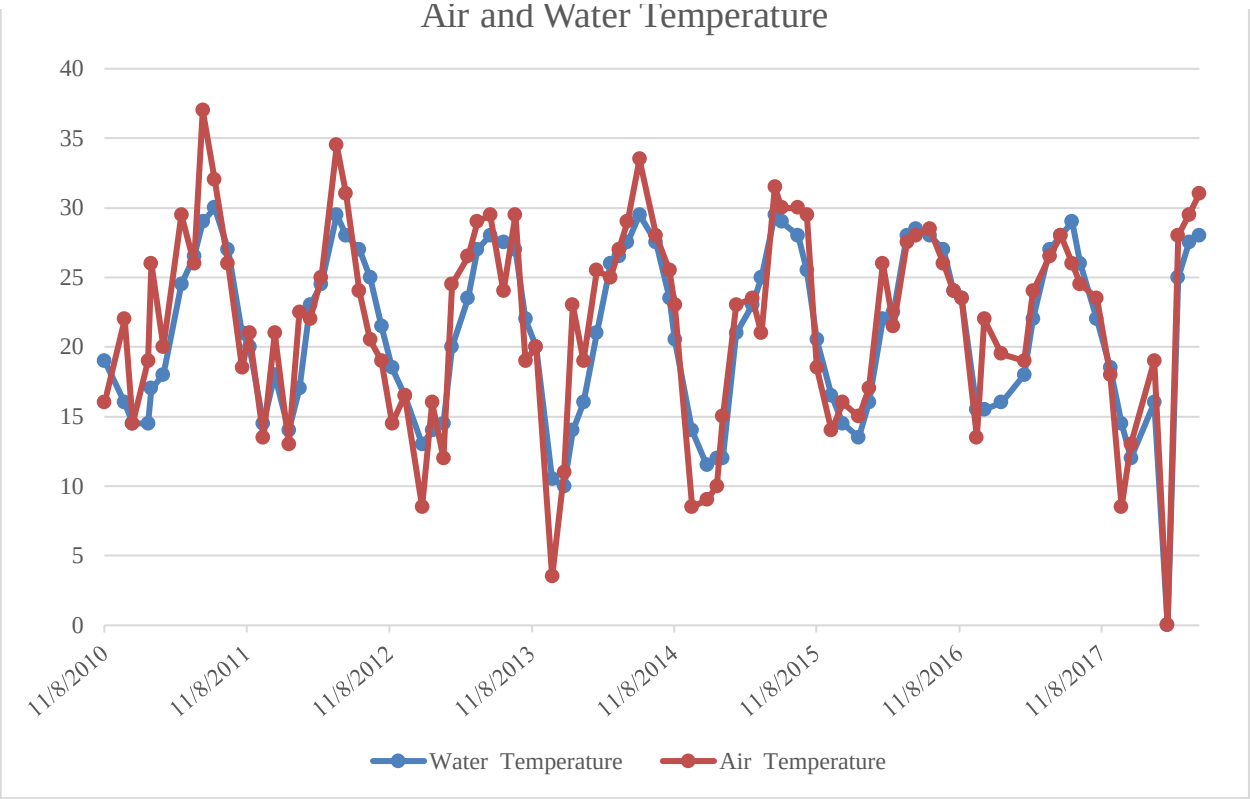

Figure 89: Air and water temperature at Site 81490

Total Dissolved Solids

Citizen scientists took a total of 91 TDS samples at this site between 11/8/2010 and 7/16/2018. The mean TDS concentration was 291 mg/L. The concentration of TDS varied from a low of 254 mg/L in August of 2016 to a high of 325 mg/L in January of 2013. The R_2 value of 0.3228 indicates that this relationship explains about 32.28 percent of the variability in the data.

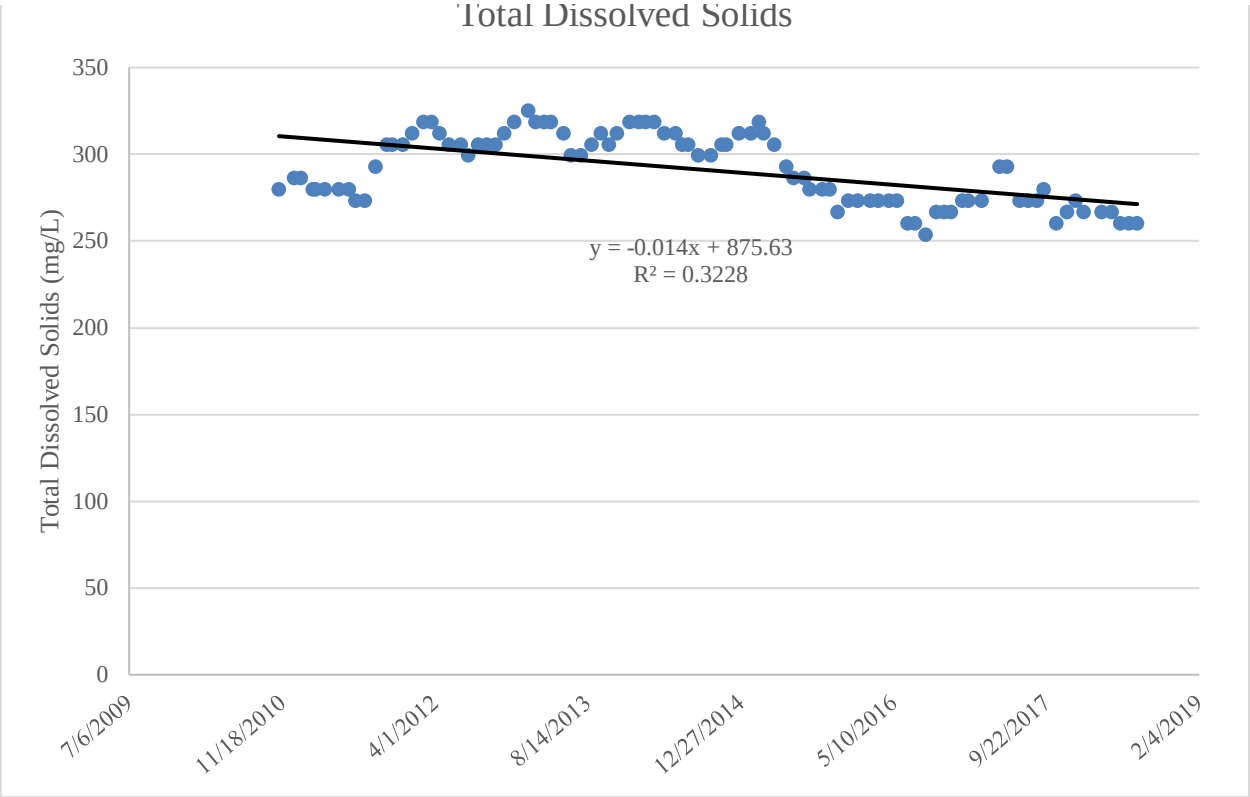

Figure 90: Total dissolved solids at Site 81490

Dissolved Oxygen

Citizen scientists took 91 DO samples at this site between 11/8/2010 and 7/16/2018. The mean DO concentration was 7.1 mg/L. The minimum DO concentration was 4.6 mg/L and was taken in October of 2016. The maximum DO concentration was 9.2 mg/L and was taken in January of 2015. The R_2 value of 0.0151 indicates that this relationship explains about 1.51 percent of the variability in the data.

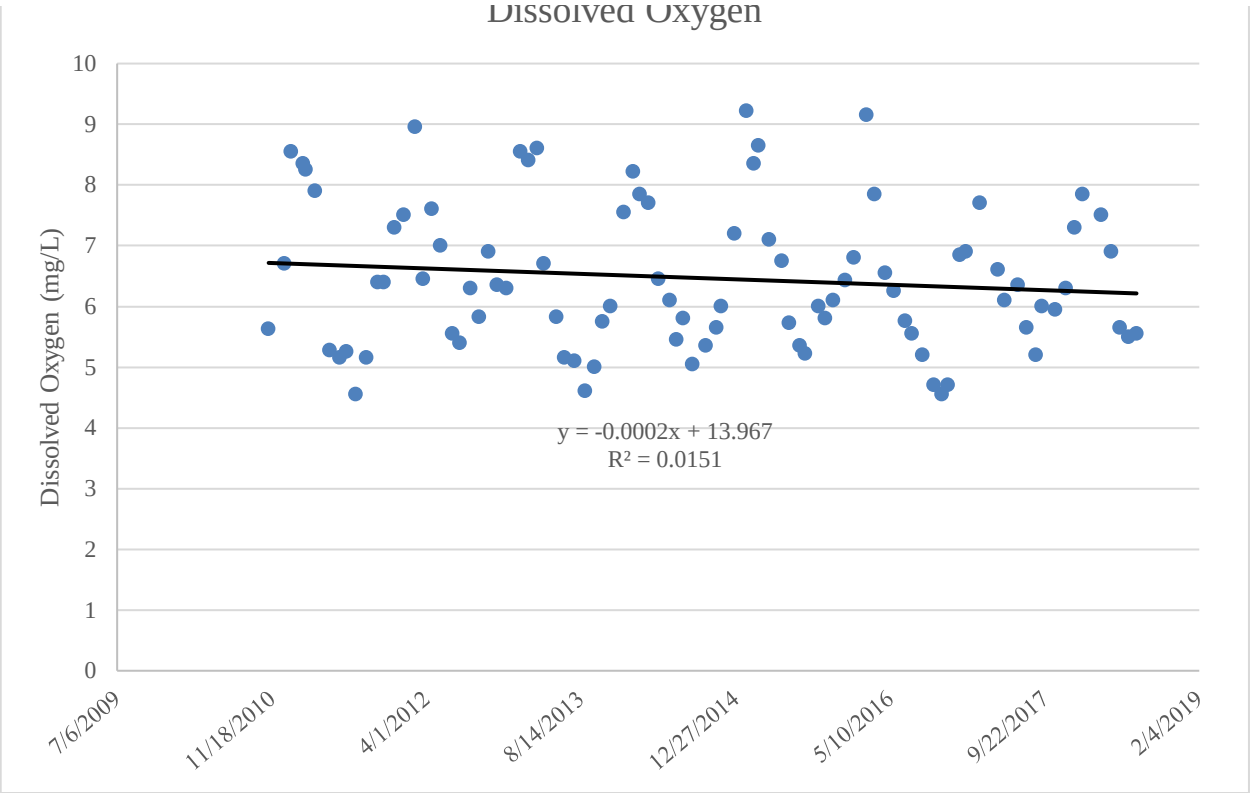

Figure 91: Dissolved oxygen at Site 81490

pH

Citizen scientists took 90 pH measurements at this site between 11/8/2010 and 7/16/2018. The mean pH was 7.5. The pH ranged from a low of 7.0 taken in December of 2011 and a high of 8.0 taken on multiple instances. The R_2 value of 0.0329 indicating that this relationship explained 3.29 percent of the variation in the data.

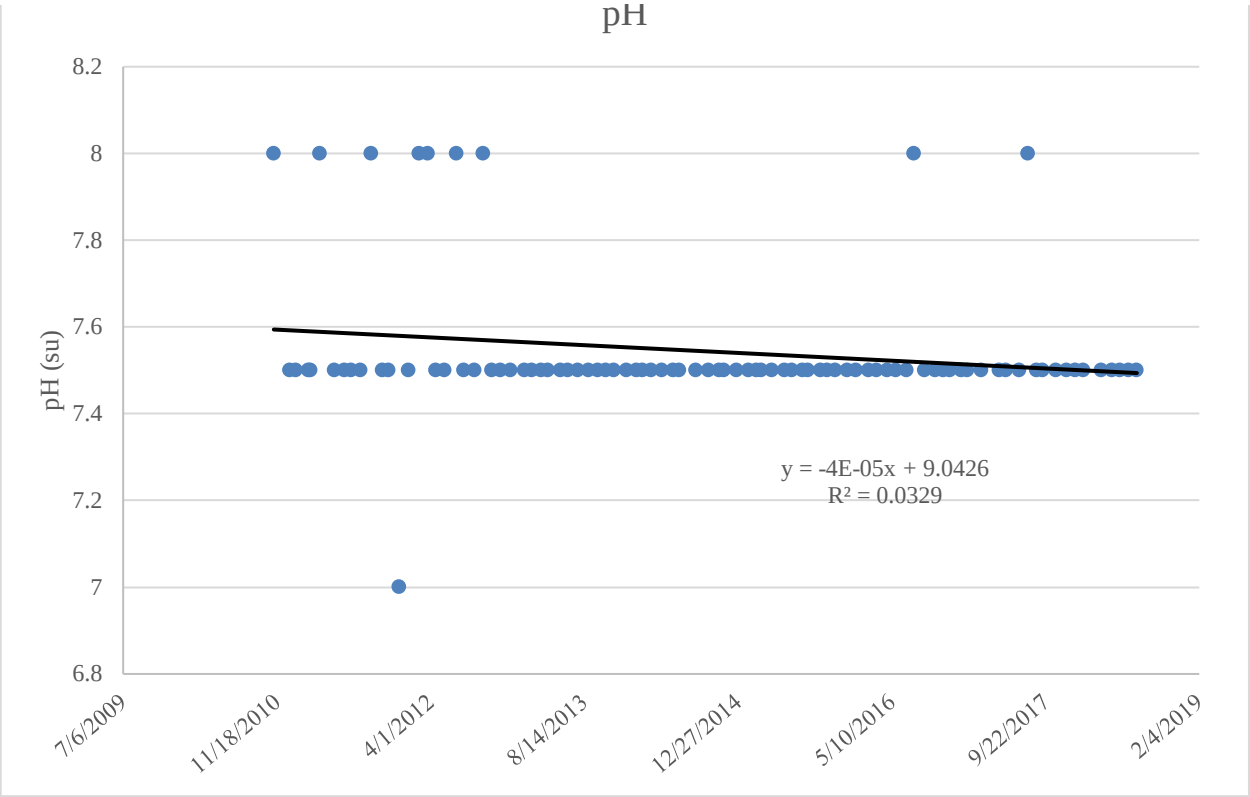

Figure 92: pH at Site 81490

E. coli

There were 76 *E. coli* measurements taken at this site between 10/27/2011 and 6/20/2018. The observed geomean was 2 CFU/100mL and ranged from a low of 1 CFU/100mL taken on several occasions to a high of 60 CFU/100mL taken in May of 2015.

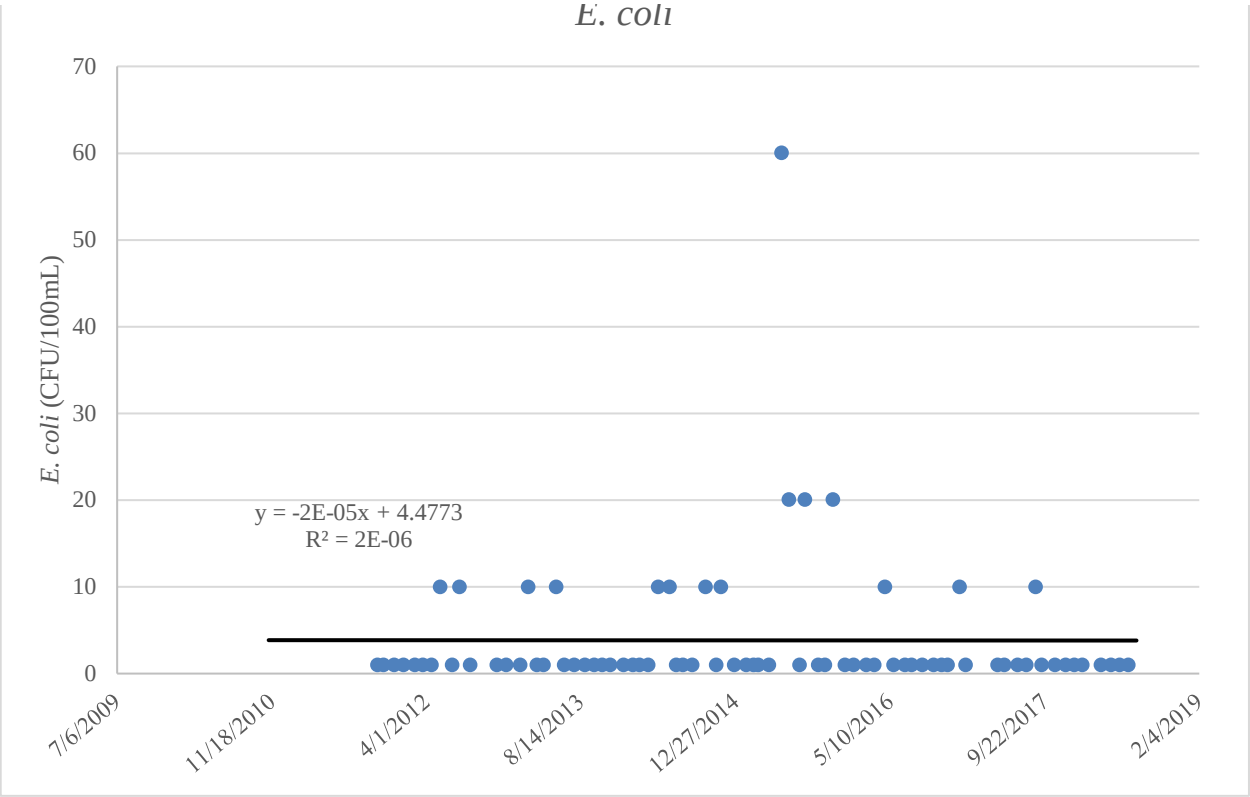

Figure 93: *E. coli* at Site 81490

Nitrate-Nitrogen

Citizen scientists collected 61 nitrate-nitrogen samples at this site between 1/31/2013 and 7/16/2018. The mean nitrate-nitrogen concentration was 0.55 mg/L. Nitrate-nitrogen ranged in concentration from 0.25 mg/L to a high of 1.0 mg/L taken on multiple instances. The R_2 value of 0.1167 indicating that this relationship explained 11.67 percent of the variation in the data.

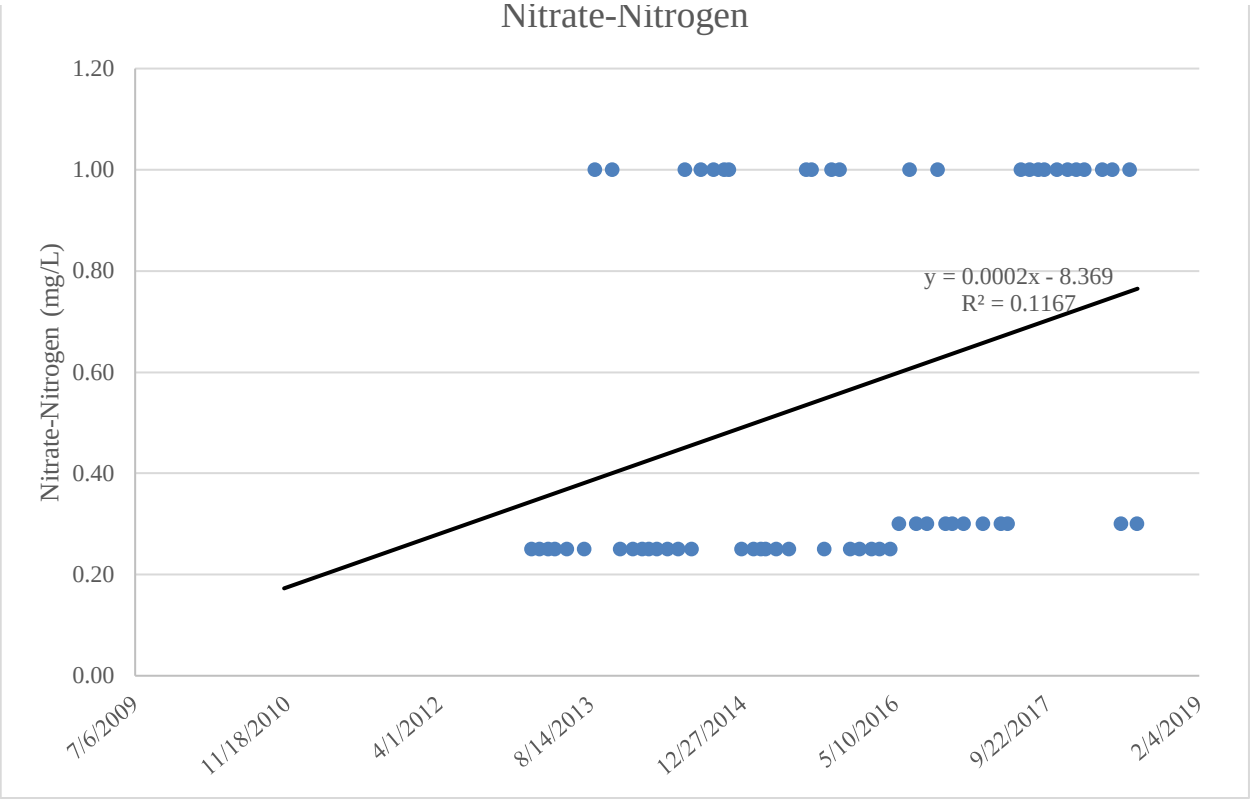

Figure 94: Nitrate-Nitrogen at Site 81490

Site 81476 – Lake Marble Falls @ Lakeside Park

Site Description

This site is located at Lakeside Park on Lake Marble Falls. Lakeside Park is located on beautiful Lake Marble Falls where the calm waters of the lake are perfect for boating and other types of water-based recreational activities.

Sampling Information

This site was monitored 264 times between 1/1/1996 and 7/18/2018. Sampling times typically occur between 7:30 and 18:00.

Table 21: Descriptive parameters for Site 81476

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	246	286 ± 33	169	364
Water Temperature (°C)	262	21.6 ± 6.6	4.0	39.0
Dissolved Oxygen (mg/L)	264	7.7 ± 1.6	3.5	12.0
pH (su)	261	8.0 ± 0.4	6.0	9.0
E. coli (CFU/100mL)	150	7 ± 119	1	910
Nitrate-Nitrogen (mg/L)	123	1 ± 0	1	5

Site 81476 was sampled 264 times between 1/1/1996 and 7/18/2018.

Air and Water Temperature

Air temperatures were taken 263 and water temperatures were taken 90 times at this site between 1/1/1996 and 7/18/2018. The mean water temperature was 21.6°C. Water temperature varied from a low of 4.0°C in December of 2017, to a high of 39.0°C in August of 2005. The air temperature varied from a low of 1.0°C in January of 2004, to a high of 39.0°C in August of 2005.

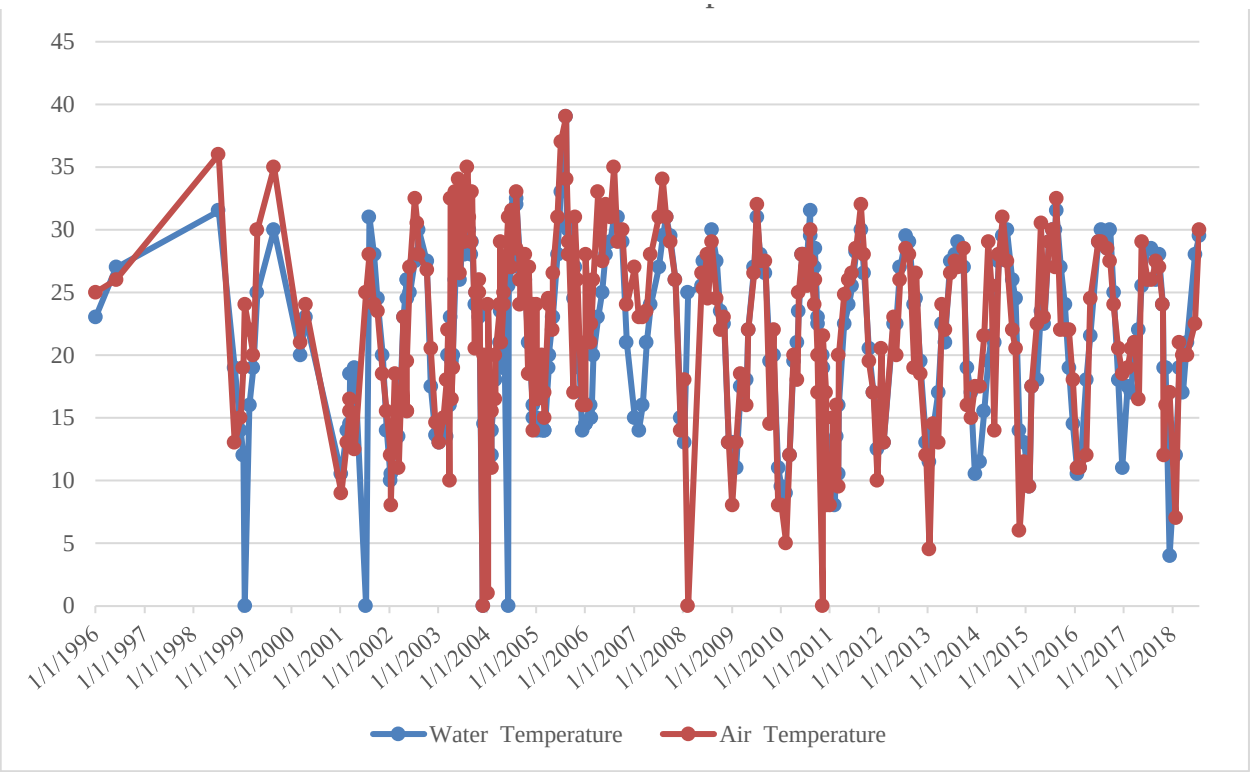

Figure 95: Air and water temperature at Site 81476

Total Dissolved Solids

Citizen scientists took a total of 246 TDS samples at this site between 1/9/2001 and 7/18/2018. The mean TDS concentration was 286 mg/L. The concentration of TDS varied from a low of 169 mg/L in January of 2003 to a high of 364 mg/L in August of 2002. The R_2 value of 0.0036 indicates that this relationship explains about 0.36 percent of the variability in the data.

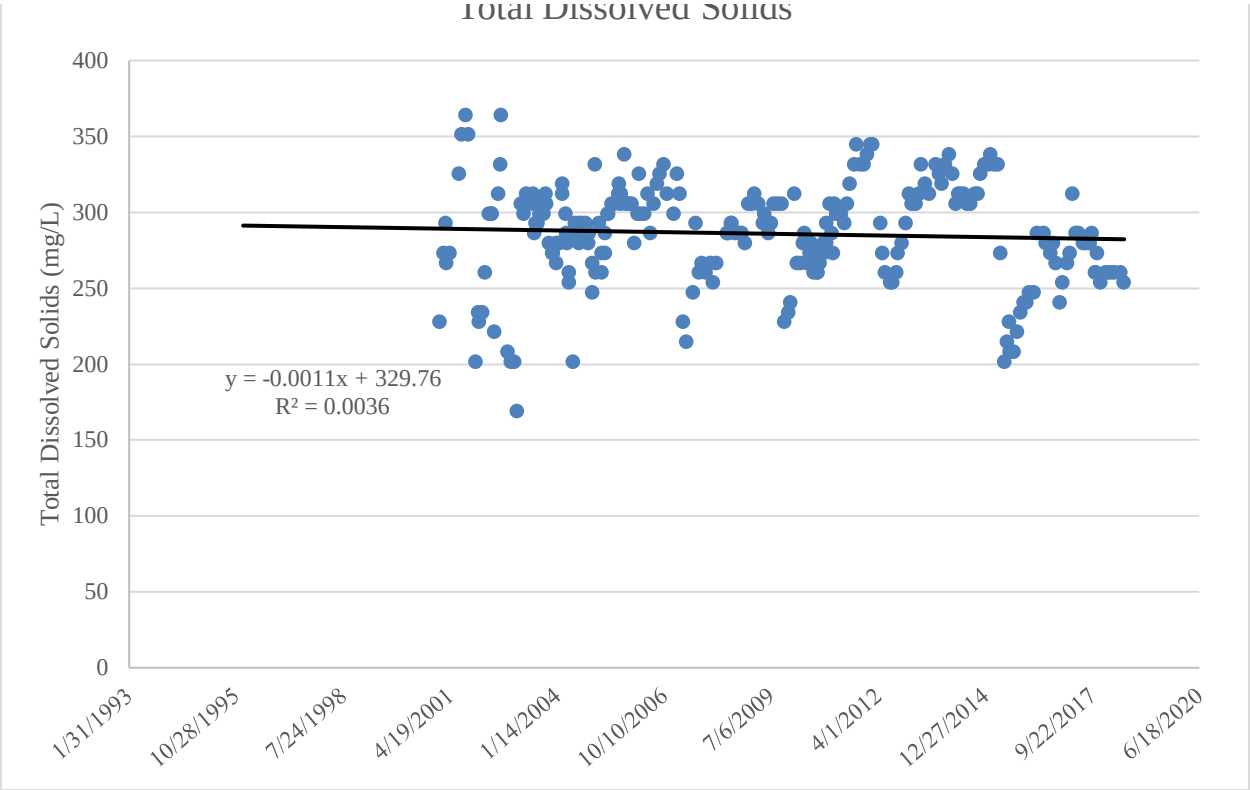

Figure 96: Total dissolved solids at Site 81476

Dissolved Oxygen

Citizen scientists took 264 DO samples at this site between 1/1/1996 and 7/18/2018. The mean DO concentration was 7.7 mg/L. The minimum DO concentration was 3.5 mg/L and was taken in July of 2010. The maximum DO concentration was 12.0 mg/L and was taken in January of 2001. The R_2 value of 0.0275 indicates that this relationship explains about 2.75 percent of the variability in the data.

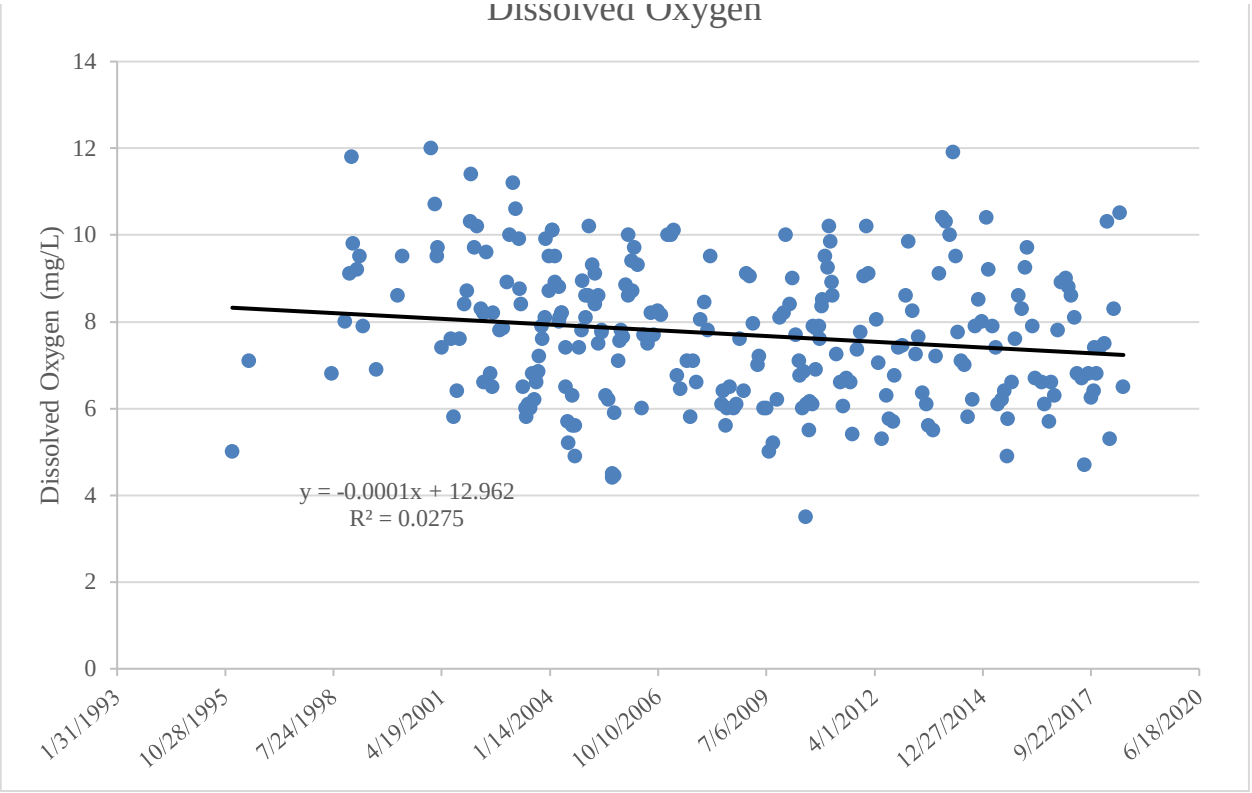

Figure 97: Dissolved oxygen at Site 81476

pH

Citizen scientists took 261 pH measurements at this site between 1/1/1996 and 7/18/2018. The mean pH was 8.0. The pH ranged from a low of 6.0 taken in May of 2005 and a high of 9.0 taken in April of 2003. The R_2 value of 0.0375 indicating that this relationship explained 3.75 percent of the variation in the data.

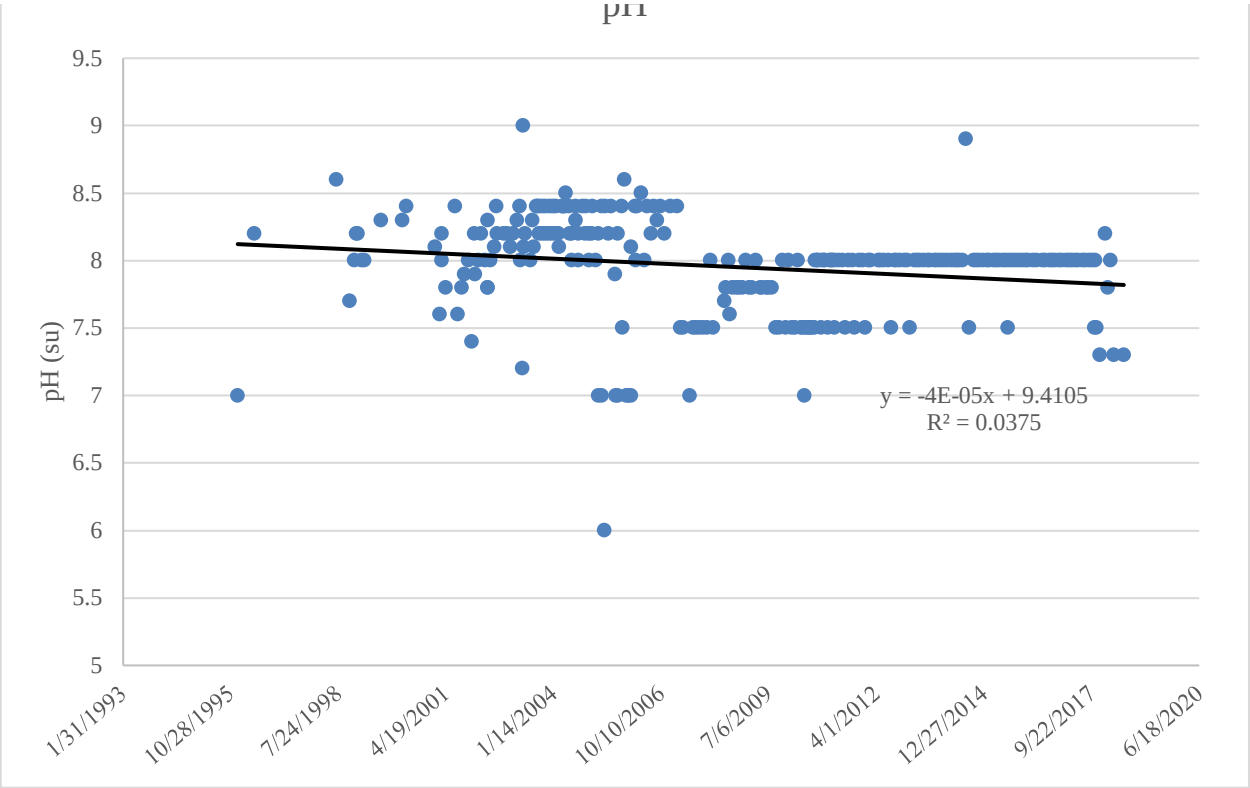

Figure 98: pH at Site 81476

E. coli

There were 150 *E. coli* measurements taken at this site between 1/1/1996 and 7/18/2018. The observed geomean was 7 CFU/100mL and ranged from a low of 1 CFU/100mL taken on several occasions to a high of 910 CFU/100mL taken in May of 2015. The R_2 value of 0.024 indicates that this relationship only explains 2.4 percent of the variation in the data.

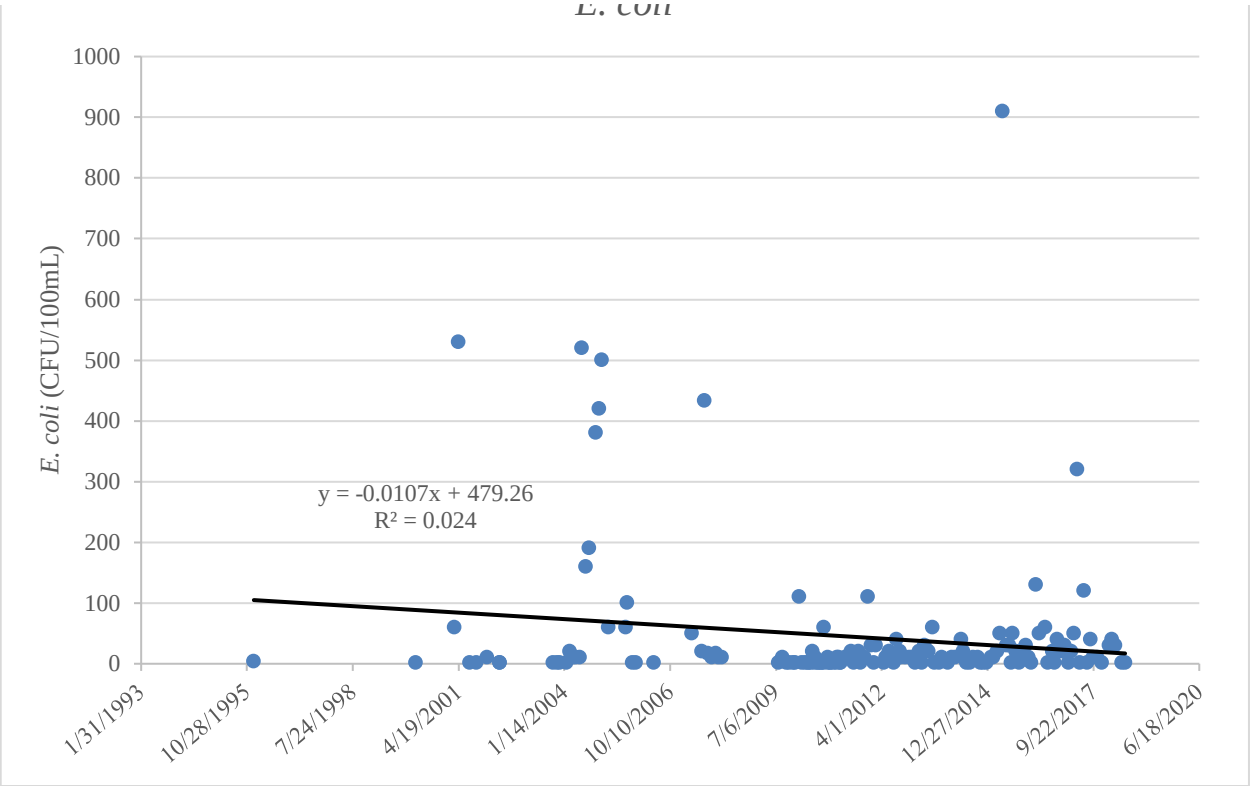

Figure 99: *E. coli* at Site 81476

Nitrate-Nitrogen

Citizen scientists collected 61 nitrate-nitrogen samples at this site between 1/1/1996 and 7/18/2018. The mean nitrate-nitrogen concentration was 1.07 mg/L. Nitrate-nitrogen ranged in concentration from 1.0 mg/L taken on multiple instances, to a high of 5.0 mg/L taken in January of 1996. The R_2 value of 0.1167 indicating that this relationship explained 11.67 percent of the variation in the data.

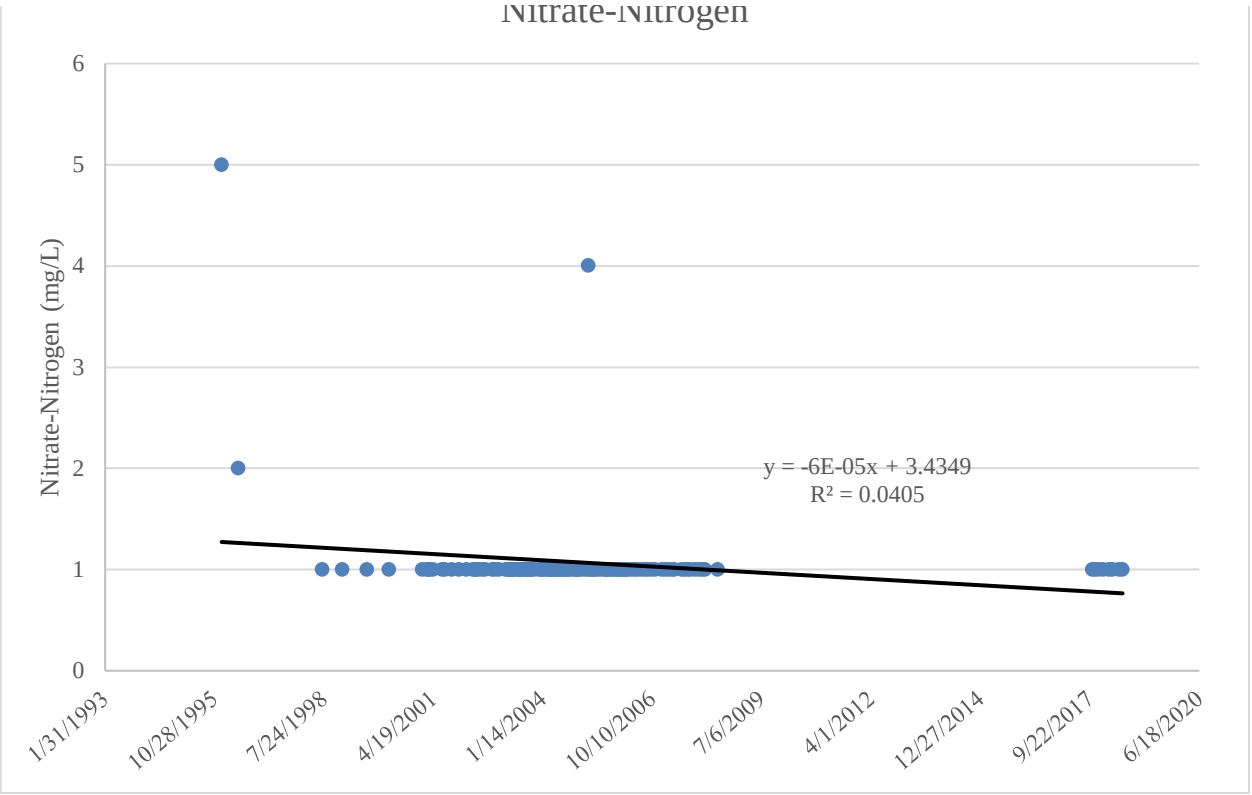

Figure 100: Nitrate-Nitrogen at Site 81476

Site 81507 – Lake Marble Falls @ Noah Thompson Park

Site Description

This site is located at Noah Thompson Park on Lakeview Drive in Cottonwood Shores, TX. The site is located on the Colorado River below Lake Lyndon B. Johnson.

Sampling Information

This site was monitored 11 times between 10/24/2017 and 8/23/2018. Sampling times typically occur between 10:15 and 14:45.

Table 22: Descriptive parameters for Site 81507

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	11	261 ± 6	247	267
Water Temperature (°C)	11	21.8 ± 6.3	9.0	30.0
Dissolved Oxygen (mg/L)	11	6.8 ± 1.5	3.7	8.9
pH (su)	10	7.3 ± 0.2	7.0	7.5
E. coli (CFU/100mL)	8	20 ± 31	1	90
Nitrate-Nitrogen (mg/L)	11	1 ± 0	1	1

Site 81507 was sampled 11 times between 10/24/2017 and 8/23/2018.

Air and Water Temperature

Air and water temperatures were taken 11 at this site between 10/24/2017 and 8/23/2018. The mean water temperature was 21.8°C. Water temperature varied from a low of 9.0°C in January of 2018, to a high of 30.0°C in July of 2018. The air temperature varied from a low of 7.0°C in January of 2018, to a high of 39.0°C in July of 2018.

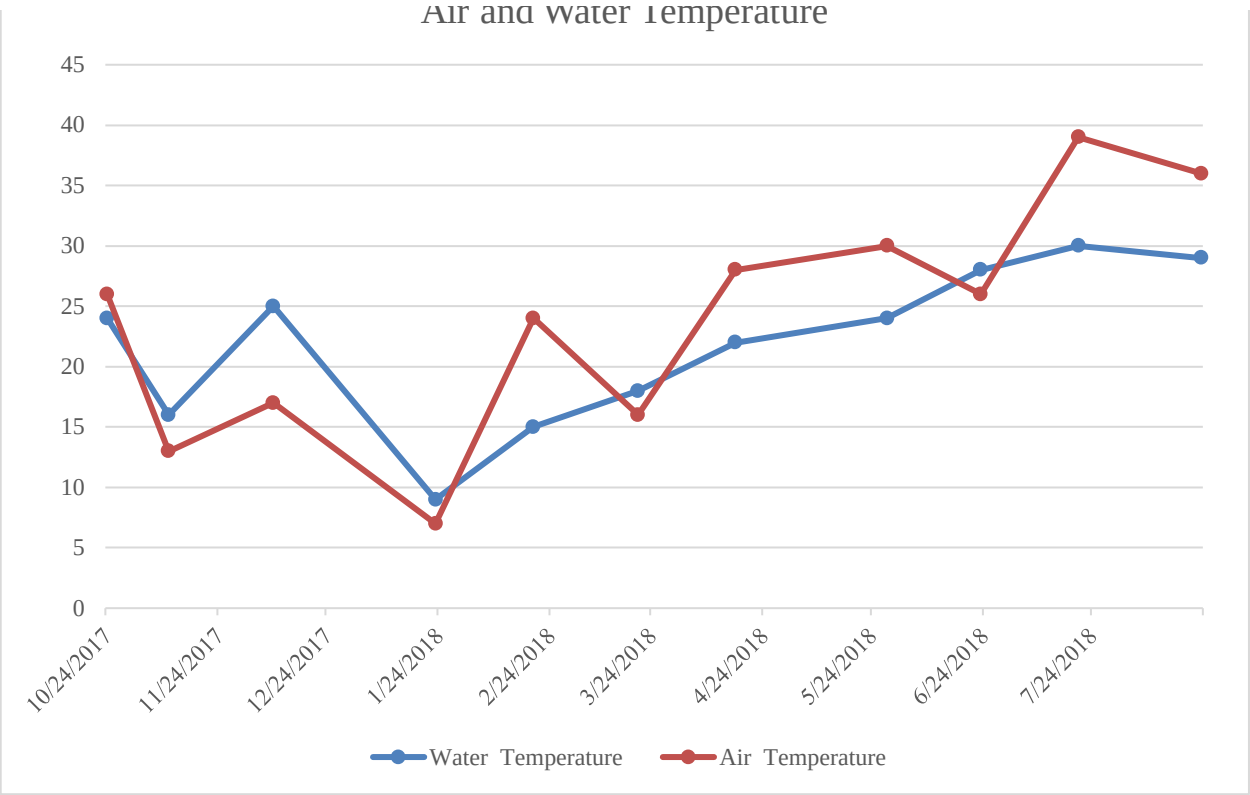

Figure 101: Air and water temperature at Site 81507

Total Dissolved Solids

Citizen scientists took a total of 11 TDS samples at this site between 10/24/2017 and 8/23/2018. The mean TDS concentration was 216 mg/L. The concentration of TDS varied from a low of 247 mg/L in November of 2017 to a high of 267 mg/L in July of 2018. The R_2 value of 0.3242 indicates that this relationship explains about 32.42 percent of the variability in the data.

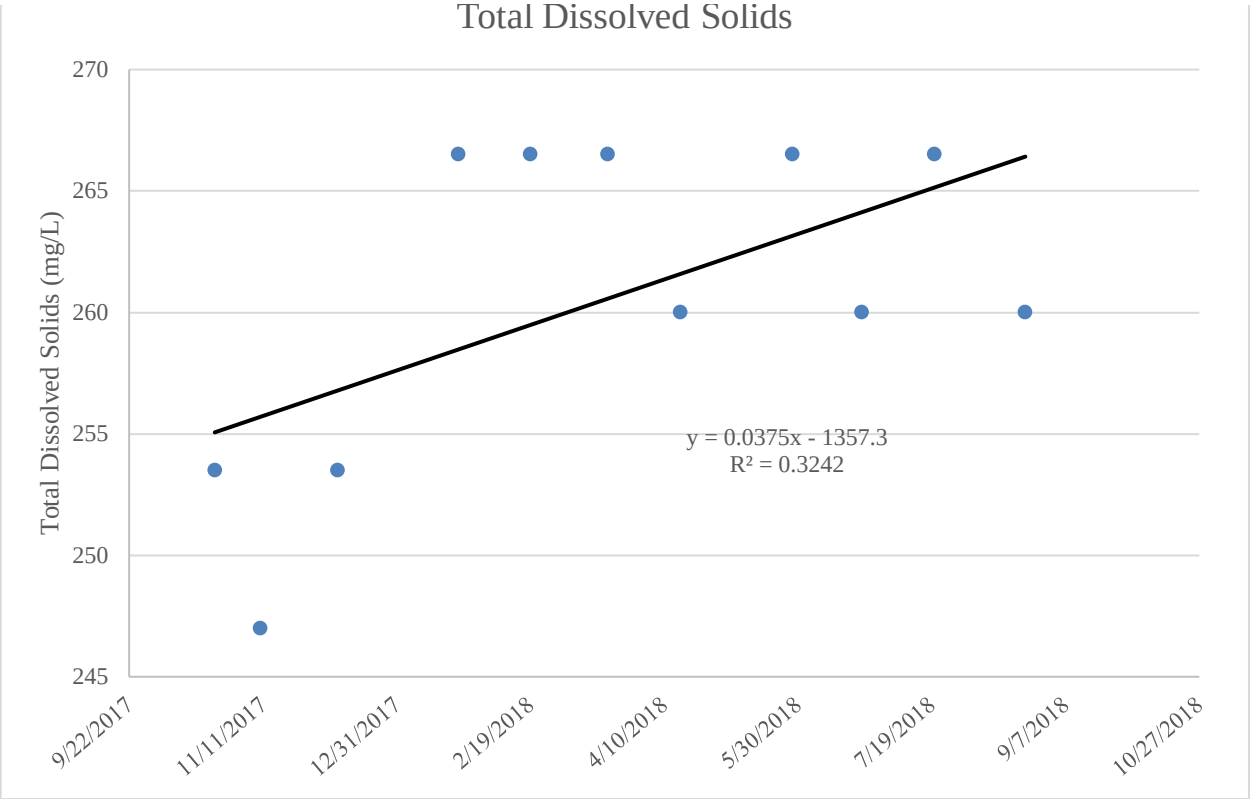

Figure 102: Total dissolved solids at Site 81507

Dissolved Oxygen

Citizen scientists took 11 DO samples at this site between 10/24/2017 and 8/23/2018. The mean DO concentration was 6.8 mg/L. The minimum DO concentration was 3.7 mg/L and was taken in August of 2018. The maximum DO concentration was 8.9 mg/L and was taken in January of 2018. The R_2 value of 0.6623 indicates that this relationship explains about 66.23 percent of the variability in the data.

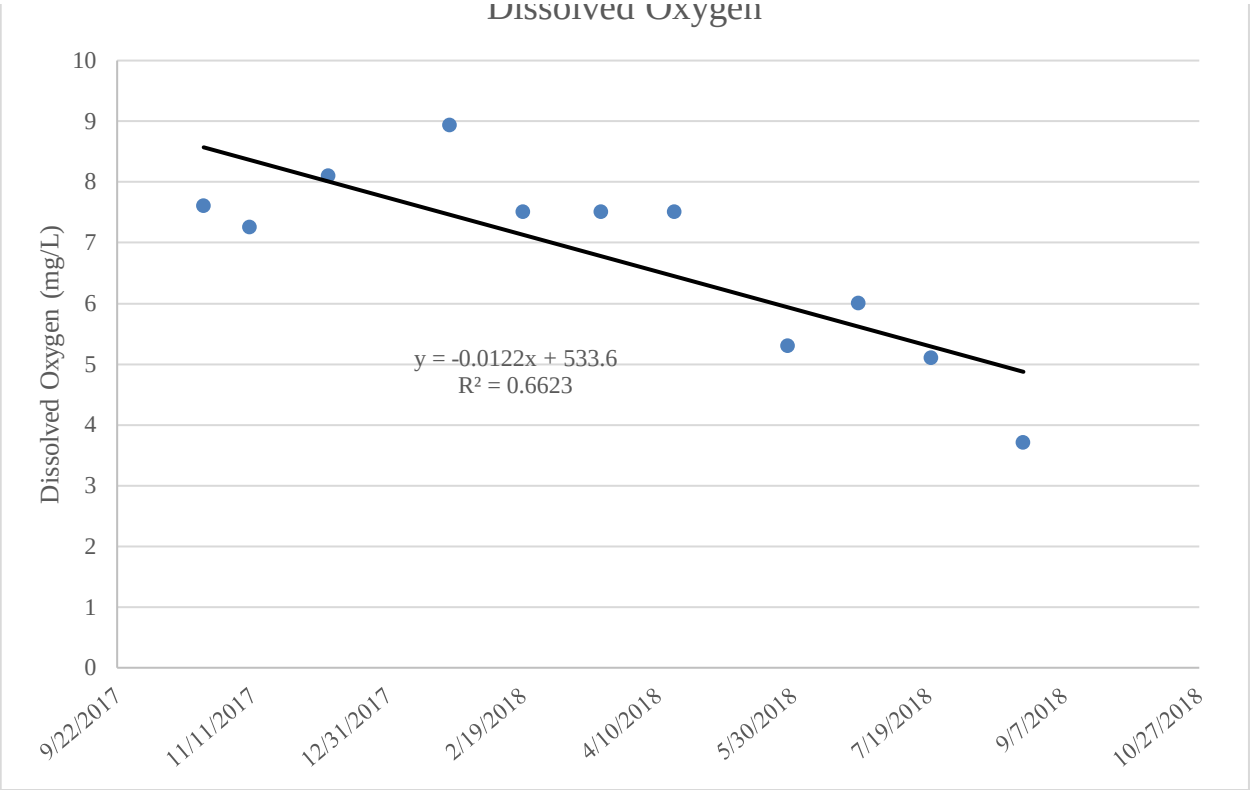

Figure 103: Dissolved oxygen at Site 81507

pH

Citizen scientists took 10 pH measurements at this site between 10/24/2017 and 8/23/2018. The mean pH was 7.3. The pH ranged from a low of 7.0 taken and a high of 7.5 taken on multiple occasions. The R_2 value of 0.0073 indicating that this relationship explained 0.73 percent of the variation in the data.

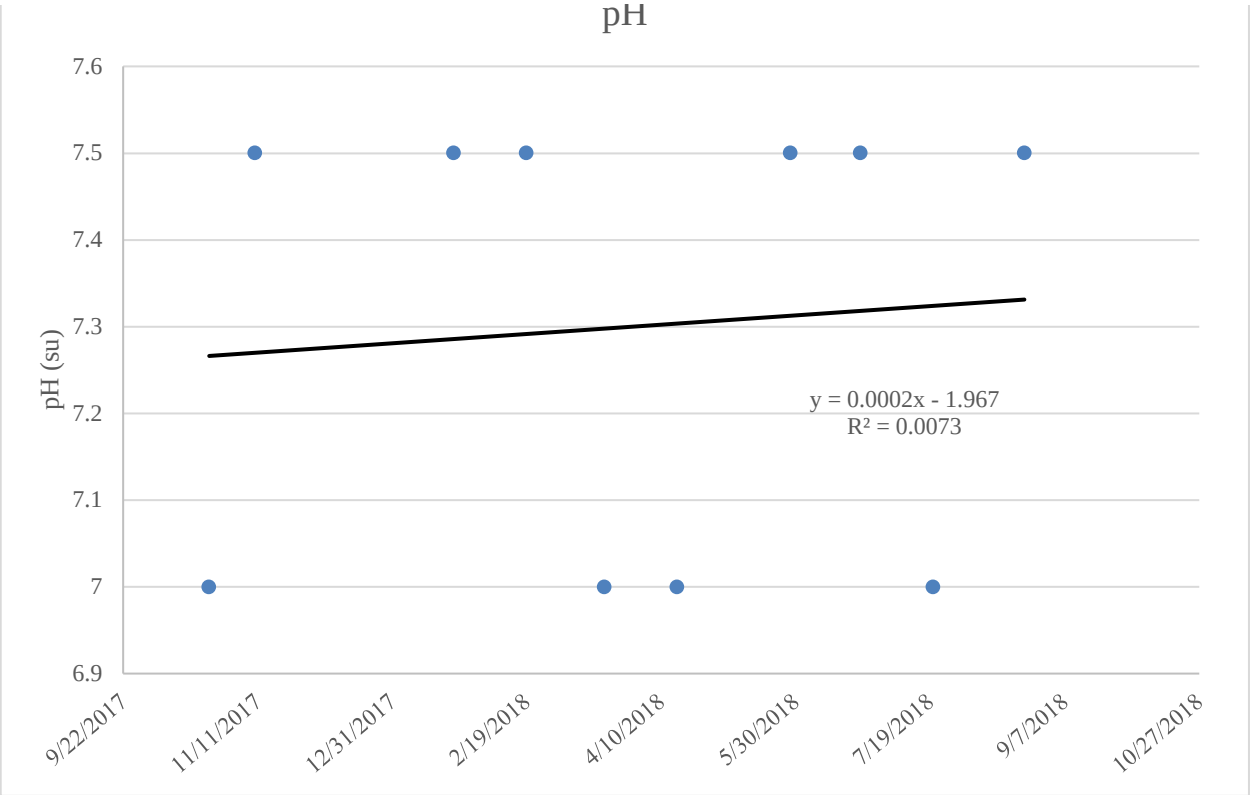

Figure 104: pH at Site 81507

E. coli

There were 8 *E. coli* measurements taken at this site between 11/10/2017 and 8/23/2018. The observed geomean was 31 CFU/100mL and ranged from a low of 1 CFU/100mL taken June of 2018 to a high of 90 CFU/100mL taken in July of 2018. The R_2 value of 0.4515 indicates that this relationship only explains 45.15 percent of the variation in the data.

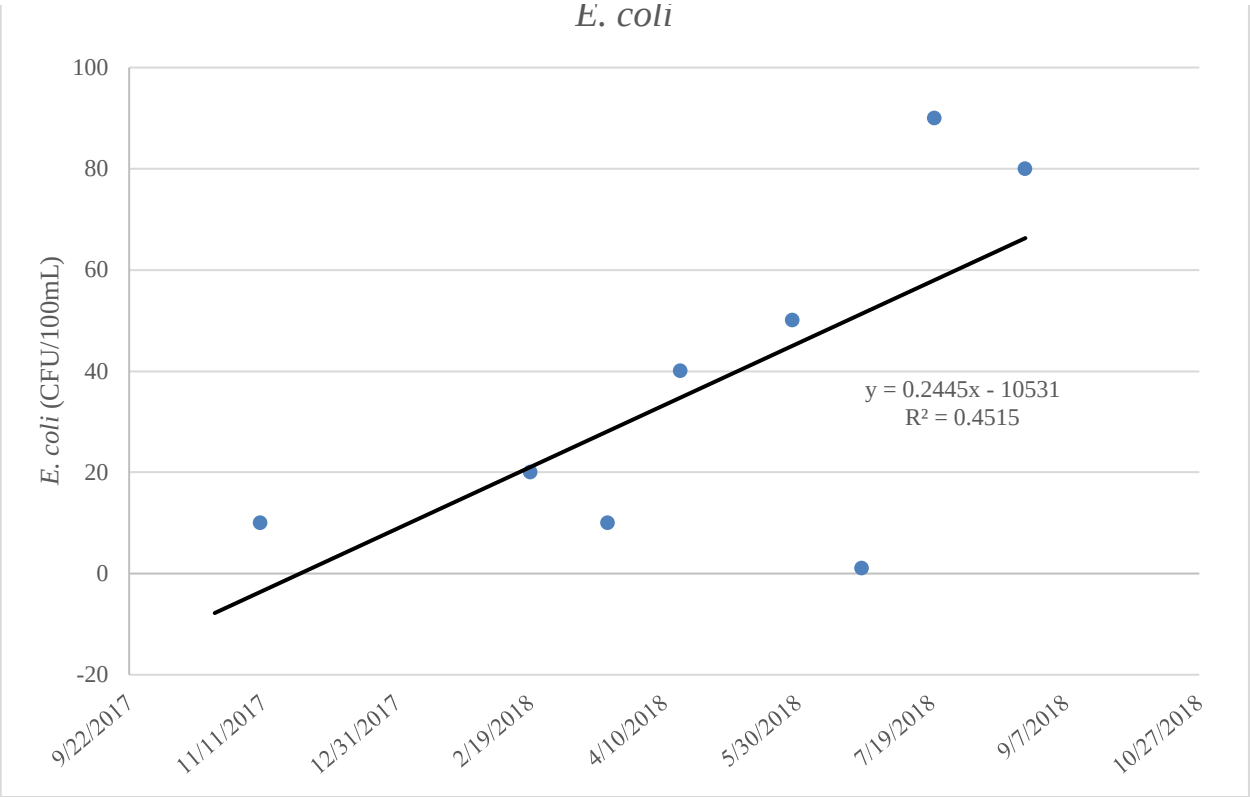

Figure 105: *E. coli* at Site 81507

Nitrate-Nitrogen

Citizen scientists collected 11 nitrate-nitrogen samples at this site between 10/24/2017 and 8/23/2018 all producing results of 1 mg/L.

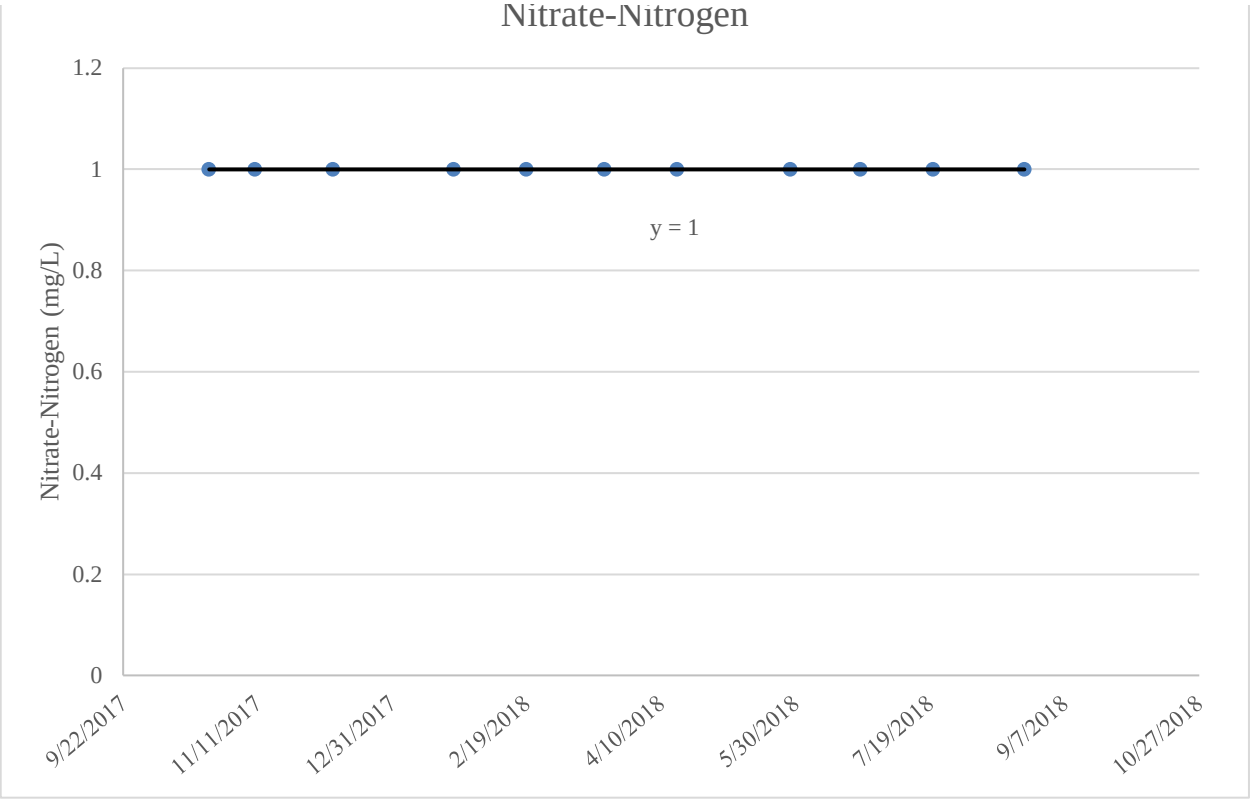

Figure 106: Nitrate-Nitrogen at Site 81507

Site 81494 – Collins Grotto

Site Description

This site is located at the headwaters of a small tributary of Cypress Creek that feeds into Lake Travis. The site is located behind the ASAP Stone and Landscape Supply on Anderson Mill Road.

Sampling Information

This site was monitored 59 times between 7/23/2013 and 8/30/2018. Sampling times typically occur between 8:30 and 15:20.

Table 23: Descriptive parameters for Site 81494

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	59	465 ± 43	293	540
Water Temperature (°C)	59	19.7 ± 2.8	13.0	25.0
Dissolved Oxygen (mg/L)	59	5.4 ± 1.1	3.2	7.5
pH (su)	59	7.1 ± 0.3	6.9	8.6
Nitrate-Nitrogen (mg/L)	56	1 ± 0	0.06	2

Site 81494 was sampled 59 times between 7/23/2013 and 8/30/2018.

Air and Water Temperature

Air and water temperatures were taken 59 at this site between 7/23/2013 and 8/30/2018. The mean water temperature was 19.9°C. Water temperature varied from a low of 13.0°C in February of 2015 and January of 2018, to a high of 25.0°C in August of 2014. The air temperature varied from a low of 1.0°C in February of 2015, to a high of 31.0°C in August of 2014 and 2018.

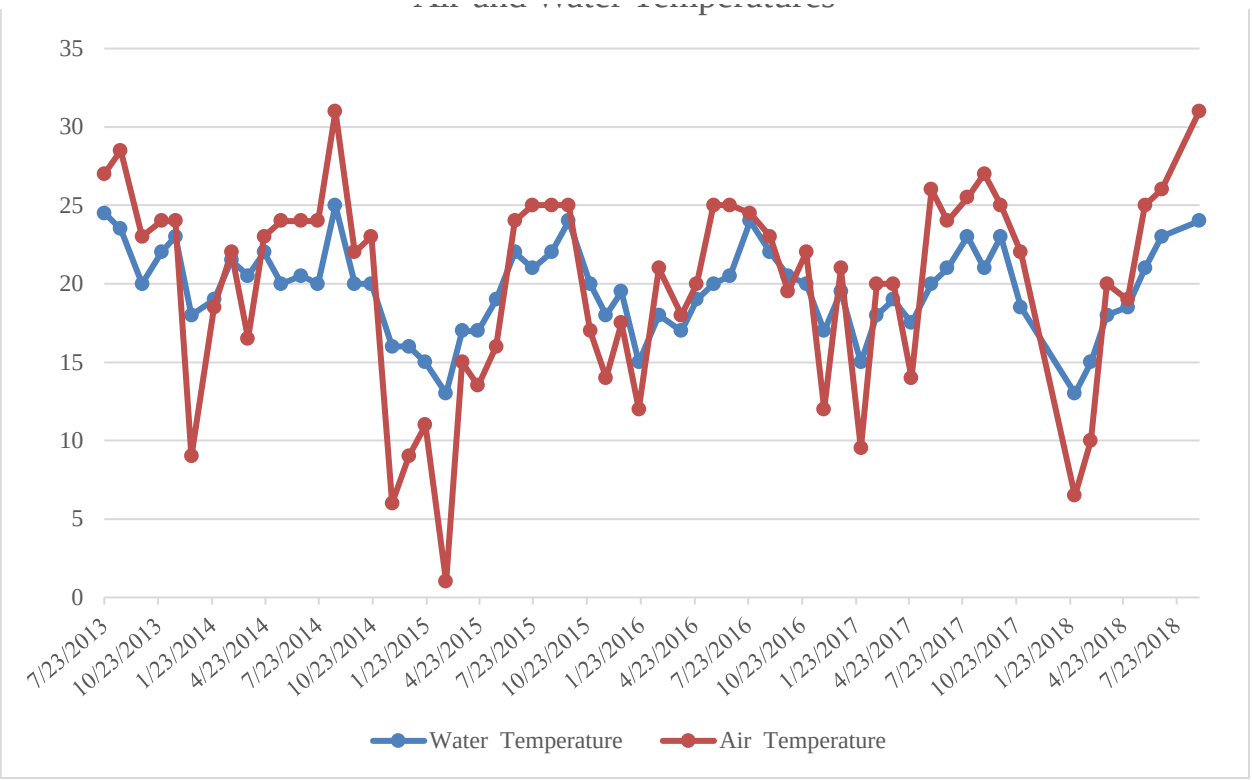

Figure 107: Air and water temperature at Site 81494

Total Dissolved Solids

Citizen scientists took a total of 59 TDS samples at this site between 7/23/2013 and 8/30/2018. The mean TDS concentration was 465 mg/L. The concentration of TDS varied from a low of 293 mg/L in July of 2016 to a high of 540 mg/L in February of 2015. The R_2 value of 0.0455 indicates that this relationship explains about 4.55 percent of the variability in the data.

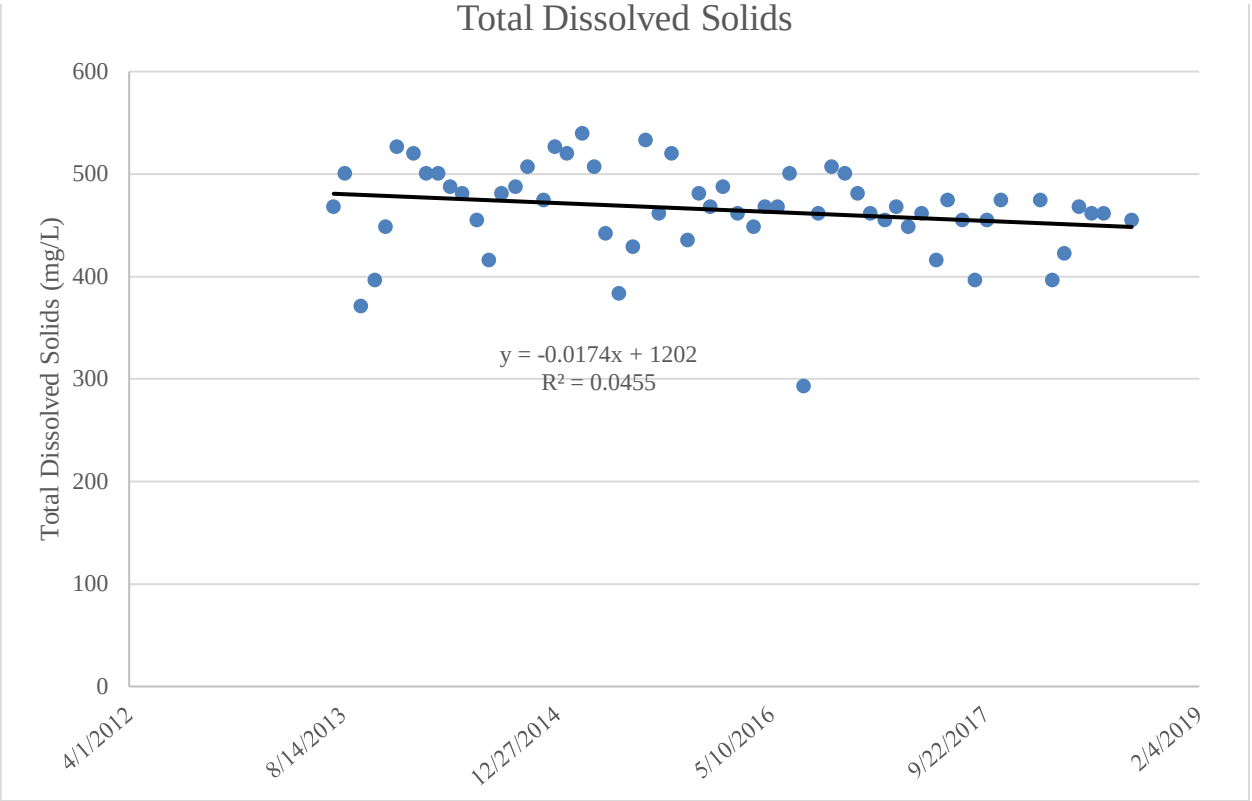

Figure 108: Total dissolved solids at Site 81494

Dissolved Oxygen

Citizen scientists took 59 DO samples at this site between 7/23/2013 and 8/30/2018. The mean DO concentration was 5.4 mg/L. The minimum DO concentration was 3.2 mg/L and was taken in July of 2016. The maximum DO concentration was 7.5 mg/L and was taken in October of 2013 and January of 2014. The R_2 value of 0.247 indicates that this relationship explains about 24.7 percent of the variability in the data.

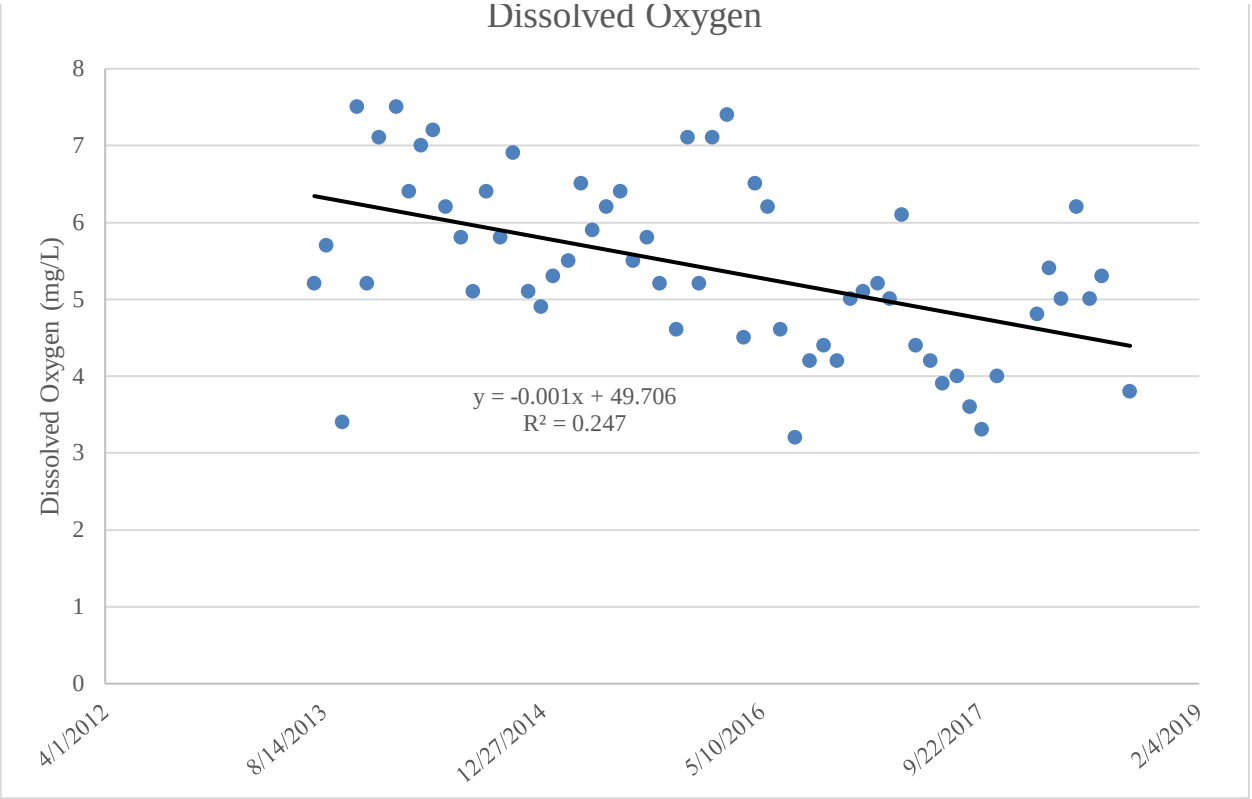

Figure 109: Dissolved oxygen at Site 81494

pH

Citizen scientists took 59 pH measurements at this site between 7/23/2013 and 8/30/2018. The mean pH was 7.1. The pH ranged from a low of 6.9 taken on multiple instances to a high of 8.6 taken in May of 2015. The R_2 value of 0.065 indicating that this relationship explained 6.5 percent of the variation in the data.

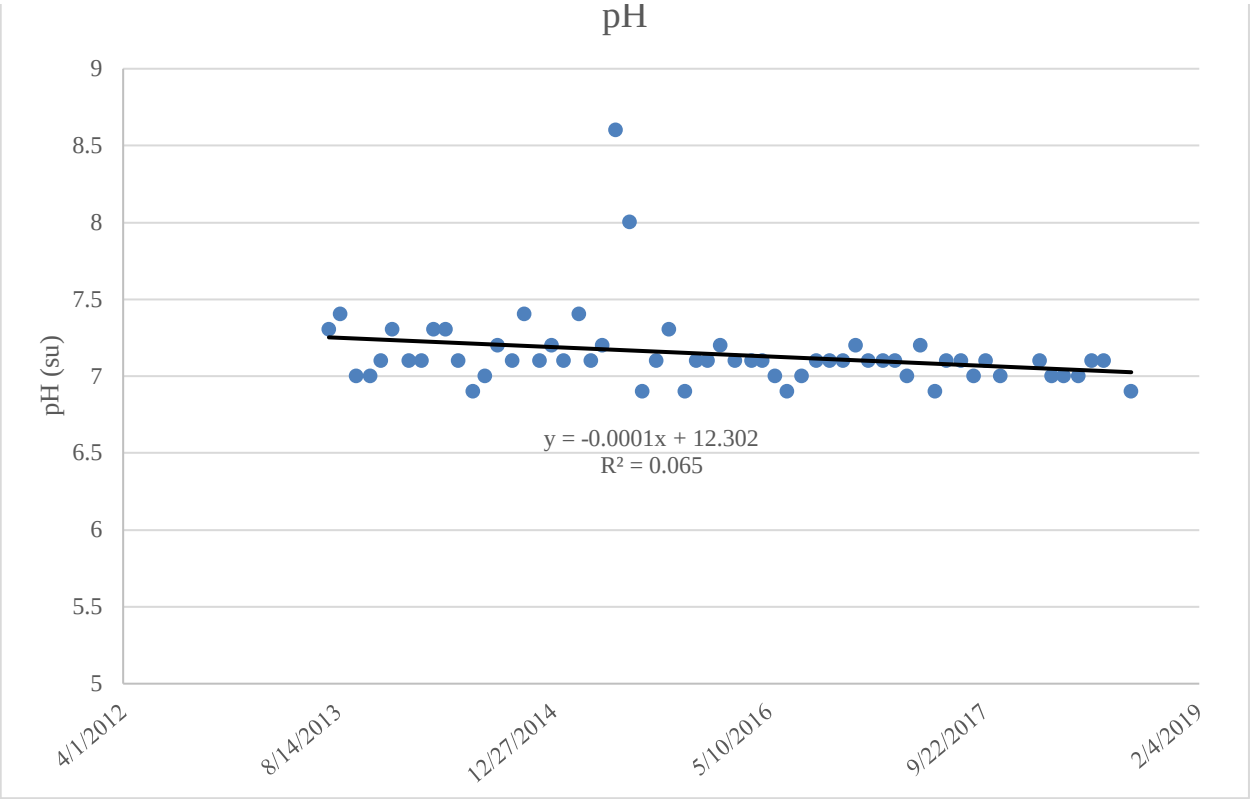

Figure 110: pH at Site 81494

Nitrate-Nitrogen

Citizen scientists collected 56 nitrate-nitrogen samples at this site between 7/23/2013 and 8/30/2018. The mean nitrate-nitrogen concentration was 0.65 mg/L. Nitrate-nitrogen ranged in concentration from a low of 0.06 mg/L taken on multiple instances, to a high of 2.0 mg/L taken in July and August of 2013. The R_2 value of 0.2122 indicating that this relationship explained 21.22 percent of the variation in the data.

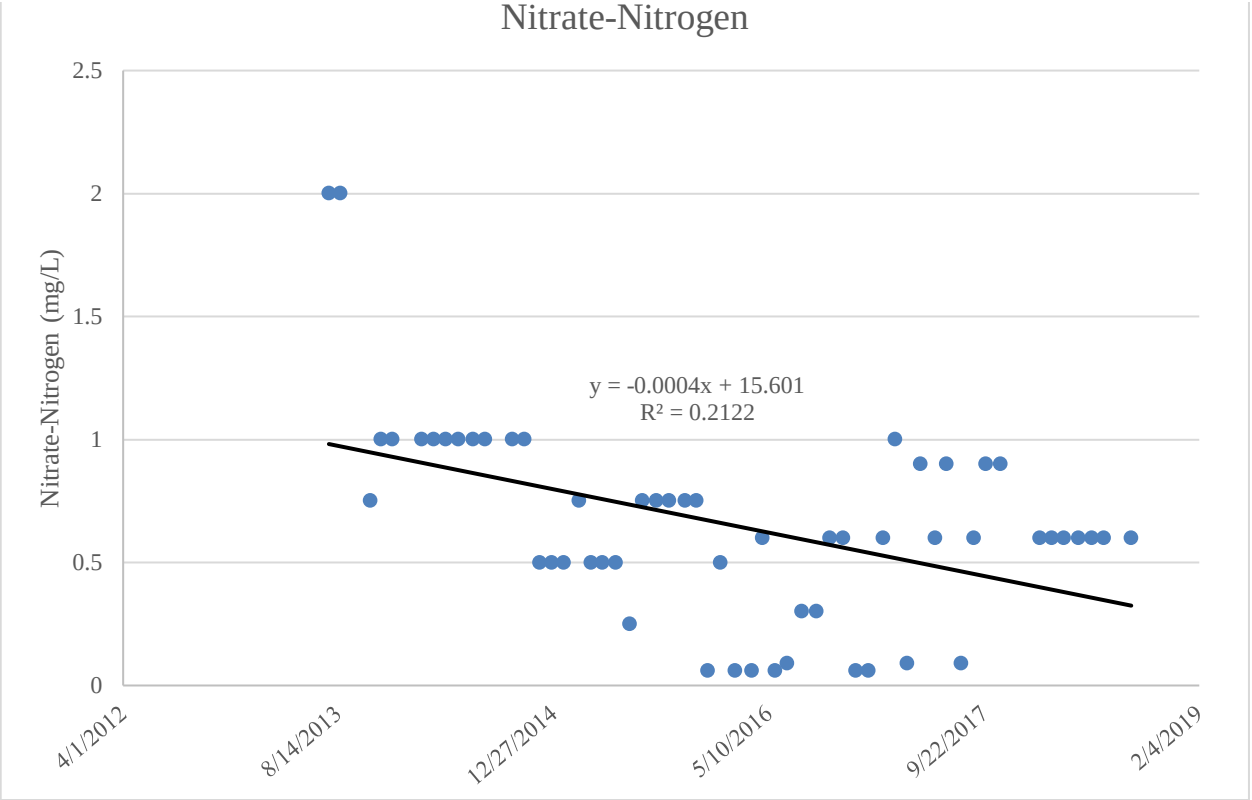

Figure 111: Nitrate-Nitrogen at Site 81494

Site 81495 – Baker Spring

Site Description

This site is located at the headwaters of a small tributary of Cypress Creek which flows into Lake Travis. The site is located near the Travis Audubon Society's Baker Sanctuary on Lime Creek Road.

Sampling Information

This site was monitored 39 times between 4/7/2014 and 3/30/2018. Sampling times typically occur between 8:00 and 13:00.

Table 24: Descriptive parameters for Site 81495

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	39	416 ± 22	306	442
Water Temperature (°C)	39	17.6 ± 3.7	5.5	24.5
Dissolved Oxygen (mg/L)	39	5.7 ± 1.1	3.0	8.6
pH (su)	38	7.0 ± 0.2	7.0	7.9
Nitrate-Nitrogen (mg/L)	39	0.5 ± 0.24	0.25	1.0

Site 81495 was sampled 39 times between 4/7/2014 and 3/30/2018.

Air and Water Temperature

Air and water temperatures were taken 39 times between 4/7/2014 and 3/30/2018. The mean water temperature was 17.6°C. Water temperature varied from a low of 5.5°C taken in January of 2018, to a high of 24.5°C in July of 2017. The air temperature varied from a low of 1.5°C in January of 2018, to a high of 27.5°C in August of 2015.

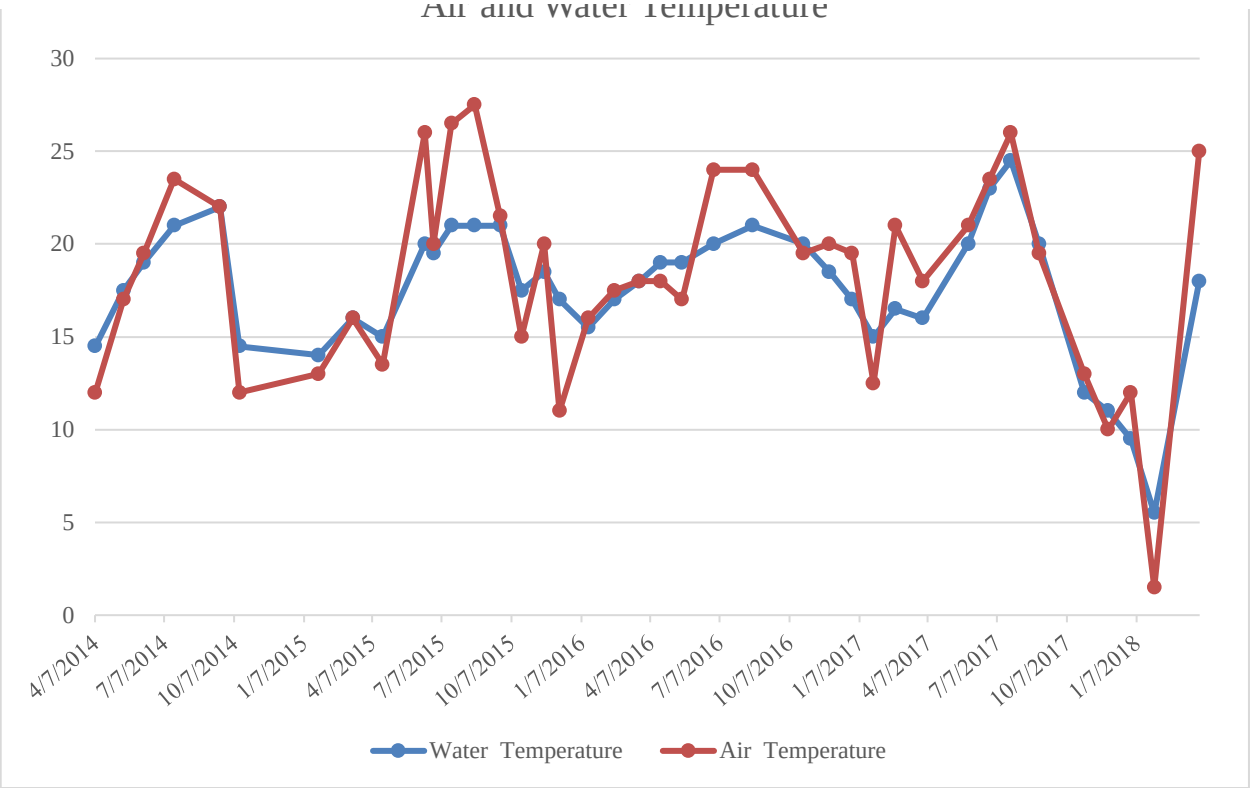

Figure 112: Air and water temperature at Site 81495

Total Dissolved Solids

Citizen scientists took a total of 39 TDS samples at this site between 4/7/2014 and 3/30/2018. The mean TDS concentration was 416 mg/L. The concentration of TDS varied from a low of 306 mg/L in April of 2016 to a high of 442 mg/L in April of 2014 and January of 2017. The R_2 value of 0.0198 indicates that this relationship explains about 1.98 percent of the variability in the data.

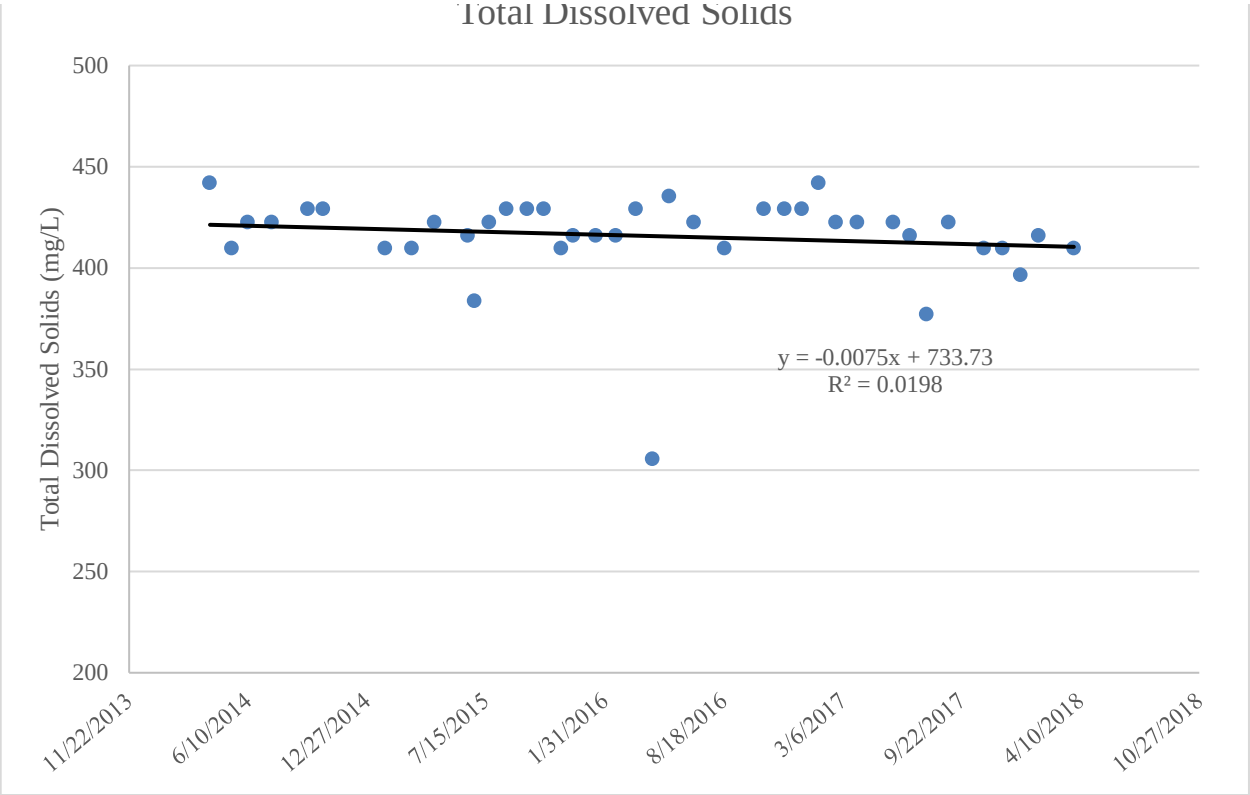

Figure 113: Total dissolved solids at Site 81495

Dissolved Oxygen

Citizen scientists took 39 DO samples at this site between 4/7/2014 and 3/30/2018. The mean DO concentration was 5.7 mg/L. The minimum DO concentration was 3.0 mg/L and was taken in July of 2017. The maximum DO concentration was 8.6 mg/L and was taken in March of 2015. The R_2 value of 0.1989 indicates that this relationship explains about 19.89 percent of the variability in the data.

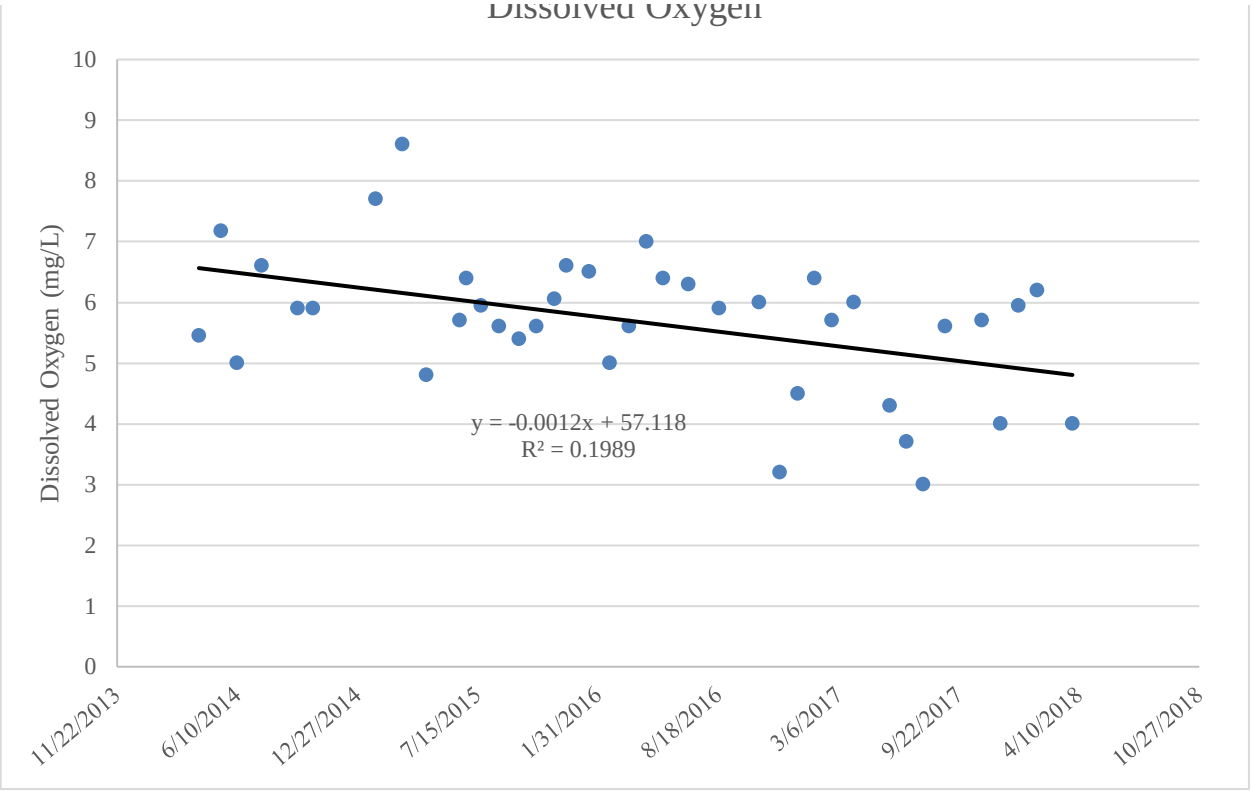

Figure 114: Dissolved oxygen at Site 81495

pH

Citizen scientists took 38 pH measurements at this site between 4/7/2014 and 3/30/2018. The mean pH was 7.0. The pH ranged from a low of 7.0 taken on multiple instances to a high of 7.9 taken in February of 2017. The R_2 value of 0.0011 indicating that this relationship explained 0.11 percent of the variation in the data.

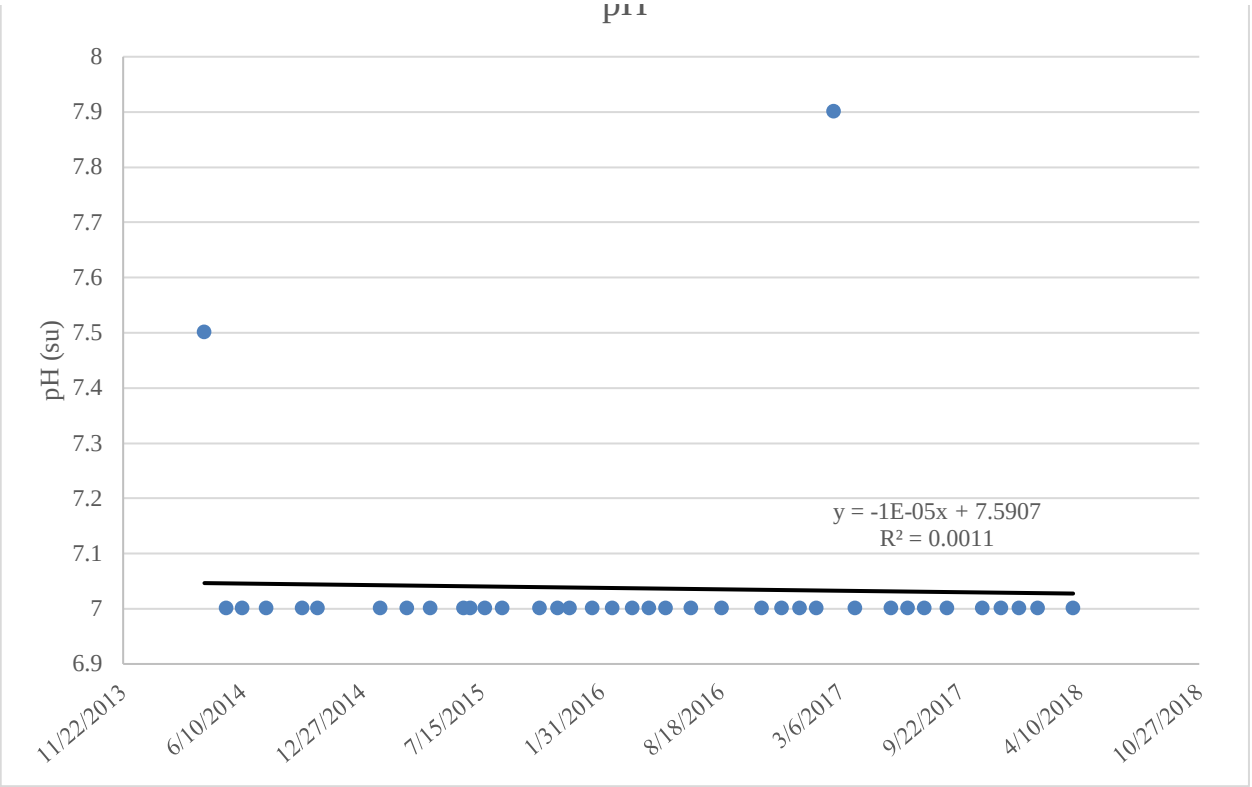

Figure 115: pH at Site 81495

Nitrate-Nitrogen

Citizen scientists collected 39 nitrate-nitrogen samples at this site between 4/7/2014 and 3/30/2018. The mean nitrate-nitrogen concentration was 0.50 mg/L. Nitrate-nitrogen ranged in concentration from a low of 0.25 mg/L taken on multiple instances, to a high of 1.0 mg/L taken on multiple instances. The R_2 value of 0.159 indicating that this relationship explained 15.9 percent of the variation in the data.

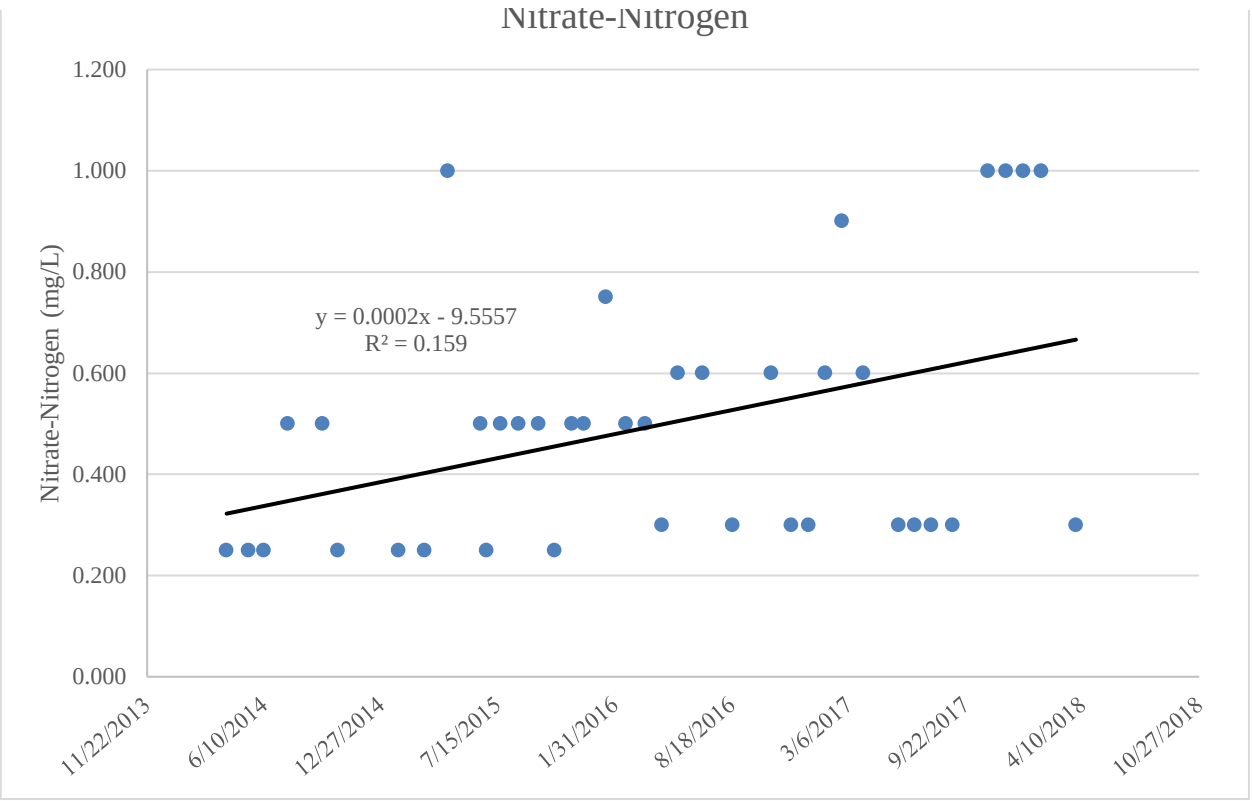

Figure 116: Nitrate-Nitrogen at Site 81495

LAKE TRAVIS WATERSHED SUMMARY

TST citizen scientists monitored several water quality parameters from eighteen different sites in the Lake Travis Watershed from 1996 to 2018, including TDS, DO, pH levels, orthophosphate, nitrate-nitrogen and *E. coli*. Data from the eighteen different monitoring sites was analyzed to find trends over the monitoring periods. There were several sampling events at Sites 12369, 17335, 80310, 80314, 80934, 80935, 80936, and 81476 with elevated *E. coli* levels reported above the standard for a single sample of 394 CFU/100 mL. The geometric mean at Site 80314 was 391 ± 1027,above the 126CFU/100mL standard. Several sites experienced low DO concentrations which are a concern in the watershed especially during droughts and low flow. The LCRA CRWN citizen scientist monitoring group will continue to monitor the water quality of the Lake Travis Watershed. Future work will consist of Riparian Bull's-Eye Evaluations and Rapid Benthic Macroinvertebrate Bioassessments at sites where there are concerns. LCRA will continue to support existing TST citizen scientists with core supplies for local citizen scientists to collect and test samples for water quality. Additionally, the LCRA CRWN will continue to create new TST monitoring sites and activate existing sites.

GET INVOLVED WITH TEXAS STREAM TEAM!

Once trained, citizen scientists can directly participate in monitoring by communicating their data to various stakeholders. Some options include: participating in the Clean Rivers Program (CRP) Steering Committee Process, providing information during "public comment" periods, attending city council and advisory panel meetings, developing relations with local TCEQ and river authority water specialists, and, if necessary, filing complaints with environmental agencies, contacting elected representatives and media, or starting organized local efforts to address areas of concern.

The Texas Clean Rivers Act established a way for the citizens of Texas to participate in building the foundation for effective statewide watershed planning activities. Each CRP partner agency has established a steering committee to set priorities within its basin. These committees bring together the diverse stakeholder interests in each basin and watershed. Steering committee participants include representatives from the public, government, industry, business, agriculture, and environmental groups. The steering committee is designed to allow local concerns to be addressed and regional solutions to be formulated. For more information about participating in these steering committee meetings, please contact the appropriate CRP partner agency for your river basin at: http://www.tceq.state.tx.us/compliance/monitoring/crp/partners.html. Currently, TST is working with various public and private organizations to facilitate data and information sharing. One component of this process includes interacting with watershed stakeholders at CRP steering committee meetings. A major function of these meetings is to discuss water quality issues and to obtain input from the general public. While participation in this process may not bring about instantaneous results, it is a great place to begin making institutional connections and to learn how to become involved in the assessment and protection system that Texas agencies use to keep water resources healthy and sustainable.

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APPENDIX A- LIST OF MAPS, TABLES, AND FIGURES

Tables

Figures