LADY BIRD LAKE WATERSHED DATA REPORT

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The Meadows Center for Water and the Environment
Texas State University

Texas Stream Team

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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, such as Basin Summary Reports and Highlight 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

Location and Climate

Lady Bird Lake is the last of a series of seven Central Texas reservoirs on the Colorado River known as the Highland Lakes. The lake, formally known as Town Lake, was formed in 1960 by the completion of Longhorn Dam across the Colorado River initially to provide cooling water for the two steam electric generating plants in the city of Austin. The lake stretches for nearly 9.7 kilometers as a run-of-the-river impoundment through the heart of Austin's central business district and occupies some 420 acres (City of Austin). The Lady Bird Lake watershed is described as having a subtropical, subhumid climate characterized by hot summers and mild, dry winters (Larkin and Bomar, 1983). The Austin area has no designated wet or dry season and is prone to flooding and droughts. Average rainfall in the Austin area is 32 to 34 inches (Flom, 2017).

Physical Description and Land Use (City of Austin)

Because of the lake's urban setting, it receives non-point source pollution from nine major tributary creeks and numerous stormwater outfalls, draining both fully developed and rapidly developing watersheds. Most of these streams are now ephemeral, dominated by storm flow. The total drainage area between Tom Miller Dam and Longhorn Dam is 158 square miles. Groundwater flow into Town Lake is also significant. During periods of low upstream releases and non-storm conditions, groundwater flows from the Barton Springs segment of the Edward's Aquifer make up the majority of the inflow to the lake. Barton Springs is the largest of the springs feeding the lake. Lady Bird Lake is operated as a constant-level reservoir with its flow regulated by releases from Tom Miller Dam upstream and Longhorn Dam downstream. Higher flows are released during the growing season to provide irrigation water to rice farmers along the Colorado River in south Texas. These high flows provide a constant supply of water from the less-developed upstream reservoirs of Lake Austin and Lake Travis; however, during the late fall and winter, flows are reduced and water quality is dictated more by urban runoff within the Lady Bird Lake watershed. Although Lady Bird Lake is vulnerable to non-point source pollution, it is also a natural resource for the Austin community. The lake is considered excellent habitat for its diversity of fish and waterfowl.

History

Lady Bird Lake was once called Town Lake. It wasn't until the death of Claudia Alta Taylor (Lady Bird) Johnson in 2007, that the city of Austin renamed it in her honor. Lady Bird Lake is considered an artificial lake in which it was created by the construction of Longhorn Dam in 1960 and has been owned and operated by the city of Austin since its creation. Found in the southern part of Austin, it is connected to the Colorado River and is managed by the Lower Colorado River Authority (LCRA). Although the lake was originally used for cooling water, the primary use of the lake is now for flood control within Austin and it also has many recreational uses. Its shoreline consists of multiple hotels, apartments, recreational parks, and buildings. For example, the Auditorium Shores at Town Lake Metropolitan Park located on the south side of the riverbank was built as part of Austin's beautification plans, where city residents and tourists experience the beauty of Lady Bird Lake (TSHA).

Lower Colorado River Authority: Colorado River Watch Network

The Colorado River Watch Network (CRWN) is a partner program of Texas Stream Team and is managed by the LCRA. As such, CRWN has their own set of procedures and quality systems for their citizen monitoring program. For more information on CRWNs data collection procedures, please visit the CRWN 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 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.

Water Quality Impairments

Whereas it is illegal in Austin to swim in Lady Bird Lake, it is not because of the water's quality. Through data collection and publications such as "A Summary of Water Quality Activities in the Colorado River Basin (2012-2016)," Lady Bird Lake has a multitude of viewable available data thanks to agencies such as the Texas Commission on Environmental Quality (TCEQ). Within this report Lady Bird Lake (described within as Town Lake) meets its water quality standard, except for Station ID 14067 – Town Lake 45 meters downstream of South 1st Street which demonstrates a concern in terms of levels of organics in the water. Within the TCEQ's 2016 Texas Integrated Report of Surface Water Quality 303(d) report, impairments on Waller Creek (Segment 1429C), a tributary to Lady Bird Lake, has implications for its downstream body of water. Its first impairment was for an impaired microbenthic community in 2002 and in 2004 a listing for bacteria, impacting recreational use, was added (TCEQ).

Wastewater Treatment Facility Discharge

There are two major wastewater treatment plants under the authority of Austin Water Utility: Walnut Creek and South Austin Regional. Austin Water Utility's sanitary sewer collection system begins through a series of screens to remove trash, sticks, and other large materials. It then flows into a grit basin where materials such as sand and stones can settle to the bottom from which they are then moved to a dump container. Gravity then pushes wastewater into primary clarifiers, where waste such as biosolids and yard trimmings settle to the bottom to be eventually transferred to the Hornsby Bend Biosolids Management Plant where it is reclaimed and treated to kill pathogens; finally these biosolids are recycled. Wastewater then flows to an equalization basin to be measured then pumped into an aeration basin. Beneficial microorganisms consume remaining organic material and multiply. When the wastewater moves on to a secondary clarifier, the microorganisms are filtered out and returned to the aeration basin. If the population of microorganisms becomes too large they are put in the Hornsby Bend Biosolids Management Plant where they can assist with organic material from primary clarifiers.

The water is treated with physical and chemical screening to make sure all contaminants are removed. As a result, 95 percent of all wastes are removed and lastly, it is filtered with sulfur dioxide or sodium bisulfite to remove chlorine from the fully-treated water, before the water is released back into the Colorado River (Austin Water).

Watershed Protection Department, City of Austin

In 1996, the City of Austin formed its Watershed Protection Department. The mission of this department is to reduce the repercussions of flooding, erosion, and water pollution throughout city creeks (City of Austin). This is done by strategic watershed engineering, operating program enhancements and regulatory modifications. Completed in 2001, the Phase I Watershed Protection Master Plan of the City of Austin addresses 27 objectives for the department's mission. It includes six primary objectives of water quality. These objectives include: "achieving or exceeding a "good" Environmental Integrity Index score for all creeks, and, to the extent possible, restoring base flow quantity and quality in urban creeks, preserving in urban creeks, preserving base flow in non- urban creeks, reducing pollutant loads in all creeks, maintaining or enhancing the existing rate of recharge to the Edwards aquifer, and maintaining or enhancing high quality environmental features such as springs and swimming holes". These strategies are placed to protect 12 urban creek watersheds and five primary non-urban creek watersheds that reside on the perimeter of the city; the main segments of these watersheds are defined as unclassified tributaries of the Colorado River: segments 1428, 1429, and 1403, also including the classified segment of Barton Creek (segment 1430).

Algal Blooms and Lady Bird Lake

Toxic algal blooms containing dangerous cyanobacteria have been known to develop in waterbodies throughout the world during prolonged hot and dry conditions. Most notably and recently at Lady Bird Lake, cyanobacteria, which is found in blue-green algae, has been named the culprit for at least four dog deaths during 2019. The risk of exposure to the bacteria by dogs at Austin's popular Red Bud Isle Park on Lady Bird Lake has prompted the director of the Austin Parks & Recreation Department to temporarily close off the park to visitors. The warmest months of the summer can help produce cyanobacteria and other algae as less freshwater inflows are arriving from upstream sources of water and increased evaporation is taking place. The increasingly urbanized watersheds within the City of Austin have also aided in the conditions of algal production due to the loading of fertilizers and nutrients (Sink, 2019). Although no cases of cyanobacteria in the US have been found to be a cause of death to humans, the bacteria does pose a threat to livestock and other animals. Once exposed to humans or other animals, the toxins found in cyanobacteria can affect the neurological system, the liver, and can cause nausea, vomiting, and irritations of the skin and mucus membranes (Sink, 2019).

Are blue-green algae in your waterbody? Consider these signs:

- Blue-green algae can be mixed with common green and brown algae;
- Blue-green algae often create an increased amount of surface-film or scum;

- Check downwind areas to see if surface-film is starting to collect against the bank;
- If water in the waterbody appears densely green, brown, blue-green, or a mix of any of these appearances, the waterbody may have cyanobacteria present.

Endangered Species and Conservation Needs

Within Travis County, the common names of 133 species listed as rare, threatened, or endangered (under the authority of Texas state law and/or under the US Endangered Species Act) include:

Table 1: Endangered species located within Travis County

AMPHIBIANS	Texas Salamander
	Barton Springs Salamander
	Jollyville Plateau Salamander
	Pedernales River Springs Salamander
	Austin blind Salamander
	Woodhouse's Toad
	Strecker's chorus Frog
BIRDS	White-faced Ibis
	Wood Stork
	Swallow-tailed Kite
	Bald Eagle
	Zone-tailed Hawk
	Black Rail
	Whooping Crane
	Piping Plover
	Mountain Plover
	Franklin's Gull
	Interior least Tern
	Western burrowing Owl
	Black-capped Vireo
	Golden-cheeked Warbler
FISHES	American Eel
	Texas Shiner
	Smalleye Shiner
	Sharpnose Shiner
	Silverband Shiner
	Guadalupe bass
MAMMALS	Southern short-tailed Shrew
	Aransas short-tailed Shrew
	Mexican long-tongued Bat
	Cave myotis Bat
	Tricolored Bat
	Big brown Bat

	Eastern red Bat
	Hoary Bat
	Mexican free-tailed Bat
	Big free-tailed Bat
	Swamp Rabbit
	Woodland Vole
	Long-tailed Weasel
	American Mink
	American Badger
	Eastern spotted Skunk
	Plains spotted Skunk
	Western hog-nosed Skunk
	Mountain Lion
REPTILES	Texas map Turtle
	Eastern box Turtle
	Western box Turtle
	Texas Tortoise
	American Alligator
	Slender glass Lizard
	Spot-tailed earless Lizard
	Northern spot-tailed earless Lizard
	Texas horned Lizard
	Common garter Snake
	Texas garter Snake
	Timber (canebrake) Rattlesnake
CRUSTACEANS	An isopod (Lirceolus bisetus)
	Ezell's Cave amphipod
	Balcones Cave amphipod
INSECTS	A springtail (Oncopodura fenestra)
	Tooth Cave ground Beetle
	A Beetle (Rhadine Austinica)
	A Beetle (Rhadine subterranea)
	Kretschmarr Cave mold Beetle
	An true weevil (Lymantes nadineae)
	American bumblebee
	A bumblebee (Bombus variabilis)
	A mining bee (Andrena scotoptera)
	Comanche harvester Ant
	A bee (Macrotera parkeri)
	A microcaddisfly (Neotrichia juani)
	A caddisfly (Xiphocentron messapus)

ARACHNIDS	Tooth Cave Spider
	Reddell Harvestman
	Bone Cave Harvestman
	A harvestman (Texella grubbsi)
	A harvestman (Texella mulaiki)
	A harvestman (Texella spinoperca)
	Tooth Cave Pseudoscorpion
	A pseudoscorpion (Tartarocreagris infernalis)
	A pseudoscorpion (Tartarocreagris intermedia)
	A pseudoscorpion (Tartarocreagris altimana)
	A pseudoscorpion (Tartarocreagris attenuata)
	A pseudoscorpion (Tartarocreagris domina)
	A pseudoscorpion (Tartarocreagris proserpina)
	Bandit Cave Spider
	A meshweaver (Cicurina travisae)
	A scaffold web spider (Eidmannella reclusa)
MOLLUSKS	Texas Fatmucket
	Smooth Pimpleback
	Texas Pimpleback
	False spike Mussel
	A mud snail (Stygopyrgus bartonensis)
	A snail (Patera leatherwoodi)
	A snail (Millerelix gracilis)
	A mud snail (Phreatodrobia punctata)
PLANTS	Plateau Milkvine
	Arrowleaf Milkvine
	Gravelbar Brickellbush
	Narrowleaf Brickellbush
	Spreading Leastdaisy
	Glandular Gay-Feather
	Texas Barberry
	Heller's Marbleseed
	Engelmann's Bladderpod
	Bracted Twistflower
	Basin Bellflower
	Tree Dodder
	Texabama Croton
	Low Spurge
	Texas Amorpha
	Texas Milk Vetch
	Wright's Milkvetch

	Net-Leaf Bundleflower
	Canyon Bean
	Turnip-Root Scurfea
	Canyon Mock-Orange
	Stanfield's Beebalm
	Correll's False Dragon-Head
	Plateau Loosestrife
	Scarlet Leather-Flower
	Texas Almond
	Greenman's Bluet
	Texas Seymeria
	Sycamore-Leaf Snowbell
	Rock Grape
	Canyon Sedge
	Glass Mountains Coral-Root
	Warnock's Coral-Root
	Texas Fescue
	Buckley Tridens

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 ($\mu S/cm_3$). A body of water is more conductive if it has more total dissolved solids (TDS) such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lower the level of 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 zero 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 one-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 9.0.

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 Lady Bird Lake 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).

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

Table 3: Sample storage, preservation, and handling requirements

*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 Lady Bird Lake watershed, as seen on page 25 in Table 4.

Methods of Analysis

All data collected from Lady Bird Lake 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. Statistically significant trends were added to Excel to be graphed. The p-value identified within the equations in the graphs 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 95 percent. 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.

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).

			Aquatic Life Use (H)		Recreation Use (PCR1)		General Use			
Segment No.	**Segment Name**	**Description**	**Dissolved Oxygen grab screening level (mg/L)**	**Dissolved Oxygen grab minimum (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)**
1429	Lady Bird Lake	From Longhorn Dam in Travis County to Tom Miller Dam in Travis County, up to the normal pool elevation of 429 feet (impounds Colorado River)	5.0	4.0	394	126	32	9.0	6.5	400

LADY BIRD LAKE WATERSHED DATA ANALYSIS

Lady Bird Lake Maps

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

Reference points are shown in all maps, layers including monitoring sites, cities, counties, and major highways were included. All shapefiles were downloaded from reliable federal, state, and local agencies.

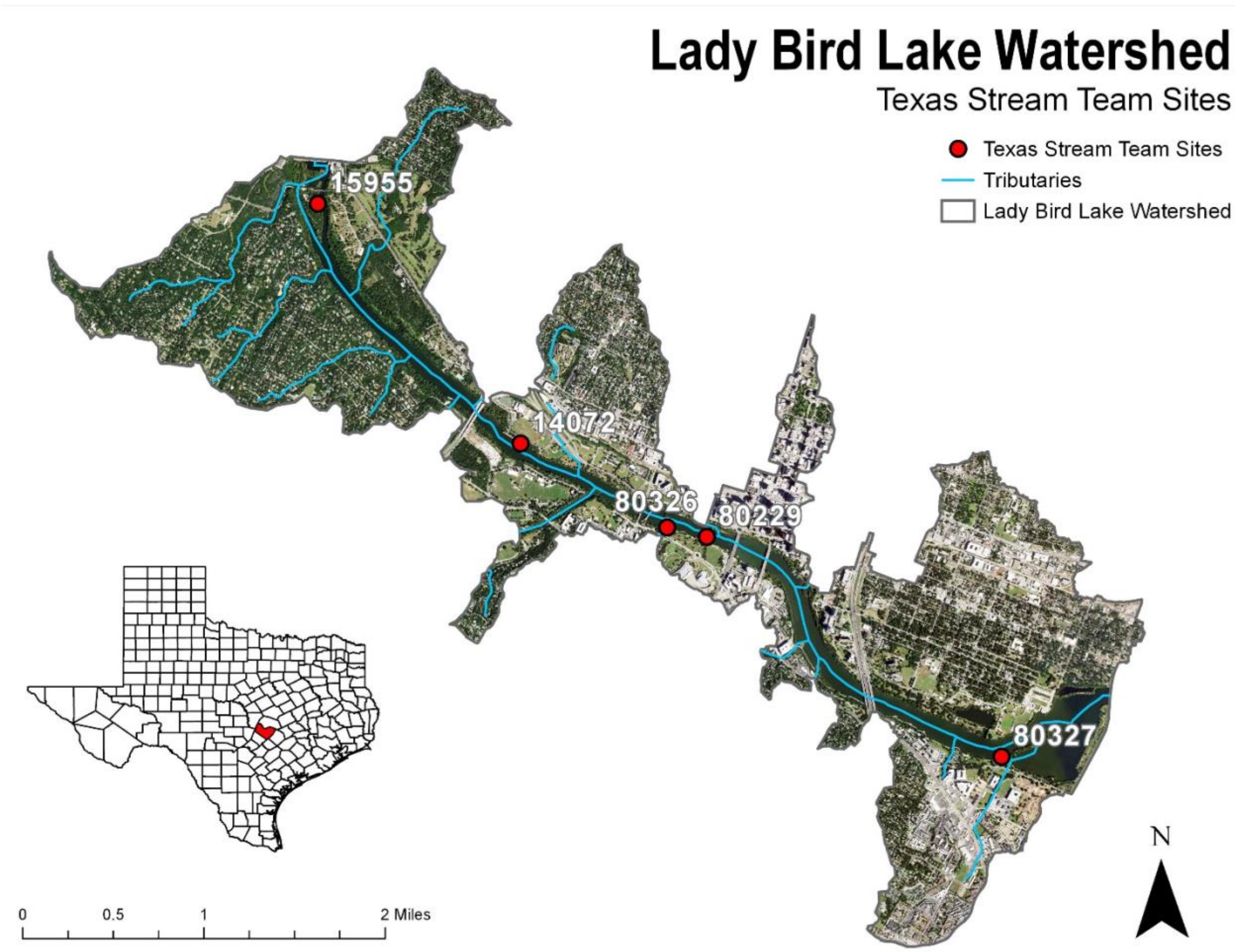

Figure 1: Lady Bird Lake Watershed and active TST sites

Lady Bird Lake Watershed Trends over Time

Sampling Trends over Time

Sampling along Lady Bird Lake began in November of 1996 and continues to this day. A total of 557 individual monitoring events from five sites were analyzed. There was no monitoring during 1997 and 1998. Since 2000, monthly monitoring has occurred on a near-consistent basis throughout the years.

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

Lady Bird Lake Watershed November 1996 – September 2018				
Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	520	328 ± 52	156	537
Water Temperature (°C)	554	21.1 ± 4.9	5	36.5
Dissolved Oxygen (mg/L)	542	7.6 ± 1.62	3.2	16.6
pH (su)	539	7.6 ± 0.45	4.7	9
E. coli (CFU/100mL)	36	33 ± 143.43	1	693
Nitrate-Nitrogen (mg/L)	527	1.07 ± 0.27	0.1	2

There were a total of 557 sampling events between 11/13/1996 and 9/17/2018. 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 551 and 554 air and water temperatures, respectively, were collected in the Lady Bird Lake watershed between 1996 and 2018. The average water temperature for all sites was 21.1°C. Water temperature exceeded the TCEQ optimal temperature of 32.2°C only once during this time. Air temperature for all sites averaged 24.3°C, and varied between 5°C and 38°C.

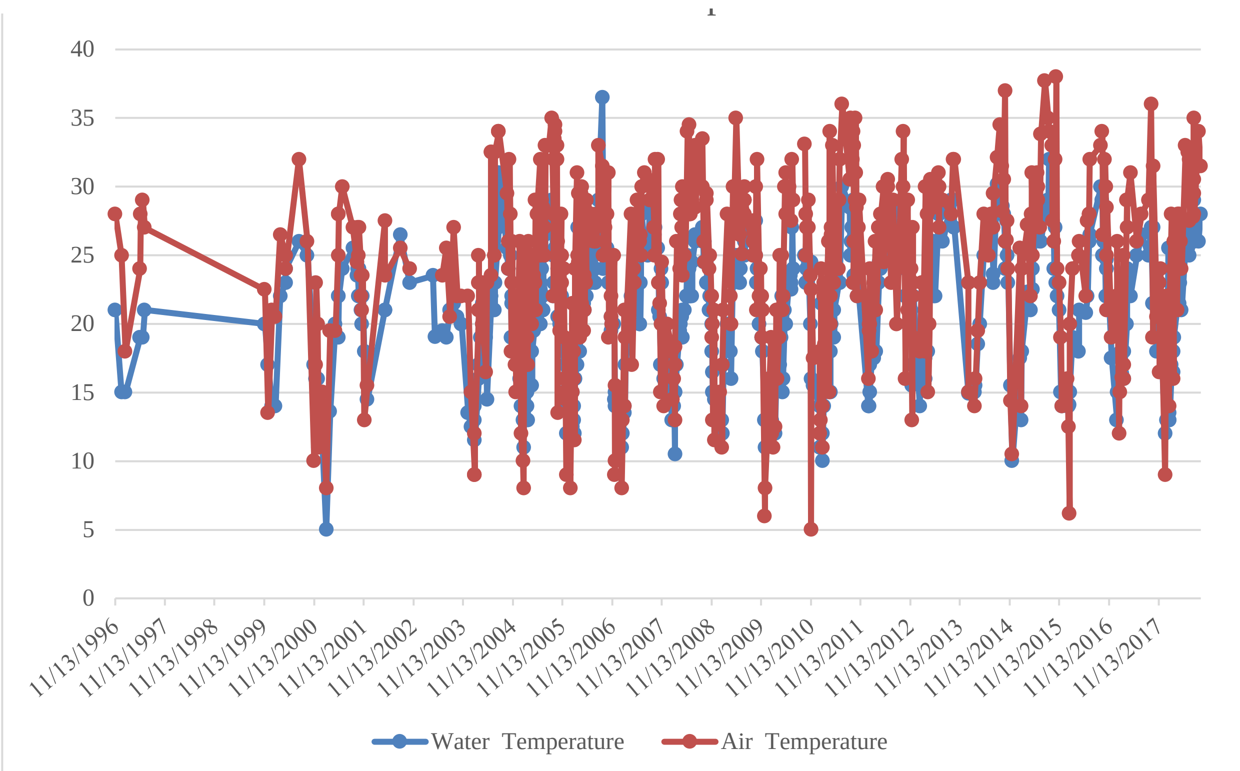

Figure 2: Air and water temperature over time at all sites within the Lady Bird Lake Watershed

Total Dissolved Solids

Citizen scientists collected 520 TDS samples within the watershed. The average TDS measurement for all sites was 328 mg/L. Measurements ranged from a low of 156 mg/L in February of 2005 to a high of 537 mg/L in October of 2016.

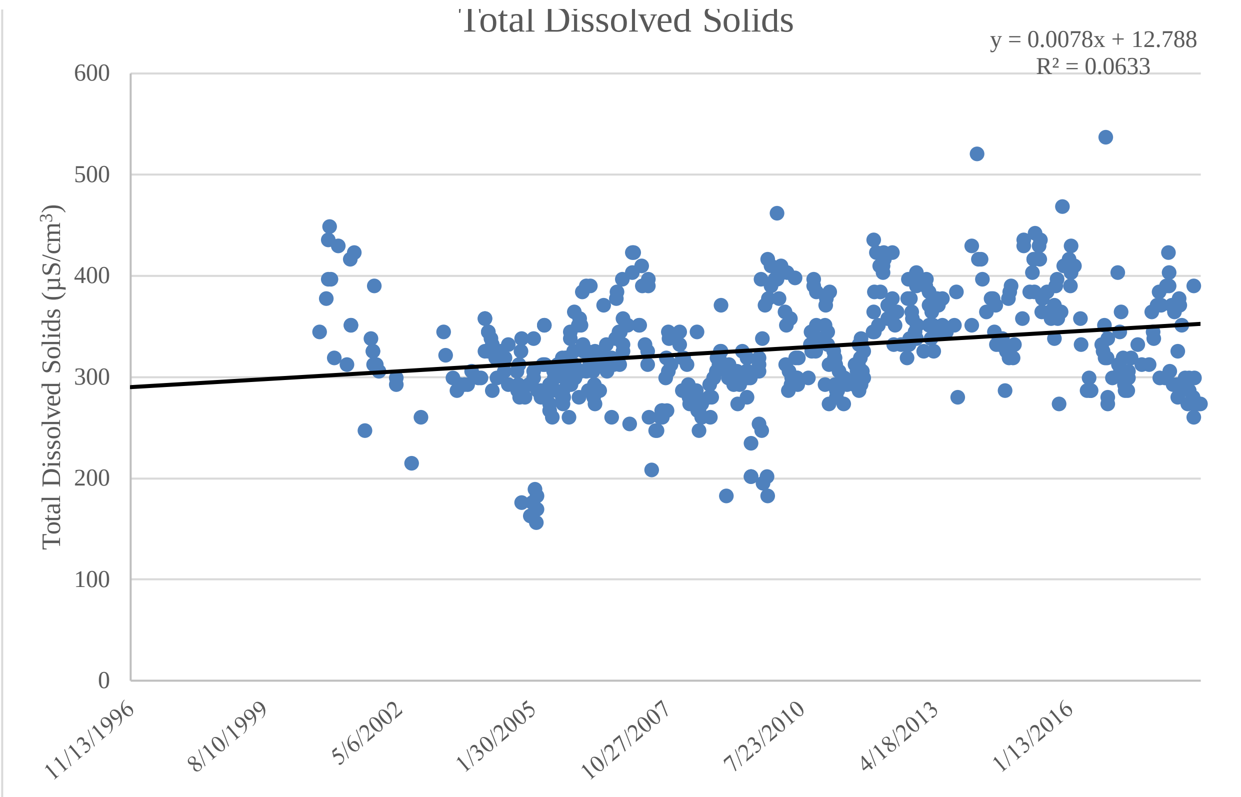

Figure 3: Total dissolved solids over time at all sites within the Lady Bird Lake Watershed

Dissolved Oxygen

Citizen scientists collected a total of 542 DO samples in the Lady Bird Lake watershed. The mean DO was 7.6 mg/L. Measurements ranged from a low of 3.2 mg/L in April of 2013 to a high of 16.6 mg/L in January of 2009.

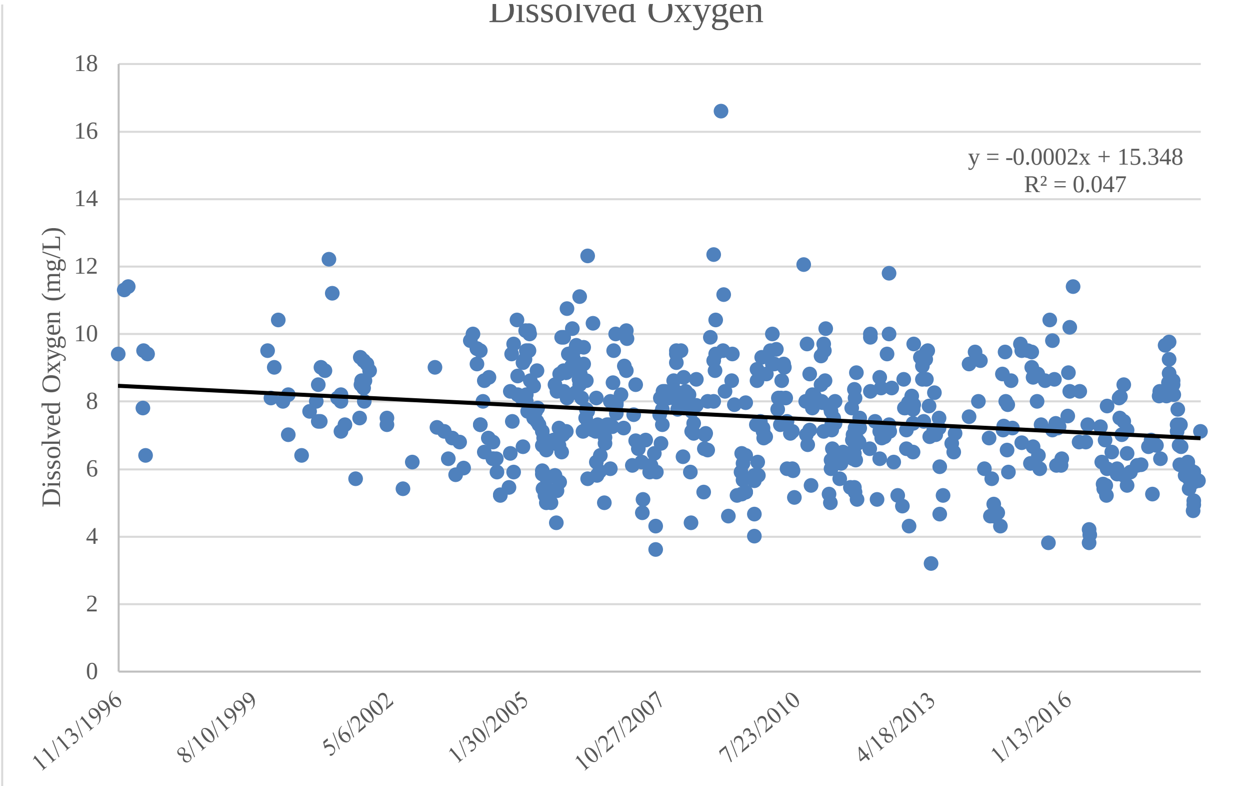

Figure 4: Dissolved oxygen over time at all sites in the Lady Bird Lake Watershed

pH

The pH was measured for 97 percent of all sampling events in the Lady Bird Lake watershed. The mean pH was 7.6 and the values ranged from 4.7 to 9.0.

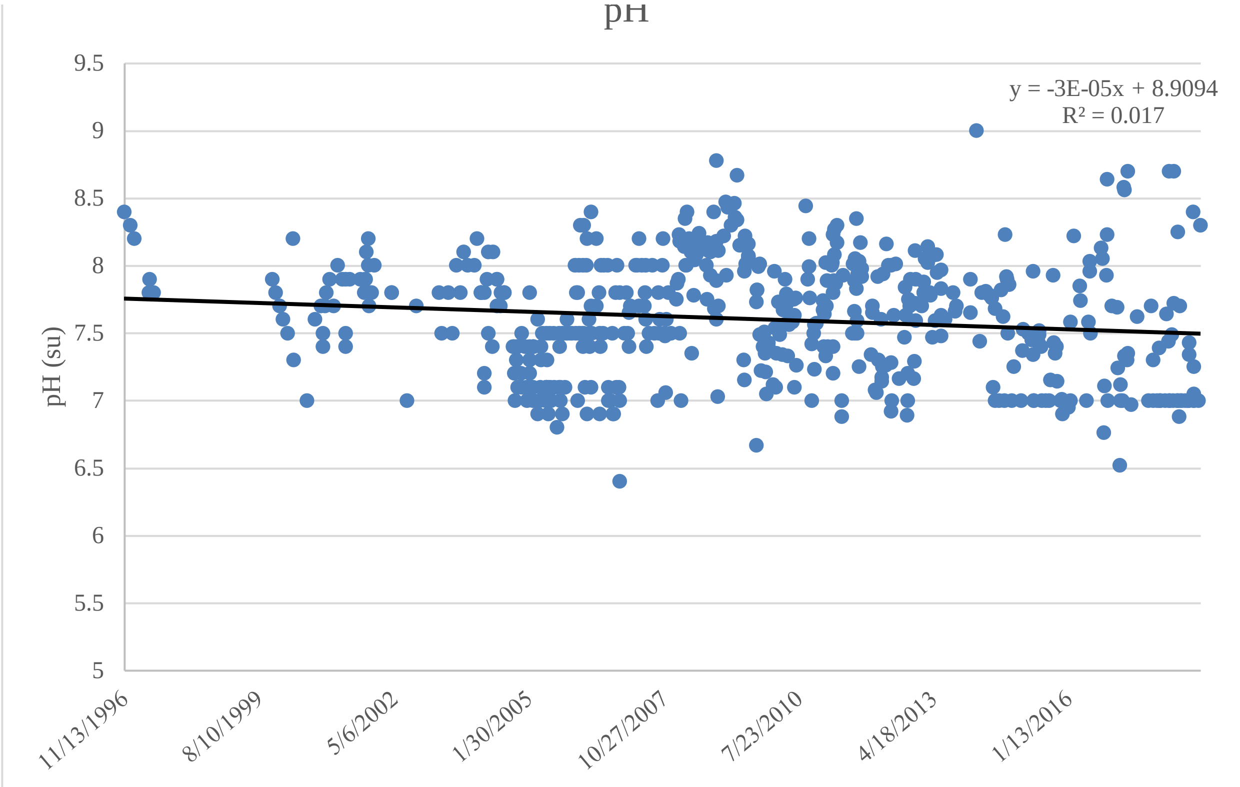

Figure 5: pH over time at all sites within the Lady Bird Lake Watershed

E. coli Bacteria

E. coli samples were taken at four out of the five selected sites in the Lady Bird Lake watershed. A total of 36 *E. coli* samples were taken. The geomean for *E. coli* was 33 CFU/100 mL. The *E. coli* counts ranged from 1 CFU/100 mL to a high of 693 CFU/100 mL in June of 2011.

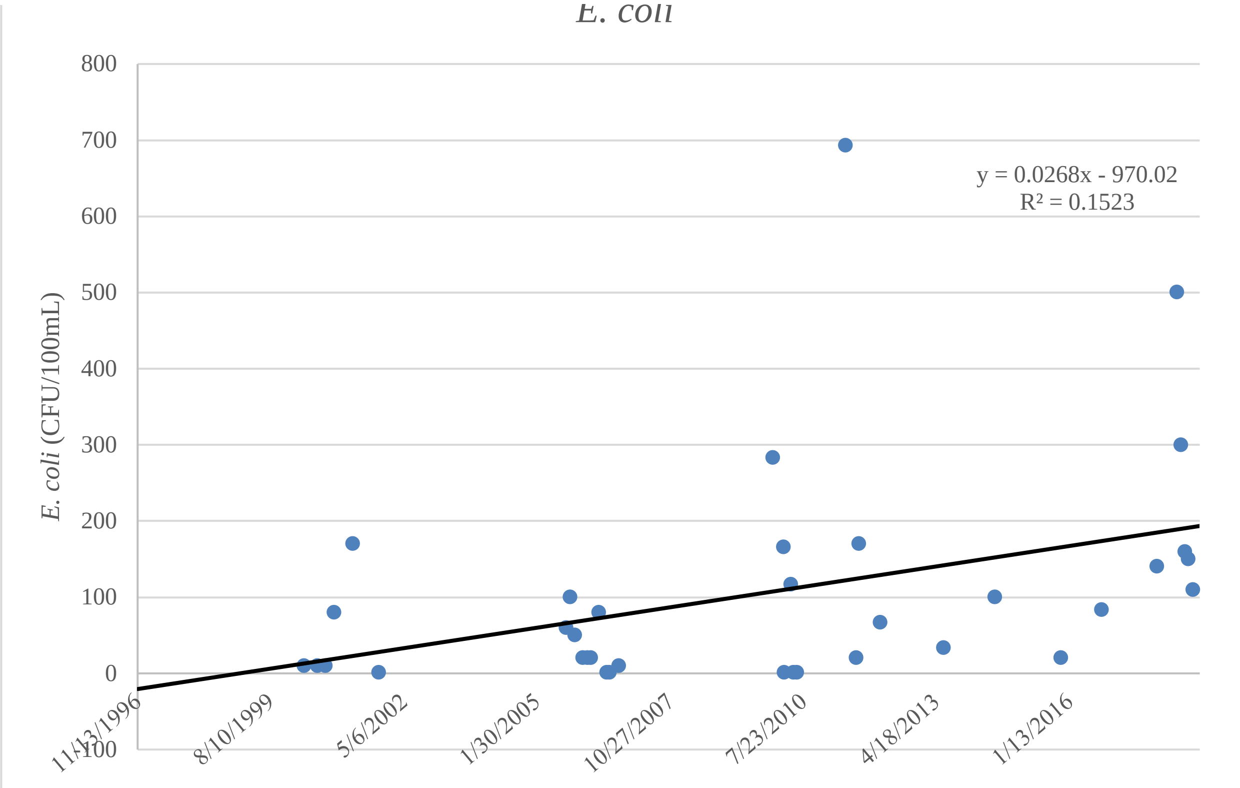

Figure 6: *E. coli* over time at all sites within the Lady Bird Lake Watershed

Nitrate-Nitrogen

Nitrate-nitrogen concentrations were taken at all of the selected sites in the Lady Bird Lake watershed. A total of 527 nitrate-nitrogen samples were taken. The mean nitrate-nitrogen concentration in the watershed was 1.07 mg/L and ranged from 0.10 mg/L to a high of 2.00 mg/L.

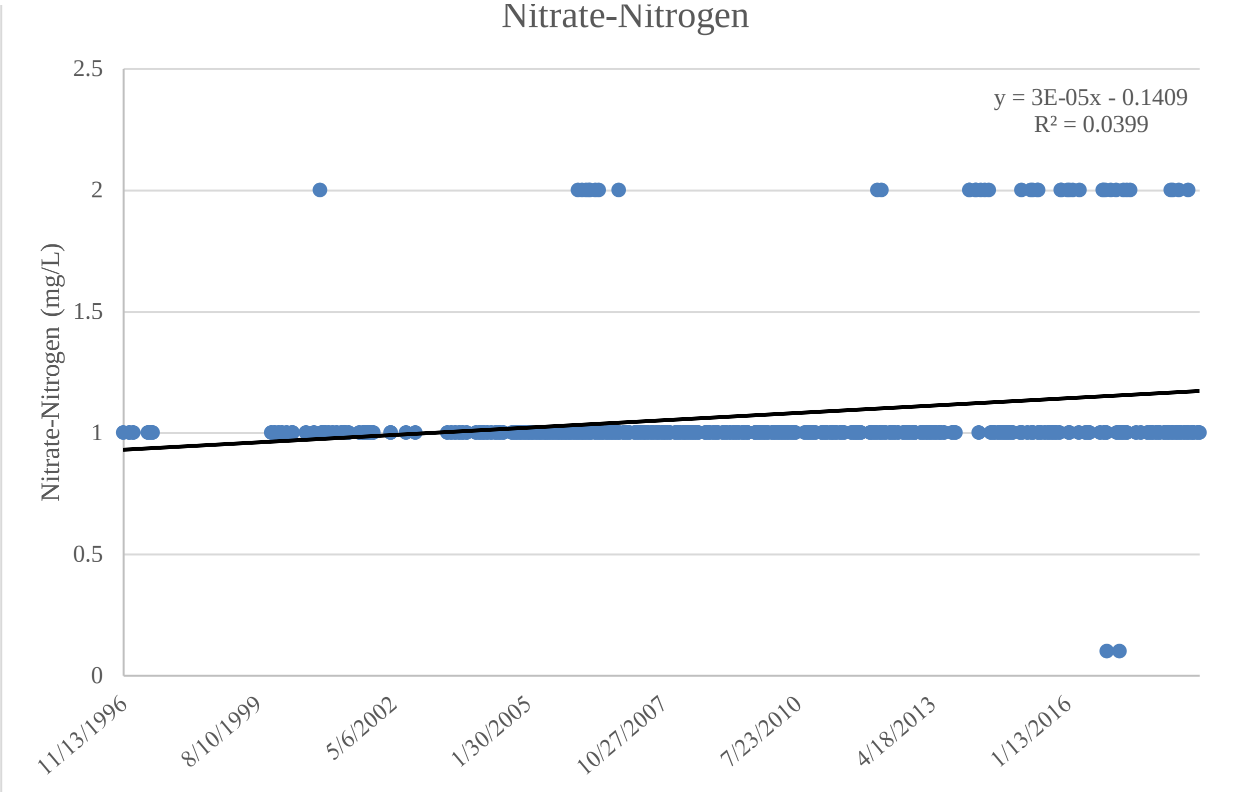

Figure 7: Nitrate-Nitrogen over time at all sites within the Lady Bird Lake Watershed

LADY BIRD LAKE 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, nitrate-nitrogen, 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 5, on the following page, 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 80326 – Town Lake @ West Bouldin Creek had the highest overall average for TDS, with a result of 345 ± 55 mg/L. Site 15955 – Town Lake Below Tom Miller Dam had the lowest average TDS, with a result of 313 ± 46 mg/L.

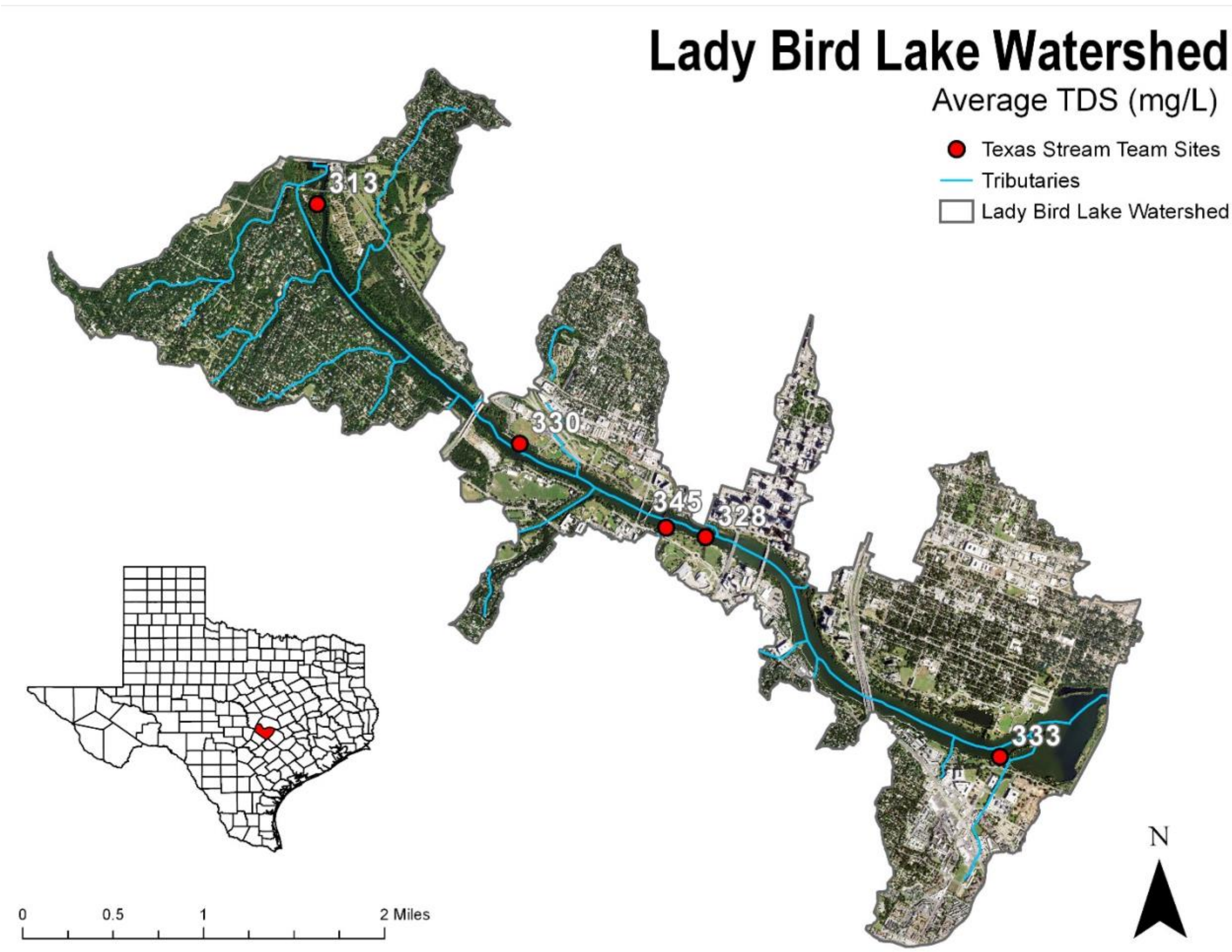

Figure 8: Map of the average total dissolved solids for sites in the Lady Bird Lake Watershed

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 15955 – Town Lake Below Tom Miller Dam had the lowest average DO reading, with a result of 7.3 ± 1.6 mg/L. Site 80327 – Town Lake @ Austin Youth Hostel had the highest average DO reading, with a result of 8.2 ± 1.5 mg/L.

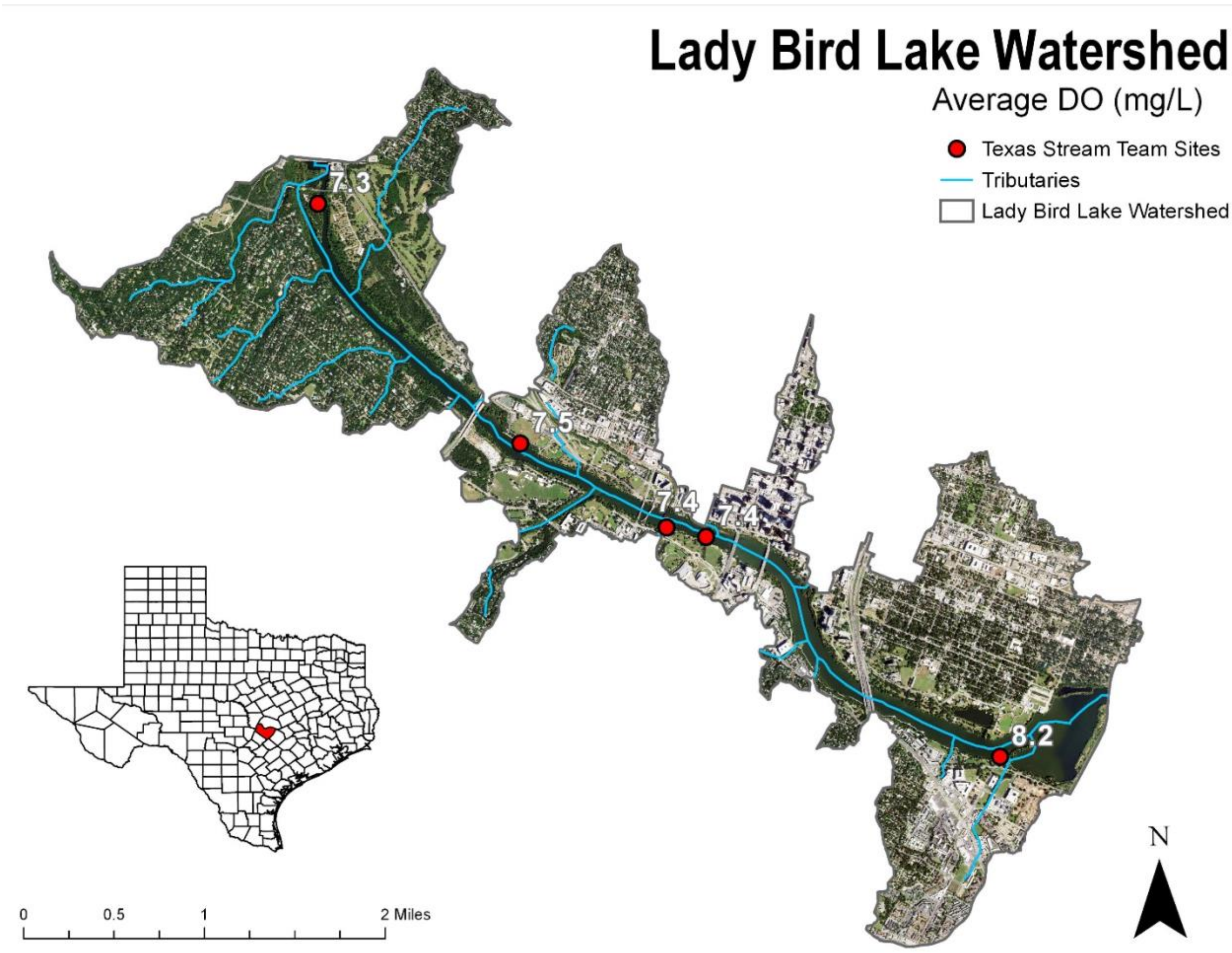

Figure 9: Map of the average dissolved oxygen concentration for sites in the Lady Bird Lake Watershed

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 9.0 for the most optimum environment. Anything below 6.5 or above 9.0 can negatively impact reproduction or can result in fish kills. There were only two instances where the pH was reported as below this widely accepted range. These instances occurred at Site 15955 – Town Lake Below Tom Miller Dam in December of 2006, and at Site 80327 – Town Lake @ Austin You Hostel in October of 2016. Site 80327 – Town Lake @ Austin You Hostel and Site

14072 – Town Lake @ 2.5 Mile Marker both had the highest average pH levels, with a result of 7.7 ± 0.6 and 7.7 ± 0.4, respectively. Site 15955 – Town Lake Below Miller Dam and Site 80326 – Town Lake @ West Bouldin Creek both had the lowest average pH levels, with a result of 7.5 ± 0.4.

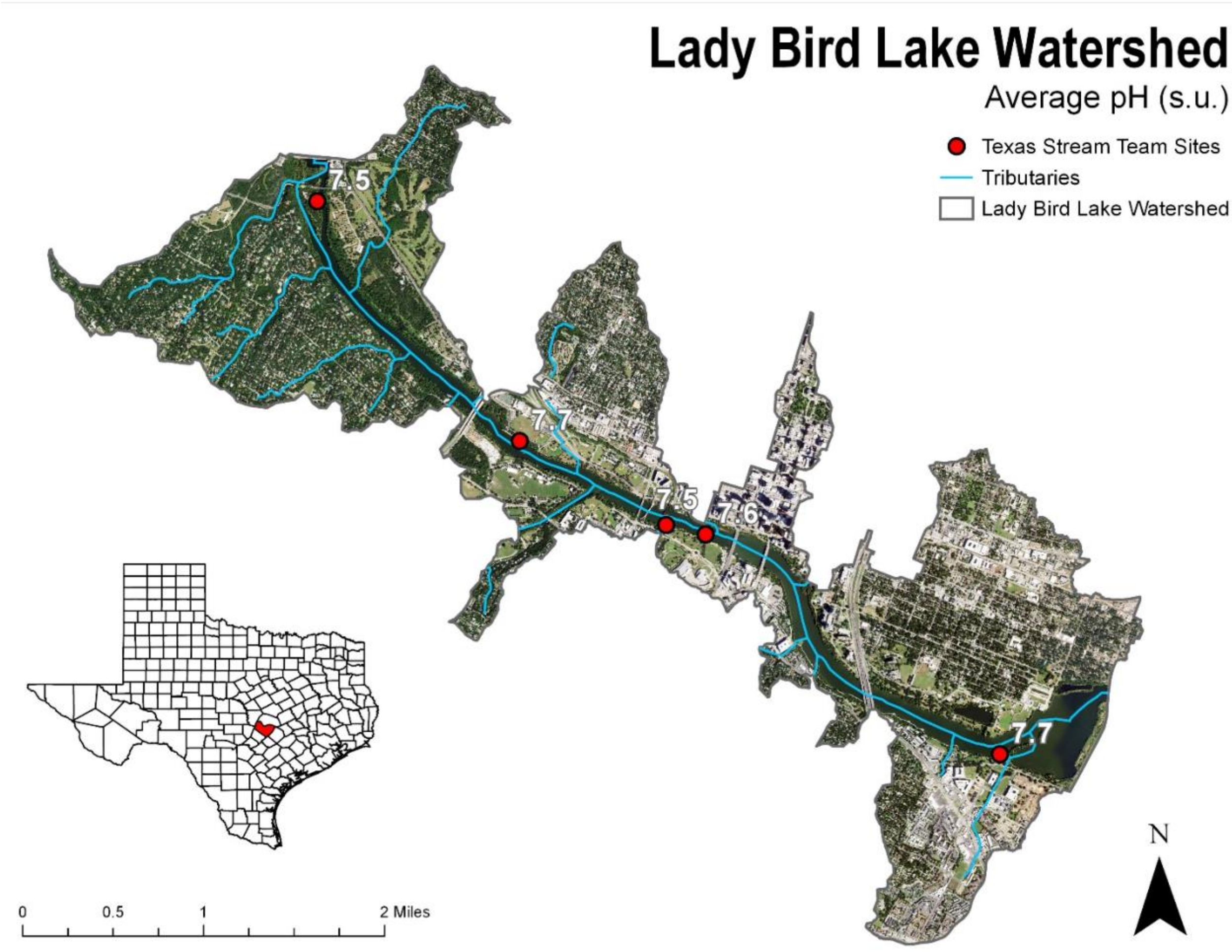

Figure 10: Map of the average pH for sites in the Lady Bird Lake Watershed

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. *E. coli* measurements taken at Site 14072 – Town Lake @ 2.5 Mile Marker, Site 15955 – Town Lake Below Tom Miller Dam, and Site 80327 – Town Lake @ Austin Youth Hostel both had a geometric mean which satisfied the TCEQ surface water quality standard and failed to yield measurements above 394 CFU/100 mL. Site 80299 – Town Lake Upstream of South First Street @ Stevie Ray Vaughn Statue had a geometric mean above the TCEQ surface water quality standard at 191 ± 128 CFU/100 mL, as well as one sample event with elevated *E. coli* levels at 500 CFU/100 mL. Site 80326 – Town Lake @ West Bouldin Creek also had a geometric mean above the TCEQ standard at 339 ± 264 CFU/100 mL, as well as one sample event with elevated *E. Coli* levels at 693 CFU/100 mL.

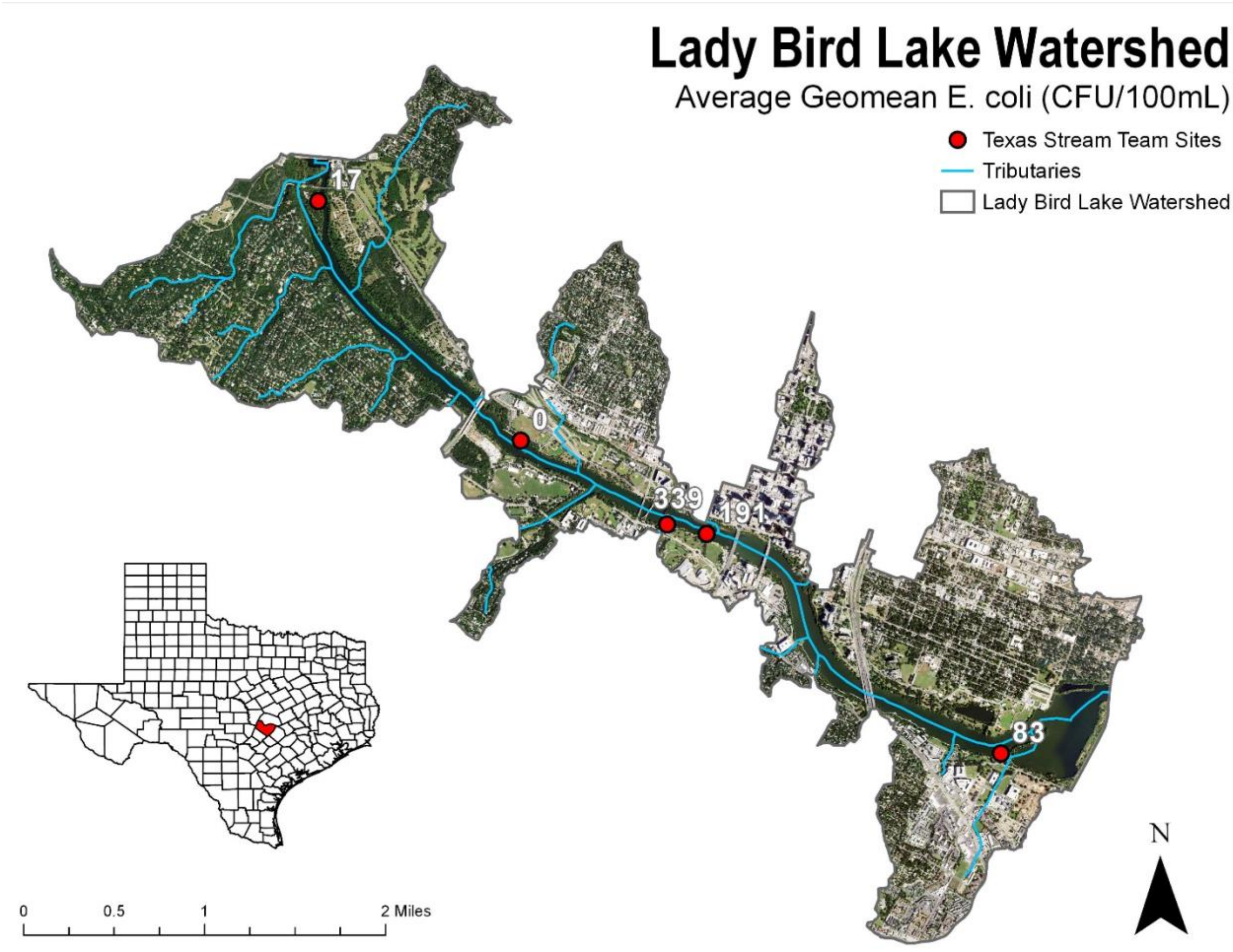

Figure 11: Map of the *E. coli* geomean for sites in the Lady Bird Lake Watershed

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 (10.00 mg/L or higher) under certain conditions. The natural level of ammonia or nitrate in surface water is typically low (less than 1.00 mg/L); in the effluent of wastewater treatment plants it can range up to 30.00 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 80229 – Town Lake Upstream of South First Street @ Stevie Ray Vaughn Statue had the minimum average nitrate-nitrogen concentration with 1.02 mg/L. Site 80326 – Town Lake @ West Bouldin Creek and Site 80327 – Town Lake @ Austin Youth Hostel both had the highest average nitrate-nitrogen concentration with 1.13 mg/L.

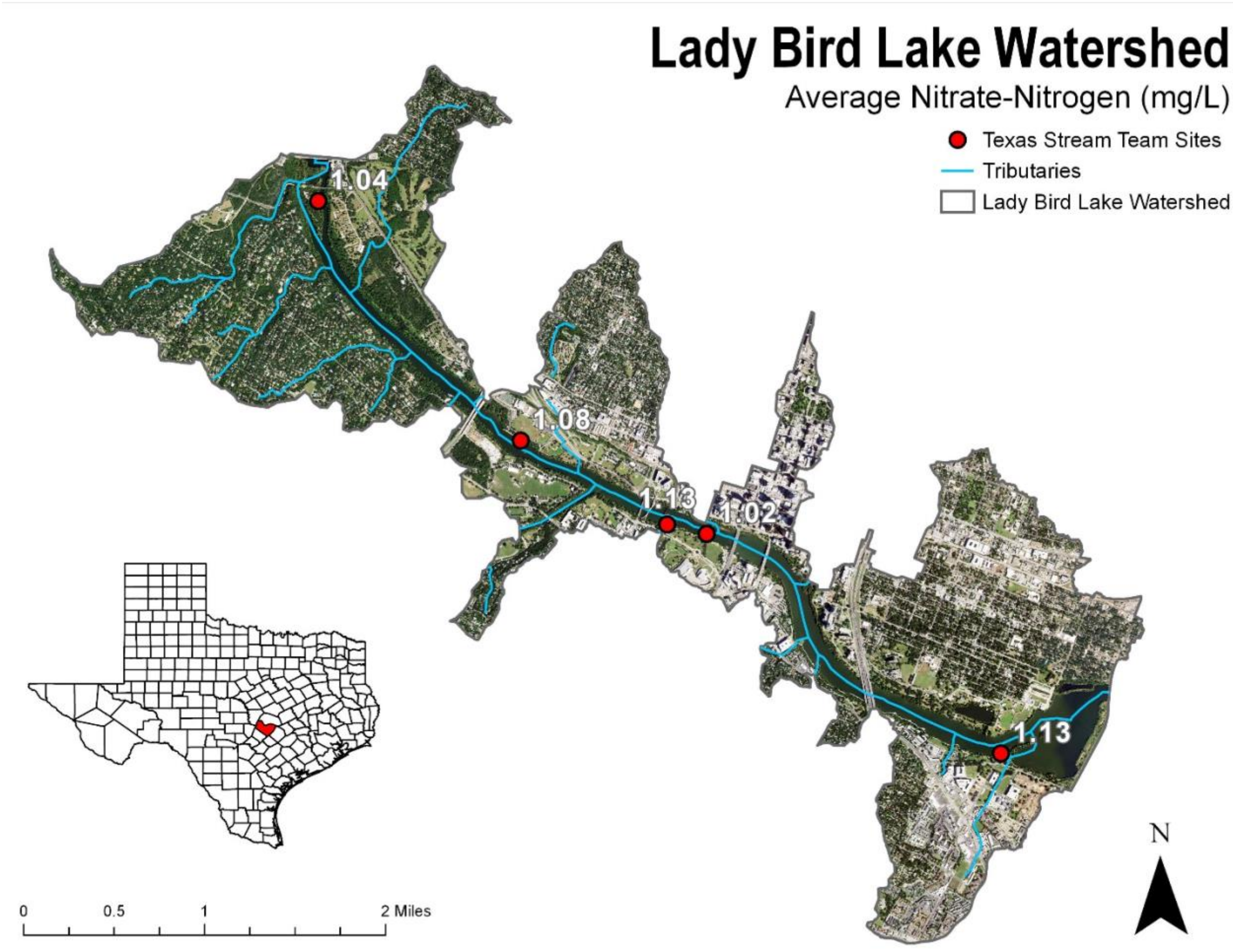

Figure 12: Map of the average nitrate-nitrogen for sites in the Lady Bird Lake Watershed

See Table 6 below for a summary of the 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. Texas Stream Team 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 Lady Bird Lake Watershed sites

Site Number	TDS (mg/L)	DO (mg/L)	pH (su)	*E.coli* (CFU/100 mL) *geomean	Nitrate-Nitrogen (mg/L)
15955	313 ± 46	7.3 ± 1.6	7.5 ± 0.4	17 ± 64	1.04 ± 0.24
80229	328 ± 44	7.4 ± 1.5	7.6 ± 0.4	191 ± 128	1.02 ± 0.15
80326	345 ± 55	7.4 ± 1.8	7.5 ± 0.4	339 ± 264	1.13 ± 0.34
80327	333 ± 60	8.2 ± 1.5	7.7 ± 0.6	83 ± 0	1.13 ± 0.33
14072	330 ± 51	7.5 ± 1.7	7.7 ± 0.4	N/A	1.08 ± 0.27

Site 15955 – Town Lake Below Tom Miller Dam

Site Description

This site is located in the upper-most reach of Lady Bird Lake immediately below Tom Miller Dam. Access to the site is through public parkland operated and owned by the Austin Parks & Recreation Department (PARD) of the City of Austin and is supported by the Friends of Red Bud Isle Volunteer Group. Red Bud Isle Park is managed as a dog park and is subject to temporary closure by discretion of the PARD Director for the purpose of preventing pet access to impacted waters. The land in this area consists of parkland, low-density residential homes, woodland, and is adjacent to Bee Creek Preserve.

Sampling Information

This site was sampled 154 times between 11/13/1996 and 8/31/2018. The time of sampling for this site ranged from 07:05 to 19:20. Nearly consistent monthly monitoring has been performed at this site since June 2003.

Table 7: Descriptive parameters for Site 15955

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	132	313 ± 46	182	442
Water Temperature (°C)	153	20.8 ± 4.6	11	30.2
Dissolved Oxygen (mg/L)	153	7.3 ± 1.6	3.6	11.4
pH (su)	152	7.5 ± 0.4	6.4	8.6
E. coli (CFU/100ml)	26	17 ± 64	1	283
Nitrate-Nitrogen (mg/L)	145	1.04 ± 0.24	0.10	2

Site was sampled 154 times between 11/13/1996 and 8/31/2018.

Air and Water Temperature

Air temperatures were taken 152 times with water temperatures taken 153 times at this site. The air temperatures fluctuated in a seasonal pattern with the highest temperature of 37.7°C in July of 2015, and the lowest temperature of 6°C in December of 2009. The mean water temperature was 20.8°C and the water temperature ranged from a low of 11°C recorded in January of 2011, to a high of 30.2°C in August of 2014.

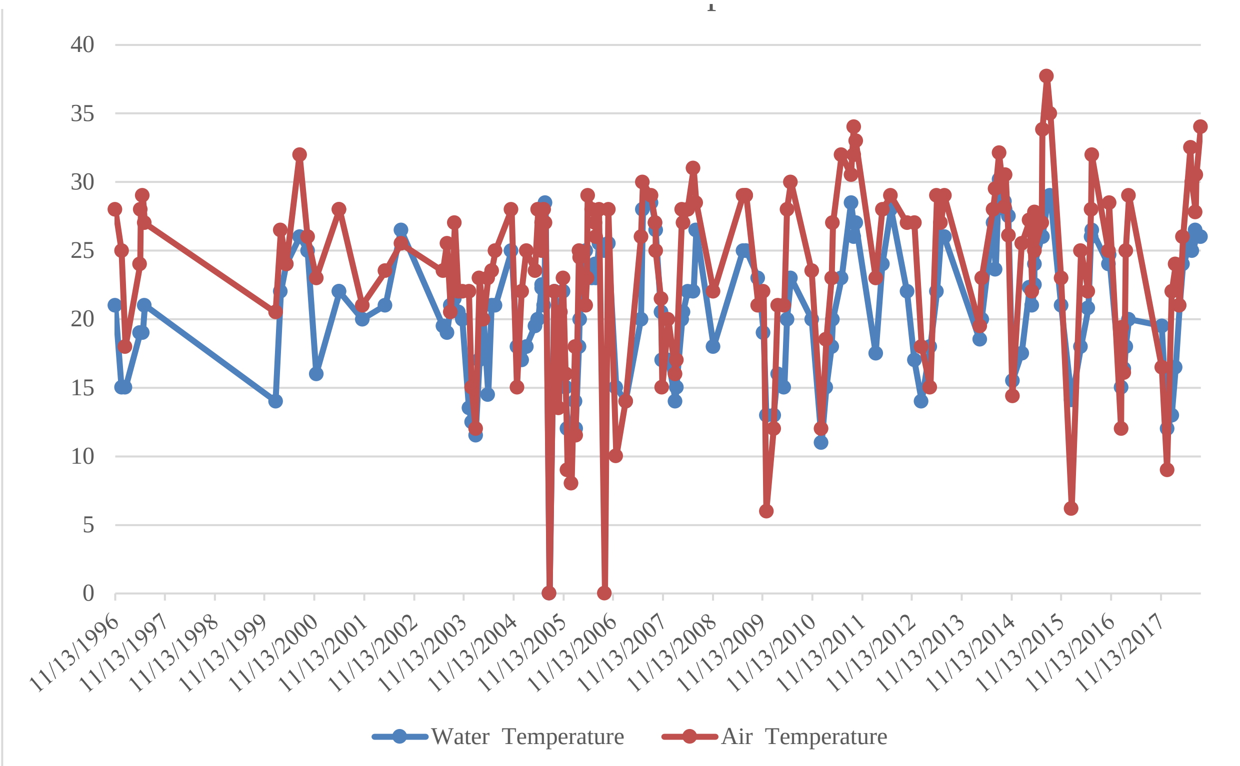

Figure 13: Air and water temperature at Site 15955

Total Dissolved Solids

Citizen scientists sampled TDS at this site 132 times between 9/24/2000 and 8/31/2018. The mean TDS concentration was 313.0 mg/L. The concentration of TDS ranged from a minimum of 182 mg/L in November of 2009 to a maximum of 442 mg/L in May of 2015.

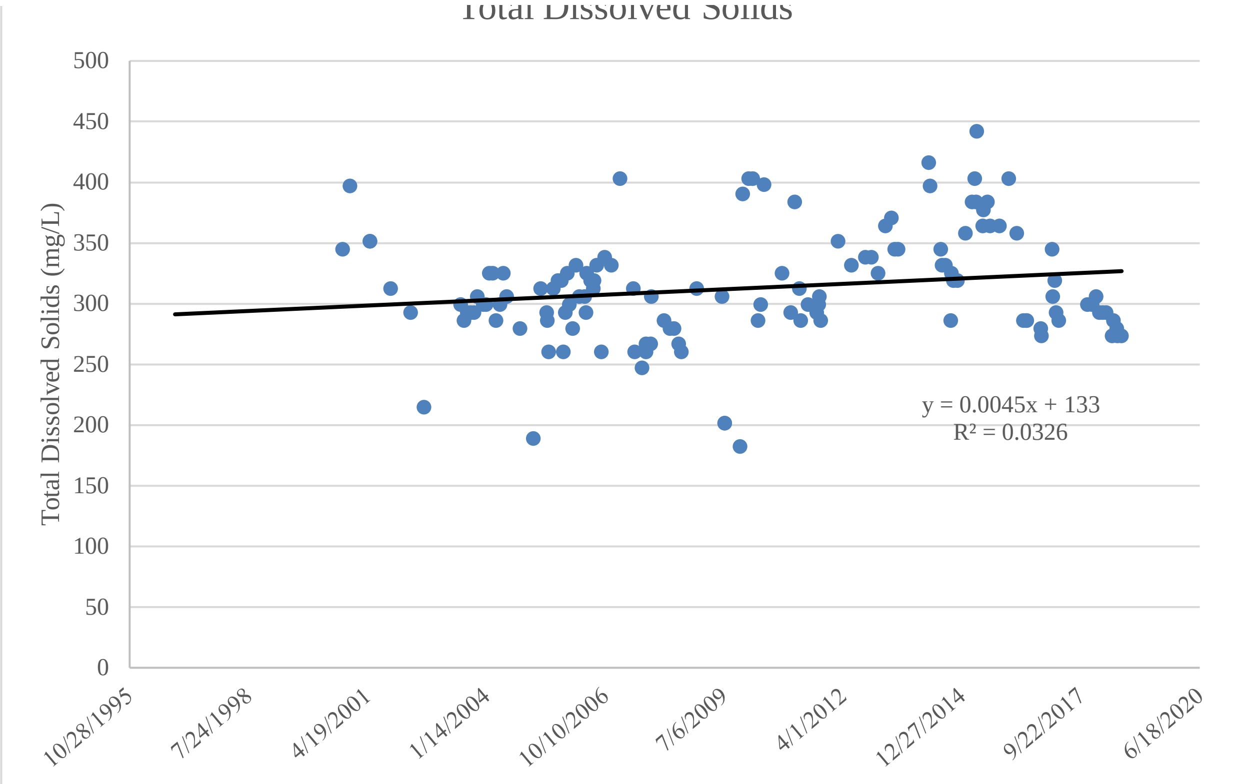

Figure 14: Total dissolved solids at Site 15955

Dissolved Oxygen

Citizen scientists took 153 DO samples at this site between 11/13/1996 and 8/31/2018. The mean DO concentration was 7.3 mg/L. DO concentrations ranged from a low of 3.6 mg/L in September of 2007 to a high of 11.4 mg/L in January of 1997.

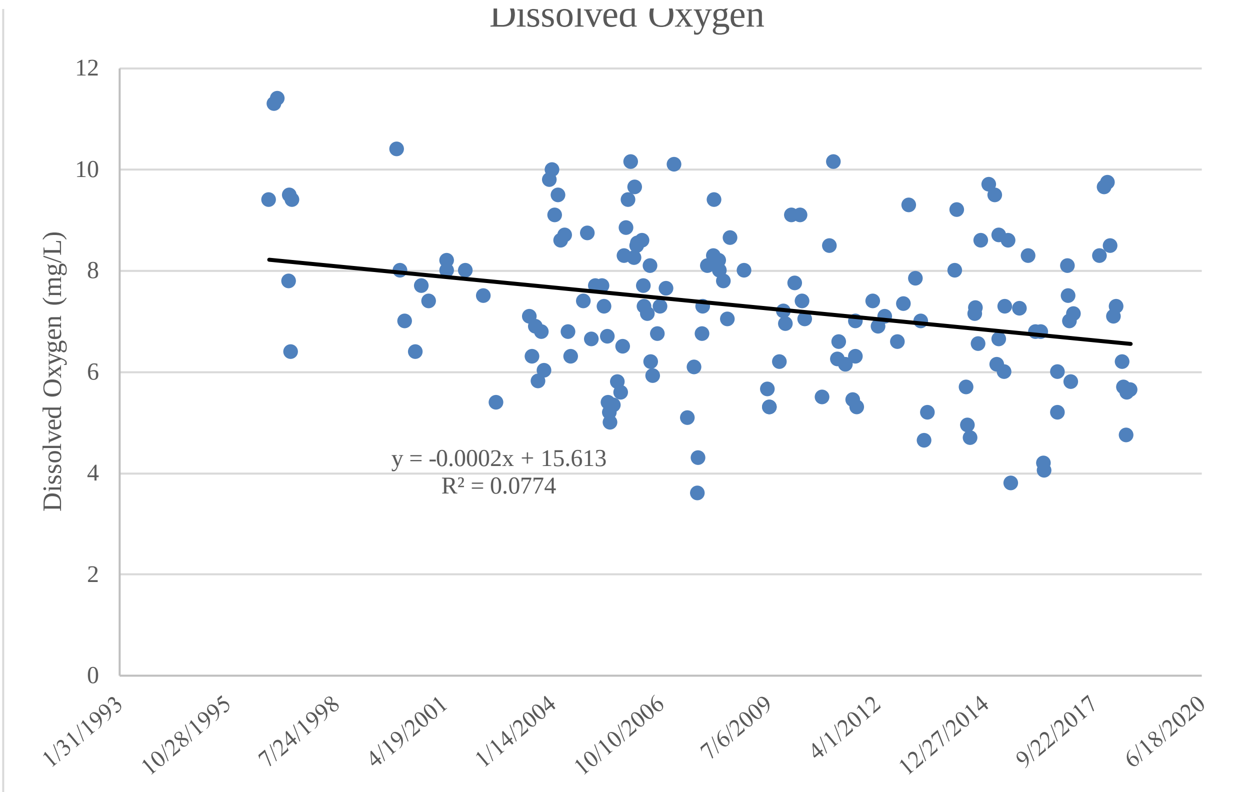

Figure 15: Dissolved oxygen at Site 15955

pH

There were 152 pH measurements taken at this site between 11/13/1996 and 8/31/2018. The mean pH was 7.5 and pH ranged from a low of 6.4 taken in December of 2006 to a high of 8.6 taken in February of 2017.

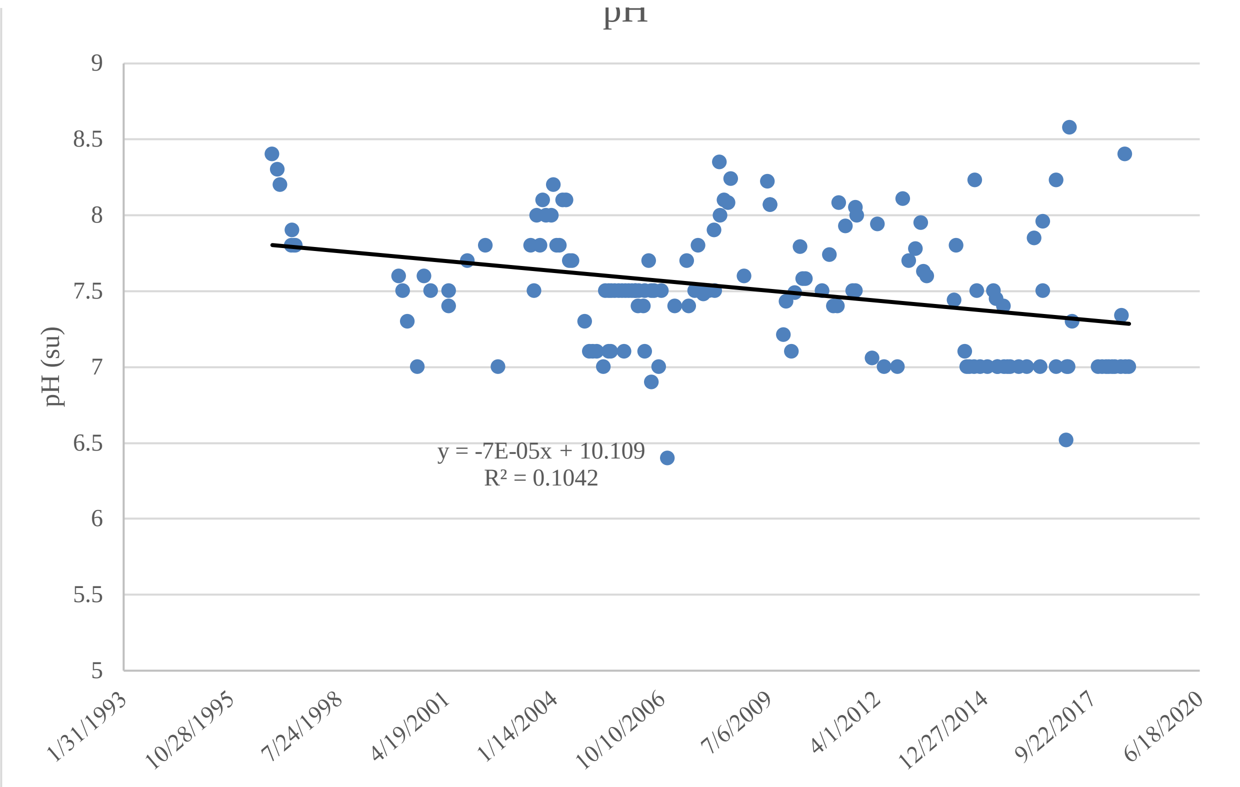

Figure 16: pH at Site 15955

E. coli

There were 26 *E. coli* measurements taken at this site between 10/27/2000 and 2/15/2018. The observed geomean was 17 CFU/100mL and ranged from 1 CFU/100mL taken on multiple occasions to a high of 283 CFU/100mL taken in December of 2009.

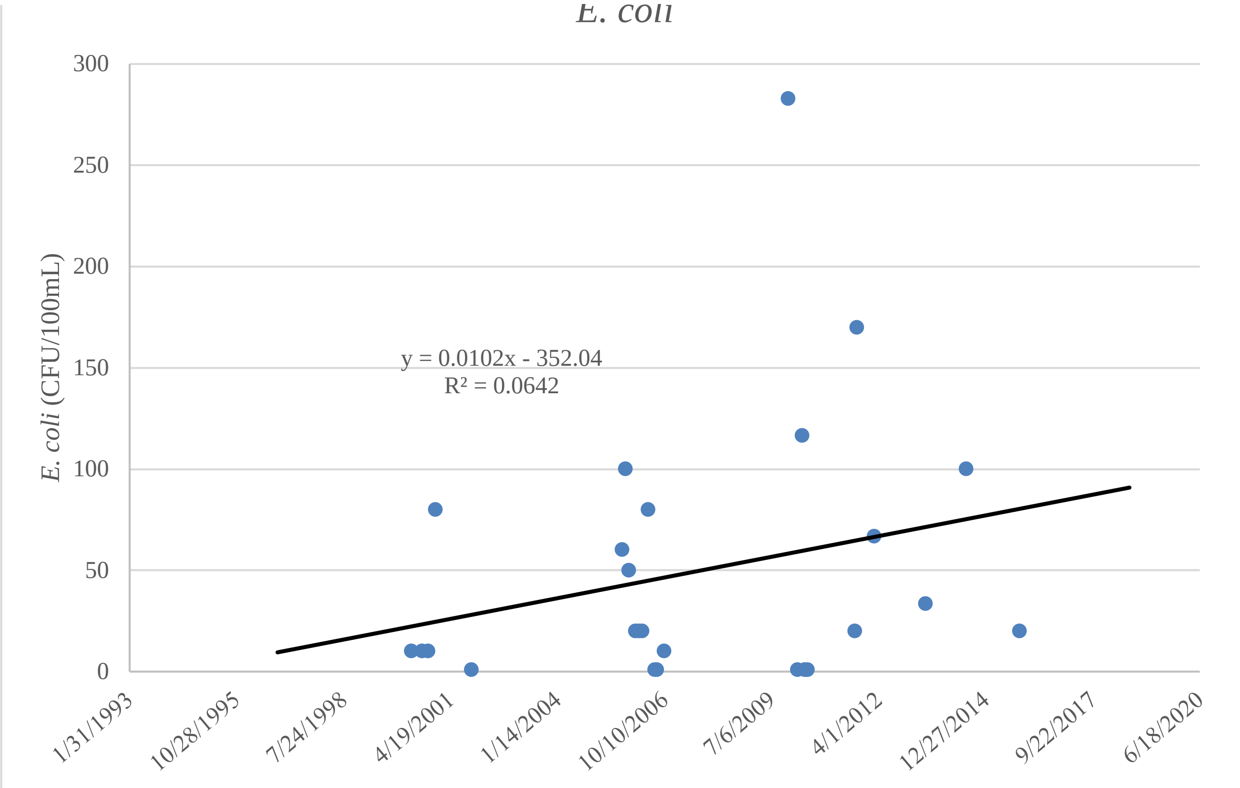

Figure 17: *E. coli* at Site 15955

Nitrate-Nitrogen

There were 145 nitrate-nitrogen measurements taken at this site between 11/13/1996 and 8/31/2018. The mean nitrate-nitrogen was 1.04 mg/L and nitrate-nitrogen ranged from a low of 0.10 mg/L taken in October of 2016 and January of 2017 to a high of 2.00 mg/L taken on several occasions.

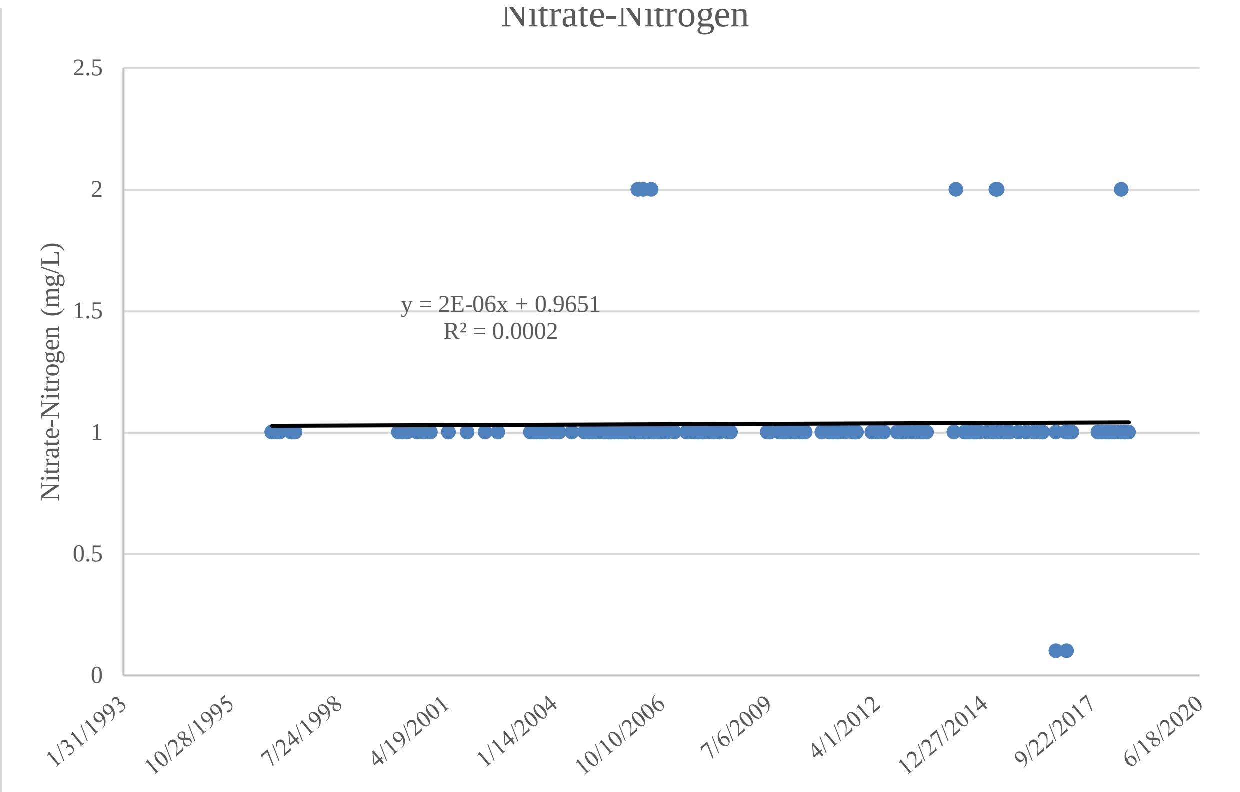

Figure 18: Nitrate-Nitrogen at Site 15955

Site 80229 – Town Lake Upstream of South 1st Street @ Stevie Ray Vaughn Statue

Site Description

This site is located within the Auditorium Shores at Town Lake Metropolitan Park, directly across the confluence of Shoal Creek and Lady Bird Lake. The parkland here is managed for recreational fields, operated by PARD. It is accessible by the Ann and Roy Butler Hike and Bike Trail, which leads up to the Stevie Ray Vaughn Statue where sampling is performed. No-mow "Grow Zones," vigorous with riparian plants, are maintained along the banks of Lady Bird Lake in and around this site. The sampling location at the Stevie Ray Vaughn Statue is approximately 165 meters downstream of the Auditorium Shores Dog Park.

Sampling Information

This site was sampled 92 times between 11/17/1999 and 7/30/2018. The time of sampling for this site ranged from 08:10 to 18:29. A notable hiatus of routine, monthly monitoring events occurred between September 2008 and July 2017.

Table 8: Descriptive parameters for Site 80229

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	83	328 ± 44	208	449
Water Temperature (°C)	92	20.8 ± 5	5	36.5
Dissolved Oxygen (mg/L)	92	7.4 ± 1.5	4.4	12.2
pH (su)	90	7.6 ± 0.4	6.9	8.3
E. coli CFU/100mL)	7	191 ± 128	110	500
Nitrate-Nitrogen (mg/L)	84	1.02 ± 0.15	1	1

Site was sampled 92 times between 11/17/1999 and 7/30/2018.

Air and Water Temperature

Air temperatures were taken 90 times and water temperatures were taken 92 times at this site between 11/17/1997 and 7/30/2018. The mean water temperature was 20.8°C and ranged from a low temperature of 5°C in February of 2001 to a high 36.5°C in September of 2006. The air temperature ranged from a low of 8°C in February of 2001, to a high of 35°C in July of 2018.

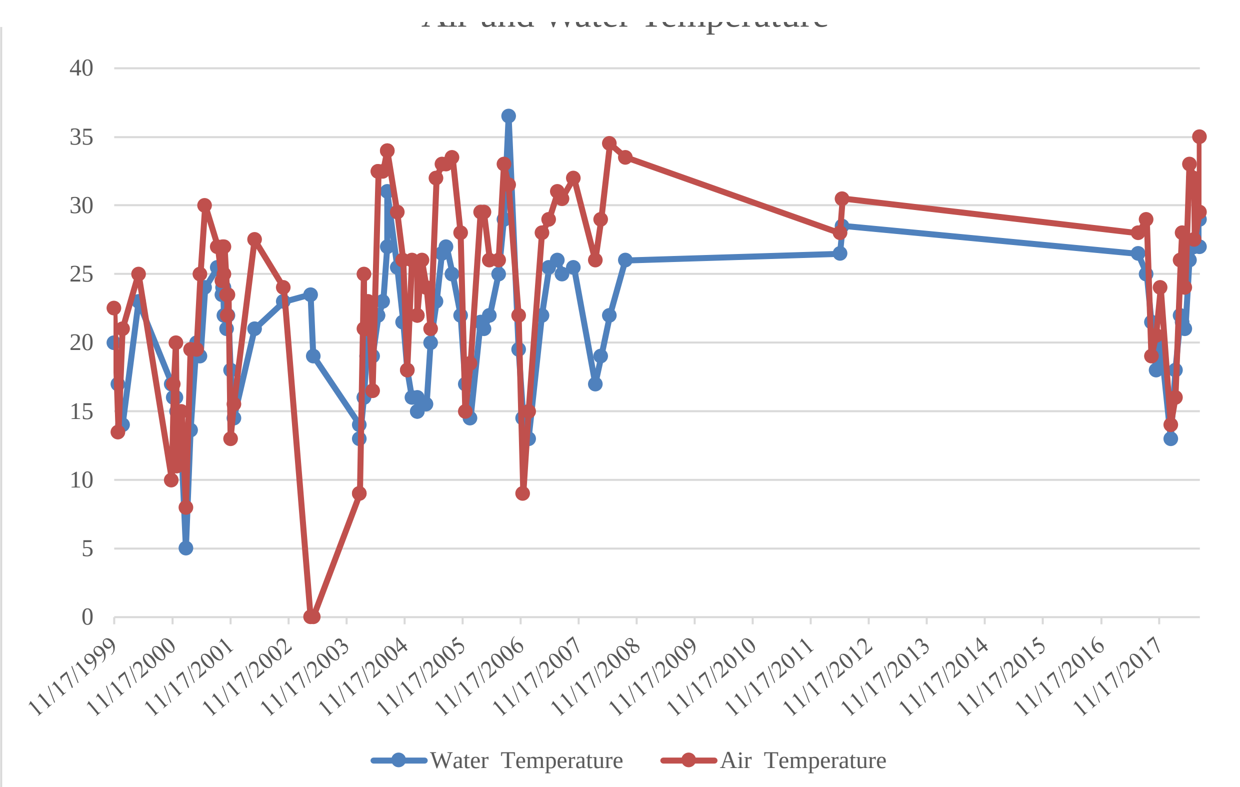

Figure 19: Air and water temperature at Site 80229

Total Dissolved Solids

Citizen scientists collected 83 TDS samples at this site between 11/17/1997 and 7/30/2018. The mean TDS concentration was 328 mg/L. The minimum TDS concentration was 208 mg/L and was taken in July of 2007. The maximum TDS concentration was 449 mg/L and was taken in December of 2000.

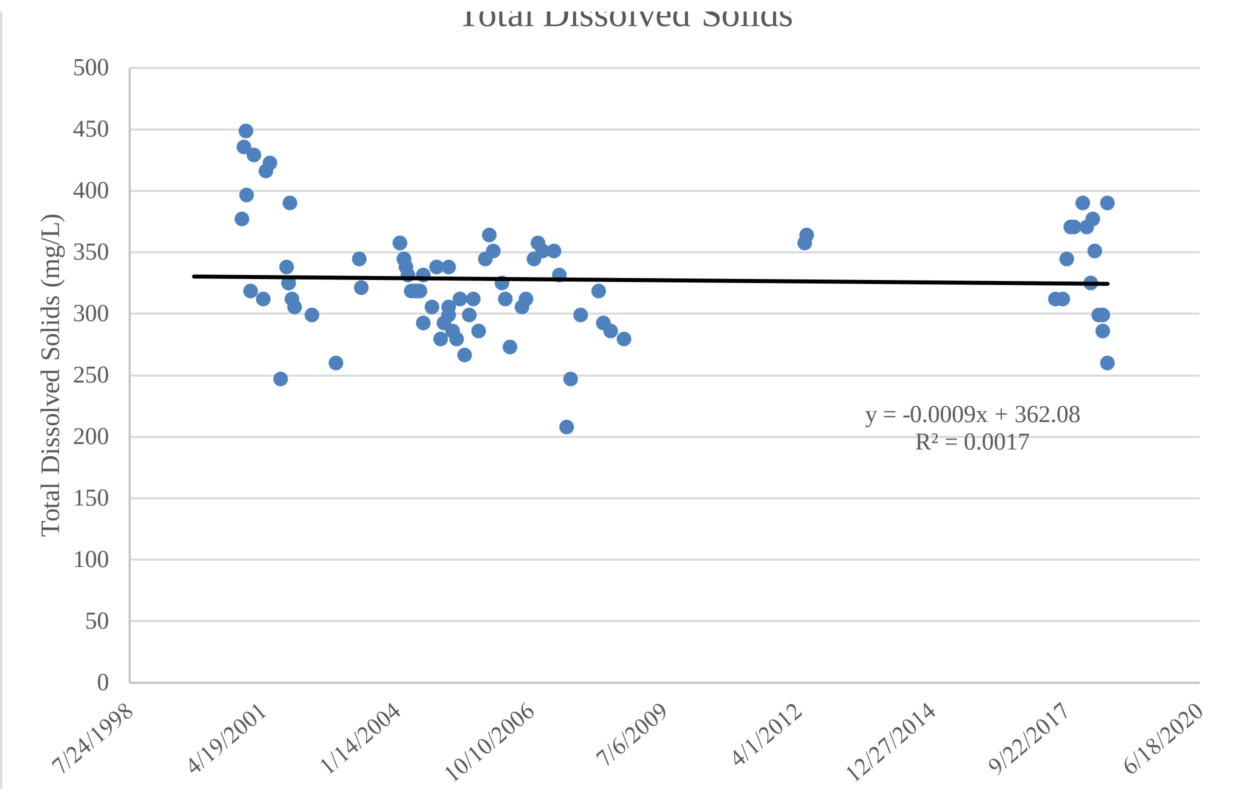

Figure 20: Total dissolved solids at Site 80229

Dissolved Oxygen

Citizen scientists collected 92 DO samples at this site between 11/17/1997 and 7/30/2018. The mean DO concentration was 7.4 mg/L. The minimum DO concentration was 4.4 mg/L and was taken in September of 2005. The maximum DO concentration was 12.2 mg/L and was taken in February of 2001.

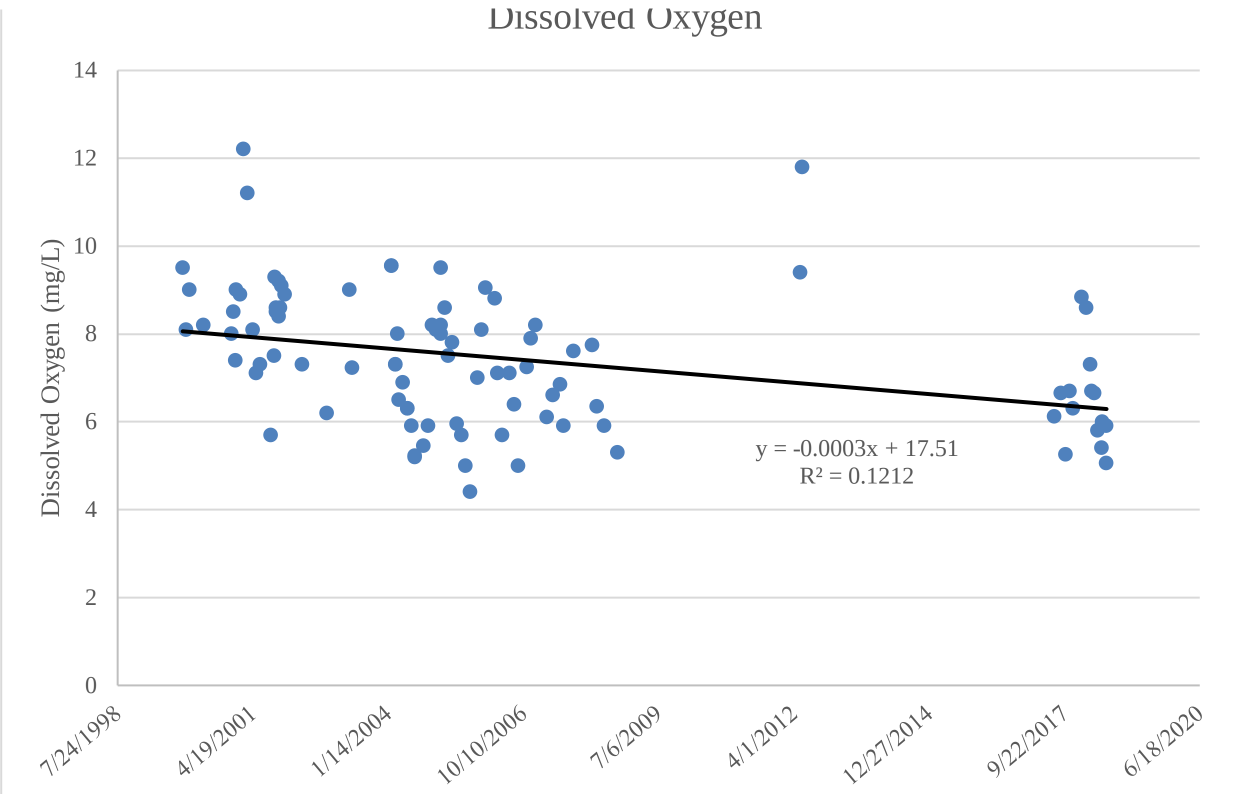

Figure 21: Dissolved oxygen at Site 80229

pH

A total of 90 pH measurements were taken at this site between 11/17/1997 and 7/30/2018. The mean pH was 7.6 and ranged from a low of 6.9 in April of 2018 to a high of 8.3 in March of 2006.

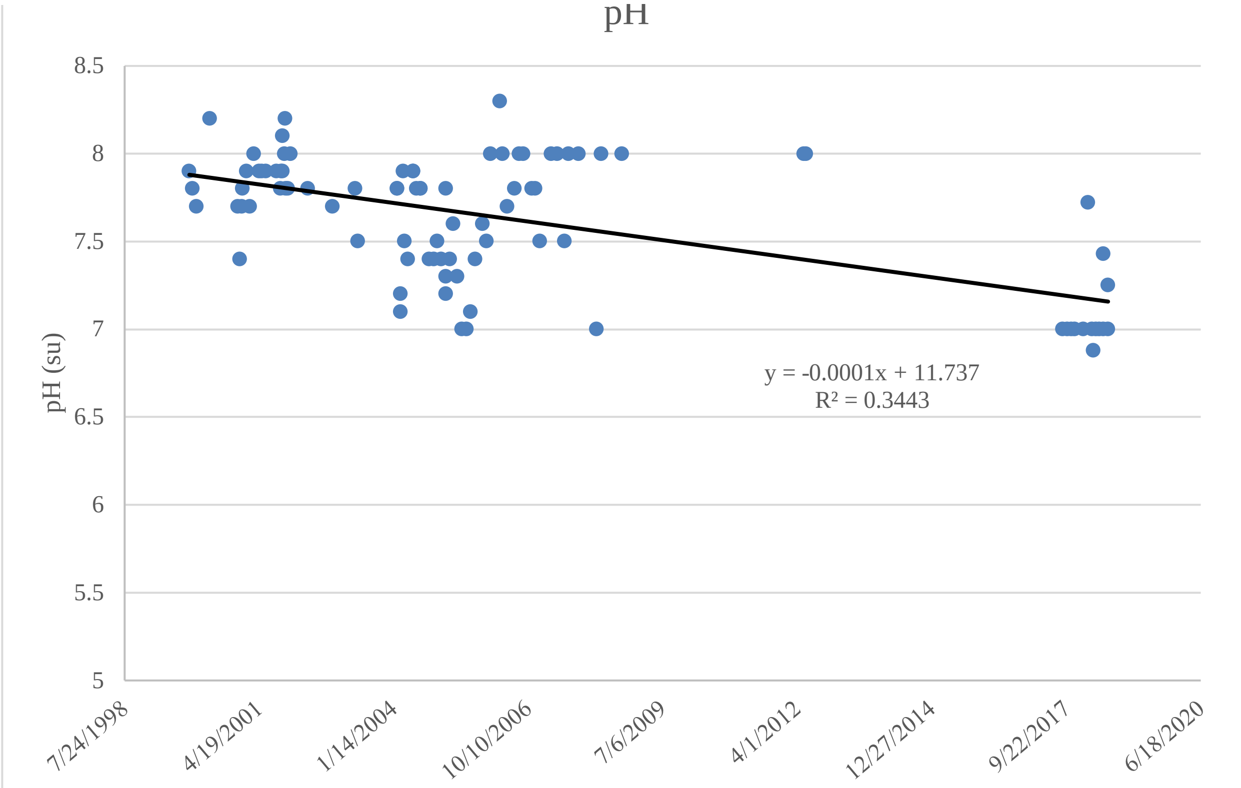

Figure 22: pH at Site 80229

E. coli

There were seven *E. coli* measurements taken at this site between 4/18/2001 and 7/30/2018. The observed geomean was 191 CFU/100mL and ranged from a low of 110 CFU/100mL in July of 2018 to a high of 500 CFU/100mL taken in March of 2018.

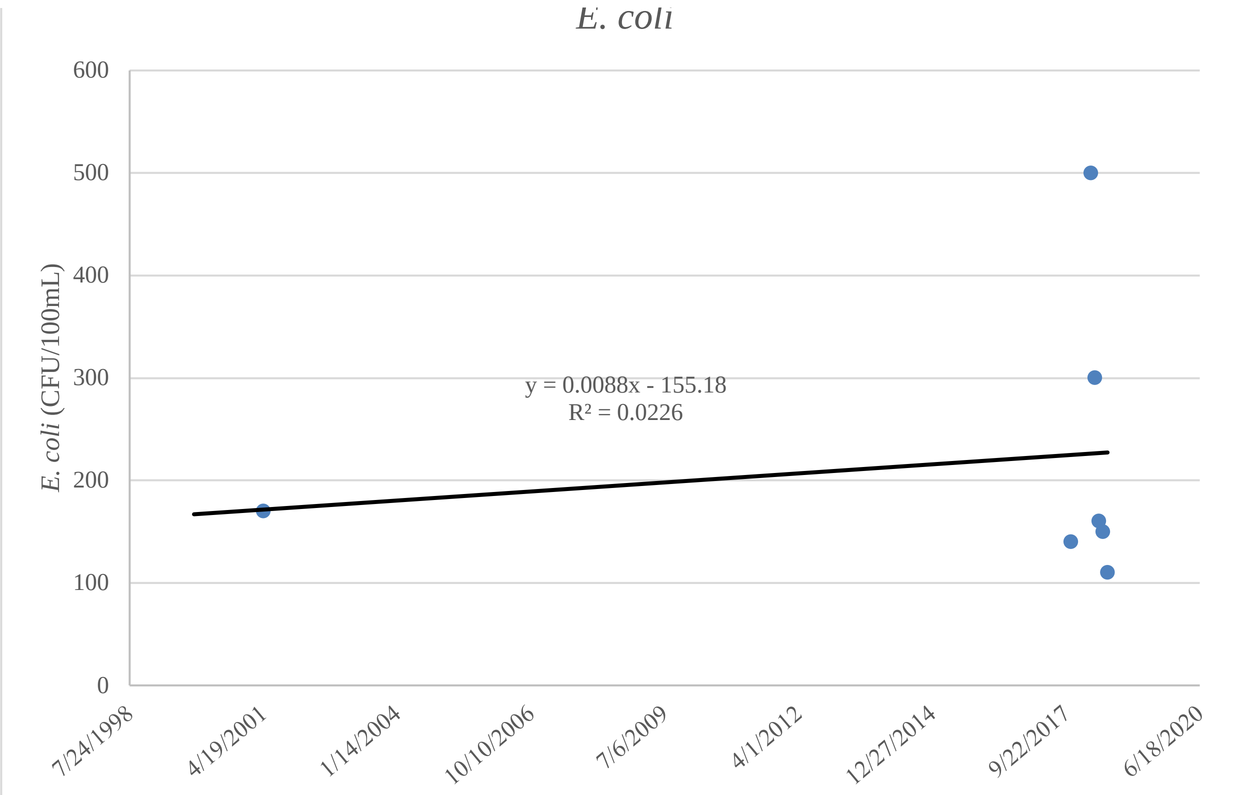

Figure 23: *E. coli* at Site 80229

Nitrate-Nitrogen

A total of 84 nitrate-nitrogen measurements were taken at this site between 11/17/1997 and 7/30/2018. The mean nitrate-nitrogen was 1.02 mg/L and ranged from a low of 1.00 mg/L on multiple instances to a high of 2.00 mg/L in March of 2018.

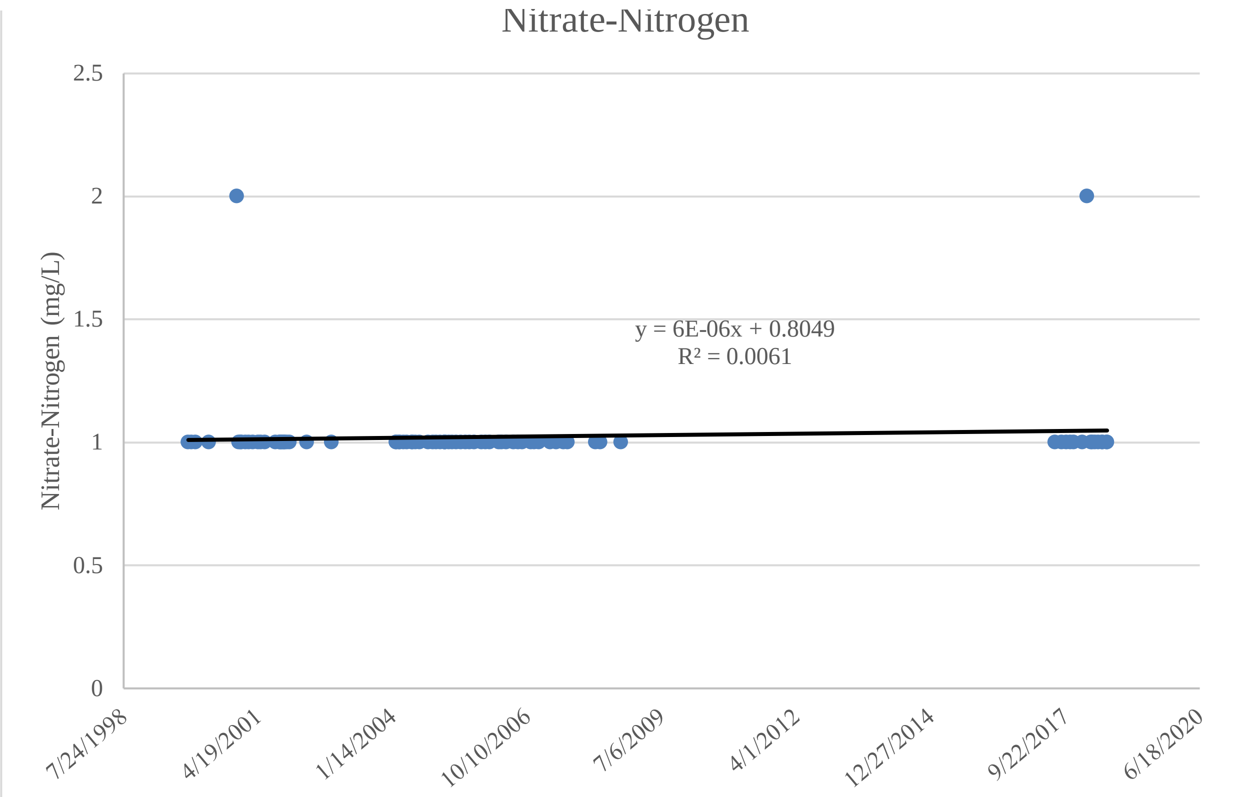

Figure 24: Nitrate-Nitrogen at Site 80229

Site 80326 – Town Lake @ West Bouldin Creek

Site Description

This site is also located within Auditorium Shores at Town Lake Metropolitan Park and exhibits the same management to the parkland that is found at Site 80229, however is immediately upstream of the Auditorium Shores Dog Park. The site is situated immediately downstream of the confluence of West Bouldin Creek and Lady Bird Lake and is about 75 meters downstream of the West Riverside Drive crossing of West Bouldin Creek, river-right.

Sampling Information

This site was sampled 72 times between 10/12/2004 and 1/24/2018. Sampling times ranged between 9:35 and 17:50. On average, this site has been monitored five times a year.

Table 9: Descriptive parameters for Site 80326

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	72	344.86 ± 55	176	436
Water Temperature (°C)	72	21.3 ± 5	11	32
Dissolved Oxygen (mg/L)	70	7.4 ± 1.8	3.2	12.4
pH (su)	70	7.5 ± 0.4	6.9	8.8
E. coli (CFU/100 mL)	2	339 ± 264	166	693
Nitrate-Nitrogen (mg/L)	68	1.13 ± 0.34	1	2

Site was sampled 72 times between 10/12/2004 and 1/24/2018.

Air and Water Temperature

Air and water temperatures were taken 72 times between 10/12/2004 and 1/24/2018. The mean water temperature was 21.5°C and ranged from a low of 11°C in February of 2005 to a high of 32°C in September of 2015. The mean air temperature was 24.5°C and ranged from a low of 5°C in November of 2010 to a high of 35°C taken in May of 2009.

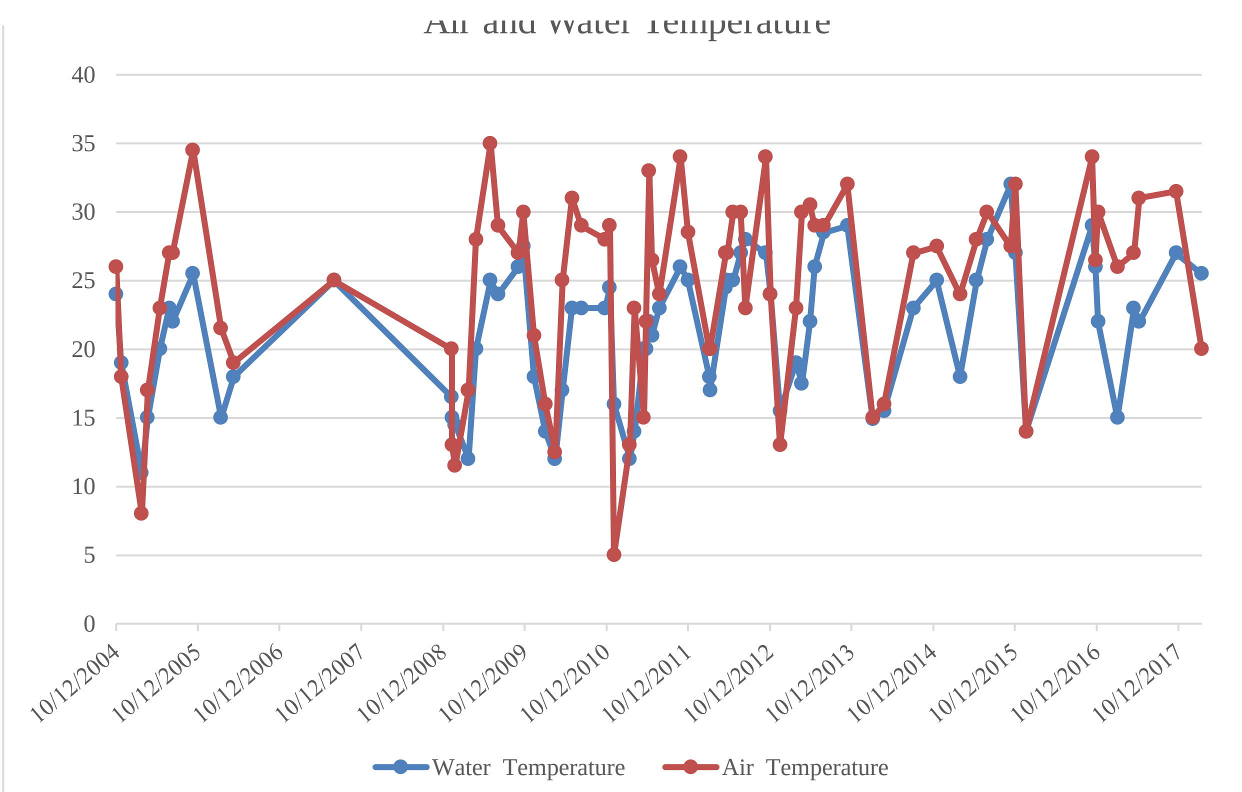

Figure 25: Air and water temperature at Site 80326

Total Dissolved Solids

Citizen scientists collected 72 TDS samples between 10/12/2004 and 1/24/2018. The mean TDS concentration was 345 mg/L and ranged from a minimum of 176 mg/L in February of 2005 to a maximum of 436 mg/L in June of 2015.

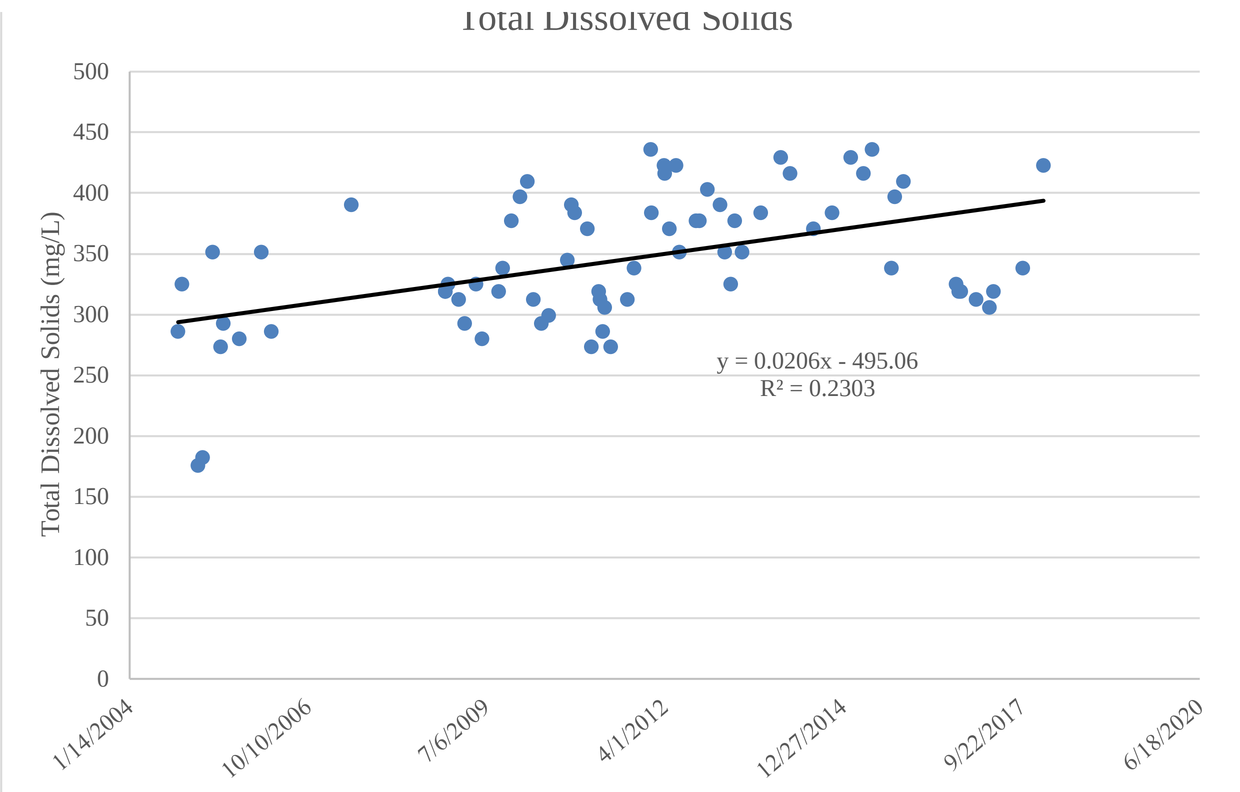

Figure 26: Total dissolved solids at Site 80326

Dissolved Oxygen

Citizen scientists collected 70 DO samples at this site between 10/12/2004 and 1/24/2018. The mean DO concentration was 7.4 mg/L. The minimum DO concentration was 3.2 mg/L and was taken in April of 2013. The maximum DO concentration was 12.6 mg/L and was taken in January of 2008.

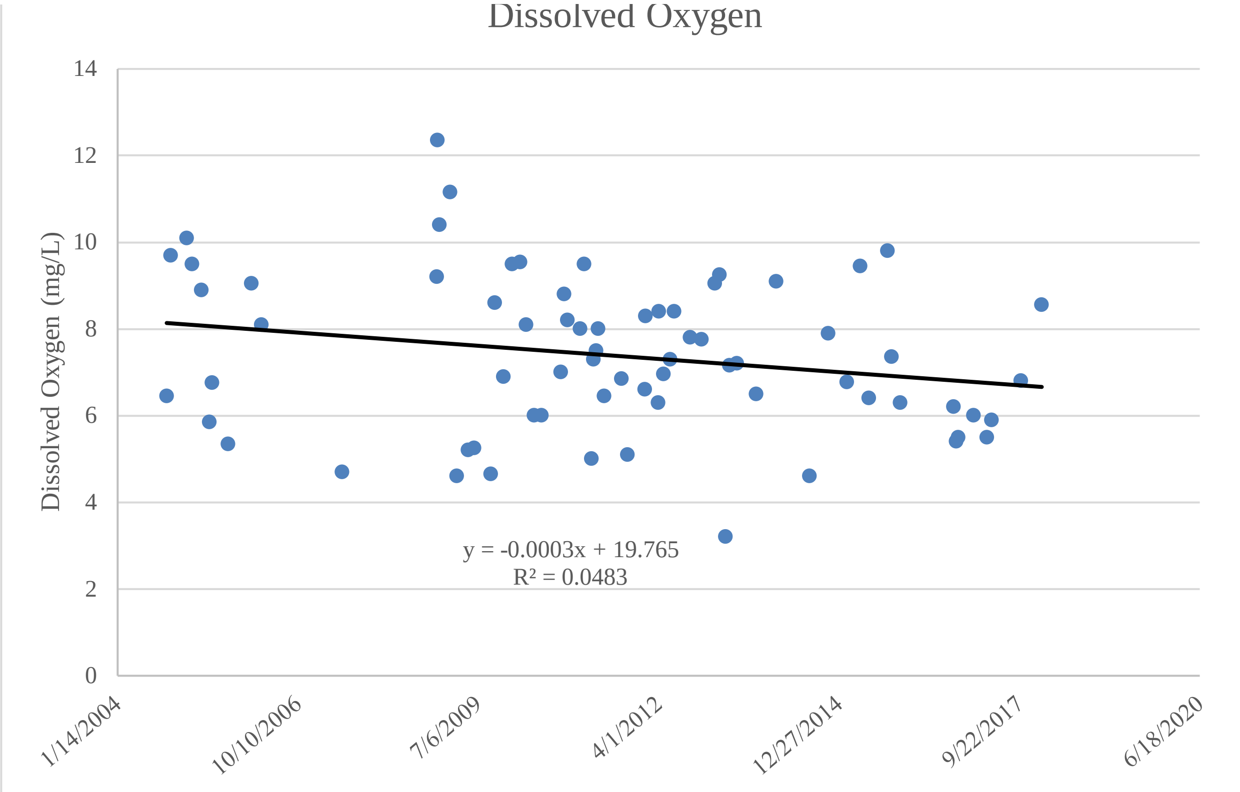

Figure 27: Dissolved oxygen at Site 80326

pH

Citizen scientists took 70 pH measurements at this site. The mean pH was 7.5 and ranged from a low of 6.0 in June of 2011 to a high of 8.8 in November of 2008.

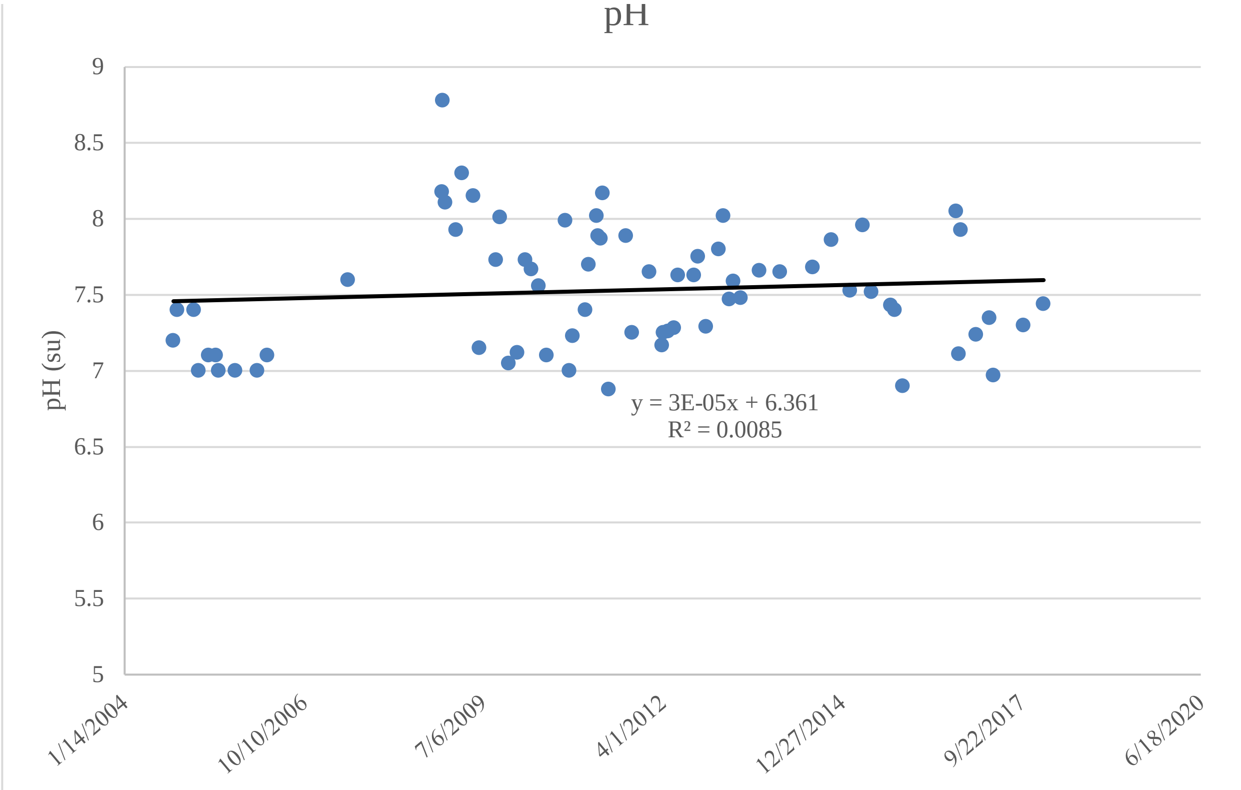

Figure 28: pH at Site 80326

E. coli

There were two *E. coli* measurements taken at this site between 2/24/2010 and 6/6/2011. The observed geomean was 339 CFU/100mL and ranged from a low of 166 CFU/100mL in February of 2010 to a high of 693 CFU/100mL taken in June of 2011.

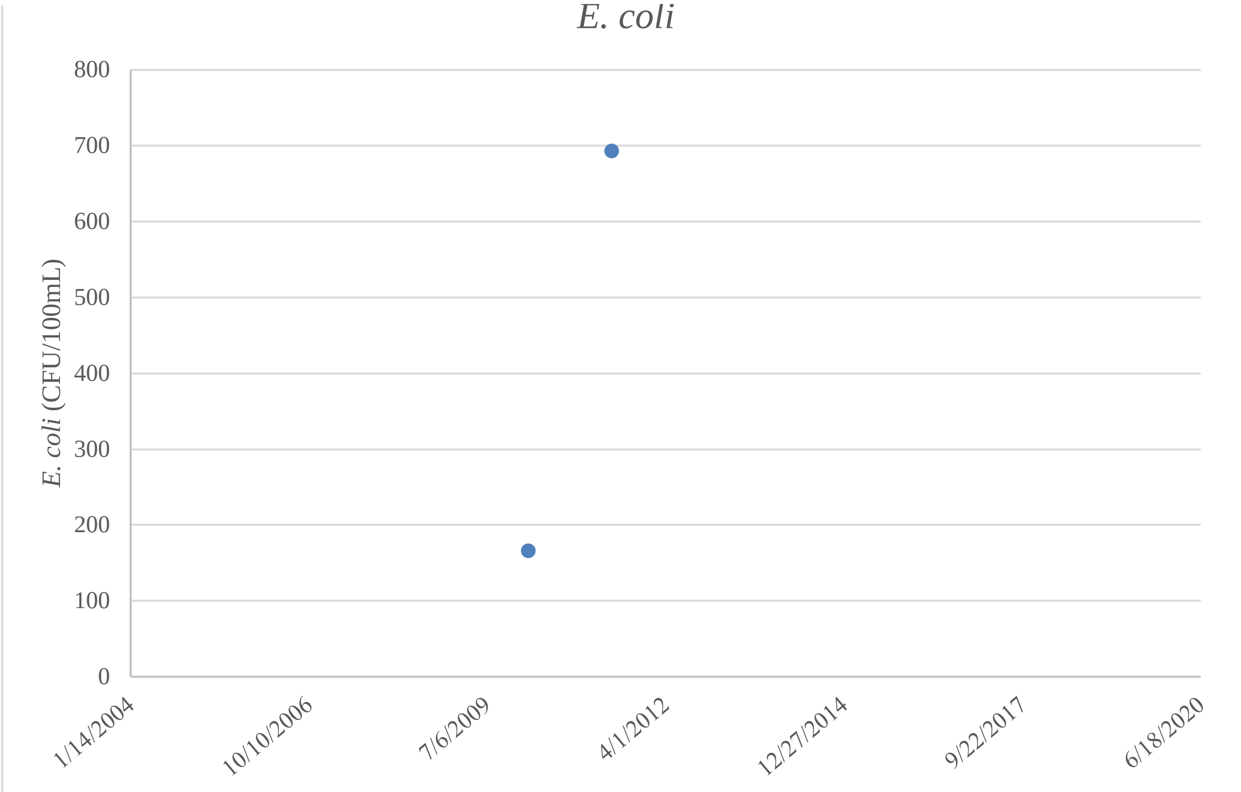

Figure 29: *E. coli* at Site 80326

Nitrate-Nitrogen

There were 68 nitrate-nitrogen measurements taken at this site between 11/4/2004 and 1/24/2018, producing a mean of 1.13 mg/L. Values ranged from a low of 1.00 mg/L on multiple instances to a high of 2.00 mg/L on multiple instances.

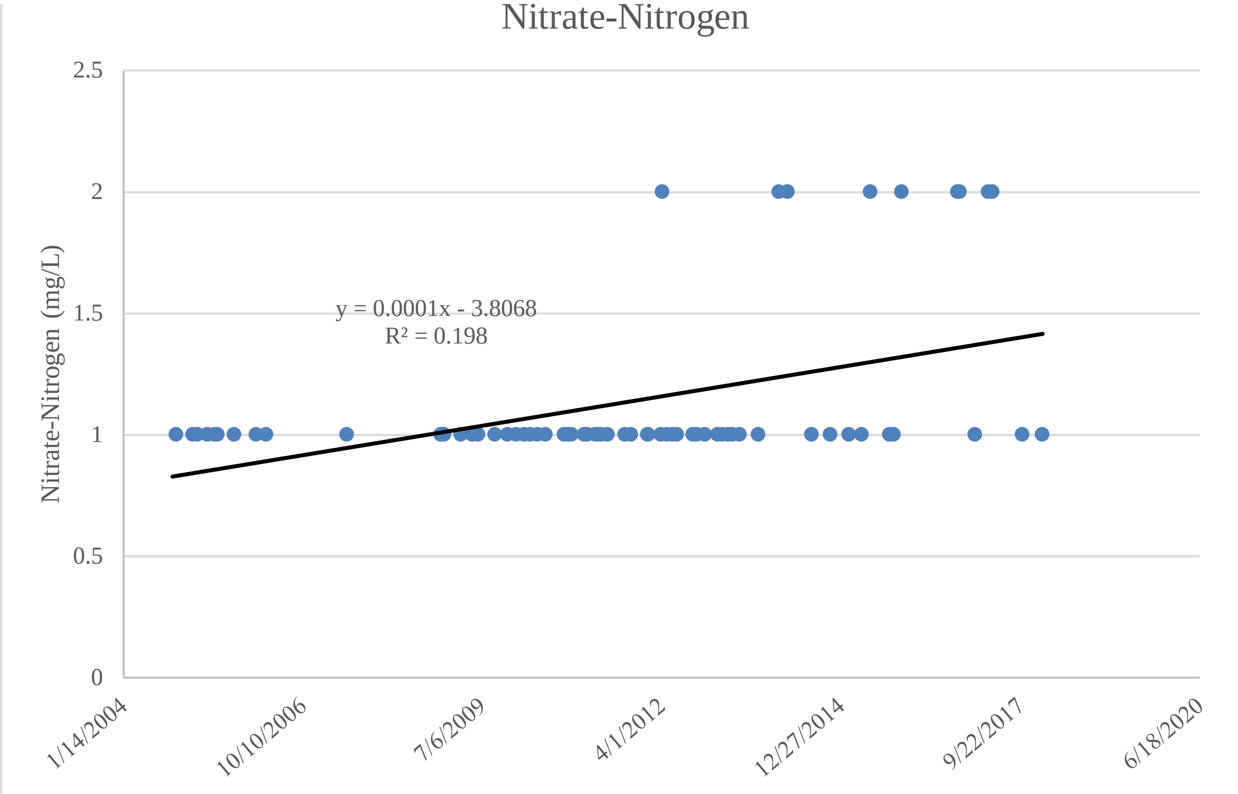

Figure 30: Nitrate-Nitrogen at Site 80326

Site 80327 – Town Lake @ Austin Youth Hostel

Site Description

This site is located at the 5-acre park, Peace Point at Lady Bird Lake Metropolitan Park and is accessible by the Ann and Roy Butler Hike and Bike Trail. The site is approximately 50 meters north of the Austin Youth Hostel located at 2200 S Lakeshore Blvd, Austin, TX 78741. The parkland here is managed very similarly to the parkland at Auditorium Shores.

Sampling Information

This site has been sampled 119 times between 10/20/2004 and 9/17/2018. Sampling times ranged between 4:56 and 17:50. On average, this site has been monitored eight times a year.

Table 10: Descriptive parameters for Site 80327

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	118	333.4 ± 60	163	537
Water Temperature (°C)	118	21.4 ± 5.4	10	32
Dissolved Oxygen (mg/L)	115	8.2 ± 1.5	4	12.3
pH (su)	115	7.7 ± 0.6	4.7	9.0
E. coli (CFU/100 ML)	1	83 ± 0	83	83
Nitrate-Nitrogen (mg/L)	112	1.13 ± 0.33	1	2

Site was sampled 119 times between 10/20/2004 and 9/17/2018.

Air and Water Temperature

Air and water temperatures were taken 118 times at this site. The mean water temperature was 21.4°C, varying from a low of 10°C in February of 2011 to a high of 32°C in August of 2015. The mean air temperature was 24.4 and varied from a low of 8°C in January of 2007 and December of 2009, to a high of 37°C in July of 2016.

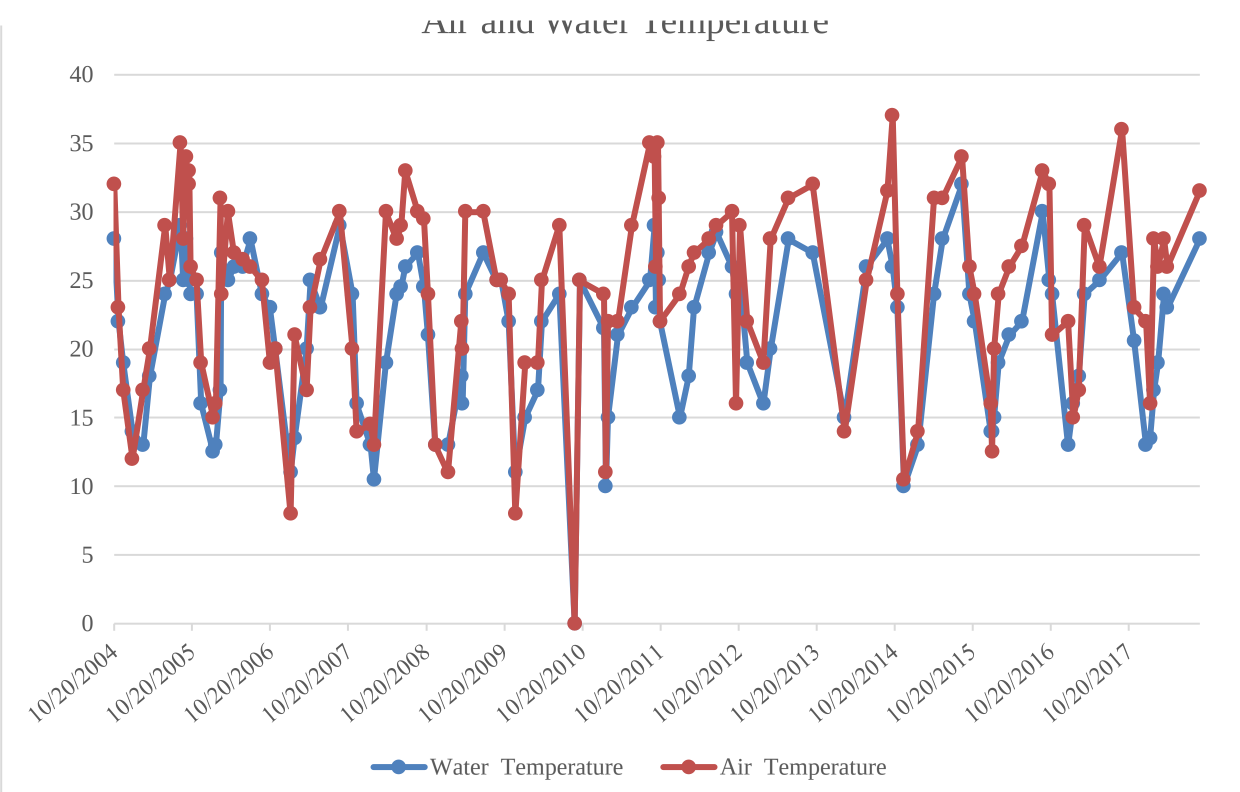

Figure 31: Air and water temperature at Site 80327

Total Dissolved Solids

Citizen scientists collected 118 TDS samples at this site between 10/20/2004 and 9/17/2018. The mean TDS concentration was 333 mg/L at this site. The minimum TDS concentration was 163 mg/L and was taken in January of 2005. The maximum TDS concentration was 537 mg/L taken in October of 2016.

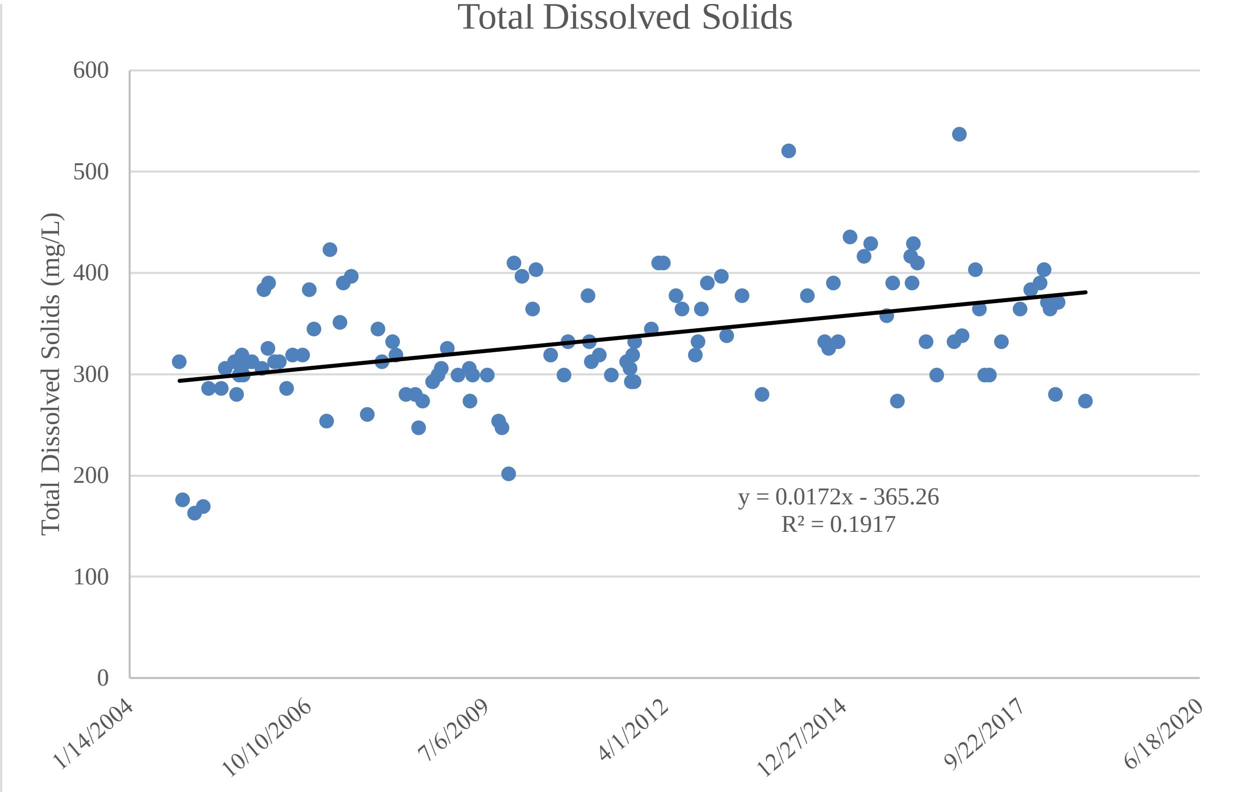

Figure 32: Total dissolved solids at Site 80327

Dissolved Oxygen

Citizen scientists collected 115 DO samples at this site between 10/20/2004 and 9/17/2018. The mean DO concentration was 8.2 mg/L. The minimum DO concentration was 4.0 mg/L and was recorded in September of 2009. The maximum DO concentration was 12.3 mg/L and was recorded in May of 2006.

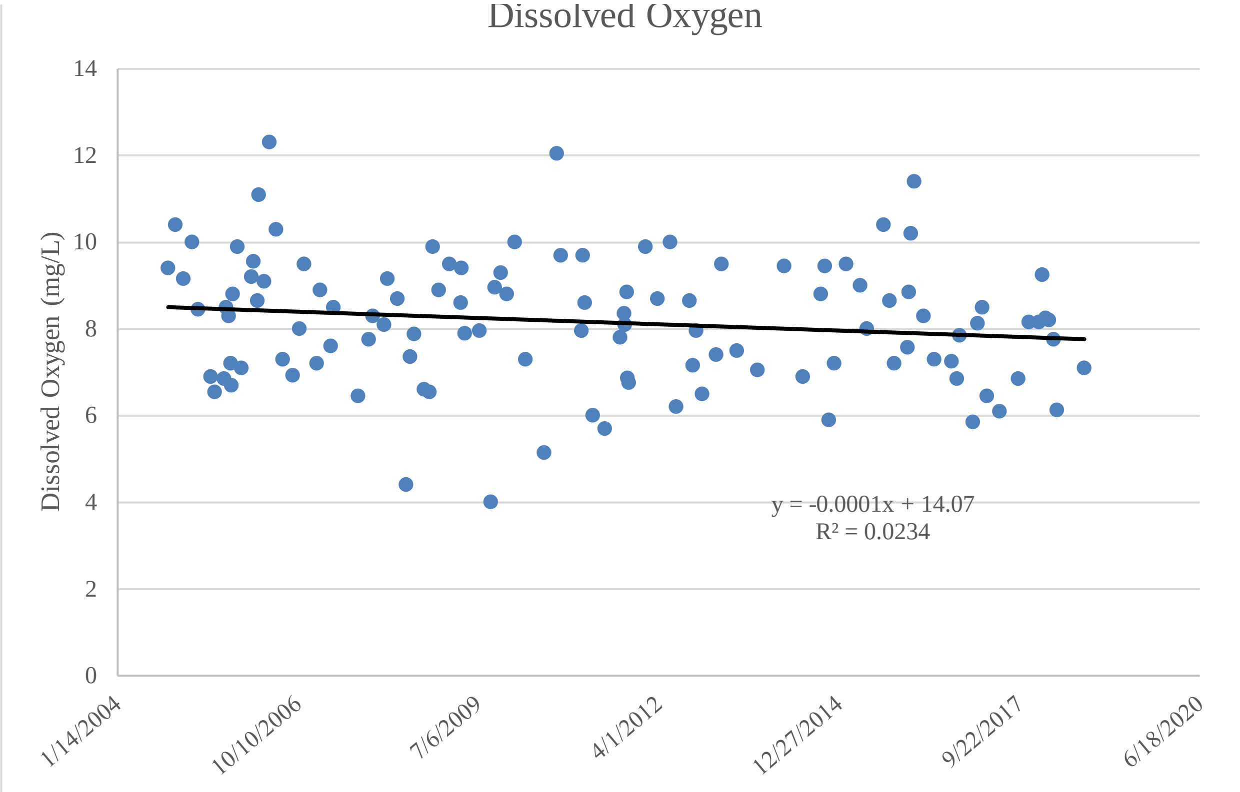

Figure 33: Dissolved oxygen at Site 80327

pH

Citizen scientists took 115 pH measurements at this site. The mean pH was 7.7 and it ranged from a low of 4.0 in October of 2016, to a high of 9.0 in February of 2014.

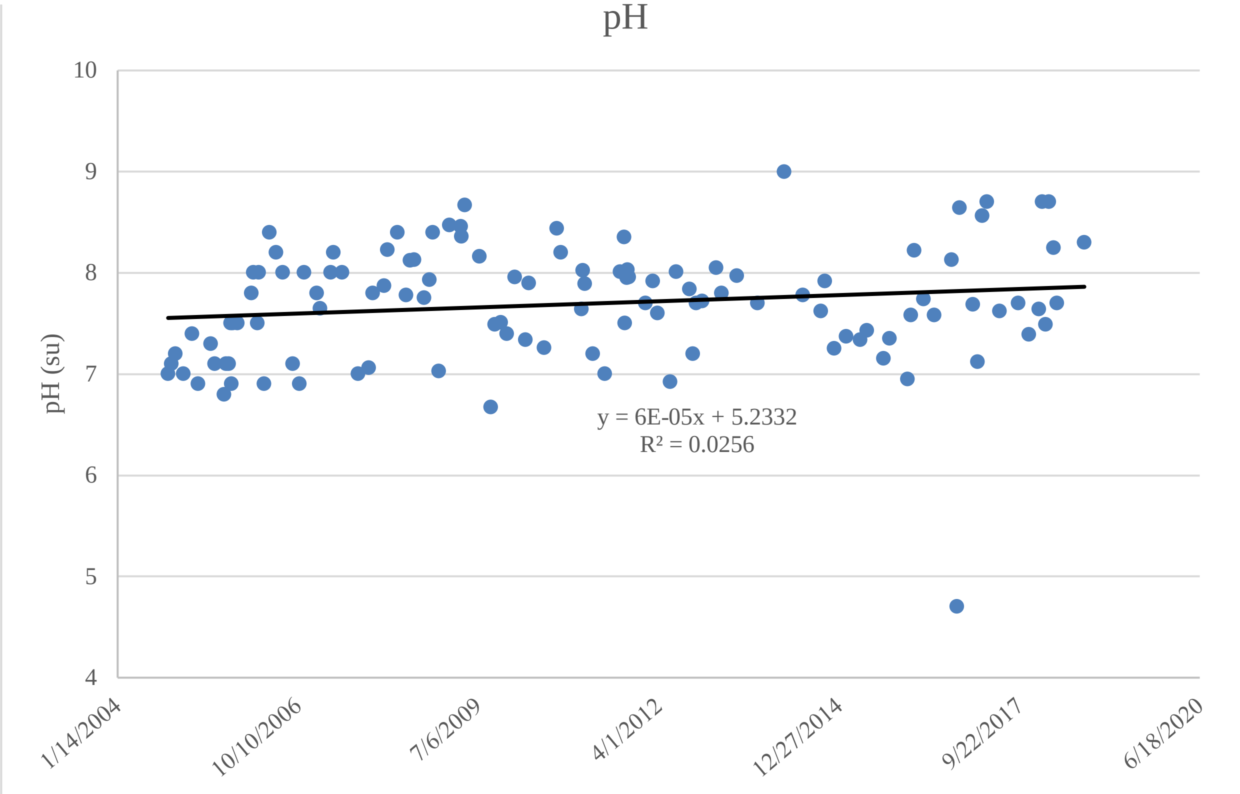

Figure 34: pH at Site 80327

E. coli

There was one *E. coli* measurement taken at this site on 9/12/2016 with a result of 83 CFU/100mL.

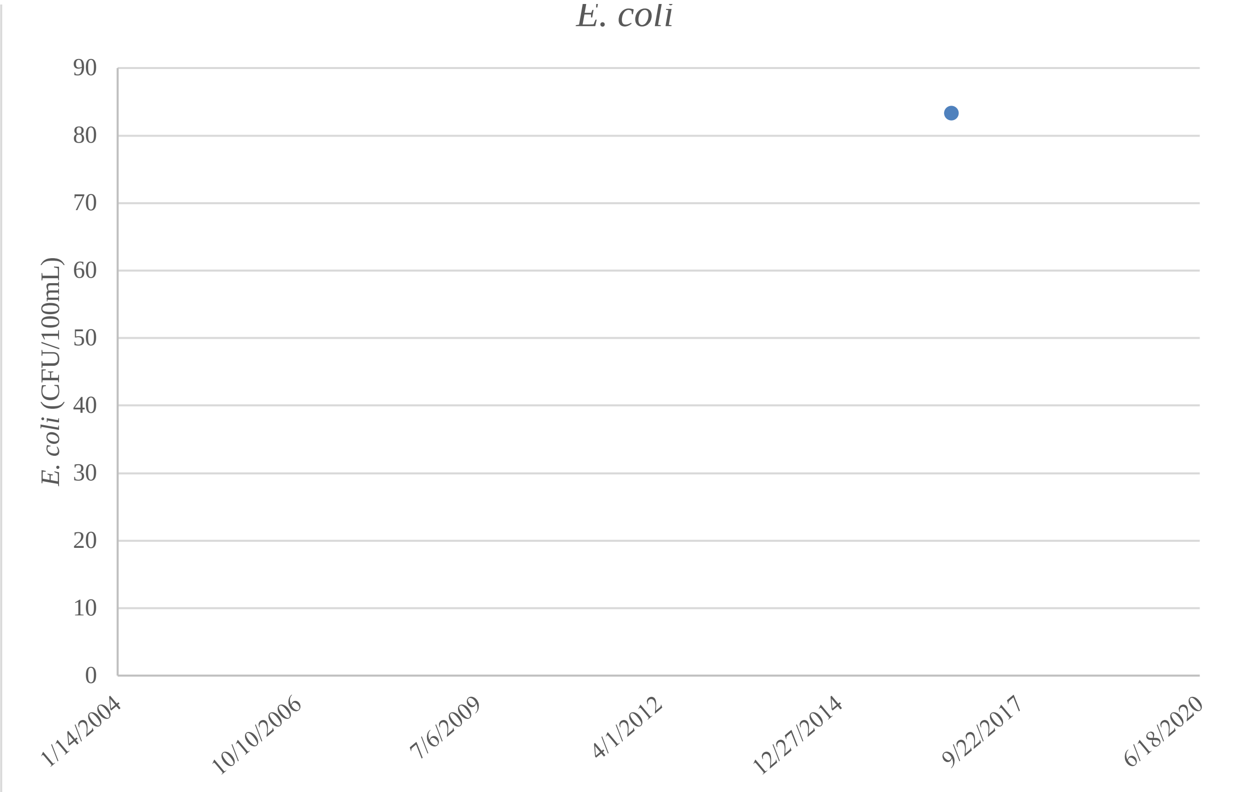

Figure 35: *E. coli* at Site 80327

Nitrate-Nitrogen

Citizen scientists collected 112 nitrate-nitrogen samples at this site between 10/20/2004 and 9/17/2018. The mean nitrate-nitrogen was 1.13 mg/L and ranged from a low of 1.00 mg/L on multiple instances to a high of 2.00 mg/L on multiple instances.

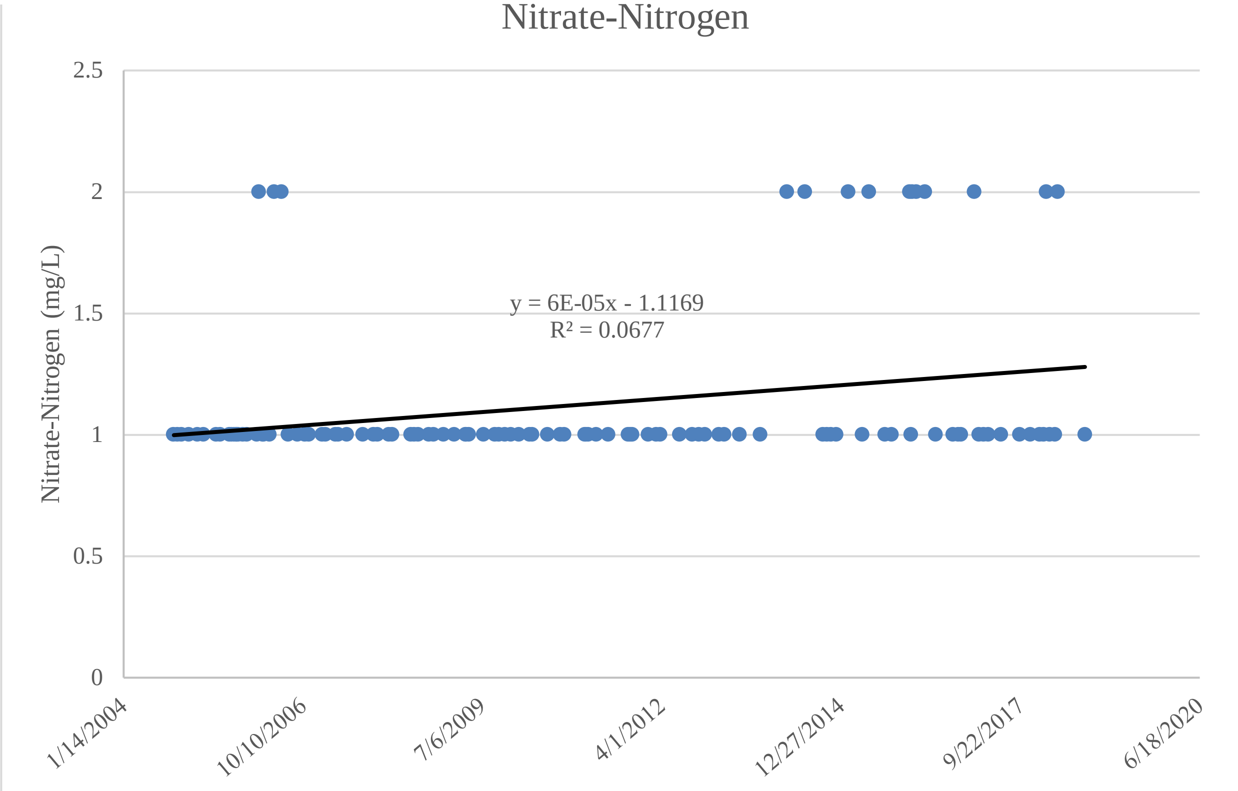

Figure 36: Nitrate-Nitrogen at Site 80327

Site 14072 – Town Lake @ 2.5 Mile Marker

Site Description

This site is located at the North Shore Overlook of Lady Bird Lake, on the 2.5-mile marker of the Ann and Roy Butler Hike and Bike Trail. This marker is located approximately 150 meters downstream of the Texas Rowing Center and is approximately 180 meters upstream of the Austin High Boat Launch. Access is gained through the Hike and Bike Trail. A no-mow "Grow Zone" is maintained throughout the riparian area, and much of the immediate bank is lined with bald cypress trees. The uplands within the vicinity are urbanized retail and commercial areas and some high-density residential areas. Austin High School is adjacent to the parkland surrounding North Shore Overlook and the monitoring site.

Sampling Information

This site has been sampled 120 times between 10/14/2004 and 8/1/2018. Monitoring at this location took place between 08:55 and 17:45. Near-consistent monthly monitoring occurred at this site from 2005 to 2013.

Table 11: Descriptive parameters for Site 14072

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	115	330 ± 51	156	468
Water Temperature (°C)	119	21.2 ± 4.4	12	30
Dissolved Oxygen (mg/L)	112	7.5 ± 1.7	3.8	16.6
pH (su)	112	7.7 ± 0.4	6.8	8.4
E. coli (CFU/100 ML)	0	N/A	N/A	N/A
Nitrate-Nitrogen (mg/L)	118	1.08 ± 0.27	1	2

Site was sampled 120 times between 10/14/2004 and 8/1/2018.

Air and Water Temperature

There were 119 air and water temperatures taken at this site. The mean water temperature was 21.2°C. Water temperature varied from a low of 12°C in January of 2007, and a high of 30°C in June of 2011. The air temperature ranged from a low of 10°C in January of 2005 to a high of 38°C in September of 2015.

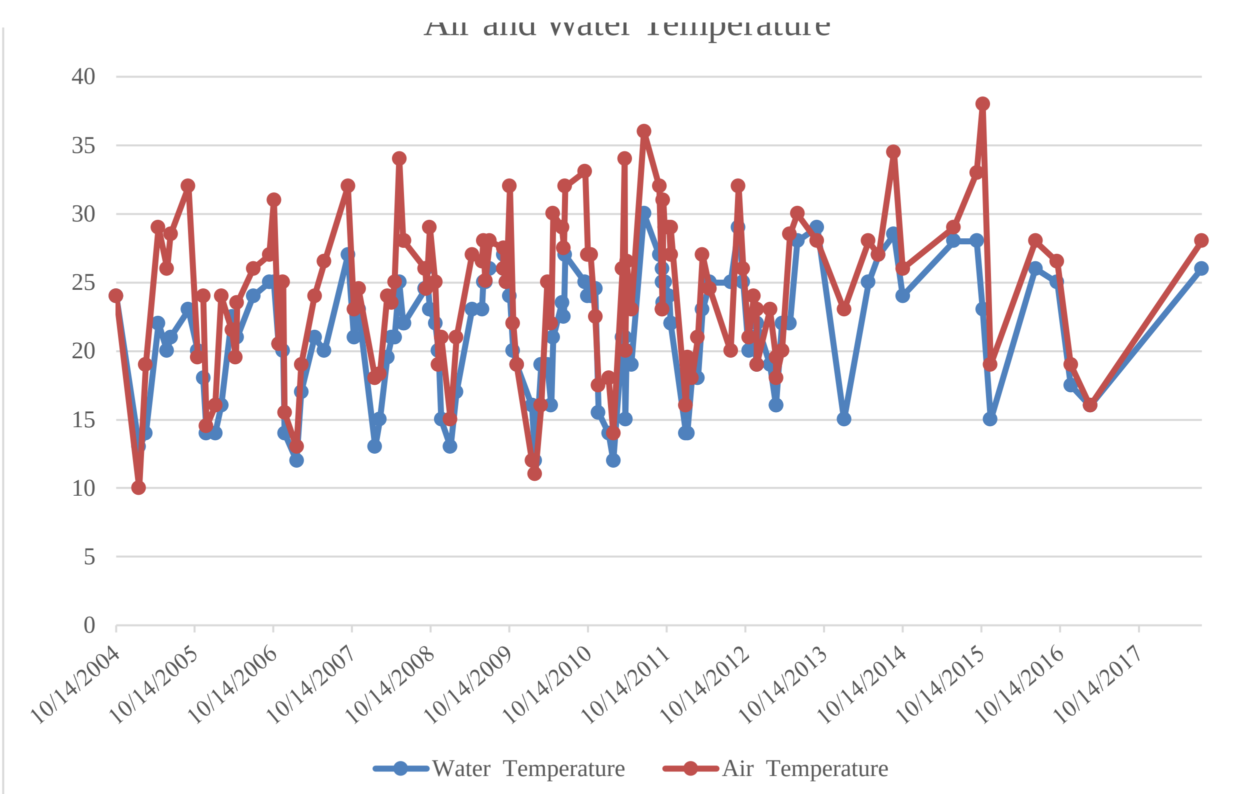

Figure 37: Air and water temperature at Site 14072

Total Dissolved Solids

Citizen scientists took 115 TDS samples at this site. The mean TDS concentration was 329.8 mg/L. The minimum TDS concentration of 156 mg/L was recorded in February of 2005. The maximum TDS concentration was recorded in November of 2015 and was 468 mg/L.

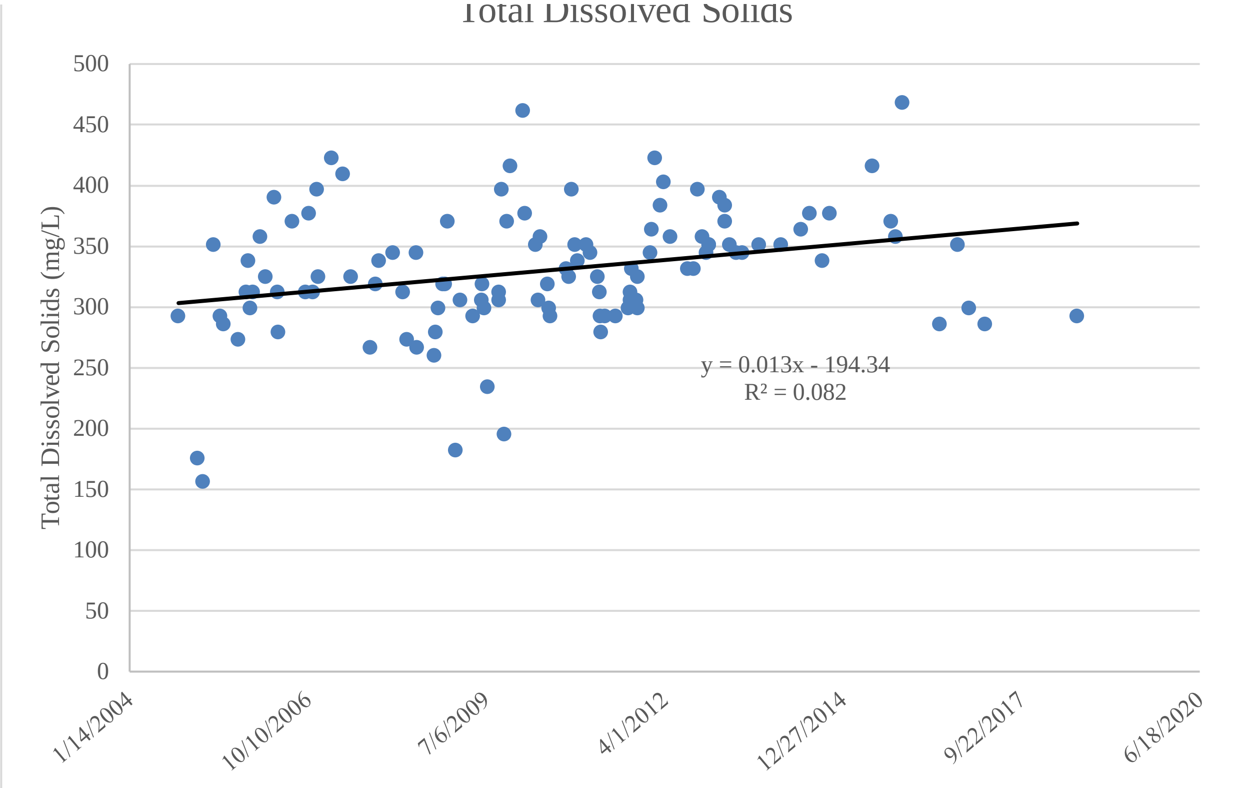

Figure 38: Total dissolved solids at Site 14072

Dissolved Oxygen

Citizen scientists collected 112 DO samples at this site between 10/14/2004 and 8/1/2018. The mean DO concentration was 7.5 mg/L. The DO concentration varied from a low of 3.8 mg/L in June of 2016, to a high of 16.6 mg/L in January of 2009.

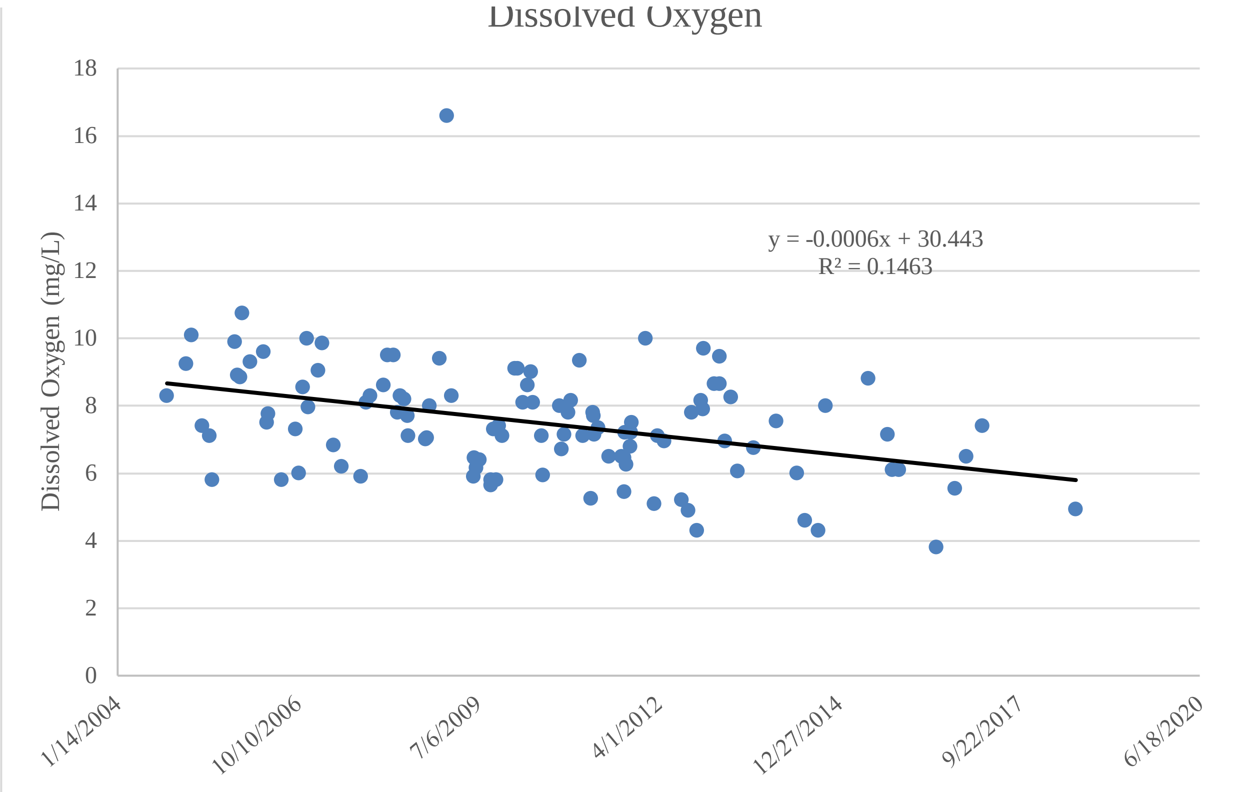

Figure 39: Dissolved oxygen at Site 14072

pH

A total of 112 pH measurements were taken at this site. The mean pH was 7.7 and it ranged from a high of 8.4 in February of 2009, to a low of 6.9 in October of 2012

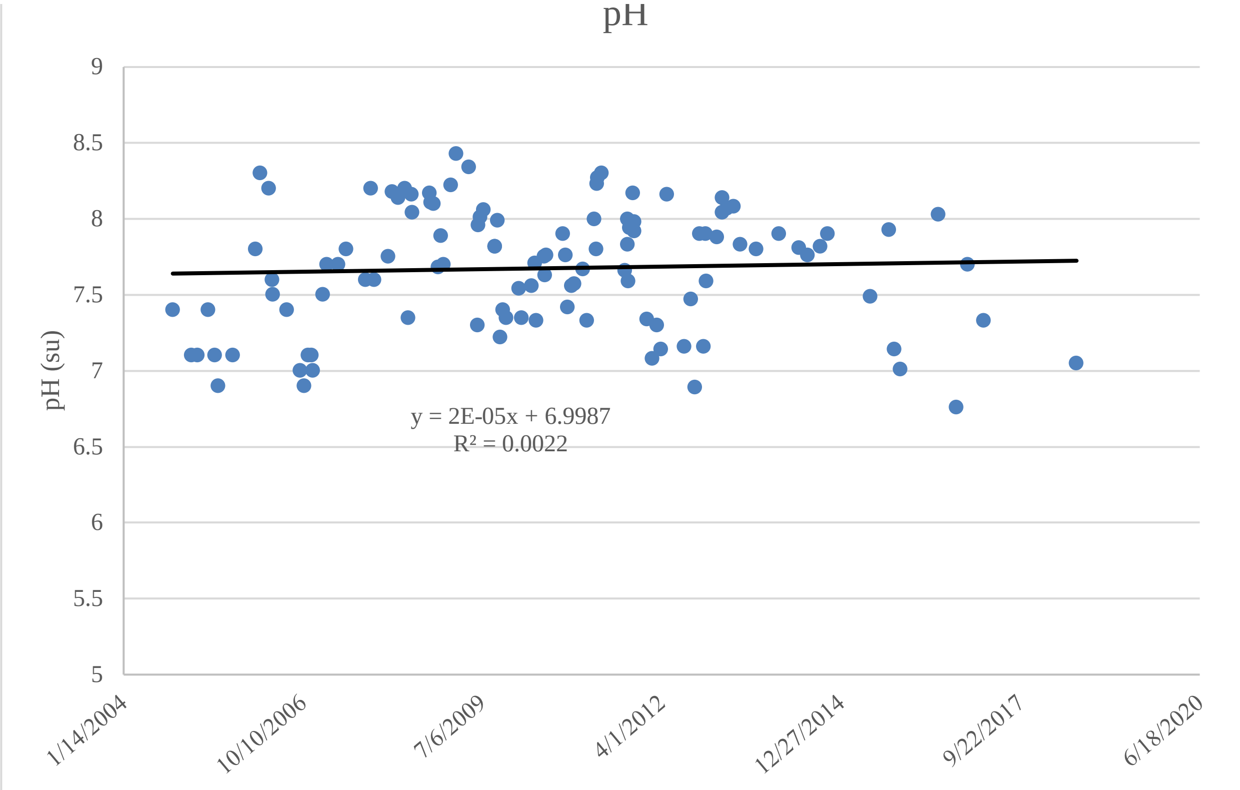

Figure 40: pH at Site 14072

Nitrate-Nitrogen

There were 118 nitrate-nitrogen measurements taken at this site between 10/14/2004 and 8/1/2018, producing a mean of 1.08 mg/L. Values ranged from a low of 1.00 mg/L on multiple instances to a high of 2.00 mg/L on multiple instances.

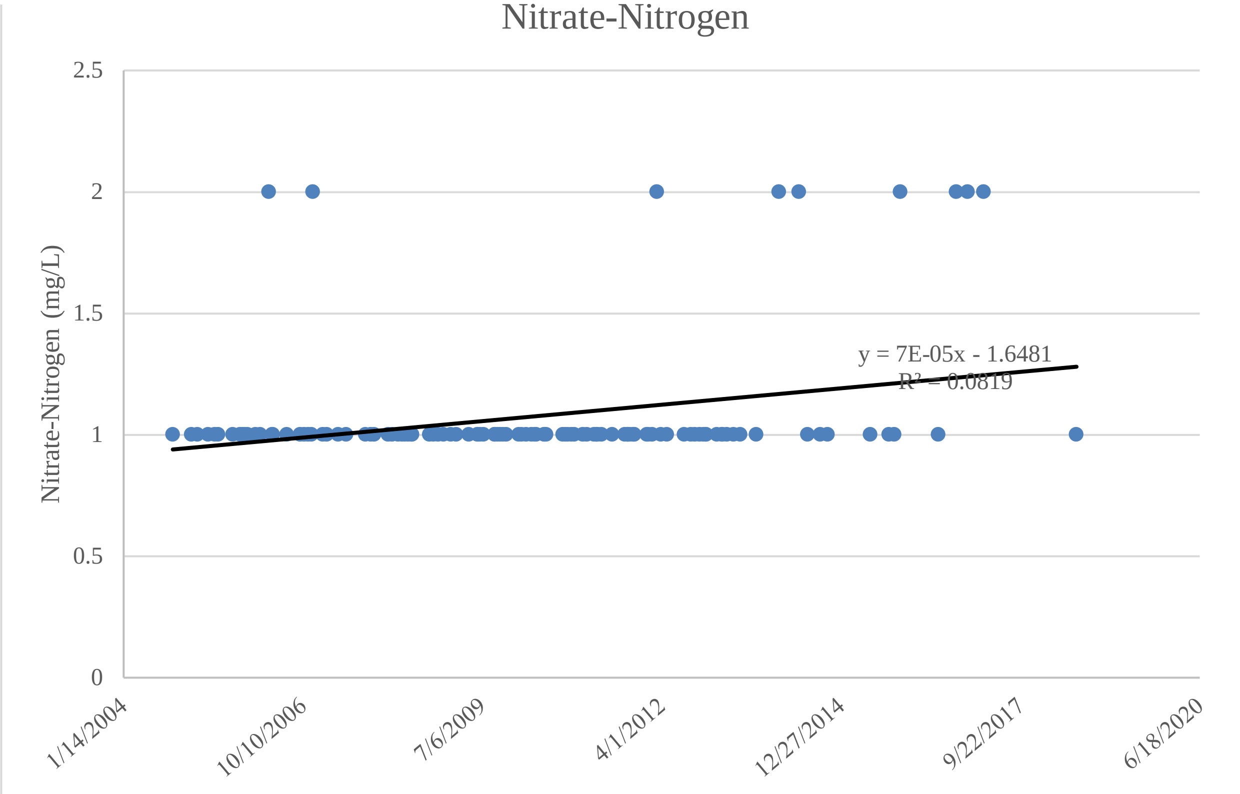

Figure 41: Nitrate-Nitrogen at Site 14072

LADY BIRD LAKE WATERSHED SUMMARY

CRWN citizen scientists monitored several water quality parameters from five different sites in the Lady Bird Lake watershed from 1996 to 2018, including TDS, DO, pH levels, *E. coli*, and nitrate-nitrogen. Data from the five monitoring sites was analyzed to find trends over the monitoring periods. There were a few sampling events at Sites 80299 and 80326 with elevated *E. coli* levels reported above the standard for a single sample and both sites failed to stay below the TCEQ standard for the geometric mean. Sites 14072 and 80327 both had a geometric mean which satisfied the TCEQ surface water quality standard and failed to yield measurements above 394 CFU/100 mL. The highest *E. coli* quantities are within the most downstream reaches of Lady Bird Lake. Water temperatures throughout the monitoring period only surpassed the TCEQ standard of 32°C once, in October 2006. Suppressed levels of DO failing to meet the TCEQ standard of 4.0 mg/L only occurred four times within the monitoring period at sites 80326, 15955, and 14072. The LCRA CRWN citizen scientist monitoring group will continue to monitor the water quality of the Lady Bird Lake watershed. LCRA will continue to support existing CRWN 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 monitoring sites and re-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 Clean Rivers Program partner for your river basin at: https://www.tceq.texas.gov/waterquality/clean-rivers/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