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Introduction

Texas Stream Team is a citizen science based 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.

Texas Stream Team citizen scientist data are not used by the state to assess whether water bodies are meeting the designated surface water quality standards. Texas Stream Team citizen scientists use different methods than the professional water quality monitoring community. These methods are utilized by Texas Stream Team due to higher equipment costs, training requirements, and stringent laboratory procedures that are required of the professional community. As a result, Texas Stream Team data do not have the same accuracy or precision as professional data, and is not directly comparable. However, the data collected by Texas Stream Team provides valuable records, often collected in portions of a water body that professionals are not able to monitor at all, or monitor as frequently. 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 Volunteer Water Quality Monitoring Manual
- Texas Commission on Environmental Quality (TCEQ) Surface Water Quality Monitoring Procedures

The information that Texas Stream Team 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 the Texas Stream Team 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 Texas Stream Team 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 partner reports, such as Basin Summary Reports and Highlight Reports
- TCEQ Total Maximum Daily Load reports
- TCEQ and Texas State Soil and Water Conservation Board Nonpoint Source Program funded reports, including Watershed Protection Plans
Questions regarding this watershed data report should be directed to the Texas Stream Team at (512) 245-1346.

Watershed Location and Physical Description

Location and Climate
The San Marcos River is divided into upper and lower segments. The Upper San Marcos River segment (Segment 1814) is 4.5 miles long and extends from its headwaters at San Marcos Springs in San Marcos, Texas to its confluence with the Blanco River (Guadalupe-Blanco River Authority). The upper San Marcos River is a tributary of the Guadalupe River (Edwards Aquifer). San Marcos has a mean annual rainfall of 33.75 inches and water temperatures averaging about 22°C (Edwards Aquifer). The southern San Antonio segment of the Edwards Aquifer underlies San Marcos Springs and the Upper San Marcos River (Hays County Commissioners’ Court, Edwards Aquifer). This area of Hays County is also a part of the Blackland Prairies Ecoregion (Cecil and Greene). The Blackland Prairies region consists of perennial and annual grasses and is dominated by oak, hackberry, pecan, and elm trees (Texas A&M University). The Blackland Prairies are characterized by a lower layer of white chalky limestone, shale, and marlstone that is covered by a dark alkaline clay soil interspersed with sandy loam. This region is mostly level and has rapid surface drainage (Texas Parks and Wildlife “Blackland Prairie Ecological Region”; Native Prairies Association of Texas).

Figure 1: Map of the Upper San Marcos Watershed with Texas Stream Team Monitor Sites
Physical Description
The Upper San Marcos River has an average width of 30 feet and a mean sea level of 574 feet mean sea level (Texas Parks and Wildlife “An Analysis of Texas Waterways”; Edwards Aquifer). The river is known for its high clarity, relatively constant flow rates and temperatures (Saunders et al. August 2001). For these reasons it is a very popular source for water recreation activities including: swimming, tubing, boating, canoeing, kayaking, golfing, snorkeling, SCUBA diving, and fishing (Edwards Aquifer). Catfish, bass, crappie, and sunfish also allow for sport fishing (Saunders et al. August 2001). Including these fish, the river is home to 56 fish species, including 44 native species, as well as 8 endangered wildlife species (Saunders et al. 2001). Some of the endangered species are the San Marcos Gambusia (Gambusia georgei), the fountain darter (Etheostoma fonticola), the San Marcos Salamander (Eurycea nana), and Texas Wild Rice (Saunders et al. August 2001; Edwards Aquifer). Due to the river’s high biodiversity and presence of a number of endemic and endangered species, the U.S. Fish & Wildlife Department and Texas Parks and Wildlife have designated the San Marcos Springs and Spring Lake as critical habitat (Meadows Center for Water and the Environment).

Land Use
There are some point and non-point pollution sources associated with land use and river use that can affect the Upper San Marcos’s water quality. For example, the majority of Eastern Hays County, where the Upper San Marcos River is located, has been converted to cropland, non-native pasture, and urban land (Hays County Commissioner’s Court). Furthermore, the City of San Marcos operates a wastewater treatment plant that discharges into the Upper San Marcos River and the A.E. Wood Fish Hatchery operated by Texas Parks and Wildlife Department operates on the river as well (Guadalupe-Blanco River Authority). However, both of these operations must follow specific limits and guidelines about acceptable discharge outlined in point-source pollution permits (Guadalupe-Blanco River Authority).

Habitat Conservation Plan
In addition to its critical habitat designation, the City of San Marcos participates in the Edwards Aquifer Habitat Conservation Plan (EAHCP) and Hays County Habitat Conservation Plan (HCHCP) (Saunders et al. August 2001; City of San Marcos Texas). The EAHCP involves several components in San Marcos including: bank stabilization, constructing river access areas, planting native trees and shrubs along the river, and invasive species removal (City of San Marcos Texas). The HCHCP will help provide adequate habitat for the endangered golden-cheeked warbler (Dendroica chrysoparia) and the black-capped vireo (Vireo atricapilla) as well as protect the surrounding areas that drain into the Edwards Aquifer and San Marcos River to help preserve water quality and quantity (Hays County Commissioners’ Court).

History
San Marcos Springs is the second largest spring in Texas and has never ceased flowing within its recorded history, giving it the most constant discharge of any spring system in the United States (Saunders et al. August 2001; Cecil and Greene). Due to its constant flow, endemic species that live in this ecosystem can be particularly vulnerable to changes in flow rate (Saunders et al. August 2001). San Marcos Springs and the surrounding areas have been inhabited since about 9500 B.C.E., determined by an archaeological dig that discovered mastodon bones and points from Clovis Paleo-Indians in the area (Saunders et al. August 2001; Hendricks and Greene). Throughout its history, San Marcos and the San Marcos River were the sites of Spanish colonization efforts, beginning in 1755 up until 1812 (Hendricks and Greene). In 1848, the
Texas Legislature Organized Hays County and designated San Marcos the county seat (Hendricks and Greene). Further developments after the city’s establishment led to the construction of the Spring Lake Dam in 1849 to run a mill for irrigation (Saunders et al. August 2001). Beginning in the 1960s with the establishment of Aquarena Springs, the Upper San Marcos River gained a reputation for its water and recreational attractions, which it is still known for today (Hendricks and Greene).

**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 Dissolved Oxygen (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.

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 micro Siemens per cubic centimeter (µS/cm³). A body of water is more conductive if it has more dissolved
solids 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 Total Dissolved Solids (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 sediments runoff into the water. Turbid waters can results 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.

**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.. 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 Upper San Marcos River is 126 CFU/100 mL. A water body is considered impaired if the geometric mean is higher than this standard.
**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 Texas Stream Team 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 Texas Stream Team’s approved Quality Assurance Project Plan (QAPP).

**Table 1: Sample Storage, Preservation, and Handling Requirements**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Matrix</th>
<th>Container</th>
<th>Sample Volume</th>
<th>Preservation</th>
<th>Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em></td>
<td>Water</td>
<td>Sterile Polystyrene (SPS)</td>
<td>100 mL</td>
<td>Refrigerate at 4°C*</td>
<td>6 hours</td>
</tr>
<tr>
<td>Nitrate/Nitrogen</td>
<td>Water</td>
<td>Plastic Test Tube</td>
<td>10 mL</td>
<td>Refrigerate at 4°C*</td>
<td>48 hours</td>
</tr>
<tr>
<td>Orthophosphate/Phosphorous</td>
<td>Water</td>
<td>Glass Mixing Bottle</td>
<td>25 mL</td>
<td>Refrigerate at 4°C*</td>
<td>48 hours</td>
</tr>
<tr>
<td>Chemical Turbidity</td>
<td>Water</td>
<td>Plastic Turbidity Column</td>
<td>50 mL</td>
<td>Refrigerate at 4°C*</td>
<td>48 hours</td>
</tr>
</tbody>
</table>

*Preservation performed within 15 minutes of collection.

**Processes to Prevent Contamination**

Procedures documented in Texas Stream Team 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 (QC) 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 Texas Stream Team.

Sampling is still encouraged with expired reagents and bacteria media; however, the corresponding values will be flagged in the database. Detailed observational data are 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 monitors collect field data and report the measurement results on Texas Stream Team approved physical or electronic datasheet. The physical data sheet is submitted to the Texas Stream Team and local partner, if applicable. The electronic datasheet is accessible in the online DataView and, upon submission and verification, is uploaded directly to the Texas Stream Team Database.

Quality Assurance & Quality Control

All data are 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 Texas Stream Team 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 are verified and evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Potential errors are identified by examination of documentation and by manual and computer-assisted examination of corollary or unreasonable data. Issues that can be corrected are corrected and documented. 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 Texas Stream Team 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 Texas Stream Team Program Manager. If repeated errors occur, the monitor and/or the group leader will be notified via e-mail or telephone.

Data Analysis Methods

Data are 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 are 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 & Exceedances

The TCEQ determines a water body to be impaired if more than 10% 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 2010 Texas Surface Water Quality Standards report was used to calculate the exceedances for the Upper San Marcos Watershed, as seen below in Table 2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2010 Texas Surface Water Quality Standards for the Upper San Marcos River</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Temperature (°C)</td>
<td>26.7° C (Maximum)</td>
</tr>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>400 mg/L (Maximum)</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>6.0 mg/L (Minimum)</td>
</tr>
<tr>
<td>pH</td>
<td>6.5-9.0 (Range)</td>
</tr>
<tr>
<td><em>E. coli</em> (CFU)</td>
<td>399 CFU/100mL</td>
</tr>
<tr>
<td></td>
<td>126 CFU/100mL</td>
</tr>
</tbody>
</table>

Methods of Analysis

All data collected from the Upper San Marcos River were exported from the Texas Stream Team database and were then grouped by site.

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 v15. Statistically significant trends were added to Excel to be graphed. 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%. 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.

**Upper San Marcos Watershed Data Analysis**

**Upper San Marcos Watershed Maps**
Numerous maps were prepared to show spatial variation of the parameters. The parameters mapped include DO, pH, TDS. There is also a reference map showing the locations of all active sites. For 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.

**Upper San Marcos Watershed Trends over Time**

**Sampling Trends over Time**
Sampling along the Upper San Marcos began in September of 1995 and continues to this day. A total of 1,938 individual monitoring events from 11 sites were analyzed. The sampling was evenly distributed throughout the 18 years of monitoring, and monthly monitoring continued on a consistent basis. The time of sampling ranged from 05:00 to 21:00, with 10:00 being the most common hour for sampling to occur. The Upper San Marcos is monitored by a combination of Texas State University Students, staff at The Meadows Center for Water and the Environment, and citizen scientists from the local group, The San Marcos River Rangers.

![Figure 2: Breakdown of monitoring events by year.](image-url)
Figure 3: Breakdown of monitoring events by month.

Figure 4: Breakdown of time of monitoring in the Upper San Marcos
Table 3: Average values for all Upper San Marcos sites

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>86.8%</td>
<td>399.2 ± 62.2</td>
<td>117.0</td>
<td>819.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>96.5%</td>
<td>21.6 ± 2.9</td>
<td>0</td>
<td>36.5</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>92.2%</td>
<td>7.6 ± 1.6</td>
<td>1.1</td>
<td>12</td>
</tr>
<tr>
<td>pH</td>
<td>96.2%</td>
<td>7.6 ± .3</td>
<td>5.3</td>
<td>9.8</td>
</tr>
<tr>
<td>E. coli  Bacteria (CFU/100 mL)</td>
<td>1.0%</td>
<td>110 ± 183</td>
<td>0</td>
<td>633.3</td>
</tr>
</tbody>
</table>

**Trend Analysis over Time**

**Air and Water Temperature**
A total of 1880 water temperature values and 1864 air temperature values were collected within the Upper San Marcos River between 1995 and 2013. Water temperature readings exceeded the TCEQ optimal temperature of 26.7 °C 54 times, with all of these occurring during summer months. Air temperature varied between -0.5 °C and 42 °C.

![Figure 5: Air and water temperature over time at all sites within the Upper San Marcos Watershed](image)

**Total Dissolved Solids**
Citizen scientists collected 1,683 TDS within the watershed. The TDS measurement was completed for 86.8% of all monitoring events. The average TDS measurement for all sites was 399.2 mg/L and there was no significant increase or decrease in TDS values over time.
Figure 6: Total Dissolved Solids over time at all sites within the Upper San Marcos Watershed

Table 4: Average Total Dissolved Solids (mg/L) by flow for the Upper San Marcos River

<table>
<thead>
<tr>
<th>Flow Level</th>
<th>Average TDS</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Flow</td>
<td>408.3</td>
<td>90.9</td>
</tr>
<tr>
<td>Low Flow</td>
<td>399.8</td>
<td>67.0</td>
</tr>
<tr>
<td>Normal Flow</td>
<td>400.3</td>
<td>59.2</td>
</tr>
<tr>
<td>High</td>
<td>389.1</td>
<td>42.1</td>
</tr>
<tr>
<td>Flood</td>
<td>360.0</td>
<td>56.7</td>
</tr>
</tbody>
</table>

Dissolved Oxygen
Citizen scientists collected a total of 1,787 DO samples within the Upper San Marcos Watershed. Dissolved oxygen fluctuated seasonally with values typically higher in the winter months than the summer months. This is because colder water holds more dissolved gasses than warmer water. The mean DO was 7.6 mg/L and it ranged from a low of 1.1 mg/L on October 23, 1995 to 12.0 on February 23, 2009. Plants and algae add a substantial amount of DO via photosynthesis, resulting in the diurnal trends of high DO levels observed during the daylight hours, peaking in the late afternoon, and decreasing after dark. This pattern is shown in Table 6.
Figure 7: Dissolved Oxygen over time at all sites within the Upper San Marcos Watershed

Table 5: Average dissolved oxygen at five different flow levels along the Upper San Marcos River

<table>
<thead>
<tr>
<th>Flow Level</th>
<th>Average DO</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Flow</td>
<td>6.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Low Flow</td>
<td>7.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Normal Flow</td>
<td>7.6</td>
<td>1.5</td>
</tr>
<tr>
<td>High</td>
<td>7.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Flood</td>
<td>7.7</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Table 6: Average Dissolved Oxygen values by sampling time within the Upper San Marcos Watershed

<table>
<thead>
<tr>
<th>Time</th>
<th>Average DO (mg/L)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00</td>
<td>6.6</td>
<td>1.4</td>
</tr>
<tr>
<td>8:00</td>
<td>6.3</td>
<td>1.6</td>
</tr>
<tr>
<td>9:00</td>
<td>6.4</td>
<td>1.8</td>
</tr>
<tr>
<td>10:00</td>
<td>6.9</td>
<td>1.5</td>
</tr>
<tr>
<td>11:00</td>
<td>7.6</td>
<td>1.4</td>
</tr>
<tr>
<td>12:00</td>
<td>7.5</td>
<td>1.5</td>
</tr>
<tr>
<td>13:00</td>
<td>8.2</td>
<td>1.5</td>
</tr>
<tr>
<td>14:00</td>
<td>8.3</td>
<td>1.3</td>
</tr>
<tr>
<td>15:00</td>
<td>8.3</td>
<td>1.3</td>
</tr>
<tr>
<td>16:00</td>
<td>8.2</td>
<td>1.5</td>
</tr>
<tr>
<td>17:00-22:00</td>
<td>7.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

pH

pH was successfully completed for 96.2% of all sampling events. There were 1,812 pH measurements taken in the Upper San Marcos Watershed, and the mean pH was 7.6. The pH for all of the sites ranged from 5.3 to 9.8. There was no significant increase or decrease in pH over time observed in the Upper San Marcos River during the study period.

Figure 8: Changes in pH over time at all sites within the Upper San Marcos Watershed
Upper San Marcos River Upstream to Downstream Trends

Total Dissolved Solids

There was no significant downstream trend in TDS concentrations observed for the study.

![Figure 9: Downstream trends in Total Dissolved Solids on the Upper San Marcos River](image)
Dissolved Oxygen

There was a significant correlation between DO measurements and distance downstream with the DO concentrations increasing as one moves downstream on the Upper San Marcos River (p = 0.000). The low $R^2$ value of 0.1239 indicates that only 12.4% of the variation in the data can be explained by this relationship though.

![Figure 11: Downstream trends in Dissolved Oxygen on the Upper San Marcos River](image-url)
Figure 12: Map of Dissolved Oxygen over time at all sites within the Upper San Marcos Watershed

**pH**

There was a significant correlation between pH and distance downstream with pH increasing slightly as one moves downstream on the Upper San Marcos. The relationship explains 14.5% of the variation in the data collected.

\[ y = 0.0513x + 7.3084 \]

\[ R^2 = 0.1446 \]
Figure 13: Downstream trends in pH on the Upper San Marcos River

![Downstream trends in pH on the Upper San Marcos River](image)

Figure 14: Map of pH at all sites within the Upper San Marcos Watershed

**Upper San Marcos Watershed Site by Site Analysis**

The following sections provide a brief summarization of analysis, by site. The average minimum and maximum values recorded in the watershed 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 7, 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 increased salts, nutrients, and sediments present in the water. Site 80646 had the highest overall average for TDS, with a result of $450.7 \pm 89.4$ mg/L. Site 80119 had the lowest average TDS, with a result of $386.0 \pm 21.4$ mg/L.

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 algae growth which then die and increase the biological oxygen demand in the water as bacteria decompose the dead algae resulting in low dissolved oxygen. Low DO can be dangerous for aquatic inhabitants, which rely upon the dissolved oxygen 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 15496 had the lowest
average DO reading, with a result of 6.2 ± 2.7 mg/L. Site 12672 had the highest average DO reading, with a result of 8.4 ± 1.0 mg/L.

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 average pH levels outside of this widely accepted range. Site 12671 had the highest average pH level, with a result of 7.8 ± 0.2. Sites 80925 and 15497 had the lowest average pH level, with a result of 7.3 ± 0.2.

*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. 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 which takes into account the high variability of parameters such as *E. coli* which can vary from zero to tens of thousands of CFU/100 mL. mL. Site 80646 was the only site where *E. coli* was sampled. This site had an *E. coli* geomean of 83.9 ± 214.7 CFU/100 mL.

Please see Table 7 for a summary of average results at all sites. It is also 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 7: Average values for all Upper San Marcos sites

<table>
<thead>
<tr>
<th>Site Number</th>
<th>TDS (mg/L)</th>
<th>DO (mg/L)</th>
<th>pH</th>
<th><em>E. coli</em> (CFU/100 mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15496</td>
<td>395.1 ± 62.5</td>
<td>6.2 ± 2.7 (min)</td>
<td>7.5 ± 0.3</td>
<td>N/A</td>
</tr>
<tr>
<td>80925</td>
<td>394.0 ± 11.1</td>
<td>7.3 ± 2.0</td>
<td>7.3 ± 0.2 (min)</td>
<td>N/A</td>
</tr>
<tr>
<td>15498</td>
<td>407.0 ± 47.0</td>
<td>7.6 ± 0.9</td>
<td>7.5 ± 0.4</td>
<td>N/A</td>
</tr>
<tr>
<td>15497</td>
<td>399.0 ± 43.4</td>
<td>6.8 ± 1.2</td>
<td>7.3 ± 0.3 (min)</td>
<td>N/A</td>
</tr>
<tr>
<td>80119</td>
<td>386.0 ± 21.4 (min)</td>
<td>7.1 ± 0.7</td>
<td>7.4 ± 0.3</td>
<td>N/A</td>
</tr>
<tr>
<td>80646</td>
<td>450.7 ± 89.4 (max)</td>
<td>N/A</td>
<td>N/A</td>
<td>83.9 ± 214.7</td>
</tr>
<tr>
<td>15499</td>
<td>390.5 ± 60.5</td>
<td>7.5 ± 1.8</td>
<td>7.5 ± 0.3</td>
<td>N/A</td>
</tr>
<tr>
<td>15500</td>
<td>397.9 ± 58.8</td>
<td>8.3 ± 1.0</td>
<td>7.6 ± 0.3</td>
<td>N/A</td>
</tr>
<tr>
<td>12672</td>
<td>408.6 ± 76</td>
<td>8.4 ± 1.0 (max)</td>
<td>7.7 ± 0.3</td>
<td>N/A</td>
</tr>
<tr>
<td>12671</td>
<td>394.0 ± 59.9</td>
<td>8.0 ± 0.9</td>
<td>7.8 ± 0.2 (max)</td>
<td>N/A</td>
</tr>
<tr>
<td>14153</td>
<td>403.3 ± 92.0</td>
<td>8.15 ± 0.8</td>
<td>7.7 ± 0.3</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Site 15496 – Sink Creek at Laurel St.

Site Description
This site is located at a low water crossing over a part of Spring Lake known as “The Slough”. “The Slough” is the confluence of Sink Creek with Spring Lake. Sink Creek is an ephemeral creek that usually contains water only after a rain event. As the name suggests, most of the water that runs into Sink Creek sinks underground into aquifer through fissures in the limestone creek bed. This site is dominated by lily pads in the water and elephant ears along the shoreline. A golf course owned by Texas State University borders both sides of this part of Spring Lake.

Sampling Information
This site is still actively monitored, but for the purposes of this study, data from 9/22/1995 to 9/11/2013 was analyzed. This site was monitored 255 times during that time period. The time of the monitoring at this site has ranged from 07:00 to 21:00 throughout the years.

Table 8: Descriptive parameters for Site 15496

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>86.3%</td>
<td>395.1 ± 62.5</td>
<td>117.0</td>
<td>773.5</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>98.4%</td>
<td>20.5 ± 4.4</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>89.1%</td>
<td>6.2 ± 2.7</td>
<td>1.1</td>
<td>12.0</td>
</tr>
<tr>
<td>pH</td>
<td>98.4%</td>
<td>7.5 ± 0.3</td>
<td>6.7</td>
<td>8.5</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>90.2%</td>
<td>0.7 ± 0.3</td>
<td>0</td>
<td>1.9</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>90.2%</td>
<td>0.7 ± 0.3</td>
<td>0</td>
<td>1.9</td>
</tr>
<tr>
<td><em>E. coli</em> Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Air and water temperature
Air and water temperatures were measured 251 times during this period. Temperatures fluctuated in a seasonal pattern with a minimum water temperature of 0°C in December of 2000, and a maximum temperature of 32°C in June of 1995. Air temperature fluctuated seasonally with a minimum of 0°C in December of 2000 and a maximum of 38°C in September of 2000.
Total Dissolved Solids

Citizen scientists collected 220 TDS samples at this site. The maximum value was 773.5 mg/L sampled in October of 1995, and the minimum value was 117.0 mg/L sampled in June of 1997. A regression analysis indicated no significant correlation between TDS measurements and time.
Dissolved Oxygen
A total of 227 dissolved oxygen samples were taken at this site. The mean DO concentration was 6.2 mg/L and was the lowest mean DO value for all of the sites monitored. The minimum DO value was 1.1 mg/L and was recorded in October of 1995. The maximum DO value recorded was 12.0 and was taken in February of 1999. The DO followed a normal seasonal trend, rising in the winter when the water temperature was low and decreasing in the summer when the water temperature was higher. There was no significant correlation between DO concentrations and time observed.

![Dissolved Oxygen at Site 15496](image)

pH
A total of 250 pH samples were taken at this site. The mean pH was 7.5 and the pH ranged from a minimum of 6.7 to a maximum of 8.5. There was a significant correlation between pH and time with a slight decrease in pH over time (p = 0.005). However, the low $R^2$ value indicates that this correlation only represents 3% of the variation in the data.
Figure 18: pH at Site 15496

**Secchi disk and total depth**

There were 230 Secchi disk depth and total depth measurements taken at this site. The mean depth of the site was 0.7 m and this was matched by the mean Secchi disk depth. Secchi disk depth was recorded as greater than or equal to total depth in all but three monitoring events, indicating that the water was clear all the way to the bottom of the sampling area a vast majority of the time.
Field Observations
Algae cover was reported as rare (< 25%) for this site. The water had no distinguishable color or odor during a majority of the monitoring events, and water clarity was recorded as clear 93% of the time.

Site 80925—San Marcos River at Spring Lake

Site Description
This site is located at the offices of The Meadows Center for Water and the Environment on Spring Lake. The office building is a renovated hotel built on the lake. The point of collection of the water samples is a spring that bubbles out from beneath the concrete embankment of the building and is known as “The Hotel Spring”.

Sampling Information
This site is currently active and has been sampled 23 times from 8/31/2012 to 11/15/2013. Sampling typically occurs between 10:00 and 16:00.
Table 9: Descriptive parameters for Site 80925

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>95.8%</td>
<td>394.0 ± 11.1</td>
<td>377.0</td>
<td>423.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>100%</td>
<td>21.4 ± 2.0</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>87.5%</td>
<td>7.3 ± 2.0</td>
<td>3.9</td>
<td>11.7</td>
</tr>
<tr>
<td>pH</td>
<td>100%</td>
<td>7.3 ± 0.2</td>
<td>6.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>100%</td>
<td>1.7 ± 0.6</td>
<td>0.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>100%</td>
<td>1.7 ± 0.6</td>
<td>0.6</td>
<td>2.3</td>
</tr>
<tr>
<td>E. coli Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Air and water temperature

Water and air temperatures were sampled 23 times at this site. Air temperature fluctuated in a seasonal pattern. The maximum air temperature occurred in June of 2013 and was 38 °C while the minimum air temperature occurred in February of 2013 and was 12 °C. The water temperature remained more stable due to the influx of groundwater from “The Hotel Spring”. The minimum water temperature was 16 °C and was recorded in February of 2013, and the maximum water temperature was recorded in August of 2013 as 25 °C.

Figure 20: Total Dissolved Solids at Site 80925
**Total Dissolved Solids**
Citizen scientists sampled TDS at this site 22 times for a mean TDS concentration of 394.0 mg/L. TDS concentrations ranged from 377.0 mg/L to 423.0 mg/L. There was no significant correlation between TDS concentrations and time for this site.

![Graph of Total Dissolved Solids](image)

y = -0.0112x + 855.01

**Dissolved Oxygen**
Twenty DO measurements were taken during the analyzed time period. The mean DO concentration for this site was 7.3 mg/L and it ranged from a minimum of 3.9 mg/L to 11.7 mg/L. There was no significant correlation between DO concentrations and time observed at this site.
pH
Twenty three pH samples were taken at this site with a mean pH of 7.3. This site and Site 15497 had the lowest mean pH of all the sites. The pH ranged from 6.7 to 7.6 and there was no significant relationship between pH and time for this site.
The mean Secchi disk depth and total depth for this site were both 1.7 m. The Secchi disk depth was recorded as greater than or equal to the total depth 100% of the time indicating that the water clarity was visible all the way to the bottom during all monitoring events.
Field Observations
Algae cover was recorded as rare (< 25% algae present) a majority of the time. The water color was recorded as no color or dark green. The water clarity was recorded as clear 100% of the time and there was no distinguishable odor detected during all monitoring events.

Site 15498– Sessom Creek at the San Marcos River

Site Description
This site is the confluence of Sessom Creek into the San Marcos River. Sessom Creek is an ephemeral stream that runs through an urbanized area of the city of San Marcos. The confluence is actually a concreted culvert that empties directly into the San Marcos River.

Sampling Information
This site was sampled 254 times between 9/30/1995 and 8/27/2013. Sampling at this site typically occurred on a twice a month basis and the time of sampling throughout the years ranged from 08:00 to 20:00.

Table 10: Descriptive parameters for Site 15498

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>92.9%</td>
<td>407.0 ± 47.0</td>
<td>228.0</td>
<td>787.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>98.8%</td>
<td>22.1 ± 2.6</td>
<td>4</td>
<td>29</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>94.1%</td>
<td>7.6 ± 0.9</td>
<td>5.6</td>
<td>12.0</td>
</tr>
<tr>
<td>pH</td>
<td>98.4%</td>
<td>7.5 ± 0.4</td>
<td>5.3</td>
<td>8.5</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>92.5%</td>
<td>0.75 ± 0.47</td>
<td>0.09</td>
<td>3.0</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>92.5</td>
<td>0.75 ± 0.47</td>
<td>0.09</td>
<td>3.0</td>
</tr>
<tr>
<td>E. coli  Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Air and water temperature
Air and water temperature were each taken 251 times at this site. Both parameters followed a seasonal pattern but with air temperature having more variability throughout the time period. Air temperature ranged from a minimum of 2°C in February 2004 to 40°C in June of 1996. Water temperature varied from a low of 4°C in January of 2008 to a high 29°C on July of 2013.
Figure 25: Air and water temperature at Site 15498

Total Dissolved Solids
A total of 234 TDS measurements were taken at this site. The mean TDS value was 407 mg/L and ranged from a high of 787.0 mg/L in January of 1996 to a low of 228.0 mg/L in August of 1997. There was no significant correlation between TDS concentrations and time observed for this site.
Citizen scientists took 239 DO samples from this site. The mean DO concentration during the analyzed time period was 7.6 mg/L. The minimum DO value observed was 5.6 mg/L in July of 2012. The maximum DO value observed was 12.0 mg/L in February of 2009. There was a significant correlation between DO values and time for this site with a slight decrease in DO over time. This relationship only explains 11% of the variation in the data set for the site.
pH
A total of 250 pH measurements were taken for this site. The mean pH was 7.5 and it ranged from a minimum of 5.3 recorded in April of 2000 to a high of 8.5 in June of 1996. There was no statistically significant relationship between pH and time observed for this site.
Secchi disk and total depth
The mean Secchi disk depth and total depth for this site were both 0.75 m. The Secchi disk depth was recorded as equal to or greater than the total depth 99% of the time indicating that the water clarity was visible all the way to the bottom during almost all monitoring events.

![Graph showing Secchi Disk Depth and Total Depth at Site 15498](image)

Figure 29: Secchi Disk Depth and Total Depth at Site 15498

Field Observations
Algae cover was absent or rare for a majority of the monitoring events. The water had no color, and had no odor for all but a few times when the monitors recorded a fishy smell. The water clarity was clear 97% of the time and was recorded as cloudy on 8 occasions.

Site 15497– Spring Lake Upstream of Dam near Saltgrass

Site Description
The site is below the Spring Lake Dam. Water rushes down a concrete mill race that was constructed for a mill that was once on site. The mill has since been replaced by a restaurant. This location is a popular swimming area for local residents during the summer months.

Sampling Information
This site was sampled 229 times between 10/1/1995 and 8/6/2012. Sampling at this site typically occurred on a twice a month basis and the time of sampling throughout the years ranged from 07:00 to 19:00.
Table 11: Descriptive parameters for Site 15497

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>89.5%</td>
<td>399.0 ± 43.4</td>
<td>202.0</td>
<td>767.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>98.6%</td>
<td>21.5 ± 2.0</td>
<td>15</td>
<td>36.5</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>96.0%</td>
<td>6.8 ± 1.2</td>
<td>3.6</td>
<td>11.7</td>
</tr>
<tr>
<td>pH</td>
<td>97.3%</td>
<td>7.3 ± 0.3</td>
<td>5.6</td>
<td>8.9</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>90.8%</td>
<td>1.82 ± 0.53</td>
<td>0.18</td>
<td>3.00</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>90.8%</td>
<td>1.82 ± 0.53</td>
<td>0.18</td>
<td>3.00</td>
</tr>
<tr>
<td>E. coli Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Site was sampled 229 times between 10/1/1995 and 8/6/2012.

Air and water temperature

Citizen scientists collected 225 measurements of both water and air temperature for this site. Air temperature ranged from a minimum of 3°C in February of 2003 to a maximum of 37.5°C in June 1998. Water temperature averaged 21.5°C with a minimum temperature recorded in January 1995 of 15°C and a maximum temperature of 36.5 recorded in June of 1998.

![Figure 30: Air and water temperature at Site 15497](image-url)
**Total Dissolved Solids**
Citizen scientists collected 204 TDS samples from this site. The mean TDS measurement was 399.0 mg/L. The minimum TDS value recorded was 201.5 mg/L collected in December of 1996, and the maximum TDS value was 767.0 mg/L collected in December of 1995. There was no significant correlation between TDS values and time observed for this site.

![Total Dissolved Solids at Site 15497](image)

**Dissolved Oxygen**
A total of 220 DO samples were taken for this site. The mean DO concentration was 6.8 mg/L. The minimum value was 3.6 mg/L collected in August 1997. The minimum value was recorded in August of 2001 and was 3.6 mg/L. The maximum value was recorded in May of 1997 and was 11.7 mg/L. There was a small but significant decrease in DO concentrations over time at this site, but the low $R^2$ value of 0.0251 indicates that there is high variability in DO concentrations that is not related to time.
Figure 32: Dissolved Oxygen at Site 15497

pH
A total of 223 pH samples were collected at this site. The mean pH was 7.3 and the pH ranged from a low of 6 collected in July of 2012, to a high of 8.9 collected in January 2008. This site and Site 80925 had the lowest mean pH. There was a significant decrease in pH over time for this site that explained 12% of the variability observed ($R^2 = 0.1217$).
Secchi disk and total depth

The mean Secchi disk depth and the mean total depth were both recorded as 1.82 m for this site. Secchi disk depth was equal to or greater than total depth for all of the monitoring events indicating that the water was clear all the way to the bottom of the sampling area for 100% of the monitoring events.
Field Observations
Algae cover was reported as absent or rare a majority of the time. The water was reported to have either no color or a light green color. The water clarity was recorded as clear 100% of the time. The water had either no distinguishable odor or a fishy order 97% of the time.

Site 80119—San Marcos River at Sewell Park

Site Description
This site is located immediately downstream of the Aquarena Springs Dr. Bridge. Sewell Park is a property owned by Texas State University and it is a popular swimming area for students. The banks of the San Marcos River as it flows through Sewell Park are concrete to protect the shoreline from erosion and to allow easy access to the water for swimmers.

Sampling Information
This site was only sampled 6 times from 1999 to 2013. Because of the sporadic sampling, the parameters were not graphed, and regression analyses were not conducted. A table displaying the mean, standard deviation, minimum, and maximum values for the parameters is displayed below. This site had the lowest mean TDS concentration of all the sites in the Upper San Marcos Watershed with a mean concentration of 386.0 mg/L.
Table 12: Descriptive parameters for Site 80119

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>100%</td>
<td>386.0 ± 21.4</td>
<td>345</td>
<td>410</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>100%</td>
<td>21.8 ± 0.8</td>
<td>20.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>71.4%</td>
<td>7.1 ± 0.7</td>
<td>20.5</td>
<td>22.5</td>
</tr>
<tr>
<td>pH</td>
<td>100%</td>
<td>7.4 ± 0.3</td>
<td>6.9</td>
<td>7.7</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>100%</td>
<td>1.92 ± 0.77</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>100%</td>
<td>1.92 ± 0.77</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td><em>E. coli</em> Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Site 80646– Stormwater Outfall Culvert to San Marcos River

Site Description
This site is at a concreted culvert adjacent to University Dr. that empties directly into the San Marcos River. The culvert drains stormwater from a heavily urbanized area of the city of San Marcos. The culvert is located directly across the river from the Lions Club which is a popular swimming area for local residents.

Sampling Information
This site was sampled 18 times between 4/22/2011 and 1/15/2013. The purpose of this site was to collect *E. coli* samples of water that was draining into the river from the culvert. This is the only site on the Upper San Marcos River where *E. coli* was consistently sampled during this time period. Water temperature and TDS were also measured at this site. This site had the highest mean TDS concentration at 450.7 mg/L.

Table 13: Descriptive parameters for Site 80646

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>72.2%</td>
<td>450.7 ± 89.4</td>
<td>390.0</td>
<td>728.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>72.2%</td>
<td>18.6 ± 2.3</td>
<td>15.5</td>
<td>21.6</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>0.0%</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>pH</td>
<td>0.0%</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>0.0%</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>0.0%</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><em>E. coli</em> Bacteria (CFU/100 mL)</td>
<td>88.9%</td>
<td>83.9 ± 214.7</td>
<td>0</td>
<td>633.3</td>
</tr>
</tbody>
</table>
**E. coli Bacteria**

The geometric mean for *E. coli* was 83.9 CFU/100 mL for this site. The individual *E. coli* samples ranged from 0 to a high of 633.33 CFU/100 mL. There was no significant correlation between *E. coli* numbers and time for this site.

![E. coli count for Site 80646](image)

**Site 15499—Purgatory Creek at San Marcos River**

**Site Description**

This site is located at the confluence of Purgatory Creek with the San Marcos River. Purgatory Creek is an ephemeral creek that drains a large area outside of the city limits. The site is along a walking trail in Bicentennial Park. It is downstream of a railroad crossing and the Hopkins St. Bridge.

**Sampling Information**

This site was sampled 274 times between 10/1/1995 and 8/25/2013. Sampling usually occurred on monthly or twice a month basis. Over the years, the time of sampling has varied between 05:00 and 20:00.
### Table 14: Descriptive parameters for Site 15499

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>88.6%</td>
<td>390.5 ± 60.5</td>
<td>130.0</td>
<td>767.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>98.5%</td>
<td>21.9 ± 3.3</td>
<td>1.5</td>
<td>32.0</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>95.6%</td>
<td>7.5 ± 1.8</td>
<td>2.3</td>
<td>10.2</td>
</tr>
<tr>
<td>pH</td>
<td>99.3%</td>
<td>7.5 ± 0.3</td>
<td>6.9</td>
<td>8.7</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>98.2%</td>
<td>1.10 ± 0.32</td>
<td>0.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>98.2%</td>
<td>1.13 ± 0.30</td>
<td>0.0</td>
<td>2.5</td>
</tr>
<tr>
<td>E. coli Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Air and water temperature

A total of 270 measurements were taken of both air and water temperatures. Temperatures fluctuated in a seasonal pattern. The minimum air temperature was -0.5°C from January 2011, and the maximum air temperature of 37.5°C was recorded in August of 1997. Water temperature averaged 21.9°C and varied from 1.5°C in January 2000 to 32°C in May 1998.

![Air and water temperature at Site 15499](image)
Total Dissolved Solids
Citizen scientists collected 242 TDS measurements at this site. The mean TDS concentration was 390.5 mg/L and ranged from a low of 130 mg/L in May 1996 to a high of 767 mg/L in October of 1995. There was no significant correlation between TDS concentrations and time observed at this site.

![Graph showing Total Dissolved Solids at Site 15499](image)

Figure 37: Total Dissolved Solids at Site 15499

Dissolved Oxygen
A total of 262 DO samples were taken for this site with a mean DO concentration of 7.5 mg/L. The DO ranged from a low of 2.3 mg/L recorded in September of 2006, to a high of 10.2 recorded in February 2008. There was a slight but significant increase in DO concentration over time (p = 0.02), but the low R^2 value of 0.0183 indicates that this relationship only explains a small percentage of the variability.
Citizen scientists took 272 pH samples at this site. The mean pH was 7.5. The minimum pH of 6.9 was recorded in April of 2012, and the maximum pH of 8.7 was recorded in October 1995. There was a small but significant decrease in pH over time at this site that explains 6.5% of the variability in the pH ($p = 0.000$).
Secchi disk and total depth
The mean Secchi disk depth was 1.10 m and the mean total depth was 1.13 m. Secchi disk depth was greater than or equal to total depth 99% of the time indicating that the water was clear enough to see all the way down to the bottom of the sampling area.
Field Observations
Algae cover was absent or rare 88% of the time. The water had no color or a light green color for 83% of the samples. The water was reported to be clear on all but 29 occasions which were reported as cloudy. There was no distinguishable odor 90% of the time with 10% of the events having a fishy smell reported.

Site 15500 – San Marcos River at Rio Vista Park

Site Description
This site is located downstream of a railroad bridge crossing the San Marcos. It is located in Rio Vista Park, a popular local swimming area.

Sampling Information
This site was sampled 240 times between 9/24/1995 and 8/25/2013. Sampling usually occurred on a twice a month basis, and the sampling time over the years has ranged from 07:00 to 21:00.
Table 15: Descriptive parameters for Site 15500

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>89.6%</td>
<td>397.9 ± 58.8</td>
<td>169.0</td>
<td>734.5</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>98.8%</td>
<td>21.7 ± 3.3</td>
<td>14</td>
<td>33.0</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>96.3%</td>
<td>8.3 ± 1.0</td>
<td>4.0</td>
<td>11.0</td>
</tr>
<tr>
<td>pH</td>
<td>99.5%</td>
<td>7.6 ± 0.3</td>
<td>6.9</td>
<td>8.5</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>97.9%</td>
<td>1.97 ± 0.52</td>
<td>0.20</td>
<td>4.00</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>97.9%</td>
<td>2.11 ± 0.43</td>
<td>1.1</td>
<td>4.0</td>
</tr>
<tr>
<td><em>E. coli</em> Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Air and water temperature
There were 237 air and water temperatures taken at this site during this time. The temperatures appeared to fluctuate seasonally. The air temperature varied from a low of 3.5°C in February 2010 to a high of 39°C in August 2010. The mean water temperature was 21.7°C. Water temperatures ranged from 14°C in November of 2005 to 33°C in May of 2013.

Figure 41: Air and water temperature at Site 15500
Total Dissolved Solids
There were 215 TDS samples taken at this site. The mean TDS concentration was 397.9 mg/L. The minimum TDS concentration was 169.0 mg/L in May 1996. The maximum value was 734.0 mg/L in October 1995. There was no significant correlation between TDS values and time for this site.

![Graph of Total Dissolved Solids at Site 15500]

\[ y = -0.0003x + 410.95 \]

Figure 42: Total Dissolved Solids at Site 15500

Dissolved Oxygen
A total of 231 DO samples were collected at this site. The mean DO value was 8.3 mg/L. The values range from 4.0 mg/L in January 2013 to a high of 11.0 mg/L on February 2012. There was a significant correlation between DO concentrations and time \((p = 0.001)\). Dissolved oxygen decreased over time at this site, but the low \(R^2\) value of 0.044 indicates that this relationship does not explain all of the variability observed at this site.
A total of 239 pH samples were taken at this site. The mean pH was 7.6 and the range varied from a low of 6.9 taken in August of 2012, to a high of 8.5 in March of 1995. There was a significant correlation between pH and time for this site ($p = 0.000$), with a decrease in pH over time explaining over 17% of the data observed.
Secchi disk and total depth
There were 234 Secchi disk depth and total depth measurements taken at this site. The average Secchi disk depth was 1.97 m while the average total depth was 2.11 m. Secchi disk depth was greater than or equal to total depth in all but 10 monitoring events indicating that the water at the site was clear enough to see all the way to the bottom.

Field Observations
Algae cover at the site was either absent or rare. The water had no color or a light green color. The water clarity was clear 88% of the time and cloudy the other 12%. The water odor was recorded as no odor 85% of the time and fishy smelling the other 15%.

Site 12672– San Marcos River at IH35 East Frontage Road
Site Description
This site is located downstream of the IH35 bridge over the San Marcos River. The riparian area is dominated by oak trees and elephant ears.

Sampling Information
This site was monitored from 9/24/1995 to 9/4/2013. A total of 176 samples were taken during this time period, usually twice a month. Sampling time ranged from 06:00 to 21:00 through the years.
Table 16: Descriptive parameters for Site 12672

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>86.9%</td>
<td>408.6 ± 76</td>
<td>325.0</td>
<td>767.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>98.9%</td>
<td>21.7 ± 3.4</td>
<td>5.5</td>
<td>29.0</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>94.3%</td>
<td>8.4 ± 1.0</td>
<td>5.1</td>
<td>10.3</td>
</tr>
<tr>
<td>pH</td>
<td>100%</td>
<td>7.7 ± 0.3</td>
<td>6.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>97.2%</td>
<td>2.01 ± 0.54</td>
<td>0.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>98.2%</td>
<td>2.17 ± 0.58</td>
<td>0.75</td>
<td>5.5</td>
</tr>
<tr>
<td>E. coli Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Air and water temperature
A total of 174 measurements of both air and water were taken at this site. The temperatures followed a seasonal pattern of increasing in the summer and decreasing in the winter. The air temperature ranged from a low of 4°C in January of 2010 to a high of 39°C. The water temperature at this site averaged 21.7°C. The temperature ranged from a low of 5.5 in April of 2013 to a high of 29°C in October of 2008.

![Air and water temperature at Site 12672](image)

Total Dissolved Solids
Citizen scientists collected a total of 153 TDS samples at this site. The mean TDS concentration was 408 mg/L. The minimum TDS value was 325 mg/L in May of 2005, and the maximum value was 767 mg/L.
collected in October of 1995. A regression analysis indicated a significant correlation between TDS values and time (p = 0.001). The slight decrease in TDS over time was responsible for 7.2% of the variation in the data set (R² = 0.0724).

![Graph of Total Dissolved Solids at Site 12672]

**Figure 47: Total Dissolved Solids at Site 12672**

**Dissolved Oxygen**

A total of 176 samples were collected by citizen scientists at this site. The mean DO value was 8.4 mg/L, and was the highest mean DO of all the sites sampled. The DO concentration ranged from a low of 5.1 mg/L collected in September 2004 to a high of 10.3 mg/L. A regression analysis indicated a significant correlation of DO concentrations slightly decreasing over time (p = 0.000, R² = 0.123).
pH
A total of 176 pH measurements were taken for this site. The pH mean was 7.7. The minimum pH value was 6.9 and was collected in March of 2012. The maximum pH value was 8.6 and was collected in October 2008. There was a slight, but significant decrease in pH over time ($p = 0.000$, $R^2 = 0.1328$).
Secchi disk and total depth
There were 170 Secchi disk depth and total depth measurements taken at this site. The mean Secchi disk depth was 2.01 m while the mean total depth was 2.17 m. Secchi disk depth was greater than or equal to total depth 77% of the time. The lower mean Secchi disk depth and the 39 measurements where Secchi disk depth was less than total depth indicate that the water clarity here does not extend all the way to the bottom of the sampling area.

![Graph showing Secchi Disk Depth and Total Depth at Site 12672](image)

Figure 50: Secchi Disk Depth and Total Depth at Site 12672

Field Observations
Algae cover was reported to be absent or rare 96% of the time. The water was reported to have no color or a light green color a majority of the time, and the water clarity was overwhelmingly clear with 18 instances (10.5%) where the water was cloudy.

Site 12671– San Marcos River at Thompson Island

Site Description
This site is on Thompson Island at the J.J. Stokes Park. The island was created when a diversion in the river was made for a concrete mill race that was used to power a mill. The mill no longer exists but the divergence and the confluence of the mill race created the Island. This site is downstream of the beginning of the mill race divergence, but upstream of its confluence.

Sampling Information
This site was sampled 270 times between 10/13/1995 and 10/23/2013. Sampling typically occurred twice a month at this site.
Table 17: Descriptive parameters for Site 12671

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>85.6%</td>
<td>394.0 ± 59.9</td>
<td>117.0</td>
<td>812.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>99.3%</td>
<td>21.5 ± 2.9</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>97.0%</td>
<td>8.0 ± 0.9</td>
<td>5.6</td>
<td>10.2</td>
</tr>
<tr>
<td>pH</td>
<td>98.1%</td>
<td>7.8 ± 0.2</td>
<td>7.0</td>
<td>8.5</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>78.9%</td>
<td>1.33 ± 0.44</td>
<td>0.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>85.9%</td>
<td>1.36 ± 0.47</td>
<td>0.00</td>
<td>3.00</td>
</tr>
<tr>
<td>E. coli Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Air and water temperature
There were 268 measurements of both air and water taken at this site. Temperatures followed a typical seasonal pattern and air temperature ranged from a low of 4°C in December of 2011, to a high of 42°C in July of 1997. Water temperature averaged 21.5°C and ranged from a low of 12°C in October 2011, to a high of 29°C in August of 2008.

Figure 51: Air and water temperature at Site 12671
**Total Dissolved Solids**

There were 231 TDS samples taken at this site. The mean TDS concentration was 394 mg/L. The minimum TDS value was recorded in December of 1996 and was 117 mg/L. The maximum TDS concentration was 812.5 mg/L and was recorded in November of 1995. There was no significant correlation between TDS and time observed for this site.

![Graph of Total Dissolved Solids at Site 12671](image)

\[ y = 0.0004x + 377.03 \]

\[ R^2 = 0.0002 \]

**Figure 52: Total Dissolved Solids at Site 12671**

**Dissolved Oxygen**

Citizen scientists collected a total of 262 DO samples from this site. The mean DO was 8.0 mg/L. The range of DO varied from a low of 5.6 in June of 2013, to 10.2 in December of 1996. There was a significant correlation between DO and time observed at this site with DO decreasing slightly over time (p = 0.000, R^2 = 0.1706).
pH
A total of 268 pH samples were taken at this site. The mean pH was 7.8 and was the highest mean pH for all of the sites sampled. The minimum pH of 7.0 was taken in March of 2010 while the maximum value of 8.5 was taken in June of 2006. There was a significant correlation between pH and time with pH decreasing slightly over time (p = 0.000, R² = 0.0512).

Figure 54: pH at Site 12671
**Secchi disk and total depth**
Secchi disk depth averaged 1.33 m while total depth averaged 1.36 m. Secchi disk depth was greater than or equal to total depth in all but 3 of the 212 depth measurements indicating that the water clarity was clear all the way to the bottom of the sampling area almost all of the time.

![Figure 55: Secchi Disk Depth and Total Depth at Site 12671](image)

**Field Observations**
Algae cover was rare or absent 100% of the time. The water either had no color or a light green color. Water clarity was clear a majority of the time, with 19% of the events recording the water as cloudy, and the clarity during two events was recorded as turbid.

**Site 14153– San Marcos River at Fish Hatchery Outfall**

**Site Description**
This site is in JJ Stokes Park. It is near the outfall of the AE Wood Fish Hatchery. The fish hatchery is owned by the Texas Parks and Wildlife Department and raises game fish in several ponds that are filled with San Marcos River water. When the ponds are drained to retrieve the raised fish, the water enters an onsite treatment plant where solid waste is removed before it is discharged into the water via the outfall where the water sampling occurs.
Sampling Information
This site was sampled 166 times between 10/13/2013 and 9/4/2013. The site was usually sampled twice a month during the time period. The time of sampling ranged from 07:00 to 21:00 throughout the years.

Table 18: Descriptive parameters for Site 14153

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Complete</th>
<th>Mean ± Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>84.9%</td>
<td>403.3 ± 92.0</td>
<td>169.0</td>
<td>819.0</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>99.4%</td>
<td>22.0 ± 2.1</td>
<td>15.0</td>
<td>27.5</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>98.2%</td>
<td>8.2 ± 0.8</td>
<td>6.0</td>
<td>10.2</td>
</tr>
<tr>
<td>pH</td>
<td>98.2%</td>
<td>7.7 ± 0.3</td>
<td>7.0</td>
<td>9.8</td>
</tr>
<tr>
<td>Secchi Disk Transparency (m)</td>
<td>59.6%</td>
<td>0.95 ± 0.44</td>
<td>0.00</td>
<td>2.50</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>73.5%</td>
<td>1.14 ± 0.69</td>
<td>0.00</td>
<td>3.00</td>
</tr>
<tr>
<td>E. coli Bacteria (CFU/100 mL)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Air and water temperature
A total of 165 air and water temperatures were taken at this site. The site followed typical seasonal patterns of increasing in the summer and decreasing in the winter. The air temperature ranged from a high of 37°C in July of 1998, to a low of 9°C in 2001. The mean water temperature was 22.0. The water temperature varied from a minimum of 15°C in January 2007 to a maximum of 27.5 in July of 2007.
Total Dissolved Solids
A total of 141 TDS samples were collected by citizen scientists at this site. The mean TDS measurement was 403.3 mg/L. The minimum TDS value was 169 mg/L and was recorded in March of 1998. The maximum TDS value was 819 mg/L and was recorded in October of 1995. There was a significant correlation between TDS and time observed for this site (p = 0.042). TDS values decreased slightly over time, but this relationship only accounts for less than 3% of the variation observed (R² = 0.0296).

Dissolved Oxygen
There were 163 DO samples collected at this site. The mean DO concentration was 8.2 mg/L. The minimum DO concentration was recorded in July 2006 and was 6.0 mg/L. The maximum DO value of 10.2 was recorded in March 2001. There was a significant correlation between DO concentration and time with the DO values slightly decreasing over time (p = 0.000, R² = 0.1694).
There were 163 pH samples collected at this site with an overall mean pH of 7.7. The minimum pH value recorded was 7.0 in March 2012. The maximum pH of 9.8 was recorded in August of 1999. There was a significant correlation between pH and time with pH decreasing slightly over time (p = 0.000, R² = 0.0941).
Secchi disk and total depth
There were 96 Secchi disk depth and total depth measurements taken at this site. The mean Secchi disk depth was 0.95 m and the mean total depth was 1.14 m. Secchi disk depth was greater than or equal to total depth for all but 6 of the monitoring events indicating that water clarity is usually clear all the way to the bottom of the sampling area.

Field Observations
Algae cover was absent or rare 98% of the time at this site. The water had no distinguishable color or a light green color a majority of the time. Water clarity was recorded as clear in all but 14 monitoring events where it was described as cloudy.

Get Involved with Texas Stream Team!
Once trained, citizen monitors 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 Texas Commission on Environmental Quality (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, Texas Stream Team 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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