Gilleland Creek Watershed Report

July 2014

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Introduction

Texas Stream Team is a volunteer-based citizen 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.

Location and Climate

Gilleland Creek is named after James Gilleland, who owned the land near the creek's origins (Texas State Historical Association (TSHA)). The creek springs up in Travis County, just northwest of Pflugerville (TSHA). It flows for 32 miles and drains approximately 76 square miles until it deposits into the Colorado River, southeast of Austin (Texas Stream Team (TST) "Gilleland Creek Intensive Bacteria Survey Addendum"). Elm Creek, Decker Creek, and Harris Branch are all tributaries of Gilleland Creek (Texas Commission on Environmental Quality (TCEQ) "Gilleland Creek Plan – Education and Outreach Elements"). This region, located in the Blacklands Prairie ecoregion, has clay and sandy loam soils (TSHA). Annual rainfall is usually between 30 and 40 inches, with more precipitation in the east (Native Prairies Association of Texas).

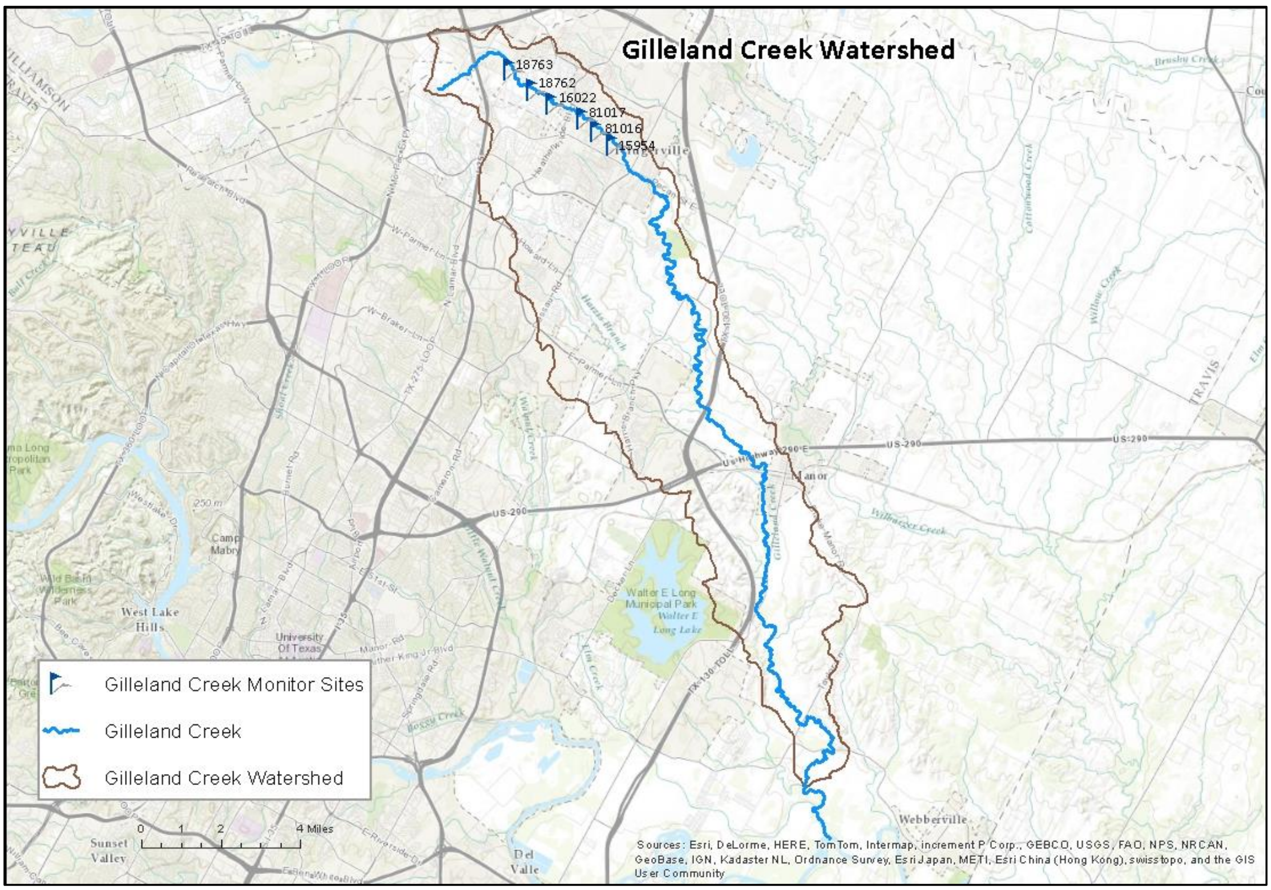

Figure 1: Map of The Gilleland Creek Watershed

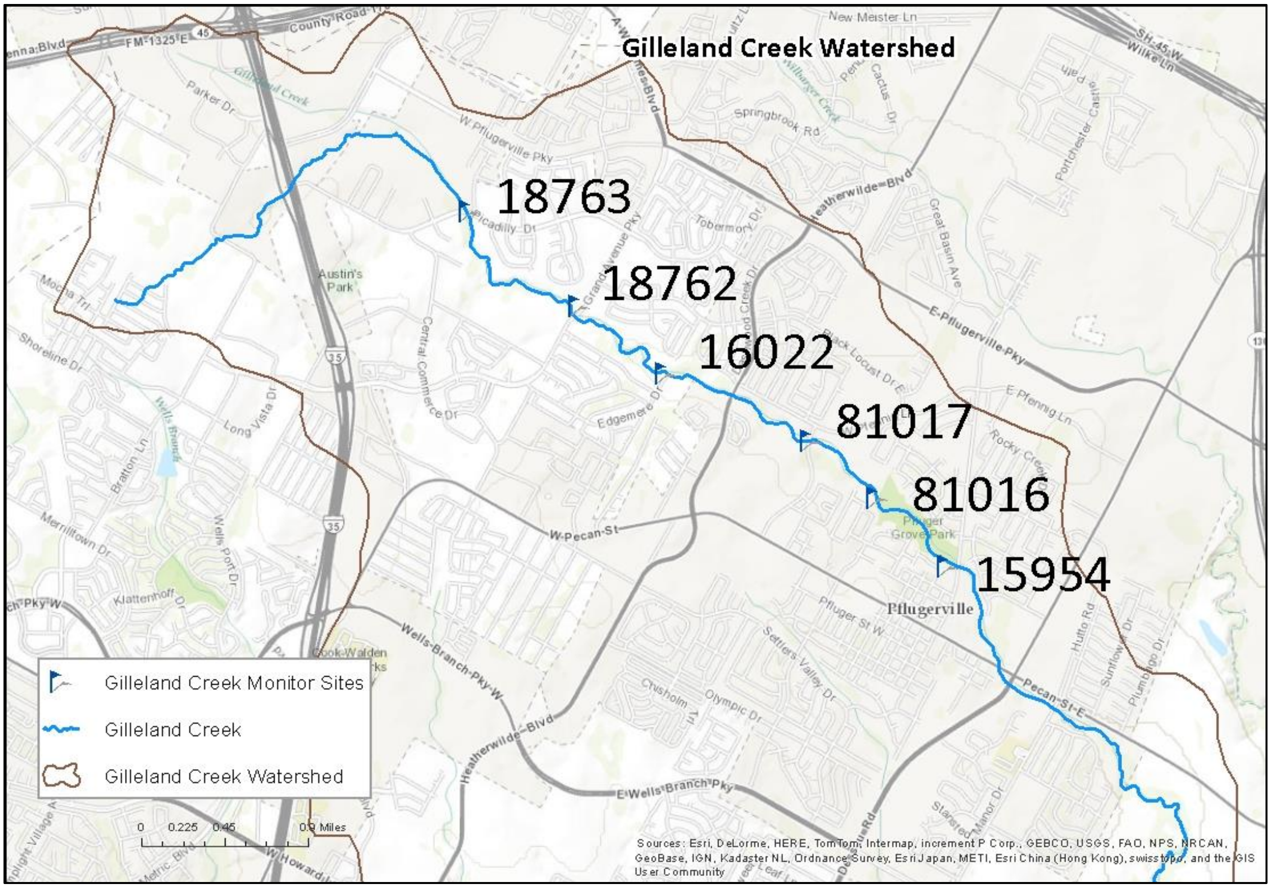

Figure 2: Map of The Gilleland Creek Watershed

Physical Description and Land Use

The clay and sandy loam soils support pecan, oak, juniper, and mesquite trees; as well as cacti and grasses (TSHA). Several wastewater treatment plants discharge into Gilleland Creek (TST "Gilleland Creek TMDL Plan I"). Due to their presence, most of the stream is comprised of treated wastewater from these treatment plants (TST "Gilleland Creek TMDL Plan I"). The watershed is primarily composed of agricultural land, however there are increasing residential and urban developments (TST "Gilleland Creek TMDL Plan I"). The stream also runs through two parks, Gilleland Creek Park and Pfluger Park (TSHA). Water quality testing has showed elevated levels of bacteria in Gilleland Creek (TST "Gilleland Creek Intensive Bacteria Survey Addendum"). In response, Texas Commission on Environmental Quality (TCEQ) has established total maximum daily loads (TMDL) of pollutants and an implementation plan to adhere to the TMDLs (TCEQ "Improving Water Quality in Gilleland Creek").

TMDL and Implementation Plan

TCEQ placed Gilleland Creek on the 303(d) List of Impaired Water Bodies in 2004 (TST "Gilleland Creek Intensive Bacteria Survey Addendum"). TCEQ and the Lower Colorado River Authority (LCRA) began developing the Gilleland Creek TMDL project (TCEQ "Improving Water Quality in Gilleland Creek"). TCEQ adopted TMDL levels in August of 2007 and EPA Region 6 approved these levels in April 2009

(TCEQ “Improving Water Quality in Gilleland Creek”). The implementation plan targets point and nonpoint pollution sources, such as wastewater treatment facilities, on-site sewage facilities, pet waste, and storm water runoff (TCEQ “Gilleland Creek Plan – Education and Outreach Elements”).

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 ($\mu S/cm^3$). 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.

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 a 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 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 nitrates, nitrites, and ammonia. Nitrate-nitrogen tests are conducted for maximum data compatibility with the 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 above under the "Dissolved Oxygen" section. Nitrates dissolve more readily than phosphates, 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 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

Parameter	Matrix	Container	Sample Volume	Preservation	Holding Time
Nitrate/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

*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.

Sampling is still encouraged with expired reagents; 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 DataViewer 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 2014 Texas Surface Water Quality Standards report was used to reference the exceedances for the Gilleland Creek Watershed, as seen below in Table 2.

Table 2: Summary of Surface Water Quality Standards for the Gilleland Creek Watershed

Parameter	Texas Surface Water Quality Standard 2014
Water Temperature (°C)	35.0
Total Dissolved Solids (mg/L)	500
Dissolved Oxygen (mg/L)	6.0
pH (su)	6.5-9.0
E.coli (CFU/100 mL)	126 (geomean during sampling period)

Methods of Analysis

All data collected from Gilleland Creek were exported from the Texas Stream Team database and were then grouped by site. Data was reviewed and, for the sake of data analysis, only one sampling event per month, per site was selected for the entire study duration. If more than one sampling event occurred per month, 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. Trends in water quality over time were analyzed using a linear regression analysis in Minitab v 15. 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.

Gilleland Creek Watershed Data Analysis

Gilleland Creek Watershed Maps

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

Gilleland Creek Watershed Trends over Time

Sampling Trends over Time

Sampling in the Gilleland Creek Watershed began in 1995 and continues to this day. A total of 163 individual monitoring events from 6 sites were analyzed. The year with the most sampling events in the watershed was 2013. The time of sampling ranged from 09:00 to 23:00 with 17:00 being the most common hour of sampling.

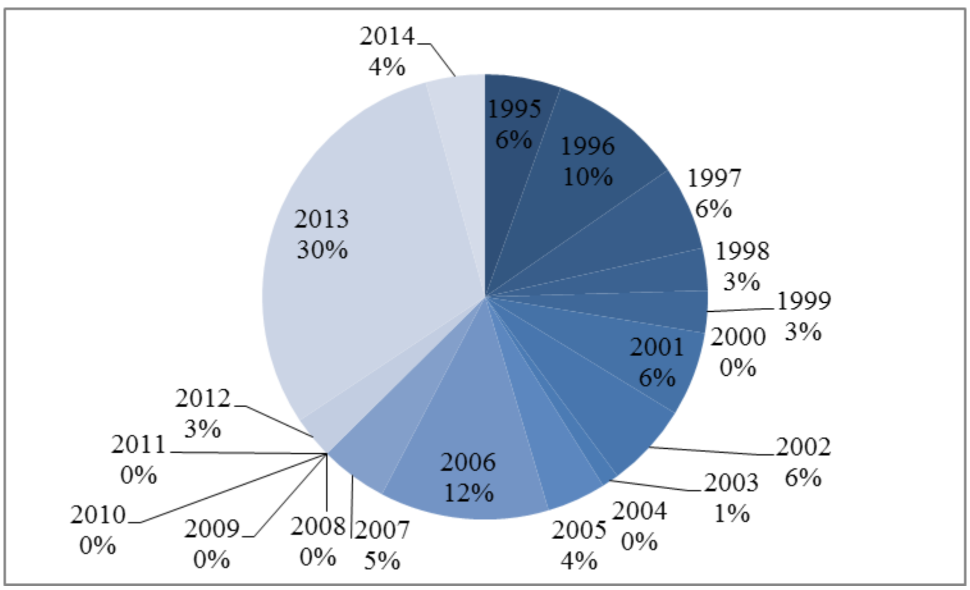

Figure 3: Breakdown of monitoring events by year.

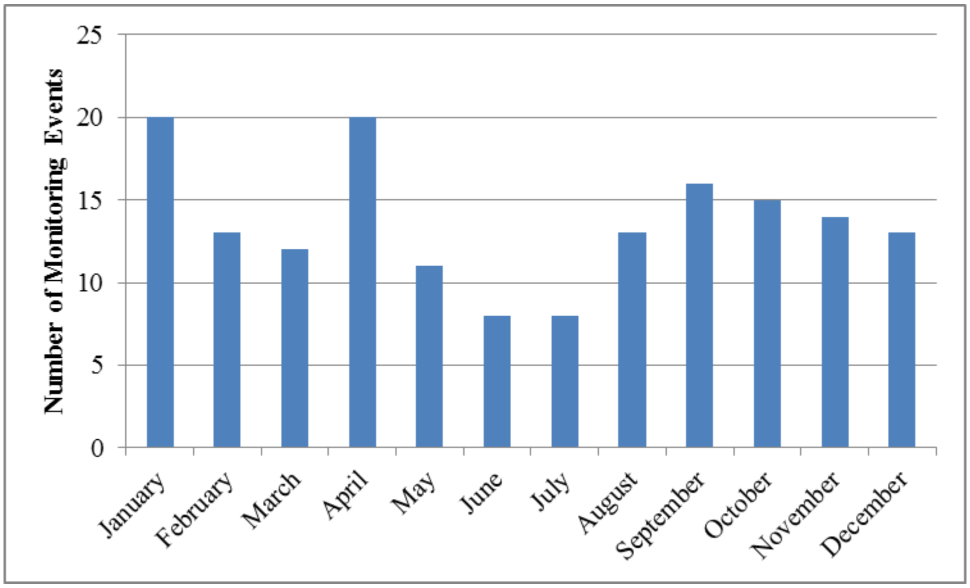

Figure 4: Breakdown of monitoring events by month.

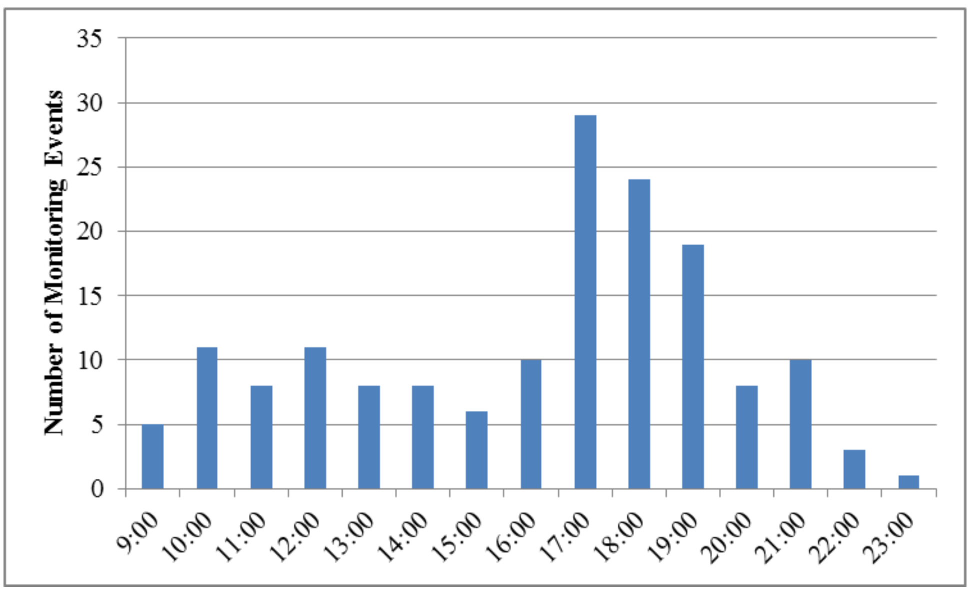

Figure 5: Breakdown of time of monitoring in the Gilleland Creek Watershed.

Table 3: Descriptive parameters for all sites in the Gilleland Creek Watershed

Gilleland Creek Creek August 1995 – February 2014				
Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	152	593.6 ± 196.8	188.5	1001
Water Temperature (°C)	159	20.6 ± 5.3	9.5	30.0
Dissolved Oxygen (mg/L)	152	7.4 ± 2.0	2.7	13.3
pH	157	7.6 ± 0.4	7.0	8.5
Nitrates	133	2.8 ± 2.4	1.0	10.0
Phosphates	34	0.27 ± 0.14	0.17	0.66

There were a total of 163 sampling events between 08/1995 and 02/2014. Mean, calculated in Microsoft Excel, is listed for all parameters.

Trend Analysis over Time

Air and water temperature

A total of 159 air and water samples were collected within the Gilleland Creek Watershed between 1995 and 2014. Water temperature never exceeded the TCEQ optimal temperature standard of 35°C. Air temperature varied between 4°C and 34 °C.

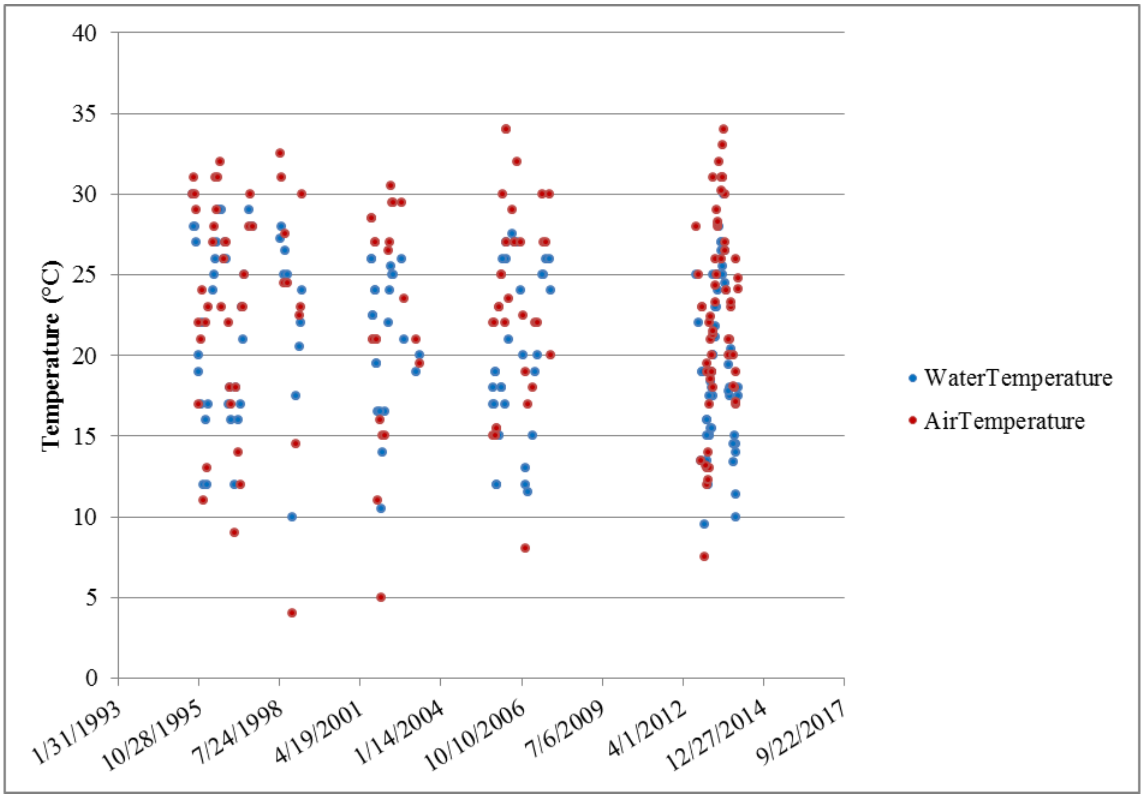

Figure 6: Air and water temperature over time at all sites within the Gilleland Creek Watershed

Total Dissolved Solids

Citizen scientists collected 152 TDS samples within the watershed. The TDS measurement was completed for 93.3% of all monitoring events. The average TDS measurement for all sites in the watershed was 593 mg/L. There was a significant correlation between TDS and time with TDS increasing over time ($p = 0.000$). The low R^2 value indicates that this relationship only explains about 9.3% of the variability in the data.

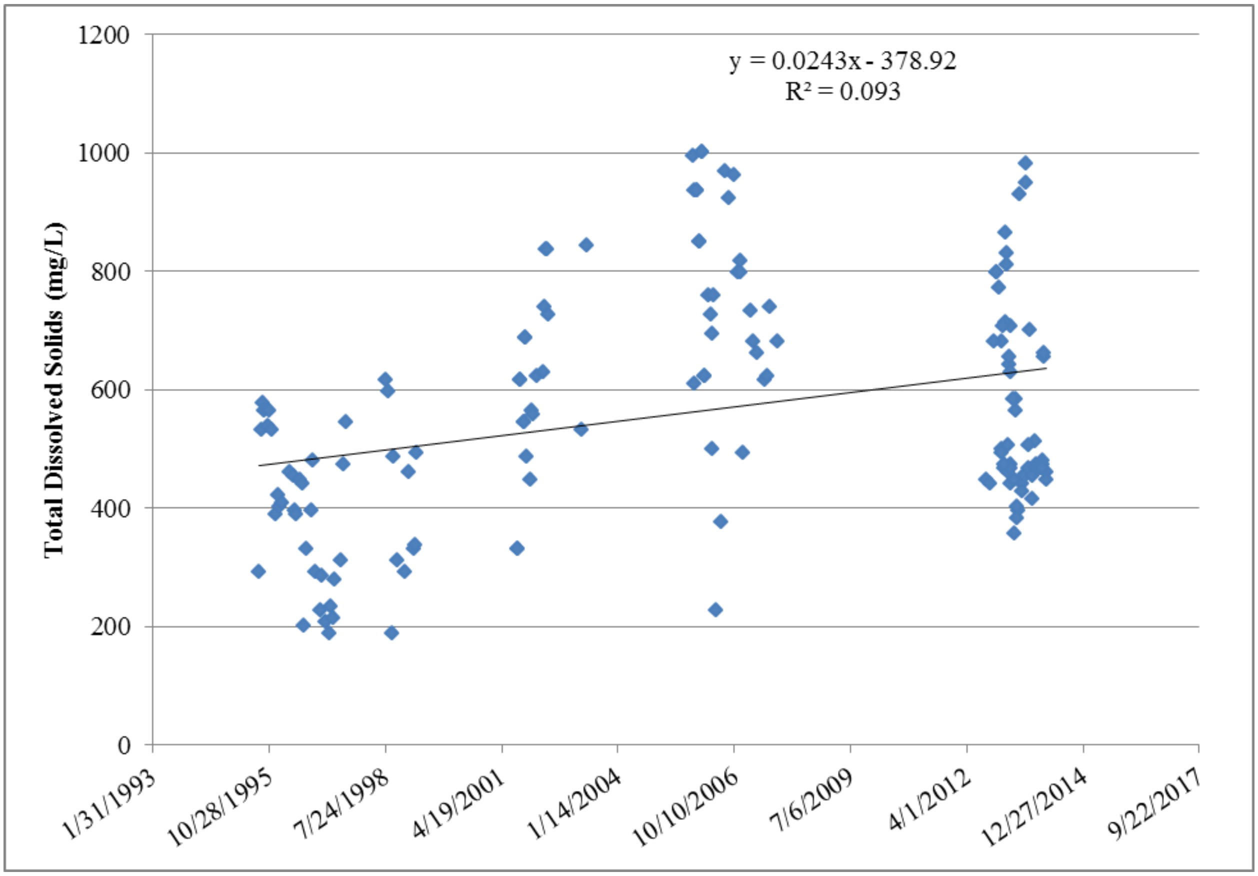

Figure 7: Total Dissolved Solids over time at all sites within the Gilleland Creek Watershed

Dissolved Oxygen

Citizen scientists collected a total of 152 DO samples in the Gilleland Creek Watershed representing 93.3% of all monitoring events. Dissolved oxygen fluctuated seasonally with the values increasing when water was cooler and decreasing when the water was warmer. This is because colder water holds more dissolved gasses than warmer water. The mean DO was 7.4 mg/L and it ranged from a low of 2.7 mg/L on 9/3/2013 and a high of 13.3 mg/L on 1/26/2014.

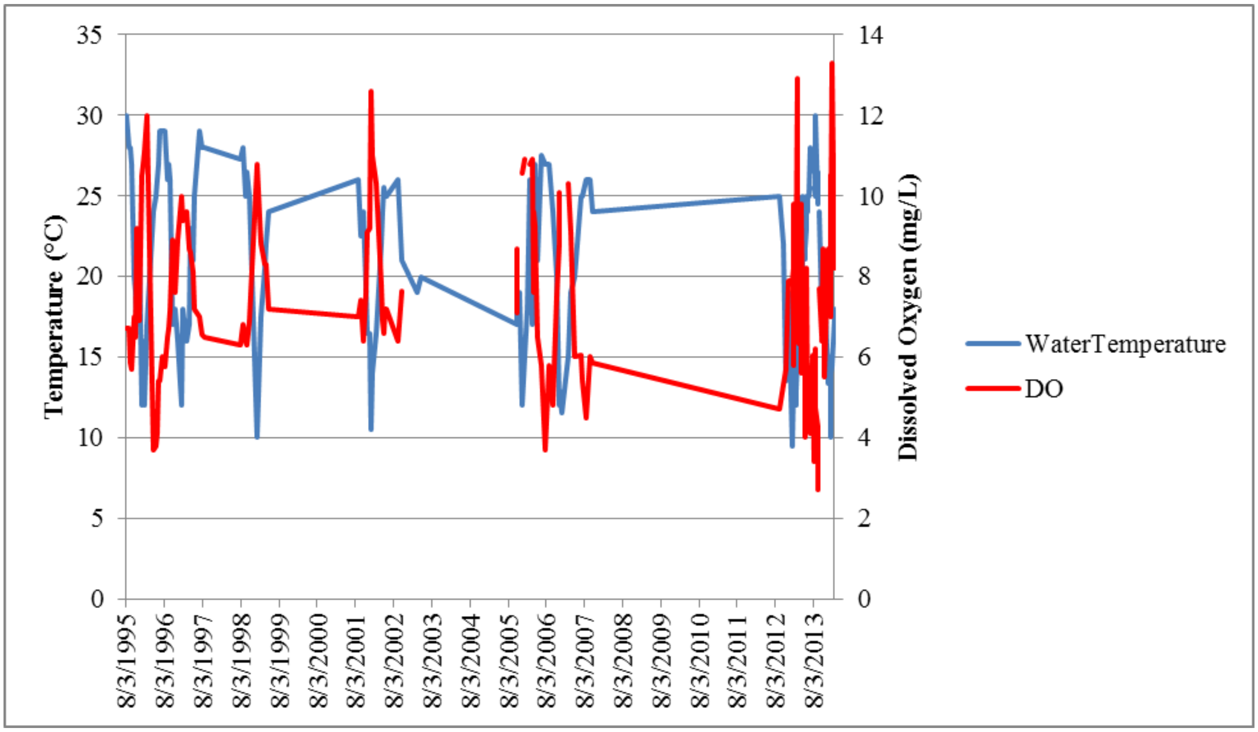

Figure 8: Dissolved Oxygen and water temperature at all sites within the Gilleland Creek Watershed

Table 4: Average Dissolved Oxygen values by Sampling Time within the Gilleland Creek Watershed

Time	Average DO (mg/L)	Standard Deviation
9:00 – 10:00	8.3	3.4
10:00 – 11:00	6.3	1.3
11:00 – 12:00	9.0	1.3
12:00 – 13:00	8.7	2.2
13:00 – 14:00	4.8	1.5
14:00 – 15:00	6.9	2.0
15:00 – 16:00	7.9	1.3
16:00 – 17:00	8.4	2.4
17:00 – 18:00	8.2	2.1
18:00 – 19:00	8.0	1.8
19:00 – 20:00	6.7	1.0
20:00 – 21:00	5.9	0.9
21:00 – 24:00	6.7	2.2

pH

pH was completed for 96.3% of all sampling events. There were 157 pH measurements taken in the Gilleland Creek Watershed, and the mean pH was 7.6. The pH for all of the sites ranged from 7.0 to 8.5. There was a statistically significant correlation between pH and time with pH decreasing over time ($p = 0.000$). The relatively large R^2 value of 0.24 indicates that this is a fairly strong relationship that explains 24% of the variability in the data.

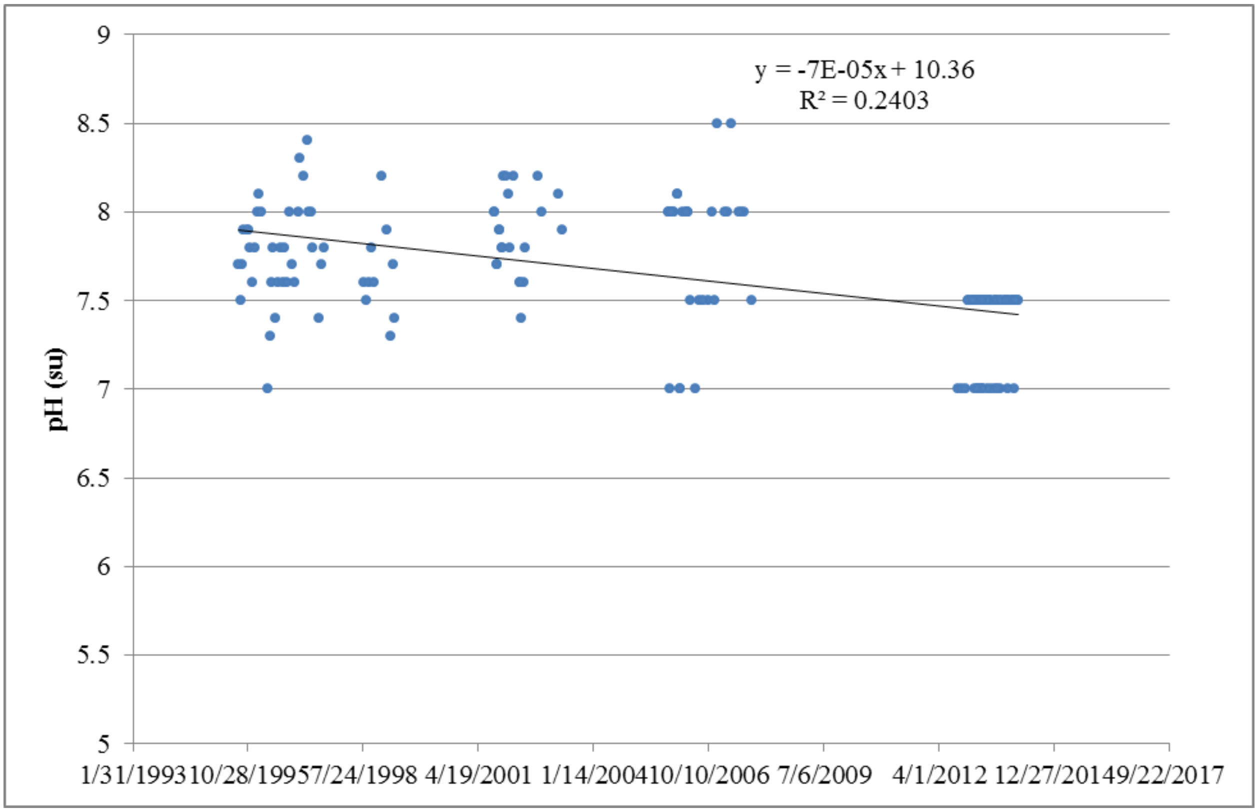

Figure 9: Changes in pH over time at all sites within the Gilleland Creek Watershed

Orthophosphate and Nitrate-Nitrogen

There were 133 nitrate-nitrogen and 34 orthophosphate measurements taken in the Gilleland Creek Watershed. The mean nitrate-nitrogen value was 2.8 mg/L and ranged from 1.0 to 10.0 mg/L. The mean orthophosphate value was 0.27 mg/L and ranged from a low of 0.17 to a high of 0.66 mg/L.

Gilleland Creek Watershed Site by Site Analysis

The following sections will provide a brief summarization of analysis, by site. The average minimum and maximum values recorded in the watershed. These values are reported in order to provide a quick overview of the watershed. The TDS, DO, and pH values are presented as an average, plus or minus the standard deviation from the average. Please see Table 5 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 81016 had the highest overall average for TDS, with a result of 788 ± 146 mg/L. Sites 18762 and 18763 had the lowest average TDS, with a result of 452 ± 35 and 452 ± 28 mg/L respectively.

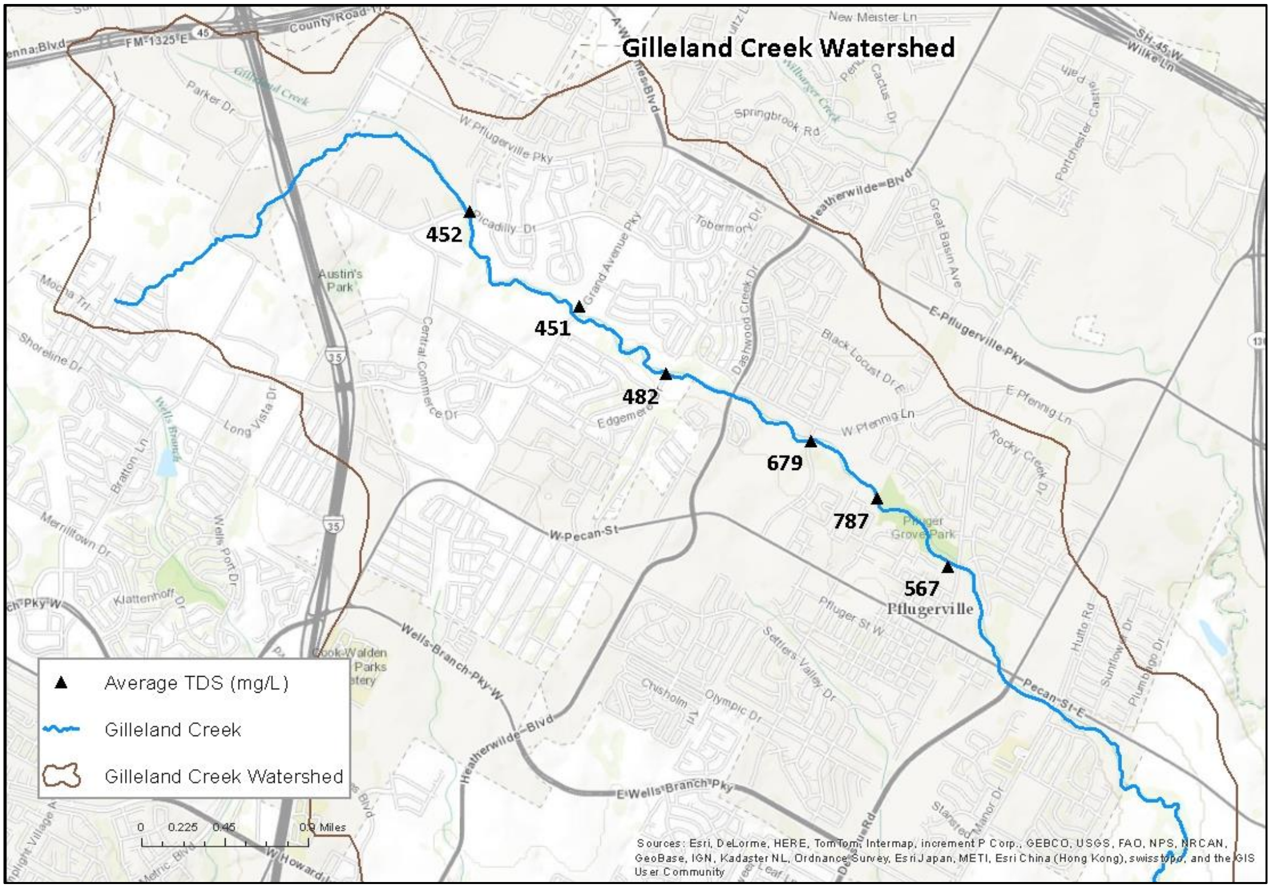

Figure 10: Map of average Total Dissolved Solids in the Gilleland Creek Watershed

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 than 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 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 16022 had the lowest average DO reading, with a result of 5.3 ± 1.7 mg/L. Site 81017 had the highest average DO reading, with a result of 9.6 ± 2.3 mg/L.

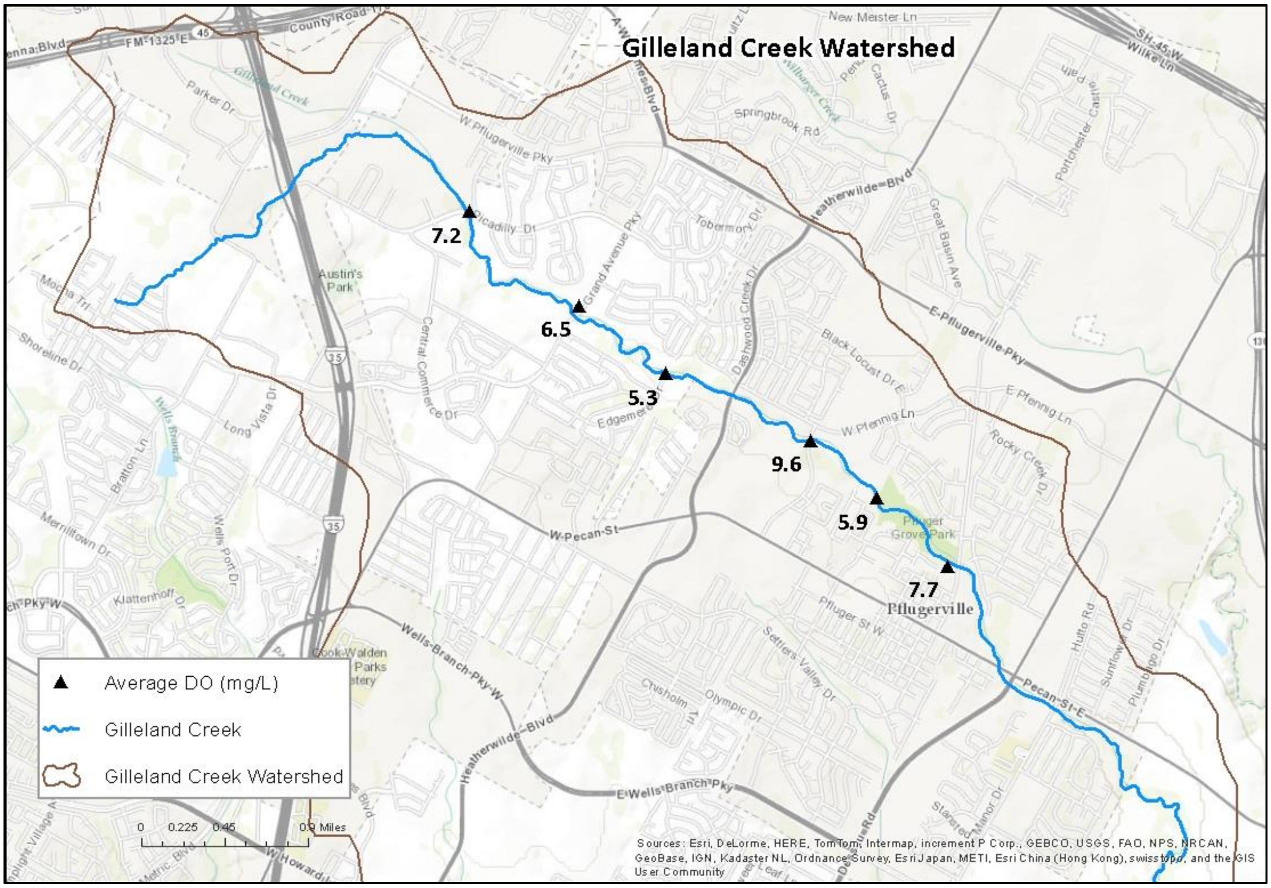

Figure 11: Map of average Dissolved Oxygen in the Gilleland Creek Watershed

The pH levels are an important indicator for the overall health of the watershed as well. Aquatic inhabitants typically require a pH range between 6.5 and 9 for the most optimum environment. Anything below 6.5 or above 9 can negatively impact reproduction or can result in fish kills. There were no reported pH levels outside of this widely accepted range. Site 15954 had the highest average pH level, with a result of 8.0 ± 0.3. Sites 81016 and 16022 had the lowest average pH level, with a result of 7.1 ± 0.2.

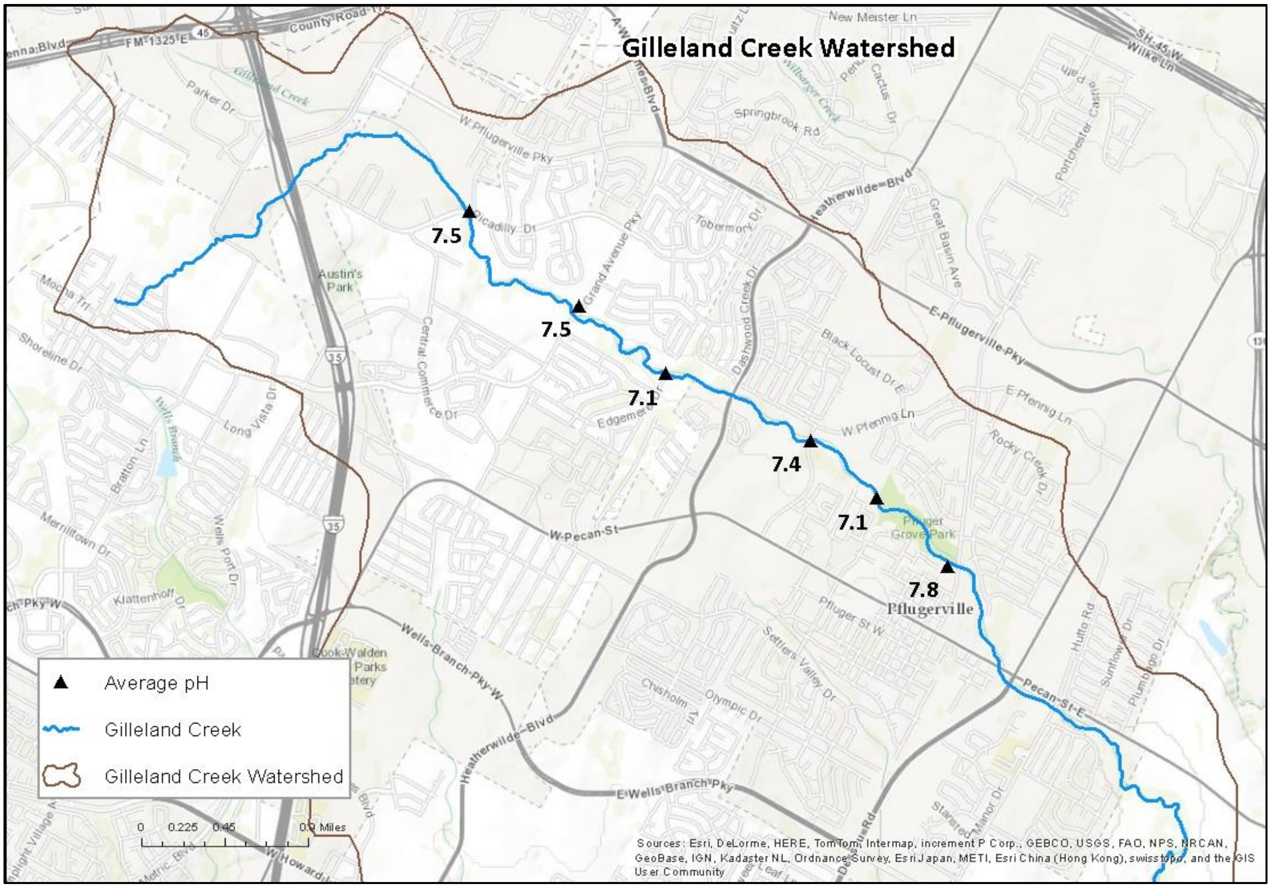

Figure 12: Map of average pH in the Gilleland Creek Watershed

Site 81017 had the highest mean nitrate-nitrogen measurement with a value of 4.4 ± 2.7 mg/L. Sites 16022, 18762, and 18763 all had a nitrate nitrogen mean of 1.0 mg/L with no deviation.

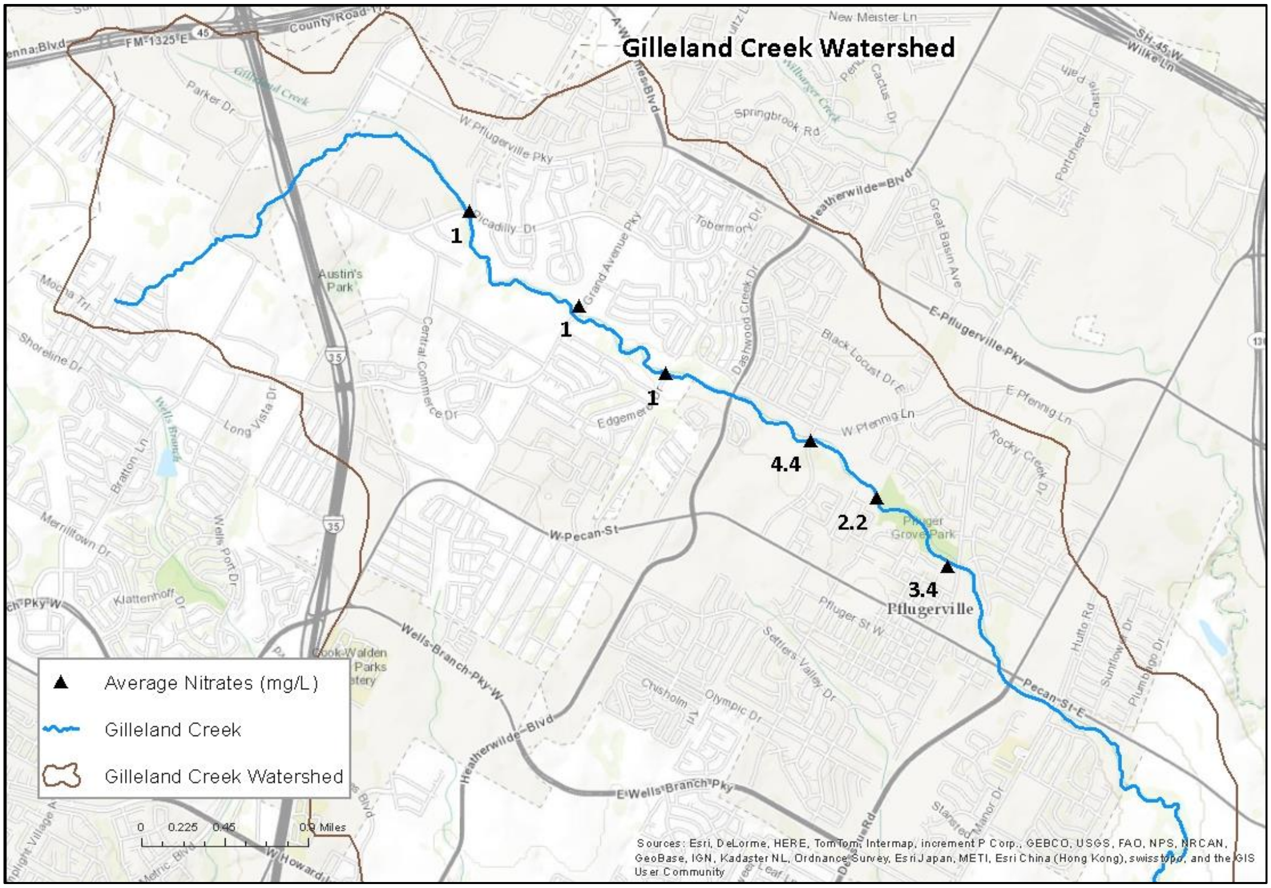

Figure 13: Map of average nitrates in the Gilleland Creek Watershed

Please see Table 5 for a summary of average results at all sites. It is important to note that there was variation in the number of times each site was tested, the time of day at which each site was tested, and the time of month the sampling occurred. While this is a quick overview of the results, it is important to keep in mind that there is natural diurnal and seasonal variation in these water quality parameters. 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 5: Average Values for all sites

Site Number	TDS (mg/L)	DO (mg/L)	pH	Nitrates (mg/L)
18763	452 ± 28	7.2 ± 1.6	7.5 ± 0.0	1.0 ± 0.0 (min)
18762	452 ± 35 (min)	6.5 ± 1.7	7.5 ± 0.0	1.0 ± 0.0 (min)
16022	482 ± 17	5.3 ± 1.7 (min)	7.1 ± 0.2 (min)	1.0 ± 0.0 (min)
81017	679 ± 121	9.6 ± 2.3 (max)	7.4 ± 0.2	4.4 ± 2.7 (max)
81016	788 ± 146 (max)	5.9 ± 1.5	7.1 ± 0.2 (min)	2.2 ± 1.0
15954	567 ± 217	7.7 ± 1.9	8.0 ± 0.3 (max)	3.4 ± 2.6

Site 18763– Gilleland Creek at Picadilly Lane

Site Description

This site is located at the Picadilly Dr. Crossing over Gilleland Creek. The riparian area at this site is wooded and is located in between Caldwell Elementary School and a commercial zone with several warehouses. There is a commercial dog kennel located off of Picadilly Drive near the banks of the creek.

Sampling Information

This site is actively monitored and was sampled 13 times in between 2/16/2014 and 2/17/2014. The sampling time at this site varied between 11:00 and 21:00.

Table 6: Descriptive parameters for Site 18763

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	11	452 ± 28	403	507
Water Temperature (°C)	11	18.5 ± 4.8	10.0	27.0
Dissolved Oxygen (mg/L)	11	7.2 ± 1.6	5.2	10.5
pH	11	7.5 ± 0.0	0.0	0.0
Nitrates	11	1.0 ± 0.0	1.0	1.0

Site was sampled 13 times between 2/16/2013 and 2/17/2014.

Air and water temperature

Air and water temperatures were measured 11 times during this period. Air temperatures fluctuated in a seasonal pattern with a minimum of 14°C in February 2013 to a maximum of 31°C in August of 2013. The minimum water temperature was 10°C in January 2014, and the maximum water temperature was 27°C in July of 2013, and the mean temperature was 18.5°C.

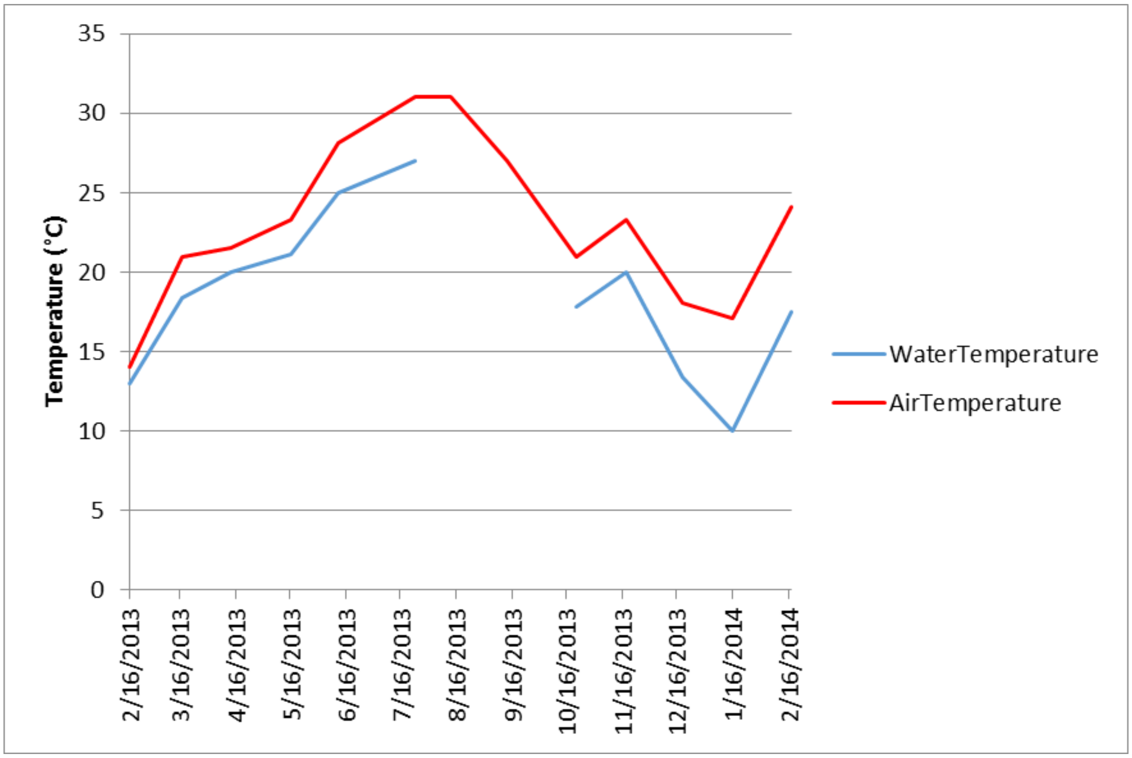

Figure 14: Air and water temperature at Site 18763

Total Dissolved Solids

Citizen scientists collected 11 TDS samples. The mean value was 452 mg/L. The maximum value was 507 mg/L from March of 2013 and the minimum value was 403 mg/L which was sampled in June 2013. There was no significant correlation between TDS and time detected.

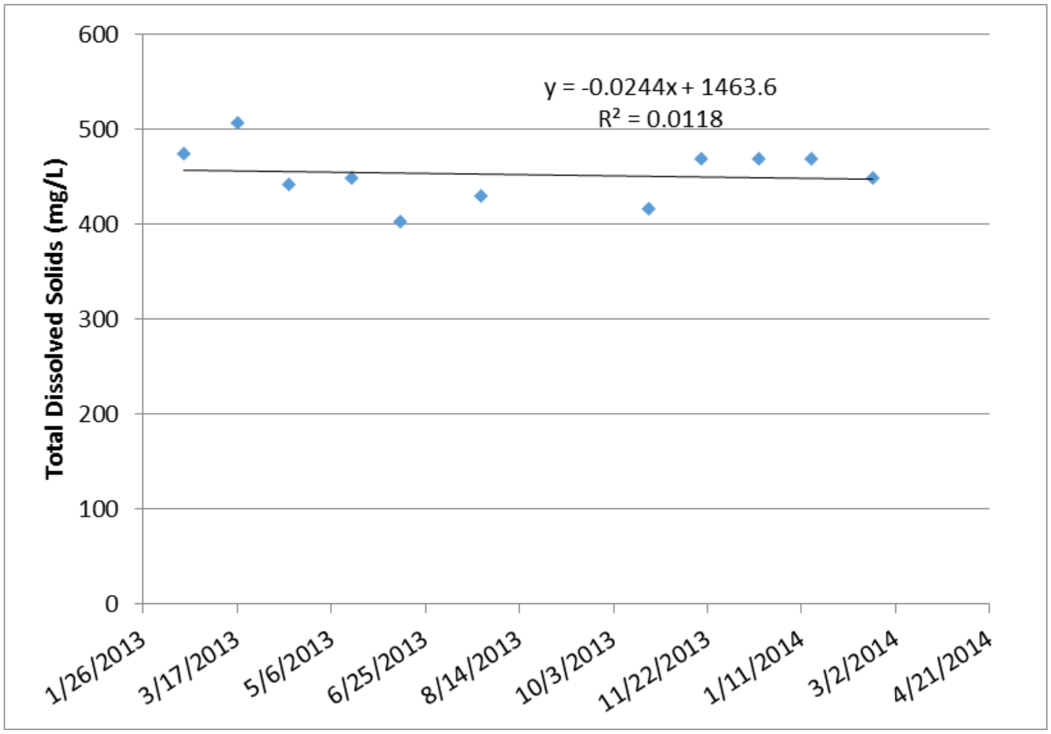

Figure 15: Total Dissolved Solids at Site 18763

Dissolved Oxygen

A total of 11 dissolved oxygen samples were taken at this site. The mean DO concentration was 7.2 mg/L. The minimum DO value was 5.2 mg/L and was recorded in May of 2013. The maximum DO value was 10.5 mg/L and was taken in January, 2014. There was no significant correlation between Dissolved oxygen and time observed.

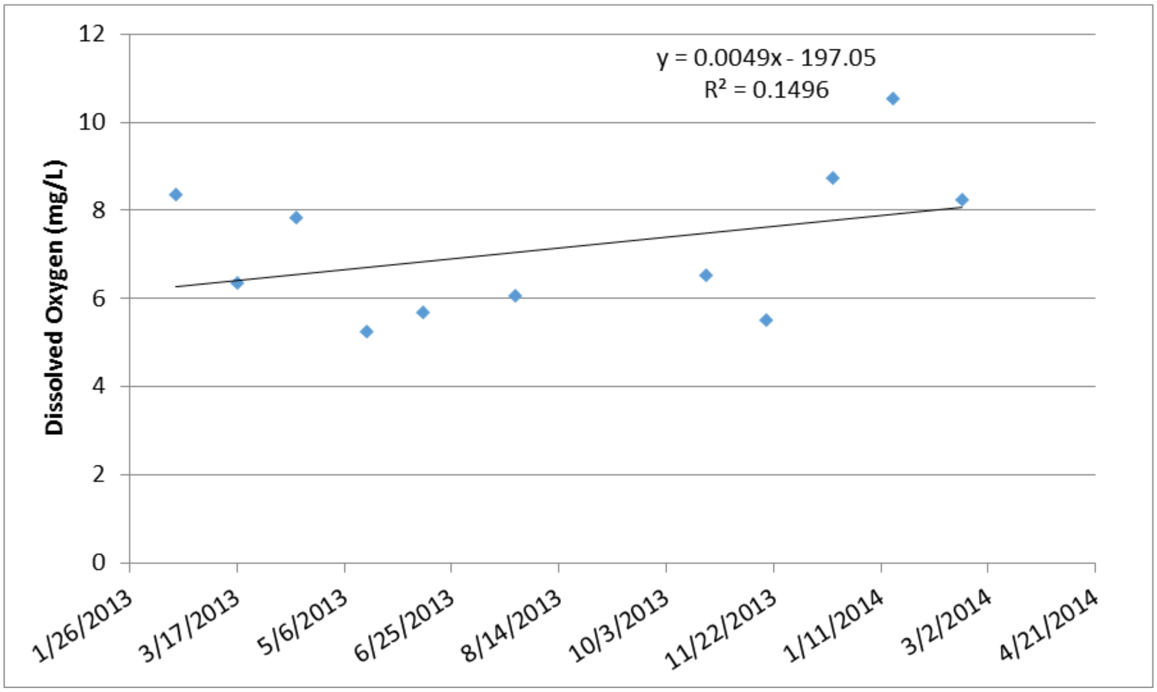

Figure 16: Dissolved Oxygen at Site 18763

pH

A total of 11 pH samples were taken at this site. All measurements were 7.5 and there was no variation.

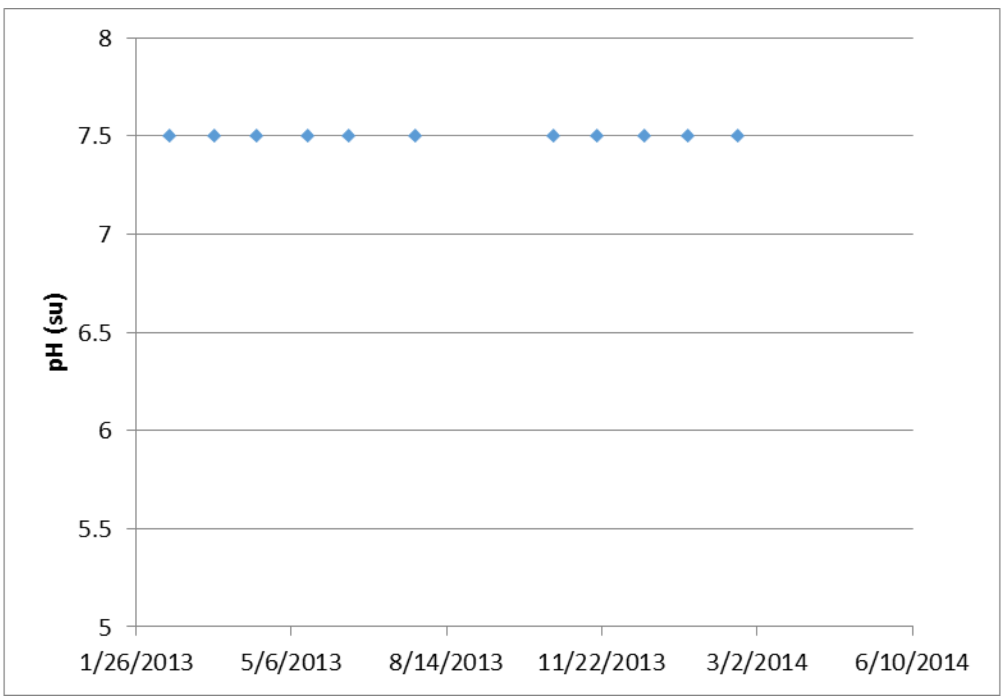

Figure 17: pH at Site 18763

Field Observations

Algae was always absent for all sampling events. The water color was recorded as light-green, and water clarity was clear.

Nitrate-Nitrogen

Nitrate-Nitrogen was recorded as 1.0 for all 11 samples taken.

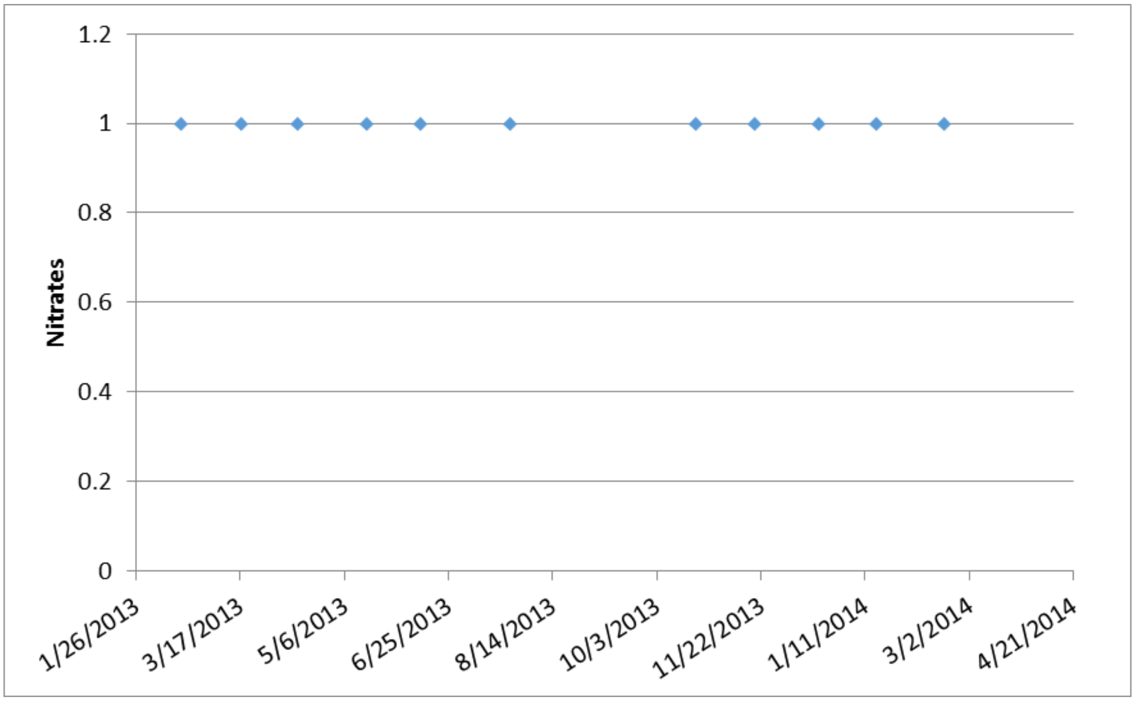

Figure 18: Nitrate-nitrogen at Site 18763

Site 18762– Gilleland Creek at Grand Avenue Parkway

Site Description

This site is at the Grand Avenue Parkway Crossing over Gilleland Creek. The banks of the creek are heavily wooded at this site. There is a nursery upstream of this location, and two housing developments on the north bank of the creek. Each housing development has a retention pond that drains into the creek.

Table 7: Descriptive parameters for Site 18762

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	14	452 ± 35	358	494
Water Temperature (°C)	14	19.4 ± 4.8	11.4	27.0
Dissolved Oxygen (mg/L)	14	6.5 ± 1.7	4.0	8.9
pH	14	7.5 ± 0.0	7.5	7.5
Nitrates	14	1.0 ± 0.0	1.0	1.0

Site was sampled 14 times between 1/22/2013 and 2/17/2014.

Sampling Information

This site was sampled 14 times between 1/22/2013 and 2/17/2014. The time of monitoring a this site ranged from 11:00 and 21:00.

Air and water temperature

Air and water temperatures were measured 14 times during this period. Air temperatures fluctuated between a minimum of 12.3°C in February of 2013 to a maximum of 31°C in August, 2013. The mean water temperature was 19.4°C. The water temperature varied from a low of 11.4°C in January 2014 to a high of 27°C in July, 2013.

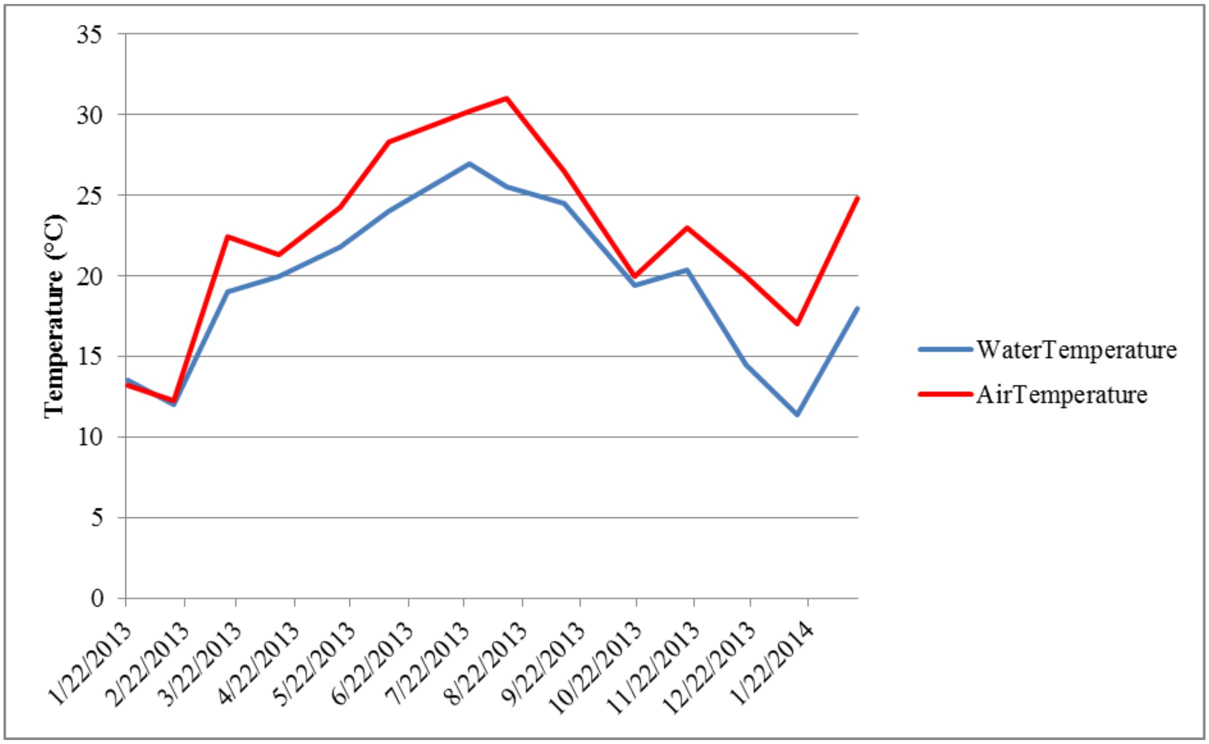

Figure 19: Air and water temperature at Site 18762

Total Dissolved Solids

Citizen scientists collected 14 sample sites at this site. The mean TDS was 452 mg/L. The maximum value was 494 mg/L and was collected on January 2013. The minimum value was 357 mg/L and was collected on May, 2013. There was no significant correlation between TDS and time detected for this site.

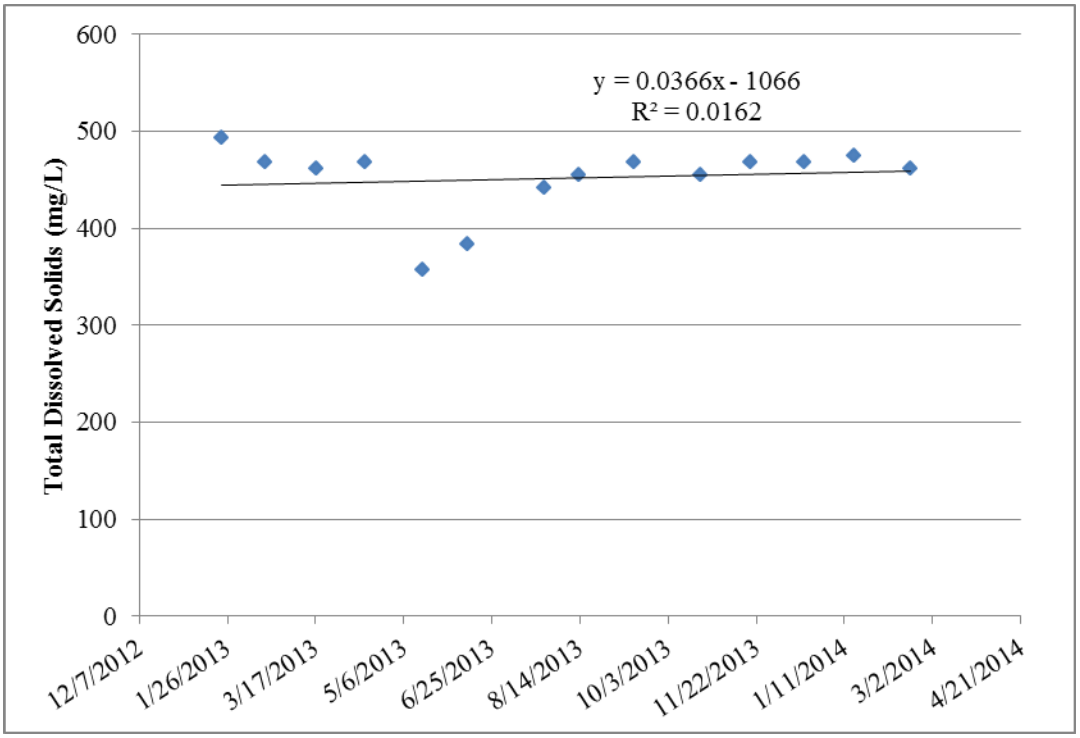

Figure 20: Total Dissolved Solids at Site 18762

Dissolved Oxygen

A total of 14 DO samples were taken at this site. The mean DO concentration was 6.5 mg/L. The minimum DO value was 4.0 and was recorded in May, 2013. The maximum DO value was 8.9 mg/L and was recorded in January of 2014. There was no correlation between DO and time observed at this site.

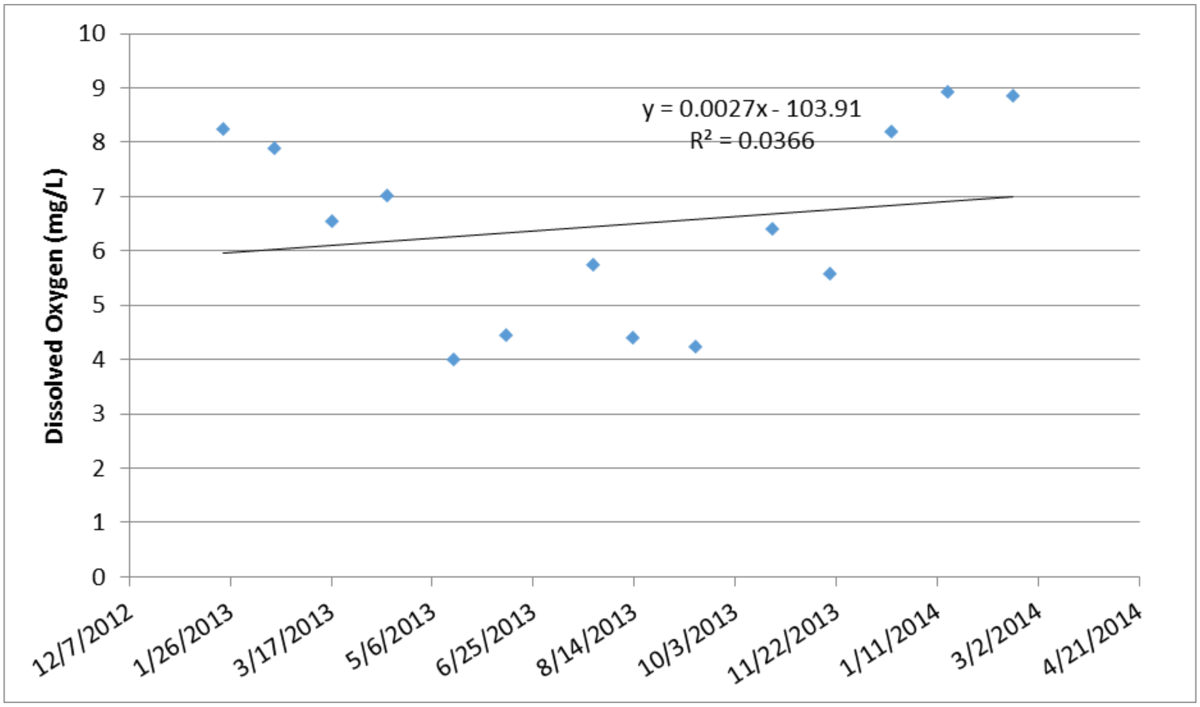

Figure 21: Total Dissolved Oxygen at Site 18762

pH

A total of 14 pH samples were taken at this site. The mean pH was 7.5 and it did not deviate from that value during this time.

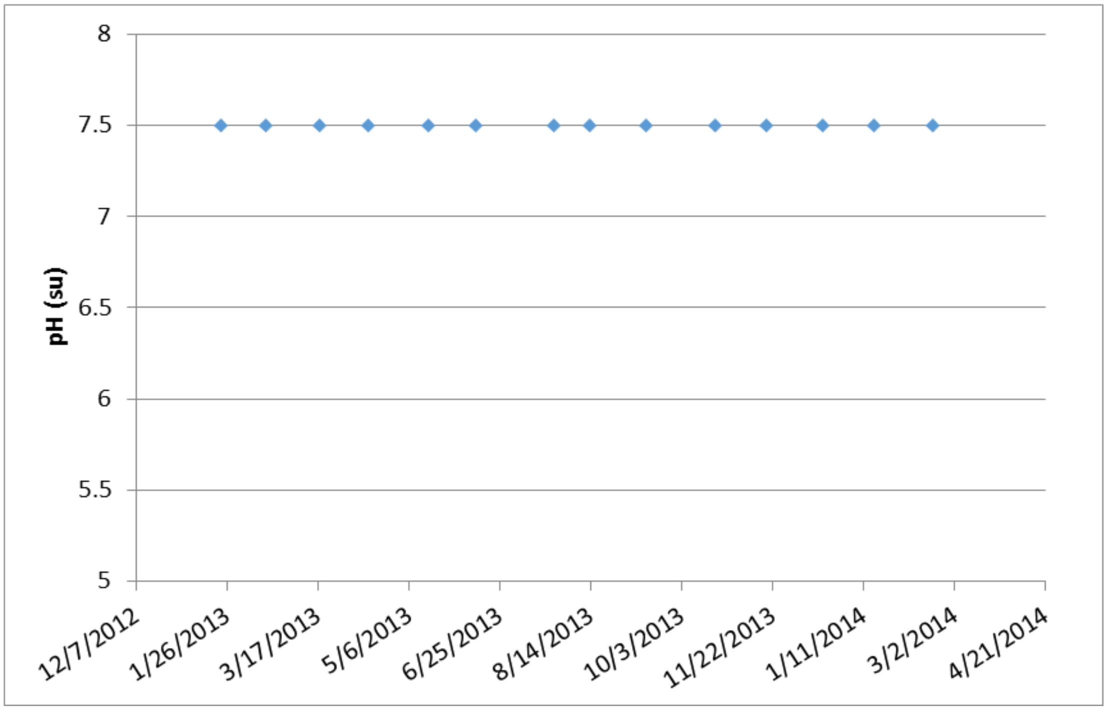

Figure 22: pH at Site 18762

Field Observations

Algae cover was recorded as absent for most of the sampling events. There was one event where the algae cover was recorded as rare (< 25%), and there was two events where the algae cover was recorded as common (26 – 50%). The water color was recorded as light green for all events and the water clarity was described as clear for all events.

Nitrate-Nitrogen

There were 14 nitrate-nitrogen samples taken at this site. The measurements for all sampling events were 1.0 mg/L.

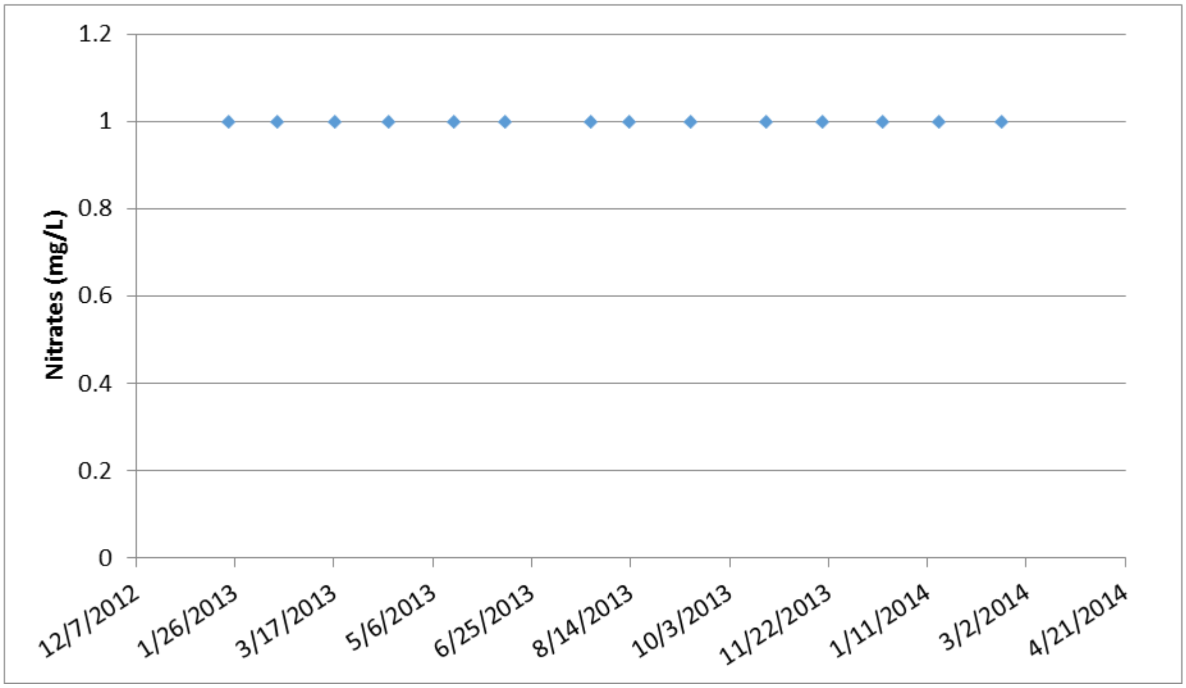

Figure 23: Nitrates-nitrogen at Site 18762

Site 16022– Gilleland Creek at Edgemere

Site Description

This site is where Edgemere Dr. dead-ends. The Gilleland Creek Trail West, a walking/biking trail, crosses the creek. The riparian area of the creek is wooded in this area and there is a wastewater treatment plant that discharges at this site.

Sampling Information

This site was sampled 6 times between 1/26/2013 and 1/12/2014. The time of monitoring varied between 13:00 and 21:00 at this site.

Table 8: Descriptive parameters for Site 16022

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	6	482 ± 17	455	507
Water Temperature (°C)	6	20.1 ± 4.7	15.0	26.5
Dissolved Oxygen (mg/L)	6	5.3 ± 1.7	2.7	7.3
pH	6	7.1 ± 0.2	7.0	7.5
Nitrates	6	1.0 ± 0.0	1.0	0.0

Site was sampled 6 times between 1/26/2013 and 1/12/2014.

Air and water temperature

There were 6 air and water temperatures taken at this site. The air temperature ranged from a low of 12 °C on January, 2013, to a high of 30 °C in September of 2013. The mean water temperature was 20.1 °C. The low water temperature was 15 °C and was recorded in January, 2014. The high water temperature was 26.5, and was recorded in August of 2013.

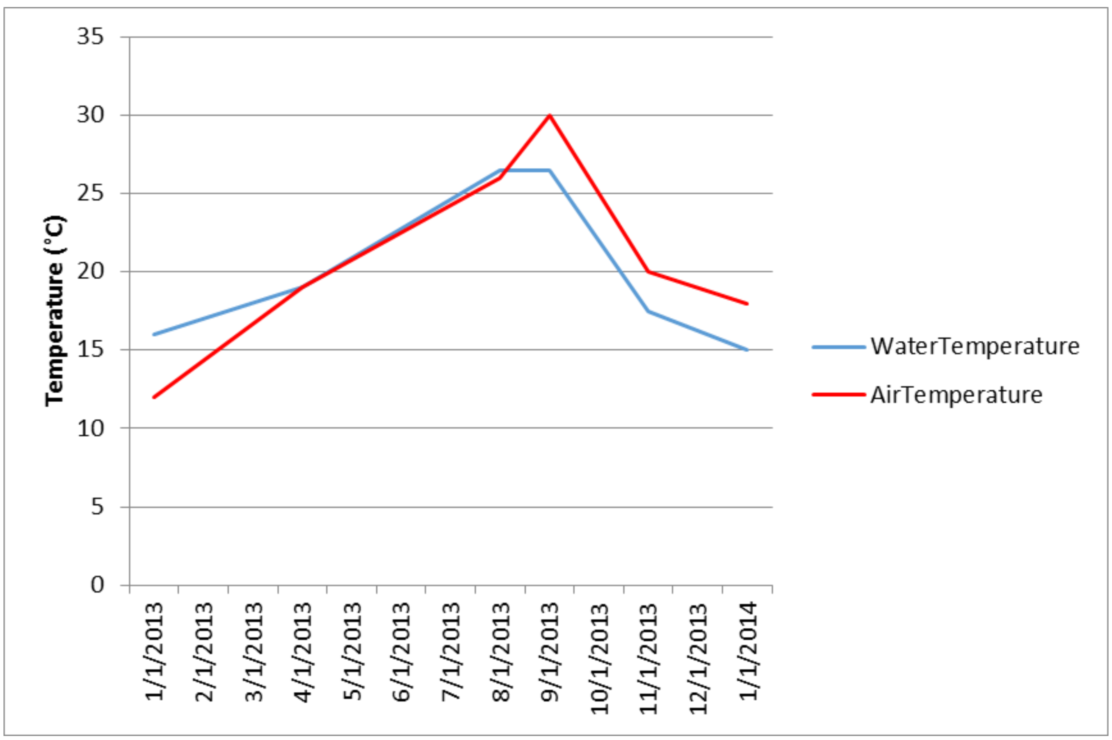

Figure 24: Air and Water Temperature at Site 16022.

Total Dissolved Solids

There were a total of 6 TDS measurements taken at this site. The mean TDS value was 482 mg/L. The minimum TDS value of 455 mg/L was recorded in August of 2013. The maximum TDS value of 507 mg/L was recorded on September, 2013.

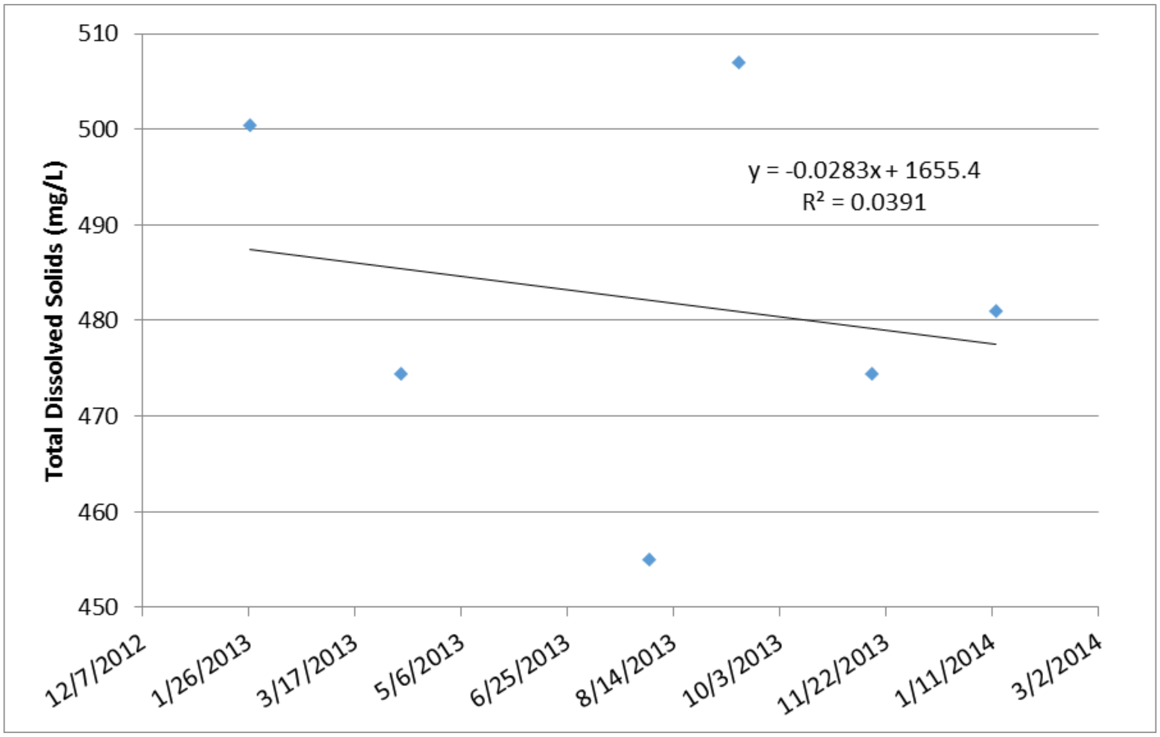

Figure 25: Total Dissolved Solids at Site 16022.

Dissolved Oxygen

There were a total of 6 DO samples taken at this site. The mean DO was 5.3 mg/L. The minimum DO value was 3.4 mg/L and was recorded in August, 2013. The maximum DO value recorded was 7.3 mg/L, and was taken in November, 2013.

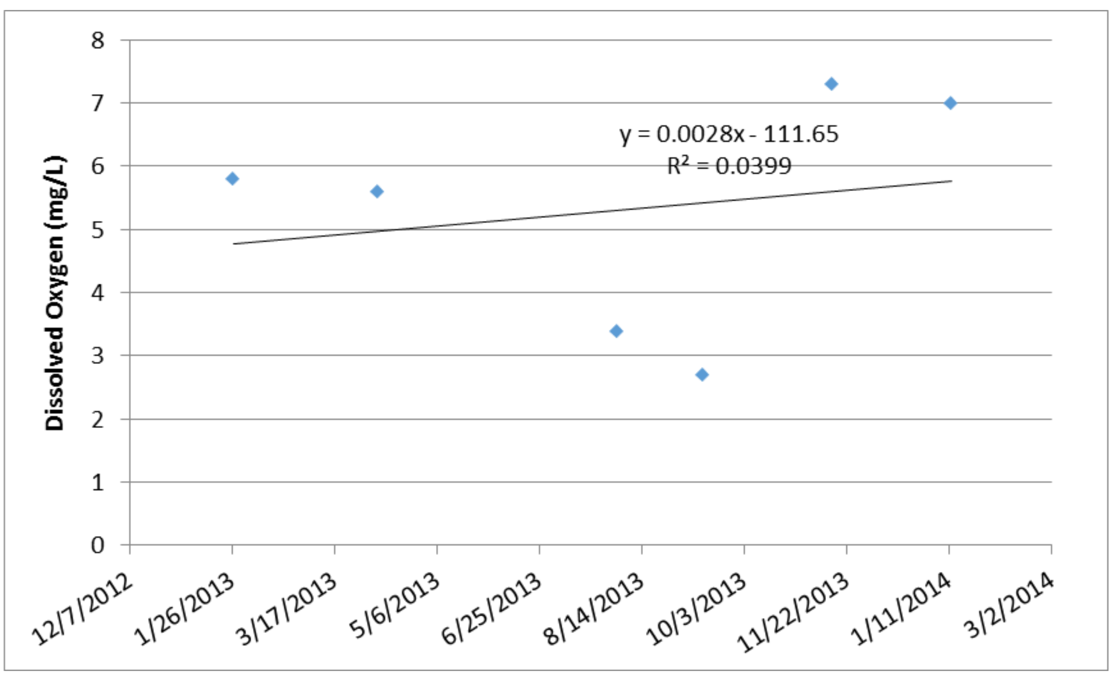

Figure 26: Total Dissolved Oxygen at Site 16022.

pH

There were a total of 6 pH measurements taken at this site. The pH for this site was 7.0 for all sampling events except one where it was 7.5.

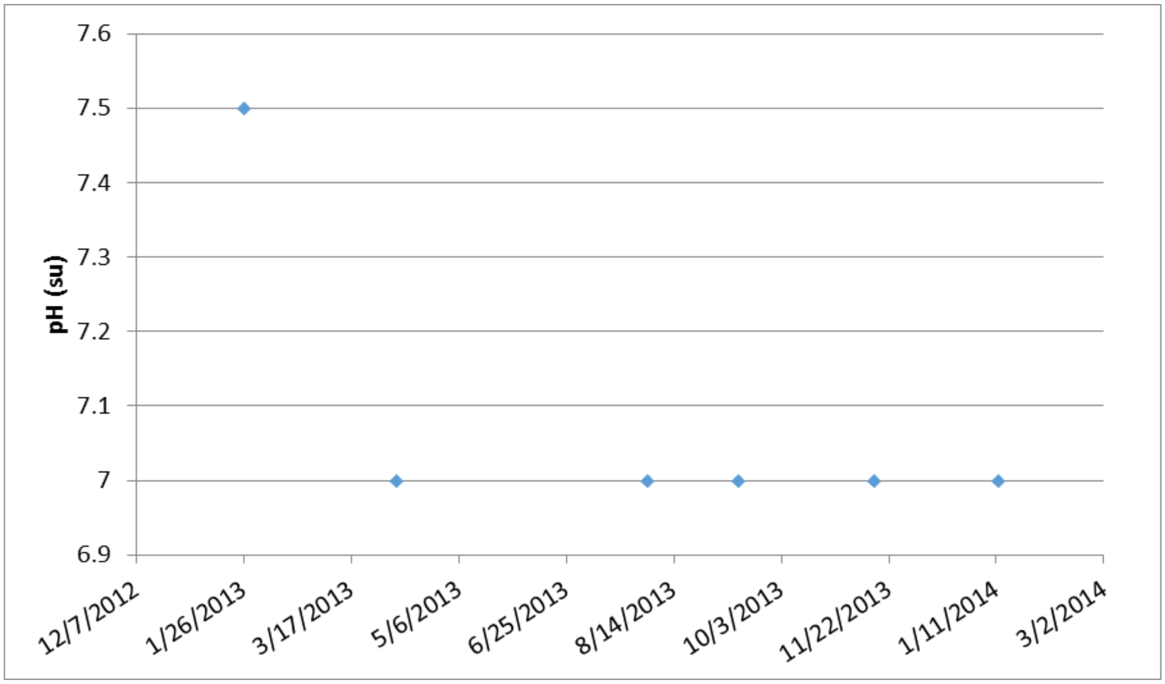

Figure 27: pH at Site 16022.

Field Observations

Algae cover was absent or rare for all events except one where it was recorded as abundant (51 – 75%). The water color was no color to a light green. The water clarity was described as clear for all events.

Nitrate-Nitrogen

There were 6 nitrate-nitrogen samples taken at this site. All measurements were recorded as 1.0 mg/L at this site.

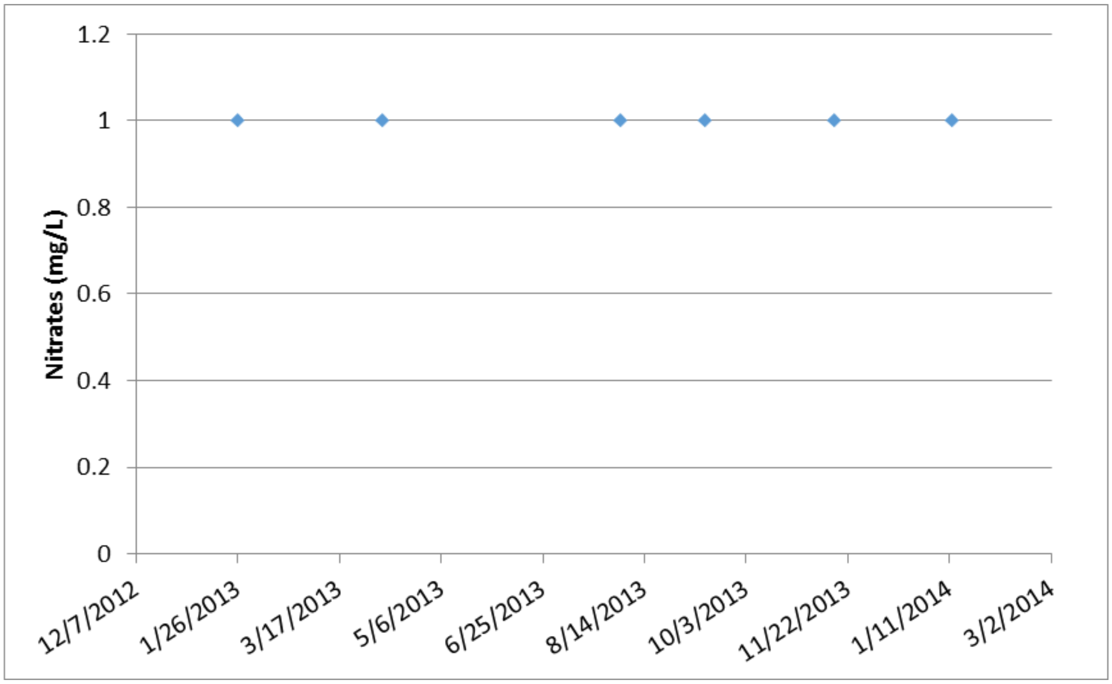

Figure 28: Nitrate-nitrogen at Site 16022.

Site 81017– Gillleland Creek at Swenson Farms

Site Description

This site is at the Swenson Farms Blvd. Bridge over Gilleland Creek. Both sides of the creek have open fields, and there is a large housing development to the north of the creek. The Gilleland Creek Trail runs along the creek downstream of this site.

Sampling Information

This site was sampled 8 times between 2/23/2013 and 1/26/2014. The time of sampling varied between 08:00 and 21:00.

Table 9: Descriptive parameters for Site 81017

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	8	679 ± 121	514	949
Water Temperature (°C)	8	19.4 ± 4.2	14.5	25.0
Dissolved Oxygen (mg/L)	8	9.6 ± 2.3	6.2	13.3
pH	8	7.4 ± 0.2	7.0	7.5
Nitrates	8	4.4 ± 2.7	1.0	8.0

Site was sampled 8 times between 2/23/2013 and 1/26/2014.

Air and water temperature

Air and water temperature were measured 8 times during this period. Air temperatures fluctuated between 13°C in February, 2013 and 33 ° C in August, 2013. The mean water temperature was 19.4 °C and ranged from a low of 15 °C in February, 2013 to a high of 25°C in August, 2013.

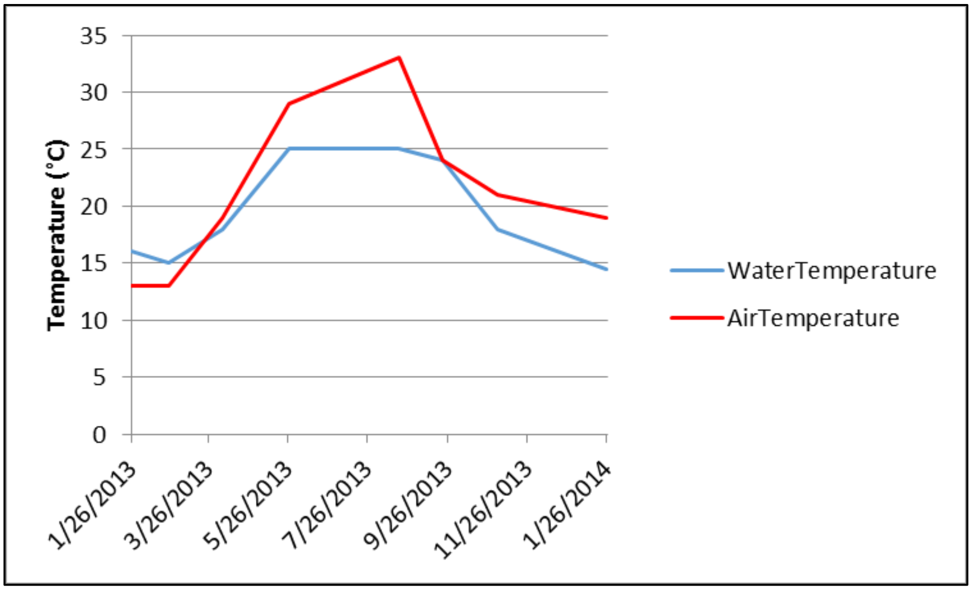

Figure 29: Air and Water Temperatures at Site 81017.

Total Dissolved Solids

There were a total of 8 TDS samples taken at this site. The mean TDS value was 679 mg/L. The minimum value was 514 mg/L and was recorded in November of 2013. The maximum value was 949 mg/L and was recorded in August of 2013. There was no correlation between TDS values and time detected at this site.

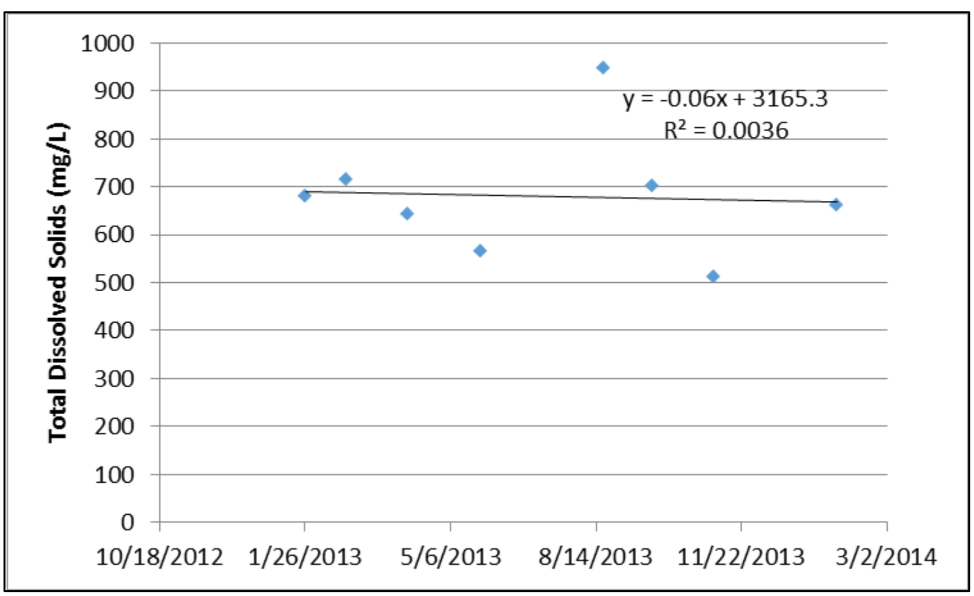

Figure 30: Total Dissolved Solids at Site 81017.

Dissolved Oxygen

There were 8 DO samples taken at this site. The mean DO value was 9.6 mg/L. The lowest DO value recorded at this site was 6.2 mg/L and was taken in August of 2013. The maximum DO value was recorded in January of 2014 and was 13.3 mg/L. There was no correlation between DO measurements and time detected at this site.

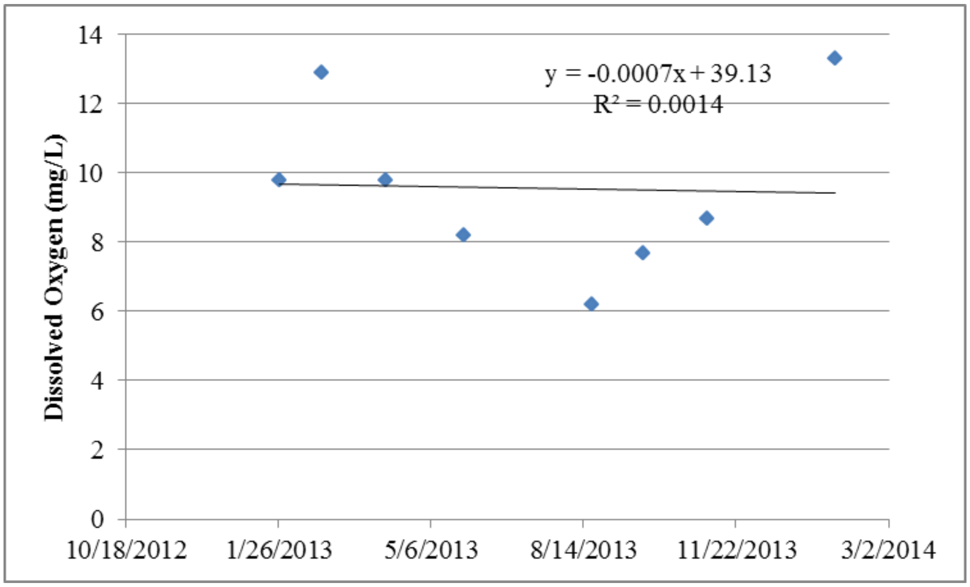

Figure 31: Dissolved Oxygen at Site 81017.

pH

There were 8 pH measurements taken at this site. The pH was 7.5 for all monitoring events except for one where it was recorded as 7.0.

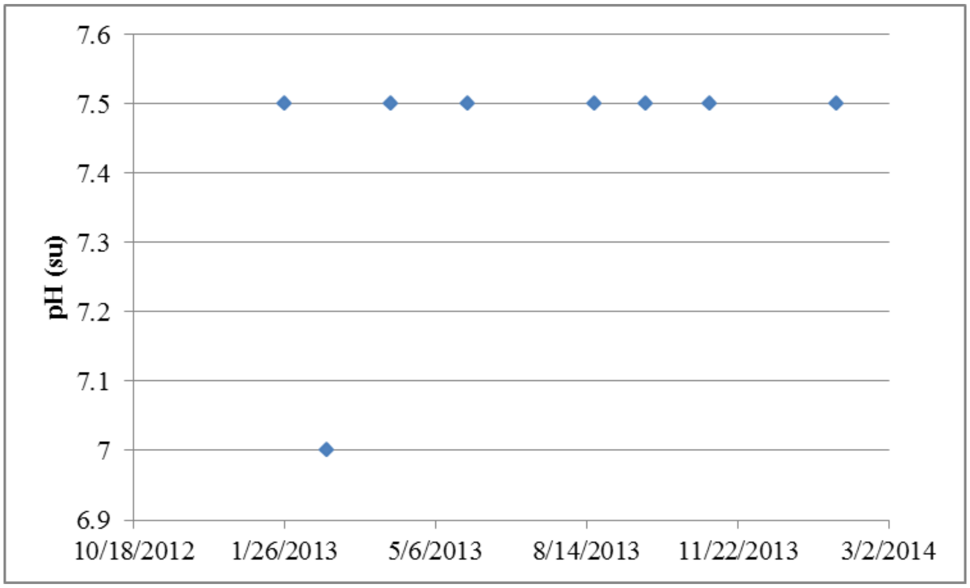

Figure 32: pH at Site 81017.

Field Observations

The algae cover was recorded as rare for all monitoring events except one where it was recorded as common (26 – 50%). The water color was described as light green to dark green, and the water clarity was described as clear.

Nitrate-Nitrogen

There were 8 nitrate-nitrogen samples taken from this site. The mean nitrate-nitrogen measurement was 4.4 mg/L and ranged from a low of 1.0 in May of 2013 to a high of 8.0 mg/L recorded in February and September of 2013.

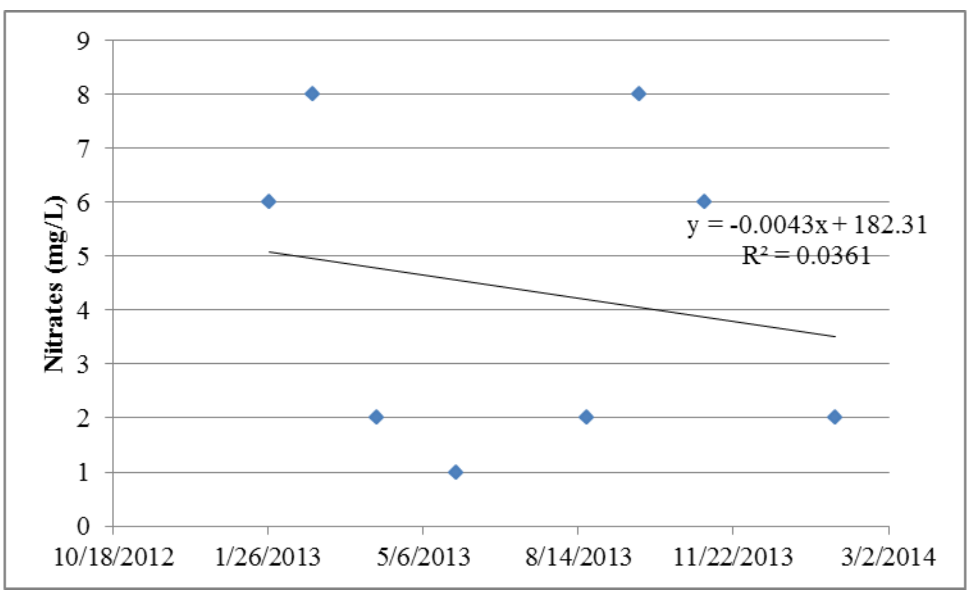

Figure 33: Nitrate-nitrogen at Site 81017.

Site 81016– Gilleland Creek at Pfluger Park Crossover

Site Description

This site is at a walking/bike trail that crosses Gilleland Creek in Pfluger Park. Both banks are lined with trees, and this site is within a suburban neighborhood.

Sampling Information

This site was sampled 6 times between 3/3/2013 and 1/18/2014. The time of sampling ranged from 14:00 to 23:00.

Table 10: Descriptive parameters for Site 81016

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	6	788 ± 146	585	981
Water Temperature (°C)	6	22.9 ± 5.6	14.0	30.0
Dissolved Oxygen (mg/L)	6	5.9 ± 1.5	4.1	8.6
pH	6	7.1 ± 0.2	7.0	7.5
Nitrates	5	2.2 ± 1.0	1.0	4.0

Site was sampled 6 times between 3/3/2013 and 1/18/2014.

Air and water temperature

There were 6 air and water temperatures taken at this site during this time period. The air temperature ranged from a low of 22°C taken in March 2013 to a high of 34°C taken in August of 2013. The mean water temperature was 22.9 °C. The water temperature varied between a low of 17.5°C in March, 2013, to a high of 30 °C.

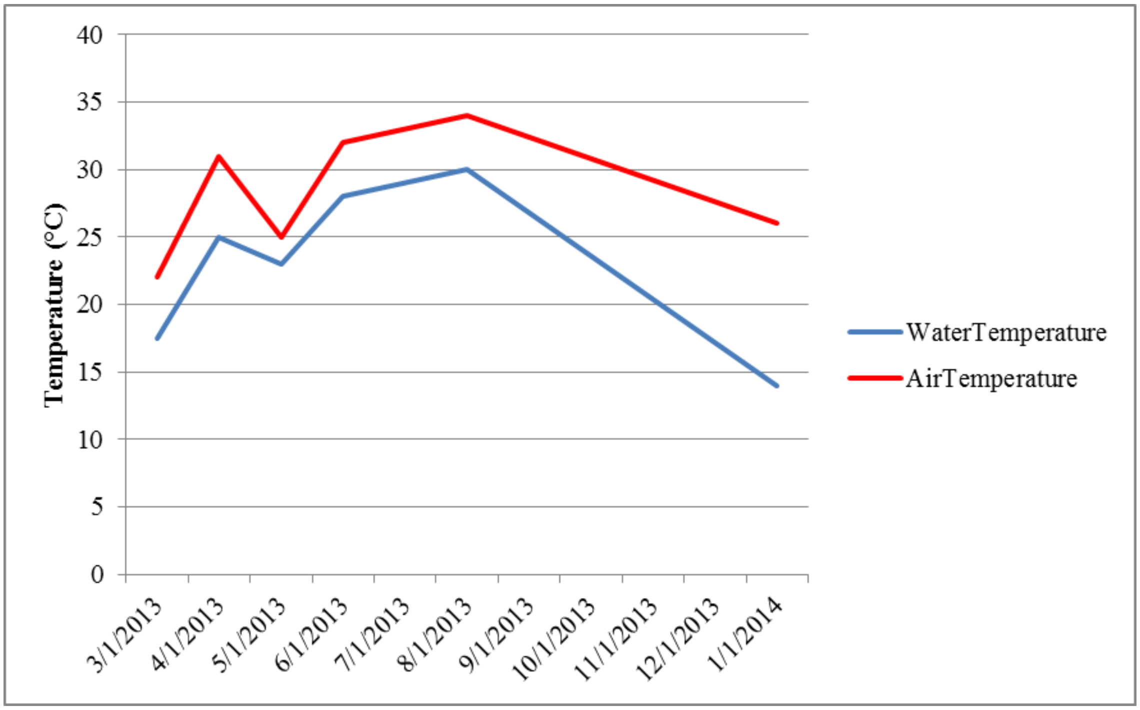

Figure 34: Air and water temperature at Site 81016.

Total Dissolved Solids

There were 6 TDS samples taken at this site. The mean TDS value was 788 mg/L. The minimum TDS measurement was 585 mg/L and was recorded in May, 2013. The maximum TDS measurement was 981 mg/L and was recorded in August of 2013.

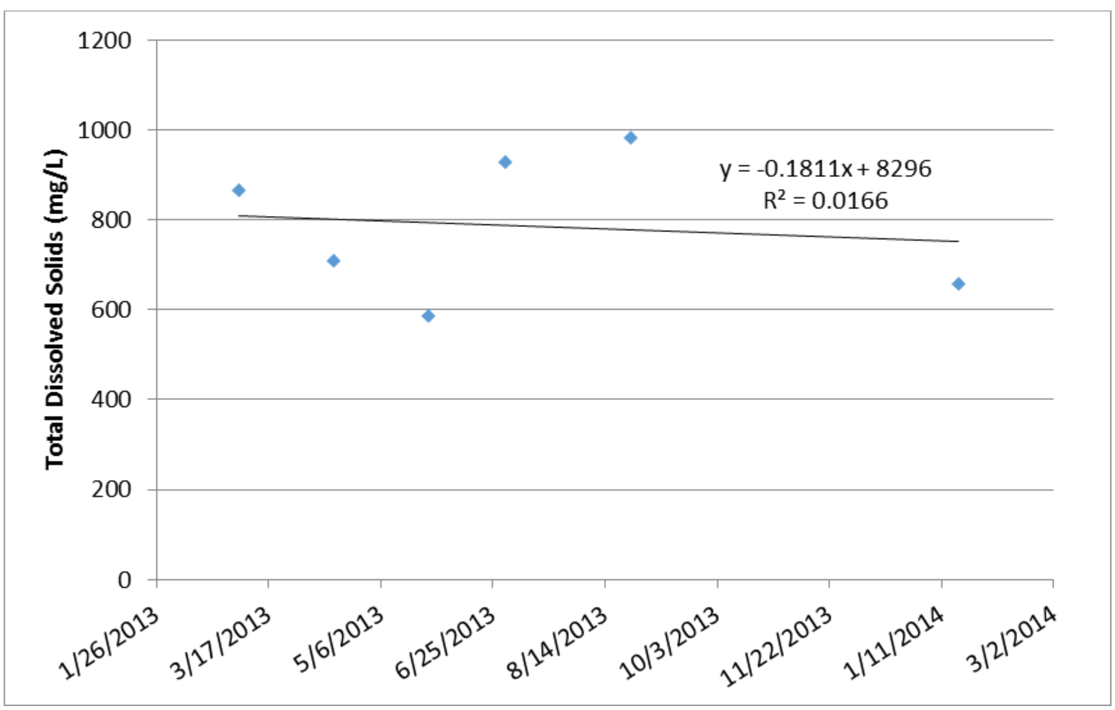

Figure 35: Total Dissolved Solids at Site 81016.

Dissolved Oxygen

There were 6 DO samples taken at this site during this time period. The mean value was 5.9 mg/L. The minimum value was 4.1 mg/L and was taken in June, 2013. The maximum DO value was 8.6 mg/L and was taken in January of 2014.

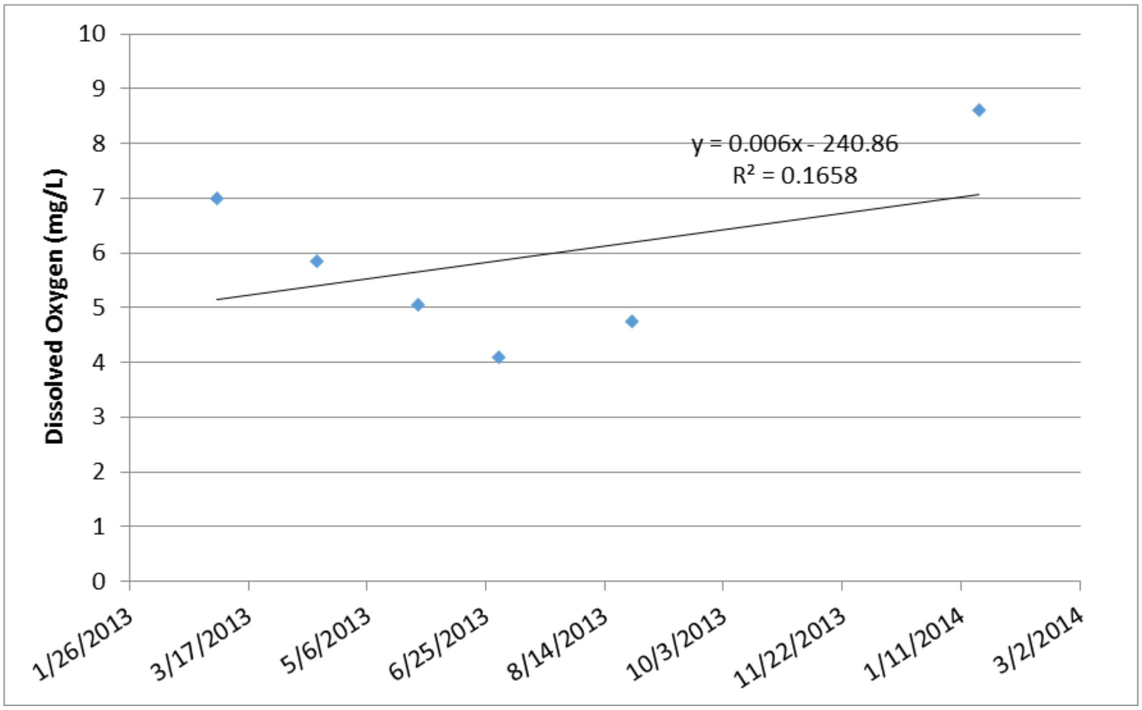

Figure 36: Dissolved Oxygen at Site 81016.

pH

There were 6 pH measurements taken at this site during this time period. The pH was 7.0 for all monitoring events except for one which was 7.5 and was taken in January, 2013.

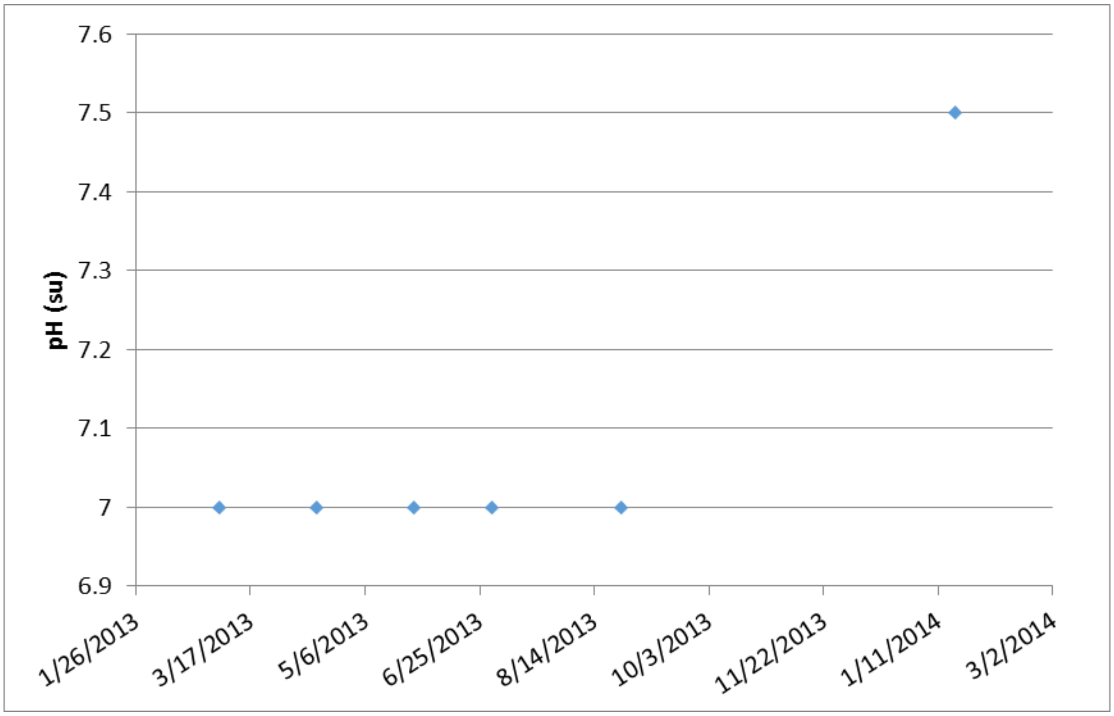

Figure 37: pH at Site 81016.

Field Observations

Algae cover was recorded as absent or rare for all monitoring events except for one where it was recorded as abundant (51 – 75%). The water was described as having no color and the clarity was described as clear.

Nitrate-Nitrogen

There were 6 nitrate-nitrogen measurements taken at this site during this time period. The mean nitrate-nitrogen concentration was 2.2 mg/L. The minimum nitrate-nitrogen concentration 1.0 mg/L and was measured in April, 2013. The maximum nitrate-nitrogen concentration was 4.0 mg/L and was recorded in August of 2013.

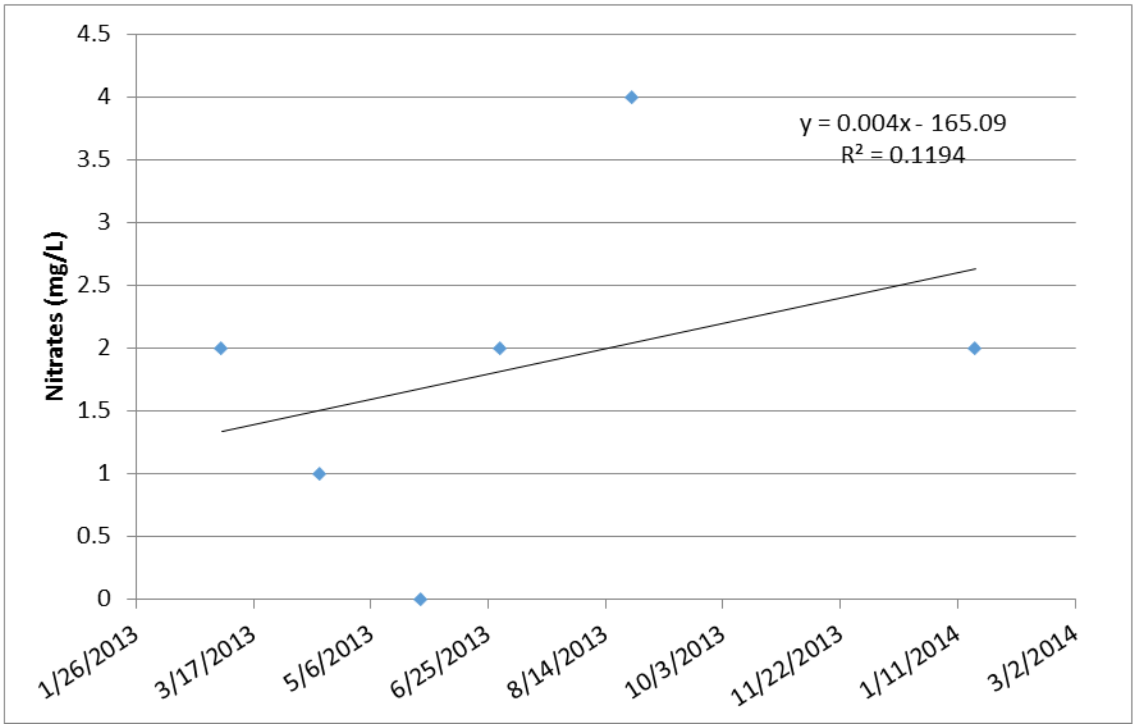

Figure 38: Nitrate-nitrogen at Site 81016.

Site 15954– Gilleland Creek at Railroad Avenue

Site Description

This site is at the N. Railroad Avenue Bridge over Gilleland Creek. Gilleland Creek Park is on the north bank of the creek. The south bank of the creek is heavily wooded.

Sampling Information

This site was sampled 106 times between 8/3/1995 and 4/16/2013. The time of monitoring ranged between 09:00 and 22:00.

Figure 39: Descriptive parameters for Site 15954

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	97	567 ± 217	188.5	1001
Water Temperature (°C)	104	21.1 ± 5.4	9.5	30.0
Dissolved Oxygen (mg/L)	97	7.7 ± 1.9	3.7	12.6
pH	104	8.0 ± 0.3	7.0	8.5
Nitrates	80	3.4 ± 2.6	1.0	10

Site was sampled 106 times between 8/3/1995 and 4/16/2013.

Air and water temperature

Air and water temperatures were taken at 104 sites during this time period. The air temperature ranged from 4°C taken in January of 1999 to a high of 34°C taken in April, 2006. The mean water temperature was 21.1°C. The minimum water temperature was 10°C and was taken in 1999. The maximum water temperature was 27 °C and was recorded in April, 2006.

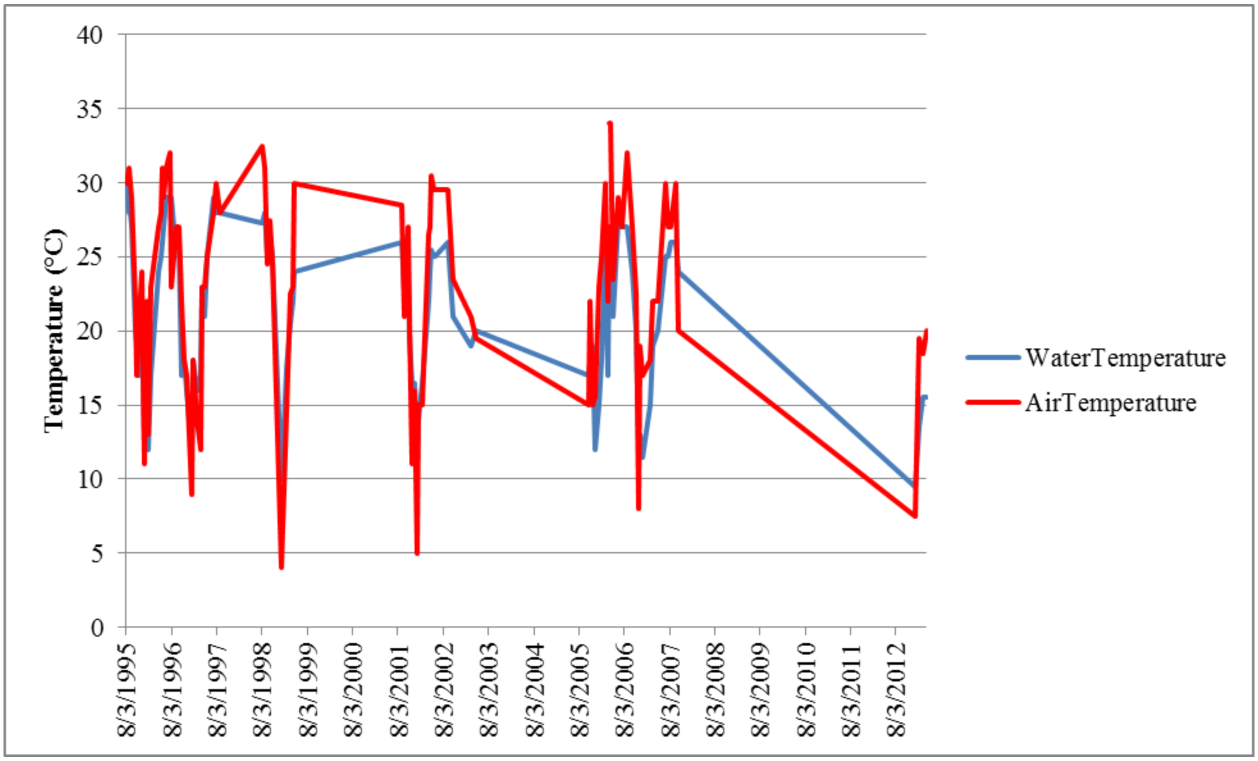

Figure 40: Air and water temperature at Site 15954.

Total Dissolved Solids

There were 97 TDS samples taken at this site. The mean TDS was 567 mg/L. The minimum value was 188.5 mg/L and was recorded in March of 1997. The maximum TDS value was 1001 mg/L and was recorded in January of 2006. There was a significant correlation between TDS concentrations and time with TDS increasing over the years of sampling. The high R^2 value of 0.46 indicates a strong relationship between the two variables.

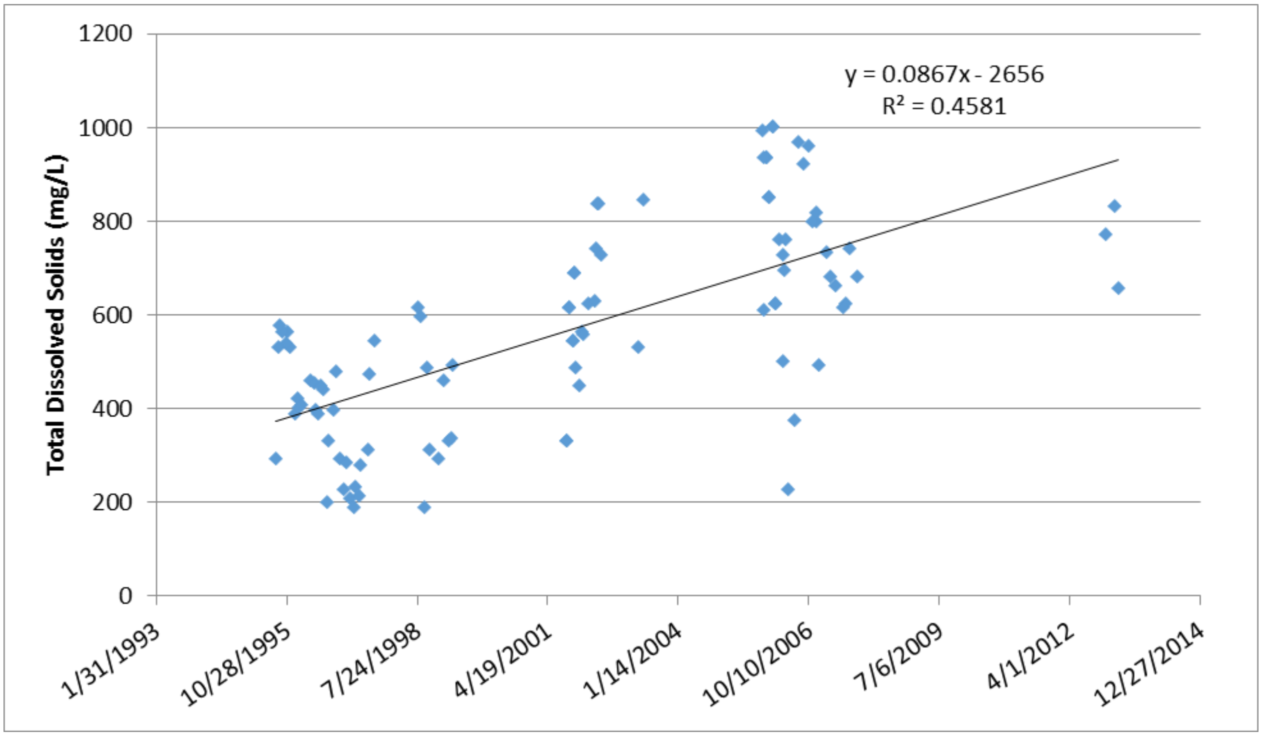

Figure 41: Total Dissolved Solids at Site 15954.

Dissolved Oxygen

There were 97 DO samples taken at this site during this time period. The mean DO concentration was 7.7 mg/L. The minimum DO value was 3.7 mg/L and was taken in April 1996. The maximum DO value was 12.6 mg/L and was taken in January 2002. There was no correlation between DO and time observed at this site.

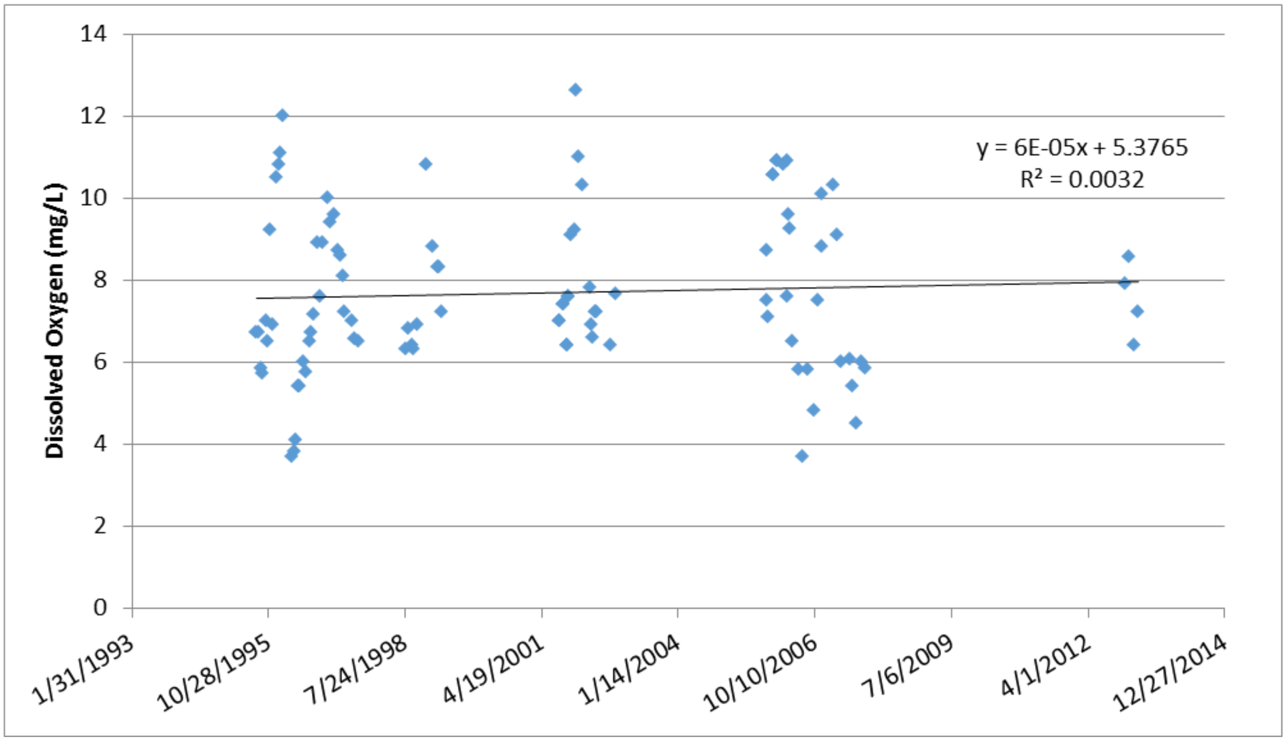

Figure 42: Dissolved Oxygen at Site 15954.

pH

There were 104 pH measurements taken at this site with a mean value of 8.0. The minimum value recorded was 7.0 and was recorded many times during the time period. The maximum value was 8.5 and was recorded in December of 2006, and April of 2007. There was no correlation between pH and time observed at this site during this time period.

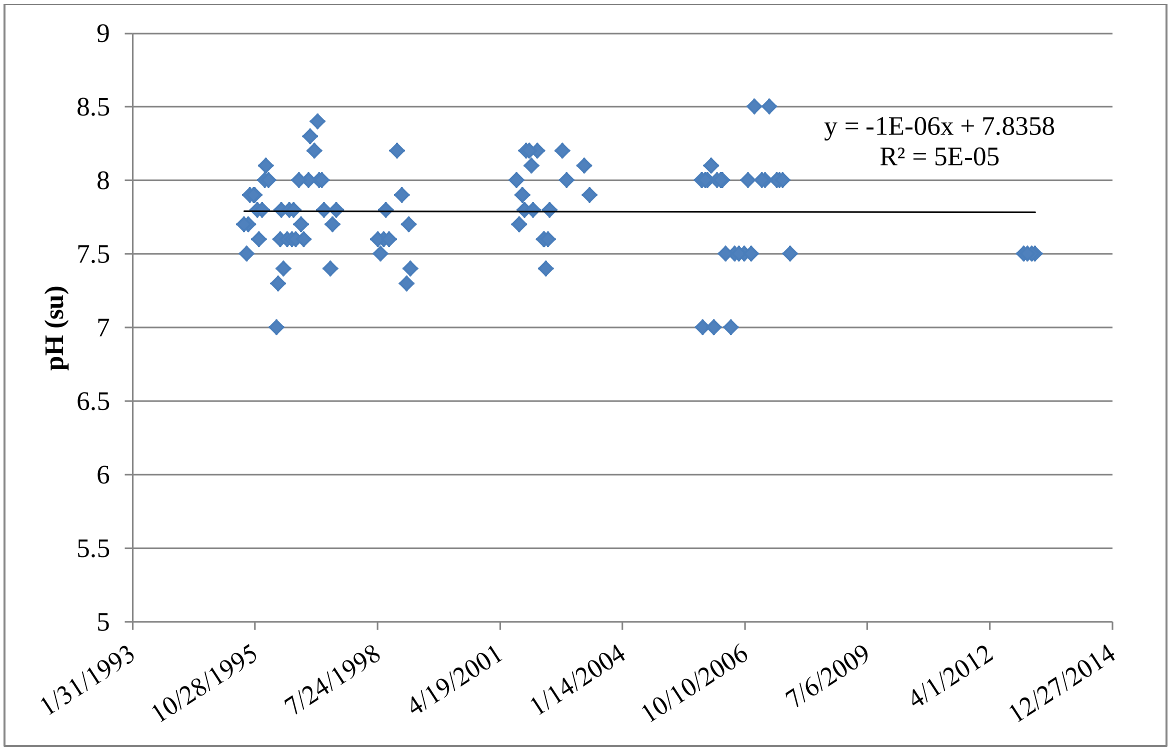

Figure 43: Dissolved Oxygen at Site 15954

Field Observations

The Algae cover was recorded as absent or rare for almost all of the monitoring events. The water color was described as having no color or light green. The water clarity was described as clear a majority of the time.

Nitrate-Nitrogen

There were 80 samples taken at this site during the time period. The mean nitrate-nitrogen concentration was 3.4 mg/L. The minimum value was 1.0 mg/L and was recorded several times during the time period. The maximum value recorded was 10 mg/L, and was recorded several 4 times during the time period.

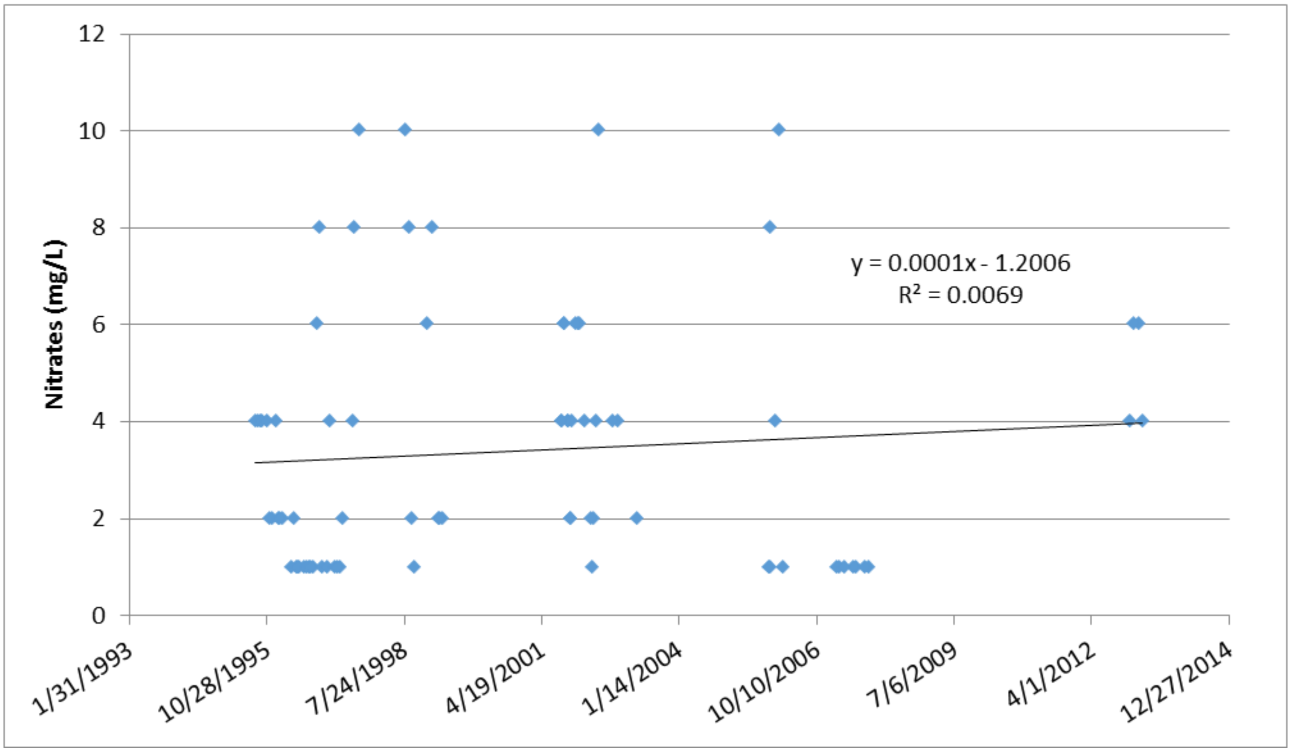

Figure 44: Nitrate-Nitrogen at Site 15954.

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.

Gilleland Creek References

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Appendix A- List of Maps, Tables, and Figures

Tables

Figures