Data Collection Report

for the

Village Creek-Lake Arlington Watershed Protection Plan

November 2017

Village Creek
Lake Arlington
WATERSHED
PROTECTION

Trinity River Authority of Texas

On the cover:

Flow data collection looking downstream on Village Creek at the Renfro Road crossing in Burleson, Texas.

Data Collection Report

for

The Village Creek-Lake Arlington Watershed Protection Plan

Funded by

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Investigating Entities

The Trinity River Authority of Texas
Tarleton State University, Texas Institute for Applied Environmental Research

Prepared by

Aaron Hoff, Trinity River Authority
Angela Kilpatrick, Trinity River Authority

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Table of Contents

List of Figures

List of Tables

List of Acronyms

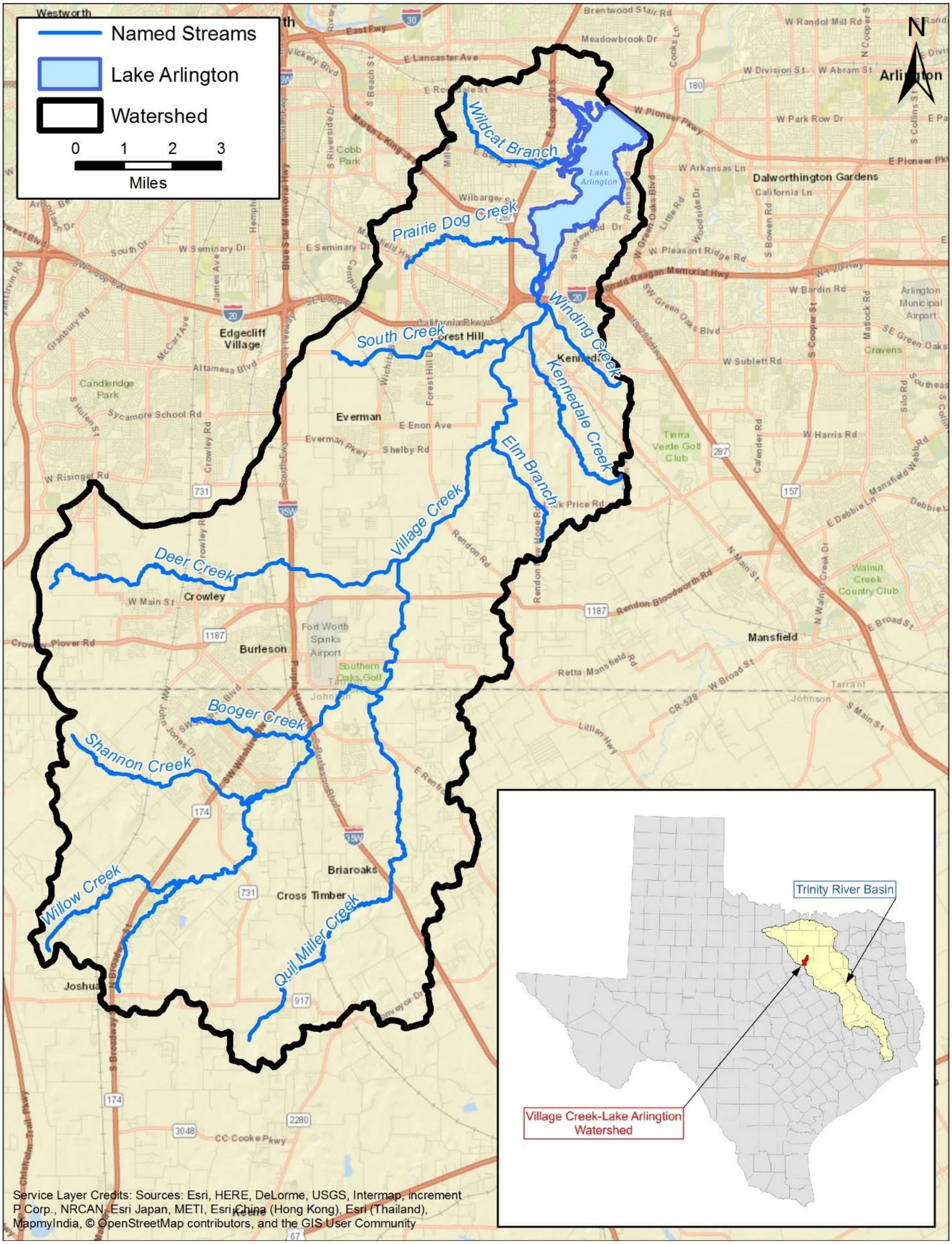
BMP	best management practice
Chl-a	chlorophyll-a
CRP	Clean Rivers Program
DO	dissolved oxygen
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
LAMP	Lake Arlington Master Plan
LDC	load duration curve
NO_2	nitrite
NO_3	nitrate
OB	Optical brightener
OP	orthophosphate
OSSF	on-site sewage facility
SELECT	Spatially Explicit Load Enrichment Calculation Tool
Sp. Cond	specific conductance
St. Dev	standard deviation
SWQM	Surface Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TKN	total Kjeldahl nitrogen
TP	total phosphorous
TRA	Trinity River Authority of Texas
TRWD	Tarrant Regional Water District
TSS	total suspended solids
TSWQS	Texas Surface Water Quality Standards
VCLA	Village Creek-Lake Arlington Watershed
WPP	watershed protection plan

1.0 Introduction

This data collection report was prepared as part of an effort to restore water quality within Village Creek. There is also a further goal of protecting water quality in Lake Arlington, which utilizes the creek as its main tributary. These waterbodies and their shared watershed are located in Tarrant and Johnson Counties, in the southern extent of the Dallas/Fort Worth Metroplex in North-central Texas (Figure 1-1). The data collected as part of this project and the ensuing analysis thereof will serve to expand and enhance the knowledge the stakeholder group as they make important management decisions to improve and protect water quality in the Village Creek-Lake Arlington watershed. This project will result in the development of a watershed protection plan (WPP) that integrates the results of these collected water quality data, Spatially Explicit Load Enrichment Calculation Tool (SELECT) calculations, and load duration curve (LDC) results with goals and strategies for water quality improvements. Aspects of the SELECT and LDC analyses will be covered in detail in the Technical Report on Source Identification and Load Reduction Evaluation, developed as part of this project.

The goal of this project was to conduct both routine and targeted water quality sampling and analysis for several parameters, including *Escherichia coli* (*E. coli*), nitrites (NO_2), nitrates (NO_3), total Kjehdahl nitrogen (TKN), total phosphorus (TP), orthophosphate (OP), in order to obtain the technical information necessary to build the WPP. The data collected will be used to inform other reports developed as part of this project, which will evaluate annual and seasonal trends, spatial patterns, hydrologic characteristics (*i.e.,* flow characterization), and other relational patterns that will help identify how and when *E. coli* and other pollutants are entering the system. Three distinct sampling regimes were conducted as part of this project:

- Regime #1 - routine sampling at 11 sites (herein after called routine monitoring). The routine monitoring consisted of bi-monthly *E. coli*, NO_2, NO_3, TKN, TP, and OP samples, as well as field and flow parameters. These routine samples were consistently taken near the beginning of the two-month cycle, regardless of flow conditions.
- Regime #2 - bi-monthly flow-biased monitoring at the same 11 sites (herein after called flow-biased monitoring) and for the same parameters described for the routine monitoring. The flows represented by these sample events were selected to represent a wide range of flows needed for building functional LDCs. The goal of the flow-biased monitoring was to ensure that, to the furthest extent possible, the full range of flows were represented in the resultant data set. Therefore, sampling for targeted flows was based on data gaps that developed in the routine monitoring. For example, if routine monitoring did not include high flow events, then higher flows were targeted for monitoring. Conversely, if routine monitoring tended to occur during normal and higher flow events, then low flow events were targeted. The needed flows and timing of flow-biased monitoring were evaluated on a continuous basis during the course of sampling to ensure that any flow-biased samples were spread out during the project as evenly as possible.



Basemap: ESRI World Streetmap.

Figure 1-1. Location of Village Creek-Lake Arlington Watershed.

- Regime #3 - optical brightener (OB) testing at various sites in the watershed including, but not necessarily limited to, the 11 sites at which routine and flow-biased monitoring were conducted. This testing consisted of deployment of natural untreated cotton sampling medium for a period of time (generally 24 to 48 hours). The sampling medium was placed in a rigid flow through sample container and fixed in the stream. After deployment, the sample medium was collected and checked for fluorescence due to the detectable presence of OBs. These compounds are found in many laundry detergents and can indicate the presence of sewage leaks or failing septic systems in the upstream watershed. The results of this testing do not generate numeric data but may help identify the potential sources of E. coli in the watersheds and provide information for the development of the WPP. In addition, this testing may help in the selection of best management practices (BMPs) for some areas of the Lake Arlington-Village Creek Watershed.

Additional information such as land use, soil types, locations of septic systems (also known as on-site sewage facilities or OSSFs), etc. will be obtained from the existing Lake Arlington Master Plan (LAMP) and acquired from other sources (e.g. stakeholders) as needed to fill data gaps for SELECT calculations.

The purpose of this report is to summarize the data collected as part of the Village Creek-Lake Arlington Watershed Protection planning project during the watershed characterization phase. This will include basic statistical parameters, such as the data range, mean, standard deviation (st. dev), as well as measures of dataset completeness (count and percent completeness). A more rigorous statistical and analytical analysis will be presented in the Technical Report that will be generated at a later stage of the project.

2.0 Overview of Sample Collection Efforts

Sampling conducted as part of this project began on 6/27/2016 and concluded on 5/9/2017. A list of all analytical parameters collected in the field are provided in Table 2-1. Please refer to Section A7, Quality Objectives and Criteria of the Quality Assurance Project Plan (QAPP) for Monitoring and Data Acquisition requirements for more information about sample collection, processing, and representativeness. For additional information about the collection, preservation, and laboratory analysis of samples collected for these parameters, please consult the Texas Commission on Environmental Quality (TCEQ) *SWQM Procedures Manual, Volume 1: Physical and Chemical Monitoring Methods* (TCEQ 2012). A brief description of the parameters of interest to stakeholders is provided in Section 2.1 through 2.4 below.

Table 2-1. List of collected parameters for water quality monitoring.

Field Parameters										
Parameter	**Units**	**Matrix**	**Method**	**Parameter Code**	**AWRL**	**Limit of Quantitation (LOQ)**	**Recovery at LOQ (%)**	**Precision (RPD of LCS/LCSD)**	**Bias %Rec. of LCS**	**Analysis Location**
TEMPERATURE, WATER (DEGREES CENTIGRADE)	DEG C	water	SM 2550 B and TCEQ SOP V1	00010	NA[1]	NA	NA	NA	NA	Field
TEMPERATURE, AIR (DEGREES CENTIGRADE)	DEG C	air	SM 2550 B and TCEQ SOP V1	00020	NA[1]	NA	NA	NA	NA	Field
TRANSPARENCY, SECCHI DISC (METERS)	meters	water	TCEQ SOP V1	00078	NA[1]	NA	NA	NA	NA	Field
SPECIFIC CONDUCTANCE,FIELD (US/CM @ 25C)	uS/cm	water	EPA 120.1 and TCEQ SOP, V1	00094	NA[1]	NA	NA	NA	NA	Field
OXYGEN, DISSOLVED (MG/L)	mg/L	water	SM 4500-O G & TCEQ SOP V1	00300	NA[1]	NA	NA	NA	NA	Field
PH (STANDARD UNITS)	s.u	water	EPA 150.1 and TCEQ SOP V1	00400	NA[1]	NA	NA	NA	NA	Field
DAYS SINCE PRECIPITATION EVENT (DAYS)	days	other	TCEQ SOP V1	72053	NA[1]	NA	NA	NA	NA	Field
TURBIDITY,FIELD NEPHELOMETRIC TURBIDITY UNITS, NTU	NTU	water	TCEQ SOP V1	82078	NA[1]	NA	NA	NA	NA	Field
DEPTH OF BOTTOM OF WATER BODY AT SAMPLE SITE	meters	water	TCEQ SOP V2	82903	NA[1]	NA	NA	NA	NA	Field
MAXIMUM POOL WIDTH AT TIME OF STUDY (METERS)[2]	meters	other	TCEQ SOP V2	89864	NA[1]	NA	NA	NA	NA	Field
MAXIMUM POOL DEPTH AT TIME OF STUDY(METERS)[2]	meters	other	TCEQ SOP V2	89865	NA[1]	NA	NA	NA	NA	Field
POOL LENGTH, METERS[2]	meters	other	TCEQ SOP V2	89869	NA[1]	NA	NA	NA	NA	Field
% POOL COVERAGE IN 500 METER REACH[2]	%	other	TCEQ SOP V2	89870	NA[1]	NA	NA	NA	NA	Field
PRIMARY CONTACT, OBSERVED ACTIVITY (# OF PEOPLE OBSERVED)	# of people observed	other	NA	89978	NA	NA	NA	NA	NA	Field
EVIDENCE OF PRIMARY CONTACT RECREATION (1 = OBSERVED, 0 = NOT OBSERVED)	NU	other	NA	89979	NA	NA	NA	NA	NA	Field

Flow Parameters										
FLOW STREAM, INSTANTANEOUS (CUBIC FEET PER SEC)	cfs	water	TCEQ SOP V1	00061	NA[1]	NA	NA	NA	NA	Field
FLOW SEVERITY:1=No Flow,2=Low,3=Normal,4=Flood,5=High,6=Dry	NU	water	TCEQ SOP V1	01351	NA[1]	NA	NA	NA	NA	Field
FLOW MTH 1=GAGE 2=ELEC 3=MECH 4=WEIR/FLU 5=DOPPLER	NU	other	TCEQ SOP V1	89835	NA[1]	NA	NA	NA	NA	Field
Bacteriological Parameters in Water										
Parameter	**Units**	**Matrix**	**Method**	**Parameter Code**	**AWRL**	**Limit of Quantitation (LOQ)**	**Recovery at LOQ (%)**	**Precision (RPD of LCS/LCSD)**	**Bias %Rec. of LCS**	**Lab**
E. COLI, COLILERT, IDEXX METHOD, MPN/100ML	MPN/100 mL	water	Colilert/ Colilert-18	31699	1	1	NA	0.50[3]	NA	TRA
E. COLI, COLILERT, IDEXX, HOLDING TIME	hours	water	NA	31704	NA	NA	NA	NA	NA	TRA
Conventional Parameters in Water										
RESIDUE, TOTAL NONFILTRABLE (MG/L)	mg/L	water	SM 2540 D	00530	5	2	NA	NA	NA	TRA
RESIDUE, VOLATILE NONFILTRABLE (MG/L)	mg/L	water	EPA 160.4	00535	5	2	NA	NA	NA	TRA
NITRITE NITROGEN, TOTAL (MG/L AS N)	mg/L	water	EPA 300.0 Rev. 2.1 (1993)	00615	0.05	0.05	70-130	20	80-120	TRA
NITRATE NITROGEN, TOTAL (MG/L AS N)	mg/L	water	EPA 300.0 Rev. 2.1 (1993)	00620	0.05	0.05	70-130	20	80-120	TRA
NITROGEN, KJELDAHL, TOTAL (MG/L AS N)	mg/L	water	EPA 351.2	00625	0.2	0.2	70-130	20	80-120	TRA
PHOSPHORUS, TOTAL, WET METHOD (MG/L AS P)	mg/L	water	SM 4500 P E	00665	0.06	0.02	70-130	20	80-120	TRA
CHLOROPHYLL-A UG/L SPECTROPHOTOMETRIC ACID. METH	µg/L	water	SM 10200 H No field of accreditation (FOA) offered	32211	3	3	NA	20	80-120	TRA
RESIDUE,TOTAL FILTRABLE (DRIED AT 180C) (MG/L)	mg/L	water	SM 2540 C	70300	10	10	NA	20	80-120	TRA
ORTHOPHOSPHATE PHOSPHORUS,DISS,MG/L,FILTER >15MIN	mg/L	water	SM 4500 P F	70507	0.04	0.02	70-130	20	80-120	TRA

1 - Reporting to be consistent with SWQM guidance and based on measurement capability.
2 - To be routinely reported when collecting data from perennial pools.
3 -This value is not expressed as a relative percent difference. It represents the maximum allowable difference between the logarithm of the result of a sample and the logarithm of the duplicate result. See Section B5.

References:
United States Environmental Protection Agency (USEPA) Methods for Chemical Analysis of Water and Wastes, Manual #EPA-600/4-79-020
American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF), Standard
TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods, 2012 (RG-415).
TCEQ SOP, V2 - TCEQ Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data, 2014 (RG-416)

2.1 Field Parameters

Water Temperature

This basic water quality parameter is perhaps one of the most important indicators of health in an aquatic ecosystem, as it is directly linked to many of the physiological processes carried out by aquatic organisms. As temperature increases, dissolved oxygen (DO) in the water decreases. This results in increased oxygen demand across the whole community, which can be stressful for higher-level, cold-blooded organisms like fish and aquatic insects, who depend on species-specific optimum temperatures to survive. Variations in water temperature become more detrimental to aquatic species when they occur rapidly, especially for organisms that may lack the biological advantages to adapt quickly to the change.

Water Transparency

Two methods were used to measure water transparency for this project, secchi depth and nephalometric turbidity. High turbidity can limit the amount of available light in the water column, inhibiting photosynthetic growth in autotrophic organisms like phytoplankton, algae, and aquatic plants. This growth limitation may be either helpful or detrimental to the overall aquatic community, depending on several other biological factors, including the trophic state of the waterbody, and whether or not algal communities are also limited by nutrients. The reduced visibility from high turbidity may also be detrimental to predatory species of fish and birds that depend on visibility to locate their prey.

Dissolved Oxygen

Although the specific needs will vary based on the community assemblage and species adaptations, DO is a vital to the survival of fish and aquatic insects. As indicated earlier, DO is affected by both temperature and nutrient concentrations, which play a part in the production and decomposition processes that affect the amount of DO in the water column. Minimum DO concentrations may vary based on the type of water body (lentic or lotic systems), flow status of lotic systems (perennial, intermittent, with or without pools), species assemblage, and in-stream habitat. The Texas Commission on Environmental Quality (TCEQ) accounts for these differences by applying waterbody-specific DO criteria, with presumed criteria based on flow status until full-scale biological surveys can be undertaken.

Specific Conductance (@ 25°C)

The efficiency with which a liquid can conduct electricity at a certain temperature is known as specific conductance. In most water quality studies, a standard temperature of 25°C is used for sonde-based deployments. A waterbody will become more conductive with increased levels of dissolved solids, which include both nutrients and salts. As levels of these solids increase, particularly for nutrients, DO decreases, which typically results in reduced water quality and overall aquatic health.

Potential Hydrogen (pH)

A waterbody is considered 'neutral' if it has a pH of 7.0, with values less than 7.0 being acidic and values greater than 7.0 considered alkaline. Healthy aquatic habitats typically fall within a pH range of 6.5-9.0, which is reflected within the TCEQ water quality standard for the parameter.

Days Since Last Precipitation Event

It is important for both field staff and data analyzers to be mindful of recent precipitation events that coincide with monitoring events. Rainfall that produces runoff can carry nonpoint source pollutants (*E. coli*, nutrients, and other solids) into a waterbody. The volume of these pollutant loads typically increase with the duration and severity of the runoff event. Monitoring precipitation events is important for data analyzers to determine if high pollutant loads are the result of inputs from a recent rainfall/runoff event, or perhaps from other factors.

2.2 Flow Parameters

Instantaneous Stream Flow

Flow measurement is an integral part of this project, as it is one of the two components required to compute the bacterial and nutrient loads that will indicate areas of interest in the watershed with respect to making informed water quality management recommendations.

Flow Severity

A qualitative observation of flow is sometimes useful in addition to instantaneous (measured) flow to group the flow regime at the time of sample collection within the greater context of the watershed. Though two tributaries may have the exact same measured flow during a given event, that flow rate may be normal in one tributary, but uncharacteristically high in the other. This difference may indicate the effects of localized rainfall, external water inputs, or other natural or man-made phenomena.

Flow Method

In addition to the use of existing U.S. Geological Survey (USGS) gage station data, TRA employs the use of two other flow measurement techniques, with application based on factors of personnel safety, width, and wadeability. It is important for data analysts to be mindful of the flow measurement method used to collect the data, as it may prove useful to explain and eventually correct any errors that may arise in flow data. See the QAPP for Monitoring and Data Acquisition for this project for more information on the approved methods used during this project.

2.3 Bacteria Parameters

E. coli

E. coli is a bacterium commonly found in the intestines of warm-blooded animals and humans. These bacteria live in the waste products of these animals and can be washed into surface and ground water during rain events or directly deposited in surface waters. High measurements of these bacteria can indicate improperly treated wastewater, illicit discharges, livestock and wildlife presence, and a host of other sources. Some strains of this bacteria produce powerful toxins and can cause severe illness if ingested. To protect public safety, Clean Rivers Program (CRP) partners sample for bacteria throughout the basin. These samples are compared to a surface water quality standard determined by the TCEQ and approved by the U.S. Environmental Protection Agency. *E. coli* is used in assessing water bodies against the Contact Recreation use standard. This standard is based on the geometric mean (geomean) of the sample set.

Optical Brighteners

Optical brighteners are dye compounds that are added to laundry detergent to make clothing seem whiter or brighter in color after washing. Although not a direct measurement of bacterial contamination, the presence or absence of OBs in the water found at the monitoring site may be an indicator of human sewage contamination, which is a potential source of *E. coli* in the watershed. However, other household, personal care, and industrial products can contain similar dyes, which can present ‘false positives’ in the test. These include, but are not limited to, antifreeze, car wash detergents, lawn grass dyes, and some viral-vector pesticides.

2.4 Conventional Parameters

Solids

Total dissolved solids (TDS) is a rudimentary measurement of all the dissolved ions within a waterbody. While it does provide a very rough indicator of general water quality, it cannot reveal the specific source or composition of the ions in the sample.

The suspended or colloidal particles, commonly referred to as total suspended solids (TSS), are the particles that are suspended in the water column that are not passed through a filter of a specific pore size. This can include organic matter such as algal and bacterial cells and planktonic organisms.

Volatile suspended solids (VSS) is the portion of the suspended solids that are lost on the ignition of the dried solids. Along with TSS, it can also provide further indication of microbial growth within a water quality sample.

Turbidity is closely related to TSS, but is technically an optical feature of the water. It is a measurement of the light scattered by a water sample rather than the mass of the material suspended in the water. The measurement can also include response to dyes in the water such as tannin staining from decaying leaves.

Nutrients

Nutrients are essential for the productivity of aquatic ecosystems. Without the building blocks, or "food", that drives the system, there will be no plant and animal life. Conversely, an overabundance of nutrients within riverine and reservoir ecosystems may have detrimental effects in some instances. Clear reservoirs are more susceptible to nutrient enrichment than sediment-laden rivers and lakes. Algae require nutrients and light to grow, but waterbodies in this watershed are generally turbid. As a result, light can be more of a limiting factor than nutrients.

The most common limiting nutrients in aquatic environments are phosphorus and nitrogen. Nutrients can enter waterbodies via runoff containing residential and agricultural fertilizers, as well as animal waste, atmospheric deposition, effluent from wastewater treatment plants, and sanitary sewer overflows.

NO_3 is one of the components of total nitrogen, along with NO_2 and TKN. NO_3 and NO_2 are inorganic, oxidized forms of nitrogen, with nitrate being the most abundant and nitrite often occurring at such low levels that for the majority of the time, the limit of quantitation was not met over the course of this monitoring effort. TKN is the final component of total nitrogen, which contains ammonia (another inorganic form of nitrogen) and organic nitrogen.

TP is a measure of all the forms of phosphorus that are present in a water sample. This includes both dissolved and particulate forms, as well as both organic and inorganic forms. Of the inorganic forms, OP (sometimes referred to as "reactive phosphorus") is important because it is the form used most readily by plants. A prominent by-product of natural process, OP is also found in sewage.

Chlorophyll-a

Chlorophyll-a (chl-a) is commonly used throughout the state as a surrogate for algal biomass. It is the pigment responsible for the green color of many algal species and is vital for photosynthesis. High levels of chl-a may indicate algal blooms have occurred or are occurring in a waterbody. Typically nutrients, such as nitrogen and phosphorous, are the limiting factors for algal growth. However, in some systems, trace metals may also be limiting.

In more turbid waterbodies, nutrients are not always the limiting factor for algal growth. In the naturally turbid waters of the river, light availability is commonly the limiting factor. High suspended sediment loads decrease light penetration into the water column. Therefore, algal productivity is limited to a narrow band at the surface of the water which can range from just a few inches to several feet depending on the turbidity of the water. In reservoirs, light can be the limiting factor in the turbid upper reaches and coves where sediments are still in suspension. As sediments settle out nearer to the main body of the reservoirs, nutrients can become the limiting factors.

Algal growth can affect levels of DO and pH. As algae cycle through photosynthesis and respiration during a 24-hour period, DO and pH levels rise and fall in response. Because chl-a is used as a surrogate for algal biomass, data analysis can show a strong correlation between chl-a, DO, and pH. The strength and direction of the correlation depends on the extent of the algal bloom and the time of day, as well as the time required for DO and pH levels to recover.

At night or during cloudy weather, algal respiration is the dominant process. Cellular respiration uses carbohydrates and oxygen to produce carbon dioxide and water. Carbon dioxide in the presence of water forms carbonic acid which reduces the pH of the water. Therefore, oxygen and pH levels can decrease.

During sunny daylight hours, algae photosynthesis becomes dominant. The process of photosynthesis uses light, carbon dioxide, and water to produce carbohydrates and oxygen. Therefore, oxygen and pH levels can increase.

During an algal bloom, it is not uncommon for the water to become supersaturated with DO during the day. At night or during cloudy weather, DO and pH can drop to very low levels. This rise and fall in DO and pH during a 24-hour period is called a diurnal swing. The severity of the diurnal swing and the resultant minimum and maximum DO and pH levels depend of the extent of the algal bloom. While uncommon in areas like the Trinity River where mineral inputs from calcareous soils provide a strong buffering capacity, water bodies with weaker buffering capacity may be more sensitive to intense DO and pH declines, occasionally causing fish kills.

3.0 Data Review and Assessment Methods

3.1 TCEQ Water Quality Standards

TCEQ is responsible for establishing numeric and narrative criteria for water quality in the state of Texas. These criteria are described in TCEQ's Texas Surface Water Quality Standards (TSWQS) and are approved by the U.S. Environmental Protection Agency (EPA). These standards are codified in the Texas Administrative Code (TAC), Title 30, Chapter 307, hereto referred to as TAC 307 (TCEQ 2014) and are used by TCEQ regulatory programs to establish reasonable methods of assessing water bodies of the state with the intent of implementing targeted strategies aimed at specific water quality uses. Site-specific water quality criteria for Lake Arlington (Segment 0828) and Village Creek (Segment 0828A), as defined in TAC 307, are presented in Table 3-1.

Table 3-1. Site-specific water quality criteria for the Village Creek-Lake Arlington watershed.

Parameter	Segment ID	
	0828	0828A
Cl^- (mg/L)	100	100
SO_4^{-2} (mg/L)	100	-
TDS (mg/L)	300	300
DO (mg/L) grab minimum	3.0	2.0
DO (mg/L) 24 hour average	5.0	3.0
DO (mg/L) 24 hour minimum	3.0	2.0
pH range	6.5-9.0	6.5-9.0
E. coli (MPN/100mL) geomean	126	126
Temperature (°F; °C)	95; 35	95; 35

3.2 Nutrient Screening Levels and Reference Criteria

Currently, no numeric standards exist for nutrients in streams in the state of Texas. Numeric standards for chl-a have been approved by EPA for 75 reservoirs in the state; however, Lake Arlington is not one of these reservoirs. In such situations where no water quality standards exist or are in the process of being developed, controls such as narrative criteria and antidegradation considerations are often used. Despite this lack of numeric criteria, TCEQ continues to screen for parameters such as nitrogen, phosphorus, and chl-a as preliminary indicators for waterbodies of possible concern for 303(d) impairments. To support this effort, nutrient screening levels and reference conditions are often used to compare a waterbody to reference values at a local, regional, or national level. Table 3-2 provides screening level values from various sources. The Texas Nutrient Screening Levels are based on statistical analyses of Surface Water Quality Monitoring (SWQM) data (TCEQ 2015a) and the EPA Reference Criteria are regional values based on data from reservoirs and streams within specific ecoregion units and subunits (USEPA 2000a, USEPA 2000b). It is worth noting that these Reference Criteria differ from the Texas Nutrient Screening Levels in that EPA developed the Reference Criteria using conditions that are indicative of minimally impacted (or in some cases, pristine) waterbodies, attainment of which would result in protection of all designated uses within those specific units and subunits. As such, Reference Criteria thresholds are much lower than those for state screening levels, and surpassing them may not necessarily indicate a concern, as is the case with the state thresholds. Where state screening levels or national reference criteria were non-existent, other sources were used, for nitrite (NO_2) in particular (Mesner and Geiger 2010).

Table 3-2. Texas Nutrient Screening Levels and EPA Nutrient Reference Criteria.

Parameter		TCEQ Screening Levels		EPA Reference Criteria				Other Sources
		Lake/Reservoir	Stream	Lake/Reservoir		Stream		
TKN	(mg/L)	-	-	0.38[a]	0.41[b]	0.3[a]	0.4[b]	
NO_2^-	(mg/L)	-	-	-	-	-	-	0.02[c]
NO_3^-	(mg/L)	0.37	1.95	-	-	-	-	
NO_2^-+NO_3^-	(mg/L)	-	-	0.017[a]	0.01[b]	0.125[a]	0.078[b]	
TP	(mg/L)	0.20	0.69	0.02[a]	0.019[b]	0.037[a]	0.038[b]	
OP[d]	(mg/L)	0.05	0.37	-	-	-	-	
Chlorophyll a[e]	(µg/L)	26.7	14.1	5.18[a]	2.875[b]	0.93[a]	1.238[b]	

(a) Reference conditions for aggregate Ecoregion IX waterbodies, upper 25th percentile of data from all seasons, 1990-1999.

(b) Reference conditions for level III Ecoregion 29 waterbodies, upper 25th percentile of data from all seasons.

(c) For nitrite, concentrations above 0.02 mg/L (ppm) usually indicate polluted waters (Mesner, N., J. Geiger. 2010. Understanding Your Watershed: Nitrogen. Utah State University, Water Quality Extension.

(d) OP is no longer used for TCEQ screening purposes, as of the 2014 Texas Integrated Report.

(e) Chlorophyll a, as measured by Spectrophotometric method with acid correction.

3.3 303(d) Water Quality Inventory Table

The TCEQ 2014 Texas Integrated Report for the Trinity River covers a seven-year assessment period from December 1, 2005 to November 30, 2012 (TCEQ 2015b). In cases where additional data was needed to meet minimum data requirements and make an informed assessment, data from an additional three-year period beginning December 1, 2003 were used. The methods used for this assessment are described in the 2014 Guidance for Assessing and Reporting Surface Water Quality in Texas (TCEQ 2015a).

Findings of the Integrated Report assessments are classified as Fully Supporting, No Concern, Use Concern, Screening Level Concern, and Not Supporting. To simplify data presentation in this report, the Use Concern and Screening Level Concern classifications were combined into a single "Concern" category. Use Concern findings are given for assessments against designated use standards for water quality parameters such as DO and *E. coli*. Use Concerns can apply to datasets with limited data where the threshold number of exceedances are met or to datasets with adequate data where there are less than the threshold number of exceedances required for a Not Supporting finding. Screening Level Concerns apply to General Use parameters, such as nutrients and chl-a, as well as a few other parameters for other designated uses. These parameters have screening levels rather than standards.

The results of the assessment are shown in Table 3-3, which call out any impairments or concerns identified in each segment. The results are accompanied by an evaluation of which designated uses have data that was available for a use assessment. Note that while data was not collected within the lake itself as part of this project, for the purposes of this report, and to a larger extent the project, segments with contaminants of concern that corresponded to the concerns in the lake are displayed. This is showcased so that data collected for these contaminants within its tributaries may potentially inform any correlations or connections between inflow of contaminants from the tributaries and the concentrations and locations of higher pollutants in the lake.

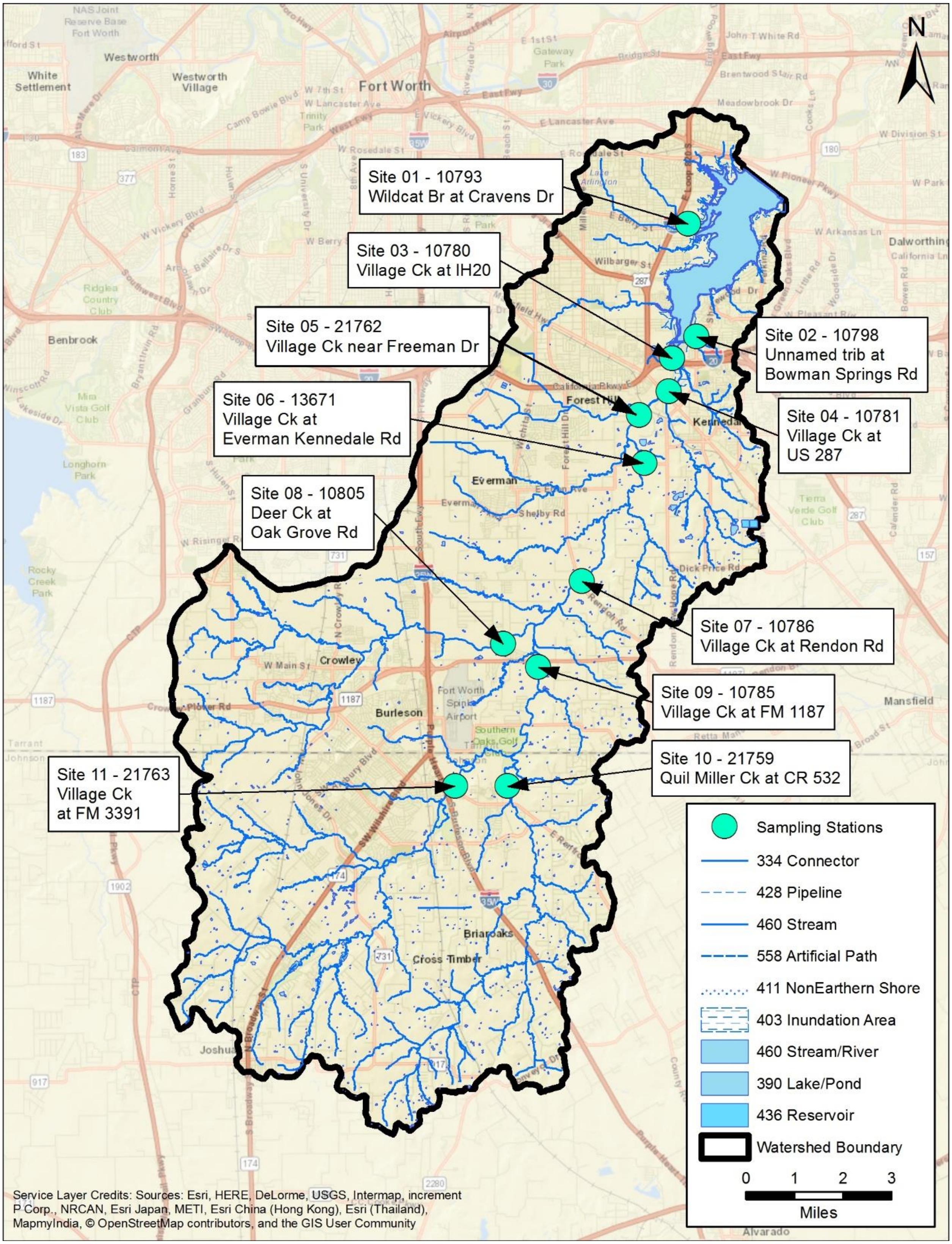
Table 3-3. 2014 Texas Integrated Report & 2015 TRA In-house Assessment information for the Village Creek-Lake Arlington Watershed.

Waterbody	Segment ID	Designated Uses*					2014 TCEQ Report	
		Aquatic Life	Contact Recreation	General Use	Fish Consumption	Public Water Supply	Impairments	Concerns
Lake Arlington: Lowermost portion of lake along western half of dam	0828_01			•	•	•		
Lake Arlington: Lowermost portion of lake along eastern half of dam	0828_02	•	•	•	•	•		• chlorophyll-a
Lake Arlington: Western half of lower portion of lake	0828_03			•	•	•		
Lake Arlington: Eastern half of lower portion of lake	0828_04	•		•	•	•		
Lake Arlington: Western half of upper portion of lake	0828_05	•	•	•	•	•		• chlorophyll-a
Lake Arlington: Eastern half of upper portion of lake	0828_06	•	•	•	•	•		• chlorophyll-a
Lake Arlington: Uppermost portion of lake	0828_07	•	•	•	•	•		• nitrate
Lake Arlington: Remainder of lake	0828_08			•	•	•		
Village Creek: From Lake Arlington to the headwaters	0828A_01	•	•	•	•		• bacteria	

**note: blanks in the "Designated Uses" column indicate that no data was available for a specific designated use in the corresponding segment, or that a specific designated use does not apply for that segment.*

4.0 Summary of Sample Collection Efforts

The data in this report summarizes a 12-month collection effort from June 2016 to May 2017. A collection of all the data sampled as part of this project is provided in Appendix A and Appendix B. Data was collected at 11 sites across the watershed (Figure 4-1). One site is located on the west side of Lake Arlington (10793), with another on the east side (10798). Seven sites are located on the main tributary to the lake, Village Creek. Two of the Village Creek sites are under influence of the lake, especially when water levels are at or near the conservation pool elevation (10780 and 10781). Further upstream, two sites are located on either side of the Tarrant Regional Water District (TRWD) outfall (21762 and 13671), which brings in additional water from two lakes in east Texas, Richland-Chambers and Cedar Creek Reservoirs. Another station (10786) is located at the site of a USGS gage, at the approximate midpoint of the watershed. Two additional stations are located further upstream (10785 and 21763). Two upstream tributaries were also monitored: Deer Creek (10805) and Quil Miller Creek (21759). The watershed consists of only two TCEQ-monitored segments, Lake Arlington (0828), a classified segment, and Village Creek (0828A), an unclassified segment. For the purposes of this source assessment study, data from only Segment 0828A and two other lake tributaries was collected. The tributaries, Wildcat Branch and an unnamed tributary to Lake Arlington, are not currently designated as TCEQ segments.



Basemap: ESRI World Streetmap.

Figure 4-1. Sampling sites and hydrology in the Village Creek-Lake Arlington Watershed.

4.1 Statistics Summary Tables

Table 4-1 through Table 4-5 contain the summary statistics for each monitored tributary in the Village Creek-Lake Arlington Watershed, for data collected June 2016 to May 2017. Stations along the main stem of Village Creek include 10780, 10781, 21762, 13671, 10786, 10785, and 21763. Wildcat Branch has one station, 10793. The unnamed tributary on the east side also has one station, 10798. Likewise, 10805 is the only station on Deer Creek, and 21759 is the sole station on Quil Miller Creek.

Table 4-1. Statistics summary table for Village Creek (main stem sites).

Village Creek (Main Stem)							
Parameter	Data Points	Range			Mean	St. Dev	% Complete
E. coli (MPN/100 mL)	84	4	-	10000	1879	3307	100%
TDS (mg/L)	84	132	-	558	300	126	100%
Nitrate (mg/L)	84	0.08	-	4.87	0.79	1.00	100%
Nitrite (mg/L)	82	n/a	-	n/a	n/a	n/a	98%
TKN (mg/L)	81	0.21	-	0.97	0.55	0.19	96%
TP (mg/L)	83	0.02	-	1.8	0.18	0.27	99%
OP (mg/L)	83	0.02	-	1.75	0.17	0.30	99%
Chlorophyll a (µg/L)	84	4.0	-	22.0	7.7	3.9	100%

Table 4-2. Statistics summary table for Wildcat Branch.

Wildcat Branch							
Parameter	Data Points	Range			Mean	St. Dev	% Complete
E. coli (MPN/100 mL)	11	12	-	9700	2645	3798	100%
TDS (mg/L)	11	123	-	367	214	80	100%
Nitrate (mg/L)	11	0.12	-	0.57	0.31	0.16	100%
Nitrite (mg/L)	11	n/a	-	n/a	n/a	n/a	100%
TKN (mg/L)	10	0.37	-	1.69	0.91	0.41	91%
TP (mg/L)	11	0.04	-	0.34	0.13	0.09	100%
OP (mg/L)	11	0.03	-	0.25	0.07	0.08	100%
Chlorophyll a (µg/L)	11	4.0	-	66.0	23.3	23.1	100%

Table 4-3. Statistics summary table for the unnamed tributary to Lake Arlington.

Unnamed tributary to Lake Arlington							
Parameter	Data Points	Range			Mean	St. Dev	% Complete
E. coli (MPN/100 mL)	12	140	-	6900	1649	2425	100%
TDS (mg/L)	12	207	-	1573	917	447	100%
Nitrate (mg/L)	12	0.06	-	0.78	0.29	0.25	100%
Nitrite (mg/L)	12	n/a	-	n/a	n/a	n/a	100%
TKN (mg/L)	10	0.22	-	0.81	0.46	0.20	83%
TP (mg/L)	12	0.02	-	0.37	0.06	0.10	100%
OP (mg/L)	12	0.27	-	0.27	0.27	n/a	100%
Chlorophyll a (µg/L)	12	6.0	-	12.0	8.4	2.9	100%

Table 4-4. Statistics summary table for Deer Creek.

Deer Creek							
Parameter	Data Points	Range			Mean	St. Dev	% Complete
E. coli (MPN/100 mL)	12	21	-	6200	1002	2001	100%
TDS (mg/L)	12	212	-	350	287	44	100%
Nitrate (mg/L)	12	0.06	-	0.69	0.28	0.20	100%
Nitrite (mg/L)	12	n/a	-	n/a	n/a	n/a	100%
TKN (mg/L)	12	0.24	-	0.71	0.47	0.13	100%
TP (mg/L)	12	0.02	-	0.26	0.07	0.08	100%
OP (mg/L)	12	0.03	-	0.04	0.03	0.01	100%
Chlorophyll a (µg/L)	12	4.0	-	8.0	5.0	1.7	100%

Table 4-5. Statistics summary table for Quil Miller Creek.

Quil Miller Creek							
Parameter	Data Points	Range			Mean	St. Dev	% Complete
E. coli (MPN/100 mL)	12	17	-	10000	1790	3769	100%
TDS (mg/L)	12	234	-	676	513	160	100%
Nitrate (mg/L)	12	0.12	-	0.43	0.30	0.12	100%
Nitrite (mg/L)	12	n/a	-	n/a	n/a	n/a	100%
TKN (mg/L)	12	0.21	-	0.99	0.46	0.28	100%
TP (mg/L)	12	0.04	-	0.38	0.11	0.12	100%
OP (mg/L)	12	0.02	-	0.19	0.07	0.06	100%
Chlorophyll a (µg/L)	12	4.0	-	6.0	5.0	1.0	100%

4.2 Parameter Summaries

Table 4-6 through Table 4-13 contain the geomean statistics for each parameter of interest in the Village Creek-Lake Arlington watershed, for data collected June 2016 to May 2017. Geomeans for the parameter at each monitoring station are presented, except when sufficient data were unavailable for the purposes of the calculation. Where applicable, each table also contains a geomean calculation based on information from all sites within the Village Creek Assessment Unit (0828A_01), which excludes Sites 01 (10793) and 02 (10798). Where relevant data were available, this was compared to the geomean presented in the 2014 Texas Integrated Report assessment results for the Trinity River (TCEQ 2015b)

4.2.1 *E. coli*

Table 4-6 contains all of the *E. coli* measurements collected as part of this project. Geomeans in red signify that the water quality criterion (126 MPN/100 mL) has been exceeded at that site for data taken over the duration of the project. The overall geomean for data at all Village Creek main stem sites was then calculated for comparison to the geomean calculated for the 2014 Texas Integrated Report (TCEQ 2015b).

Table 4-6. Summary of *E. coli* measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
E. coli (MPN/ 100 mL)	92	68	290	58	39	9700	21	7900	7700	530	2900
	21	250	130	21	48	640	30	59	210	610	12
	4800	9700	9700	6200	9700	9700	320	9700	9700	6500	4800
	1100	64	100	32	35	53	4	310	380	340	9700
	220	200	67	86	110	150	61	38	43	210	770
	3000	10000	6100	4100	9200	3300	370	490	4600	560	30
	37	22	96	37	24	180	17	8	56	410	37
	150	49	140	80	34	54	4	6	32	190	9700
	17	310	230	260	70	52	10000	8200	7300	6900	120
	34	17	150	290	22	65	22	70	42	140	970
	220	600	540	820	570	1000	5200	6900	5700	1300	52
	140	200	49	41	30	30	26	15	48	2100	
	Site Geomeans (Village Creek Sites in bold)										
	172	*222*	***275***	*171*	***124***	***328***	***76***	***255***	***487***	*713*	*425*
	Project Geomean (VC main stem sites):					210.224	VC Geomean from 2014 TCEQ IR:				302.36

**note: TCEQ Standard for E. coli is 126 MPN/100 mL. Values in red exceed the standard.*

4.2.2 Total Dissolved Solids

Table 4-7 contains all of the TDS measurements collected as part of this project. Geomeans in red signify that the water quality criterion (300 mg/L) has been exceeded at that site for data taken over the duration of the project. The overall geomean for data at all Village Creek main stem sites was then calculated. However, no geomean was calculated for comparison in the 2014 Texas Integrated Report (TCEQ 2015b) due to an insufficient number of data points.

Table 4-7. Summary of TDS measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
TDS (mg/L)	553	676	558	350	509	276	152	304	233	1304	164
	515	613	501	309	461	481	191	167	238	1573	244
	158	234	204	212	202	190	146	179	192	240	187
	370	528	402	268	304	355	172	157	154	815	144
	303	410	246	253	223	216	159	161	171	1093	194
	232	237	180	216	209	211	132	145	156	535	367
	453	556	408	300	318	312	149	151	164	1142	339
	455	672	412	286	328	341	162	168	173	1219	130
	527	604	514	324	408	416	271	220	203	207	238
	529	662	535	345	430	467	408	418	335	1095	123
	353	384	312	297	299	285	278	273	272	509	227
	474	585	438	284	339	360	284	236	263	1272	
	Site Geomeans										
	387	*484*	***369***	*284*	***322***	***312***	***196***	***203***	***207***	*776*	*202*
	Project Geomean (VC main stem sites):					274.817	VC Geomean from 2014 TCEQ IR:				n/a

**note: TCEQ Standard for TDS is 300 mg/L. Values in red exceed the standard.*

4.2.3 Nitrogen

Table 4-8 contains all of the NO_3 measurements collected as part of this project. Geomeans in yellow signify that the TCEQ screening level (1.95 mg/L) has been exceeded at that site for data taken over the duration of the project. The overall geomean for data at all Village Creek main stem sites was then calculated. However, no geomean was calculated for comparison in the 2014 Texas Integrated Report (TCEQ 2015b) due to an insufficient number of data points.

Table 4-8. Summary of NO_3 measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
Nitrate (mg/L)	2.45	0.29	0.31	0.54	0.14	0.44	0.17	0.37	0.62	0.2	0.25
	< 0.05	0.12	0.4	0.15	< 0.05	< 0.05	0.23	0.2	0.14	< 0.05	< 0.05
	0.34	0.43	0.37	0.39	0.33	0.35	0.33	0.28	0.23	0.4	0.33
	< 0.05	< 0.05	1.17	< 0.05	< 0.05	< 0.05	0.67	0.56	0.63	0.06	0.41
	2.14	< 0.05	0.96	0.1	0.08	0.26	0.74	0.72	0.71	< 0.05	0.12
	1.03	0.39	0.45	0.35	0.42	0.36	0.26	0.25	0.25	0.18	< 0.05
	4.65	< 0.05	0.41	0.3	< 0.05	< 0.05	0.32	0.31	0.29	0.09	< 0.05
	4.52	< 0.05	0.26	0.25	0.19	0.84	0.35	0.33	0.33	0.1	0.57
	4.87	< 0.05	2.02	0.15	0.78	0.67	0.93	0.73	0.71	0.78	< 0.05
	2.93	< 0.05	0.19	0.08	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.19
	1.2	0.29	0.78	0.69	0.64	0.63	0.93	1.06	0.8	0.21	< 0.05
	< 0.05	< 0.05	0.16	0.06	< 0.05	< 0.05	< 0.05	0.48	0.18	0.58	
	Site Geomeans										
	2.06	*0.28*	***0.47***	*0.21*	***0.28***	***0.47***	***0.42***	***0.42***	***0.38***	*0.21*	*0.28*
	Project Geomean (VC main stem sites):					0.51	VC Geomean from 2014 TCEQ IR:				n/a

Table 4-9 contains all of the NO_2 measurements collected as part of this project. Literature values from Utah State Water Quality Extension for NO_2 in polluted waters is 0.02 mg/L. However, the limit of quantitation for NO_2 is 0.05 mg/L. Values in yellow exceed the limit of quantitation and thus the screening level. For the purposes of this analysis, none of the measurements that fell below the limit of quantitation were considered to be exceedances of the screening level. Due to the limited dataset, no geomeans for the individual sites or for the Village Creek main stem in overall could be generated. Likewise, no geomean was calculated for comparison in the 2014 Texas Integrated Report (TCEQ 2015b) due to an insufficient number of data points.

Table 4-9. Summary of nitrite measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
Nitrite (mg/L)	0.07	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	0.16	< 0.05	0.08	< 0.05	< 0.05	< 0.05		< 0.05	< 0.05	< 0.05	< 0.05
		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.09	< 0.05	< 0.05	

**note: Literature values from Utah State Water Quality Extension for nitrite in polluted waters is 0.02 mg/L. However, the limit of quantitation for nitrite is 0.05 mg/L. Values in yellow exceed the limit of quantitation and thus the screening level. Due to the limited dataset, no geomeans could be generated.*

Table 4-10 contains all of the TKN measurements collected as part of this project. Geomeans in yellow signify that the EPA Reference Criteria (0.4 mg/L) for streams in this ecoregion (Ecoregion 29) has been exceeded at that site for data taken over the duration of the project. This point of reference differs significantly from both a water quality criteria (as is used with *E. coli* and TDS) and from TCEQ screening levels (NO_3, TP, OP) in that it does not indicate a cause for concern, but rather is a reference to TKN levels found in healthy, functioning streams in the region (USEPA 2000b). For that reason, several more yellow geomeans for each site appear in the dataset. The overall geomean for data at all Village Creek main stem sites was then calculated. However, no geomean was calculated for comparison in the 2014 Texas Integrated Report (TCEQ 2015b) due to an insufficient number of data points.

Table 4-10. Summary of TKN measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
Total Kjeldahl Nitrogen (mg/L)	0.67	0.39	0.42	0.49	0.45	0.72	0.47	0.61	0.96	0.38	1.08
	0.41	0.26	0.5	0.45	0.37	0.21	0.42	0.42	0.59	0.36	0.65
	0.72	0.99	0.83	0.71	0.81	0.88	0.45	0.88	0.9	0.68	0.82
	0.48	0.21	0.29	0.31	0.29	< 0.2	0.48	0.45	0.27	0.22	1.35
	0.58	0.22	0.36	0.42	0.38	0.44	0.44	0.53	0.56	0.26	0.55
	0.63	0.79	0.54	0.59	0.59	0.53	0.51	0.45	0.38	0.47	0.37
	0.89	< 0.2	0.31	0.24	0.36	0.32	0.44	0.51	0.46	0.47	0.6
	0.48	< 0.2	0.24	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.22	< 0.2	
	0.84	0.41	0.81	0.49	0.53	0.48					1.17
	0.66	0.26	0.61	0.44	0.43	0.46	0.44	0.46	0.69	0.81	0.8
	0.51	0.58	0.61	0.56	0.62	0.71	0.77	0.95	0.92	0.65	1.69
	0.52	< 0.2	0.58	0.48	0.97	0.4	0.36	0.48	0.58	0.31	
	Site Geomeans										
	0.60	*0.39*	***0.47***	*0.45*	***0.49***	***0.48***	***0.47***	***0.55***	***0.54***	*0.42*	*0.83*
	Project Geomean (VC main stem sites):					0.51405	VC Geomean from 2014 TCEQ IR:				n/a

4.2.4 Phosphorus

Table 4-11 contains all of the TP measurements collected as part of this project. None of the site geomeans exceeded the TCEQ screening level (0.69 mg/L) over the duration of the project. The overall geomean for data at all Village Creek main stem sites was also calculated. However, no geomean was calculated for comparison in the 2014 Texas Integrated Report (TCEQ 2015b) due to an insufficient number of data points.

Table 4-11. Summary of total phosphorus measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
Total Phosphorus (mg/L)	0.14	0.05	0.03	< 0.02	0.02	0.17	0.04	0.12	0.35	0.02	0.14
	0.2	0.05	0.02	< 0.02	< 0.02	< 0.02	0.03	0.04	0.05	0.02	0.04
	0.22	0.38	0.28	0.26	0.25	0.4	0.05	0.33	0.28	0.06	0.09
	0.25	0.06	0.07	0.03	0.03	0.03	0.04	0.04	0.06	0.02	0.22
	0.56	0.06	0.13	0.04	0.05	0.09	0.06	0.05	0.06	0.03	0.06
	0.34	0.31	0.19	0.09	0.16	0.14	0.07	0.07	0.08	0.04	0.05
	1.24	0.06	0.15	< 0.02	0.03	0.04	0.04	0.04	0.04	0.03	0.09
	1.8	0.04	0.18	0.02	0.11	0.09	0.04	0.04	0.04	0.02	0.34
		0.04	0.09	0.03	0.03	0.03	0.29	0.65	0.54	0.37	0.09
	0.89	0.04	0.14	0.02	0.03	0.04	0.03	0.04	0.05	0.04	0.19
	0.38	0.2	0.25	0.08	0.14	0.16	0.24	0.26	0.24	0.08	0.12
	0.48	0.04	0.1	0.03	0.18	0.04	0.02	0.03	0.03	0.04	
	Site Geomeans (Village Creek Sites in bold)										
	0.44	*0.08*	***0.11***	*0.05*	***0.07***	***0.08***	***0.05***	***0.08***	***0.09***	*0.04*	*0.11*
	Project Geomean (VC main stem sites):					0.10	VC Geomean from 2014 TCEQ IR:				n/a

**note: TCEQ screening level for TP is 0.69 mg/L. Values in yellow exceed the screening level.*

Table 4-12 contains all of the OP measurements collected as part of this project. Geomeans in yellow signify that the previously-used TCEQ screening level (0.37 mg/L) has been exceeded at that site for data taken over the duration of the project. The overall geomean for data at all Village Creek main stem sites was then calculated. However, no geomean was calculated for comparison in the 2014 Texas Integrated Report (TCEQ 2015b) due to an insufficient number of data points.

Table 4-12. Summary of orthophosphate measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
Orthophosphate (mg/L)	0.1	0.07	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	0.11	< 0.02	0.04
	0.18	0.04	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	0.13	0.17	0.08	0.04	0.07	0.06	< 0.02	0.04	0.02	< 0.02	0.03
	0.23	0.05	0.03	< 0.02	< 0.02	< 0.02	0.03	0.03	0.02	< 0.02	0.08
	0.52	0.05	0.1	< 0.02	0.03	0.04	0.03	0.03	0.03	< 0.02	0.03
	0.28	0.19	0.12	0.03	0.08	0.06	0.03	0.03	0.03	< 0.02	< 0.02
	1.16	0.04	0.12	< 0.02	< 0.02	< 0.02	0.02	0.02	< 0.02	< 0.02	0.04
	1.75	0.03	0.16	< 0.02	0.08	0.07	< 0.02	< 0.02	< 0.02	< 0.02	0.25
		0.02	0.04	< 0.02	< 0.02	< 0.02	0.16	0.13	0.14	0.27	< 0.02
	0.88	0.02	0.07	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.05
	0.37	0.1	0.18	0.03	0.09	0.07	0.12	0.13	0.1	< 0.02	< 0.02
	0.43	0.03	0.06	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	
	Site Geomeans (Village Creek Sites in bold)										
	0.38	*0.05*	***0.08***	*0.03*	***0.07***	***0.06***	***0.04***	***0.04***	***0.05***	*0.27*	*0.05*
	Project Geomean (VC main stem sites):					0.08	VC Geomean from 2014 TCEQ IR:				n/a

**note: TCEQ screening level previously used for orthophosphate is 0.37 mg/L. Values in yellow exceed the screening level.*

4.2.5 Chlorophyll-a

Table 4-13 contains all of the chl-a measurements collected as part of this project. Geomeans in yellow signify that the TCEQ screening level (14.1 µg/L) has been exceeded at that site for data taken over the duration of the project. The overall geomean for data at all Village Creek main stem sites was then calculated. However, no geomean was calculated for comparison in the 2014 Texas Integrated Report (TCEQ 2015b) due to an insufficient number of data points.

Table 4-13. Summary of chlorophyll a measurements in the Village Creek-Lake Arlington Watershed.

Site	VC11	VC10	VC09	VC08	VC07	VC06	VC05	VC04	VC03	VC02	VC01
TCEQ #	21763	21759	10785	10805	10786	13671	21762	10781	10780	10798	10793
Chlorophyll a (µg/L)	< 3	< 3	5	4	< 3	7	6	11	9	11	17
	< 3	< 3	< 3	4	4	< 3	< 3	5	12	< 3	17
	6	< 3	8	8	4	8	9	8	6	< 3	4
	< 3	< 3	4	4	< 3	4	< 3	4	8	< 3	< 3
	< 3	< 3	< 3	5	< 3	< 3	8	6	5	6	< 3
	4	< 3	4	< 3	4	< 3	6	7	6	< 3	< 3
	< 3	< 3	< 3	< 3	< 3	< 3	< 3	4	4	< 3	< 3
	< 3	< 3	< 3	< 3	< 3	< 3	11	9	9	< 3	< 3
	12	6	11	< 3	< 3	4	7	14	22	< 3	31
	4	< 3	15	< 3	< 3	4	< 3	8	18	12	5
	6	5	< 3	< 3	< 3	< 3	8	12	< 3	7	66
	< 3	4	< 3	< 3	< 3	< 3	< 3	< 3	9	6	
	Site Geomeans										
	5.86	*4.93*	***6.88***	*4.80*	***4.00***	***5.14***	***7.69***	***7.39***	***8.64***	*8.02*	*15.09*
	Project Geomean (VC main stem sites):					6.91	VC Geomean from 2014 TCEQ IR:				n/a

**note: TCEQ screening level for chlorophyll a in streams is 14.1 µg/L. Values in yellow exceed the screening level.*

4.3 Site-by-Site Summaries for *E. coli, Optical Brightener Detection,* and Streamflow

Figure 4-2 through Figure 4-12 correlate flow, *E. coli* measurements, and OB test results to rainfall events. Flow is represented by black horizontal bars. *E. coli* is represented by the horizontal bars, with light blue representing measurements with negative OB detection, and purple bars representing positive OB detection. The red dotted line represents the water quality criteria for *E. coli* (126 MPN/100 mL), which is technically only appropriate for geomean measurements, but is shown here for a rough comparison.

4.3.1 Site 01 – Wildcat Branch at Cravens Road (10793)

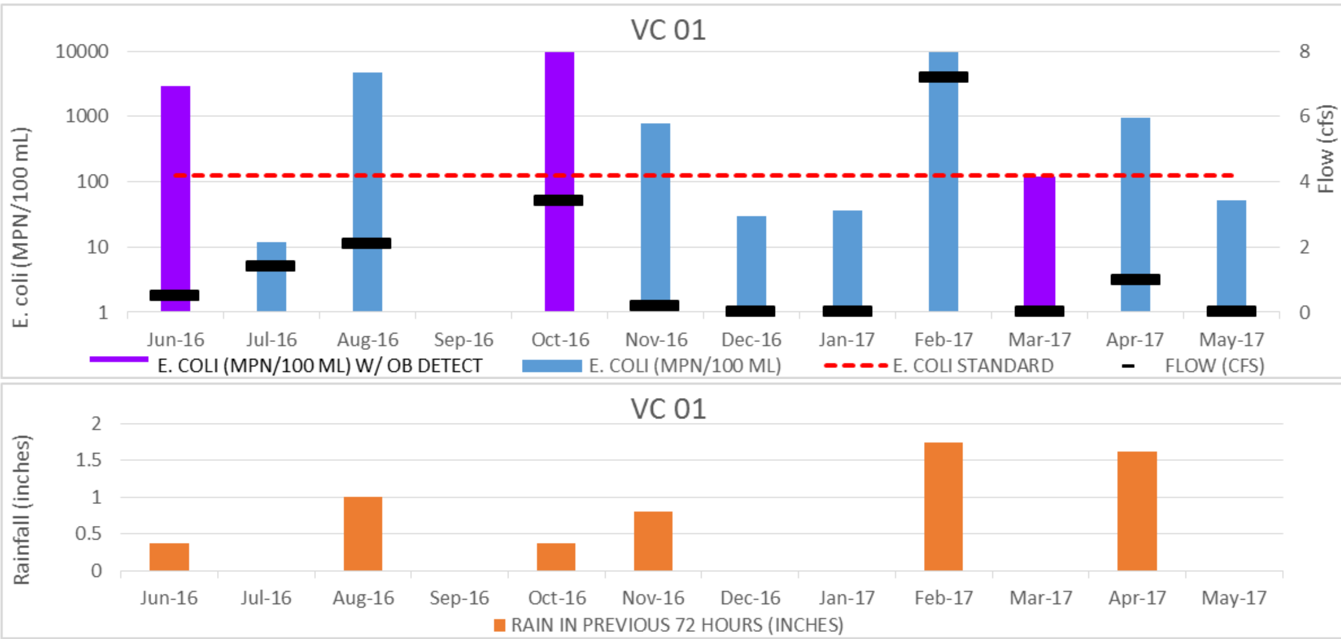


Figure 4-2. Hydrology and *E. coli* parameters, Wildcat Branch at Cravens Road (10793).

4.3.2 Site 02 – Tributary of Lake Arlington (10798)

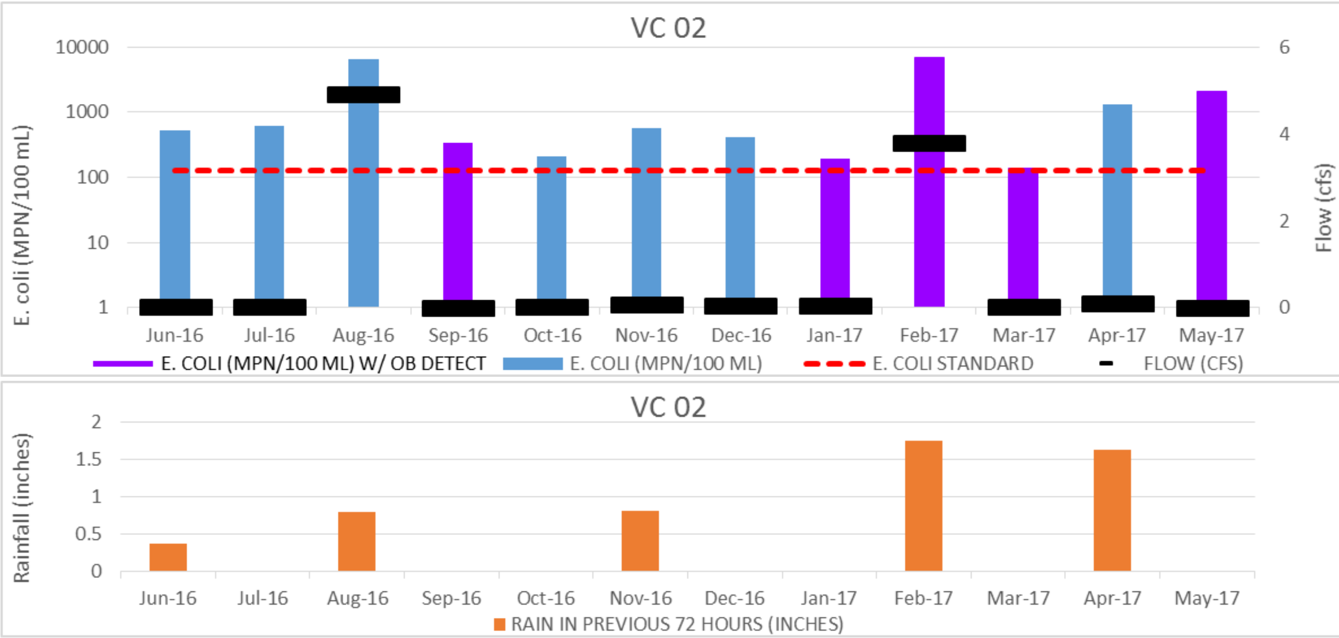


Figure 4-3. Hydrology and E. coli parameters, Tributary of Lake Arlington (10798).

4.3.3 Site 03 – Village Creek at IH-20 (10780)

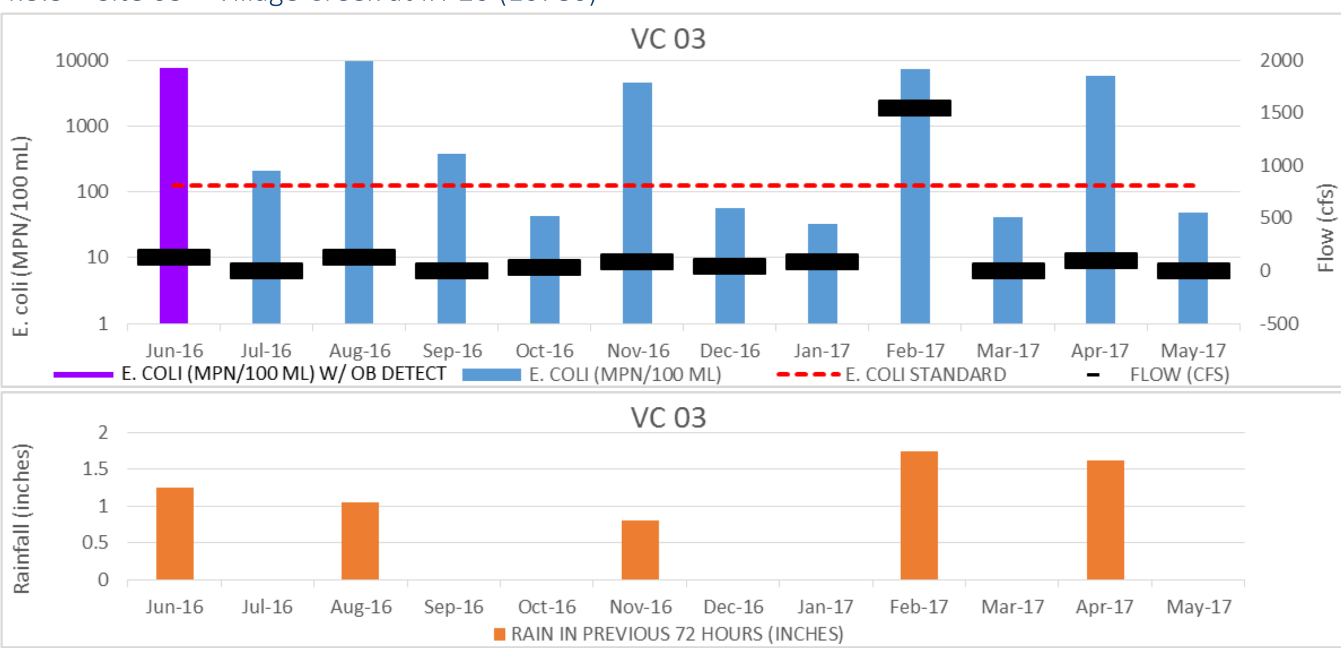


Figure 4-4. Hydrology and E. coli parameters, Village Creek at IH-20 (10780).

4.3.4 Site 04 – Village Creek Downstream of US BUS 287 (10781)

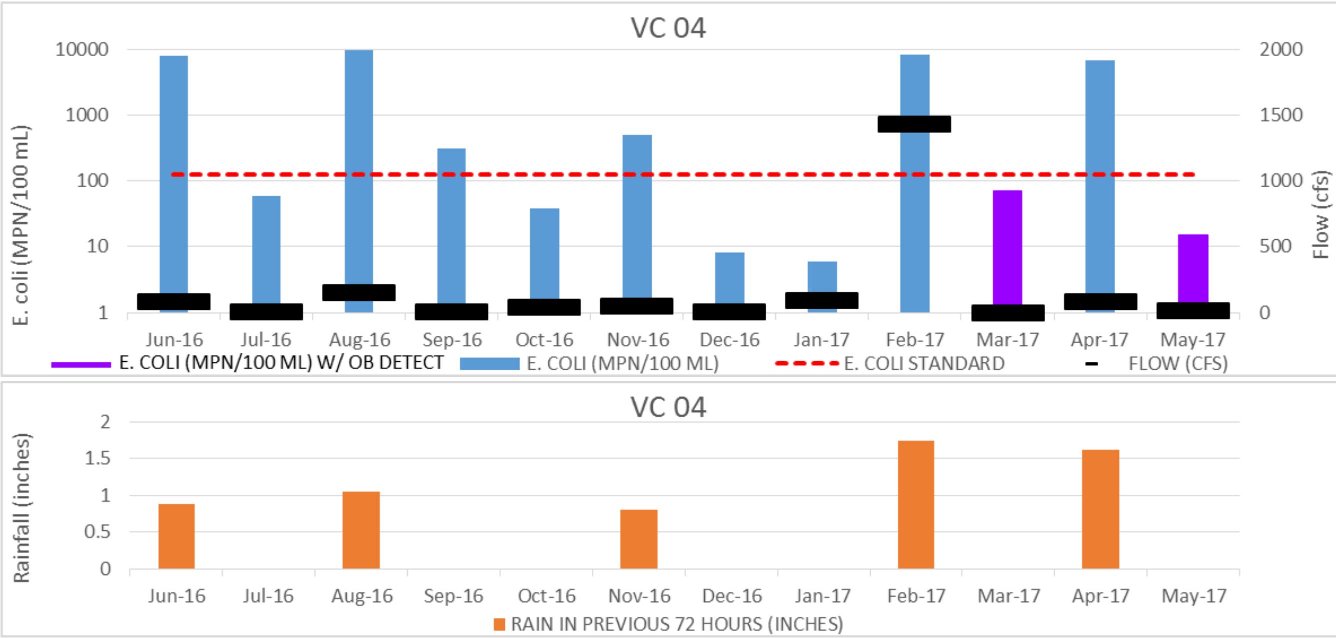


Figure 4-5. Hydrology and E. coli parameters, Village Creek Downstream of US BUS 287 (10781).

4.3.5 Site 05 – Village Creek near Freeman Drive (21762)

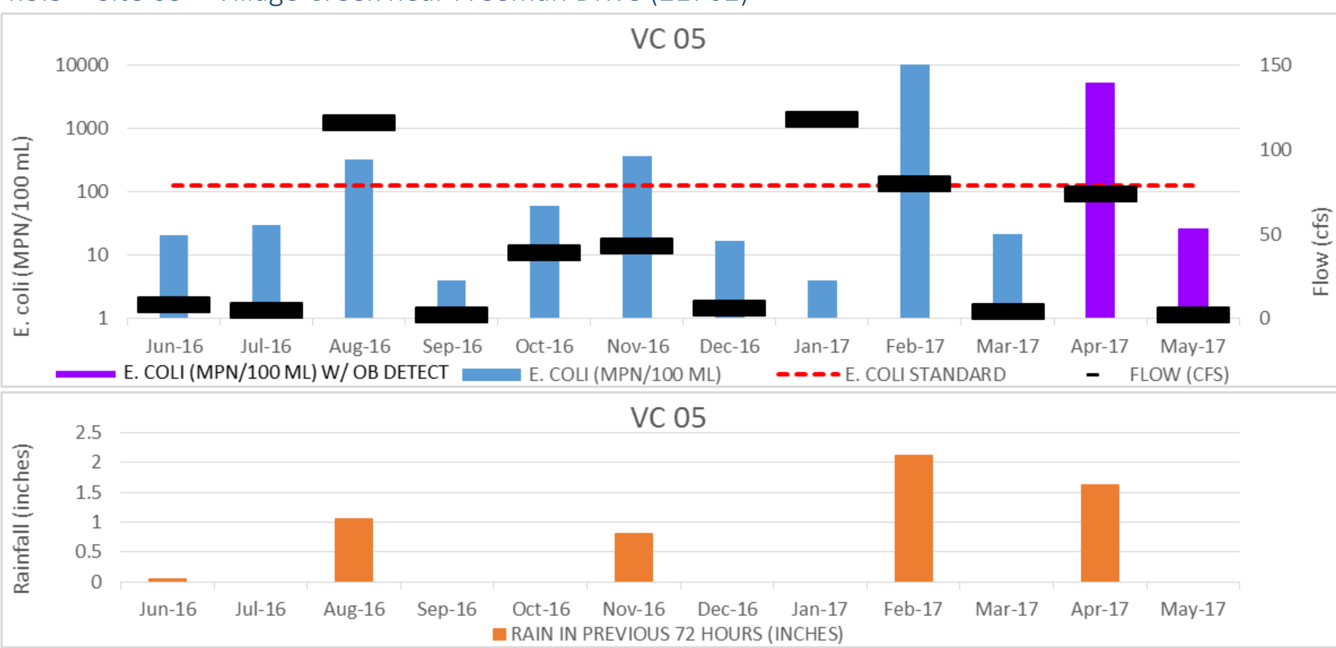


Figure 4-6. Hydrology and E. coli parameters, Village Creek near Freeman Drive (21762).

4.3.6 Site 06 – Village Creek at Everman Drive (13671)

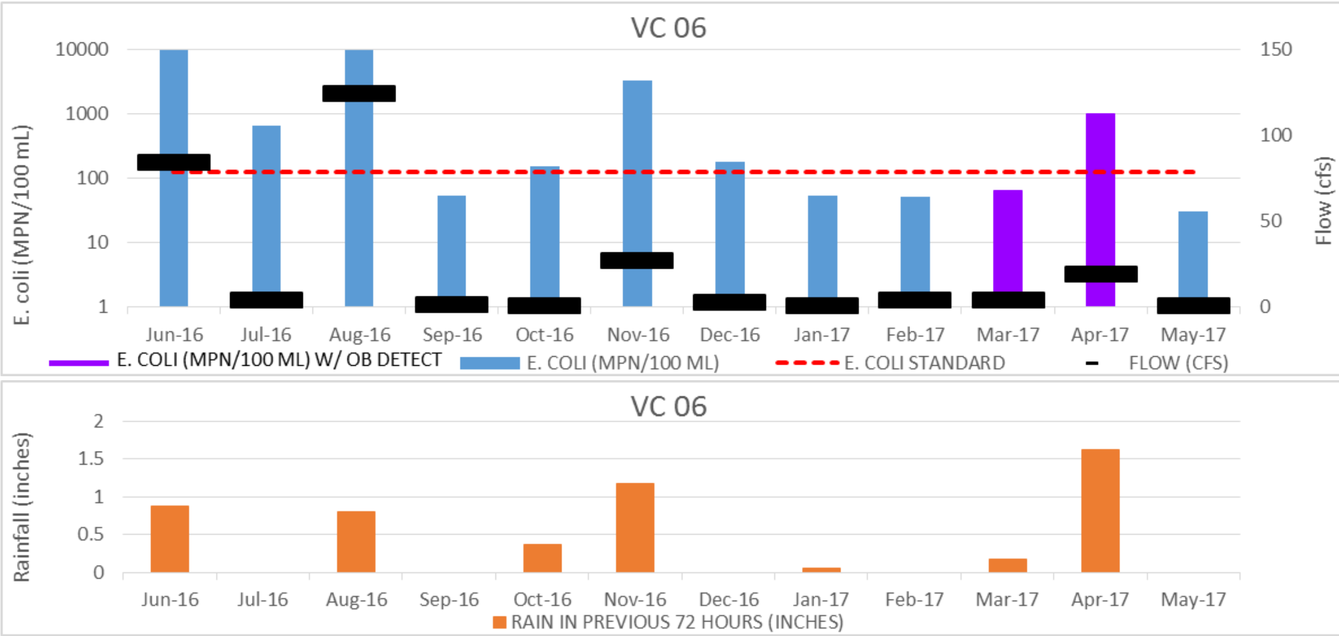


Figure 4-7. Hydrology and E. coli parameters, Village Creek at Everman Drive (13671).

4.3.7 Site 07 – Village Creek at Rendon Road (10786)

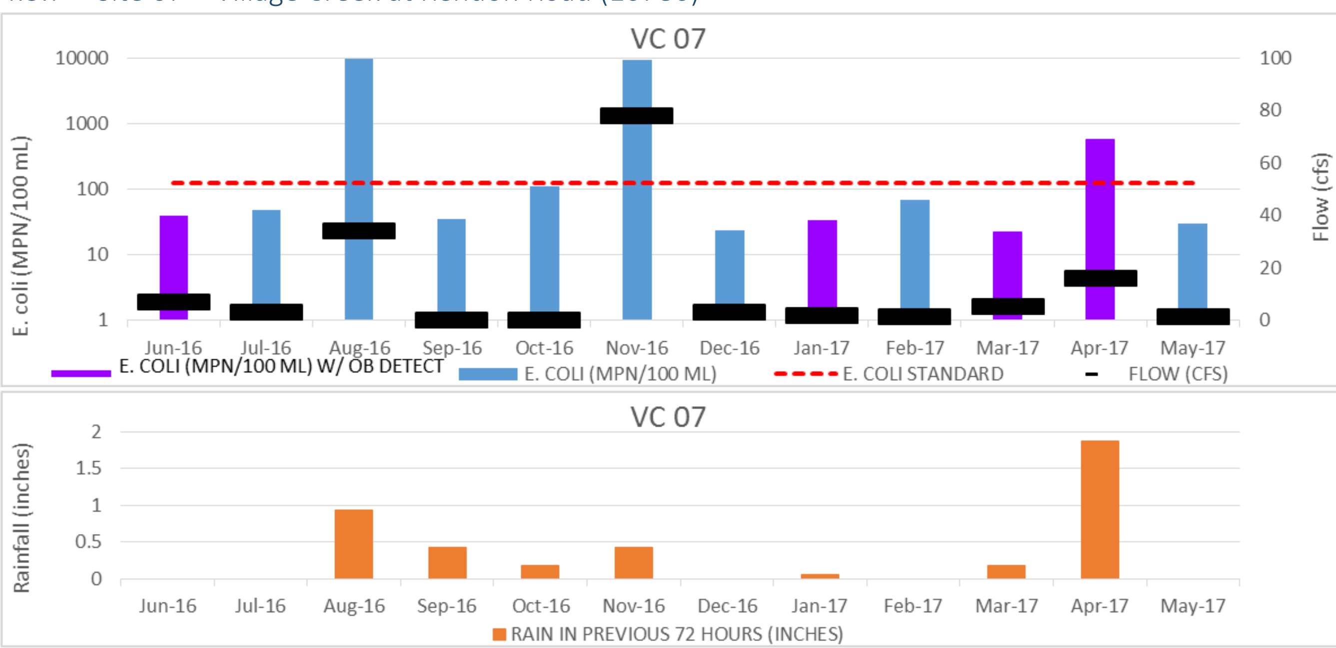


Figure 4-8. Hydrology and E. coli parameters, Village Creek at Rendon Road (10786).

4.3.8 Site 08 – Deer Creek at Oak Grove Road (10805)

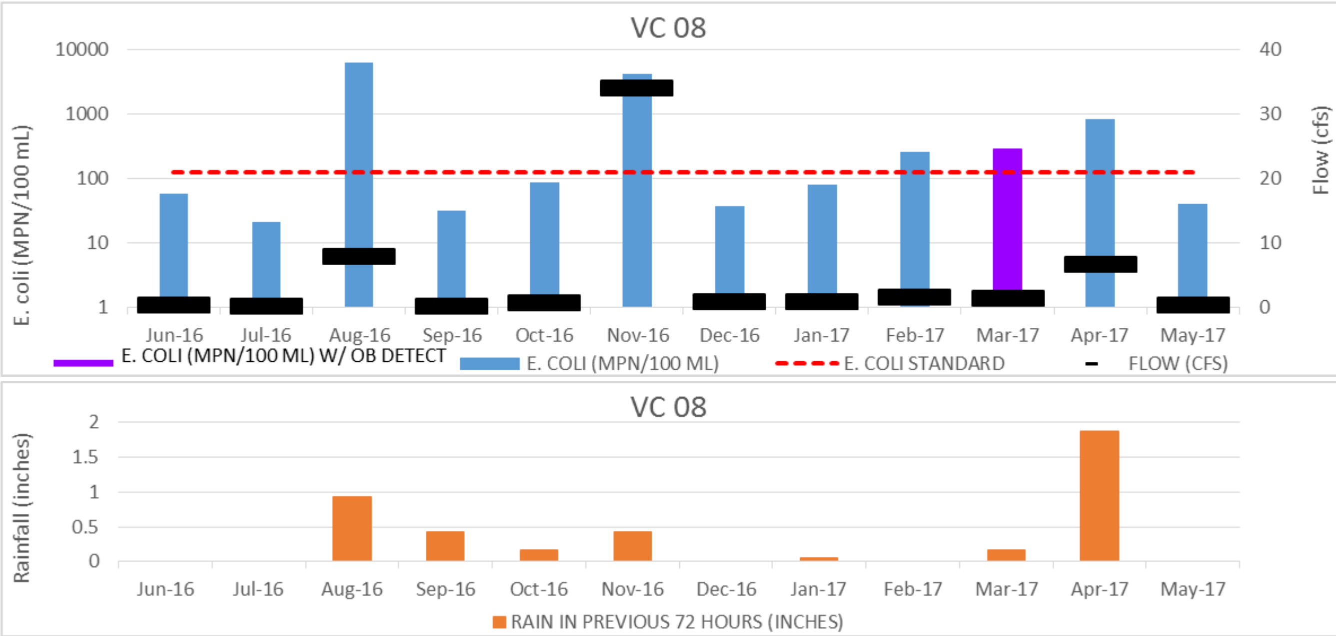


Figure 4-9. Hydrology and E. coli parameters, Deer Creek at Oak Grove Road (10805).

4.3.9 Site 09 – Village Creek upstream of Oak Grove (10785)

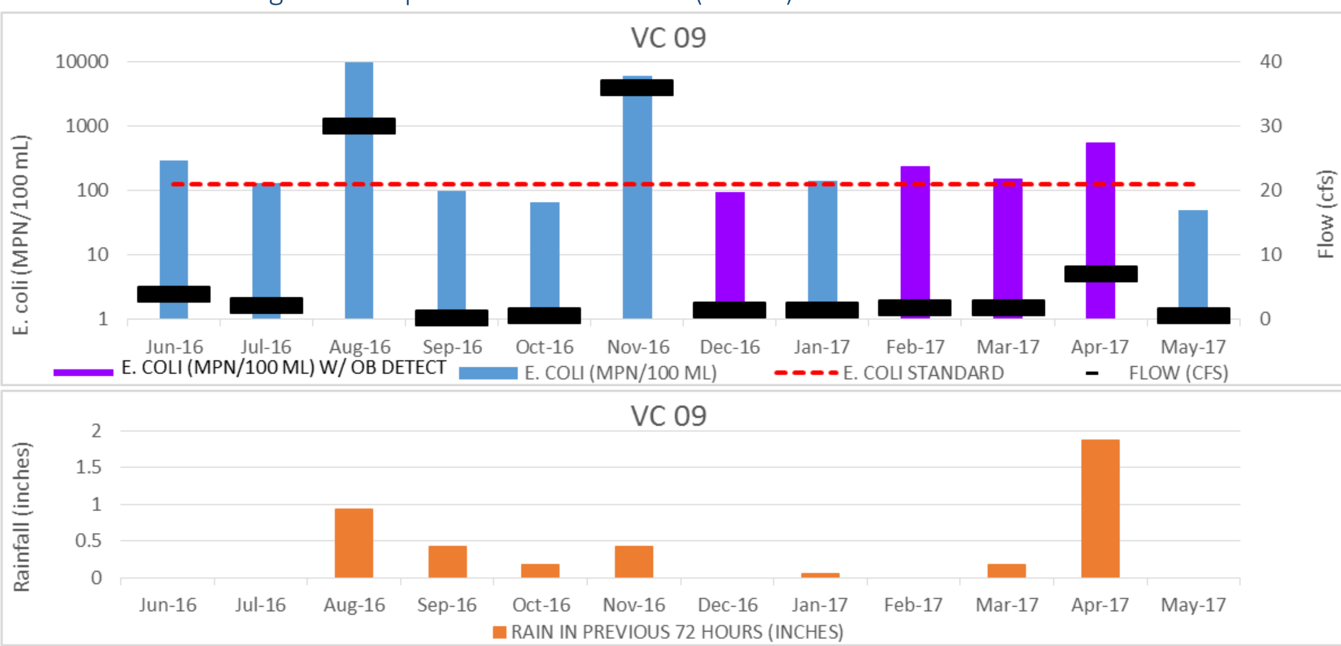


Figure 4-10. Hydrology and E. coli parameters, Village Creek upstream of Oak Grove (10785).

4.3.10 Site 10 – Quil Miller Creek at County Road 532 in Burleson (21759)

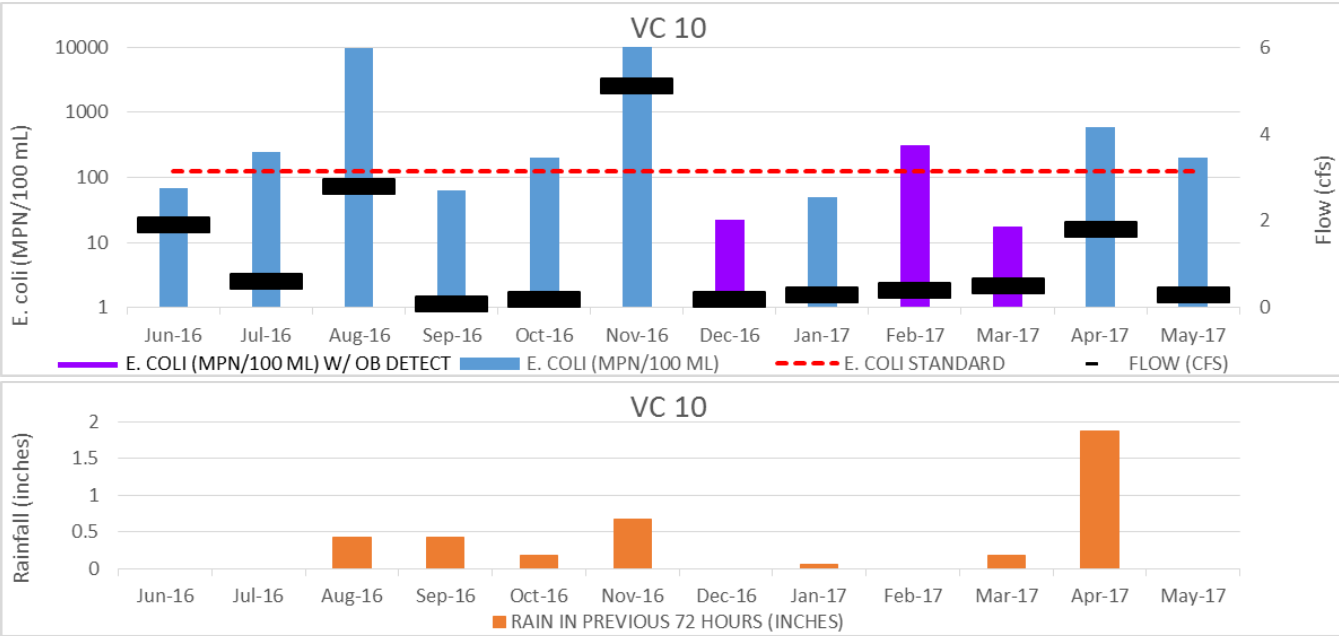


Figure 4-11. Hydrology and E. coli parameters, Quil Miller Creek at County Road 532 in Burleson (21759).

4.3.11 Site 11 – Village Creek at FM 3391 (21763)

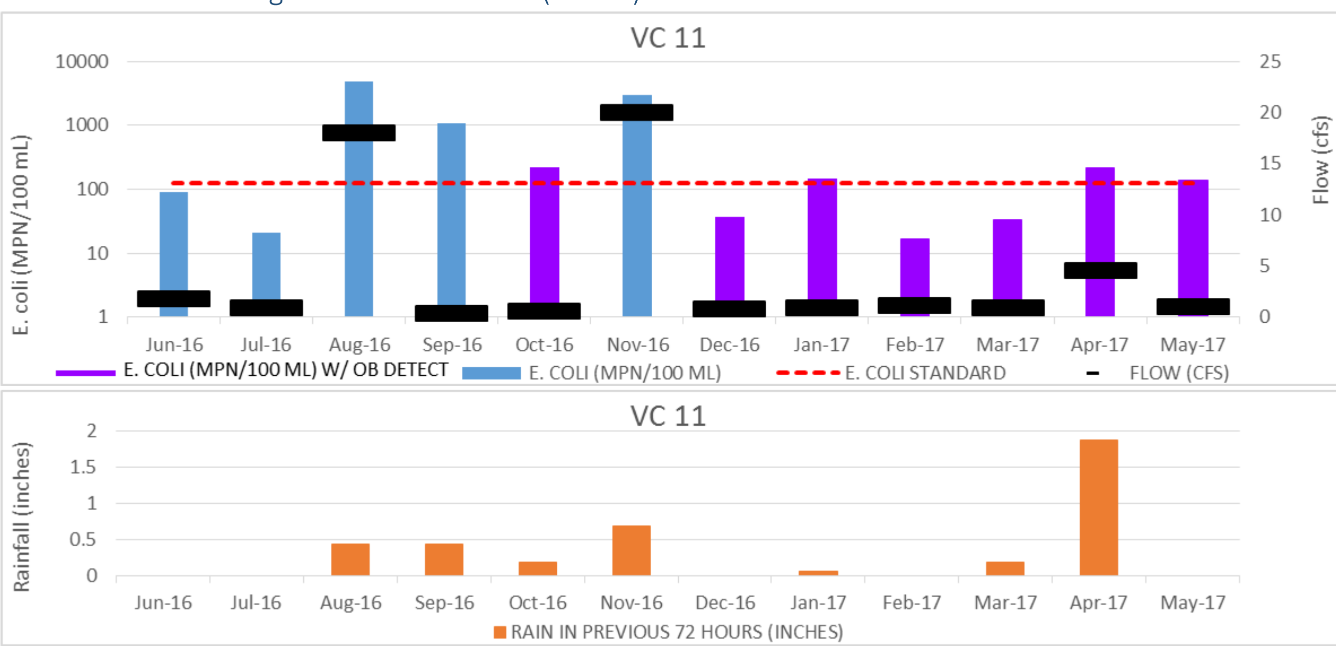


Figure 4-12. Hydrology and E. coli parameters, Village Creek at FM 3391 (21763).

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Appendix A

Analytical and Field Data for Stations in
AUs 0828A and 0828

Appendix A: Analytical and Field Data for Stations in AUs 0828A and 0828

Station ID	End Date	End Time	OB's	24 Hr rain	72 Hr rain	Water Temp (C)	Air Temp (C)	DO (mg/L)	pH (SU)	Sp. Cond (uS/cm)	Secchi Depth (m)	Days Since Precip	Contact Rec Observed	# People Observed
10793	6/29/2016	8:55:00 AM	Yes	0.375	0.375	28.8	29	1.8	6.5	298	0.42	2	0	0
10798	6/28/2016	12:56:00 PM		0.375	0.375	26.2	34	5.2	6.7	1940	> 0.6	1	0	0
10780	6/29/2016	9:50:00 AM	Yes	0.375	1.25	25.8	29	5.8	6.8	348	0.07	2	0	0
10781	6/28/2016	12:07:00 PM		0.875	0.875	29.5	33	6.8	7.3	587	0.15	1	0	0
21762	6/28/2016	10:30:00 AM		0.875	0.875	28.8	29	6.4	7.1	587	0.1	1	0	0
13671	6/28/2016	9:05:00 AM		0.875	0.875	28.4	26	5.9	7.3	527	0.08	1	0	0
10786	6/27/2016	1:30:00 PM	Yes	0	0	30.4	38	10.1	7.6	860	> 0.6	13	0	0
10805	6/27/2016	10:46:00 AM		0	0	29.4	31.5	6.1	7.2	604	> 0.6	13	1	1
10785	6/27/2016	11:22:00 AM		0	0	28.6	30.5	9.1	7.8	939	0.56	13	0	0
21759	6/27/2016	9:51:00 AM		0	0	25.3	29	6.1	7.4	1110	> 0.6	13	0	0
21763	6/27/2016	8:52:00 AM		0	0	27.7	28.5	5.7	7.6	932	> 0.6	13	0	0
10793	7/19/2016	1:20:00 PM		0	0	32.4	37.5	6.1	7.6	430	> 0.6	9	0	0
10798	7/20/2016	12:25:00 PM		0	0	27	37	4.5	7.2	2240	> 0.6	10	0	0
10780	7/20/2016	11:55:00 AM		0	0	31	36	6.9	7.7	370	0.21	10	0	0
10781	7/20/2016	11:10:00 AM		0	0	29.1	34	6.2	7.5	280	> 0.6	10	0	0
21762	7/20/2016	10:00:00 AM		0	0	28.9	33	7.6	7.6	287	> 0.6	10	0	0
21762	7/12/2016	11:25:00 AM		0	0.055	29.2	32	9.1	7.6	283	> 0.6	2	0	0
13671	7/20/2016	9:00:00 AM		0	0	29.2	30	6.6	7.6	762	0.47	10	0	0
10786	7/20/2016	8:25:00 AM		0	0	28.2	28	5.6	7.3	751	> 0.6	10	0	0
10805	7/19/2016	11:10:00 AM		0	0	30.1	32	6.6	7.6	530	> 0.6	9	0	0
10785	7/19/2016	10:15:00 AM		0	0	27.7		7	7.9	855	> 0.6	9	0	0
21759	7/19/2016	9:15:00 AM		0	0	26.2	27	5.3	7.6	989	0.37	9	0	0
21763	7/19/2016	8:30:00 AM		0	0	28	26.5	5.4	7.8	869	> 0.6	9	0	0
10793	8/15/2016	1:15:00 PM		0.63	1	26.1	20.5	5.4		315	0.53	< 1	0	0
10798	8/17/2016	2:05:00 PM		0	0.8	25.6	21	7.4	7.4		0.53	< 1	0	0
10780	8/15/2016	11:45:00 AM		0.88	1.05	26.1	20	5.5		267	0.65	< 1	0	0
10781	8/15/2016	10:45:00 AM		0.88	1.05	26.1	20	6.1		246	> 0.6	< 1	0	0

Station ID	End Date	End Time	OB's	24 Hr rain	72 Hr rain	Water Temp (C)	Air Temp (C)	DO (mg/L)	pH (SU)	Sp. Cond (uS/cm)	Secchi Depth (m)	Days Since Precip	Contact Rec Observed	# People Observed
21762	8/17/2016	2:50:00 PM		0	1.05	29.2	24	6.8	7.7	253	0.38	< 1	0	0
13671	8/15/2016	9:45:00 AM		0.63	0.8	26	20	6.2		248	0.06	< 1	0	0
10786	8/15/2016	1:45:00 PM		0.88	0.93	26	24	6.6	7.4	252	0.1	< 1	0	0
10805	8/15/2016	12:50:00 PM		0.88	0.93	25.4	25	6.3	7.8	211	0.08	< 1	0	0
10785	8/15/2016	12:05:00 PM		0.88	0.93	25.7	25	5.9	7.4	279	0.1	< 1	0	0
21759	8/15/2016	10:15:00 AM		0.38	0.43	24.9	26	5.7	7.4	279	0.08	< 1	0	0
21763	8/15/2016	9:15:00 AM		0.38	0.43	25.8	25	6.2	7.4	222	0.19	< 1	0	0
10793	9/13/2016	11:35:00 AM		0	0		32.5					11	0	0
10798	9/13/2016	10:55:00 AM	Yes	0	0	24.8	27	3.4	7	1260	> 0.6	11	0	0
10780	9/13/2016	12:00:00 PM		0	0	28.2	28	7.5	7.8	248	0.34	11	0	0
10781	9/13/2016	10:00:00 AM		0	0	27.2	26.5	6.2	7.7	262	> 0.6	11	0	0
21762	9/13/2016	8:45:00 AM		0	0	26.7	25	5.4	7	270	> 0.6	11	0	0
13671	9/13/2016	7:44:00 AM		0	0	24.8	22	5.7	7.4	598	0.42	11	0	0
10786	9/12/2016	1:35:00 PM		0	0.43	26.1	33	7.9	7.8	521	> 0.6	10	0	0
10805	9/12/2016	12:44:00 PM		0	0.43	25.1	33	5.6	7.6	448	> 0.6	10	0	0
10785	9/12/2016	11:46:00 AM		0	0.43	22.6	28	5.6	7.5	662	> 0.6	10	0	0
21759	9/12/2016	10:00:00 AM		0	0.43	22.9	27	4.1	7.2	864	> 0.6	10	0	0
21763	9/12/2016	10:55:00 AM		0	0.43	24.5	27	4.5	7.3	600	> 0.6	10	0	0
10793	10/11/2016	12:00:00 PM		0	0							3		
10793	10/20/2016	10:05:00 AM	Yes	0.375	0.375	15	21.9	7	6.9	191	0.14	< 1	0	0
10798	10/11/2016	11:26:00 AM		0	0	19.2	22	4.3	6.9	1590	> 0.6	3	0	0
10780	10/11/2016	10:40:00 AM		0	0	22.9	19.5	7.2	7.5	265	0.47	3	0	0
10781	10/11/2016	9:35:00 AM		0	0	22.9	19	7.2	7	259	> 0.6	3	0	0
21762	10/11/2016	8:22:00 AM		0	0	23.8	10.5	6.9	7.6	256	0.34	3	0	0
13671	10/10/2016	12:20:00 PM		0	0.375	20	19	8	7.6	390	0.23	2	0	0
10786	10/10/2016	11:50:00 AM		0	0.175	17.7	20	7.8	7.7	381	> 0.6	2	1	1
10805	10/10/2016	10:28:00 AM		0	0.175	18.1	17	7	7.6	417	0.42	2	0	0
10785	10/10/2016	11:02:00 AM		0	0.175	16.7	21	7.3	7.3	427	> 0.6	2	0	0
21759	10/10/2016	8:42:00 AM		0	0.175	17.8	9	4.5	7.2	686	> 0.6	2	0	0

Station ID	End Date	End Time	OB's	24 Hr rain	72 Hr rain	Water Temp (C)	Air Temp (C)	DO (mg/L)	pH (SU)	Sp. Cond (uS/cm)	Secchi Depth (m)	Days Since Precip	Contact Rec Observed	# People Observed
21763	10/10/2016	9:34:00 AM	Yes	0	0.175	17.2	11.5	7.3	7.3	502	> 0.6	2	0	0
10793	11/9/2016	1:45:00 PM		0.055	0.805	18.8	17	6.2	7.4	325	> 0.6	1	0	0
10798	11/9/2016	1:00:00 PM		0.055	0.805	19.3	17	4.8	6.8	879	> 0.6	1	0	0
10780	11/9/2016	12:06:00 PM		0.055	0.805	21.7	17	8.2	7.6	264	0.22	1	0	0
10781	11/9/2016	11:10:00 AM		0.055	0.805	21.5	17.5	3.2	7.3	265	0.42	1	0	0
21762	11/9/2016	10:52:00 AM		0.055	0.805	21.8	17	8.1	7.9	260	0.54	1	0	0
13671	11/9/2016	9:13:00 AM		0.175	1.175	18.6	17	8	7.7	335	0.15	1	0	0
10786	11/8/2016	2:41:00 PM		0.375	0.43	19.2	18	8.8	7	295	0.14	0	0	0
10805	11/8/2016	2:04:00 PM		0.375	0.43	19.4	18	8.4	8	352	0.14	0	0	0
10785	11/8/2016	1:12:00 PM		0.375	0.43	19.2	17.7	7.9	7.8	272	0.16	0	0	0
21759	11/8/2016	11:44:00 AM		0.625	0.68	19	13.5	7.6	7.7	279	0.09	0	0	0
21763	11/8/2016	9:54:00 AM		0.625	0.68	19.1	16	7.9	7.7	316	0.15	0	0	0
10793	12/14/2016	8:41		0	0	7.3	6	7.9	7.2	747	> 0.6	8	0	0
10798	12/13/2016	11:34		0	0	12.1	11	5.3	7	1750	> 0.6	7	0	0
10780	12/14/2016	9:35		0	0	11.2	6.5	9.9	6.7	277	0.54	8	0	0
10781	12/13/2016	10:10		0	0	13.2	9.5	10.2	7.5	248	> 0.6	7	0	0
21762	12/13/2016	9:17		0	0	13.3	9.5	9.7	7.8	254	> 0.6	7	0	0
13671	12/13/2016	8:10		0	0	9	8.5	10.6	7.6	543	> 0.6	7	0	0
10786	12/12/2016	11:38		0	0	9.9	16	11.2	8.1	546	> 0.6	6	0	0
10805	12/12/2016	10:15		0	0	9	8	10.9	7.9	517	> 0.6	6	0	0
10785	12/12/2016	10:50	Yes	0	0	8.9	9	10.8	7.8	670	> 0.6	6	0	0
21759	12/12/2016	8:40	Yes	0	0	9.2	5.5	7.5	7.4	922	> 0.6	6	0	0
21763	12/12/2016	9:20	Yes	0	0	9	6.5	10	8	761	> 0.6	6	0	0
10793	1/10/2017	13:10		0	0	9.8	24	2.6	7.2	542	0.44	8	0	0
10798	1/10/2017	12:30	Yes	0	0	14.5	24	6.1	7	1780	> 0.6	8	0	0
10780	1/10/2017	11:24		0	0	10.6	20	11.2	8	303	0.5	8	0	0
10781	1/10/2017	10:15		0	0	10.7	20.5	12.3	8.1	290	0.51	8	0	0
21762	1/10/2017	9:05		0	0	10.4	18.5	11.9	8	288	0.56	8	0	0
13671	1/9/2017	12:10		0	0.055	6.4	16.5	12.9	7.7	595	> 0.6	7	0	0

Station ID	End Date	End Time	OB's	24 Hr rain	72 Hr rain	Water Temp (C)	Air Temp (C)	DO (mg/L)	pH (SU)	Sp. Cond (uS/cm)	Secchi Depth (m)	Days Since Precip	Contact Rec Observed	# People Observed
10786	1/9/2017	11:36	Yes	0	0.055	3.4	14	13.8	8.2	604	> 0.6	7	0	0
10805	1/9/2017	10:14		0	0.055	3	9.5	13.2	8.1	505	> 0.6	7	0	0
10785	1/9/2017	10:52		0	0.055	4.2	10	13	8	759	> 0.6	7	0	0
21759	1/9/2017	8:45		0	0.055	3.9	6	11.1	7.5	1060	> 0.6	7	0	0
21763	1/9/2017	9:25	Yes	0	0.055	3.7	7.5	12.7	7.9	765	> 0.6	7	0	0
10793	2/14/2017	12:00		1.75	1.75	10.4	8	10.5	6.8	164	0.15	< 1	0	0
10798	2/14/2017	10:45	Yes	1.75	1.75	10.9	7	10.4	7	263	0.23	< 1	0	0
10780	2/14/2017	10:10		1.75	1.75	11	8	10.2	7.3	229	0.04	< 1	0	0
10781	2/14/2017	9:10		1.75	1.75	11.2	8	10.1	7.5	167	0.03	< 1	0	0
21762	2/15/2017	12:20		0.375	2.125	11	14	10.4	7.6	352	0.09	1	0	0
13671	2/13/2017	12:15		0	0	16.3	17	10.2	7.4	708	0.59	21	0	0
10786	2/13/2017	11:40		0	0	15.6	17	11	7.8	698	> 0.6	21	0	0
10805	2/13/2017	10:08		0	0	15.4	17	9.1	7.5	572	> 0.6	21	0	0
10785	2/13/2017	10:50	Yes	0	0	15.4	17	11.2	7.8	867	> 0.6	21	0	0
21759	2/13/2017	8:23	Yes	0	0	14.8	15	6.9	7.5	987	> 0.6	21	0	0
21763	2/13/2017	9:23	Yes	0	0	14.3	17	9	7.8	883	> 0.6	21	0	0
10793	3/28/2017	12:05	Yes	0	0	21.1	20	2.2	7	417	0.55	3	0	0
10798	3/28/2017	11:25	Yes	0	0	18.8	18	3.7	6.8	1630	> 0.6	0	0	0
10780	3/28/2017	10:26		0	0	20.9	20	7.6	7.6	546	0.32	0	0	0
10781	3/28/2017	9:25	Yes	0	0	20.8	17	6	7.3	684	0.43	0	0	0
21762	3/28/2017	8:20		0	0	19.4	17	5.7	7.5	676	> 0.6	0	0	0
13671	3/27/2017	13:05	Yes	0	0.175	22.3	17	10	7.9	763	0.42	0	0	0
10786	3/27/2017	12:32	Yes	0	0.175	20.3	17	8.7	7.9	710	> 0.6	2	0	0
10805	3/27/2017	11:15	Yes	0	0.175	19.9	17	8.7	7.9	568	> 0.6	2	0	0
10785	3/27/2017	11:40	Yes	0	0.175	19.5	18	10.3	8	789	> 0.6	2	0	0
21759	3/27/2017	9:40	Yes	0	0.175	18.5	15	6	7.2	1040	> 0.6	2	0	0
21763	3/27/2017	10:30	Yes	0	0.175	18.7	16	7.4	7.5	759	> 0.6	2	0	0
10793	4/3/2017	9:02		1.25	1.625	18.1	13	4.1	6.6	178	0.13	1	0	0
10798	4/3/2017	8:25		1.25	1.625	17.1	11	5.4	6.7	805	> 0.6	1	0	0

Station ID	End Date	End Time	OB's	24 Hr rain	72 Hr rain	Water Temp (C)	Air Temp (C)	DO (mg/L)	pH (SU)	Sp. Cond (uS/cm)	Secchi Depth (m)	Days Since Precip	Contact Rec Observed	# People Observed
10780	4/3/2017	10:18		1.25	1.625	17.9	15	7.6	7.1	367	0.09	1	0	0
10781	4/3/2017	11:27		1.25	1.625	18	20	8.1	7.6	370	0.08	1	0	0
21762	4/3/2017	12:46	Yes	1.25	1.625	18.8	22	8.3	7.8	373	0.07	1	0	0
13671	4/4/2017	15:36	Yes	0	1.625	20.4	28	7.8	7.8	438	0.17	2	0	0
10786	4/4/2017	14:22	Yes	0	1.875	20.9	27	10.3	7.8	461	0.4	2	0	0
10805	4/4/2017	12:01		0	1.875	20	23	7.7	7.8	459	0.35	2	0	0
10785	4/4/2017	13:15	Yes	0	1.875	19.8	26	7.9	7.8	490	0.32	2	0	0
21759	4/4/2017	9:40		0	1.875	17.8	17	6.5	7.2	551	0.16	2	0	0
21763	4/4/2017	10:58	Yes	0	1.875	19	22	7.9	7.8	561	> 0.6	2	0	0
10793	5/9/2017	12:35		0	0	24	25	2.9	6.8	422	0.35	5	0	0
10798	5/9/2017	12:10	Yes	0	0	21.2	23	5.7	7	1850	> 0.6	5	0	0
10780	5/9/2017	11:25		0	0	22.4	24	7.2	7.1	430	0.47	5	0	0
10781	5/9/2017	9:40	Yes	0	0	22.8	22	6.7	7.4	407	> 0.6	5	0	0
21762	5/9/2017	8:45	Yes	0	0	22	21	8.1	7.7	497	> 0.6	5	0	0
13671	5/8/2017	14:37		0	0	25.7	27	10.6	8	628	0.35	4	0	0
10786	5/8/2017	13:16		0	0	23.7	25	9.4	7.9	596	> 0.6	4	0	0
10805	5/8/2017	12:36		0	0	22.5	25	6.9	7.5	486	> 0.6	4	0	0
10785	5/8/2017	12:05		0	0	20.4	23	6.6	7.7	768	0.56	4	0	0
21759	5/8/2017	9:35		0	0	19.1	20	4.3	7.3	946	> 0.6	4	0	0
21763	5/8/2017	10:30	Yes	0	0	21	22	6.6	8	790	> 0.6	4	0	0

Appendix B

Water Chemistry and Streamflow Data for Stations in AUs 0828A and 0828

Appendix B: Water Chemistry and Streamflow Data for Stations in AUs 0828A and 0828

Station ID	End Date	End Time	Flow Severity	Flow (cfs)	Flow Method	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	TKN (mg/L)	TP (mg/L)	OP (mg/L)	*E. coli* (MPN/ 100mL)	Chl-a (ug/L)
10793	6/29/2016	8:55:00 AM	5	0.5	5	10	< 3	164	< 0.05	0.25	1.08	0.14	0.04	2900	17
10798	6/28/2016	12:56:00 PM	3	0.03	2	< 2	< 2	1304	< 0.05	0.2	0.38	0.02	< 0.02	530	11
10780	6/29/2016	9:50:00 AM	3	133	5	116	< 14	233	< 0.05	0.62	0.96	0.35	0.11	7700	9
10781	6/28/2016	12:07:00 PM	3	83	5	54	< 6	304	< 0.05	0.37	0.61	0.12	< 0.02	7900	11
21762	6/28/2016	10:30:00 AM	5			69	< 9	324	< 0.05	0.4	0.69	0.11	< 0.02	> 9700	11
13671	6/28/2016	9:05:00 AM	5	84	2	87	< 11	276	< 0.05	0.44	0.72	0.17	< 0.02	> 9700	7
10786	6/27/2016	1:30:00 PM	3	7	1	5	< 2	509	< 0.05	0.14	0.45	0.02	< 0.02	39	< 3
10805	6/27/2016	10:46:00 AM	3	0.5	2	4	< 2	350	< 0.05	0.54	0.49	< 0.02	< 0.02	58	4
10785	6/27/2016	11:22:00 AM	3	4	2	8	< 2	558	< 0.05	0.31	0.42	0.03	< 0.02	290	5
21759	6/27/2016	9:51:00 AM	3	1.9	2	3	< 2	676	< 0.05	0.29	0.39	0.05	0.07	68	< 3
21763	6/27/2016	8:52:00 AM	3	1.8	2	8	< 2	553	0.07	2.45	0.67	0.14	0.1	92	< 3
10793	7/19/2016	1:20:00 PM	3	1.4	5	7	3	244	< 0.05	< 0.05	0.65	0.04	< 0.02	12	17
10798	7/20/2016	12:25:00 PM	3	0.017	2	4	< 2	1573	< 0.05	< 0.05	0.36	0.02	< 0.02	610	< 3
10780	7/20/2016	11:55:00 AM	3	-2.757	5	20	3	238	< 0.05	0.14	0.59	0.05	< 0.02	210	12
10781	7/20/2016	11:10:00 AM	3	3.3	5	9	< 2	167	< 0.05	0.2	0.42	0.04	< 0.02	59	5
21762	7/20/2016	10:00:00 AM	3	5	2	5	< 2	191	< 0.05	0.23	0.42	0.03	< 0.02	30	< 3
21762	7/12/2016	11:25:00 AM	3	8.2	5	8	< 2	152	< 0.05	0.17	0.47	0.04	0.02	21	6
13671	7/20/2016	9:00:00 AM	3	4.2	2	5	< 2	481	< 0.05	< 0.05	0.21	< 0.02	< 0.02	640	3
10786	7/20/2016	8:25:00 AM	3	3.2	1	4	< 2	461	< 0.05	< 0.05	0.37	< 0.02	< 0.02	48	4
10805	7/19/2016	11:10:00 AM	3	0.2	5	5	< 2	309	< 0.05	0.15	0.45	< 0.02	< 0.02	21	4
10785	7/19/2016	10:15:00 AM	3	2.1	2	4	< 2	501	< 0.05	0.4	0.5	0.02	< 0.02	130	< 3
21759	7/19/2016	9:15:00 AM	3	0.6	2	4	< 2	613	< 0.05	0.12	0.26	0.05	0.04	250	< 3
21763	7/19/2016	8:30:00 AM	3	0.9	2	8	< 2	515	< 0.05	< 0.05	0.41	0.2	0.18	21	< 3
10793	8/15/2016	1:15:00 PM	5	2.1	5	12	< 8	187	< 0.05	0.33	0.82	0.09	0.03	> 4800	4
10798	8/17/2016	2:05:00 PM	5	4.9	2	19	< 15	240	< 0.05	0.4	0.68	0.06	< 0.02	6500	3
10780	8/15/2016	11:45:00 AM	5	132	5	128	12	192	< 0.05	0.23	0.9	0.28	0.02	> 9700	6
10781	8/15/2016	10:45:00 AM	5	154	5	152	< 16	179	< 0.05	0.28	0.88	0.33	0.04	> 9700	8

Station ID	End Date	End Time	Flow Severity	Flow (cfs)	Flow Method	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	TKN (mg/L)	TP (mg/L)	OP (mg/L)	*E. coli* (MPN/ 100mL)	Chl-a (ug/L)
21762	8/17/2016	2:50:00 PM	5	116	2	21	< 9	146	< 0.05	0.33	0.45	0.05	< 0.02	320	9
13671	8/15/2016	9:45:00 AM	5	124	5	196	< 20	190	< 0.05	0.35	0.88	0.4	0.06	> 9700	8
10786	8/15/2016	1:45:00 PM	5	34	1	58	< 19	202	< 0.05	0.33	0.81	0.25	0.07	> 9700	4
10805	8/15/2016	12:50:00 PM	5	7.9	2	137	< 14	212	< 0.05	0.39	0.71	0.26	0.04	6200	8
10785	8/15/2016	12:05:00 PM	5	30	2	54	< 17	204	< 0.05	0.37	0.83	0.28	0.08	> 9700	8
21759	8/15/2016	10:15:00 AM	5	2.8	2	54	< 14	234	< 0.05	0.43	0.99	0.38	0.17	> 9700	< 3
21763	8/15/2016	9:15:00 AM	5	18	2	40	< 8	158	< 0.05	0.34	0.72	0.22	0.13	> 4800	6
10793	9/13/2016	11:35:00 AM	1												
10798	9/13/2016	10:55:00 AM	2	0.01	2			815	< 0.05	0.06	0.22	0.02	< 0.02	340	< 3
10780	9/13/2016	12:00:00 PM	2	0.4	5			154	< 0.05	0.63	0.27	0.06	0.02	380	8
10781	9/13/2016	10:00:00 AM	2	3.3	5			157	< 0.05	0.56	0.45	0.04	0.03	310	4
21762	9/13/2016	8:45:00 AM	2	2.6	2			172	< 0.05	0.67	0.48	0.04	0.03	4	< 3
13671	9/13/2016	7:44:00 AM	2	1.6	2			355	< 0.05	< 0.05	< 0.2	0.03	< 0.02	53	4
10786	9/12/2016	1:35:00 PM	2	0.08	2			304	< 0.05	< 0.05	0.29	0.03	< 0.02	35	< 3
10805	9/12/2016	12:44:00 PM	2	0.3	2			268	< 0.05	< 0.05	0.31	0.03	< 0.02	32	4
10785	9/12/2016	11:46:00 AM	2	0.2	2			402	< 0.05	1.17	0.29	0.07	0.03	100	4
21759	9/12/2016	10:00:00 AM	1	0.1	2			528	< 0.05	< 0.05	0.21	0.06	0.05	64	< 3
21763	9/12/2016	10:55:00 AM	2	0.4	2			370	< 0.05	< 0.05	0.48	0.25	0.23	1100	< 3
10793	10/11/2016	12:00:00 PM	1	0											
10793	10/20/2016	10:05:00 AM	3	3.4	5	58	10	144	< 0.05	0.41	1.35	0.22	0.08	> 9700	< 3
10798	10/11/2016	11:26:00 AM	2	0.02	2	8	< 2	1093	< 0.05	< 0.05	0.26	0.03	< 0.02	210	6
10780	10/11/2016	10:40:00 AM	3	34	5	13	2	171	< 0.05	0.71	0.56	0.06	0.03	43	5
10781	10/11/2016	9:35:00 AM	3	35	5	8	< 2	161	< 0.05	0.72	0.53	0.05	0.03	38	6
21762	10/11/2016	8:22:00 AM	3	39	2	14	3	159	< 0.05	0.74	0.44	0.06	0.03	61	8
13671	10/10/2016	12:20:00 PM	3	1	2	22	< 4	216	< 0.05	0.26	0.44	0.09	0.04	150	3
10786	10/10/2016	11:50:00 AM	3	0.2	1	3	< 2	223	< 0.05	0.08	0.38	0.05	0.03	110	< 3
10805	10/10/2016	10:28:00 AM	3	0.8	2	10	2	253	< 0.05	0.1	0.42	0.04	< 0.02	86	5
10785	10/10/2016	11:02:00 AM	3	0.6	2	2	< 2	246	< 0.05	0.96	0.36	0.13	0.1	67	< 3
21759	10/10/2016	8:42:00 AM	3	0.2	2	7	< 2	410	< 0.05	< 0.05	0.22	0.06	0.05	200	< 3

Station ID	End Date	End Time	Flow Severity	Flow (cfs)	Flow Method	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	TKN (mg/L)	TP (mg/L)	OP (mg/L)	*E. coli* (MPN/ 100mL)	Chl-a (ug/L)
21763	10/10/2016	9:34:00 AM	3	0.6	2	8	< 2	303	0.06	2.14	0.58	0.56	0.52	220	< 3
10793	11/9/2016	1:45:00 PM	3	0.2	2	3	< 2	194	< 0.05	0.12	0.55	0.06	0.03	770	3
10798	11/9/2016	1:00:00 PM	3	0.07	2	3	< 2	535	< 0.05	0.18	0.47	0.04	< 0.02	560	< 3
10780	11/9/2016	12:06:00 PM	3	86	5	21	< 6	156	< 0.05	0.25	0.38	0.08	0.03	4600	6
10781	11/9/2016	11:10:00 AM	3	46	5	12	< 4	145	< 0.05	0.25	0.45	0.07	0.03	490	7
21762	11/9/2016	10:52:00 AM	3	43	2	15	< 4	132	< 0.05	0.26	0.51	0.07	0.03	370	6
13671	11/9/2016	9:13:00 AM	3	27	2	42	< 7	211	< 0.05	0.36	0.53	0.14	0.06	3300	3
10786	11/8/2016	2:41:00 PM	3	78	1	34	< 9	209	< 0.05	0.42	0.59	0.16	0.08	9200	4
10805	11/8/2016	2:04:00 PM	5	34	2	38	< 8	216	< 0.05	0.35	0.59	0.09	0.03	4100	< 3
10785	11/8/2016	1:12:00 PM	3	36	2	24	< 7	180	< 0.05	0.45	0.54	0.19	0.12	6100	4
21759	11/8/2016	11:44:00 AM	3	5.1	2	35	< 9	237	< 0.05	0.39	0.79	0.31	0.19	10000	< 3
21763	11/8/2016	9:54:00 AM	3	20	2	28	< 6	232	< 0.05	1.03	0.63	0.34	0.28	3000	4
10793	12/14/2016	8:41	2	< 0.01	2	4	< 2	367	< 0.05	< 0.05	0.37	0.05	< 0.02	30	< 3
10798	12/13/2016	11:34	3	0.05	2	< 2	< 2	1142	< 0.05	0.09	0.47	0.03	< 0.02	410	< 3
10780	12/14/2016	9:35	3	47	5	8	< 2	164	< 0.05	0.29	0.46	0.04	< 0.02	56	4
10781	12/13/2016	10:10	3	7.9	5	3	< 2	151	< 0.05	0.31	0.51	0.04	0.02	8	4
21762	12/13/2016	9:17	3	6.5	2	2	< 2	149	< 0.05	0.32	0.44	0.04	0.02	17	< 3
13671	12/13/2016	8:10	3	2.8	2	5	< 2	312	< 0.05	< 0.05	0.32	0.04	< 0.02	180	< 3
10786	12/12/2016	11:38	3	3.2	1	2	< 2	318	< 0.05	< 0.05	0.36	0.03	< 0.02	24	< 3
10805	12/12/2016	10:15	3	1	2	2	< 2	300	< 0.05	0.3	0.24	< 0.02	< 0.02	37	< 3
10785	12/12/2016	10:50	3	1.4	2	2	< 2	408	< 0.05	0.41	0.31	0.15	0.12	96	< 3
21759	12/12/2016	8:40	3	0.2	2	2	< 2	556	< 0.05	< 0.05	< 0.2	0.06	0.04	22	< 3
21763	12/12/2016	9:20	3	0.8	2	< 2	< 2	453	< 0.05	4.65	0.89	1.24	1.16	37	< 3
10793	1/10/2017	13:10	1	0	5	6	< 3	339	< 0.05	< 0.05	0.6	0.09	0.04	37	< 3
10798	1/10/2017	12:30	3	0.05	2	3	< 2	1219	< 0.05	0.1	< 0.2	0.02	< 0.02	190	< 3
10780	1/10/2017	11:24	3	91	5	8	< 2	173	< 0.05	0.33	0.22	0.04	< 0.02	32	9
10781	1/10/2017	10:15	3	87	5	8	< 2	168	< 0.05	0.33	< 0.2	0.04	< 0.02	6	9
21762	1/10/2017	9:05	3	118	2	8	< 2	162	< 0.05	0.35	< 0.2	0.04	< 0.02	4	11
13671	1/9/2017	12:10	2	1	2	6	< 2	341	< 0.05	0.84	< 0.2	0.09	0.07	54	< 3

Station ID	End Date	End Time	Flow Severity	Flow (cfs)	Flow Method	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	TKN (mg/L)	TP (mg/L)	OP (mg/L)	*E. coli* (MPN/ 100mL)	Chl-a (ug/L)
10786	1/9/2017	11:36	3	2.1	1	< 2	< 2	328	< 0.05	0.19	< 0.2	0.11	0.08	34	< 3
10805	1/9/2017	10:14	3	1	2	< 2	< 2	286	< 0.05	0.25	< 0.2	0.02	< 0.02	80	< 3
10785	1/9/2017	10:52	3	1.5	2	< 2	< 2	412	< 0.05	0.26	0.24	0.18	0.16	140	< 3
21759	1/9/2017	8:45	3	0.3	2	< 2	< 2	672	< 0.05	< 0.05	< 0.2	0.04	0.03	49	< 3
21763	1/9/2017	9:25	3	0.9	2	< 2	< 2	455	< 0.05	4.52	0.48	1.8	1.75	150	< 3
10793	2/14/2017	12:00	5	7.2	5	26	< 4	130	< 0.05	0.57		0.34	0.25	9700	< 3
10798	2/14/2017	10:45	5	3.8	2	24	4	207	< 0.05	0.78		0.37	0.27	6900	< 3
10780	2/14/2017	10:10	5	1545	5	426	35	203	< 0.05	0.71		0.54	0.14	7300	22
10781	2/14/2017	9:10	5	1432	5	470	40	220	< 0.05	0.73		0.65	0.13	8200	14
21762	2/15/2017	12:20	5	80	2	59	< 7	271		0.93		0.29	0.16	10000	7
13671	2/13/2017	12:15	3	4.1	2	11	< 2	416	< 0.05	0.67	0.48	0.03	< 0.02	52	4
10786	2/13/2017	11:40	3	1.5	1	< 2	< 2	408	< 0.05	0.78	0.53	0.03	< 0.02	70	< 3
10805	2/13/2017	10:08	3	1.7	2	4	< 2	324	< 0.05	0.15	0.49	0.03	< 0.02	260	< 3
10785	2/13/2017	10:50	3	1.8	2	7	< 2	514	0.08	2.02	0.81	0.09	0.04	230	11
21759	2/13/2017	8:23	3	0.4	2	3	< 2	604	< 0.05	< 0.05	0.41	0.04	0.02	310	6
21763	2/13/2017	9:23	3	1.2	2	3	< 2	527	0.16	4.87	0.84			17	12
10793	3/28/2017	12:05	1	0		8	4	238	< 0.05	< 0.05	1.17	0.09	< 0.02	120	31
10798	3/28/2017	11:25	3	0.03	2	5	2	1095	< 0.05	< 0.05	0.81	0.04	< 0.02	140	12
10780	3/28/2017	10:26	1	0		14	< 3	335	< 0.05	< 0.05	0.69	0.05	< 0.02	42	18
10781	3/28/2017	9:25	2	0.04	5	15	< 2	418	< 0.05	< 0.05	0.46	0.04	< 0.02	70	8
21762	3/28/2017	8:20	3	4.1	2	8	< 2	408	< 0.05	< 0.05	0.44	0.03	< 0.02	22	< 3
13671	3/27/2017	13:05	3	4.5	2	15	< 2	467	< 0.05	< 0.05	0.46	0.04	< 0.02	65	4
10786	3/27/2017	12:32	3	5.3	1	2	< 2	430	< 0.05	< 0.05	0.43	0.03	< 0.02	22	< 3
10805	3/27/2017	11:15	3	1.4	2	5	< 2	345	< 0.05	0.08	0.44	0.02	< 0.02	290	< 3
10785	3/27/2017	11:40	3	1.8	2	47	10	535	< 0.05	0.19	0.61	0.14	0.07	150	15
21759	3/27/2017	9:40	3	0.5	2	13	4	662	< 0.05	< 0.05	0.26	0.04	0.02	17	< 3
21763	3/27/2017	10:30	3	0.9	2	3	< 2	529		2.93	0.66	0.89	0.88	34	4
10793	4/3/2017	9:02	3	1	5	38	< 6	123	< 0.05	0.19	0.8	0.19	0.05	9700	5
10798	4/3/2017	8:25	3	0.1	2	6	< 2	509	< 0.05	0.21	0.65	0.08	< 0.02	1300	7

Station ID	End Date	End Time	Flow Severity	Flow (cfs)	Flow Method	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	TKN (mg/L)	TP (mg/L)	OP (mg/L)	*E. coli* (MPN/ 100mL)	Chl-a (ug/L)
10780	4/3/2017	10:18	3	101	5	68	9	272	< 0.05	0.8	0.92	0.24	0.1	5700	< 3
10781	4/3/2017	11:27	3	80	5	64	< 7	273	< 0.05	1.06	0.95	0.26	0.13	6900	12
21762	4/3/2017	12:46	3	74	2	72	9	278	< 0.05	0.93	0.77	0.24	0.12	5200	8
13671	4/4/2017	15:36	3	19	2	35	5	285	< 0.05	0.63	0.71	0.16	0.07	1000	< 3
10786	4/4/2017	14:22	3	16	1	12	< 2	299	< 0.05	0.64	0.62	0.14	0.09	570	< 3
10805	4/4/2017	12:01	3	6.7	2	21	< 2	297	< 0.05	0.69	0.56	0.08	0.03	820	3
10785	4/4/2017	13:15	3	7	2	16	< 2	312	< 0.05	0.78	0.61	0.25	0.18	540	< 3
21759	4/4/2017	9:40	3	1.8	2	26	< 3	384	< 0.05	0.29	0.58	0.2	0.1	600	5
21763	4/4/2017	10:58	3	4.6	2	8	< 2	353	< 0.05	1.2	0.51	0.38	0.37	220	6
10793	5/9/2017	12:35	1	0		20	9	227	< 0.05	< 0.05	1.69	0.12	< 0.02	52	66
10798	5/9/2017	12:10	3	0.01	2	5	< 2	1272	< 0.05	0.58	0.31	0.04	< 0.02	2100	6
10780	5/9/2017	11:25	1	0		12	< 2	263	< 0.05	0.18	0.58	0.03	< 0.02	48	9
10781	5/9/2017	9:40	3	9.4	5	9	< 2	236	0.09	0.48	0.48	0.03	< 0.02	15	3
21762	5/9/2017	8:45	3	2.4	2	6	< 2	284	< 0.05	< 0.05	0.36	0.02	< 0.02	26	3
13671	5/8/2017	14:37	3	1	2	23	< 2	360	< 0.05	< 0.05	0.4	0.04	< 0.02	30	3
10786	5/8/2017	13:16	3	1.7	1	140	17	339	< 0.05	< 0.05	0.97	0.18	< 0.02	30	< 3
10805	5/8/2017	12:36	3	0.4	2	8	< 2	284	< 0.05	0.06	0.48	0.03	< 0.02	41	< 3
10785	5/8/2017	12:05	3	0.6	2	6	< 2	438	< 0.05	0.16	0.58	0.1	0.06	49	3
21759	5/8/2017	9:35	3	0.3	2	37	4	585	< 0.05	< 0.05	< 0.2	0.04	0.03	200	4
21763	5/8/2017	10:30	3	1	2	16	2	474	< 0.05	< 0.05	0.52	0.48	0.43	140	< 3