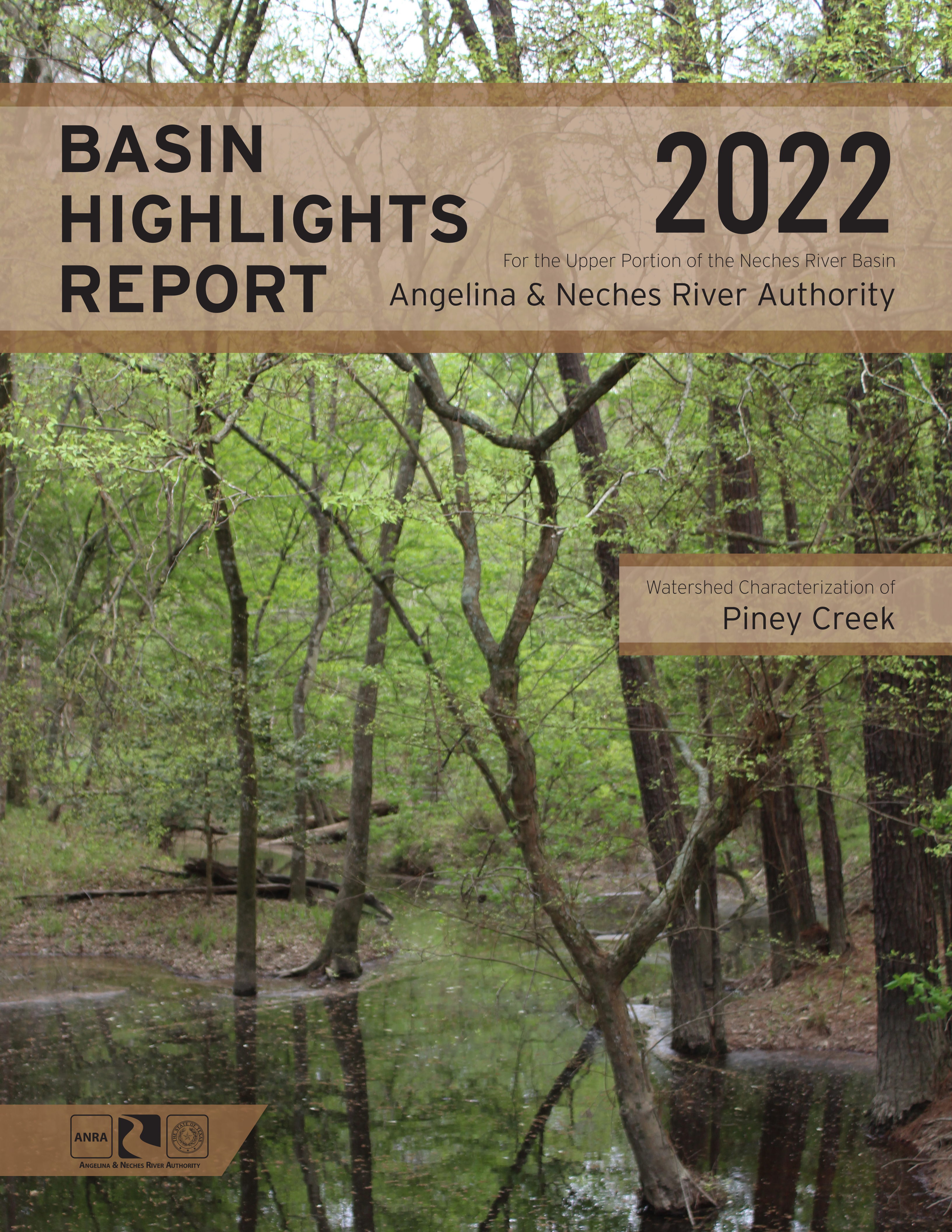
BASIN HIGHLIGHTS REPORT

2022

For the Upper Portion of the Neches River Basin

Angelina & Neches River Authority



Watershed Characterization of

Piney Creek

ANRA

Angelina & Neches River Authority

Cover Photos:
Front: Piney Creek at FM 2781, March 2020
Back: Piney Creek at FM 1987, Sept 2013

EXECUTIVE SUMMARY

This document is an annual publication by the Angelina & Neches River Authority (ANRA) in cooperation with the Texas Commission on Environmental Quality (TCEQ) under the authorization of the Texas Clean Rivers Act. It discusses surface water quality in the upper portion of the Neches River Basin. This year, the report focuses on a watershed characterization of Piney Creek, a tributary of the Neches River below Lake Palestine (See Figure 1.0).

ANRA is one of 18 river authorities in the state of Texas and one of the 15 regional water authorities that partner with the TCEQ to conduct water quality monitoring, assessment, and stakeholder outreach in the 23 major river and coastal basins of Texas via the Texas Clean Rivers Program (CRP).

In the Neches River Basin specifically, CRP surface water quality monitoring is routinely performed by the TCEQ regional offices in Tyler and Beaumont, ANRA, and the Lower Neches Valley Authority (LNVA).

In even-numbered years, the TCEQ compiles the data collected in the preceding seven years and assesses the surface water quality across the entire state. This assessment is called the Texas Integrated Report and it includes a list of "impaired" water bodies.

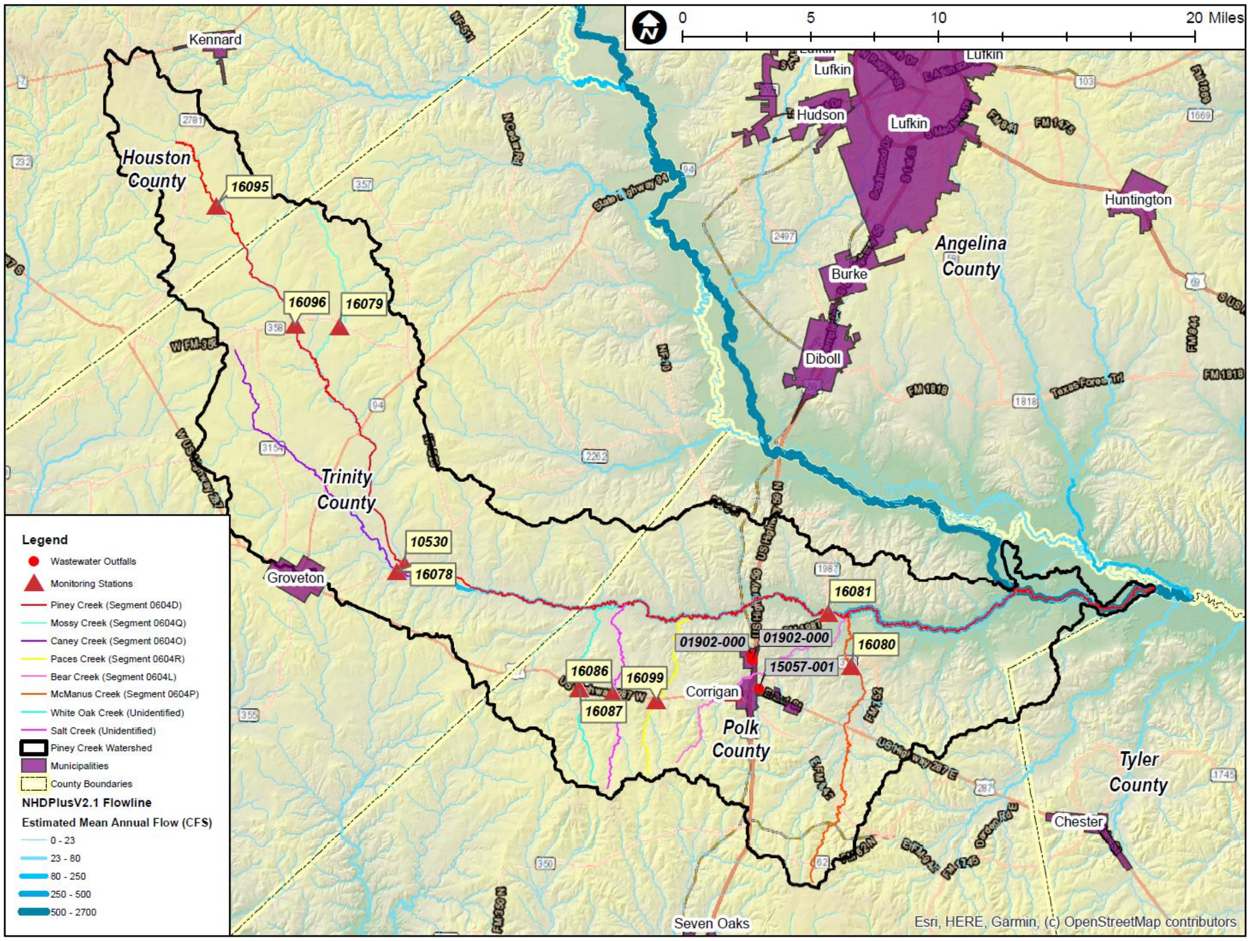
Within the Texas Surface Water Quality Standards, the TCEQ sets and implements standards for surface water quality to improve and maintain the quality of water in the state. Examples of some designated uses are aquatic life, recreation, and drinking water use. Each of these uses has associated criteria. Impaired water bodies are bodies of water that are failing to meet the criteria for their designated uses.

The TCEQ, CRP partners, and federal agencies, such as the Environmental Protection Agency (EPA), work together with local stakeholders to address these impaired water bodies through a variety of programs that can provide education, technical assistance, and sometimes financial assistance to entities or individuals that help solve or mitigate the causes of these impairments.

As part of its responsibility as a CRP Partner, ANRA publishes an annual report of CRP and related water quality activities in the upper half of the Neches River Basin. Most years, a highlights/update report is published, but every sixth year, the report is a comprehensive summary report of water quality throughout the entire upper portion of the basin. ANRA's most recent summary report was published in 2020.

This year's Basin Highlights Report focuses on a single watershed within the basin – Piney Creek Watershed- for a comprehensive watershed characterization.

Figure 1.0. Overview Map of Piney Creek (Segment 0604D) Watershed.



Piney Creek is a tributary of the Neches River below Lake Palestine and above B.A. Steinhagen Reservoir. It is located southeast of the City of Lufkin. The watershed covers 367 square miles and crosses Trinity, Polk, Houston, and a very small portion of Tyler County. The watershed includes the City of Corrigan and the northern third of the City of Groveton. The watershed is mostly rural, with the majority of the land cover consisting of evergreen forests, woody wetlands, and pastures.

Some portions of Piney Creek have been listed as impaired since 2004, for depressed dissolved oxygen (criterion for aquatic life use), and since 2006, for elevated bacteria levels (criterion for recreational use). This report will look at land use, land cover, hydrologic, water quality, and rainfall data to evaluate current conditions in the Piney Creek Watershed. Based on the information evaluated, it is recommended that monitoring should be continued and that more monitoring stations should be introduced to narrow potential sources of water quality impairments. Currently, there is only one actively monitored station. Piney Creek has historically maintained nine different monitoring stations, although not all at the same time.

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1.0 INTRODUCTION

ABOUT THE ANGELINA & NECHES RIVER AUTHORITY

The Angelina & Neches River Authority, originally named the Sabine & Neches Conservation District, was created in 1935 by the Texas Legislature as a conservation and reclamation district. The Legislature divided the territory of the Sabine & Neches Conservation District into the Sabine River Authority and the Neches River Conservation District in 1949. It was not until 1971, that the Neches River Conservation District was activated and began operating as a water resource agency. In 1977, Senate Bill 125 changed the name of the Neches River Conservation District to the Angelina & Neches River Authority.

ANRA's office is located in Lufkin, Texas. ANRA's territorial jurisdiction consists of 8,500 square miles that lie wholly or in part of the following counties: Van Zandt, Smith, Henderson, Newton, Cherokee, Anderson, Rusk, Houston, Nacogdoches, San Augustine, Shelby, Angelina, Trinity, Sabine, Polk, Jasper, and Orange.

ANRA has the responsibility for monitoring, protecting, and enhancing water resources in the Neches River Basin. ANRA's functions in the basin include:

- Water Quality Monitoring
- Drinking Water and Wastewater Analysis
- On-site Sewage Facility Permitting
- Water Resources Development
- Regional Wastewater/Composting Facilities
- Other Regional Planning Efforts
- Water and Wastewater Facilities

ABOUT THE CLEAN RIVERS PROGRAM

The Texas Clean Rivers Act, enacted in 1991 by the Texas Legislature, requires that each Texas river basin conduct ongoing water quality assessments, integrating water quality issues, while using a watershed management approach. The Clean Rivers Program implements the Clean Rivers Act through water quality monitoring, assessment, and public outreach. Currently, monitoring in the state of Texas includes more than 1,800 sites and regional water quality assessments within the 23 major river and coastal basins and their subwatersheds.

The mission of the CRP is to maintain and improve the quality of water within each river basin in Texas through an ongoing partnership involving the TCEQ, river authorities, other agencies, regional entities, local governments, industry, and citizens. The goals of the program's watershed management approach is to identify and evaluate water quality issues, establish priorities for corrective action, work to implement those actions, and adapt to changing priorities.

ABOUT THE BASIN HIGHLIGHTS REPORT

This Basin Highlights Report is produced annually by ANRA, and typically provides an overview of the previous year's events and ongoing programs in the upper and middle portions of the Neches River Basin that are relevant to the Clean Rivers Program. To address impaired water bodies in the basin, the 2022 report focuses on water bodies that do not currently meet *Texas Surface Water Quality Standards* and those listed in the 2020 *Texas Integrated Report of Surface Water Quality for Clean Water Act, Sections 305(b) and 303(d).*

The 2022 Basin Highlights Report was prepared by ANRA in cooperation with the TCEQ under the authorization of the Texas Clean Rivers Act.

LIST OF ACRONYMS AND ABBREVIATIONS

ALU – Aquatic Life Use

ANRA – Angelina & Neches River Authority

AU – Assessment Unit

BMP – Best Management Practices

CFS – Cubic Feet Per Second

CR – County Road

CRP – Clean Rivers Program

CWA – Clean Water Act

DEM – Digital Elevation Model

DO – Dissolved Oxygen

EPA – Environmental Protection Agency

EROM – Extended Unit Runoff Method

FM – Farm-to-Market

FY – Fiscal Year

HWY – Highway

I/I – Inflow and Infiltration

mg/L – Milligrams Per Liter

MGD – Million Gallons Per Day

NHDPlus – National Hydrography Dataset Plus

NOAA – National Oceanic and Atmospheric Administration

NLCD – National Land Cover Data

NPDES – National Pollution Discharge Elimination System

NPS – Non-point Source

OSSF – On-Site Sewage Facility

SU – Standard Units

SWQM – Surface Water Quality Monitoring

SQ. MI – Square Miles

TCEQ – Texas Commission on Environmental Quality

TMDL – Total Maximum Daily Load

TPDES – Texas Pollutant Discharge Elimination System

TPWD – Texas Parks and Wildlife Department

TSWQS – Texas Surface Water Quality Standards

USGS – United States Geologic Survey

CFS – Cubic Feet Per Second

UAA - Use-Attainability Analysis

WWTF – Wastewater Treatment Facility

WWTP – Wastewater Treatment Plant

2.0 UPDATES FOR 2022

STAFF UPDATES

Mr. Rene Barelas joined ANRA in November 2021, as the CRP Coordinator following the departure of Mrs. Carla Ethridge. Mr. Barelas received his bachelor of science degree in Environmental Science with a concentration in Land and Water Resources, from Stephen F. Austin State University (SFA). Mr. Barelas has experience working with SFA, Natural Resource Conservation Service (NRCS), and the TCEQ Beaumont and Dallas regional offices. His education and work experience has made him familiar with East Texas and the Neches River Basin.

EDUCATION & OUTREACH ACTIVITIES

Through dedicated and improved public awareness and education efforts, since 2020, ANRA more than tripled its number of outreach activities, focused on the Clean Rivers Program and Clean Water Activities. Although there was a decrease in opportunities during the summer and fall of 2021, due to uncertainty regarding the ongoing COVID-19 pandemic, as the world began to move beyond the pandemic, a boom of activity was experienced throughout the spring of 2022.

ANRA participated in nearly 20 individual outreach and educational activities related to water quality, conservation, and recreation, throughout the Upper Neches River Basin. Events included presenting at school career days, conducting and attending trainings, hosting public meetings, participating in stream cleanups, distributing education and outreach materials, and sponsoring events.

Participation in these activities have allowed ANRA's Clean Rivers Program to experience a significant increase in positive, public exposure, allowing more opportunities to educate the public about the importance of environmental stewardship and water quality to humans, animals, and the environments in which they reside.

3.0 WATER QUALITY

TEXAS SURFACE WATER QUALITY STANDARDS

Texas Surface Water Quality Standards (TSWQS) are state rules adopted by the TCEQ that are designed to establish numeric and narrative goals for water quality throughout the state. TSWQS are developed to maintain the quality of surface water in Texas to support public health, recreational enjoyment, and protect aquatic life, consistent with the sustainable economic development of the state. TSWQS describes the physical, chemical, and biological conditions to be attained in surface water and identifies uses and criteria associated with those uses. TSWQS also provides a basis on which the TCEQ regulatory programs, such as Permitting, Total Maximum Daily Load (TMDL), Non-Point Source (NPS), and Monitoring/Assessment, can establish reasonable methods to implement and attain the state's goal for water quality.

Section 304(a)(1) of the Federal Clean Water Act (CWA) requires the development of criteria for water quality that accurately reflects the latest scientific knowledge. Criteria are based solely on data and scientific judgments on pollutant concentrations and environmental or human health effects. Section 304(a) also guides states and tribes in adopting water quality standards. Criteria are developed for the protection of aquatic life as well as for human health. Criteria are numerical numbers representing a specific use for the water body. For example, for high aquatic life use, the dissolved oxygen 24-hour minimum criteria are 3.0 mg/L. Impairments occur when water quality conditions do not meet assigned uses/criteria as defined in the TSWQS.

As defined in the TSWQS, a water body can be assigned specific uses including aquatic life, public water supply, and contact recreation use. Other uses, such as oyster waters, do not apply in the Upper Neches River Basin. Designated uses typically have corresponding numerical criteria. There are general criteria that cover the entire state, but if sufficient information is available for a given water body, then site-specific standards may be developed and assigned to that water body.

- Aquatic Life Use (ALU) has corresponding 24-hour dissolved oxygen criteria. Water bodies have assigned/presumed ALU. ALU categories are exceptional, high, intermediate, limited, and minimal.

- General Use criteria are used to protect overall water quality rather than a single specific use. Parameters used to gauge support for this use include chloride, sulfate, total dissolved solids (TDS), pH, and temperature. A water body is classified as Fully Supporting for general use if it meets all of these criteria. Parameters such as ammonia, nitrates, phosphorus, and chlorophyll-a are used in the assessment to screen for nutrient concerns.

- Public water supply use includes chlorides, sulfates, and TDS criteria in drinking water. Criteria for these parameters are set so that public water supplies are capable of treating and delivering water of acceptable quality.

- Contact recreation use is assessed using criteria for bacteria indicators such as E. coli (for freshwater). Contact recreation use refers to the ability of the water body to support activities that involve physical contact with the water, such as swimming and wading. There are primary and secondary contact recreation uses.

    - Primary contact recreation activities, such as swimming, are presumed to involve a significant risk of ingestion of water.

- Secondary contact recreation activities, such as fishing, are presumed to involve a less significant risk of water ingestion than primary contact recreation due to limited body contact incidental to shoreline activity. The difference between secondary and primary contact is the frequency that the secondary contact recreation activities occur due to the physical characteristics of the water body or limited public access.

Many of the state's water resources cannot currently meet their existing, designated, presumed, and attainable uses because of pollution problems from a combination of point sources, such as sewage treatment plants and industrial dischargers, and non-point sources, such as pollutants carried by rainfall runoff from forests, agriculture lands, abandoned mine lands, etc.

Through the Clean Rivers Program, the TCEQ and its partners continually help monitor and evaluate the quality of water bodies throughout the state by measuring parameters such as dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria.

SURFACE WATER QUALITY PARAMETERS

ANRA staff collect field and conventional parameters at specific monitoring stations on a quarterly basis. See Table 3.0 for the parameters collected.

Field Parameters are collected on-site by direct monitoring in the water body.

Conventional & Bacteria Parameters are values that are obtained via laboratory analysis of samples collected from the water body.

Flow Parameters are collected for stream and river monitoring sites, but not generally for lake or reservoir sites.

Table 3.0. Field, Flow, Bacteria, & Conventional Parameters		
Parameter	**Potential Impacts**	**Possible Sources/Causes**
pH	pH is a measure of whether water is acidic or basic. Most aquatic organisms are adapted to live within a specific pH range. pH can also affect the toxicity of many substances, which generally increase in solubility as pH decreases. The ability of water to resist changes in pH (its buffering capacity) is essential to aquatic life.	pH can be affected by industrial and wastewater discharges, runoff, and accidental spills. Natural variation in seasons may also affect pH.
Dissolved Oxygen (DO)	DO is a measure of the amount of dissolved oxygen that is available in the water. DO is vital for aquatic organisms to live. Where DO is too low, aquatic organisms may have insufficient oxygen to live.	DO is temperature-dependent, with water being able to hold more dissolved oxygen at lower temperatures due to the solubility of gases increasing as the temperature decreases. The amount of oxygen present usually decreases with depth, rising temperatures, and the oxidation of organic matter and pollutants. Bacteria and algal blooms may cause DO to decrease as the decomposition of organic material consumes oxygen in the water, resulting in hypoxic (low oxygen) areas.
Specific Conductance	Specific Conductance is the measure of the water's capacity to carry an electrical current and is indicative of the amounts of dissolved solids present in a water body.	Dissolved salt-forming substances such as sulfate, chloride, and sodium increase the conductivity of the water.
Temperature	Water temperature affects the oxygen content of the water (dissolved oxygen). Temperature also has an impact on cold-blooded animals.	Water temperature may be affected by alterations to the riparian zone, changes in ambient temperature, and discharges
Flow	Flow is a measurement of the velocity of the water, measured in cubic feet per second (cfs). Flow combined with other parameters can be a good indicator of water quality.	Flow can be affected by both natural and manmade sources.

Escherichia coli (E. coli)	E. coli is an indicator of fecal contamination. Fecal contamination is a health concern to the general public and its presence indicates a risk for contact recreation. The presence of E. coli in the water indicates that pathogenic organisms may be present.	E. coli is abundant in the gastrointestinal tract of warm-blooded animals. Elevated bacterial levels are indicative of a potential pollution problem. Reasons for the presence of fecal coliforms such as E. coli include failing septic systems, animal wastes, and inadequately treated sewage.
Ammonia-Nitrogen	Ammonia, which is produced from the breakdown of nitrogen-containing compounds, is found naturally in waters. In excess, algal blooms may occur. Elevated ammonia levels are indicative of organic pollution. These elevated levels can cause stress on aquatic organisms, as well as damage to tissue and gills.	Ammonia enters a body of water via excretion of nitrogenous wastes, decomposition of plants and animals, and runoff. Ammonia is an ingredient in many fertilizers. It is also present in sewage, wastewater discharges, and stormwater runoff.
Chloride	Chloride is one of the major inorganic ions in water and wastewater. It is an essential element for maintaining normal physiological functions in all organisms. Elevated chloride concentrations can adversely affect the survival, growth, and/or reproduction of aquatic organisms.	An elevated chloride concentration can be indicative of natural or man-made pollution. Natural sources of chloride include the weathering and leaching of sedimentary rocks, soils, and salt deposits. Other possible sources include oil exploration and storage, sewage and industrial discharges, and landfill runoff.
Chlorophyll-a	Chlorophyll-a is an indicator of algal biomass in a water body. Increased concentrations indicate potential eutrophication or nutrient loading. Diurnal shifts in DO and pH resulting from increased photosynthesis and respiration can cause stress to aquatic organisms.	Chlorophyll-a is a photosynthetic pigment that plays a vital role in photosynthesis. It is found in most plants, cyanobacteria, and algae. When chlorophyll-a levels are consistently high or variable, this may be indicative of algal blooms.
Nitrate + Nitrite-Nitrogen	Elevated levels of nitrite and nitrate can produce nitrite toxicity in fish ("brown blood disease") and methemoglobinemia ("blue baby syndrome") in infants by reducing the oxygen-carrying capacity of the blood. In surface water, high levels of nitrates can lead to the excessive growth of aquatic plants. High levels of nitrates are also indicative of human-caused pollution.	As part of the nitrogen cycle, nitrogenous compounds are converted from ammonia to nitrite and then to nitrate by bacterial and chemical processes. Potential sources include effluent discharges from wastewater treatment plants, fertilizers, and agricultural runoff.

Total Phosphorus	Phosphorus is essential to the growth of organisms and is considered a growth-limiting nutrient. Elevated levels in water may stimulate the growth of photosynthetic aquatic macro- and microorganisms. Elevated phosphorus levels contribute to eutrophication and may cause algal blooms.	Phosphorus is commonly known as a man-made pollutant. It is present in industrial and domestic wastewater discharges, as well as agricultural and stormwater runoff. It is an ingredient in soaps and detergents and is used extensively in the treatment of boiler waters. Phosphates are also used by some water supplies during treatment.
Total Dissolved Solids (TDS)	TDS, reported in mg/L, is a measure of the total dissolved particles in water. Typically, it is comprised of chlorides, sulfates, and other salt-forming anions. TDS is an important measure of drinking water quality.	TDS can occur naturally from the dissolution of carbonate and salt deposits in rocks and soils. Other sources include agricultural and stormwater runoff, effluent discharges from industrial and domestic wastewater treatment plants, and oil exploration.
Total Suspended Solids (TSS)	TSS, reported in mg/L, is a measure of the total suspended particles in water. High levels of TSS increase the turbidity of the water, reducing light penetration which subsequently decreases oxygen production by plants.	Elevated TSS can result from multiple point and non-point sources. Soil erosion and runoff are two primary sources.
Sulfate	Sulfate is essential for plant growth, and low levels (under 0.5 mg/L) can be detrimental to algal growth. Excessive levels of sulfate can form strong acids and change the pH of the water. Excessively high levels may be toxic to cattle and other animals. Sulfate can also affect drinking water.	Sulfate occurs in almost all natural waters due to an abundance of elemental and organic sulfur in the environment. It usually enters into water bodies by water passing over rock or soil containing minerals like gypsum, as well as runoff from agricultural lands, industrial discharges, and sewage treatment plant discharges. Sulfate can also enter water bodies from atmospheric deposition from such sources as burning fossil fuels.

4.0 WATERSHED CHARACTERIZATION REPORT

ABOUT THE WATERSHED CHARACTERIZATION REPORT

The Watershed Characterization Report serves to characterize impaired water bodies and/or water bodies of interest. This is accomplished by reviewing data, mapping land use and permits, tracking watershed events, and recording information from site visits and communication with monitoring personnel, stakeholders, and local residents. The goal of this report is to describe the key sources that are most likely to impact water quality. Additionally, the report is designed to provide a collection of local knowledge for use in prioritizing monitoring efforts. The Watershed Characterization Report will also provide useful information about the watershed that can be used for Watershed Action Planning activities.

FLOW METHODOLOGY

Throughout the descriptions of the watershed and inflows, distances are measured in miles and estimated mean annual flow measurements are measured in cubic feet per second (cfs) using the National Hydrography Dataset Plus High Resolution (NHDPlus HR) model. The Enhanced Unit Runoff Method – Mean Annual (EROMMA) dataset and the NHDFlowline feature class were used to approximate mean annual flow measurements for all subwatersheds within the Piney Creek watershed. The NHDPlus HR combines data such as annual rainfall, catchment area characteristics, and flow direction to create a model that estimates the amount of flow in a drainage area. This method of calculating estimated flows also incorporates USGS data and known amounts of water transfers and withdrawals of the water body. Estimated flow data is very useful and informative, but accuracy is limited and values may differ from actual in-stream flows measurements. For more information about the NHDPlus HR and the EROMMA flow data, please visit https://www.usgs.gov/national-hydrography/nhdplus-high-resolution.

DELINEATING WATERSHEDS

The watersheds and subwatersheds described throughout this report were created with ArcGIS Pro using the Spatial Analyst tools to process a set of 1/3 arc second (10 meter) Digital Elevation Models (DEMs) published to the National Map in 2013. When delineating a watershed, a boundary is created using the area's topography and uses an outlet as a focal point. For delineating the Piney Creek Watershed, the focal points used were the most downstream points for each assessment unit within the overall Piney Creek Watershed, along with the Piney Creek and Neches River confluence.

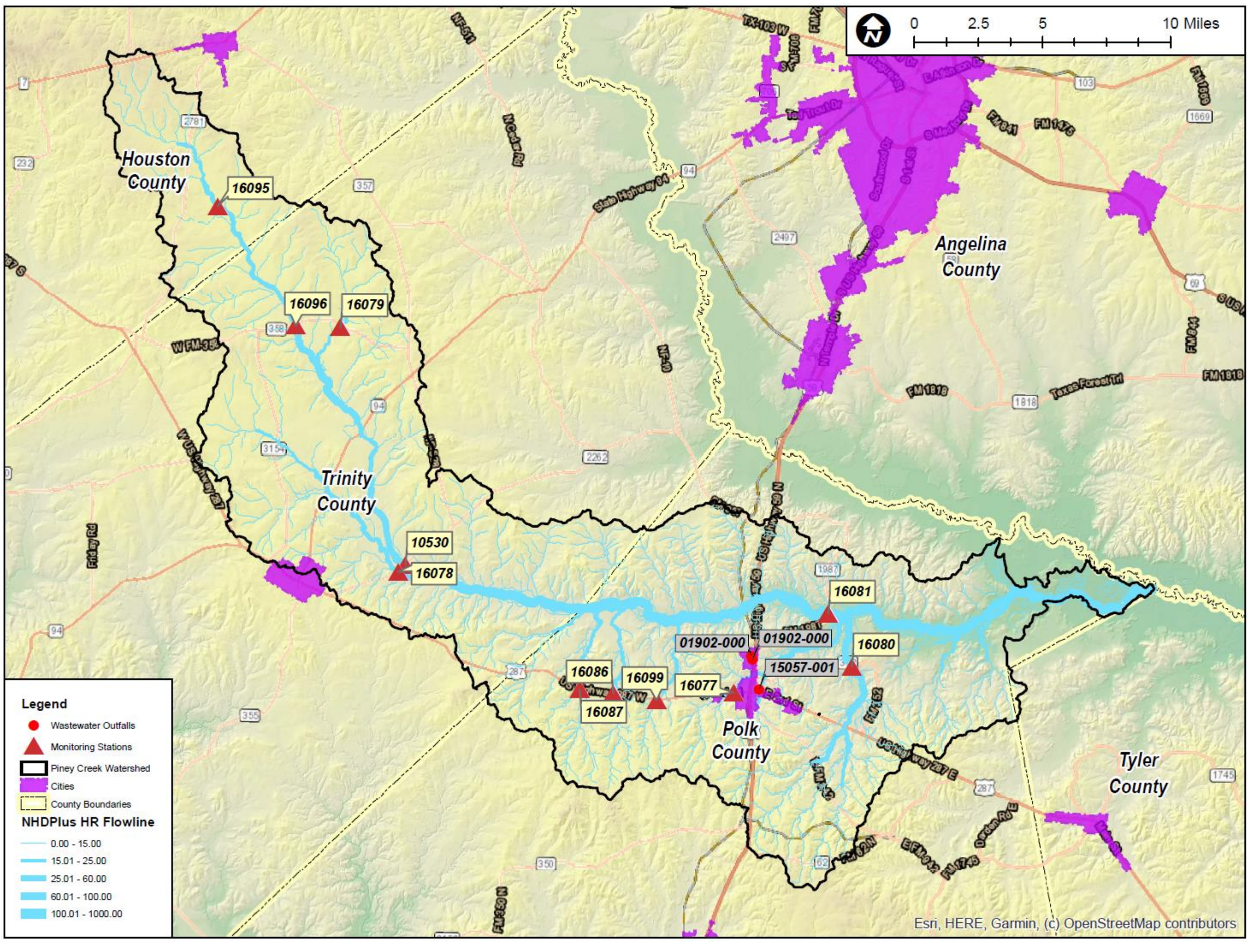
5.0 THE PINEY CREEK WATERSHED

SEGMENT DESCRIPTION

Piney Creek (Segment 0604D) is approximately 78-miles long and begins from the confluence of the Neches River at the Polk, Tyler, and Angelina County lines, east of Corrigan, to the upstream perennial portion of the stream east of Crockett in Houston County.

The Piney Creek Watershed is approximately 234,972-acres (367 sq. mi) and drains into the Neches River below Lake Palestine. The watershed extends across Houston, Trinity, and Polk counties (See Figure 5.0).

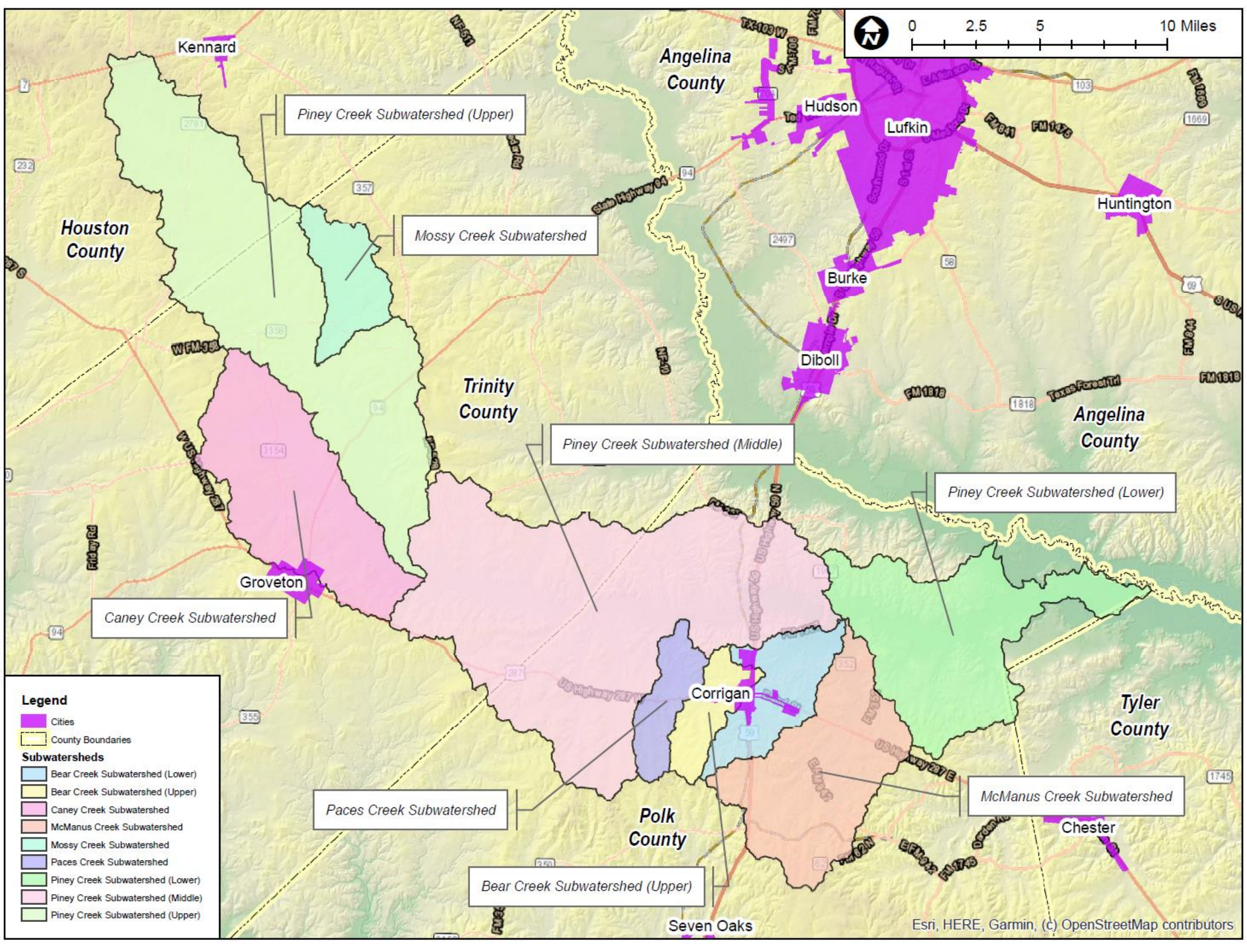
Figure 5.0. Piney Creek Watershed and Stream Segment 0604D.



In addition to the Piney Creek Watershed, subwatersheds were created by identifying Assessment Units (AUs) or assessed areas within the watershed. The AUs are known tributaries that contribute to Piney Creek (Segment 0604D). The subwatersheds are as follows:

Table 5.0. Piney Creek Subwatersheds		
Subwatersheds	**Size (acres)**	**Size (sq. mi)**
Piney Creek (Upper)	54,226	85
Piney Creek (Middle)	70,721	111
Piney Creek (Lower)	29,458	46
Mossy Creek	7,928	12
Caney Creek	27,338	43
Paces Creek	5,908	9
Bear Creek (Upper)	5,524	9
Bear Creek (Lower)	9,823	15
McManus Creek	24,046	38

Figure 5.1. Piney Creek Subwatershed Map.



ASSESSMENT UNITS

There are currently two AUs that are described in the Texas 303(d) List (See Table 5.1).

Table 5.1. Assessment Units in Piney Creek Watershed (Segment 0604D)	
AU ID	**Description**
0604D_01	Middle portion of the stream from the confluence with Bear Creek (0604L) in Polk County upstream to the confluence with Caney Creek (0604O) in Trinity County.
0604D_02	Upper portion of the stream from the confluence with Caney Creek (0604O) in Trinity County upstream to confluence with unnamed tributary in Houston County approximately 0.5-miles West of FM 2781.

Figure 5.2. Piney Creek Assessment Unit 0604D_01.

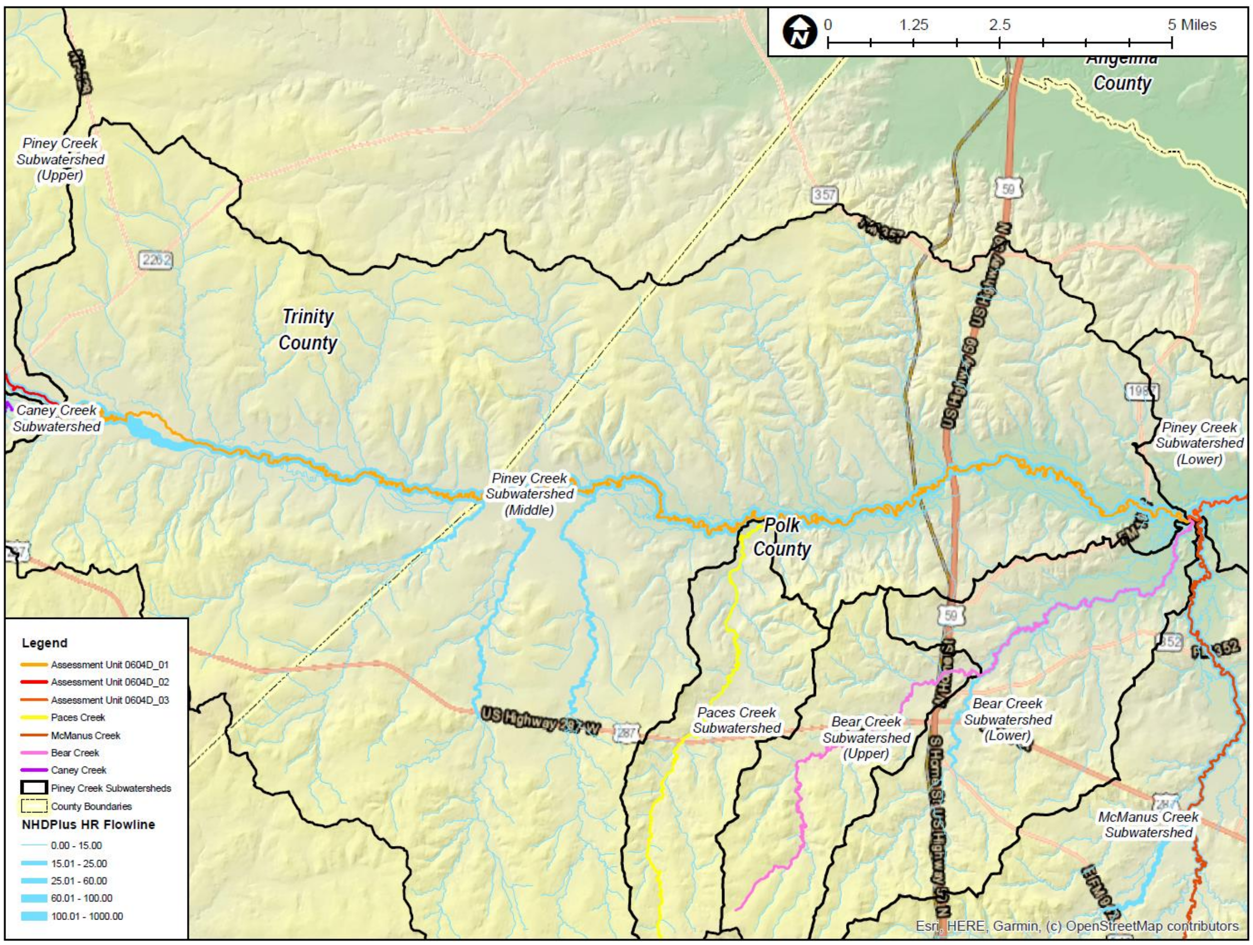
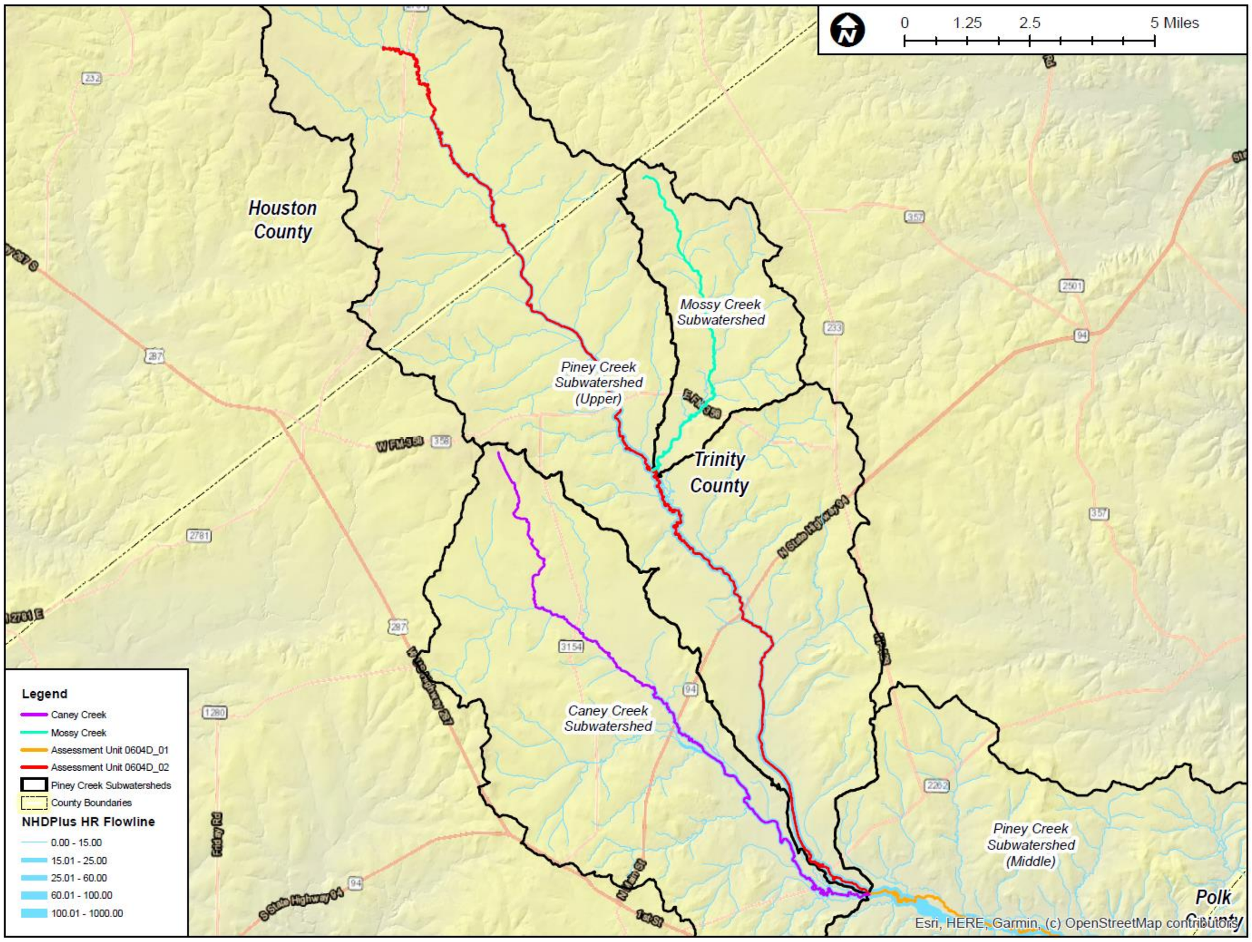


Figure 5.3. Piney Creek Assessment Unit 0604D_02.



MONITORING STATIONS

Within the Piney Creek watershed, there have been numerous historical monitoring sites. Many of these stations have been inactive for many years (See Table 5.2). Currently, there are three active monitoring stations within the watershed (See Table 5.3). A visual representation of the monitoring station will be presented in the Characterization by Subwatershed section of this report.

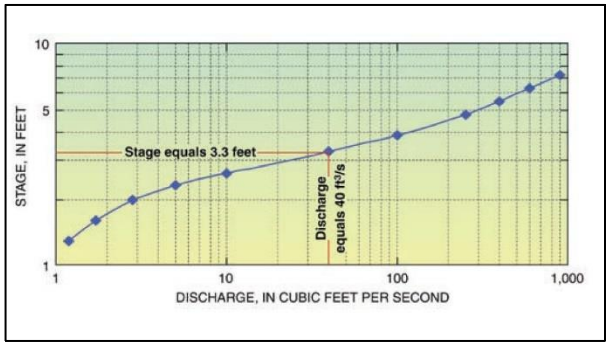
Table 5.2. Historical Monitoring Stations within the Piney Creek Watershed.

Segment Name	Segment ID	Station ID	Brief Description
Piney Creek	0604D	16095	Piney Creek at Recreation Trail
Bear Creek	0604L	16077	Bear Creek at US 287
Caney Creek	0604O	16078	Caney Creek at FM 2262
McManus Creek	0604P	16080	McManus Creek at FM 352
Mossy Creek	0604Q	16079	Mossy Creek at FM 358
Paces Creek	0604R	16099	Paces Creek at US 287

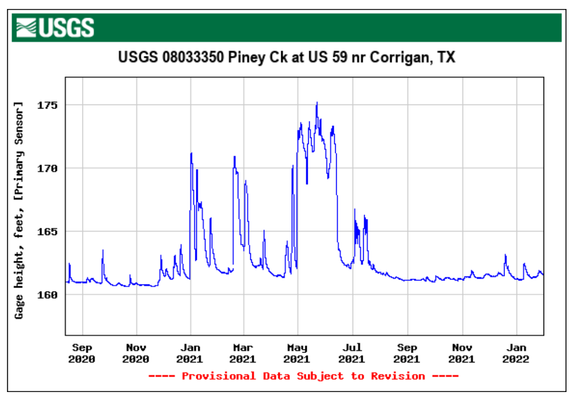
Table 5.3. Historical Monitoring Stations within the Piney Creek Watershed.			
Segment Name	Segment ID	Station ID	Brief Description
Piney Creek	0604D	16096	Piney Creek at FM 358 (Monitored by ANRA)
		10530	Piney Creek at FM 2262
		16081	Piney Creek at FM 1987

HYDROLOGIC CHARACTERISTICS

UNITED STATES GEOLOGIC SURVEY (USGS) STREAMGAGING



The United States Geologic Survey (USGS) operates and maintains a stream gage station (USGS 08033350) located on Piney Creek at US-59 near Corrigan. USGS 08033350 is the only stream gage station located within the Piney Creek watershed and only records water levels. Streamgaging typically involves three steps: measuring the stream stage (height), streamflow (discharge), and the stage-streamflow relation (estimate of discharge). The relationship between the two is determined by simultaneous measurements over a natural range of flows. Factors such as shape, size, slope, and channel roughness can affect the relationship. This relationship can be used to produce streamflow data from the stream gage station. Typically, the stage-streamflow relation is linear, the increase in stage height corresponds with an increase in discharge (*see example graph above.)* The data recorded by the USGS stream gage station is used to describe conditions at Piney Creek.



According to the USGS website, no data was available prior to August 13, 2020. It is possible that the station could have been a new installation, however, no additional information could be found. USGS 08033350 records instantaneous gage measurements at 15-minute increments. In FY2021, the maximum and minimum gage heights recorded at USGS08033350 were 175.27 feet in May 2021 and 160.65 feet in November 2020, respectively.

Table 5.4. U.S. Geological Survey, National Water Information System - USGS 08033350 Piney Creek at US 59 near Corrigan, Texas		
Measurement Date and Time	**Gage Height (feet)**	**Streamflow rate (cfs)**
12/31/2020 11:32	169.39	522
1/4/2021 15:53	166.67	241
4/30/2021 10:16	171.66	1190
5/5/2021 12:34	172.83	1800
6/2/2021 12:22	169.97	636

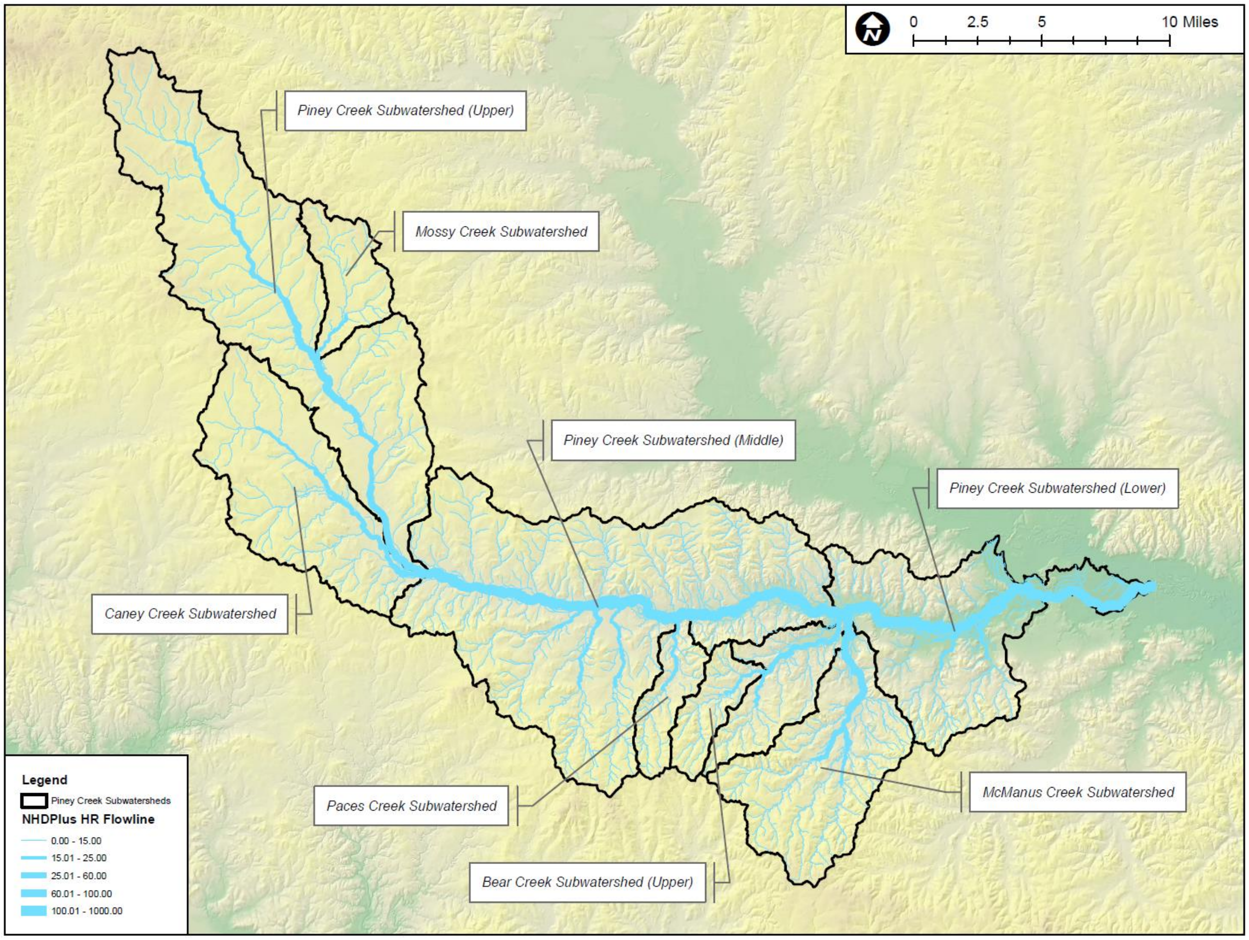
Additionally, six surface water field measurements were recorded from December 31, 2020, and June 2, 2021, by USGS personnel (See Table 5.4). Using the USGS station, field measurements were collected and included parameters such as gauge height and streamflow. The median gage height and streamflow rate recorded at the site during these routine sampling events were 169.97 feet and 636 cfs in June. The maximum and minimum gage height also corresponded with the flow rate measuring at 172.83 feet and 166.67 feet, respectively. The highest and lowest flow rate measurements were 1,800 cfs in May 2021 and 241 cfs in January 2021, respectively. Piney Creek is currently assessed/presumed as a perennial stream. However, data suggests that portions of the stream have intermittent flows.

NATIONAL HYDROGRAPHY DATASET PLUS HIGH RESOLUTION (NHDPLUS HR)

Due to the limited amount of stream gage flow data available for Piney Creek, the USGS NHD Plus HR was utilized to estimate mean annual flows, specifically, the gage-adjusted flow estimate values from the EROMMA data since they are considered the best estimates for models and analyses. For the Piney Creek Watershed, the accumulation of flow was estimated from the upper portion of the stream in Houston County to the lower portion of the stream from its confluence with the Neches River in Polk County (See Figure 5.4).

There several unnamed tributaries that feed into the beginning of Piney Creek and throughout the entirety of the creek. Throughout the report, a breakdown of several subwatersheds and their influencing factors will be discussed. The factors will include land cover/land type use and estimated flows. At the upper most part of Piney Creek (Segment 0604D), an estimated stream flow of 16 cfs is calculated by the NHD Plus HR. As the water flows downstream, there is a gradual accumulation of streamflow estimates. The gradual growth is based on the networks of named and unnamed tributaries in the Piney Creek watershed. At the lowest part of the stream prior to the Neches River confluence, the final estimated streamflow is 413 cfs. At USGS 08033350, the estimated streamflow is 251 cfs. Based on the previously recorded data, the estimated streamflow is in the range of possibility for that specific location.

Figure 5.4. NHDPlus HR Flowline Map of the Piney Creek Watershed.



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) WEATHER DATA

Near the Piney Creek watershed, the National Oceanic and Atmospheric Administration (NOAA) operated two weather stations near the City of Corrigan (Station ID: USC00412017, Inactive: August 15, 2016) and the City of Groveton (Station ID: USC00413778, Inactive: July 10, 2009). The 30-year U.S. Climate Normals, which include daily, monthly, and annual averages for precipitation and temperature parameters, were evaluated (See Table 5.5).

Table 5.5. Estimated annual precipitation data from the City of Corrigan (Station ID USC00412017) 30-year U.S. Climate Normals

Month	Precipitation (inches)
January	4.9
February	4.0
March	4.3
April	4.1
May	6.3
June	5.6
July	3.8
August	4.0
September	4.4
October	5.0
November	5.3
December	5.2
Total	**56.9**
Minimum	**3.8**
Maximum	**6.3**

Based on the data, the estimated annual precipitation in the area is 56.88 inches. The mean monthly averages range from a minimum of 3.8 inches in July to a maximum of 6.28 inches in May. When comparing the NOAA precipitation data to the USGS 08033350 streamflow data, there is a direct correlation to the seasonality of flow. The increase of precipitation in the month of May influences gage height and streamflow.

Table 5.6. Estimated annual temperature data from the City of Groveton (Station ID USC00413778) 30-year U.S. Climate Normals

Month	Max Temp. (°F)	Min Temp. (°F)	Average Temp. (°F)
January	62.2	38.3	50.2
February	66.7	42.6	54.6
March	73.4	47.5	60.4
April	81.5	54.9	68.2
May	87.4	63.7	75.5
June	92.5	70.3	81.4
July	95.7	72.4	84
August	96.5	72.2	84.3
September	91.7	66.6	79.2
October	83.7	55	69.3
November	71.3	46.7	59
December	63.9	39.9	51.9
Estimated Average	**80.5**	**55.8**	

Based on the data, the estimated annual average temperature in the area was 68.2° Fahrenheit. Estimated maximum and minimum annual temperature is 80.5° Fahrenheit and 55.8° Fahrenheit, respectively. The estimated mean monthly average temperatures range from a minimum of 50.2° Fahrenheit in January and maximum of 84.3° Fahrenheit in August (See Table 5.6).

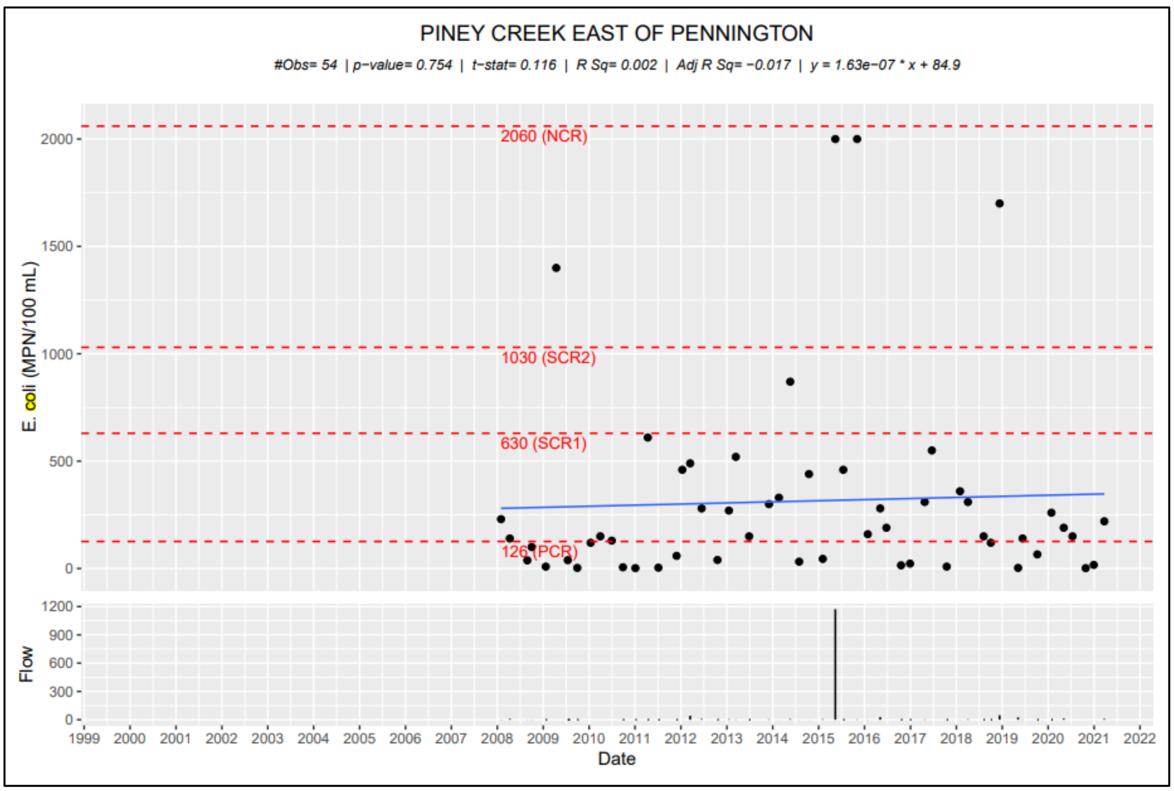
DESCRIPTION OF WATER QUALITY ISSUE

Piney Creek is listed in the 2020 Texas Integrated Report 303(d) and is impaired for contact recreation and its designated aquatic life use. AU 0604D_01 was listed in 2004 for depressed dissolved oxygen in the water and AU 0604D_02 was listed in 2006 for bacteria in the water.

BACTERIA

According to the integrated report, in AU 0604D_02, the geometric mean of 20 samples of *E. coli* bacteria that were assessed was 292 MPN/100 mL, exceeding the criteria of 126 MPN/100mL. The bacteria impairment is currently classified as 5c, meaning additional data will be collected and evaluated for *E. coli* before a management strategy is selected.

In addition to this data, E. coli data was gathered from the TCEQ's Surface Water Quality Monitoring Information System (SWQMIS). E. coli data was pulled from Piney Creek at FM 358, also known as Piney Creek East of Pennington (Monitoring Station 16096). Data ranged from 2008 to 2021. The following table shows the collected data over that period. Based on the data collected, there is a slight linear trend for the presence of E. coli. Although the data is sparse, there are multiple spikes that are above the 126 MPN/100 mL standard.



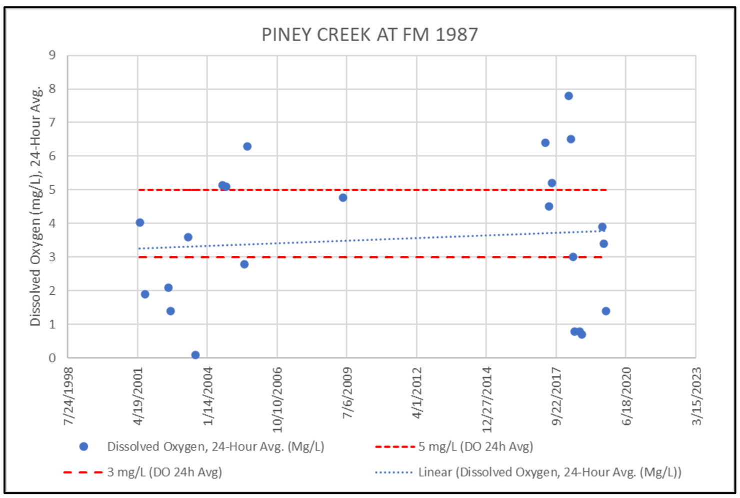
DISSOLVED OXYGEN (DO)

From 2017 to 2019, the TCEQ performed a Use-Attainability Analysis (UAA) on Segment 0604D to assess the aquatic life use and determine if the current dissolved oxygen standard of 5.0 mg/L was appropriate. In total, 15 separate 24-Hour DO monitoring events were conducted at three monitoring stations (Station ID 10530, 16081, and 16096). As a result, all three stations fell below the presumed standard of 5.0 mg/L average and 3.0 mg/L minimum for perennial streams.

Results of the biological portion of the UAA found intermediate and high aquatic life use (ALU), therefore, the ALU criteria was met. Average dissolved oxygen levels varied yielding results less than 3.0 mg/L to results greater than 5.0 mg/L. Overall, average dissolved oxygen levels were low, especially in the upper stream section (Station ID 16096).

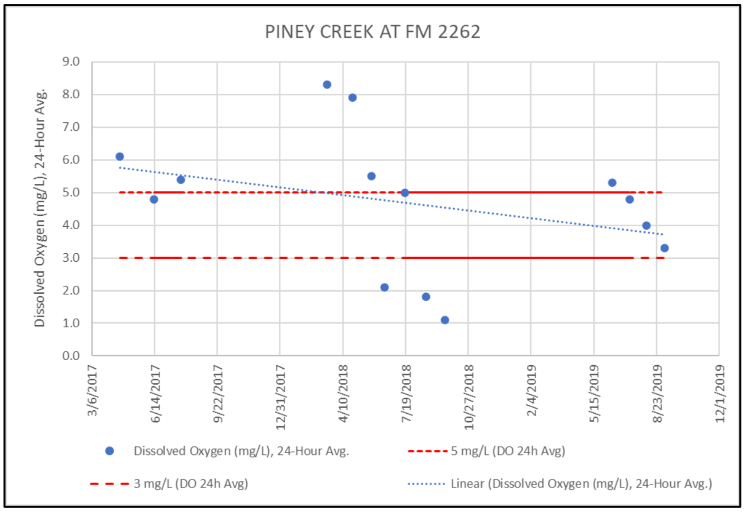
PINEY CREEK AT FM 1987 (MONITORING STATION 16081)

In addition to the data collected during the UAA, historical DO data was gathered from the TCEQ's SWQMIS.



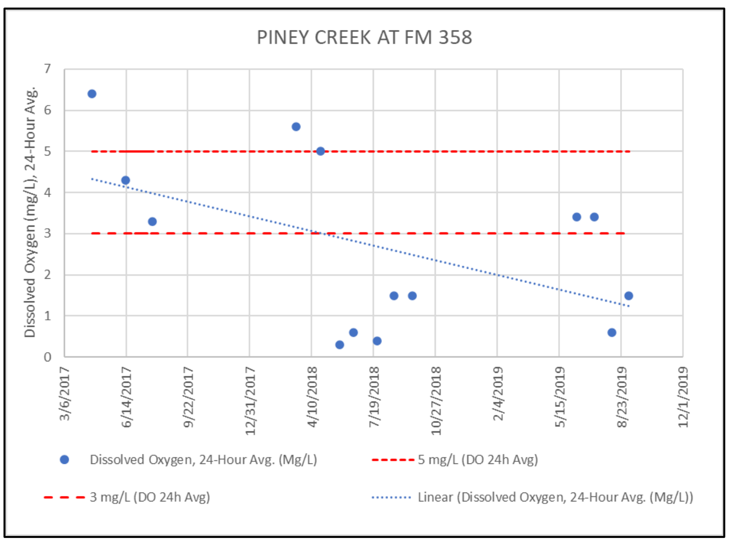
Piney Creek at FM 1987 (Monitoring Station 16081) is maintained by the TCEQ and it is located at the end of the Piney Creek subwatershed (Middle). DO 24-Hour average data is present from May 18, 2001 to September 5, 2019. The data is not seasonally-biased and is collected at different times throughout the year. The lowest and the highest 24-Hour DO averages recorded during this time was 0.1 mg/L on July 31, 2003 and 7.8 mg/L on March 16, 2018, respectively. The data indicates that DO levels are sparse throughout the year and show no trends or patterns. However, the data does indicate that many of the 24-Hour DO averages are range below the 3.0 mg/L minimum and above the 5.0 mg/L average.

PINEY CREEK AT FM 2262 (MONITORING STATION 10530)



Piney Creek at FM 2262 (Monitoring Station 10530) is maintained by the TCEQ and had DO 24-Hour average data from April 20, 2017 to September 5, 2019. The lowest and highest 24-Hour DO averages recorded during this time was 1.1 mg/L on September 20, 2018 and 8.3 mg/L on March 16, 2018, respectively. Unlike Monitoring Station 16081, the data was limited to only two years. The data suggest that few DO averages fell below the 3.0 mg/L minimum, but most were above 5.0 mg/L average.

PINEY CREEK AT FM 358 (MONITORING STATION 16096)



Piney Creek at FM 358 (Monitoring Station 16096) is maintained by ANRA and has 24-Hour DO average data from April 20, 2017 to September 15, 2019. The lowest and highest 24-Hour DO averages data recorded during this period was 0.3 mg/L on May 25, 2018 and 6.4 mg/L on April 20, 2017, respectively. Like Monitoring Station 10530, the data was only available for two years. The data indicates that many of the data points fell below the 3.0 mg/L minimum and very few were above the 5.0 mg/L average.

LAND USE & NATURAL CHARACTERISTICS

The total approximate landmass of the Piney Creek watershed is 234,972-acres (367-sq. mi). Based on satellite imagery, the landcover is mostly dense pine forests with a variety of other mixed land uses and coverage like hardwood forests and pasture/grazing land.

The USGS's 2019 National Land Cover Database (NLCD) and the Texas Parks and Wildlife's (TPWD) Land Use Land Cover (LULC) mapping data were used to create a more detailed comparison of the watershed's current land use and its significance to the watershed. The NLCD is categorized into 14 different classifications for the Piney Creek watershed and the landcover classifications for all subwatersheds are described in Figure 5.5 and Table 5.7. The TPWD LULC is categorized into 15 different landcover types for the Piney Creek watershed and is described in Figure 5.6 and Table 5.8. Detailed land use and land cover maps of the subwatersheds are displayed in the Maps section of this report.

According to the 2019 NLCD, an estimated 76% of the landcover is described as natural land types (such as evergreen forests, mixed forests, wetlands, and shrubs), and 19% is hay/pasture/grasslands, and 4.6% is developed. The TPWD LULC map has similar landcover descriptions and percentages identified as the 2019 NLCD. According to the TPWD LULC data, an estimated 83% of the landcover is described as pine forest/plantation, hardwood forests, and seasonally flooded riparian forests. In addition, 13% of the landcover is grassland/shrubland and less than 1% of the area is categorized as urban. Based on the information, the 2019 NLCD is more descriptive in its classification.

Figure 5.5. 2019 National Land Cover Data (NLCD) land uses within the Piney Creek Watershed.

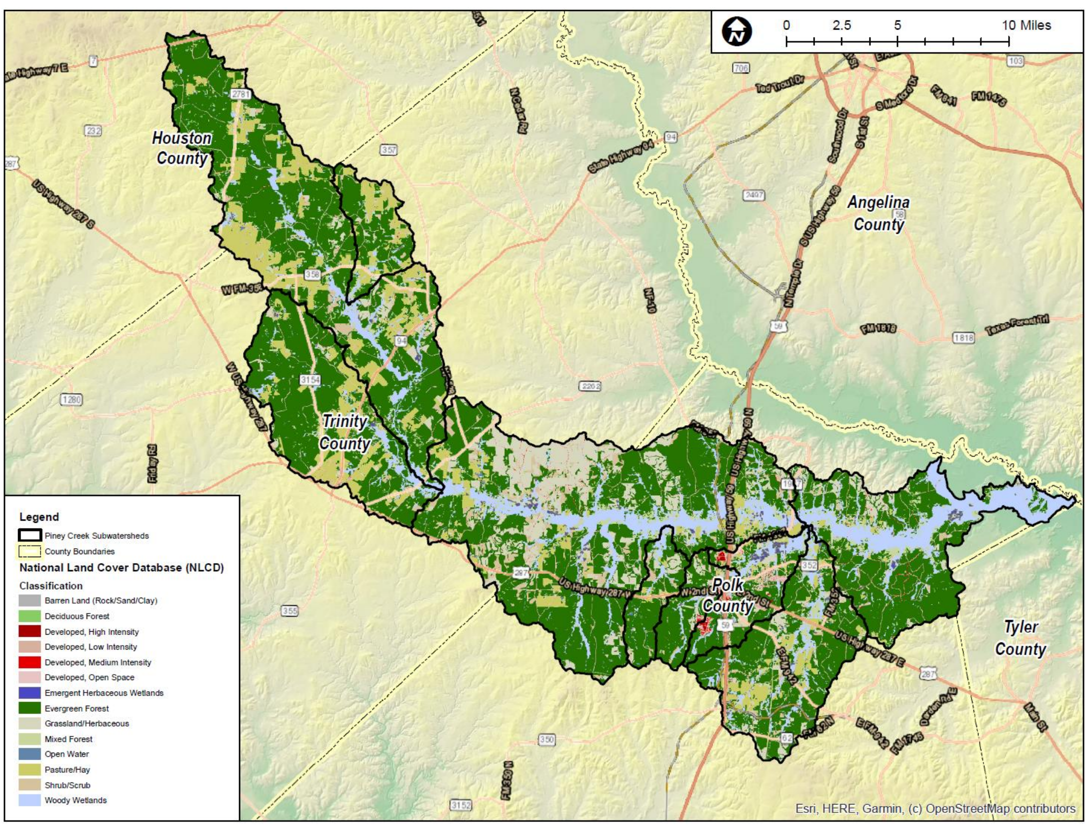


Table 5.7. 2019 NLCD Classification by size and percentage.			
Classification	**Acres**	**Square Miles**	**Percentage (%)**
Woody Wetlands	29178	45.59	12.4
Shrub/Scrub	7277	11.37	3.1
Pasture/Hay	25538	39.90	10.9
Open Water	301	0.47	0.1
Mixed Forest	8475	13.24	3.6
Grassland/Herbaceous	19660	30.72	8.4
Evergreen Forest	132496	207.01	56.4
Emergent Herbaceous Wetlands	742	1.16	0.3
Developed, Open Space	6370	9.95	2.7
Developed, Medium Intensity	854	1.33	0.4
Developed, Low Intensity	3375	5.27	1.4
Developed, High Intensity	189	0.29	0.1
Deciduous Forest	442	0.69	0.2
Barren Land (Rock/Sand/Clay)	57	0.09	0.0

Figure 5.6. Texas Parks and Wildlife (TPWD) Land Use Land Cover (LULC) Classification.

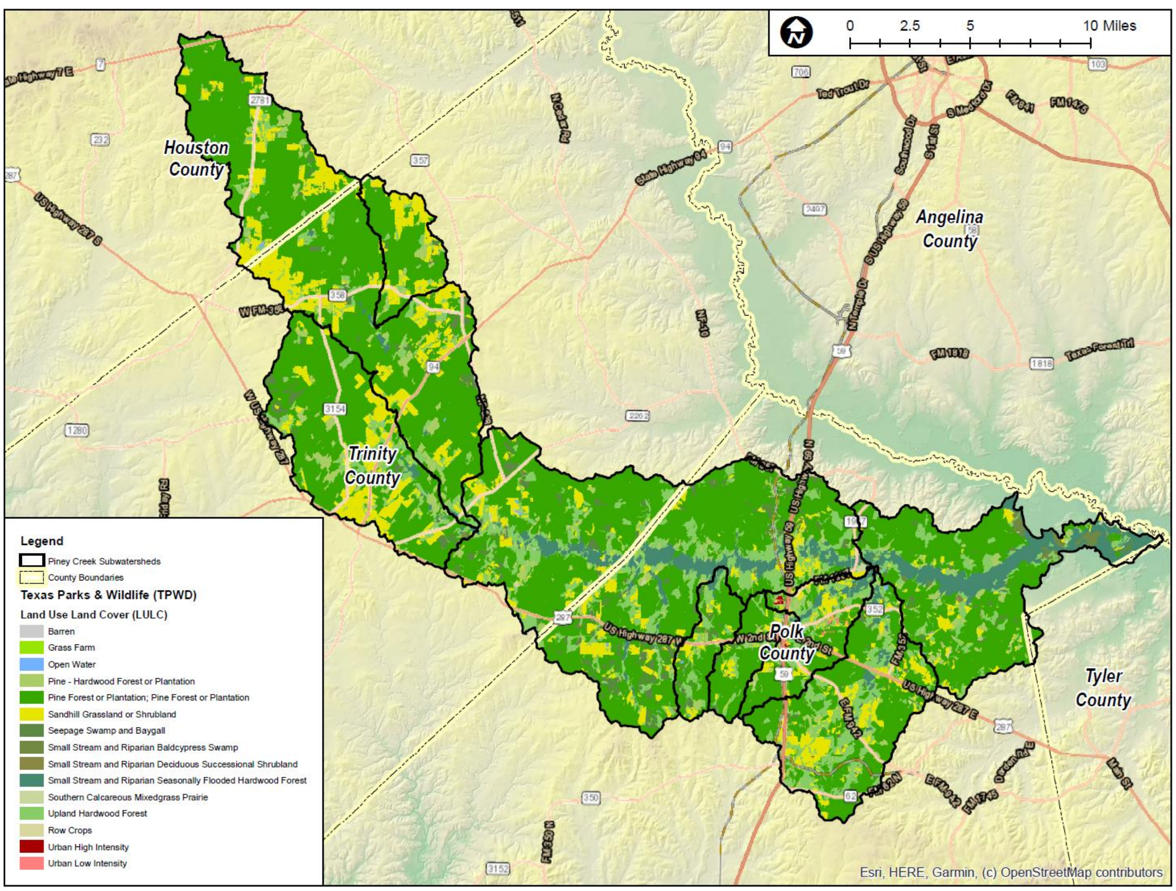
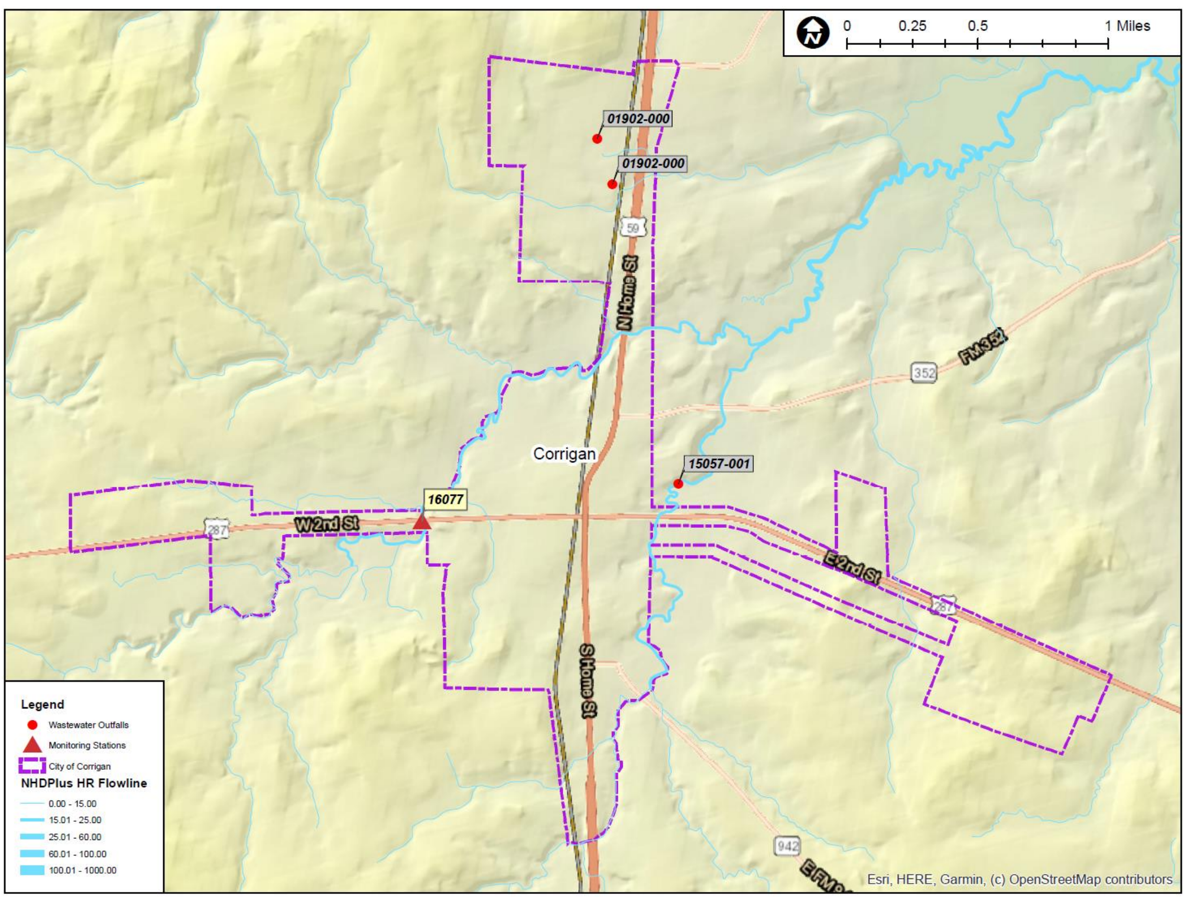


Table 5.8. TPWD LULC type by size and percentage.			
Common Name	**Acres**	**Square Miles**	**Percentage (%)**
Pine Forest or Plantation	141022	220.35	60.0
Pine - Hardwood Forest or Plantation	8755	13.68	3.7
Upland Hardwood Forest	31220	48.78	13.3
Sandhill Grassland or Shrubland	30408	47.51	12.9
Seepage Swamp and Baygall	7474	11.68	3.2
Southern Calcareous Mixed-Grass Prairie	422	0.66	0.2
Small Stream and Riparian Deciduous Successional Shrubland	425	0.66	0.2
Small Stream and Riparian Seasonally Flooded Hardwood Forest	12527	19.57	5.3
Small Stream and Riparian Baldcypress Swamp	937	1.46	0.4
Barren	58	0.09	0.0
Row Crops	218	0.34	0.1
Grass Farm	5	0.01	0.0
Urban High Intensity	169	0.26	0.1
Urban Low Intensity	1130	1.77	0.5
Open Water	203	0.32	0.1

Figure 5.7. Map of the City of Corrigan with TPDES Outfalls defined.



There are two urban developments within Piney Creek watershed: the City of Corrigan and the City of Groveton. Additionally, there is a small subdivision east of the City of Corrigan. The City of Corrigan is the only incorporated city that is fully contained within the watershed (See Figure 5.7). The city area is approximately 1,485 acres and has an approximate population of 2,300 people.

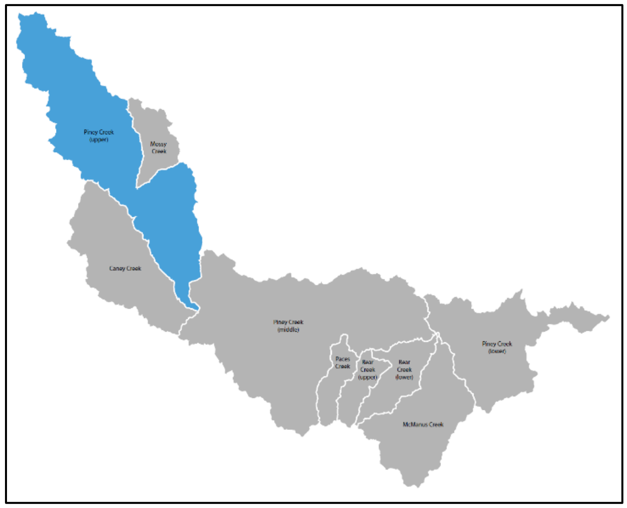
There are two permitted dischargers at the lower end of AU 0604D_01: The City of Corrigan (TPDES Permit No. WQ0015057001) and Georgia-Pacific Wood Products LLC (TPDES Permit No. WQ0001902000). The facilities do not discharge directly into the AU 0604D_01, but do discharge to connecting tributaries. The City of Corrigan is permitted to discharge 0.30 million gallons per day (MGD) of treated wastewater. Georgia-Pacific maintains two outfalls that have intermittent and flow-variable discharges.

There are several state highways, county roads, and farm-to-market roads within the Piney Creek Watershed. Presumably, most residences maintain on-site sewage facilities (OSSFs). An estimation of OSSFs was calculated based on the number of households located within the watershed, excluding households within city limits. There are approximately 2,500 OSSFs within the Piney Creek Watershed.

6.0 CHARACTERIZATION BY SUBWATERSHEDS

(For the remainder of this section, all LULC data will be referenced using the 2019 NLCD LULC Data. In addition, during the NHDPlus HR Flowline analysis, the computed flow loss discovered can be caused by several factors such as USGS gage data adjustments or common natural occurrences such as excessive evapotranspiration (ET)).

PINEY CREEK SUBWATERSHED (UPPER)



LAND USE LAND COVER (LULC)

The Piney Creek subwatershed (Upper) is approximately 54,226 acres and is mostly comprised of evergreen forests and pasture/hay areas (about 88%) (See Figure 6.0). There are approximately 513 households in the subwatershed, with most close to major farm-to-marketroads, state highways, and rural areas. Some households are located close to the unnamed tributaries that drain into Piney Creek (See Figure 6.1).

MONITORING STATIONS

There are several previously-operated monitoring stations in the Piney Creek subwatershed (Upper): Monitoring Stations 16095, 16096, and 10530. The only actively-monitored station is Monitoring Station 16096, which is monitored by ANRA. Monitoring Stations 10530 and 16095 were previously monitored by the TCEQ. Monitoring Stations 10530 and 16096 were monitored intermittently from 1989 to 2019 and from 1997 to 2020, respectively.

NHDPLUS HR FLOWLINE

Piney Creek (AU 0604D_02) begins approximately 0.5 miles northwest of FM-2781 and CR-4615 junction and has an estimated flow of 14.9 cfs (See Figure 6.2). Smaller tributaries contribute to the beginning of the Piney Creek stream segment and as the flow travels downstream, the stream flow value accumulates and increases the estimated flow. Following the path of the stream, the next known tributary to add significant stream flow value is Mossy Creek. Prior to the confluence of Mossy Creek, Piney Creek has an estimated flow of 68.3 cfs. Following the confluence, the estimated flow increases to 82.1 cfs. According to the data, the portion of Mossy Creek joining with Piney Creek contributes an estimated flow of 21.0 cfs. The final estimated flow calculated prior to the confluence of the Piney Creek subwatershed (Middle) is 65.3 cfs.

Figure 6.0. Piney Creek Subwatershed (Upper) 2019 NLCD Land Use Land Cover (LULC) Map.

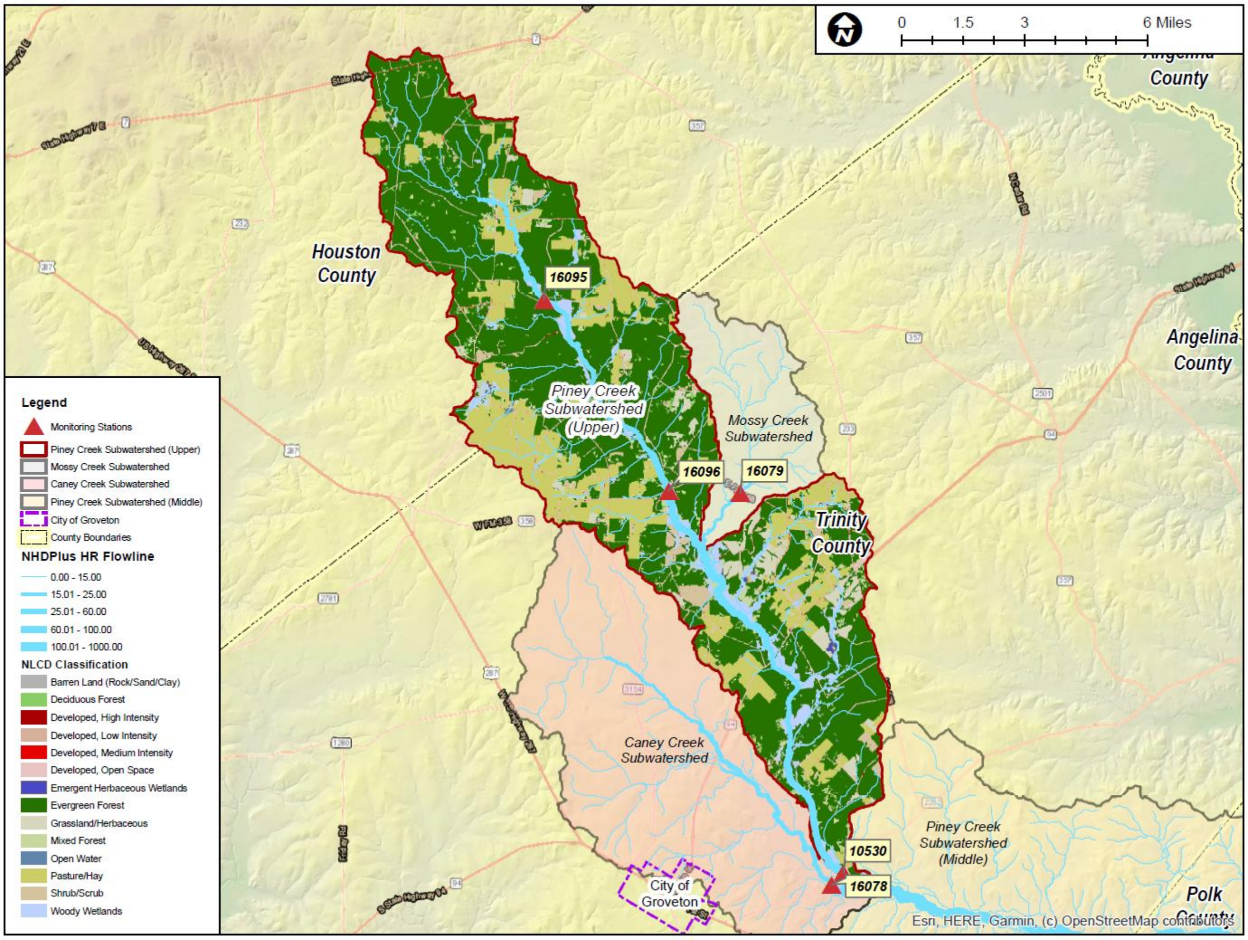


Figure 6.1. Piney Creek Subwatershed (Upper) Imagery and Address Location Map.

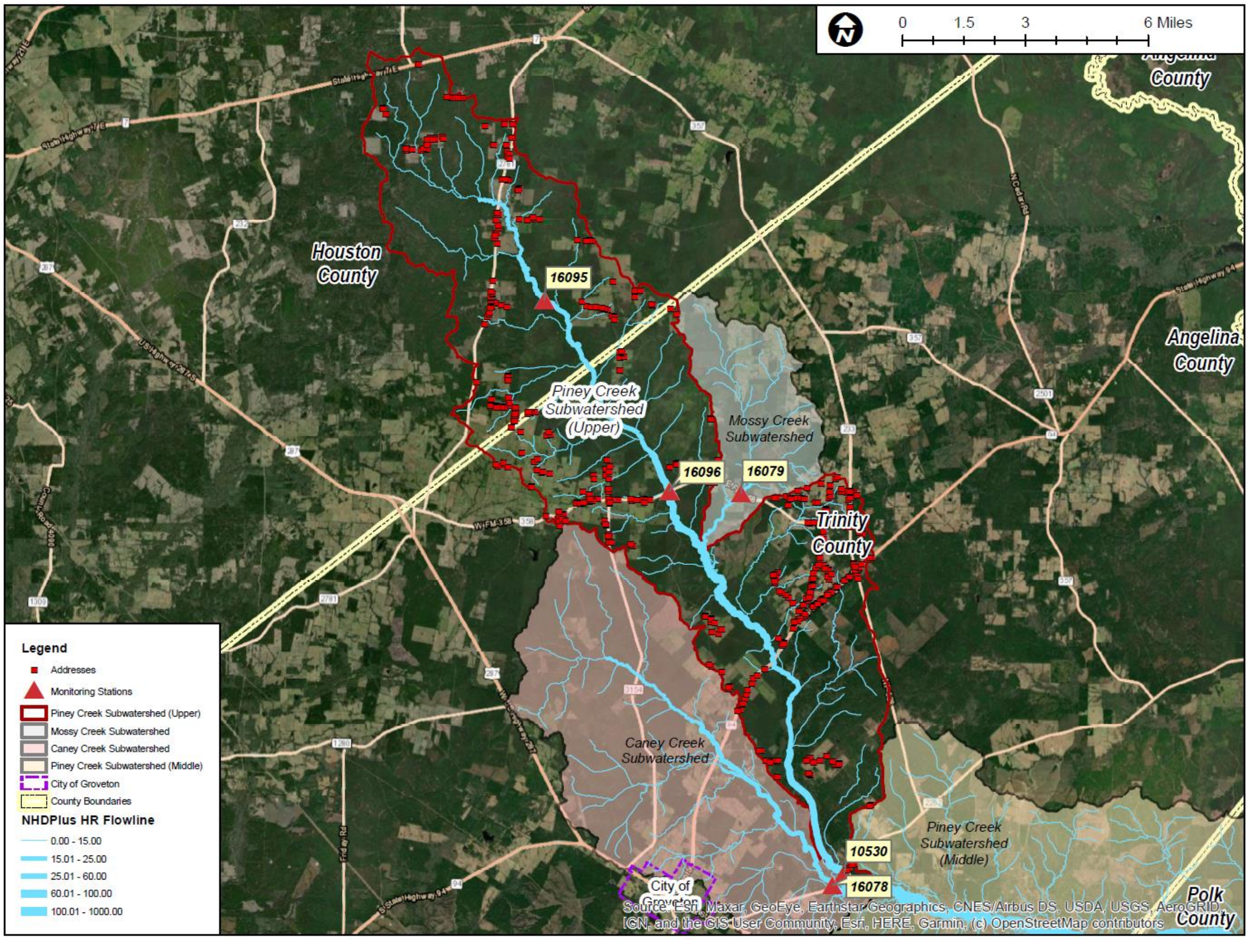
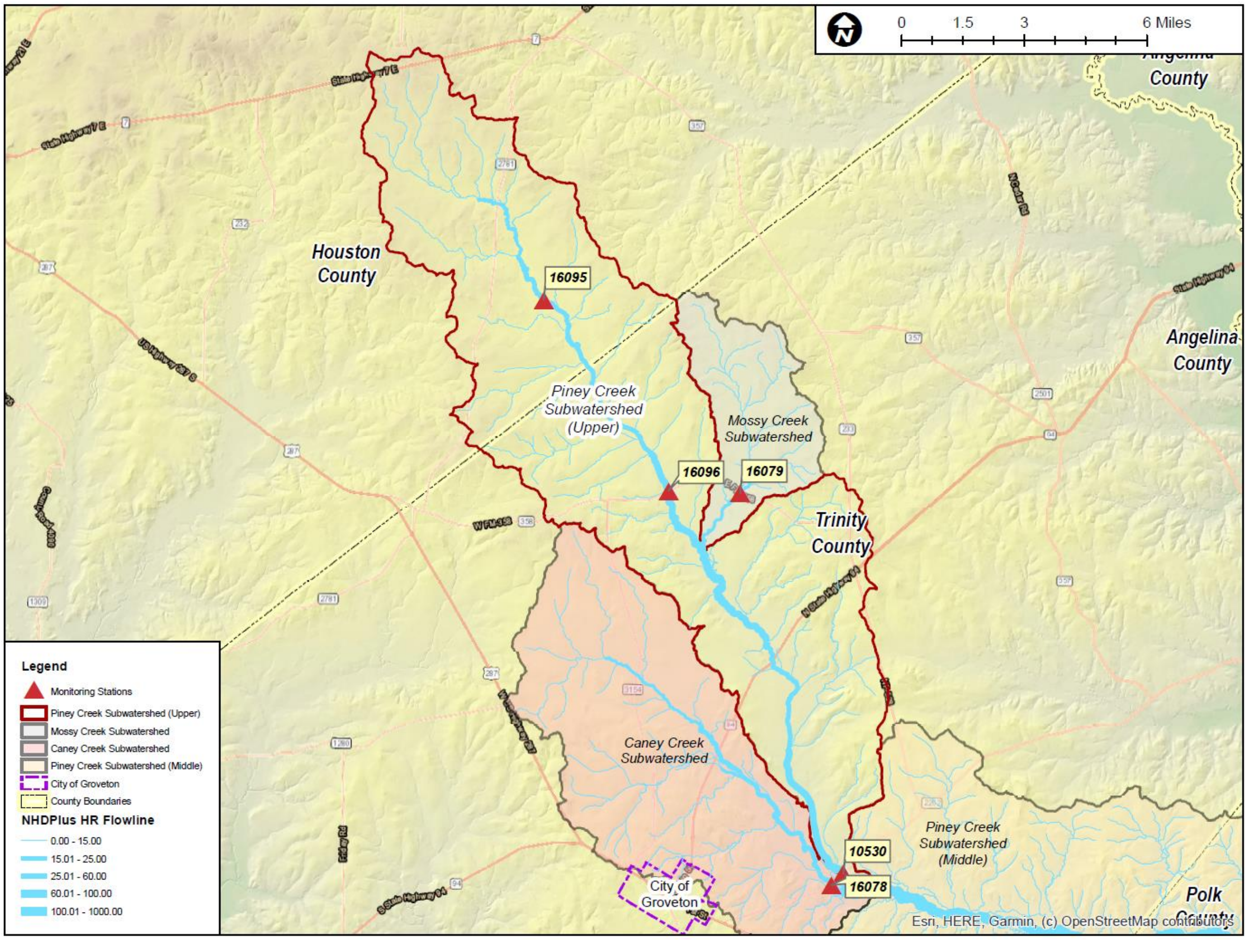
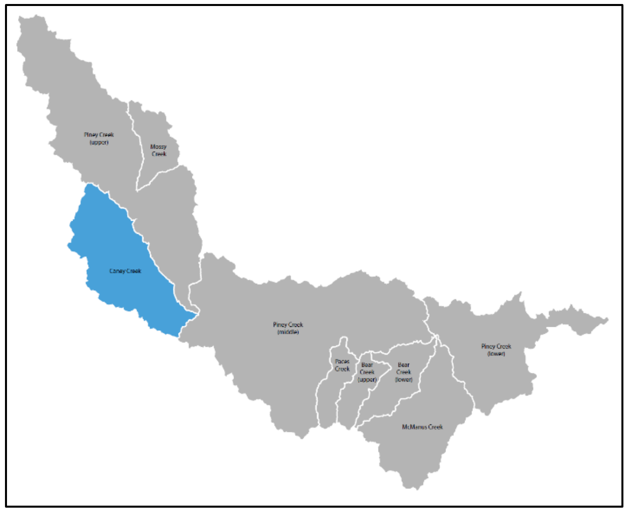


Figure 6.2. Piney Creek Subwatershed (Upper) NHDPlus HR Flowline Map.



CANEY CREEK SUBWATERSHED



LAND USE LAND COVER (LULC)

The Caney Creek subwatershed is approximately 27,338 acres and is mostly comprised of evergreen forests and pasture/hay areas (about 84%) (See Figure 6.3). There are approximately 374 households in the subwatershed, locatedmostly near farmroads and state highways (See Figure 6.4). Additionally, many of the households are within the city limits of Groveton. The City of Groveton operates a wastewater treatment facility (WQ Permit No. WQ0010556001); however, it is not located within the Piney Creek Watershed and does not have any tributaries that contribute to Piney Creek.

MONITORING STATION

There is one known monitoring station (16078) on Caney Creek. The monitoring station was monitored by ANRA from 1997 to 1998.

NHDPLUS HR FLOWLINE

Caney Creek begins approximately one mile southwest of the FM-358 and FM-3154 junction and has an estimated flow of 0.6 cfs. There are no other tributaries before the beginning of Caney Creek. As the streamflow continues downstream, several tributaries contribute to Caney Creek and accumulates. Before the Piney Creek confluence, Caney Creek has an estimated flow of 61.4 cfs (See Figure 6.5).

Figure 6.3. Piney Creek Subwatershed 2019 NLCD Land Use Land Cover (LULC) Map.

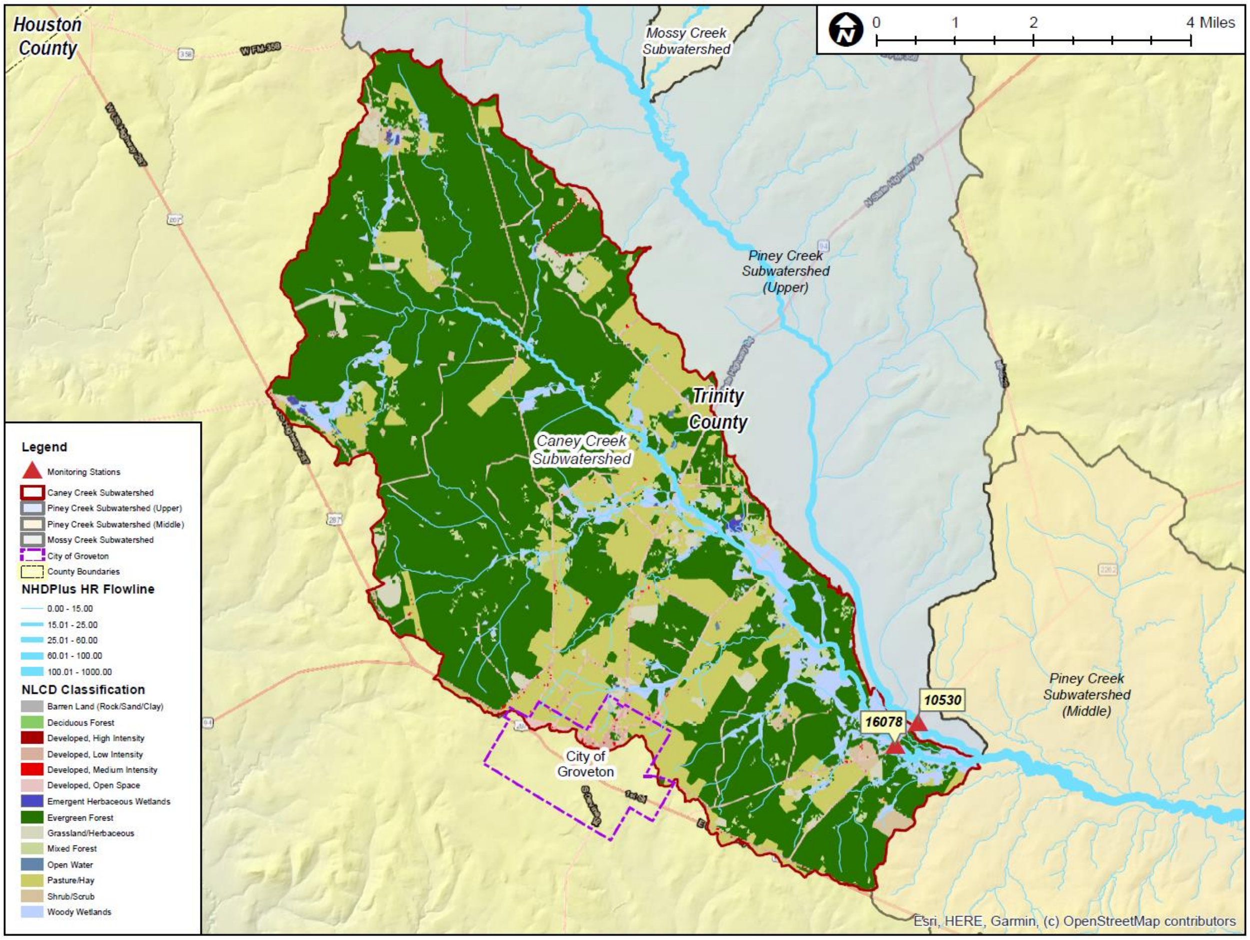


Figure 6.4. Caney Creek Subwatershed Imagery and Address Location Map.

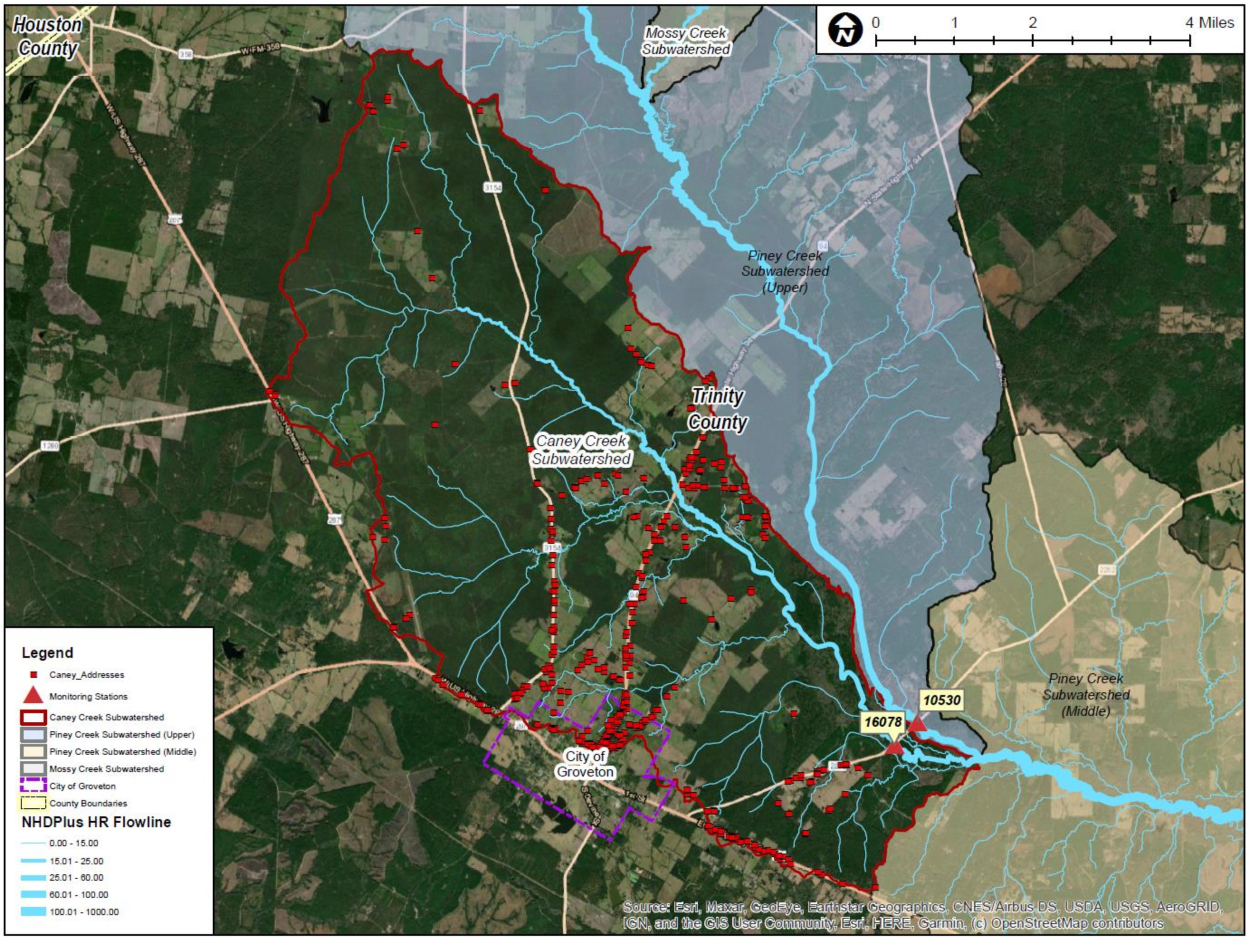
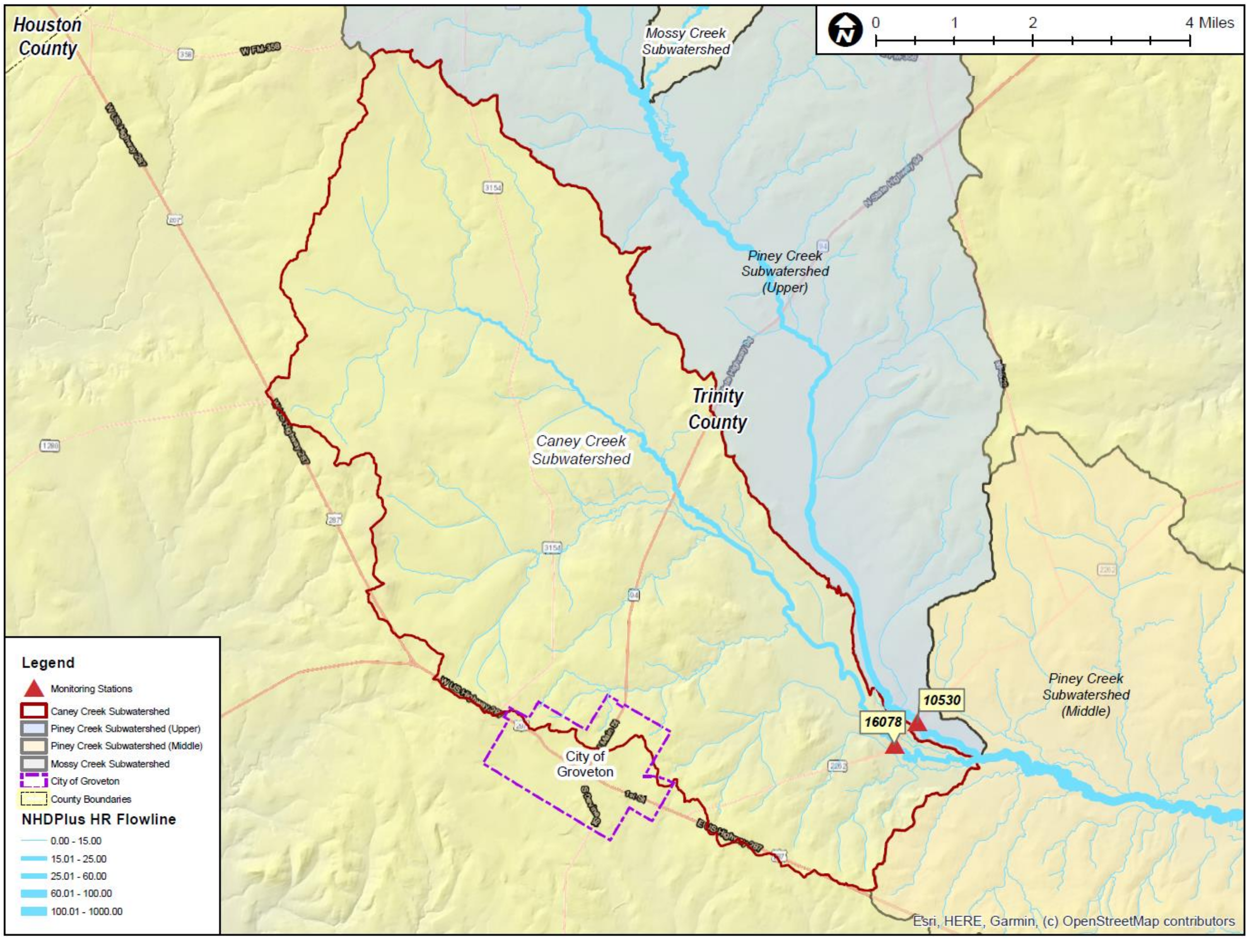
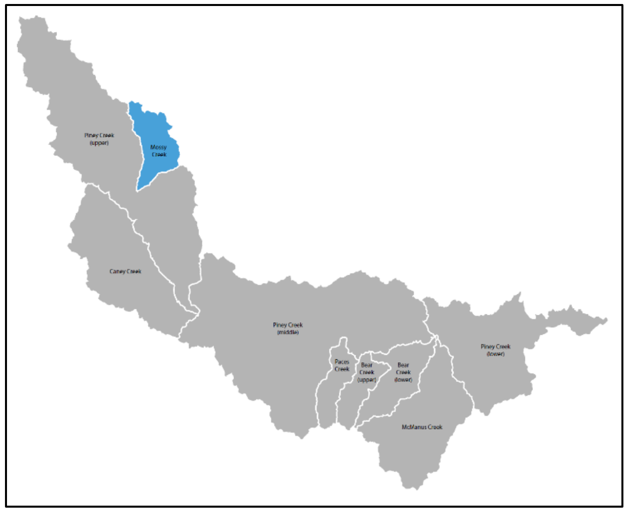


Figure 6.5. Caney Creek Subwatershed NHDPlus HR Flowline Map.



MOSSY CREEK SUBWATERSHED



LAND USE LAND COVER (LULC)

The Mossy Creek subwatershed is approximately 7,928 acres (12 sq. mi.) and is a smaller subwatershed within the Piney Creek Watershed. The Mossy Creek subwatershed is made up of mostly evergreen forests and pasture/hay areas (about 82%) (See Figure 6.6). There are approximately 108 households within the subwatershed, mostly located on pasture/hay land off of unspecified rural roads and away from most farm roads (See Figure 6.7).

MONITORING STATION

There is one historically-known monitoring station (Station ID 16079) within the Mossy Creek subwatershed, which was monitored by ANRA from 1997 to 1998

NHDPLUS HR FLOWLINE

Mossy Creek begins approximately three miles Northwest of FM-357 and FM-233 junction and begins with an estimated flow of 1.3 cfs. There are no other tributaries before the beginning of Mossy Creek. As the flow continues downstream. Before the Piney Creek confluence, Mossy Creek has an estimated flow of 21.0 cfs (See Figure 6.8).

Figure 6.6. Mossy Creek Subwatershed 2019 NLCD Land Use Land Cover (LULC) Map.

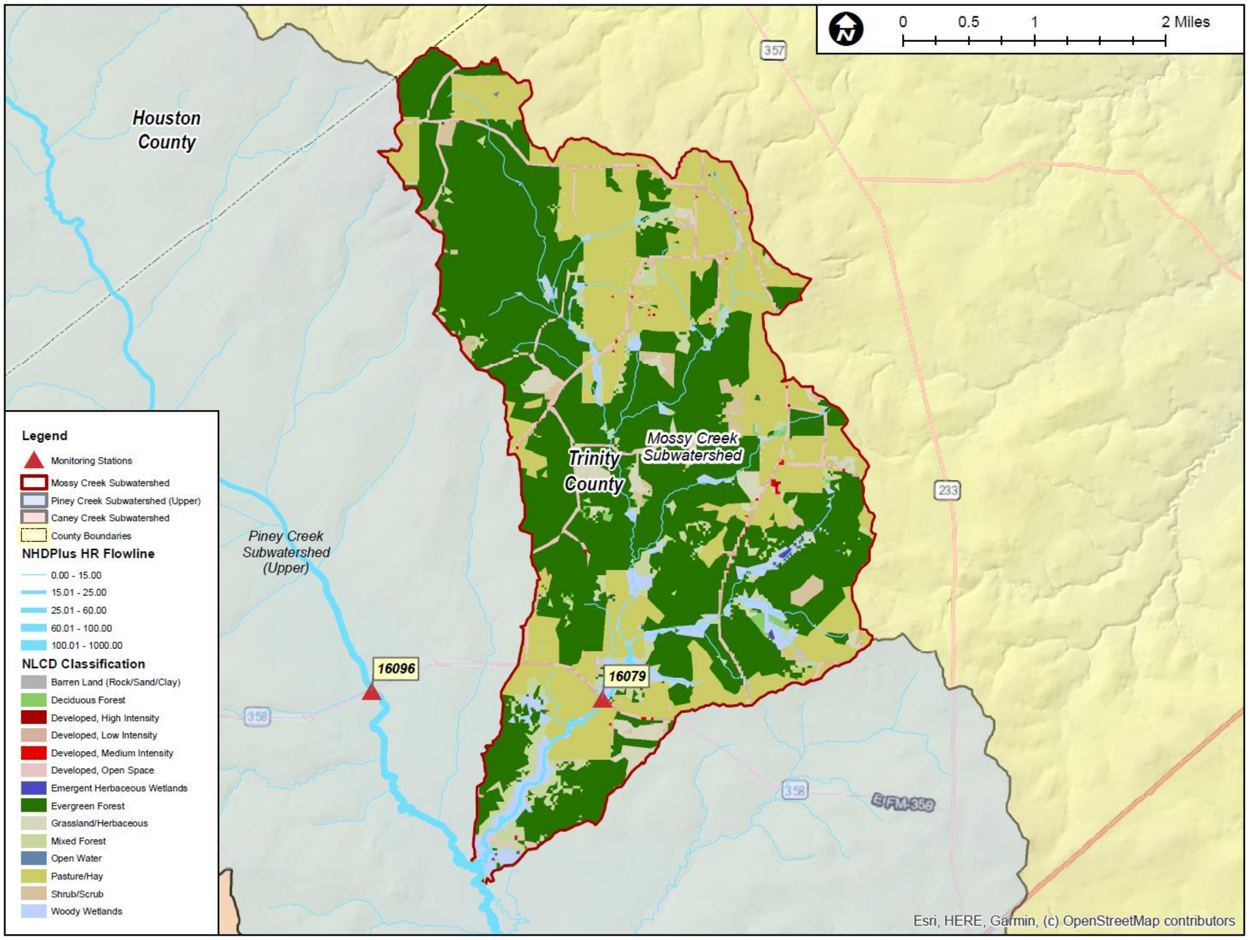


Figure 6.7. Mossy Creek Subwatershed Imagery and Address Location Map.

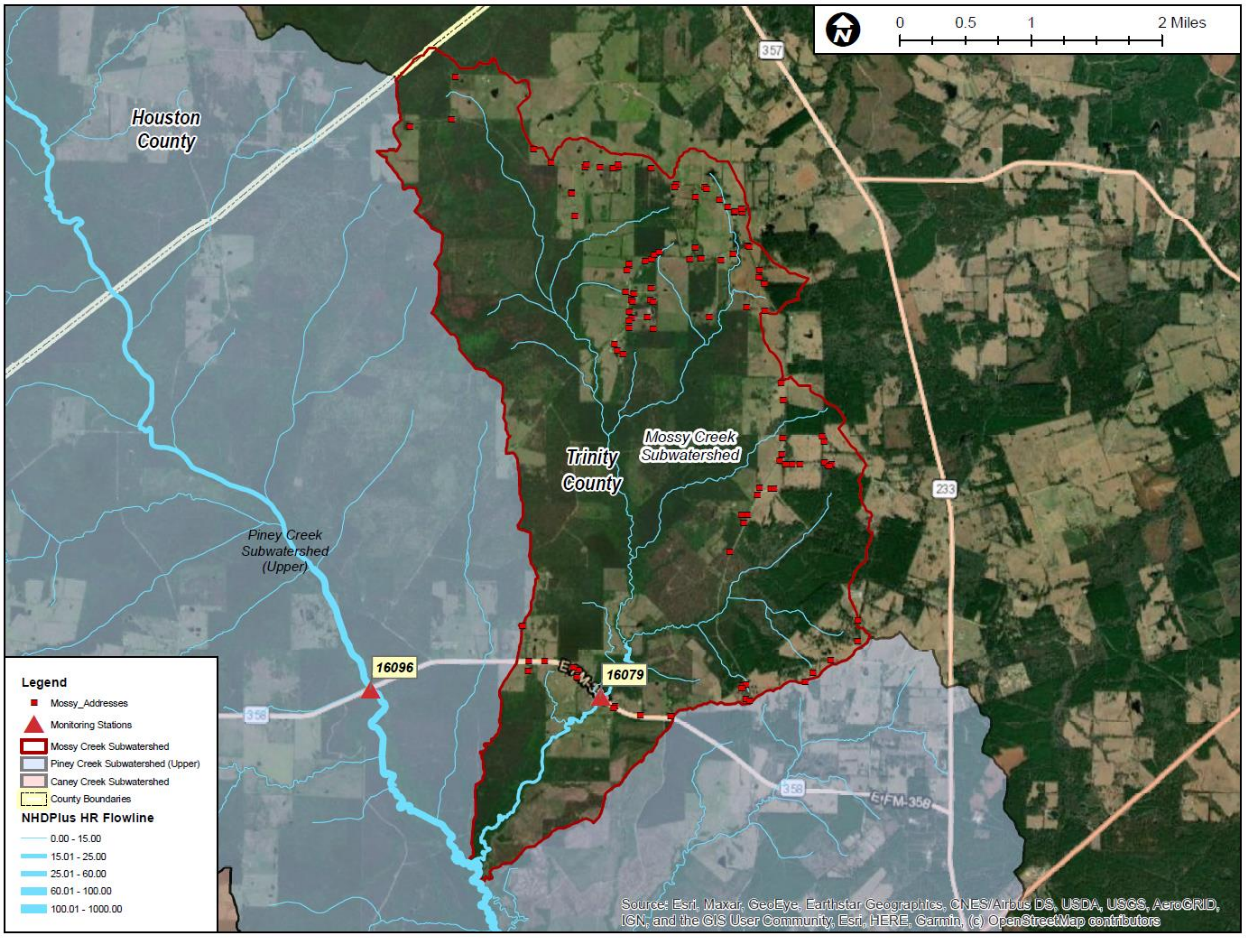
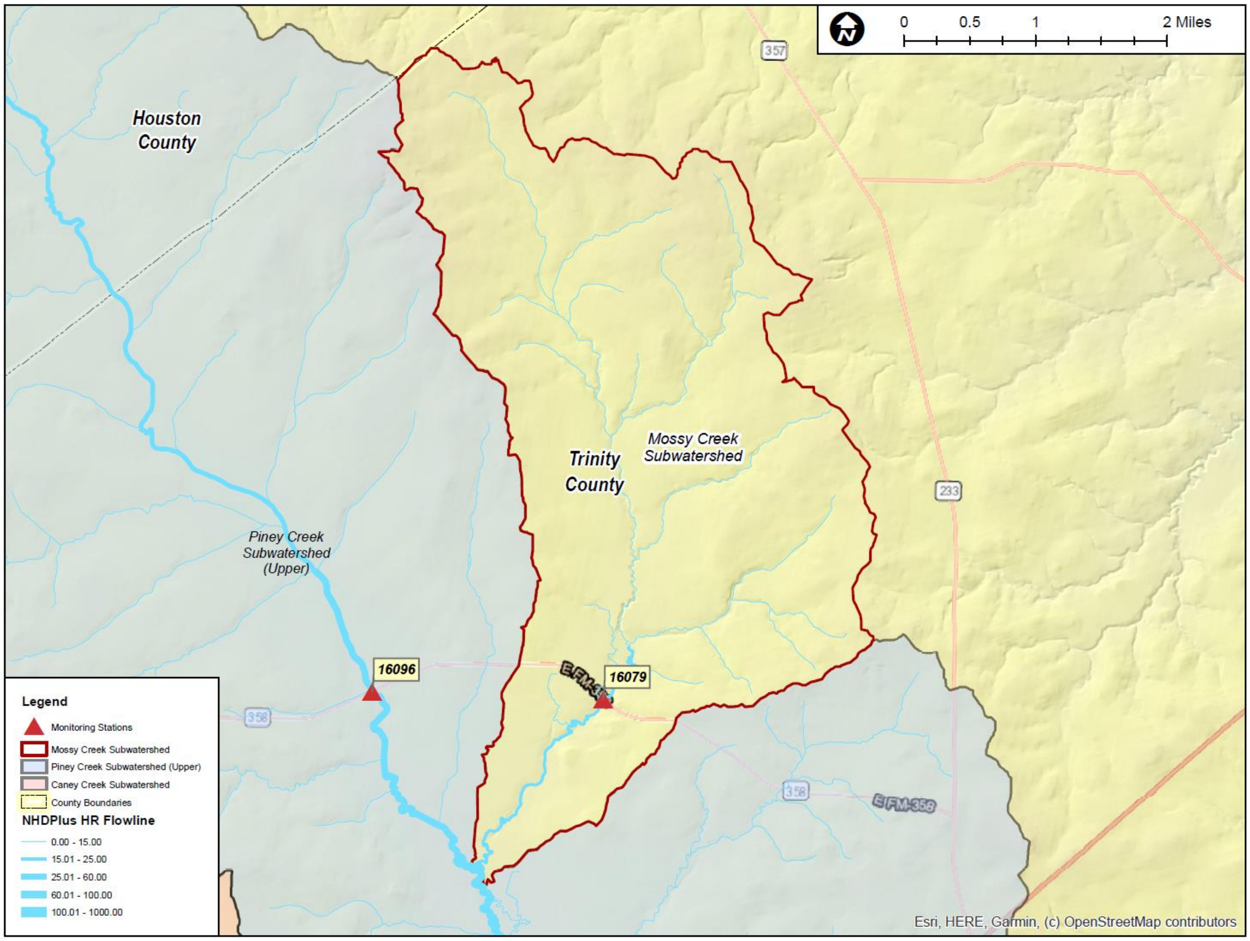


Figure 6.8. Mossy Creek Subwatershed NHDPlus HR Flowline Map.



PINEY CREEK SUBWATERSHED (MIDDLE)

LAND USE LAND COVER (LULC)

The Piney Creek subwatershed (Middle) is approximately 70,721 acres (110 sq. mi) and is the largest subwatershed within the Piney Creek Watershed. The subwatershed is mostly comprised of evergreen forests, pasture/hay lands, and a mixed number of woody wetlands (about 81%) (See Figure 6.9). The subwatershed has a sparse population, mainly located along major US highways, farm roads, and public and private access roads. Concentrated populations are also located on pastureland away from most tributaries that contribute to Piney Creek. There are approximately 472 households located within the Piney Creek subwatershed (Middle) (See Figure 6.10).

MONITORING STATIONS

In the past, there have been three monitoring stations located within the subwatershed (Monitoring Stations 16086, 16087, and 16081). Monitoring Station 16081 was previously monitored by the TCEQ from 1997 to 2019. Monitoring Stations 16086 and 16087 were monitored by ANRA from 1997 to 1998.

NHDPLUS HR FLOWLINE

Piney Creek Segment AU 0604D_01 begins at the confluence of AU_0604D_02 and Caney Creek approximately four miles east of the FM-2262 and US-287 junction and has an estimated flow of 110.7 cfs (See Figure 6.11). The subwatershed receives flow from Piney Creek (Upper) and Caney Creek subwatershed. As the stream segment flows downstream, many tributaries contribute to Piney Creek. ne Paces Creek is the only major tributary thatcontributes to Piney Creek. Before the Paces Creek confluence, Piney Creek has an estimated flow of 214.5 cfs. After the confluence, there is an estimated flow of 227.3 cfs. According to the data, Paces Creek contributes an estimated flow of 23.0 cfs. At the end of the subwatershed, the estimated flow is 264.7 cfs before the Bear Creek, McManus Creek, and Piney Creek (Lower) subwatershed.

Figure 6.9. Piney Creek Subwatershed (Middle) 2019 NLCD Land Use Land Cover (LULC) Map.

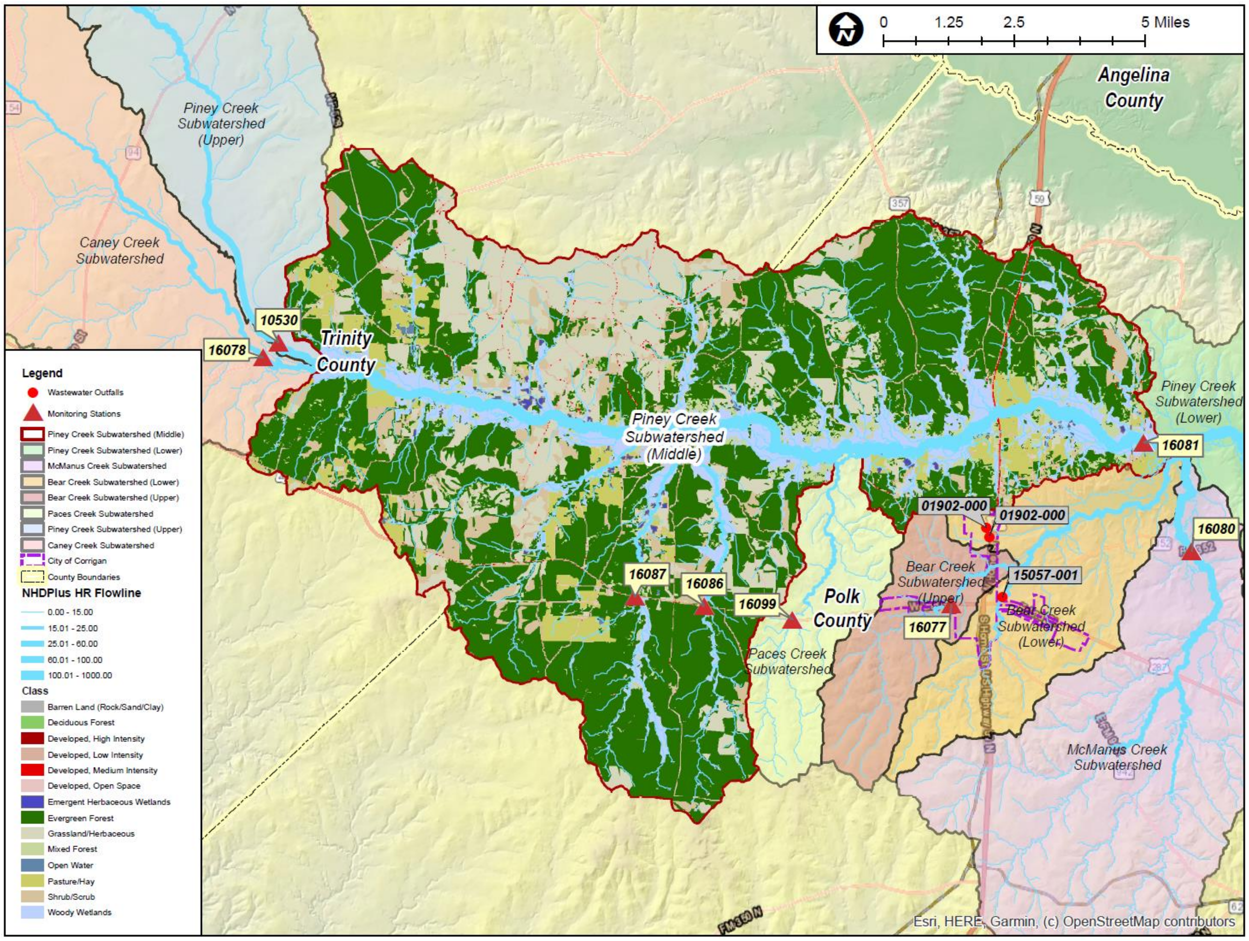


Figure 6.10. Piney Creek Subwatershed (Middle) Imagery and Address Location Map.

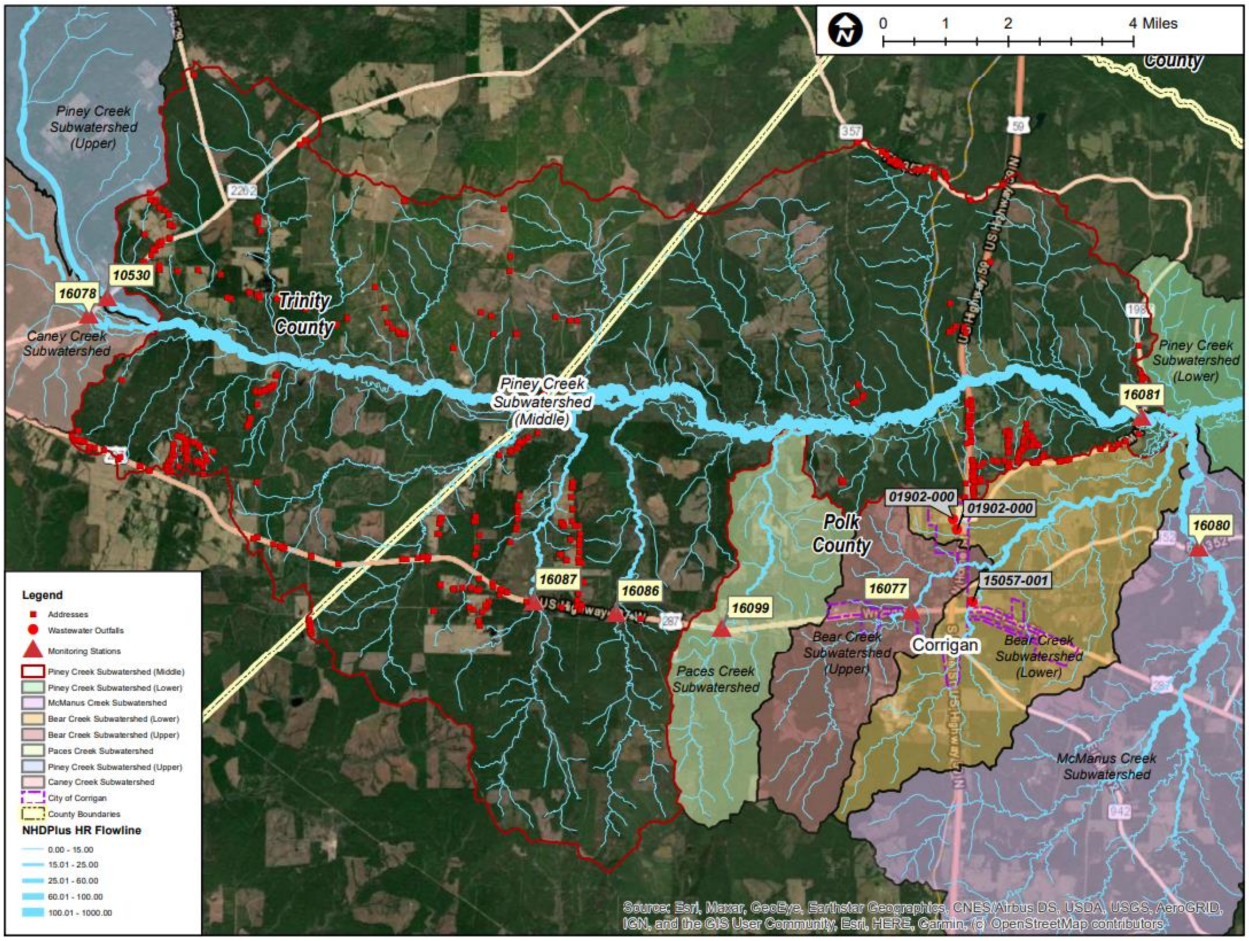
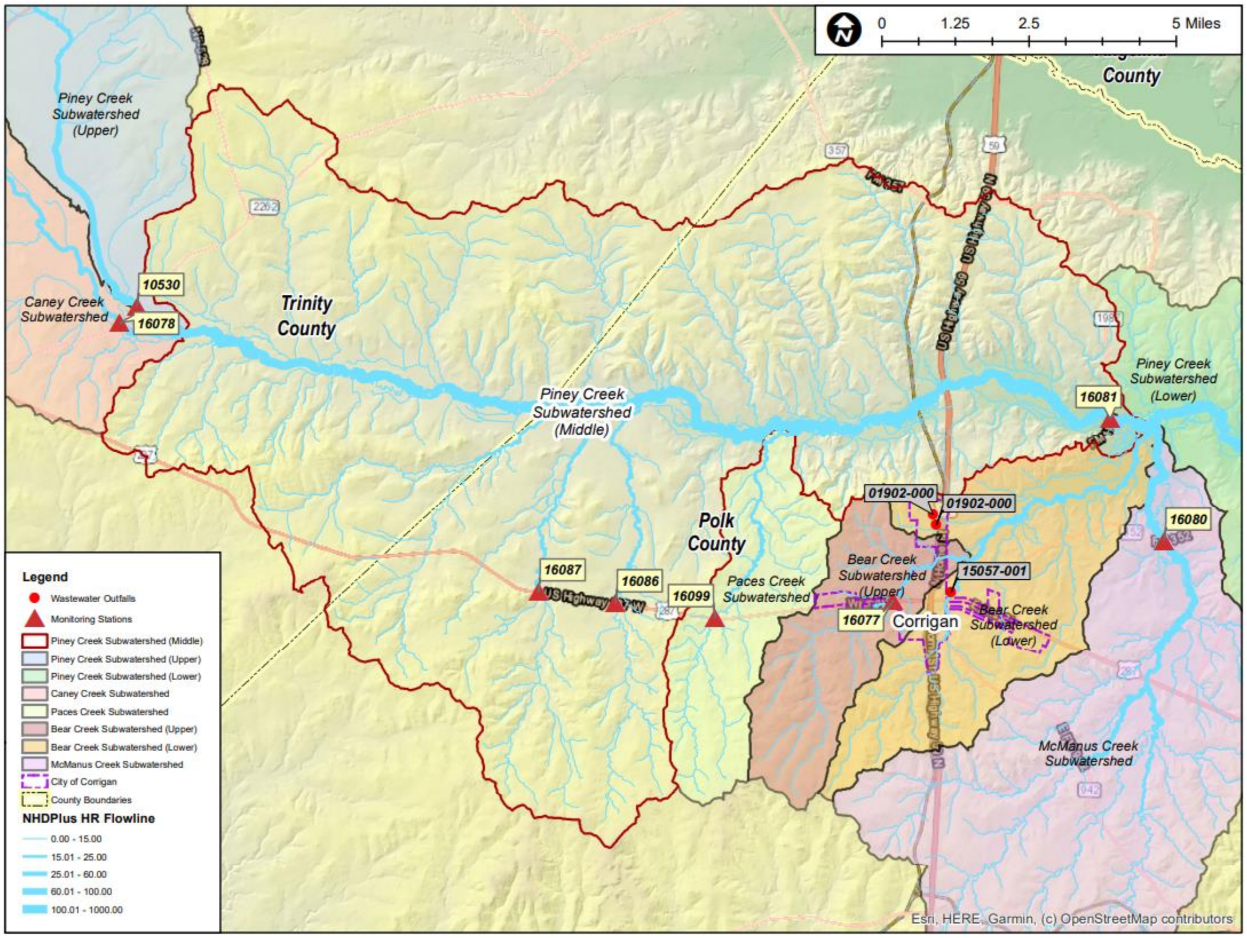
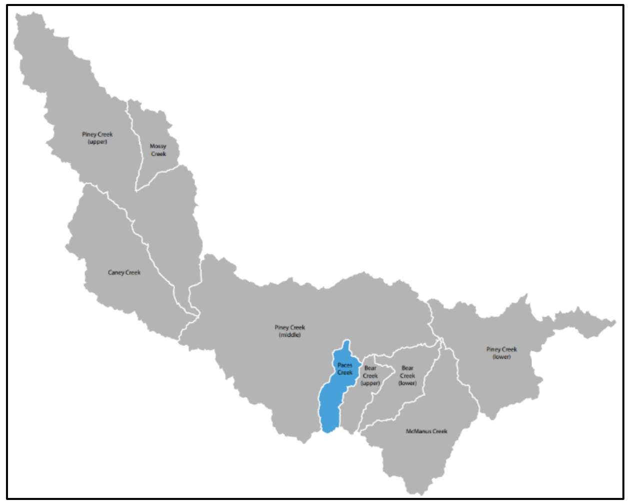


Figure 6.11. Piney Creek Subwatershed (Middle) NHDPlus HR Flowline Map.



PACES CREEK SUBWATERSHED

LAND USE LAND COVER (LULC)



The Paces Creek subwatershed is approximately 5,908 acres (9 sq. mi.). The subwatershed is mostly comprised of natural landscapes such as evergreen and mixed forests, shrubs/scrubs, woody wetlands, pasture/hay, and grasslands (about 98%) (See Figure 6.12). There are around 65 households in the subwatershed,mostly along U.S. Highway with a few located in rural areas. Very few households are located on Paces Creek or its connecting tributaries (See Figure 6.13).

MONITORING STATION

There is one previously operated monitoring station (Station 16099) within the Paces Creek subwatershed. The monitoring station was previously monitored by ANRA from 1997 to 1998.

NHDPLUS HR FLOWLINE

Paces Creek begins approximately 4.5 miles northwest of the US Highway 59 and the FM-350 junction and has an estimated flow of 0.2 cfs (See Figure 6.14). Smaller tributaries contribute to the streamflow as it travels downstream. The final estimated flow of Paces Creek before the Piney Creek confluence is 23.0 cfs.

Figure 6.12. Paces Creek Subwatershed 2019 NLCD Land Use Land Cover (LULC) Map.

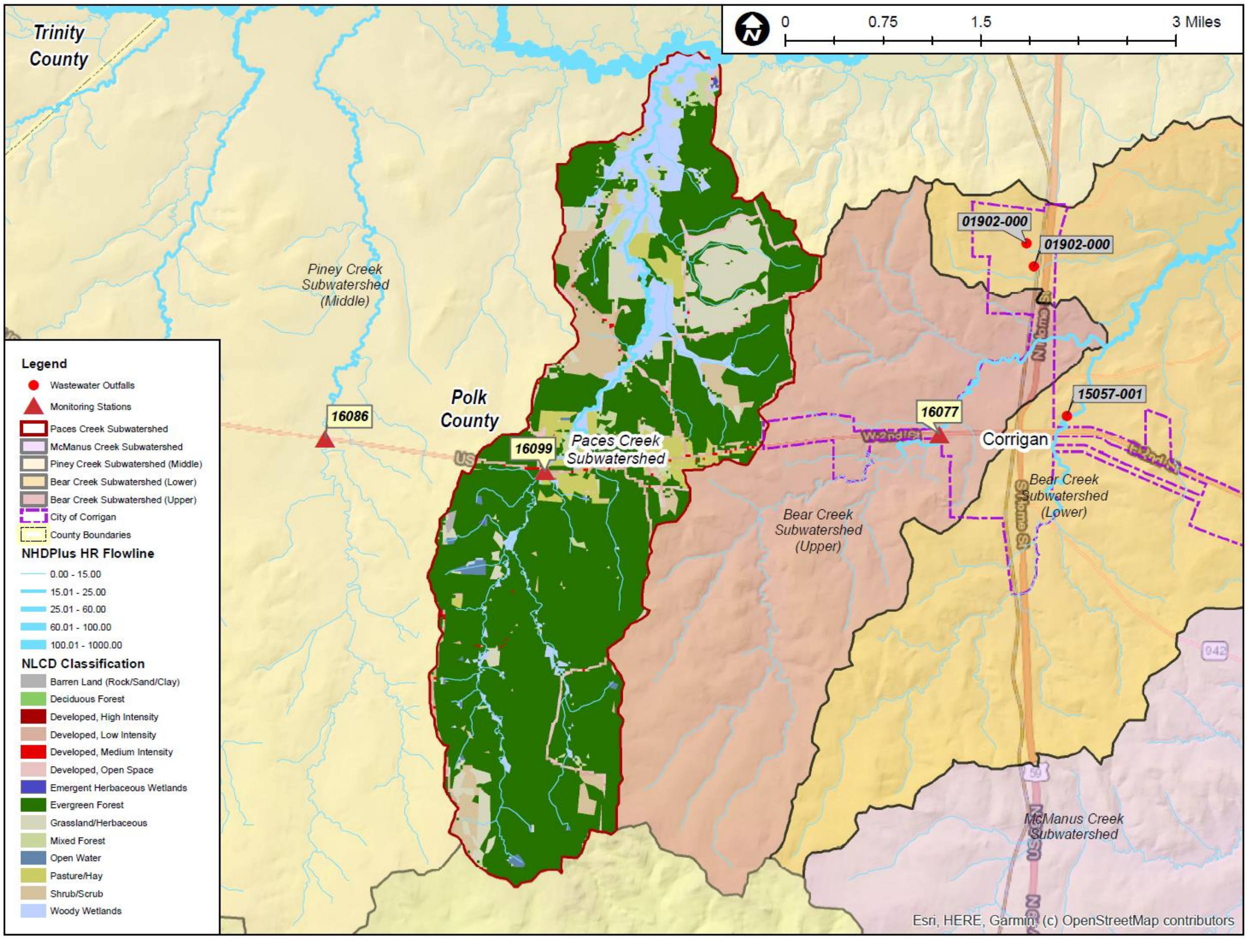


Figure 6.13. Paces Creek Subwatershed Imagery and Address Location Map.

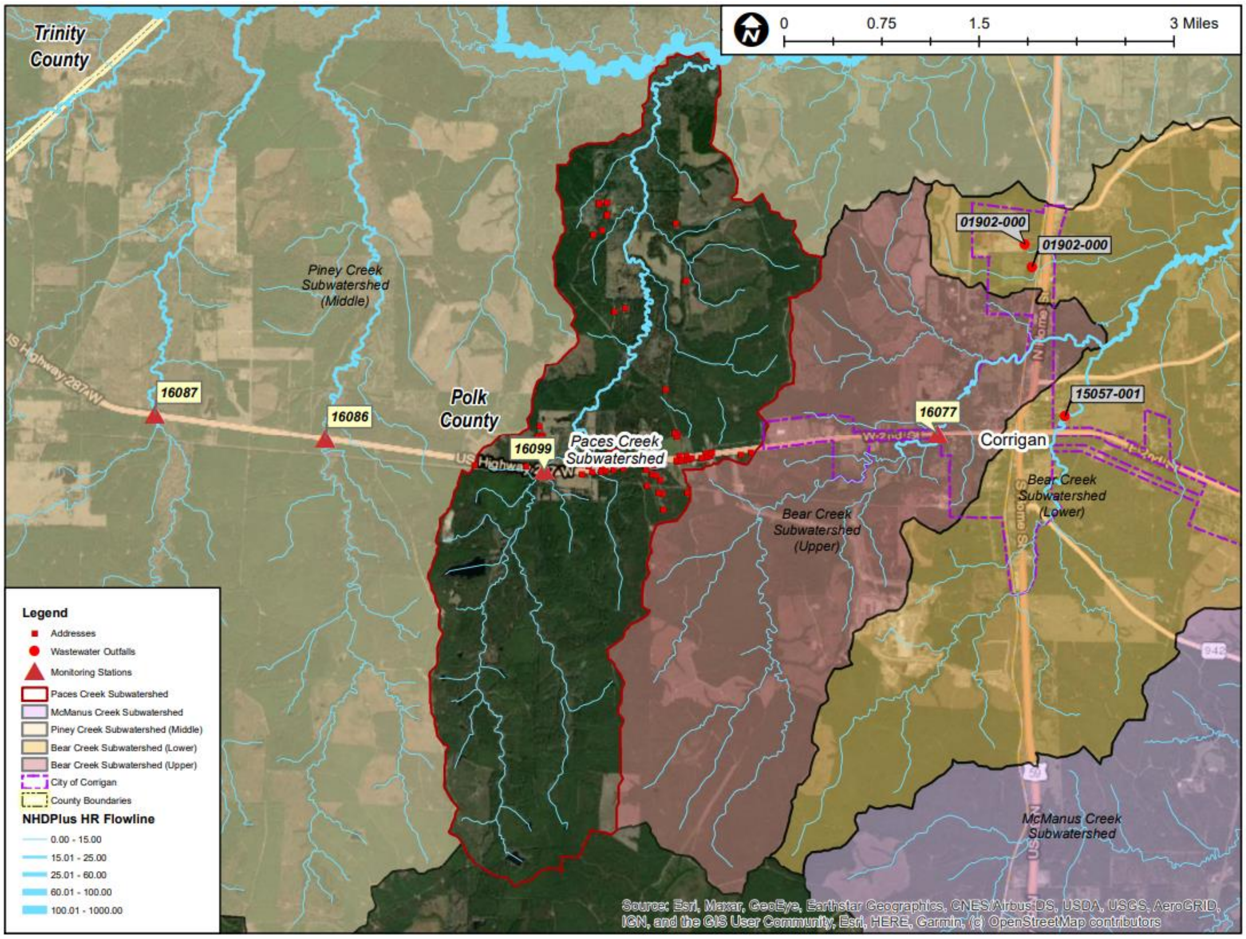
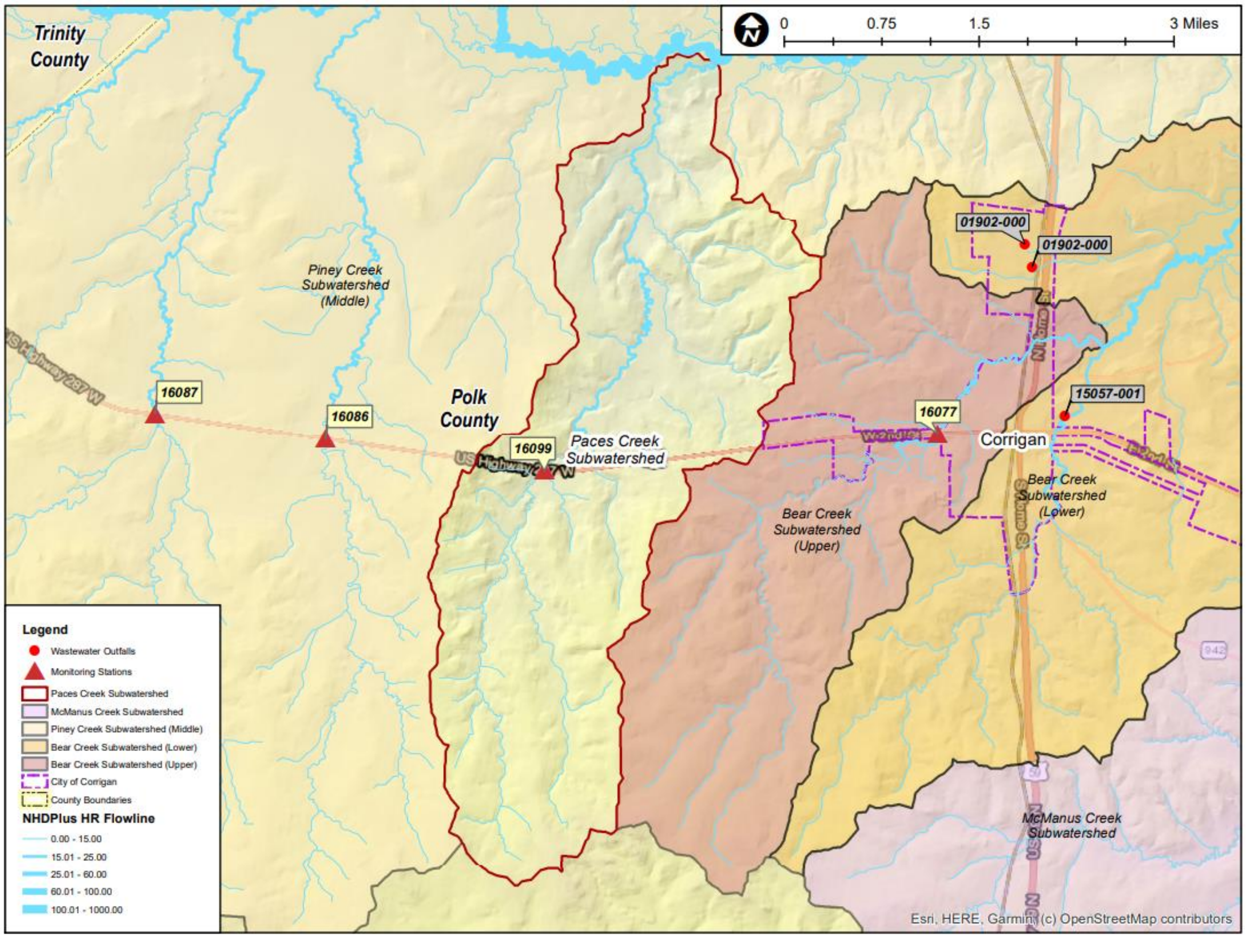
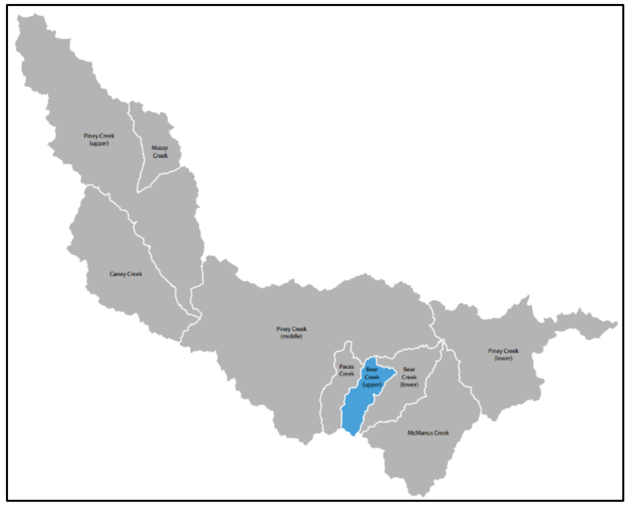


Figure 6.14. Paces Creek Subwatershed NHDPlus HR Flowline Map.



BEAR CREEK SUBWATERSHED (UPPER)



LAND USE LAND COVER (LULC)

Since Bear Creek is separated into two AUs, two individual assessments will be covered. The Bear Creek subwatershed (Upper) is approximately 5,524 acres (8.6 sq. mi.) and it is the smallest subwatershed within the Piney Creek Watershed. The subwatershed is mostly comprised of evergreen forests, grasslands, and woody wetlands (about 84%). In addition, the Bear Creek subwatershed shows the first indicators of larger developed land (See Figure 6.15). The City of Corrigan and the Corrigan Oriented Strand Board (OSB) Plant make up most of the developed land in the subwatershed (about 10%). The Corrigan OSB Plant does not have any wastewater permits nor does it discharge into any tributary known to the Bear Creek subwatershed (Upper), however, they do maintain a stormwater permit (TXR05DY63) for regulated stormwater runoff. No additional research has been conducted to determine if the Corrigan OSB Plant has any major effect on the watershed. There are approximately 259 households located within the city limits of Corrigan (See Figure 6.16).

MONITORING STATION

There is one known historical monitoring station within the Bear Creek subwatershed (Upper) (Monitoring Station 16077). The monitoring station is located within Corrigan city limits. The monitoring station was operated by ANRA from 1997 to 1998.

NHDPLUS HR FLOWLINE

Bear Creek begins approximately four miles northwest of the junction of FM-350 and US Highway 59 and has an estimated flow of 0.7 cfs. As the path of the flow travels downstream, the accumulated flow before the Bear Creek subwatershed (Lower) is 22.9 cfs (See Figure 6.17).

Figure 6.15. Bear Creek Subwatershed (Upper) 2019 NLCD Land Use Land Cover (LULC) Map.

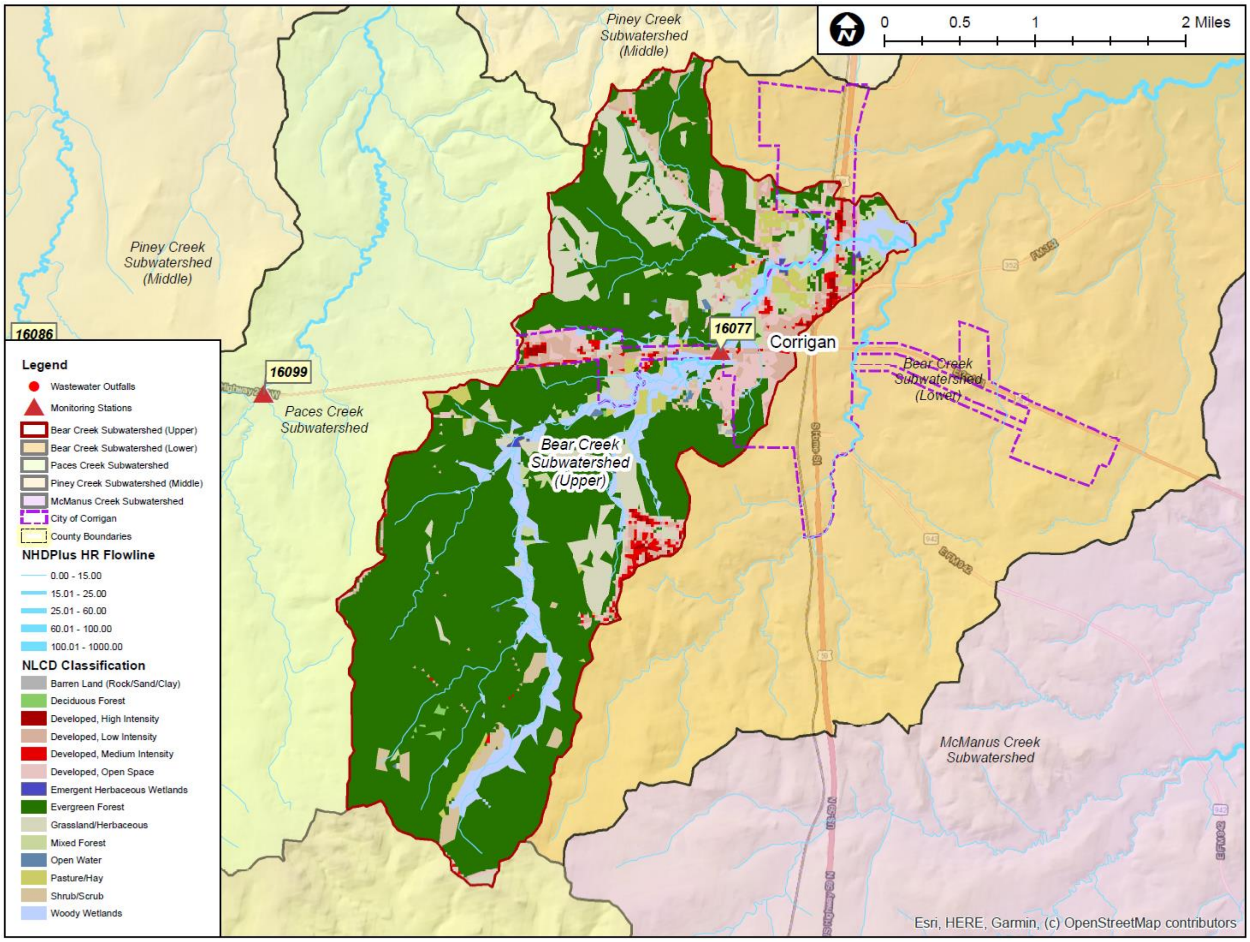


Figure 6.16. Bear Creek Subwatershed Imagery and Addresses Location Map.

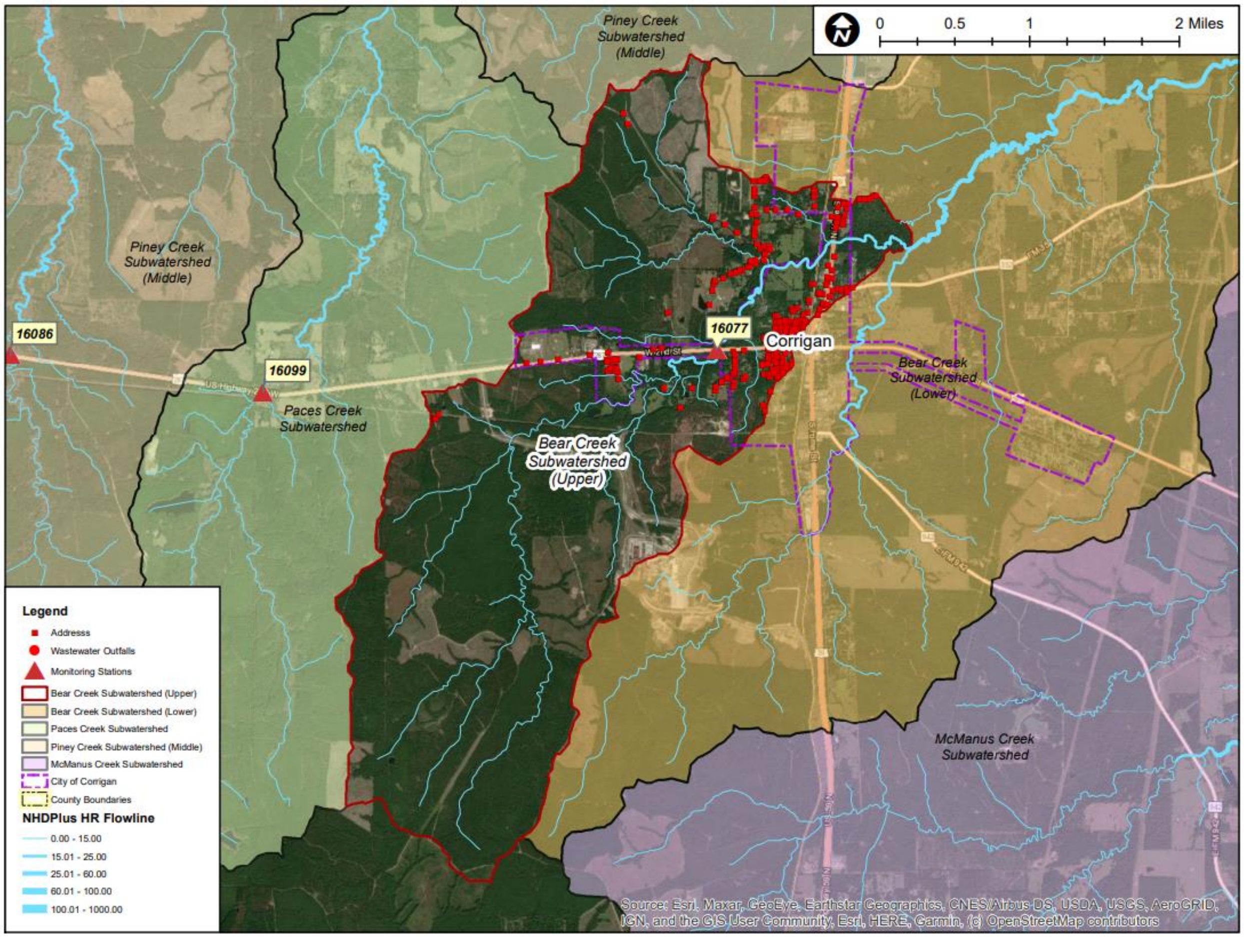
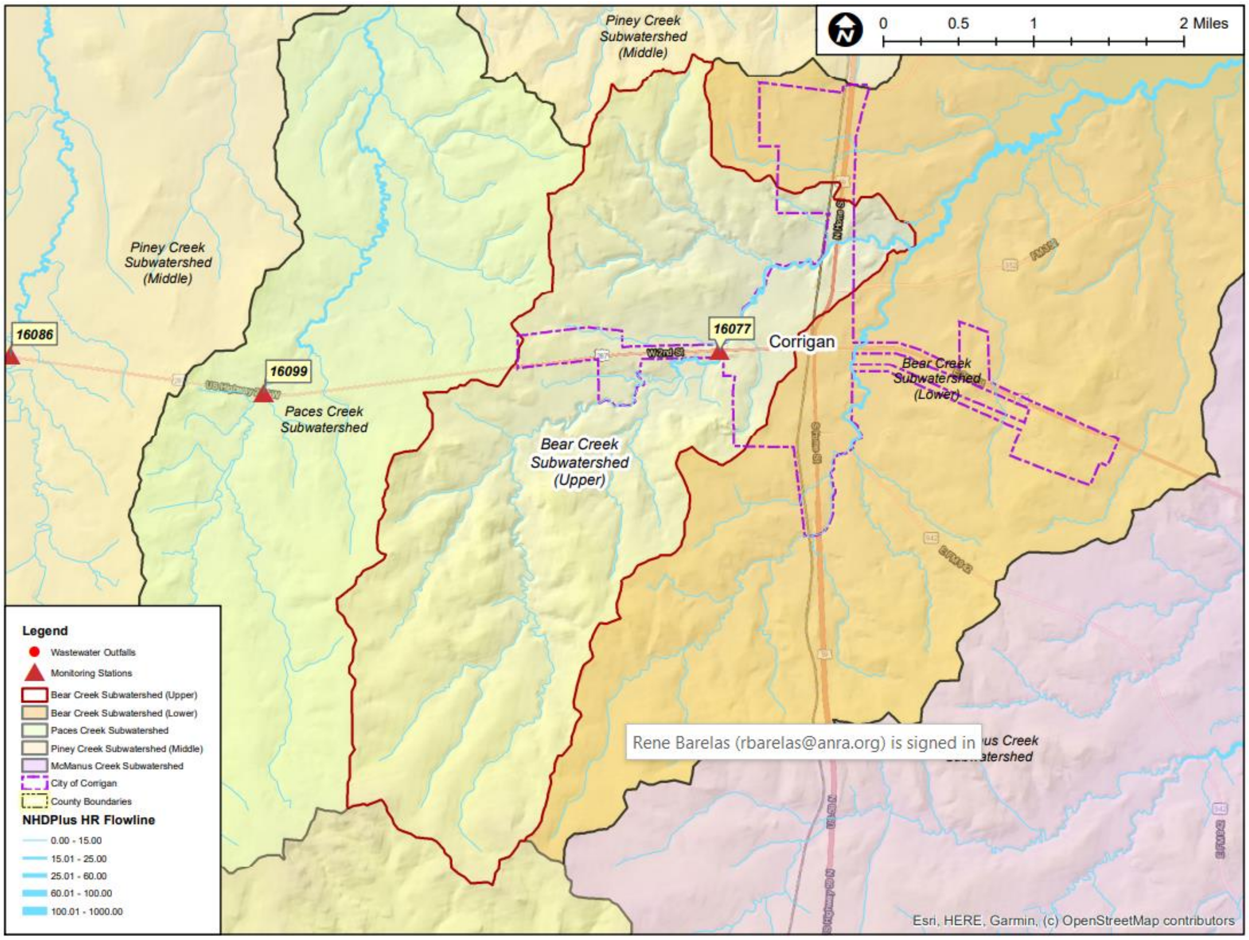
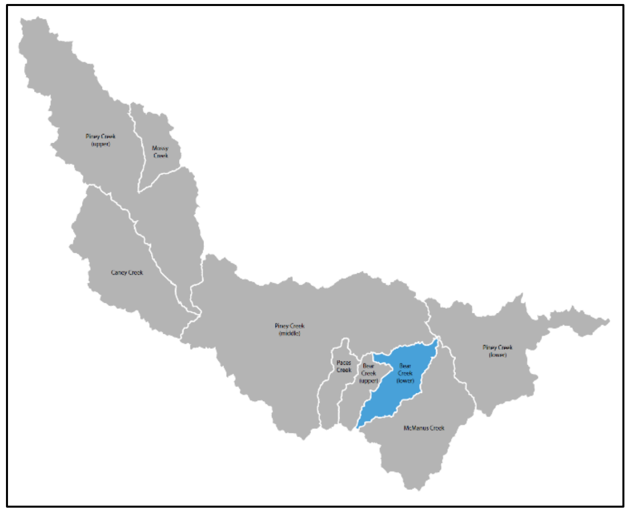


Figure 6.17. Bear Creek Subwatershed (Upper) NHDPlus HR Flowline Map.



BEAR CREEK SUBWATERSHED (LOWER)



LAND USE LAND COVER (LULC)

The Bear Creek subwatershed (Lower) is approximately 9,823 acres (15.3 sq. mi..) and is mostly comprised of evergreen forest and woody wetlands (about 61%). In addition, about 17% of the LULC is classified as developed, which is the most in any of the subwatersheds (See Figure 6.18). Like the Bear Creek (Upper) subwatershed, part of the City of Corrigan is located within the subwatershed. This includes multiple outfalls which were previously described in this report in Section 5.0 Piney Creek Watershed. There are approximately 825 households in the subwatershed, mostly withinthe City of Corrigan and two subdivisions located east of the city. The majority of households are located away from Bear Creek and its connecting tributaries (See Figure 6.19).

MONITORING STATIONS

The Bear Creek subwatershed (Lower) does not have any history of monitoring stations. However, Monitoring Station 16077 is connected via Bear Creek subwatershed (Upper) as stated in the previous section.

NHDPLUS HR FLOWLINE

Bear Creek (Lower) is a continuation of Bear Creek (Upper) and its segment begins approximately one mile Northeast of the US-59 and US-287 intersection. The stream begins with an estimated flow of 36.3 cfs. There are two streams that contribute a significant amount of flow to Break Creek (Lower), one being Bear Creek (Upper), contributing approximately 22.9 cfs and another unnamed tributary contributing 16.8 cfs. At the end of the stream segment, prior to Piney Creek, Bear Creek has an estimated flow of 55.6 cfs.

Figure 6.18. Bear Creek Subwatershed (Lower) Land Use Land Cover (LULC) Map.

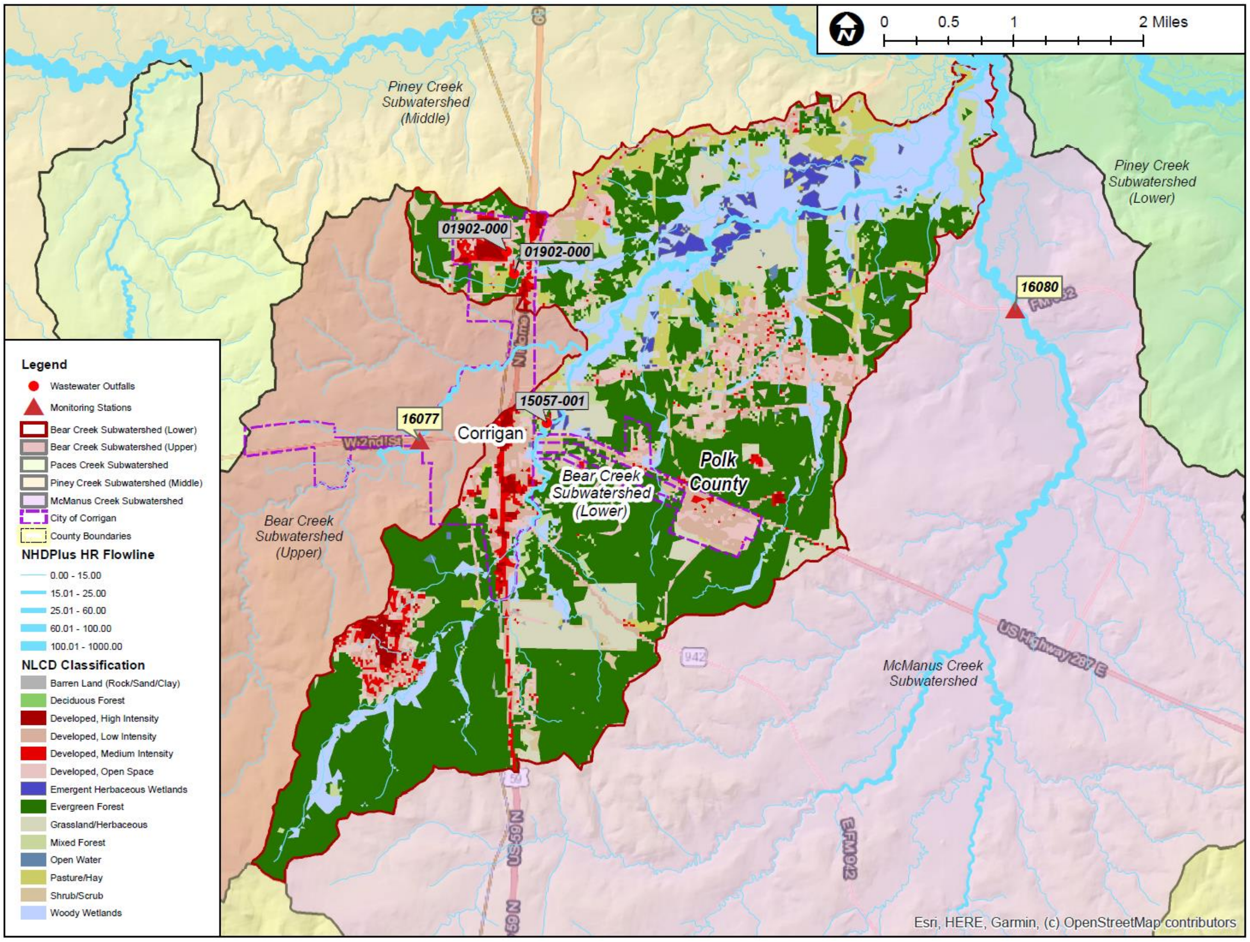


Figure 6.19. Bear Creek Subwatershed (Lower) Imagery and Addresses Location Map.

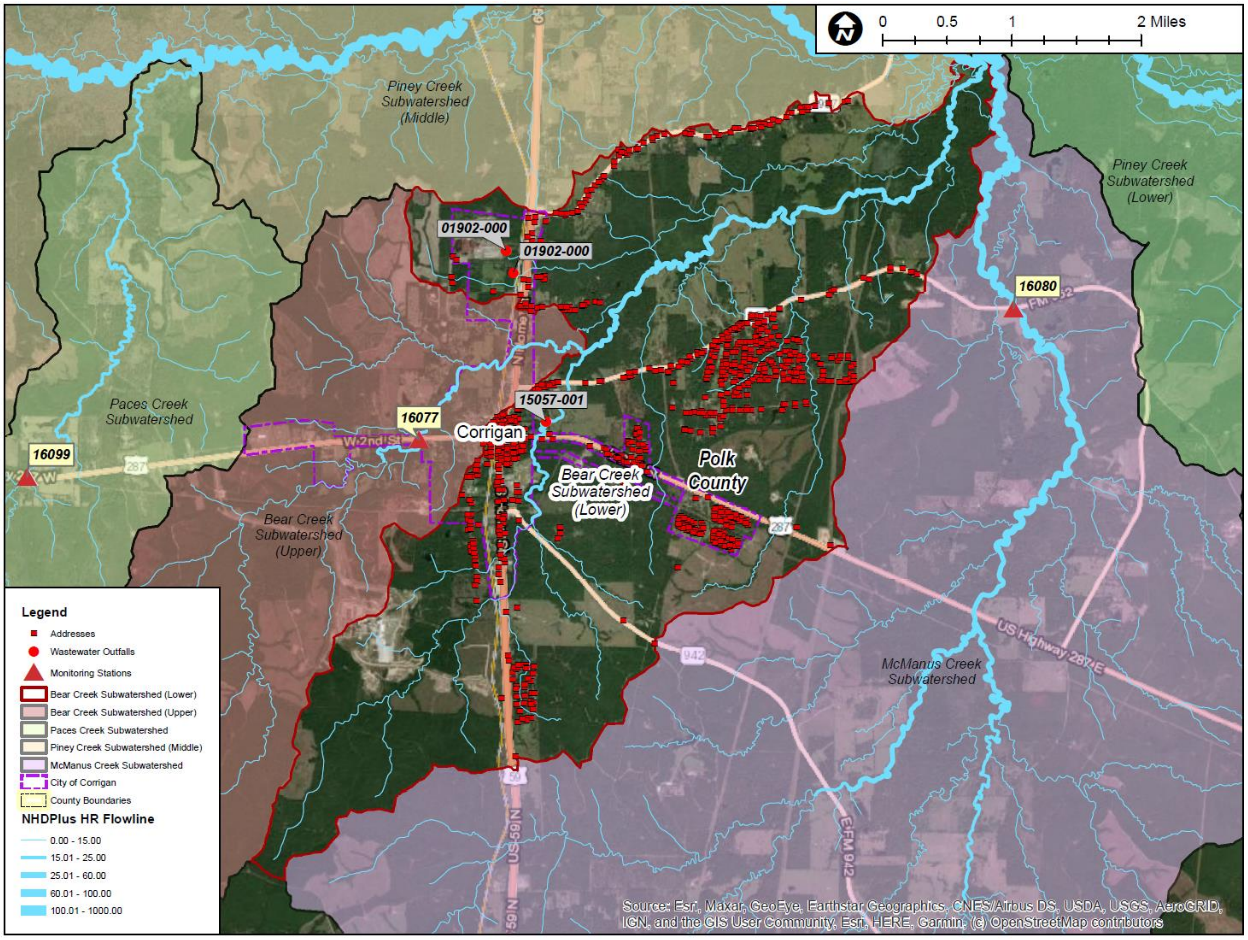
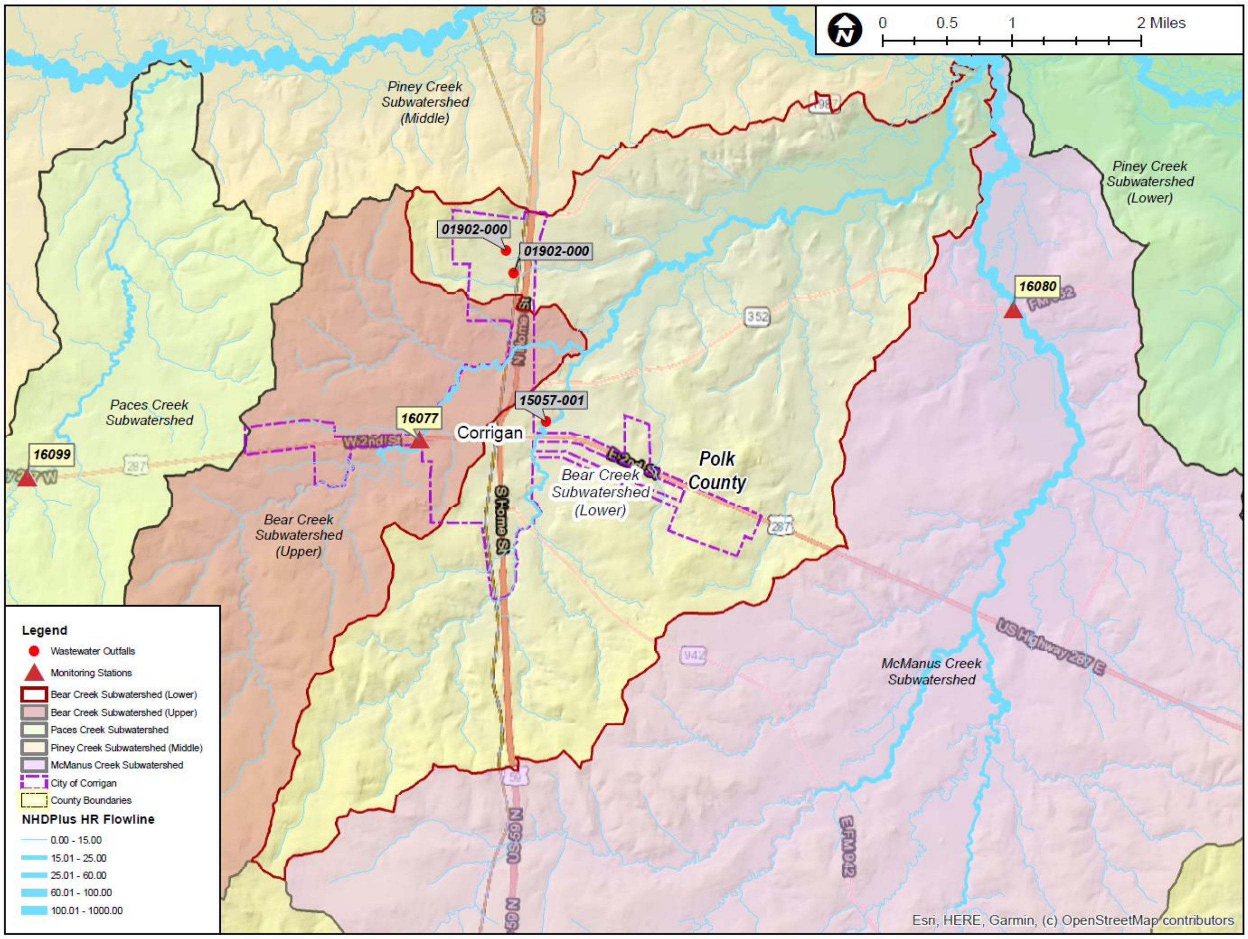
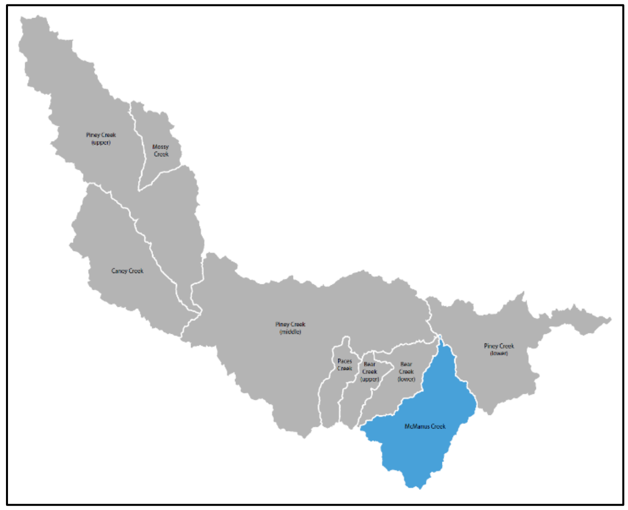


Figure 6.20. Bear Creek Subwatershed (Lower) NHDPlus HR Flowline Map.



MCMANUS CREEK SUBWATERSHED



LAND USE LAND COVER (LULC)

The McManus Creek subwatershed is approximately 24,046 acres and is mostly comprised of natural landscapes like evergreen forests, woody wetlands, and pasture/hay lands (about 80%) (See Figure 6.21). There are approximately 552 households located in the subwatershed, most located along US Highway 59 within the city limits of Moscow, Texas. Other concentrations of populations are located along farm roads (See Figure 6.22). The City of Moscow does maintain a WWTP (WQ Permit No. WQ0011139001), however, the outfall is not located within the Piney Creek Watershed and there are no connecting streams or tributaries that discharge directly into Piney Creek.

MONITORING STATIONS

There is one historical monitoring station in McManus Creek (Station ID 16080). The station was monitored by ANRA from 1997 to 1998.

NHDPLUS HR FLOWLINE

McManus Creek begins approximately three miles Southeast of the junction of US Highway 59 and FM-350 and has a beginning estimated flow of 0.4 cfs (See Figure 6.23). There are many large unnamed tributaries that contribute to McManus Creek, with estimated flow ranging from 0.3 cfs to as much as 27.0 cfs before reaching the Piney Creek confluence. Prior to the Piney Creek confluence, McManus Creek has an estimated flow of 79.1 cfs.

Figure 6.21. McManus Creek Subwatershed 2019 NLCD Land Use Land Cover (LULC) Map.

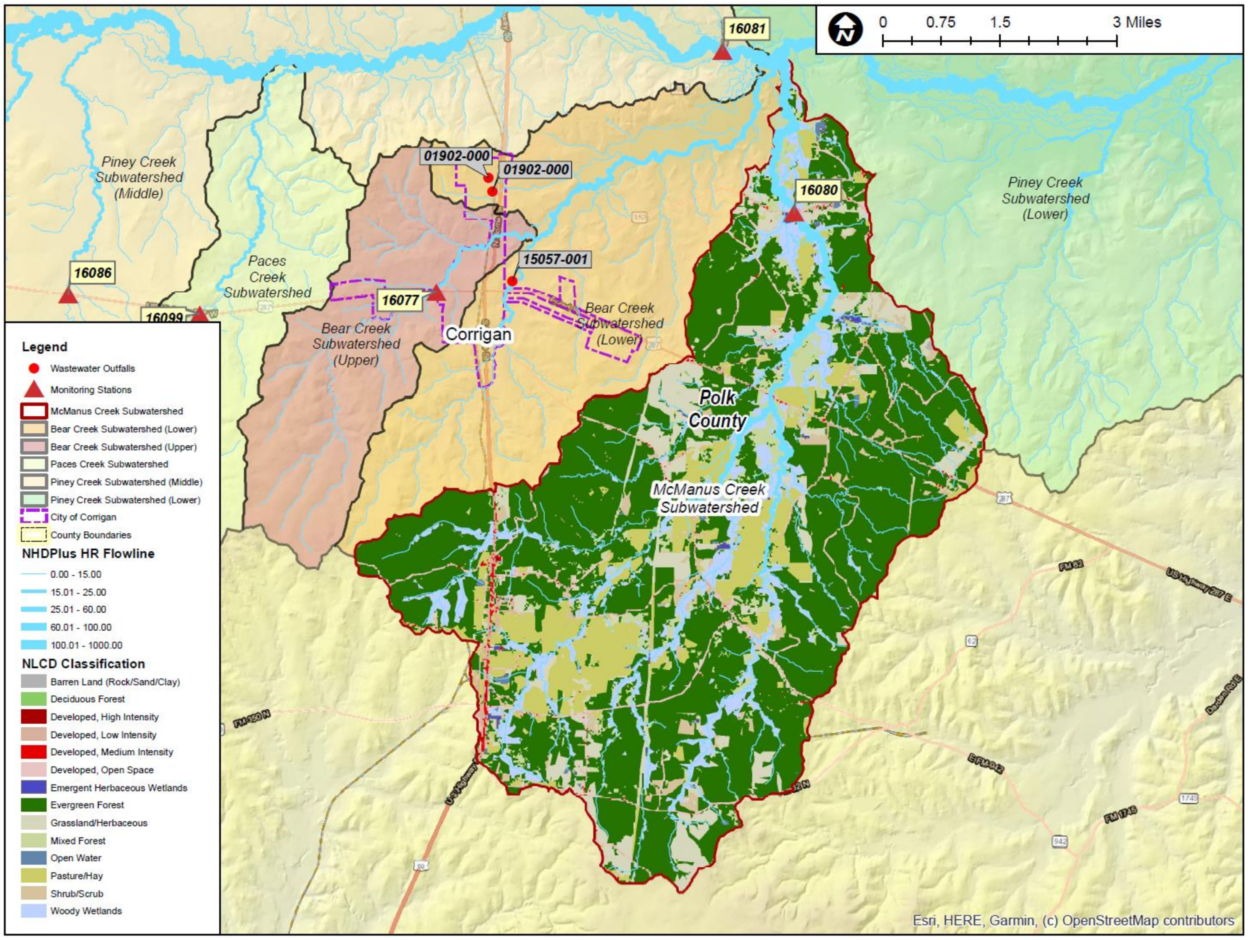


Figure 6.22. McManus Creek Subwatershed Imagery and Addresses Location Map.

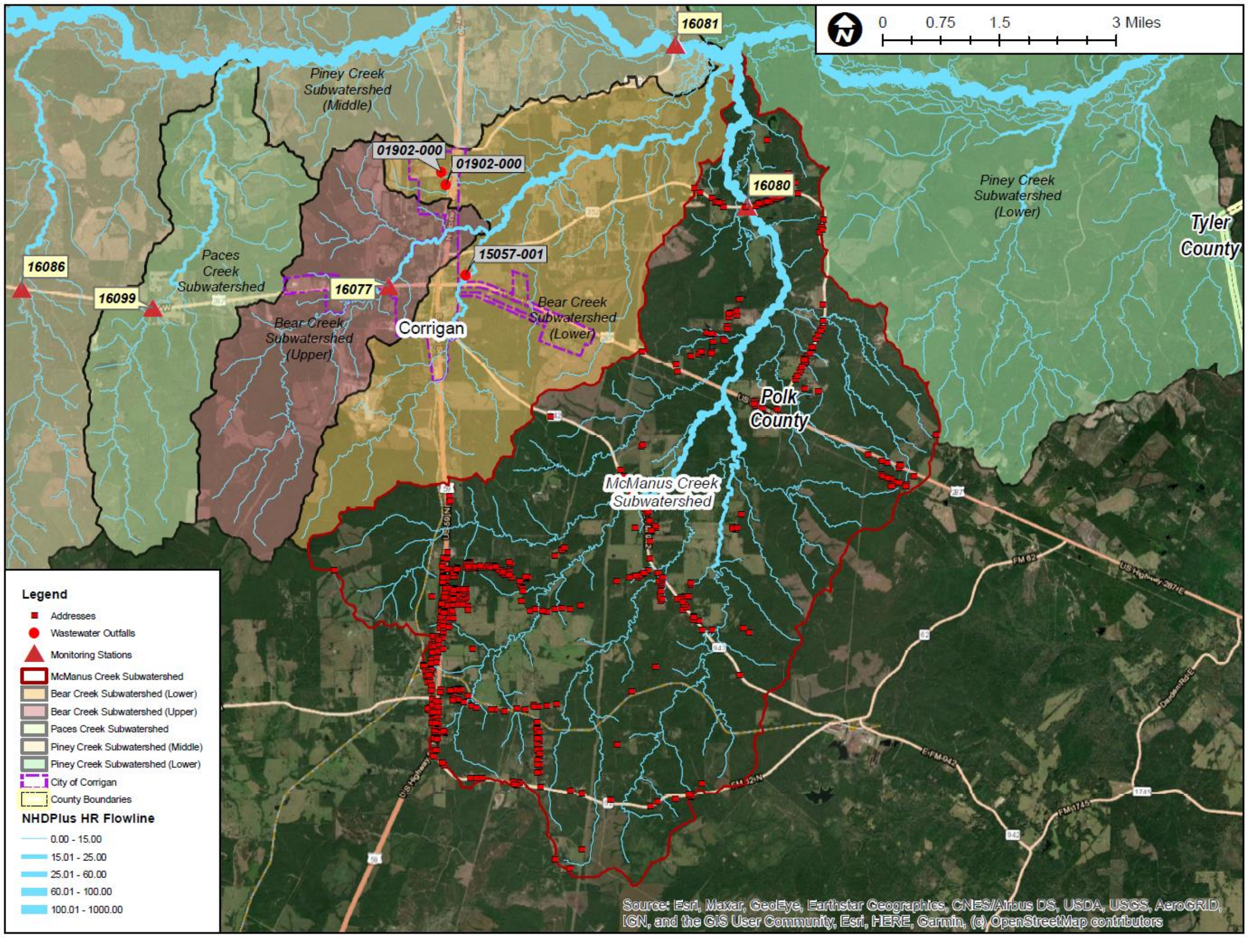
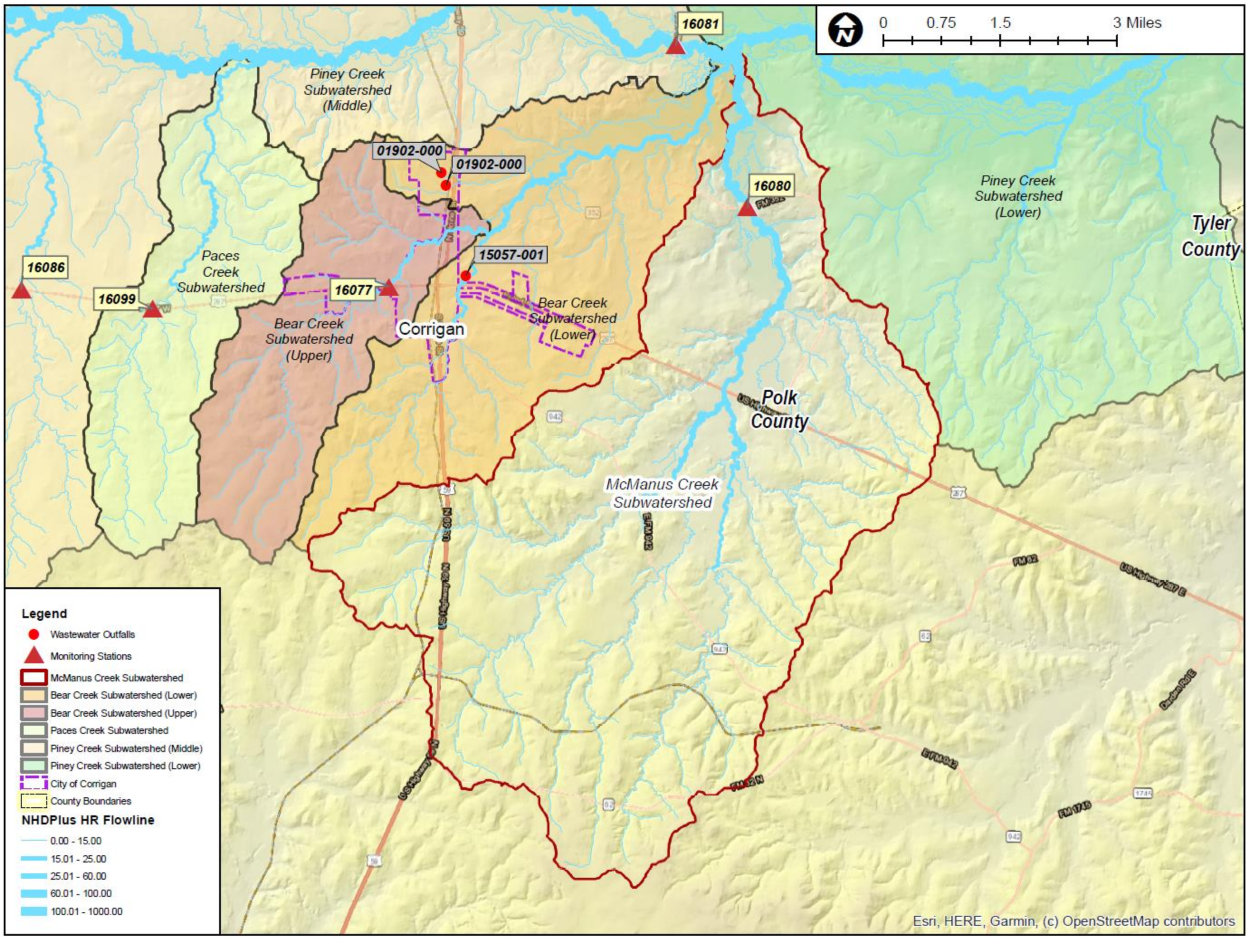
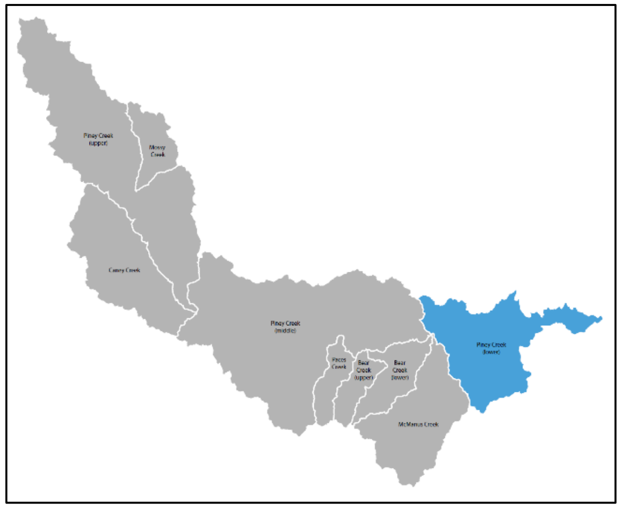


Figure 6.23. McManus Creek Subwatershed 2019 NLCD Land Use Land Cover (LULC) Map.



PINEY CREEK SUBWATERSHED (LOWER)

LAND USE LAND COVER (LULC)



The Piney Creek subwatershed (Lower) is approximately 29,547 acres and is mostly comprised of natural landscapes such as evergreen forests, woody wetlands, grasslands, and mixed forested area (about 93%), making it the least developed subwatershed in the entirety of the Piney Creek watershed (See Figure 6.24). Unlike the previously mentions subwatershed, the Piney Creek subwatershed (Lower) is the least densely populated area out of all the subwatersheds although it is one of the largest in the area. There are 96 households located in the subwatershed. Many of the households are scattered throughout the subwatershed located in rural areas with very few households located along the tributaries (See Figure 6.25). Because it is a large, rural area, impairments could be indicative of agricultural and wildlife runoff.

MONITORING STATIONS

There are no monitoring stations located the Piney Creek subwatershed (Lower). Data collected for Piney Creek is based off of stations previously mentioned in the Piney Creek Upper and Middle subwatershed sections.

NHDPLUS HR FLOWLINE

Piney Creek (AU 0604D_03) begins approximately five miles Northeast of the intersection of US-59 and US-287 in the City of Corrigan and has an estimated flow of 299.4 cfs (See Figure 6.26). Piney Creek AU 0604D_03 is a continuation of 0604D_01 and receives contributed flow from Bear Creek (about 55.6 cfs) and McManus Creek (about 79.1 cfs). After the McManus Creek confluence, the estimated flow of 0604D_03 is 350.7 cfs. Piney Creek (AU 0604D_03) has one of the largest networks of tributaries that contribute to the creek. At the final point of the creek prior to the Neches River confluence, Piney Creek has an estimated flow of 413.2 cfs.

Figure 6.24. Piney Creek Subwatershed (Lower) 2019 NLCD Land Use Land Cover (LULC) Map.

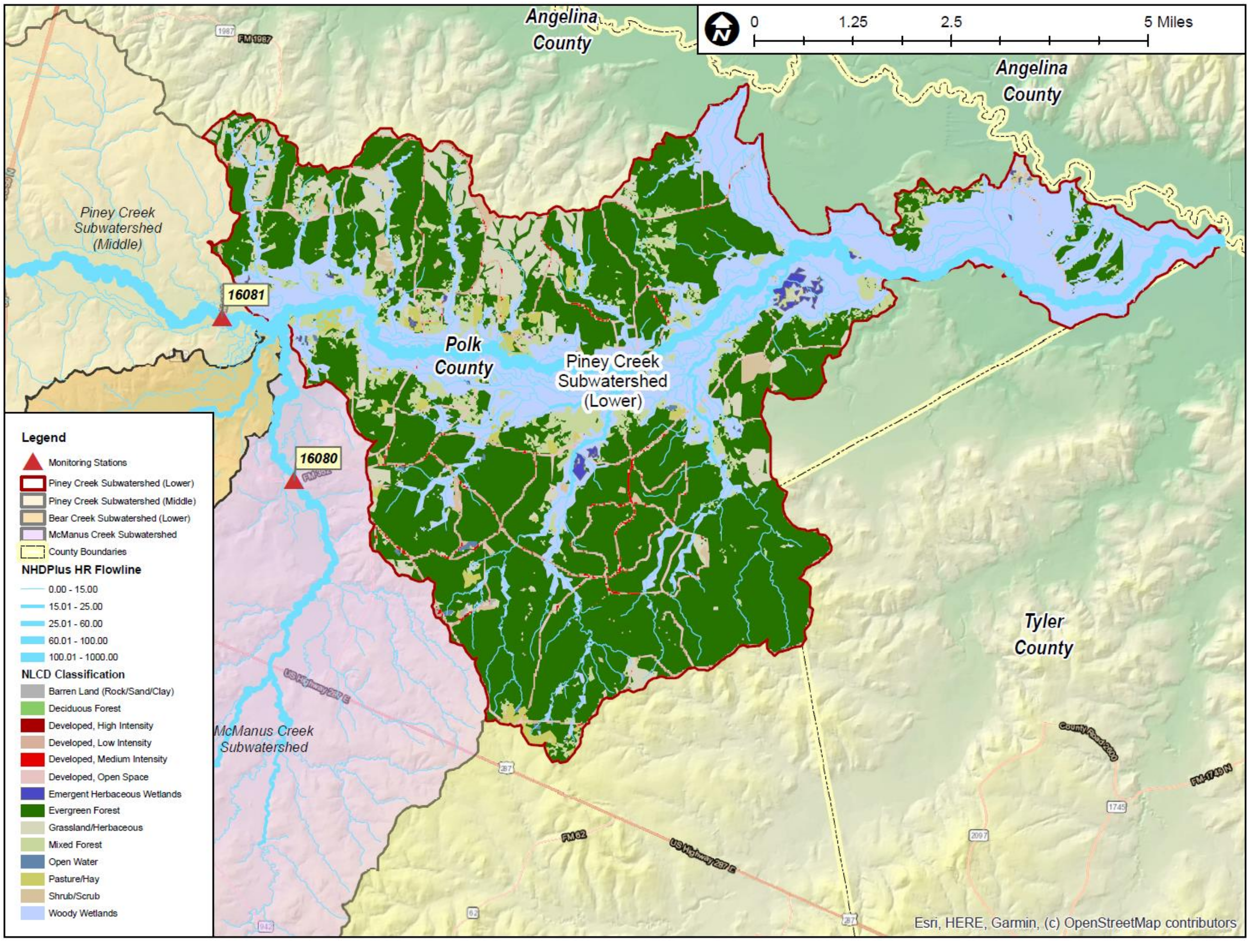


Figure 6.26. Piney Creek Subwatershed (Lower) Imagery and Addresses Location Map.

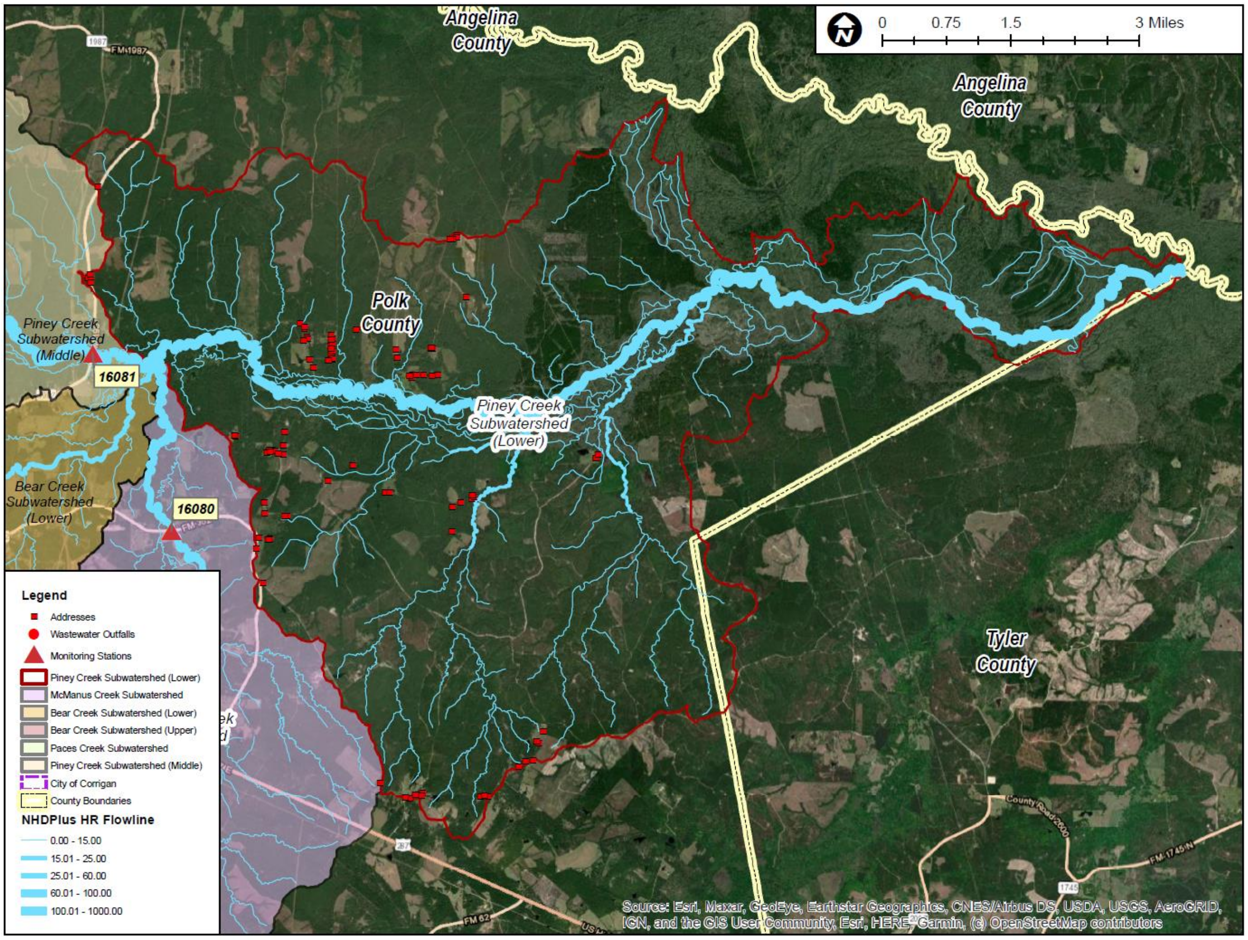
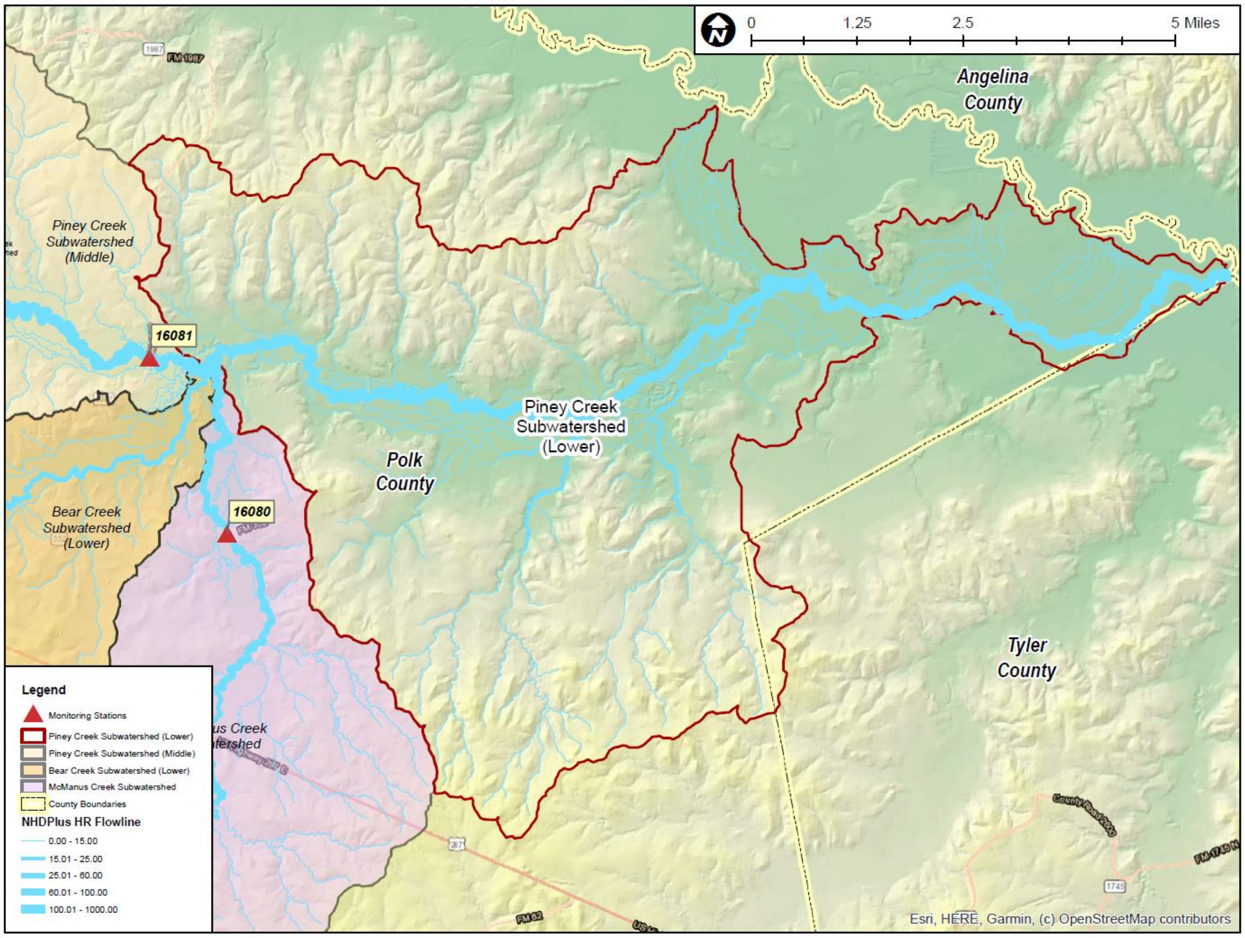


Figure 6.27. Piney Creek Subwatershed (Lower) NHDPlus HR Flowline Map.



7.0 POTENTIAL CAUSE OF WATER QUALITY ISSUE

Numerous potential sources of pollution, both point, and non-point, were identified in the Piney Creek Watershed. Further evaluation is needed to determine the sources of impairments and concerns within the watershed. Since a Recreational Use-Attainability Analysis (RUAA) has not been performed on this watershed, there is a possibility that the presumed standard for primary contact recreation may not be appropriate.

POINT SOURCE

The City of Corrigan and Georgia-Pacific Woods operate facilities that have discharge permits in the Piney Creek Watershed. Both facilities discharge into Bear Creek (Segment-0604L) and from there to Piney Creek (Segment-0604D). Factors like inflow and infiltration (I&I) or unauthorized discharges (UDs) may contribute to bacteria impairments but are likely improbable contributors due to the impairments at AU 0604D_02, located outside of the city limits. The City of Corrigan is located south of AU 0604D_03.

NON-POINT SOURCE

Agricultural – Based on aerial imagery most of the watershed land is covered in forested areas. Runoff from fields for cattle grazing is probable, but presumably causes minimal bacteria levels. However, dissolved oxygen (DO) levels could potentially be impaired for the concentration of nutrients. In addition, timber management and clear-felling could affect DO levels in the water. In addition, bacteria can be introduced from animal agricultural operations, such as cattle and/or poultry.

Wildlife – The East Texas Region has a variety of wildlife that may greatly contribute to water quality impairments. Wildlife species include wild pigs, white-tail deer, and migratory birds. Since there is an indirect source, it may be presumed that some of the bacterial impairments may be caused by wildlife.

Urban Runoff – Within the city limits of the City of Corrigan and City of Groveton, home and business located within the city limits may contribute impairments to the watershed. Factors such as failing wastewater lines or inadequate septic systems may be sources of bacteria

OSSF – Failing or non-existent OSSFs in the Piney Creek Watershed have not been identified, however, it is plausible that there are failing systems in the watershed, especially in more rural areas away from the cities and on major roads.

Pet Waste - Although minimal, runoff from domesticated animal feces may also be a potential source.

8.0 POTENTIAL STAKEHOLDERS

- Angelina & Neches River Authority
- Local Municipalities
    - City of Corrigan
    - City of Groveton
- Landowners
- Natural Resource Conservation Service
- Texas A&M AgriLife Extension
- Texas Commission on Environmental Quality
- Texas Department of Agriculture
- Texas Parks and Wildlife
- Texas Railroad Commission
- Texas State Soil and Water Conservation Board
- US Fish and Wildlife Service
- US Geological Survey

9.0 ONGOING PROJECTS

The TCEQ completed a UAA in 2019 and the results of that project are still in the process of approval. If approved, the DO minimum standard may be reduced from 3.0 mg/L to 2.0 mg/L and/or the Piney Creek Assessment Units may be divided into two, rather than three, to better address water quality impairments in distinct areas.

ANRA will continue to monitor for bacteria, conventional, and field parameters at Piney Creek at FM 358. Monitoring will be completed quarterly as a part of the CRP commitment.

10.0 RECOMMENDED ACTIONS

As mentioned in the previous section (9.0 Ongoing Projects), TCEQ's UAA conducted in 2019, gave insight into potential recommendations to improve water quality in the Piney Creek Watershed. ANRA reviewed the UAA and supports any potential recommendations/changes to be implemented.

Recommended actions include lowering DO standards in the watershed due to naturally occurring physical conditions. Conditions such as low flow can result in lower DO conditions. Additional actions include dividing the creek into two separate sections with distinct DO and aquatic life criteria. ANRA would agree to the recommended actions.

In addition, ANRA recommends continuing monitoring in Piney Creek and seeks to add additional or re-introduce historical monitoring sites to best narrow potential causes of water impairment. Additional sites, such as Piney Creek at US 59 could be beneficial for data collection of bacteriological and DO impairments.

11.0 MAJOR WATERSHED EVENTS

There are no known or anticipated occurrences that have had the potential to either positively or negatively impact the water quality (such as new/ amended permits, fish kills, flood/drought, implementing best management practices (BMPs), and/or land development.

12.0 OTHER WATER QUALITY-RELATED ACTIVITIES

Although not funded by the CRP, at any given time, ANRA partners with multiple organizations and government agencies on a multitude of Surface Water Quality-related projects in the Neches River Basin. These projects are typically funded in part by Clean Water Act funds from the EPA, as well as funds from the TCEQ, and the Texas State Soil and Water Conservation Board (TSSWCB).

These projects focus on bringing stakeholders in diverse watersheds together to address water quality issues. They include: data collection and interpretation, education and outreach, implementation of BMPs, assistance for low-income households, and more.

Surface water quality projects that ANRA is actively participating in or has recently participated in are listed below.

ATTOYAC BAYOU WPP IMPLEMENTATION – BMP EFFECTIVNESS MONITORING

The TSSWCB, TWRI, SFA, and ANRA are working together to perform monthly routine monitoring in the Attoyac Bayou Watershed and increase public education and outreach efforts. This series of projects initially began in 2013 after the Attoyac Bayou Watershed Protection Plan was completed. Water quality samples will be collected through August 2024.

SFA collects monthly samples at five sites within the watershed. ANRA's environmental laboratory analyzes the samples and sends the results to TWRI and TCEQ to determine the effectiveness of BMPs that have been put in place, under the guidance of the Attoyac WPP and also assesswater quality for the Integrated Report. Multiple educational events have been held in the area over the course of the project.

This project is funded by the TSSWCB through a CWA Section 139(h) grant from the EPA.

For further information about this project, contact:
Mr. Rene Barelas at ANRA (rbarelas@anra.org) or
Ms. Emily Monroe at TWRI (Emily.Monroe@ag.tamu.edu).

ATTOYAC BAYOU WPP IMPLEMENTATION – OSSF REMEDIATION

In conjunction with the TCEQ, TWRI, Pineywoods Resources Conservation & Development (RC&D), SFA, and ANRA, the Attoyac OSSF Remediation Project was created to replace/repair failing On-Site Sewage Facilities (OSSFs) within the Attoyac Bayou Watershed. In addition, outreach and education initiatives were created to educate residents on best practices related to owning and maintaining OSSFs. The Attoyac Bayou WPP identified failing or non-existent OSSFs as one of the leading contributors to lower water quality in the Attoyac Bayou watershed.

Like the Attoyac BMP Effectiveness Project discussed previously, this series of projects began in 2013. To date, more than 60 OSSFs have been repaired or replaced. The current project began in September of 2021, and is expected to replace or repair approximately 21 additional OSSFs.

This project is funded by TCEQ through a CWA Section 319(h) grant.

For further information about this project, contact:
Mr. Rene Barelas at ANRA (rbarelas@anra.org) or
Ms. Emily Monroe at TWRI (Emily.Monroe@ag.tamu.edu).

LA NANA BAYOU WATERSHED PROTECTION PLAN DEVELOPMENT

TCEQ, TWRI, and ANRA are working with local stakeholders including SFA and the City of Nacogdoches to develop a Watershed Protection Plan to address elevated bacteria levels in La Nana Bayou.

To date, four stakeholder meetings have been held and drafts of chapters 1-5 of the WPP have been shared for public comment.

The project will also host at least three educational events over the next several years while developing the WPP.

This project is funded by the TCEQ through a CWA, Section 319(h) grant from the EPA.

For further information about this project, contact:
Mr. Rene Barelas at ANRA (rbarelas@anra.org) or
Ms. Emily Monroe at TWRI (Emily.Monroe@ag.tamu.edu).

KICKAPOO CREEK WATERSHED PROTECTION PLAN

This project is in partnership with the Texas Institute for Applied Environmental Research (TIAER), TSSWCB, and ANRA to coordinate with local stakeholders to develop a WPP to achieve the needed pollutant load reductions in order for the creek to begin meeting state surface water quality standards. Routine monthly monitoring is already underway to further assess local water quality above Lake Palestine within the Kickapoo Creek (Segment 0605A). Several stakeholder meetings have already taken place to educate and assist stakeholders to how develop the WPP. The project began March 2021 and will continue through February 2023.

Project goals include providing stakeholders and agencies with the sufficient information needed to address the bacteria and dissolved oxygen impairments within Kickapoo Creek andto develop a database of existing water quality and land-use information to evaluate and characterize causes and sources of pollution for the segment.

This work is being funded via state funds provided by a State Nonpoint Source grant from TSSWCB.

For more information about this project, contact:
Mr. Rene Barelas (rbarelas@anra.org) or
Ms. Leah Taylor at TIAER (ltaylor@tarleton.edu).

ADDRESSING INDICATOR BACTERIA IMPAIRMENT IN THE AYISH BAYOU WATERSHED

This project,in partnership with TCEQ, TWRI, and ANRA, aims to collect and review existing data, evaluate data gaps that need to be filled, and begin contacting stakeholders to develop a plan to address water quality impairments in the Ayish Bayou. The project will continue through the end of FY 2022. A follow-up project in FY 2023 is proposed to collect additional water quality samples throughout the watershed and to continue informing and educating stakeholders. If approved, the follow-up project will begin September 1, 2022.

This project is funded by the TCEQ through the TMDL program.

For more information about this project, contact:
Mr. Rene Barelas (rbarelas@anra.org) or
Mr. Duncan Kikoyo Ahimbisibwe at TWRI (Duncan.ahimbisibwe@ag.tamu.edu).

ANGELINA WATERSHED CHARACTERIZATION

In mid-2021, the Angelina Watershed Characterization Project was completed.

The project was funded by the Texas State Soil and Water Conservation Board (TSSWCB) through a Clean Water Act, Section 319(h) grant from the EPA.

This project was a partnership between TSSWCB, TWRI, and ANRA. The goal for the project was to evaluate existing water quality and watershed data to identify and characterize potential sources of pollution in the watershed. The project began in May of 2017, and was originally intended to be completed in April of 2019, but was extended into 2021, to enable additional targeted monitoring on Mud and West Mud creeks.

From March 2018 to February 2019, TWRI and ANRA collected monthly water quality samples at nine monitoring sites. Routine field parameters were collected and water samples were analyzed by ANRA's Environmental Laboratory for E. coli bacteria, Ammonia-N, Nitrate-N, Nitrite-N, sulfate, chloride, total phosphorus, and total suspended solids.

The project extension provided an additional 12 months of monitoring on Mud and West Mud creeks (Stations 18302, 10538, 14477, and 10532) from March of 2020 through February of 2021. Stakeholder engagement and general education activities were also conducted through this project. These programs help raise stakeholder awareness of local water quality concerns and inform them of options to address these concerns moving forward.

A watershed characterization report was created using the data collected and is now available.

A followup project has been proposed with the goal of bringing stakeholders together to address the water quality impairments in the West Mud Creek portion of the watershed.

If approved, the follow-up project is expected to begin work in FY 2023.

For more information about this project, contact:
Mr. Rene Barelas (rbarelas@anra.org) or
Mr. Michael Schramm at TWRI (Michael.Schramm@ag.tamu.edu).

13.0 IMAGES

Photographs of upstream and downstream sections of Piney Creek at FM 358 were taken between 2010 and 2022. The images show different stream conditions throughout the years at this specific monitoring point (Monitoring Station 16096).

July 6, 2011: Piney Creek (upstream) during the 2011 drought.

November 3, 2011: The 2011 drought caused Piney Creek to dry up completely at times.

March 15, 2012: P The 2011 drought caused continued pooling at the site, even into the spring of 2012.

December 12, 2013: Water is present, but obvious damming has occurred.

November 3, 2015: Brush and litter cause continuous damming, which prohibits steady stream flow.

May 11, 2020: Damming prohibits normal flow,causing large areasd of pooling beneath the bridge.

February 9, 2022: The most recent monitoring event at Piney Creek at FM 358 showed signs of continued damming, flooding, and litter accumulation in area, and accurate flow measurements are challenging to obtain due to these conditions.

14.0 ADDITIONAL INFORMATION

CONTACT INFORMATION

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ANRA OPERATIONS

The Angelina & Neches River Authority promotes public involvement in the Upper Neches River Basin through numerous operations and departments. In addition to monitoring water quality through the Clean Rivers Program, ANRA operates and maintains numerous public drinking water and municipal wastewater facilities, maintains the on-site septic system program for Sam Rayburn Reservoir, San Augustine County, and Angelina County, and operates an Environmental Laboratory. Additionally, ANRA produces and sells biosolid compost at the Neches Compost Facility.

INFORMATIONAL LITERATURE

Numerous pamphlets, brochures, and other educational and informational literature on topics such as water quality, conservation, and on-site septic facilities are available to the public at ANRA's office.

ANRA PUBLICATIONS

Every year, ANRA's Clean Rivers Program produces either a Basin Highlights Report or Basin Summary Report (every third biennium) that discusses water quality in the Neches River Basin. These reports are distributed to our Steering Committee members, interested stakeholders, and other interested parties.

ANRA WEBSITE

The Angelina & Neches River Authority provides the public with information concerning water quality issues on our website, which is updated frequently. The ANRA website provides public access to information on the Clean Rivers Program, current and historical Basin Summary and Basin Highlights reports, meeting agendas and minutes, maps, and water quality data.

Please visit us online at http://www.anra.org.

2022 Upper Neches Basin Highlights Report

The 2022 Basin Highlights Report was prepared by the Angelina & Neches River Authority in cooperation with the Texas Commission on Environmental Quality (TCEQ) under the authorization of the Texas Clean Rivers Act.