BASIN HIGHLIGHTS REPORT

2024

For the Upper Portion of the Neches River Basin

Angelina & Neches River Authority

Watershed Characterization of

Sam Rayburn Reservoir & Lake Palestine

ANRA

Angelina & Neches River Authority

COVER PHOTOS:

FRONT: SAM RAYBURN RESERVOIR – NEAR DEER STAND CUTOFF, AUGUST 2021

BACK: SAM RAYBURN RESERVOIR – OPEN WATER NEAR SHIRLEY CREEK, AUGUST 2021

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 and middle portions of the Neches River Basin. This year, the report focuses on a watershed characterization of the Sam Rayburn Reservoir and Lake Palestine watersheds.

ANRA is one of the 15 program partners for the Texas Clean Rivers Program (CRP), which involves working directly with the TCEQ to conduct water quality monitoring, assessment, and stakeholder outreach in the 23 major river and coastal basins of Texas.

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 comprehensive characterizations of two watersheds within the basin: Sam Rayburn Reservoir and Lake Palestine watersheds.

2024 Basin Highlights Report for the Upper and Middle Portions of the Neches River Basin

TABLE OF CONTENTS

GLOSSARY

Ac	Acre
Ac-ft	Acre-Feet
ALU	Aquatic Life Use
ANRA	Angelina & Neches River Authority
AU	Assessment Unit
BMP	Best Management Practices
CARRI	Center for Applied Research and Rural Innovation
cfs	Cubic Feet per Second
Chl-α	Chlorophyll-α
CRP	Clean Rivers Program
CS	Concern for Screening Level
CWA	Clean Water Act
DO	Dissolved Oxygen
DWS	Domestic Water Supply
DWU	Dallas Water Utilities
EPA	Environmental Protection Agency
EROMMA	Extended Unit Runoff Method Mean Annual
FM	Farm to Market Road
ft	Feet
FY	Fiscal Year
HWY	Highway
ID	Identification Number
IR	Integrated Report
Km	Kilometer
LNVA	Lower Neches Valley Authority
mg/L	Milligrams per Liter
MGD	Millions of Gallons per Day
msl	Mean Sea Level
NCR	Non-Contact Recreation
NELAP	National Environmental Laboratory Accreditation Program
NHDPlus	National Hydrography Dataset Plus
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NR	Near
NRCD	Neches River Conservation District
NRCS	Natural Resources Conservation Service
OSSF	On Site Sewage Facility
PCR	Primary Contact Recreation
PS	Public Supply
RC&D	Resource Conservation and Development

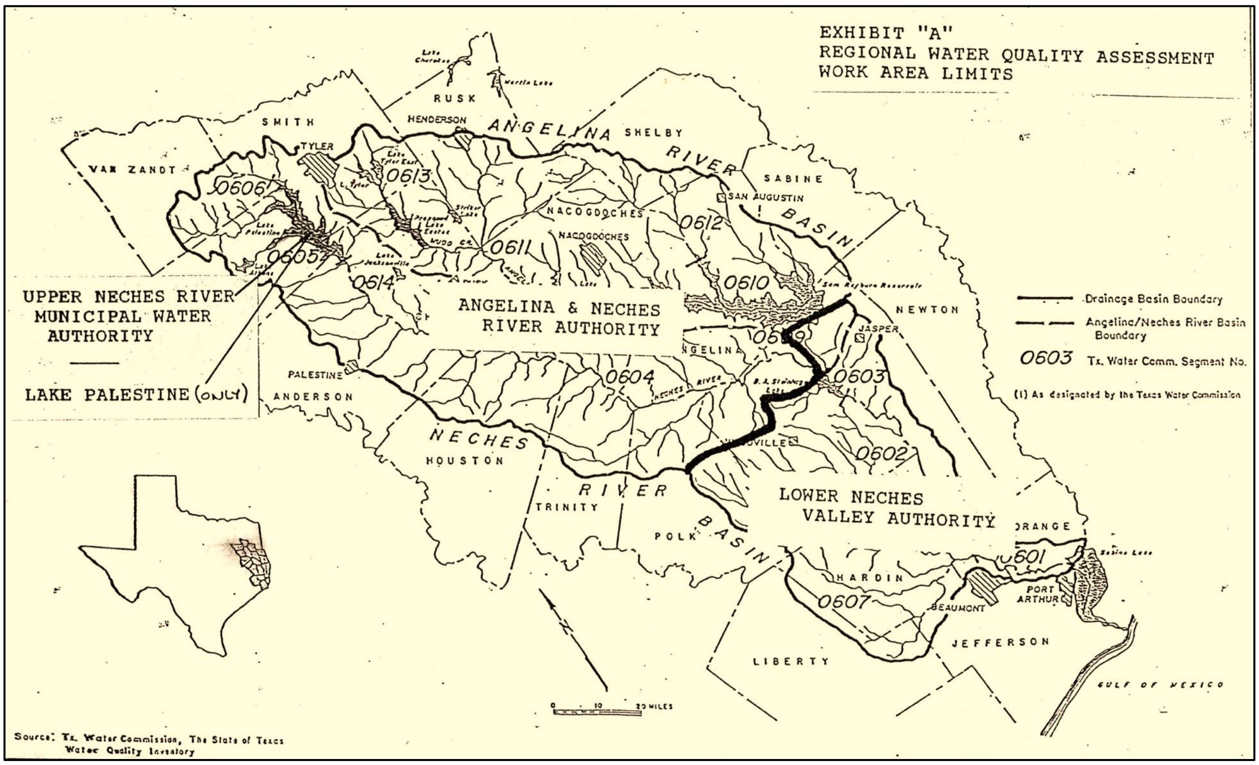
GLOSSARY (CONTINUED)

RU	Recreation Use
RUAA	Recreational Use Attainability Analysis
SB	Senate Bill
SCR	Secondary Contact Recreation
SFA	Stephen F. Austin State University
SH	State Highway
SNCD	Sabine-Neches Conservation District
Sq Mi	Square Miles
SS	Sole Source
SWQM	Surface Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality
TIAER	Texas Institute for Applied Environmental Research
TMDL	Total Maximum Daily Load
TPWD	Texas Parks and Wildlife Department
TRWD	Tarrant Regional Water District
TSI	Trophic Status Index
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
TxDSHS	Texas Department of State Health Services
µg/L	Micrograms per Liter
UNRMWA	Upper Neches River Municipal Water Authority
UNT	Unnamed Tributary
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WPP	Watershed Protection Plan
WS	Watershed
WWTP	Wastewater Treatment Plant

INTRODUCTION

ABOUT THE CLEAN RIVERS PROGRAM

The Texas Clean Rivers Program (CRP) began in 1991 after Texas lawmakers passed the Texas Clean Rivers Act, which requires ongoing water quality monitoring and assessments in every major river basin in Texas. For the Neches River Basin, responsibility for monitoring and assessment was initially shared between the Angelina & Neches River Authority (ANRA), the Lower Neches Valley Authority (LNVA), and the Upper Neches Municipal Water Authority (UNRMWA.)

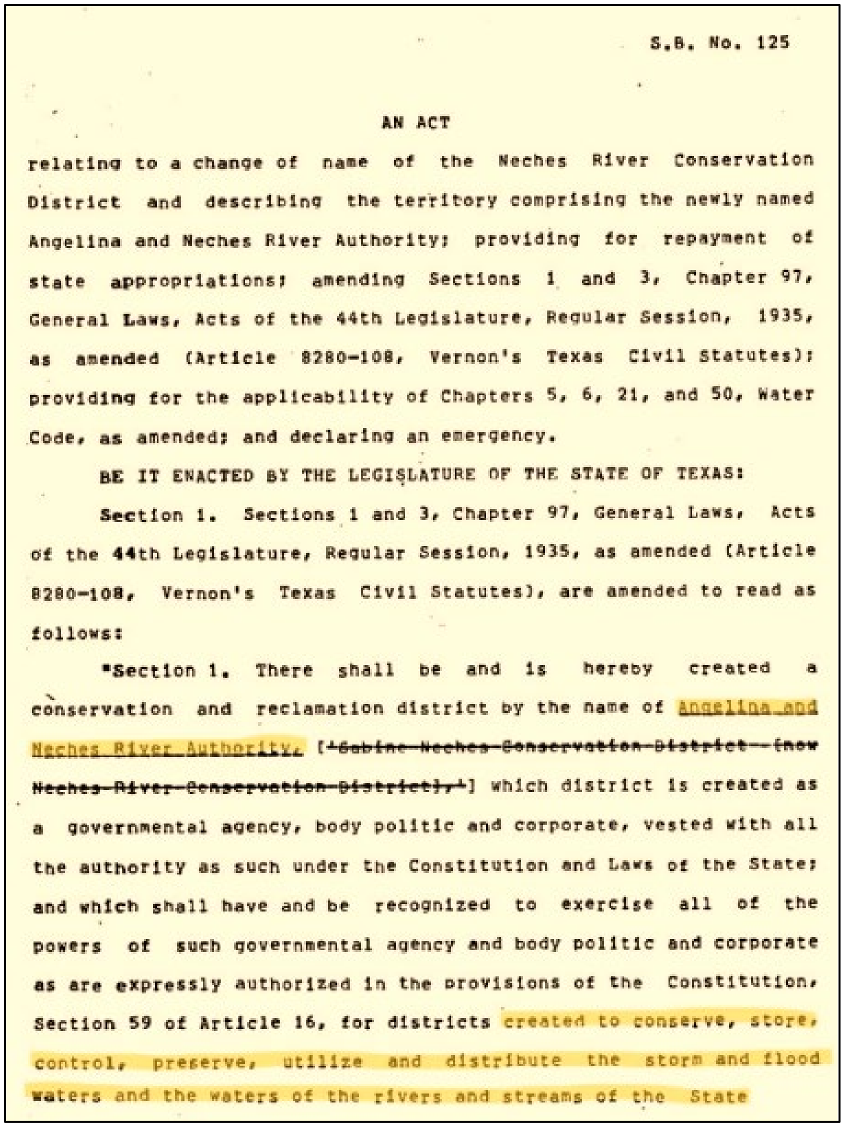


AN EARLY MAP SHOWING THE DIVISION OF CRP WORK AREAS WITHIN THE NECHES RIVER BASIN

Today, CRP consists of TCEQ and 15 partner agencies who collect water quality data at over 1,800 sites across the 23 river and coastal basins in Texas. This program aims at identifying water quality issues, creating plans to remediate these issues, and then executing those plans. Throughout the process, a major emphasis is placed on involving the public and other local entities. The public's input is paramount as circumstances are unique in each in every watershed, which in turn calls for watershed planning to be catered to those unique circumstances.

ABOUT THE ANGELINA & NECHES RIVER AUTHORITY

The Angelina & Neches River Authority started as part of the Sabine-Neches Conservation District (SNCD), which was formed in 1935 by the Texas Legislature. In 1949, the SNCD was split by the legislature into the Sabine River Authority of Texas, and the Neches River Conservation District (NRCD). Following their reorganization in 1950, activity fluctuated over the next two decades, with little activity recorded after 1966. However, in 1971, Texas Governor Preston Smith appointed nine members to the NRCD Board of Directors. Following this, the NRCD became consistently active. The NRCD soon began offering water and wastewater utility operational assistance, sample collection, and lab testing services. Later, in 1977, the NRCD was renamed the Angelina & Neches River Authority. Despite all of the name changes, <u>the mission of the authority has remained the same</u>: **to conserve, store, control, preserve, utilize, and distribute the water, floodwater, and the waters of the rivers and streams of the state in the Neches Basin for the benefit of the human environment and the natural environment**.



S.B. No. 125

AN ACT

relating to a change of name of the Neches River Conservation District and describing the territory comprising the newly named Angelina and Neches River Authority; providing for repayment of state appropriations; amending Sections 1 and 3, Chapter 97, General Laws, Acts of the 44th Legislature, Regular Session, 1935, as amended (Article 8280-108, Vernon's Texas Civil Statutes); providing for the applicability of Chapters 5, 6, 21, and 50, Water Code, as amended; and declaring an emergency.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF TEXAS:

Section 1. Sections 1 and 3, Chapter 97, General Laws, Acts of the 44th Legislature, Regular Session, 1935, as amended (Article 8280-108, Vernon's Texas Civil Statutes), are amended to read as follows:

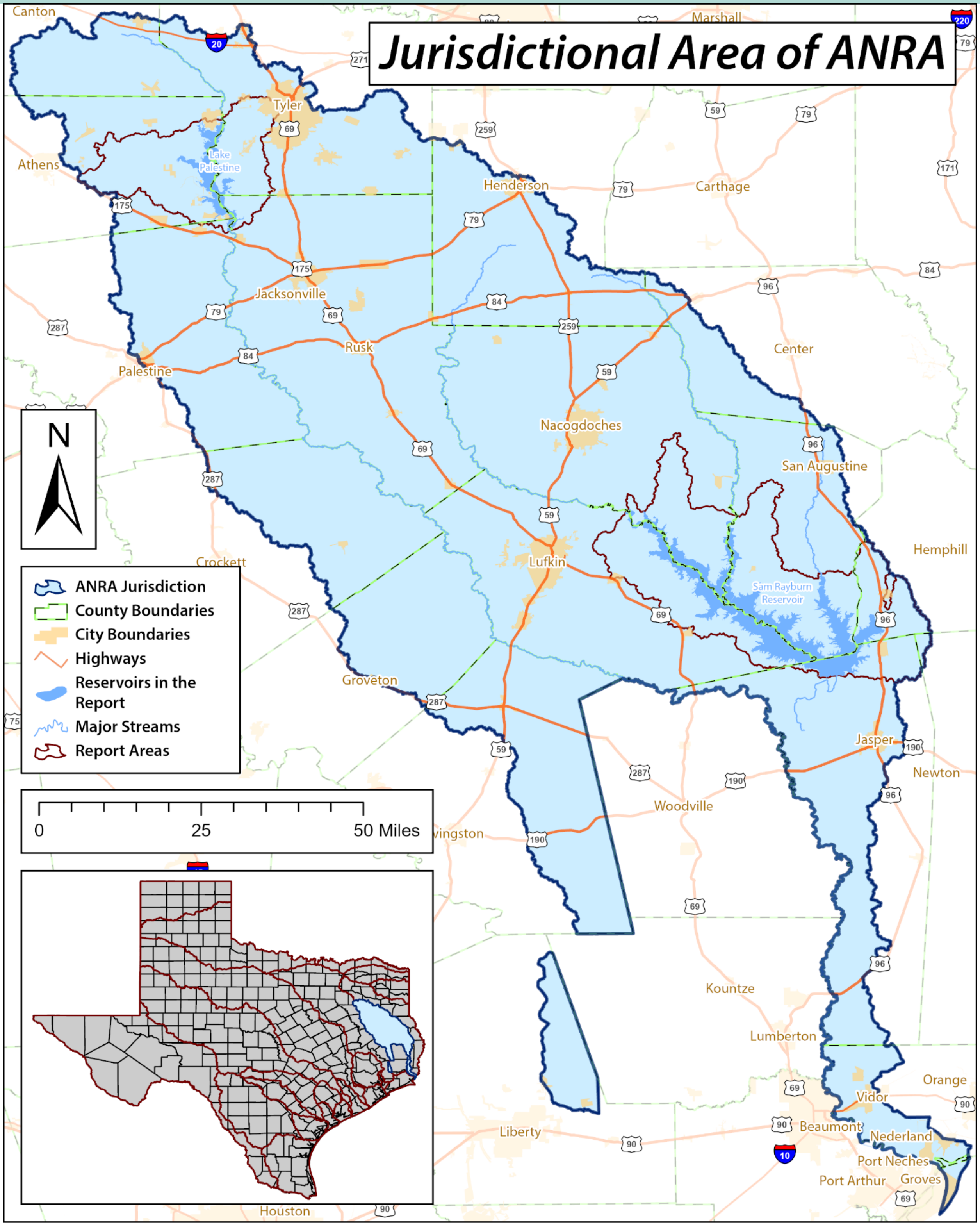
"Section 1. There shall be and is hereby created a conservation and reclamation district by the name of <u>Angelina and Neches River Authority</u>, [~~"Sabine-Neches Conservation District" (now Neches River Conservation District),~~"] which district is created as a governmental agency, body politic and corporate, vested with all the authority as such under the Constitution and Laws of the State; and which shall have and be recognized to exercise all of the powers of such governmental agency and body politic and corporate as are expressly authorized in the provisions of the Constitution, Section 59 of Article 16, for districts created to conserve, store, control, preserve, utilize and distribute the storm and flood waters and the waters of the rivers and streams of the State

EXCERPT OF SB 125, A PORTION OF ANRA'S ENABLING LEGISLATION

THE AUTHORITY TODAY

ANRA operates multiple water and wastewater utilities, a National Environmental Laboratory Accreditation Program (NELAP) certified environmental laboratory, a biosolids composting facility, and an On-Site Sewage Facility (OSSF) permitting and licensing program. The Authority also participates in multiple Clean Water Act (CWA) projects and is the Clean Rivers Program partner for the Upper and Middle Neches River Basin. ANRA's central office and environmental laboratory are located in Lufkin, Texas. The Authority's 8,500 square mile jurisdiction lies wholly or partially in these counties: Anderson, Angelina, Cherokee, Henderson, Houston, Jasper, Liberty, Nacogdoches, Newton, Orange, Polk, Rusk, Sabine, San Augustine, Shelby, Smith, and Trinity.

ANGELINA & NECHES RIVER AUTHORITY JURISDICTIONAL AREA



ABOUT THE REPORT

As part of its CRP responsibilities, every year ANRA produces a Basin Highlights Report. To avoid redundant reports, the style of the report changes each year on a six-year revolving cycle. Last year's report was in the Standard Report format, this report follows the Watershed Characterization Report format. The Watershed Characterization format involves an analysis of a watershed by providing information on: current segments, hydrologic properties, impairments and concerns, land use, potential causes of impairments, potential stakeholders, recommendations for improving water quality, ongoing projects, maps, major watershed events, and more. This is accomplished by reviewing data, mapping land use, tracking various watershed events, and gathering information from stakeholders with the intended goal of describing potential sources of water quality issues.

The main goal of this report is to characterize the Sam Rayburn Reservoir and Lake Palestine watersheds using the methods mentioned above. Also found in this report will be updates to Clean Rivers Program activities and efforts in the upper and middle Neches Basin since the previous report's release. Many of the watersheds upstream of the report areas have been part of recent CWA projects, and as such have either already been characterized, or are currently being studied. To avoid duplication of effort, this report will focus on the report areas shown on the previous page. The "Status of Upstream Segments" subsections of this report give brief information on CWA projects.

A BALD EAGLE PERCHED ON A TREE STUMP IN THE MIDDLE OF SAM RAYBURN RESERVOIR

Sam Rayburn Reservoir and Lake Palestine are the two largest impoundments of water on the Angelina and Neches Rivers, respectively. Sam Rayburn Reservoir is also the largest reservoir wholly within Texas. These two lakes inundate over 140,000 acres combined across portions of nine counties in east Texas. Their watersheds cover a total area of just over 1,000 square miles and are home to nearly 65,000 people.
These two watersheds face similar water quality issues:

- Excessive algal growth, high pH, and elevated mercury levels in fish tissue impairments in the reservoirs
- Elevated levels of iron and manganese in sediment concerns in the reservoirs
- Bacteria and low dissolved oxygen impairments in the tributaries of the reservoirs

INTRODUCTION TO THE TEXAS SURFACE WATER QUALITY STANDARDS

The TCEQ sets and implements standards for surface water quality in Texas. These narrative and numeric standards are designed to maintain and protect water quality in Texas to ensure human and ecologic health. The Federal Clean Water Act requires states to create and maintain water quality standards using the most recent scientific knowledge.

DESIGNATED USES OF WATER BODIES AND THEIR STANDARDS

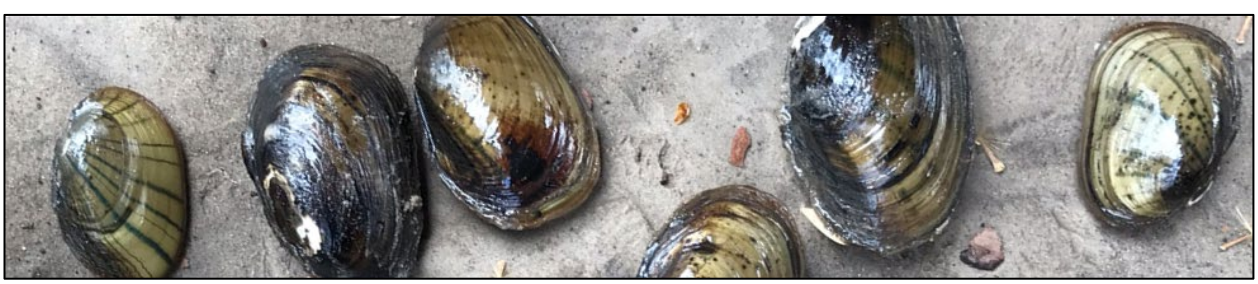
Designated uses are specific uses assigned to water bodies by the TCEQ. These designated uses are associated with sets of water quality standards, which usually end up being more stringent than general criteria. Designated uses include things like recreation, aquatic life, and domestic water supply. Most of these uses involve consuming water, consuming things from the water, or having the possibility of consuming water which is why standards for water bodies with designated uses are generally higher than normal. The Aquatic Life, Recreation, and Domestic Water Supply uses are specifically listed in the Texas Surface Water Quality Standards (TSWQS) Chapter 307, §307.7. In this section, there are also additional criteria and uses listed, which are more general in nature.

AQUATIC LIFE USE

Aquatic Life Use is based on the habitat the water body provides and the amount of ecologic diversity it has. These are defined in the TSWQS Ch. 307, §307.7

AQUATIC LIFE USE CATEGORIES

Category	Mean/ Min. DO (mg/L)	Mean/ Min. DO (mg/L) (Spring)	Habitat Character-istics	Species Assemblage	Sensitive Species	Diversity	Species Richness	Trophic Structure
Exceptional	6.0/4.0	6.0/5.0	Outstanding natural variability	Exceptional or unusual	Abundant	Exceptio-nally high	Exceptio-nally high	Balanced
High	5.0/3.0	5.5/4.5	Highly diverse	Usual association of regionally expected species	Present	High	High	Balanced to slightly imbalanced
Intermediate	4.0/3.0	5.0/4.0	Moderately diverse	Some expected species	Very low in abundance	Moderate	Moderate	Moderately imbalanced
Limited	3.0/2.0	4.0/3.0	Uniform	Most regionally expected species	Absent	Low	Low	Severely imbalanced
Minimal	2.0/1.5	-	-	-	-	-	-	-



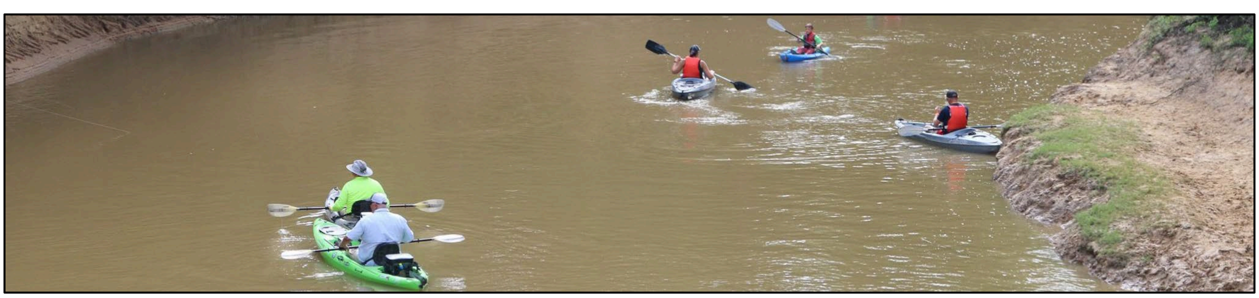
FRESHWATER MUSSELS FOUND IN THE NECHES BASIN

RECREATION USE

Recreation involves many of the typical things one would think of when going in the water, such as swimming, wading, or boating. There are multiple classes of recreation that are based on how likely a person is to ingest water while recreating. These are defined in the TSWQS Ch. 307, §307.7.

RECREATION USE CATEGORIES

Category	TCEQ Descriptions for Recreation Use Categories	Geometric Mean Criterion: *E. Coli* per 100mL	Single Sample Criterion: *E. Coli* per 100mL
Primary Contact Recreation 1 (PCR 1)	Activities that are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, handfishing as defined by Texas Parks and Wildlife Code, §66.115, and the following whitewater activities: kayaking, canoeing, and rafting).	126	399
Primary Contact Recreation 2 (PCR 2)	Water recreation activities, such as wading by children, swimming, water skiing, diving, tubing, surfing, handfishing as defined by Texas Parks and Wildlife Code, §66.115, and whitewater kayaking, canoeing, and rafting, that involve a significant risk of ingestion of water but that occur less frequently than for primary contact recreation 1 due to: (A) physical characteristics of the water body; or (B) limited public access.	206	-
Secondary Contact Recreation 1 (SCR 1)	Activities that commonly occur but have limited body contact incidental to shoreline activity (e.g. fishing, canoeing, kayaking, rafting, and motor boating). These activities are presumed to pose a less significant risk of water ingestion than primary contact recreation 1 or 2 but more than secondary contact recreation 2.	630	-
Secondary Contact Recreation 2 (SCR 2)	Activities with limited body contact incidental to shoreline activity (e.g. fishing, canoeing, kayaking, rafting, and motor boating) that are presumed to pose a less significant risk of water ingestion than secondary contact recreation 1. These activities occur less frequently than secondary contact recreation 1 due to the physical characteristics of the water body or limited public access.	1,030	-
Non-Contact Recreation (NCR)	Activities that do not involve a significant risk of water ingestion, such as those with limited body contact incidental to shoreline activity, including, birding, hiking, and biking. Noncontact recreation may also be assigned where primary and secondary contact recreation activities should not occur because of unsafe conditions, such as ship and barge traffic.	2,060	-



PEOPLE KAYAKING DOWN THE NECHES RIVER

DOMESTIC WATER SUPPLY USE

Domestic water supply use is for municipalities or other entities to take water from water bodies to treat and use for drinking water. These are defined in the TSWQS Ch. 307, §307.7.

The categories are:

- Public Supply
- Sole Source Supply
- Aquifer Protection

These three categories have drinking water standards for radioactivity associated with dissolved minerals, toxic material concentrations, and chemical and microbiological quality of surface waters defined in Ch. 290 of the TSWQS.

A WASTEWATER TREATMENT PLANT

ADDITIONAL CRITERIA

These are the additional criteria outlined in the TSWQS:

- Chemical Parameters: Site-specific criteria for chloride, sulfate, and total dissolved solids based on averages over an annual period
- pH: Site-specific numerical criteria based on absolute minima and maxima
- Temperature: Site-specific criteria based on an absolute maxima
- Toxic Materials: Criteria based on values established in §307.6 of the TSWQS
- Nutrients: Site-specific numeric and narrative criteria for reservoirs are established in §307.10, Appendix F

ADDITIONAL USES

These uses are somewhat broader in scope, for things like navigation, agricultural/industrial water supply, wetlands, etc. which should be maintained and protected as well according to the TSWQS.

IMPAIRMENTS

A water body is considered impaired when it does not meet state standards for its designated uses. TCEQ assigns water bodies with the categories seen below based on the data available. In even-numbered years, the TCEQ uses data collected during the preceding seven years to assess the water bodies in the state.

IMPAIRMENT CATEGORIES

Category	Description
1	Attaining all water quality standards and no use is threatened.
2	Attaining some water quality standards and no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.
3	Insufficient data and information are available to determine if any water quality standard is attained.
4	Water quality standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.
4a	TMDL has been completed and approved by EPA.
4b	Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.
4c	Nonsupport of the water quality standard is not caused by a pollutant.
5	The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.
5a	A TMDL is underway, scheduled, or will be scheduled.
5b	A review of the water quality standards for the water body will be conducted before a TMDL is scheduled.
5c	Additional data and information will be collected before a TMDL is scheduled.
5n	Water body does not meet its applicable Chl α criterion, but additional study is needed to verify whether exceedance is associated with causal nutrient parameters or impacts to response variables.
5r*	A WPP covering this region is being developed or has been approved by the EPA

**The new 5r category is discussed in depth in the Clean Rivers Program Updates section near the end of the report.*

THE RIVERINE PORTION OF SAM RAYBURN RESERVOIR

DESIGNATED USES, STANDARDS, AND IMPAIRMENTS OF SAM RAYBURN AND LAKE PALESTINE

DESIGNATED USES ASSIGNED TO SAM RAYBURN RESERVOIR AND LAKE PALESTINE

Both of these reservoirs have the same assigned Designated Uses, although Sam Rayburn Reservoir is also considered a Sole Source Supply in addition to its Public Supply use.

ID	Name	Domestic Water Supply	Recreation	Aquatic Life
605	Lake Palestine	Public Supply	PCR 1	High
610	Sam Rayburn Reservoir	Public Supply, Sole Source Supply	PCR 1	High

ADDITIONAL CRITERIA APPLIED TO SAM RAYBURN RESERVOIR AND LAKE PALESTINE

The table below outlines the numeric criteria in place for these two reservoirs. Site-specific chlorophyll-α values have been an ongoing development since 2001. By 2010, TCEQ adopted nutrient criteria for 75 reservoirs, including Lake Palestine and Sam Rayburn Reservoir. Out of the 75, the EPA approved chlorophyll-α criteria for 39 reservoirs in 2013. Of the 39, Sam Rayburn Reservoir's chlorophyll-α criterion of 6.22 µg/L was approved. For Lake Palestine, its criterion of 27.34 µg/L was not approved by the EPA, and so it remains at the narrative criteria of 24.29 µg/L.

SITE-SPECIFIC CRITERIA FOR SAM RAYBURN RESERVOIR AND LAKE PALESTINE

ID	Name	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	DO (mg/L)	pH (SU)	*E. Coli* (CFU)	Temp (°f)	Chlorophyll -a (µg/L)
605	Lake Palestine	50	50	200	5.0	6.5 – 9.0	126	90	26.7*
610	Sam Rayburn Reservoir	100	100	400	5.0	6.0 - 8.5	126	93	6.22

**General screening level*

SAM RAYBURN RESERVOIR IMPAIRMENTS

Impairment Description	Assessment Units Listed	Impairment Category	Year First Listed
Excessive algal growth in water	All Assessment Units	5n	2022
Dioxin in edible tissue	All Assessment Units	5a	2014
Mercury in edible tissue	All Assessment Units	5c	1996
pH (high)	AU 05 (Lower Attoyac Bayou Arm)	5c	2022

SAM RAYBURN RESERVOIR CONCERNS

Concern Description	Assessment Units Listed	Level of Concern
Iron in sediment	All Assessment Units	CS
Mercury in edible tissue	All Assessment Units	CS
Manganese in sediment*	All Assessment Units	CS

**This Concern was listed in the 2022 IR, but not the Draft 2024 IR. It has been a concern from 2006-2022.*

LAKE PALESTINE IMPAIRMENTS

Impairment Description	Assessment Units Listed	Impairment Category	Year First Listed
pH (high)	All Assessment Units	5b	2006

LAKE PALESTINE CONCERNS

Concern Description	Assessment Units Listed	Level of Concern
Manganese in sediment	All Assessment Units	CS
Depressed Dissolved Oxygen in Water	AU 01 (Main Pool/Dam)	CS
Excessive algal growth*	All Assessment Units	CS

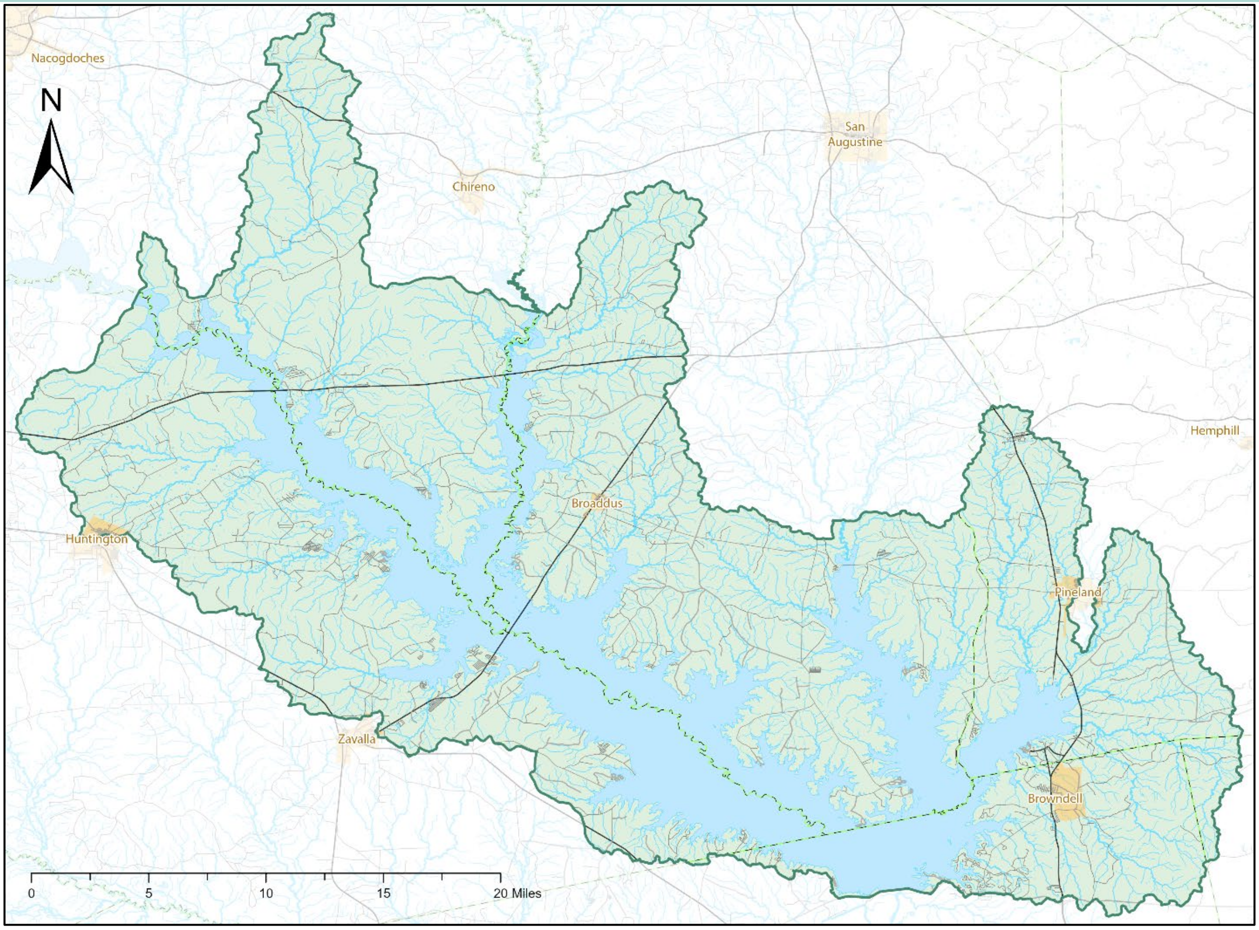
**This concern was listed in the 2022 IR, but not the Draft 2024 IR. This is a newer type of concern, but chlorophyll-α concerns, which are related, have been present in this reservoir from 2008-2014.*

GEOGRAPHIC FEATURES OF THE WATERSHEDS

The following several pages have been laid out in such a way that the reader can compare and contrast different features of these two watersheds. These first six maps will depict the location, size, population, and land use of these two watersheds.

AN AERIAL VIEW OF A PORTION OF SAM RAYBURN RESERVOIR

GEOGRAPHY – SAM RAYBURN RESERVOIR WATERSHED

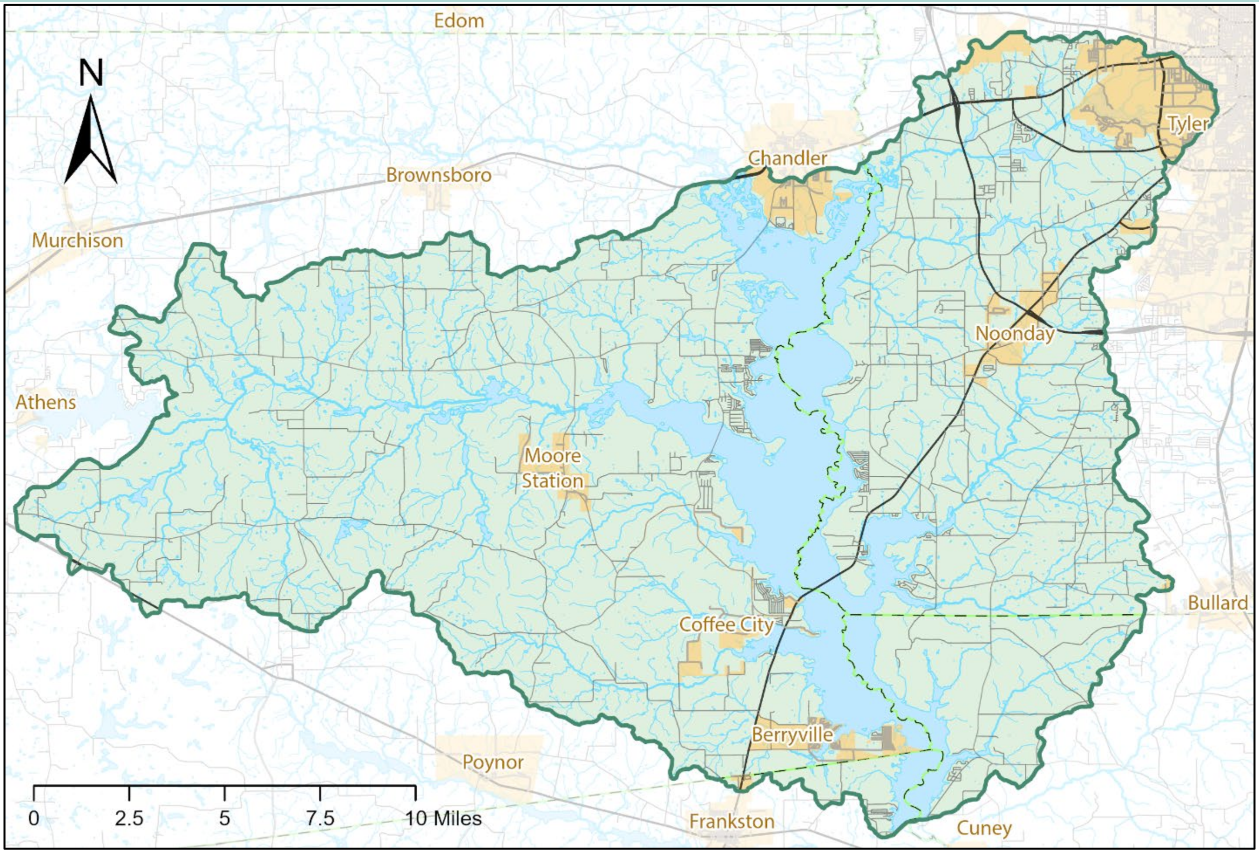


GEOGRAPHIC INFORMATION – SAM RAYBURN RESERVOIR

County	County Area (Sq Mi)	County Area in Watershed (Sq Mi)	Percentage of County within Watershed
Angelina	865	206.70	23.90%
Jasper	970	69.70	7.19%
Nacogdoches	981	142.47	14.52%
Newton	940	6.41	0.68%
Sabine	576	89.59	15.55%
San Augustine	593	245.60	41.42%
Total Square Miles of Watershed	-	**760.47**	-

Sam Rayburn Reservoir Watershed is within portions of six counties, including Angelina, Jasper, Nacogdoches, Newton, Sabine, and San Augustine. The watershed covers an area of 760.47 square miles, with 29.3% of that area being inundated by the reservoir, which has a surface area of 222.97 square miles. Notice that the Sam Rayburn Reservoir is nearly 2.5 times larger than the Lake Palestine Watershed. Cities in this region are geographically separated, and are relatively small.

GEOGRAPHY – LAKE PALESTINE WATERSHED

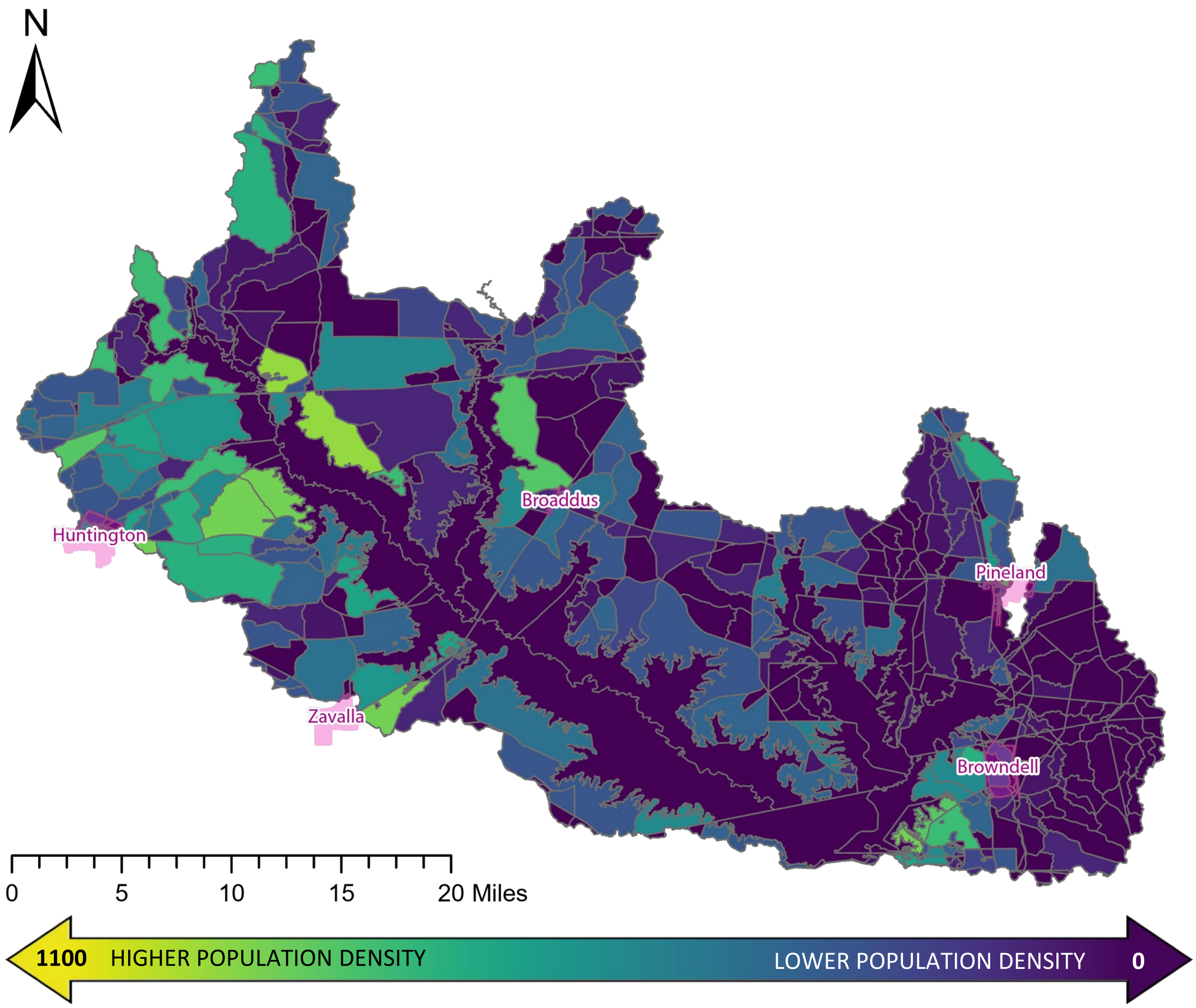


GEOGRAPHIC INFORMATION – LAKE PALESTINE

County	Total Area (Sq Mi)	County Area in Watershed (Sq Mi)	Percentage of County within Watershed
Anderson	1078	4.2	0.39%
Cherokee	1062	20	1.87%
Henderson	949	183	19.29%
Smith	950	99	10.44%
Total Square Miles of Watershed	**-**	**306.20**	**-**

The Lake Palestine Watershed is within portions of four counties: Anderson, Cherokee, Henderson, and Smith. The watershed covers an area of 306.20 square miles, 13% of which is inundated by Lake Palestine which has a surface area of 39.94 square miles. Again, note that this is a much smaller watershed compared to the Sam Rayburn Reservoir Watershed. Cities in this watershed are closer to one another, and the major city of Tyler is expanding toward the lake over time.

POPULATION DISTRIBUTION – SAM RAYBURN RESERVOIR WATERSHED



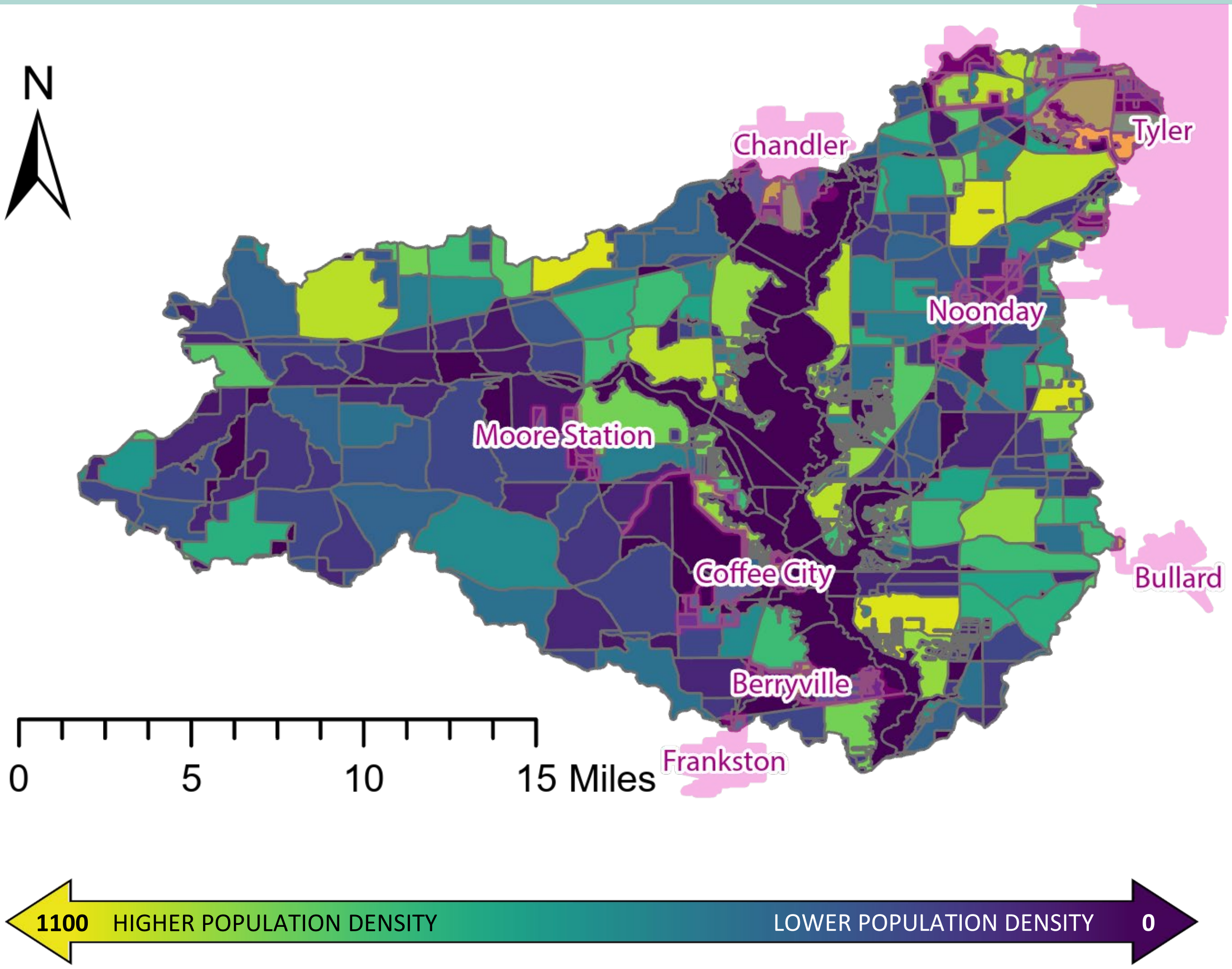
POPULATION STATISTICS – SAM RAYBURN RESERVOIR

City Name	2020 Population	2010 Population	2000 Population	1990 Population	30-Year % Change
Broaddus	184	207	189	212	-13.21%
Browndell	160	197	219	192	-16.67%
Huntington*	2,025	2,118	2,068	1,794	+12.88%
Pineland*	888	850	980	882	+0.68%
Zavalla*	603	713	647	701	-13.98%
Total Watershed Population		**17,265**			

**Only portions of these cities are within the watershed boundary*

The majority of the population in this area is concentrated towards the western side of the watershed, surrounding the cities of Huntington and Broaddus. The other two population centers in this watershed are Browndell and Pineland, which are isolated on the east end of the watershed. Aside from Huntington, most cities in this region are declining or remaining static in population. The total population in this region is much lower than the population of the Lake Palestine Watershed.

POPULATION DISTRIBUTION – LAKE PALESTINE WATERSHED



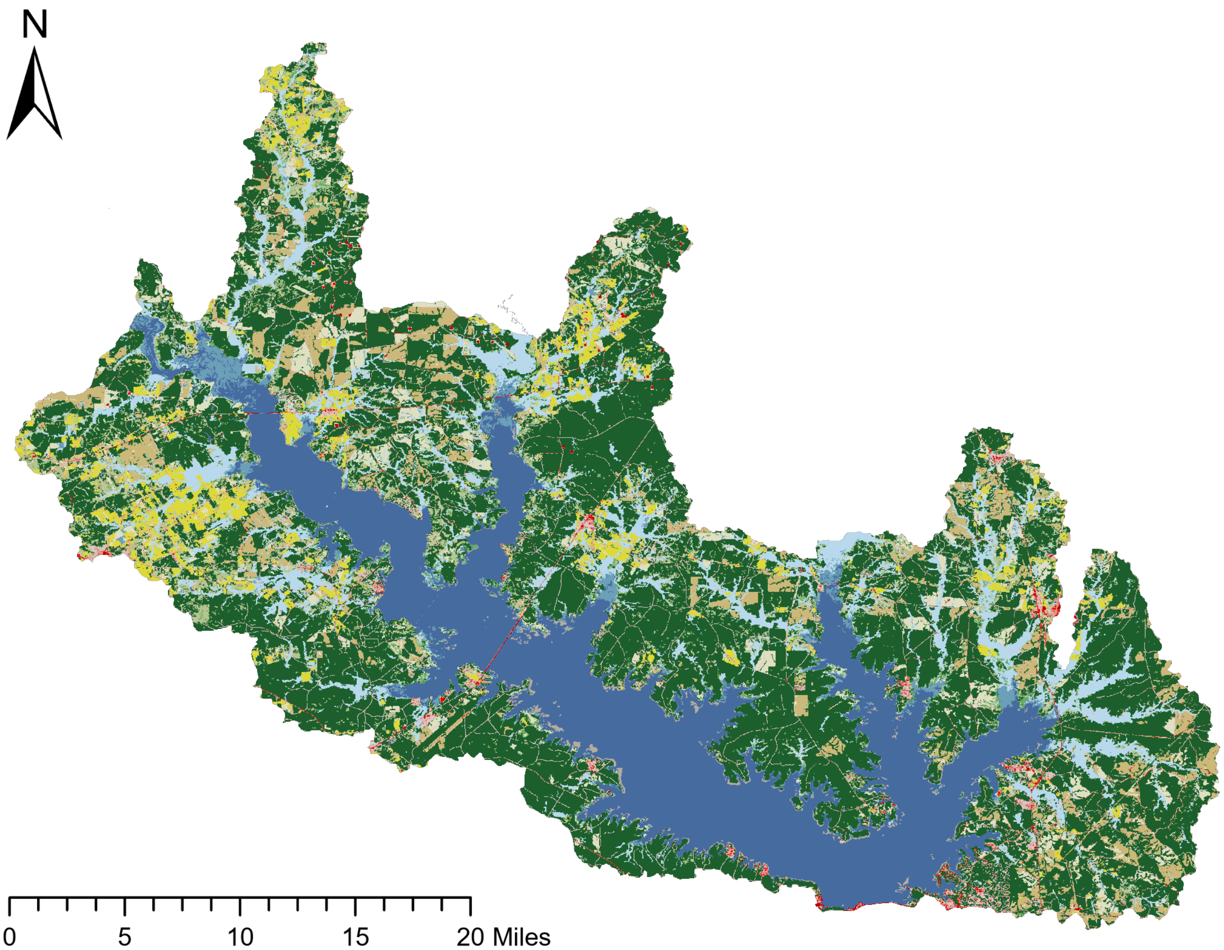
POPULATION STATISTICS – LAKE PALESTINE

City Name	2020 Population	2010 Population	2000 Population	1990 Population	30-Year % Change
Berryville	824	975	891	749	+10.01%
Bullard*	3,318	2463	1150	890	+272.81%
Chandler*	3,275	2734	2099	1630	+100.92%
Coffee City	249	278	193	216	+15.27%
Frankston*	1,126	1229	1209	1127	-0.09%
Moore Station	160	201	184	256	-37.50%
Noonday	612	777	515	466	+31.33%
Tyler*	105,995	96900	83650	75450	+40.48%
Total Watershed Population		**47,371**			

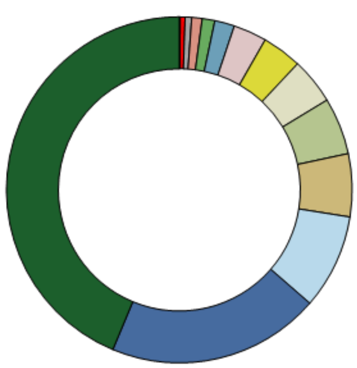
**Only portions of these cities are within the watershed boundary*

The most densely populated areas in this watershed surround the lake and the outskirts of Tyler. The southwest portion of the watershed is more sparsely populated. Excluding Moore Station and Frankston, cities in this region are experiencing growth, especially Tyler and the cities near it. Despite being a much smaller land area compared to Sam Rayburn Reservoir Watershed, this watershed has a total population 2.7 times larger than the Rayburn Watershed.

LAND USE/COVER DISTRIBUTION – SAM RAYBURN RESERVOIR WATERSHED

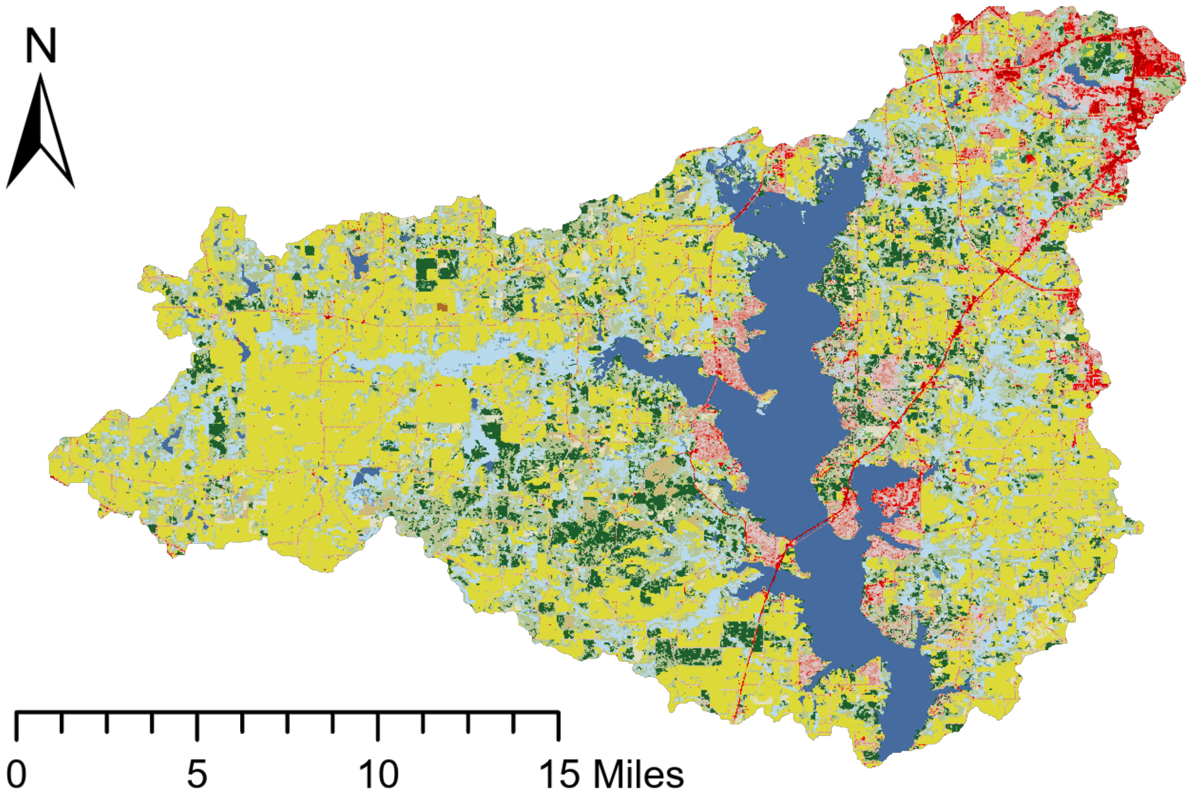


LAND COVER STATISTICS – SAM RAYBURN RESERVOIR

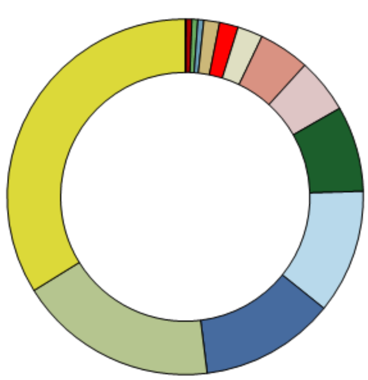
Land Cover Distribution Chart	Percent Area	Area in Acres	Land Cover Type	Symbol
	43.72%	212,785.59	Evergreen Forest	
	19.90%	96,853.46	Open Water	
	8.87%	43,170.36	Woody Wetlands	
	5.88%	28,618.01	Shrub/Scrub	
	5.32%	25,892.48	Mixed Forest	
	4.31%	20,976.80	Herbaceous	
	3.72%	18,105.27	Hay/Pasture	
	3.12%	15,185.06	Developed, Open Space	
	1.86%	9,052.63	Emergent Herbaceous Wetlands	
	1.18%	5,743.07	Deciduous Forest	
	0.97%	4,721.00	Developed, Low Intensity	
	0.61%	2,968.87	Barren Land	
	0.45%	2,190.15	Developed, Medium Intensity	
	0.09%	438.03	Developed, High Intensity	

This watershed is predominately evergreen (pine) forest, woody wetlands, and shrubland. There are 22,534.25 acres of developed space in this watershed, which is 4.63% of the total area.

LAND USE/COVER DISTRIBUTION – LAKE PALESTINE WATERSHED



LAND COVER STATISTICS – LAKE PALESTINE



Land Cover Distribution Chart	Percent Area	Area in Acres	Land Cover Type	Symbol
	33.83%	66,295.97	Hay/Pasture	
	18.13%	35,529.00	Mixed Forest	
	12.24%	23,986.48	Open Water	
	11.29%	22,124.79	Woody Wetlands	
	7.80%	15,285.50	Evergreen Forest	
	4.98%	9,759.21	Developed, Open Space	
	4.62%	9,053.72	Developed, Low Intensity	
	2.30%	4,507.26	Herbaceous	
	1.70%	3,331.46	Developed, Medium Intensity	
	1.42%	2,782.75	Shrub/Scrub	
	0.54%	1,058.23	Emergent Herbaceous Wetlands	
	0.53%	1,038.63	Developed, High Intensity	
	0.53%	1,038.63	Deciduous Forest	
	0.06%	117.58	Barren Land	
	0.02%	39.19	Cultivated crops	

This region is mainly pasture, mixed forests, and woody wetlands. There are 23,183.01 acres of developed space in this watershed, which is 11.84% of the total area.

DISCUSSION

These two watersheds differ geographically in many ways. The Sam Rayburn Reservoir Watershed has much more land area with a much larger reservoir, but is sparsely populated. The Lake Palestine Watershed is the opposite, with a smaller reservoir and watershed area, but a much larger population.

Both watersheds have a similar acreage of developed areas, but the Rayburn Watershed developed areas take up a much lower percentage of the total watershed area when compared to the Palestine Watershed.

The Palestine Watershed is within the Post Oak Savannah ecoregion of Texas, which is reflected by its predominant land cover types of pasture and mixed forest. The Rayburn Watershed is within the Pineywoods ecoregion of Texas, which follows the predominant land cover type being evergreen forest. It is important to note that different land cover types cause rainfall to act differently when it hits the land surface. Forests and grasslands tend to slow down rainfall, causing more of the water to infiltrate into the ground or to be used by plants. Developed areas tend to cause more runoff due to impervious surfaces (concrete, asphalt, etc.) and a lack of vegetation to slow water down.

POTENTIAL STAKEHOLDERS OF SAM RAYBURN RESERVOIR AND LAKE PALESTINE WATERSHEDS

Being from within the same basin, some stakeholders overlap such as ANRA itself, or federal and state agencies. Each watershed has its own municipalities, landowners, water customers, industries, RC&D districts, and TCEQ Regional Offices which are all affected by water quality and quantity in their respective watersheds.

The Upper Neches River Municipal Water Authority owns and operates the Blackburn Crossing Dam and Lake Palestine, and also controls the water rights. Tarrant Regional Water District and Dallas Water Utilities have been constructing a pipeline from Lake Palestine to Dallas for water supply. The Texas Institute for Applied Environmental Research has conducted several water quality projects in this area, one of which recently produced the Kickapoo Creek Watershed Protection Plan.

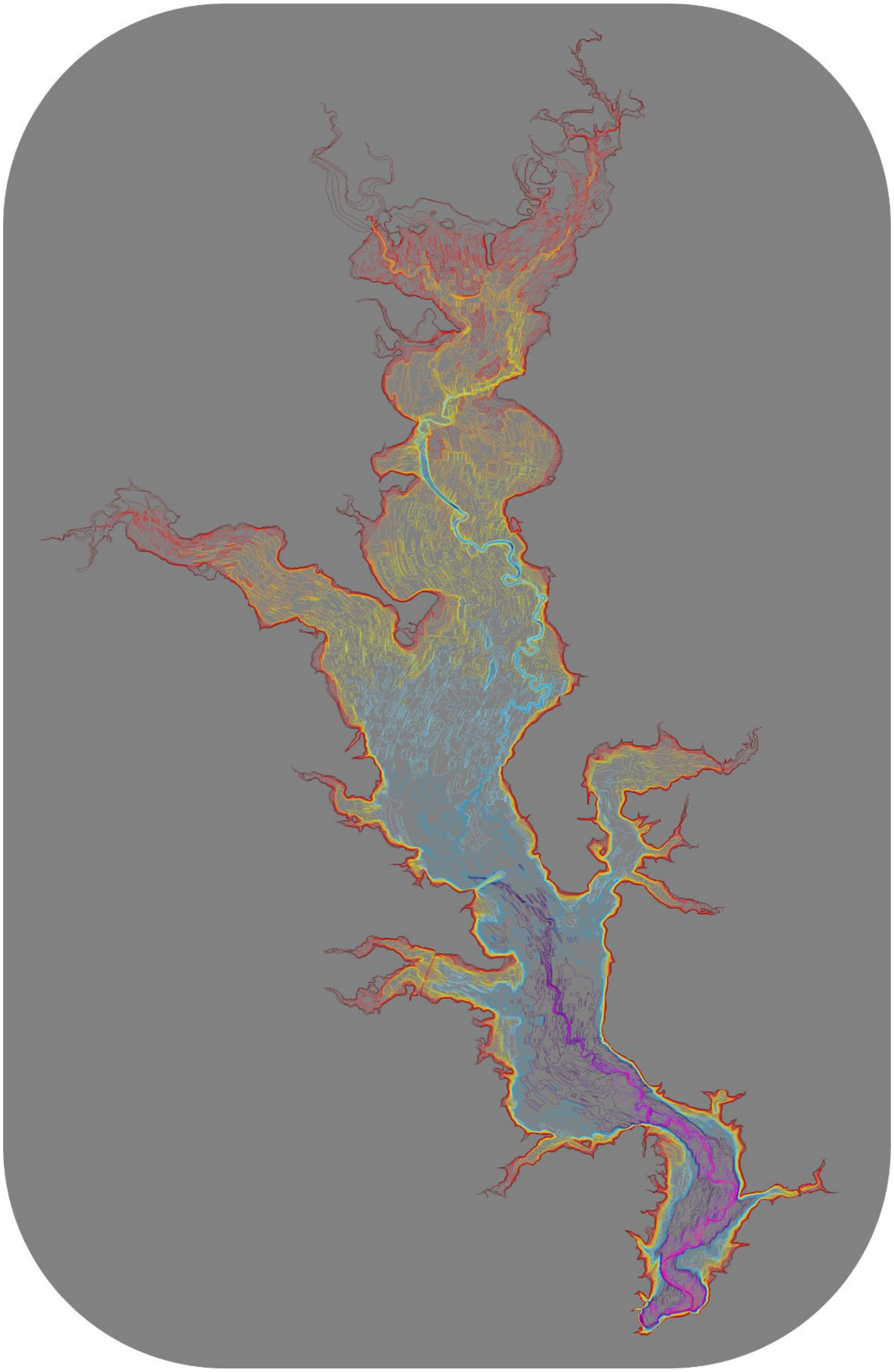
The United States Army Corps of Engineers owns and operates the Sam Rayburn Dam and Reservoir, and the Lower Neches Valley Authority controls the bulk of the water rights. The Texas Water Resources Institute has completed many water quality projects in the area, and has worked together with ANRA to create the Attoyac Bayou and the La Nana Bayou Watershed Protection Plans.

STAKEHOLDERS FOR THE RAYBURN AND PALESTINE WATERSHEDS

Sam Rayburn Reservoir Stakeholders	Regional Stakeholders	Lake Palestine Stakeholders
United States Army Corps of Engineers	Environmental Protection Agency Region 6	Upper Neches River Municipal Water Authority
Lower Neches Valley Authority	National Resource Conservation Service	UNRMWA Water Customers
LNVA Water Customers	United States Fish and Wildlife Service	TCEQ Region 5
TCEQ Region 10	Unites States Forest Service	Texas Institute for Applied Environmental Research
Texas Water Resources Institute	United States Geological Survey	Sabine-Neches RC&D
Pineywoods RC&D	Railroad Commission of Texas	Tarrant Regional Water District
Logging and Paper Companies	Texas Parks and Wildlife Department	Dallas Water Utilities
Local Cities	Texas State Soil and Water Conservation Board	Local Cities
Local Landowners	Texas Water Development Board	Local Landowners

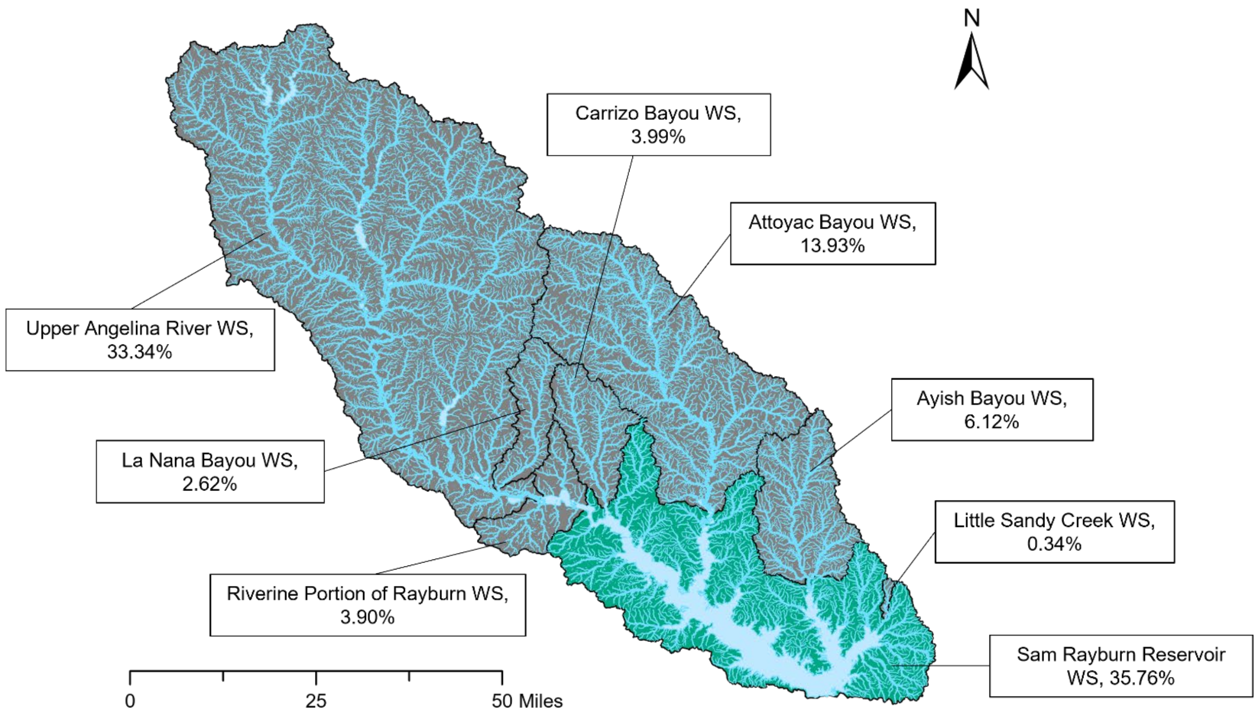
HYDROLOGIC INFORMATION ABOUT THE WATERSHEDS

This section is laid out in the same comparison style as before. The focus of the following maps and charts is to compare where water comes from, and where water moves within these watersheds.



A BATHYMETRIC MAP OF LAKE PALESTINE. PINK/PURPLE SHOWS THE DEEPEST PARTS OF THE LAKE.

WATER SOURCES – SAM RAYBURN RESERVOIR WATERSHED



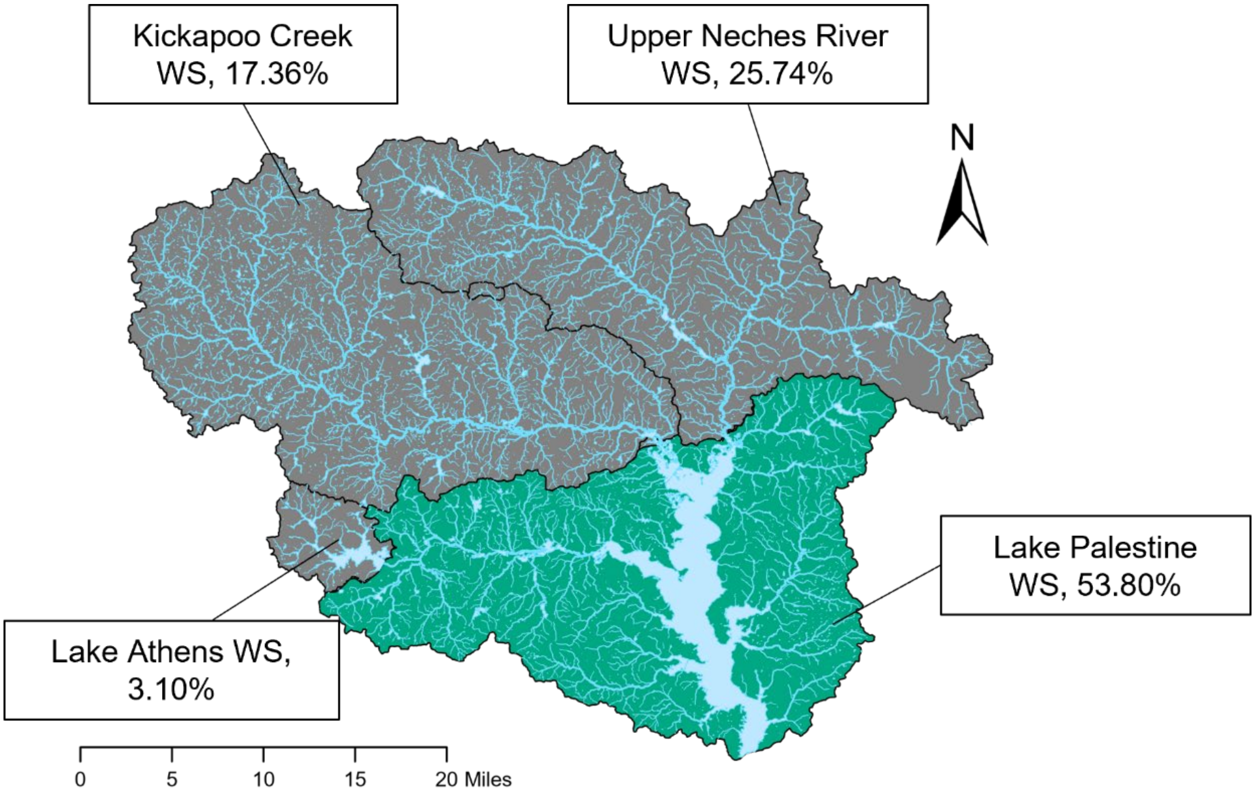
The green watershed indicates the project area of this report, while the gray areas show surrounding watersheds that flow into the report area watershed.

DISTRIBUTION STATISTICS – SAM RAYBURN RESERVOIR

Segment ID	Name	Average Flow (cfs)	Percentage of Total Average Flow
0610	The Rayburn Watershed	1434.0	35.76%
0611	Angelina River	1337.5	33.34%
0612	Attoyac Bayou	558.7	13.93%
0610A	Ayish Bayou	245.4	6.12%
0610P	Carrizo Bayou	159.9	3.99%
0615	Riverine Portion of Rayburn	156.3	3.90%
0611B	La Nana Bayou	104.9	2.62%
0610C	Little Sandy Creek	13.6	0.34%
-	**Total of Average Flow**	**4,010.3**	**100%**

The Rayburn Watershed total flow is a summation of all the significant stream flow values found in the Rayburn Subwatershed portion of the Appendix. The Angelina River, and the Attoyac and Ayish Bayous are the largest inflows to Sam Rayburn Reservoir. When including the surrounding inflowing watersheds, the Sam Rayburn Watershed becomes about 4.1 times larger than the Lake Palestine Watershed with its added surrounding watersheds. This also correlates with the total annual flow, which is 4.4 times greater in the Rayburn Watershed compared to the Palestine Watershed.

WATER SOURCES – LAKE PALESTINE WATERSHED



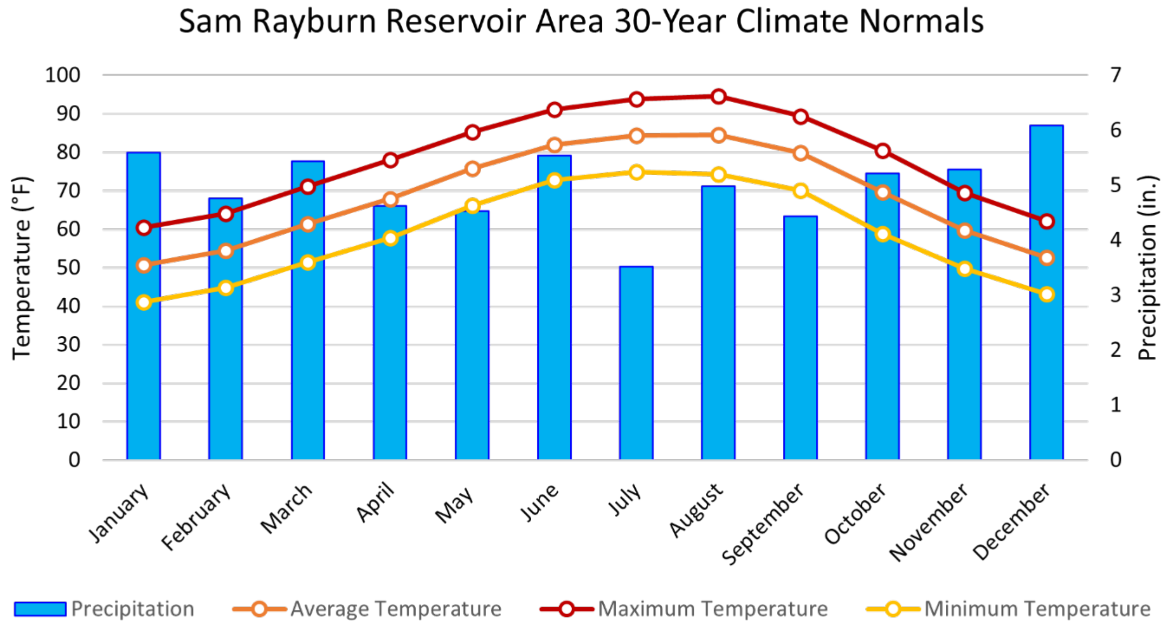
The green watershed indicates the project area of this report, while the gray areas show surrounding watersheds that flow into the report area watershed.

DISTRIBUTION STATISTICS – LAKE PALESTINE

Segment ID	Name	Average Flow (cfs)	Percentage of Total Average Flow
0605	The Palestine Watershed	494.6	53.80%
0606	Neches River above Lake Palestine	236.6	25.74%
0605A	Kickapoo Creek	159.6	17.36%
0605F	Lake Athens/Flat Creek	28.5	3.10%
-	**Total of Average Flow**	**919.3**	**100%**

The Palestine Watershed total flow is a summation of all the significant stream flow values found in the Palestine Subwatershed portion of the Appendix. The Neches River is the next largest inflow, followed by Kickapoo Creek. As expected with a much smaller drainage basin, there is much less total flow coming into Lake Palestine compared to Rayburn.

RAINFALL AND CLIMATE – SAM RAYBURN RESERVOIR WATERSHED



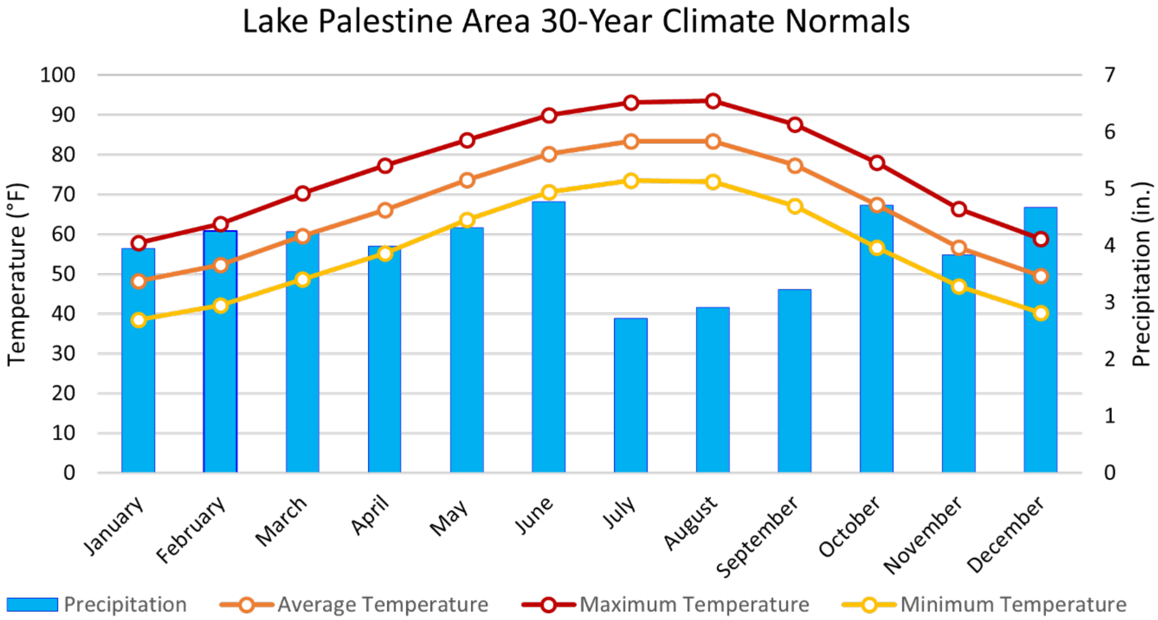
CLIMATE STATISTICS – SAM RAYBURN RESERVOIR

Month	Precipitation	Average Temperature	Maximum Temperature	Minimum Temperature
January	5.59"	50.7 °F	60.4 °F	41.0 °F
February	4.76"	54.4 °F	64.0 °F	44.8 °F
March	5.44"	61.3 °F	71.1 °F	51.4 °F
April	4.63"	67.9 °F	78.0 °F	57.7 °F
May	4.53"	75.8 °F	85.3 °F	66.2 °F
June	5.54"	82.0 °F	91.1 °F	72.8 °F
July	3.52"	84.4 °F	93.9 °F	74.9 °F
August	4.98"	84.5 °F	94.6 °F	74.3 °F
September	4.44"	79.8 °F	89.4 °F	70.1 °F
October	5.22"	69.6 °F	80.5 °F	58.8 °F
November	5.29"	59.7 °F	69.5 °F	49.8 °F
December	6.09"	52.6 °F	62.1 °F	43.1 °F

Information based on 30-year climate normals data from NOAA weather station USC00417936

The Rayburn Watershed area sees an average of 60.03 inches of rain per year, with a monthly average of 5.00 inches. The highest average maximum temperature is 94.6 °F in August, and the lowest average minimum temperature is in January, at 41.0 °F.

RAINFALL AND CLIMATE – LAKE PALESTINE WATERSHED



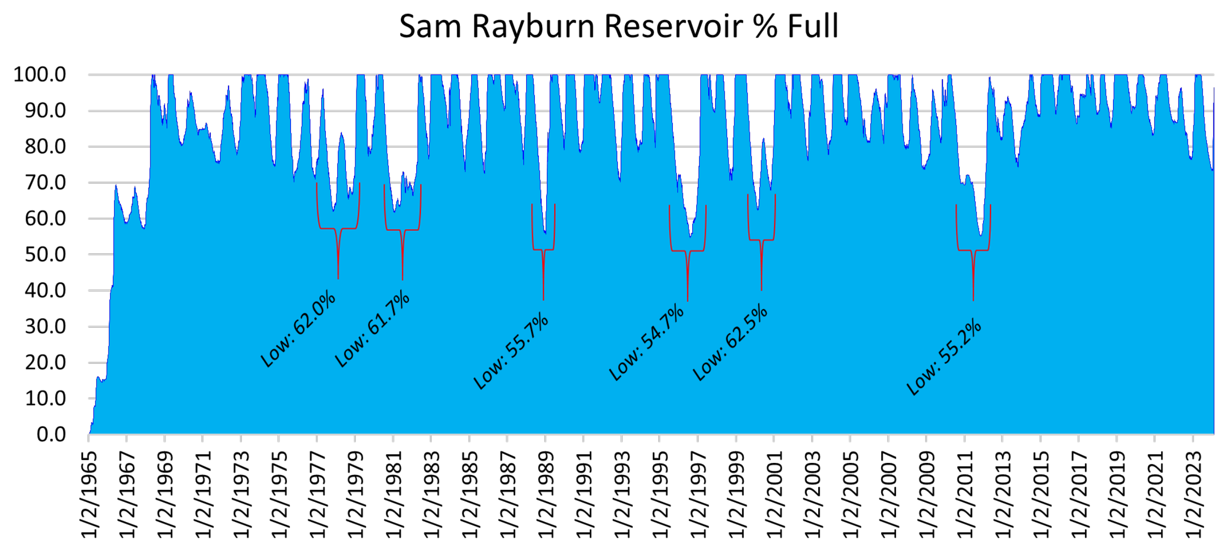
CLIMATE STATISTICS – LAKE PALESTINE

Month	Precipitation	Average Temperature	Maximum Temperature	Minimum Temperature
January	3.95"	48.2 °F	57.9 °F	38.5 °F
February	4.26"	52.4 °F	62.6 °F	42.2 °F
March	4.25"	59.6 °F	70.4 °F	48.7 °F
April	3.99"	66.2 °F	77.3 °F	55.2 °F
May	4.32"	73.7 °F	83.7 °F	63.7 °F
June	4.78"	80.3 °F	89.9 °F	70.7 °F
July	2.72"	83.4 °F	93.1 °F	73.6 °F
August	2.92"	83.4 °F	93.6 °F	73.2 °F
September	3.23"	77.4 °F	87.6 °F	67.2 °F
October	4.72"	67.4 °F	78.1 °F	56.7 °F
November	3.84"	56.7 °F	66.4 °F	47.0 °F
December	4.68"	49.5 °F	58.8 °F	40.2 °F

Information based on 30-year climate normals data from NOAA weather station USC00419207

The Palestine Watershed area sees an average of 47.66 inches of rain per year, with a monthly average of 3.97 inches. The highest average maximum temperature is 93.6 °F in August, and the lowest average minimum temperature is in January, at 38.5 °F.

LAKE LEVELS AND CAPACITY – SAM RAYBURN RESERVOIR



Information based on TWDB data

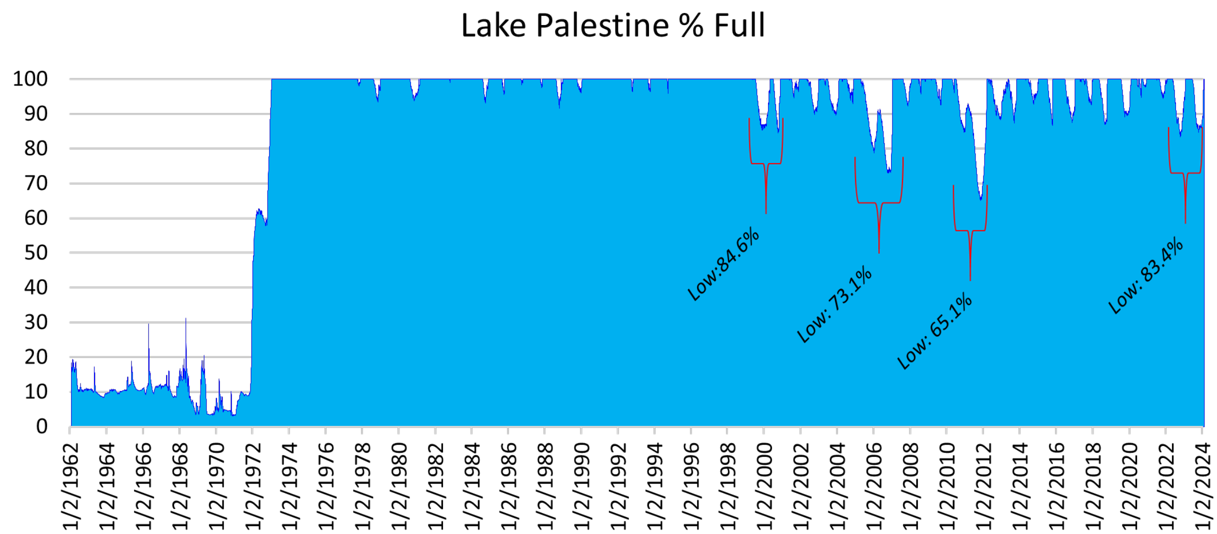
At flood control pool, 173 feet above mean sea level, Sam Rayburn Reservoir can hold nearly 4,000,000 acre-feet of water. Sam Rayburn Reservoir is the largest reservoir wholly within Texas and is one of the largest reservoirs in the nation.

Sam Rayburn Reservoir has been through six major droughts that led to significant drawdowns: 1977-1978, 1981-1982, 1989, 1996-1997, 2000-2001, and 2010-2011. Droughts tend to have a negative impact on water quality, which will be discussed in further detail near the end of this section. During normal conditions, the reservoir sits between 100-80% full, this fluctuation is likely due to power generation or maintenance on the dam.

Sam Rayburn Reservoir has an interesting set of rules when it comes to water usage and storage. The reservoir is used for electric power generation, so the water must be kept at or above 149ft mean sea level, or about 53% full in order to meet power generation requirements. The Army Corps of Engineers requires that the reservoir generate 42,000 kilowatts of power for a minimum period of 75 hours per month during six periods between mid-April to mid-October.

Water rights are strange, and in this case the reader will have to consider Sam Rayburn Reservoir and B. A. Steinhagen Reservoir to the south as one system. Between these two reservoirs, the LNVA has rights to 792,000 acre-feet of water annually. The City of Lufkin owns water rights to 28,000 acre-feet of water annually from Sam Rayburn Reservoir.

LAKE LEVELS AND CAPACITY – LAKE PALESTINE

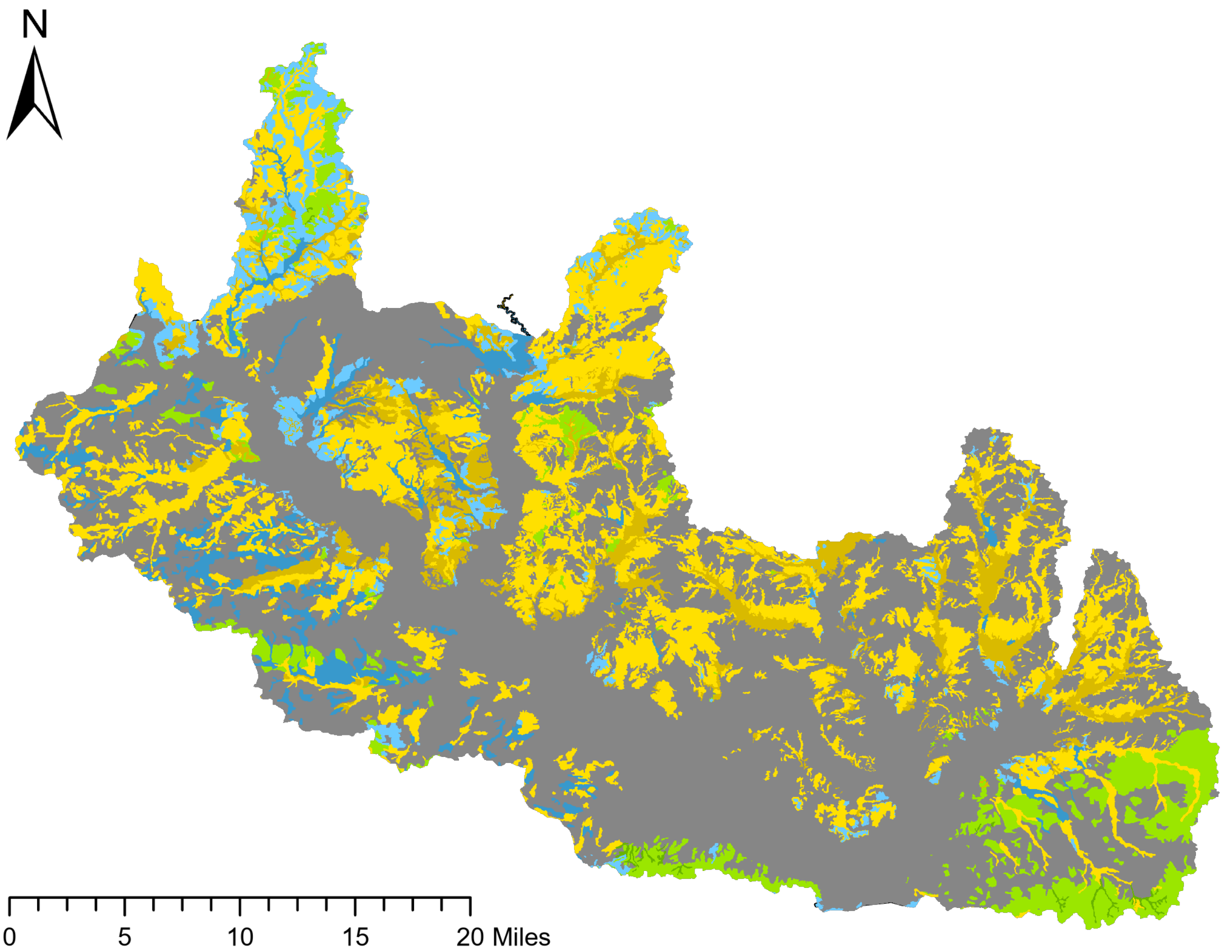


Information based on TWDB data

Lake Palestine can hold nearly 400,000 acre-feet of water, making its total capacity about 10% of what Sam Rayburn can hold. However, Lake Palestine still is the second largest impoundment in the Neches Basin and the largest impoundment of the Neches River. Lake Palestine tends to have a more stable water level when compared to Sam Rayburn Reservoir. This is likely due to two reasons: Lake Palestine does not have power generation requirements, and the ratio of incoming average annual flow to overall storage is more ideal.

Lake Palestine has been through three major droughts that have led to significant drawdown: 2000-2001, 2005-2006, 2010-2011, and 2022. The water in this reservoir remains remarkably stable, with only two droughts ever dropping the reservoir below 80% capacity. The Upper Neches River Municipal Water Authority has the water rights to Lake Palestine and can divert 212,000 acre-feet of water from the reservoir per year.

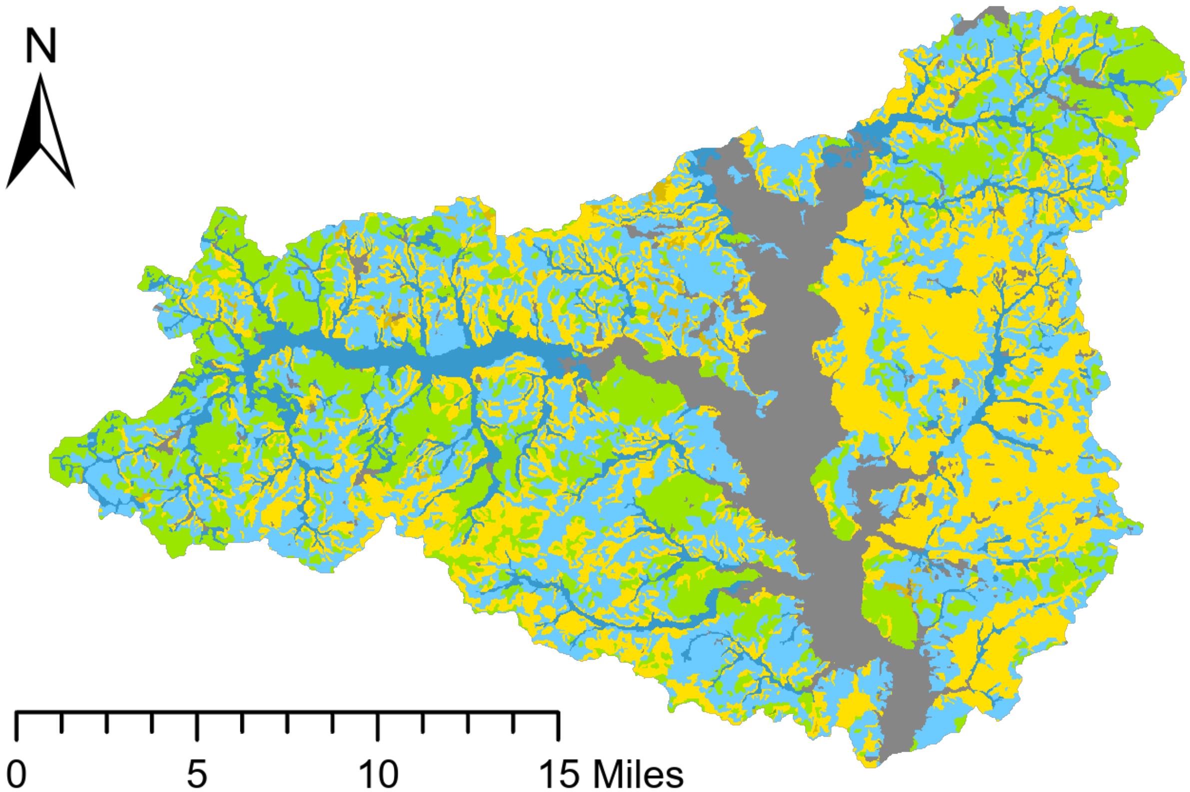
HYDROLOGIC SOIL GROUPS – SAM RAYBURN RESERVOIR WATERSHED



SOIL DESCRIPTIONS AND STATISTICS

Symbol	Group	Percent Area	NRCS Description
	A	5.89%	Deep, well drained sands or gravelly sands with high infiltration and low runoff rates.
	B	4.74%	Deep well drained soils with a moderately fine to moderately coarse texture and a moderate rate of infiltration and runoff.
	C	21.51%	Soils with a layer that impedes the downward movement of water or fine textured soils and a slow rate of infiltration.
	D	57.14%	Soils with a very slow infiltration rate and high runoff potential. This group is composed of clays that have a high shrink-swell potential, soils with a high water table, soils that have a clay layer at or near the surface, and soils that are shallow over near impervious material
	A/D	0.18%	Soils that naturally have a very slow infiltration rate due to a high water table but will have high infiltration and low runoff rates if drained.
	B/D	4.31%	Soils that naturally have a very slow infiltration rate due to a high water table but will have a moderate rate of infiltration and runoff if drained.
	C/D	6.24%	Soils that naturally have a very slow infiltration rate due to a high water table but will have a slow rate of infiltration if drained.

HYDROLOGIC SOIL GROUPS – LAKE PALESTINE WATERSHED



SOIL DESCRIPTIONS AND STATISTICS

Symbol	Group	Percent Area	NRCS Description
	A	18.03%	Deep, well drained sands or gravelly sands with high infiltration and low runoff rates.
	B	30.51%	Deep well drained soils with a moderately fine to moderately coarse texture and a moderate rate of infiltration and runoff.
	C	28.63%	Soils with a layer that impedes the downward movement of water or fine textured soils and a slow rate of infiltration.
	D	13.80%	Soils with a very slow infiltration rate and high runoff potential. This group is composed of clays that have a high shrink-swell potential, soils with a high water table, soils that have a clay layer at or near the surface, and soils that are shallow over near impervious material
	A/D	0.00%	Soils that naturally have a very slow infiltration rate due to a high water table but will have high infiltration and low runoff rates if drained.
	B/D	8.48%	Soils that naturally have a very slow infiltration rate due to a high water table but will have a moderate rate of infiltration and runoff if drained.
	C/D	0.54%	Soils that naturally have a very slow infiltration rate due to a high water table but will have a slow rate of infiltration if drained.

DISCUSSION

The Sam Rayburn Watershed is in a warmer and wetter climate than the Palestine Watershed. As a larger watershed with larger inflows, Rayburn receives around 4 times as much water than Palestine. At the same time, due to water releasing conditions on Sam Rayburn Reservoir, Lake Palestine has a much more stable water level. Rayburn holds approximately ten times the volume of water that Lake Palestine does.

In the previous section, Land Cover types were discussed, which have an impact on what happens to rainfall as it hits the land surface. This section is focused on another controlling factor of runoff vs infiltration – the underlying sediments. Particle size contributes to how fast a sediment can allow the infiltration of water into to the subsurface. Larger sediment sizes have larger pore (air) spaces between particles, allowing for faster infiltration. Finer sediments have smaller pore sizes, and in turn have slower infiltration rates. The Lake Palestine Watershed has underlying sediments with larger particle sizes (Groups A & B) while most of the sediments underlying the Sam Rayburn Reservoir Watershed are finer particles (Groups C & D). Both of these regions sit on minor aquifer outcrops and have potential to interact with the groundwater. It is likely that the Lake Palestine Watershed sees higher groundwater interaction due to its easily infiltrated soils. This could also be another factor as to why Lake Palestine holds water so consistently – it is possible that it is recharged to some degree by groundwater.

Floodwaters carry nutrients in addition to sediment and other debris. When floodwaters are able to easily infiltrate soils, they take nutrients with them, which are then used up by the overlying plants. In areas where soils don't allow for fast infiltration, the floodwater and nutrients will be runoff that drains into major streams or reservoirs.

DROUGHT

As mentioned in the storage subsections of this section, both reservoirs have experienced droughts and their associated lower water levels. When droughts occur, there is less water to dilute pollutants, making them more concentrated. Streams that may have usually been dominated by ambient water may become effluent dominated during drought conditions. Heat, also associated with drought, can have negative impacts on dissolved oxygen levels and aquatic wildlife, as beyond certain temperatures aquatic wildlife can become stressed or even die.

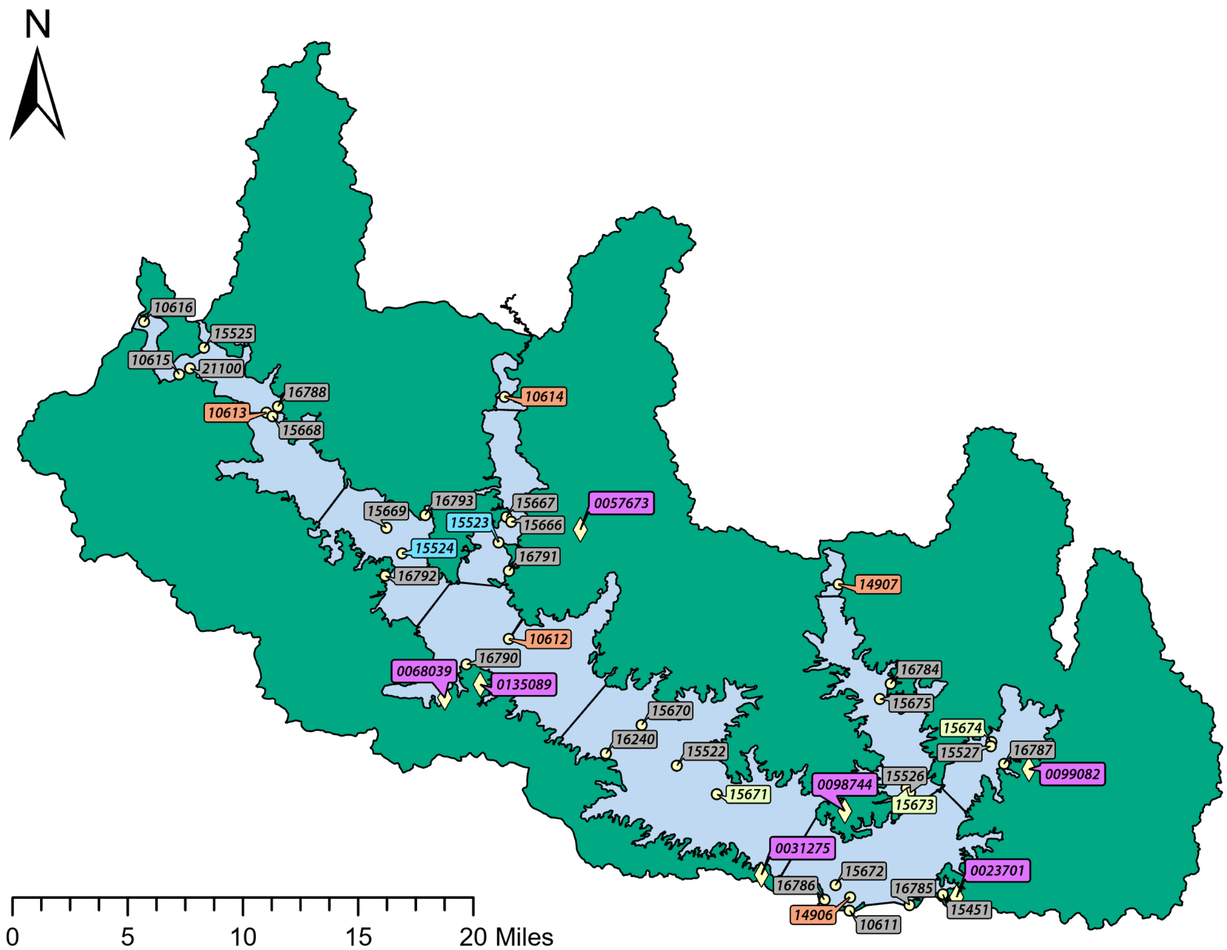
IMAGES SHOWING DIFFERENT WATER LEVELS IN THE NORTHERN PORTION OF SAM RAYBURN

MONITORING AND HYDROLOGIC INPUTS OF THE WATERSHEDS

This section's main focus is to look at where monitoring occurs in these watersheds, and the inputs which have an impact on water quality such as wastewater outfalls, agriculture in the area, and the water quality of surrounding inflows.

AN INVASIVE WATER HYACINTH DOWNSTREAM OF MARION'S FERRY ON SAM RAYBURN RESERVOIR

MONITORING SITES AND OUTFALLS – SAM RAYBURN RESERVOIR WATERSHED



LIST OF ACTIVE MONITORING SITES – SAM RAYBURN RESERVOIR

Station ID	Description	Collecting Entity	Year Established
10612	SAM RAYBURN RESERVOIR AT SH147	TCEQ	1991
10613	SAM RAYBURN RESERVOIR AT SH103	TCEQ	1991
10614	SAM RAYBURN RESERVOIR AT SH103	TCEQ	1996
14906	SAM RAYBURN RES AT MAIN POOL	TCEQ	1995
14907	SAM RAYBURN RESERVOIR AT FM 83	TCEQ	1995
15523	SAM RAYBURN NR ALLIGATOR COVE	ANRA	1995
15524	SAM RAYBURN AT SHIRLEY CREEK	ANRA	1995
15671	SAM RAYBURN RESERVOIR SITE FC	LNVA	1994
15673	SAM RAYBURN RESERVOIR SITE AC	LNVA	1994
15674	SAM RAYBURN RESERVOIR SITE LC	LNVA	1994

LIST OF INACTIVE MONITORING SITES – SAM RAYBURN RESERVOIR

Station ID	Description	Year Established	Year Last Monitored
10611	SAM RAYBURN INTAKE STRUCTURE	No Data	No Data
10615	SAM RAYBURN RES AT MARIONS	1995	2011
10616	SAM RAYBURN RES AT PIPELINE	No Data	No Data
15451	TWIN DIKES MARINA AT SAM RAYBU	No Data	No Data
15522	SAM RAYBURN NR VEACH BASIN	1995	2007
15525	SAM RAYBURN AT KINGTOWN	1995	1996
15526	SAM RAYBURN NR NEEDMORE POINT	1995	2007
15527	SAM RAYBURN NR MILL CREEK PARK	1995	2008
15666	SAM RAYBURN RESERVOIR SITE NC	1994	1999
15667	SAM RYBURN RESERVOIR SITE IC	1994	1999
15668	SAM RAYBURN RESERVOIR SITE KC	1994	1999
15669	SAM RAYBURN RESERVOIR SITE JC	1994	2006
15670	SAM RAYBURN RESERVOIR SITE GC	1994	2018
15672	SAM RAYBURN RESERVOIR SITE CC	1994	2010
15675	SAM RAYBURN RESERVOIR SITE MC	1994	2018
16240	SAM RAYBURN RES AT CAMP HIS WA	No Data	No Data
16784	SAM RAYBURN AT SAN AUGUSTINE	1998	2001
16785	SAM RAYBURN AT EAST END	1998	2001
16786	SAM RAYBURN AT EBENEZER PARK	1998	2001
16787	SAM RAYBURN AT MILL CREEK PARK	1998	2001
16788	SAM RAYBURN AT ETOILE PARK	1999	1999
16790	SAM RAYBURN AT CASSEL-BOYKIN	1999	1999
16791	SAM RAYBURN AT JACKSON HILL	1998	2001
16792	SAM RAYBURN AT HANKS CREEK	1999	1999
16793	SAM RAYBURN AT SHIRLEY CREEK	1999	1999
21100	SAM RAYBURN RESERVOIR ON ANGELINA RIVER NEAR MARIONS FERRY	2011	2018

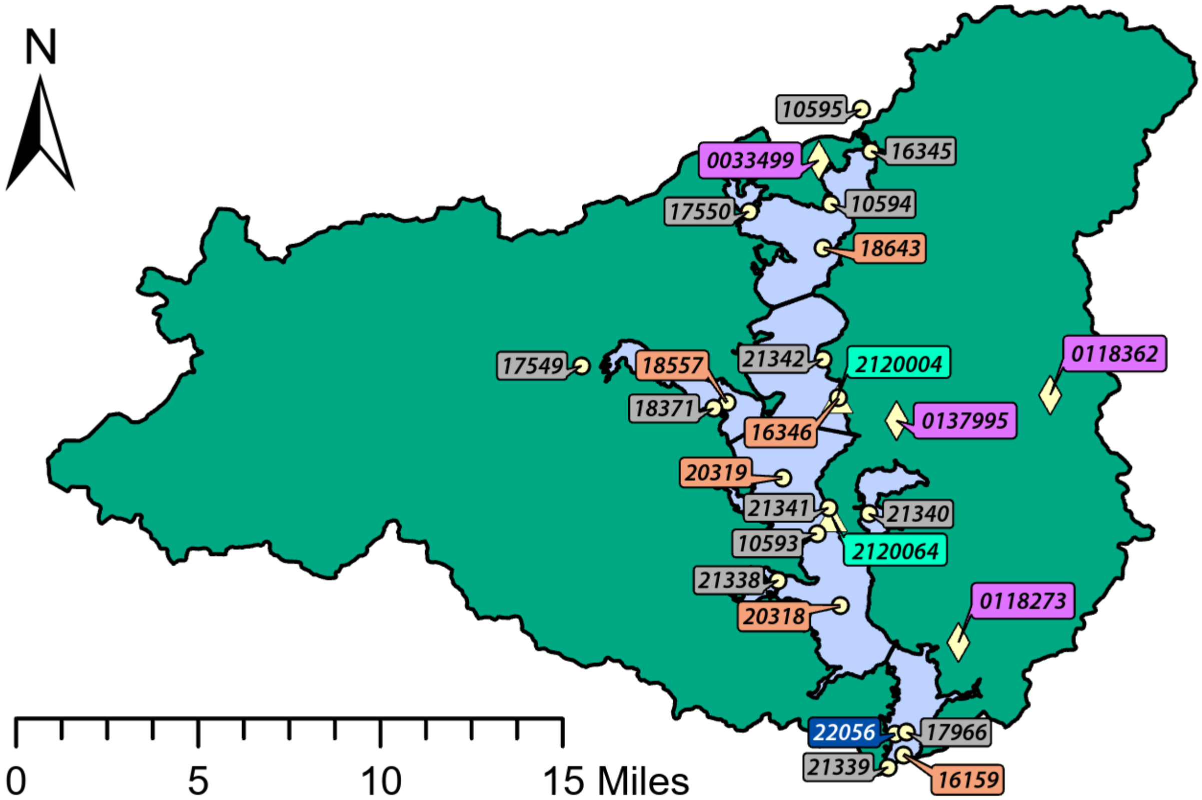
LIST OF PERMITTED DISCHARGES – SAM RAYBURN RESERVOIR

NPDES Number	Outfall Number	Permittee	County	Permitted Discharge (MGD)
68039	001	TEXAS AIRSTREAM HARBOR INC	ANGELINA	0.01
57673	001	CITY OF BROADDUS	SAN AUGUSTINE	0.135
99082	001	BROOKELAND ISD	SABINE	0.008
98744	001	STEPHEN F AUSTIN STATE UNIVERSITY	SAN AUGUSTINE	0.02
31275	001	WESTWOOD WSC	JASPER	0.025
135089	001	SHERRY SMITH MILNER	ANGELINA	0.0073
23701	001	RAYBURN COUNTRY MUD	JASPER	0.3

CENSUS OF AGRICULTURE DATA – ADJUSTED FOR LAND AREA WITHIN SAM RAYBURN WATERSHED

County	Cattle	Hog	Horse	Goat	Sheep	Chicken - Layers	Chicken - Pullets	Chicken - Broilers	Turkey
Angelina	2815	76	310	250	21	6870	63	491040	6
Jasper	771	9	57	65	35	367	15	70	6
Nacogdoches	5381	57	182	26	12	33702	54205	2672569	-
Newton	26	3	5	7	1	22	2	3	1
Sabine	720	15	24	21	2	112	N/A	N/A	8
San Augustine	2828	37	82	26	44	51782	N/A	4593435	13

MONITORING SITES, INTAKES, AND OUTFALLS – LAKE PALESTINE WATERSHED



LIST OF ACTIVE MONITORING SITES – LAKE PALESTINE

Station ID	Description	Collecting Entity	Year Established
16159	LAKE PALESTINE AT DAM	TCEQ	1998
16346	LAKE PALESTINE AT TYLER INTAKE	TCEQ	1999
18557	LAKE PALESTINE IN FLAT BAY	TCEQ	2005
18643	UPPER LAKE PALESTINE NE	TCEQ	2005
20318	LAKE PALESTINE MIDLAKE NEAR LEDBETTER BAY	TCEQ	2008
20319	Lake Palestine CWQMN site, mid-lake, between Cape Tranquility Drive and Regal Row	TCEQ	2008
22056	LAKE PALESTINE IN BLACKBURN BAY NORTHEAST OF PRIVATE ROAD 7010	TRWD	2018

LIST OF INACTIVE MONITORING SITES – LAKE PALESTINE

Station ID	Description	Year Established	Year Last Monitored
10593	LAKE PALESTINE MID LAKE	1991	2008
10594	LAKE PALESTINE AT BIG EDDY BAY	1998	1999
10595	LAKE PALESTINE IN NECHES RIVER CHANNEL AT SH 31 NORTHEAST OF CHANDLER	1997	2019
16345	LAKE PALESTINE UPPER LAKE	1999	2006
17549	LAKE PALESTINE AT FM 314	2001	2003
17550	LAKE PALESTINE AT FM 315 NORTH	2001	2007
17966	LAKE PALESTINE 1KM N OF DAM	2003	2007
18371	LAKE PALESTINE AT FM 315 SOUTH	2004	2005
21338	LAKE PALESTINE NEAR THE INTERSECTION OF SH 155 & COFFEE LANDING RD	No Data	No Data
21339	LAKE PALESTINE NEAR DEEP END RAMP	No Data	No Data
21340	LAKE PALESTINE NEAR LAKESIDE GETAWAY	No Data	No Data
21341	LAKE PALESTINE AT THE END OF THE BOAT RAMP AT PALESTINE PINES	No Data	No Data
21342	LAKE PALESTINE NEAR THE VILLAGES MARINA	No Data	No Data

LIST OF PERMITTED DISCHARGES – LAKE PALESTINE

NPDES Number	Outfall Number	Permittee	County	Permitted Discharge (MDG)
137995	1	LIBERTY UTILITIES SILVERLEAF WATER LLC	SMITH	0.125
33499	1	CITY OF CHANDLER	HENDERSON	0.5
118273	1	SOUTHERN UTILITIES CO	CHEROKEE	0.0144
118362	1	SOUTHERN UTILITIES CO	SMITH	0.0006

LIST OF WATER INTAKES – LAKE PALESTINE

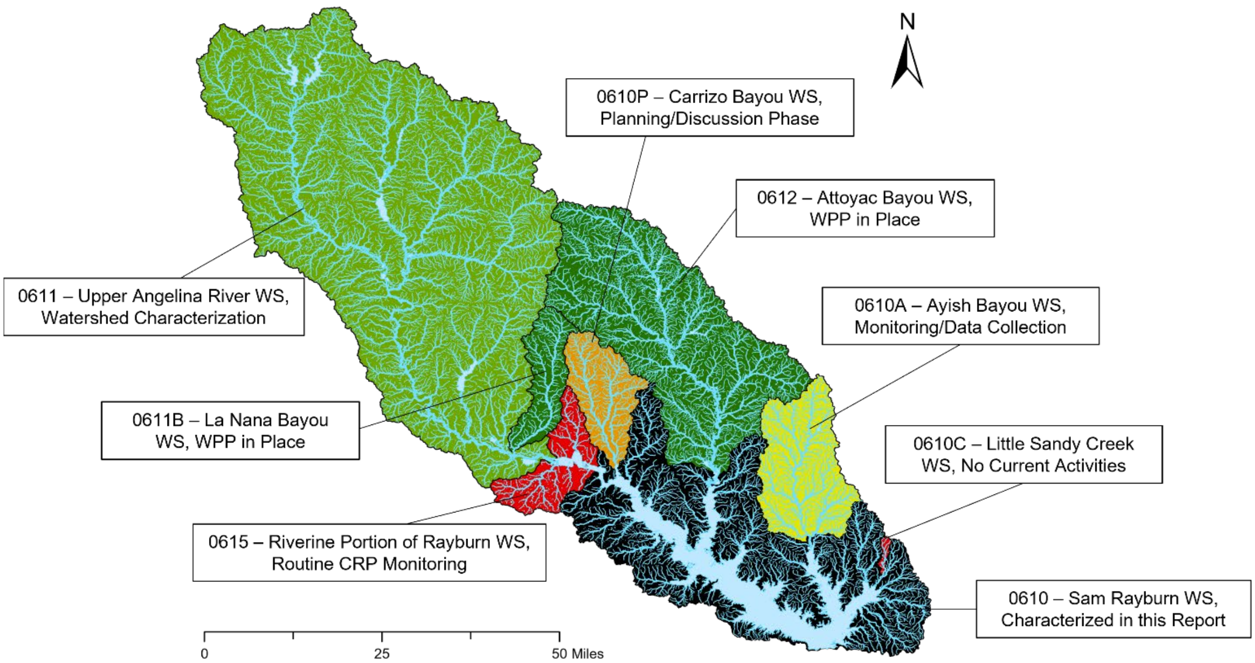
PWS ID	System Name
2120004	CITY OF TYLER
2120064	LAKEWAY HARBOR SUBDIVISION

CENSUS OF AGRICULTURE DATA – ADJUSTED FOR LAND AREA WITHIN LAKE PALESTINE WATERSHED

County	Cattle	Hog	Horse	Goat	Sheep	Chicken - Layers	Chicken - Pullets	Chicken - Broilers	Turkey
Anderson	214	N/A	6	5	2	15	2	16186	-
Cherokee	1108	5	27	29	4	63	8	16618	2
Henderson	11979	131	540	321	96	1784	230	748	53
Smith	4593	46	349	289	100	9945	94	N/A	26

STATUS OF UPSTREAM SEGMENTS THAT FLOW INTO THE SAM RAYBURN RESERVOIR WATERSHED

This report is focused on reviewing the immediate watershed of segment 0610 – Sam Rayburn Reservoir, but there are several upstream segments with watersheds that drain into the 0610 watershed. For the most part, these upstream watersheds have either already been characterized in other recent reports or are in the planning stages for future efforts. This section will briefly introduce those upstream watersheds and provide information about the efforts and projects that are associated with them.



The following projects are ones that ANRA has been a part of, either directly or indirectly. These are all projects by the Texas Water Resources Institute, a long-time partner of ANRA. The vast majority of these projects are associated with bacteria impairments, and working towards creating Watershed Protection Plans to implement best management practices to reduce the overall *E. Coli* loading in these watersheds. Some of these areas haven't seen much work yet, but they are all in some form of planning stage. As for the Sam Rayburn Watershed itself, there have been numerous studies that have observed Sam Rayburn Reservoir in some capacity. These studies are listed in the "Major Watershed Events" subsections of this report, in the Appendix section.

AYISH BAYOU WATERSHED – 0610A, 0610G, 0610I, 0610K, 0610M

This watershed is part of an ongoing project titled: *Addressing Indicator Bacteria Impairments in the Ayish Bayou and West Mud Creek Watersheds*. Segment 0610A – Ayish Bayou is impaired for elevated bacteria levels. Work to address the impairment began in September of 2021, a cooperative effort between TCEQ, TWRI, and ANRA. Year one focused on data gathering and review of existing data, followed by year two with data collection. At the time of this report, the watershed is in the planning stages for additional monitoring which is expected to provide insight into the scope of the impairment.

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

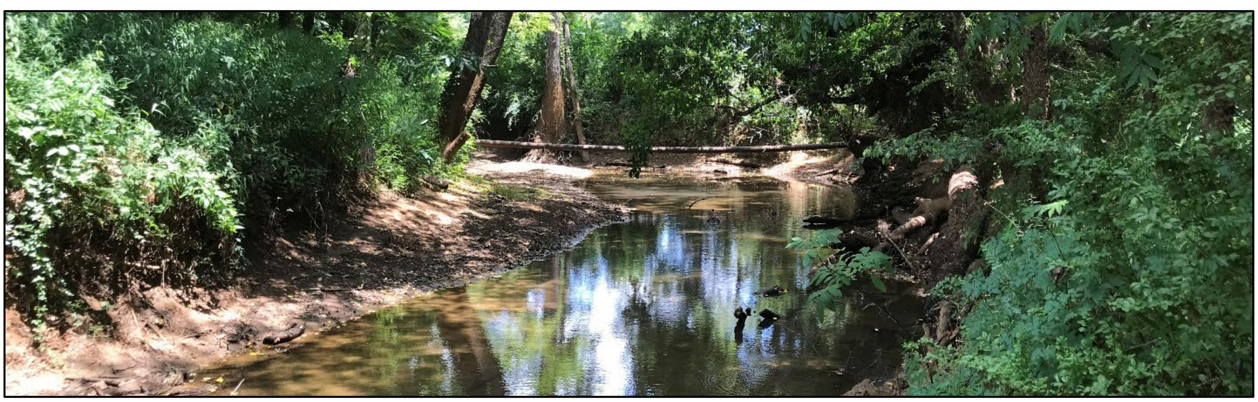
For more information about this project, contact:

Mr. Andrew Henry (ahenry@anra.org)

Mr. Duncan Kikoyo Ahimbisibwe at TWRI (duncan.kikoyo@ag.tamu.edu)

Project website: https://ayish.twri.tamu.edu/

BAYOU CARRIZO WATERSHED – 0610P



This watershed is in the preliminary planning stages for a CWA §319(h) funded project. It first became monitored at SWQM Station 21432 in FY 2014 and was placed on the 303(d) List for the first time in FY 2022. TWRI and ANRA have been working together to devise a monitoring plan, followed by a characterization of the watershed.

For more information about this project, contact:

Mr. Andrew Henry (ahenry@anra.org)

Mr. Duncan Kikoyo Ahimbisibwe at TWRI (duncan.kikoyo@ag.tamu.edu)

ANGELINA RIVER WATERSHED (ABOVE SAM RAYBURN RESERVOIR) – 0611, 0611A, 0611C, 0611D

In 2017, TSSWCB, TWRI and ANRA began monitoring in the Upper Angelina River Watershed in order to collect data for a watershed characterization. Monitoring ended in early FY 2022, with TWRI releasing a watershed characterization report in October of 2022. These efforts could lead to a Watershed Protection Plan in the future.

This project is funded by the TSSWCB through CWA §319(h) grants.

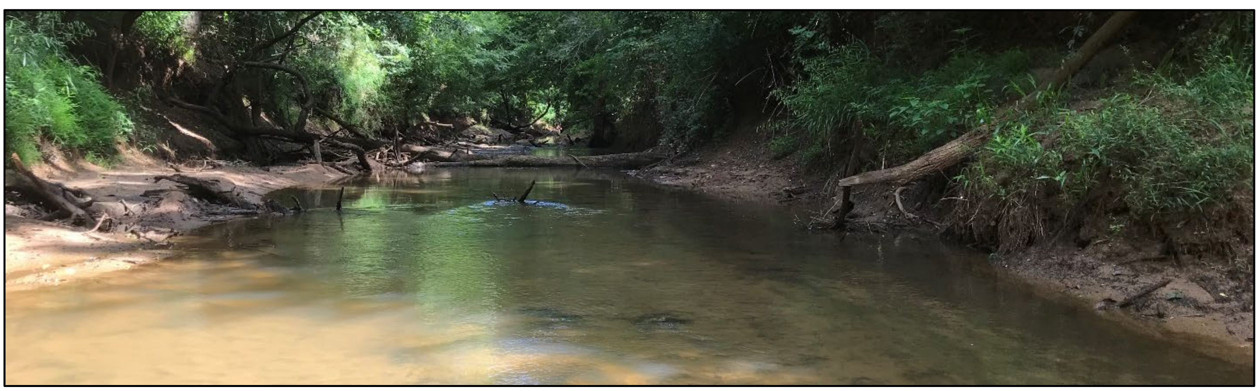
For more information about this project, contact:

Mr. Andrew Henry (ahenry@anra.org)

Ms. Luna Yang at TWRI (luna.yang@ag.tamu.edu)

Watershed Characterization Report: https://twri.tamu.edu/media/6089/tr-539.pdf

LA NANA CREEK WATERSHED – 0611B



TCEQ, TWRI, ANRA, and local stakeholders (SFA, City of Nacogdoches, etc.) worked together to develop a Watershed Protection Plan, which was accepted by the EPA in July of 2023. Implementation of the plan (monitoring to determine pollutant sources, public outreach, etc.) began in FY 2024, and is still currently ongoing at the release of this basin highlights report.

This project is funded by the TCEQ through CWA §319(h) grants.

For more information about this project, contact:

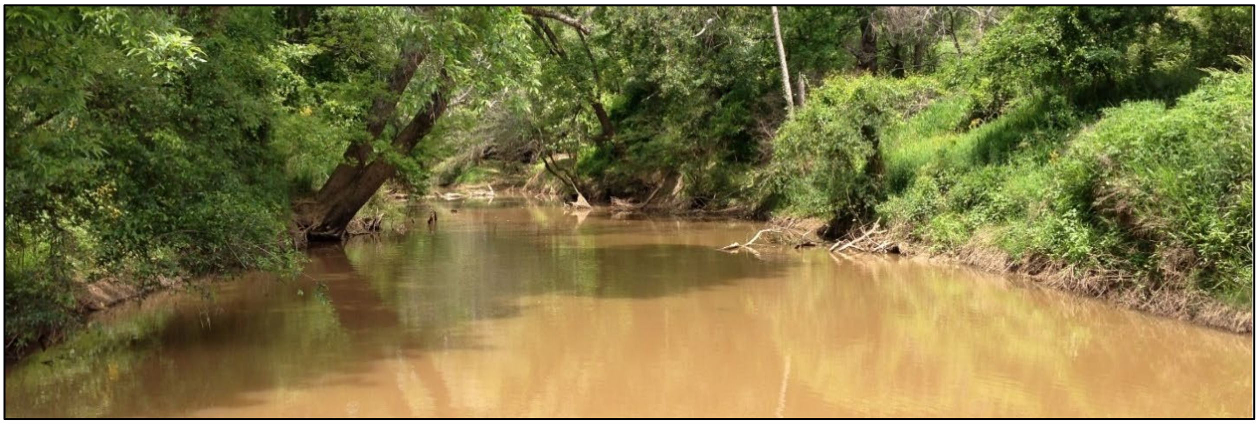
Mr. Andrew Henry (ahenry@anra.org)

Mr. Alexander Neal at TWRI (alexander.neal@ag.tamu.edu)

Watershed Protection Plan: https://twri.tamu.edu/media/6290/tr-547.pdf

ATTOYAC BAYOU WATERSHED – 0612, 0612A, 0612B, 0612C, 0612D, 0612E, 0612F, 0612E

In 2009, with funding from the EPA and TSSWCB, the Attoyac Watershed Partnership was formed and a Watershed Protection Plan was put in place. Water quality projects implementing the WPP began in late 2013. Since that time there has been an ongoing series of implementation projects continuing those efforts via two tracks, BMP Effectiveness Monitoring, and OSSF Remediation. Both projects had education and outreach components to them.



BMP EFFECTIVENESS MONITORING

The current project is a continuation of the ongoing effort between TSSWCB, TWRI, SFA, and ANRA to conduct monthly monitoring at several sites in the Attoyac Watershed to determine if the BMPs implemented from the WPP are having a positive effect towards reducing the bacterial load in the Attoyac Bayou.

OSSF REMEDIATION

This partnership between TCEQ, TWRI, Pineywoods RC&D, SFA, and ANRA is focused on replacing and repairing failing OSSFs within the Attoyac Bayou Watershed.

These projects are funded by CWA §319(h) grants distributed through the TSSWCB and TCEQ.

For more information about either of these projects, contact:

Mr. Andrew Henry (ahenry@anra.org)

Mr. Alexander Neal at TWRI (alexander.neal@ag.tamu.edu)

Project Website: https://attoyac.tamu.edu/

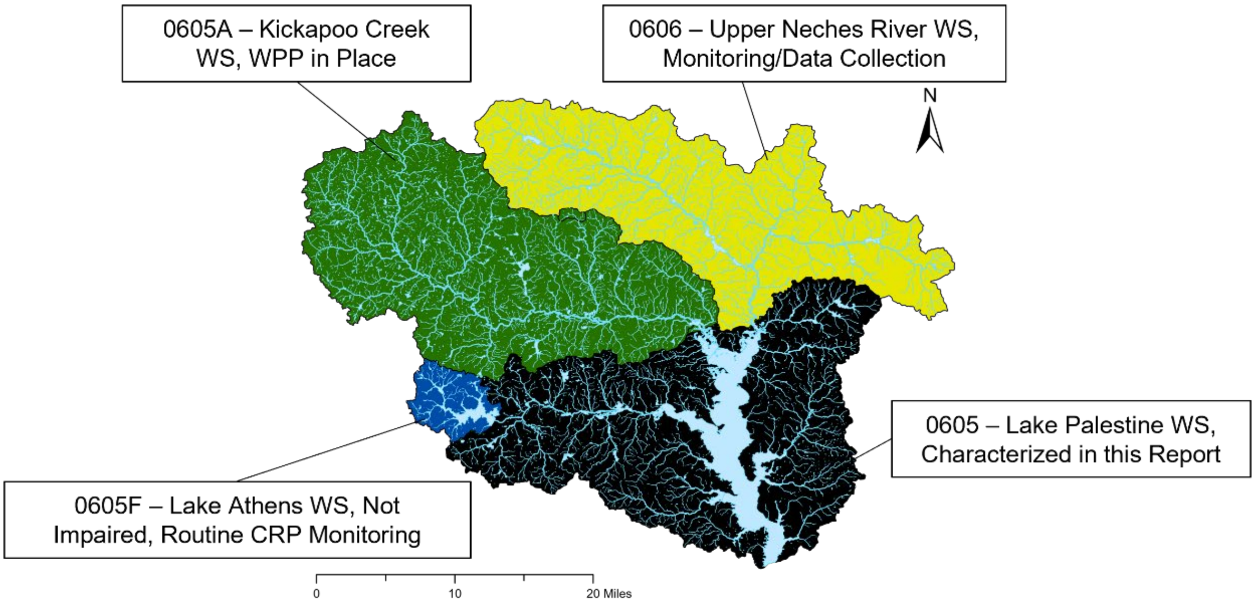
OTHER INFLOWS – 0615, 0610C

Two other inflows into Sam Rayburn Reservoir Watershed 0610C are the Riverine Portion of Sam Rayburn Reservoir 0615, and Little Sandy Creek in Sabine County. The Riverine Portion of Sam Rayburn Reservoir, segment 0615_01, is the assessment unit with the most impairments in the entire Neches Basin. Currently, through CRP monitoring, 24-hour dissolved oxygen, pH, conductivity, and temperature data is being collected by ANRA. Upstream CWA and infrastructure projects may lessen the pollutant loading coming into this segment in the near future. Regardless, more information is still needed on this segment.

Little Sandy Creek 0610C is an interesting segment. It has a segment designation by the TCEQ but no record of any monitoring activity in SWQMIS. It appears that this segment designation was likely created in the mid-late 1990s because a discharge was permitted for Little Sandy Creek, but we found no evidence that any routine monitoring has ever been performed on the segment.

STATUS OF UPTREAM SEGMENTS THAT FLOW INTO TO THE LAKE PALESTINE WATERSHED

This section will briefly cover the inflows that come into the Lake Palestine Watershed. These watersheds are not discussed in-depth in this report to avoid duplication of effort, as many of them are in different stages of the remediation process.



The following projects are ones that ANRA has been a part of or supported. These are all projects by the Texas Institute for Applied Environmental Research, another long-time partner of ANRA. These two projects were both associated with bacteria impairments, but one was focused on which recreation designated use would be appropriate. Plans to implement best management practices to reduce the overall *E. Coli* loading in the Kickapoo Creek Watershed. The Lake Athens Watershed currently needs no action. As for Lake Palestine Watershed itself, there have been a few studies of the area. These studies are listed in the "Major Watershed Events" subsections of this report, in the Appendix section.

LAKE ATHENS – 0605F

Lake Athens is currently not impaired and is actively monitored by the TCEQ quarterly, which is typical of CRP monitoring. Since there are no apparent impairments in this segment, no action is needed beyond the standard monitoring.

KICKAPOO CREEK – 0605A

A collaborative effort between TSSWCB, TIEAR, ANRA, and local stakeholders led to the development of a WPP for Kickapoo Creek's bacteria impairment. Water quality sampling was started in 2021 and was completed in February 2023, the WPP received EPA acceptance in January 2024. Implementation is likely to begin soon.

This project is funded by a State Nonpoint Source Program grant from TSSWCB.

For more information about this project, contact:

Mr. Andrew Henry (ahenry@anra.org), or

Ms. Leah Taylor at TIAER (ltaylor@tarleton.edu)

Watershed Protection Plan: https://tsswcb.texas.gov/sites/default/files/Kickapoo%20Creek%20WPP-FINAL.pdf

NECHES RIVER ABOVE LAKE PALESTINE – 0606, 0606A, 0606D

In 2015, TIAER and the TSSWCB conducted a RUAA over several watersheds surrounding Lake Palestine, including parts of the upper Neches River. The project determined that the existing uses for these Upper Neches Watersheds were appropriate and their standards should not be changed. Further work is needed to bring these areas back into compliance with water quality standards.

This project was funded by a State Nonpoint Source Program grant from TSSWCB.

For more information about this project, contact:

Ms. Leah Taylor at TIAER (ltaylor@tarleton.edu)

RUAA Document: https://www.tceq.texas.gov/waterquality/standards/ruaas/upperneches

DISCUSSION OF WATER QUALITY ISSUES IN THE WATERSHEDS

As discussed earlier in the report, these two watersheds have the same impairments and concerns despite having vastly different geographic and hydrologic qualities. Water quality is a very complex issue with a lot of moving parts, but pollutants from different sources can still lead to similar outcomes.

The Rayburn Watershed nutrient sources probably come from agricultural and wildlife sources due to its rural nature and lower soil infiltration rates. The Palestine watershed still likely gets nutrients from agricultural and wildlife sources, but OSSFs and WWTPs likely have a much higher impact here, coupled with high potential for groundwater interaction.

Both watersheds were likely affected by coal emissions, which are not watershed specific. East Texas was known to have multiple coal burning plants in the past, but their numbers have dwindled due to economic and political reasons. However, contaminants like mercury, which come from these emissions, are often persistent in the environment. It appears that Lake Palestine was only tested for mercury in fish tissue once, in 1996, where TxDSHS concluded it was not a concern. The author cannot find any evidence of testing for dioxins or other contaminants in fish tissue in this lake.

Industrial discharges are a possible source for metals, with steel manufacturing being more historically likely in the Palestine Watershed, and paper mills historically more common in the Rayburn Watershed. Both watersheds have wastewater treatment plants, which can also produce metal pollutants if not functioning properly. Some metals like iron may not necessarily be pollutants at all. Certain rock units in east Texas are known for containing low grade iron ore, which had been mined in the past.

SAM RAYBURN RESERVOIR IMPAIRMENTS

Impairment Description	Assessment Units Listed	Impairment Category	Year First Listed
Excessive algal growth in water	All Assessment Units	5n	2022
Dioxin in edible tissue	All Assessment Units	5a	2014
Mercury in edible tissue	All Assessment Units	5c	1996
pH (high)	AU 05 (Lower Attoyac Bayou Arm)	5c	2022

SAM RAYBURN RESERVOIR CONCERNS

Concern Description	Assessment Units Listed	Level of Concern
Iron in sediment	All Assessment Units	CS
Mercury in edible tissue	All Assessment Units	CS
Manganese in sediment*	All Assessment Units	CS

**This Concern was listed in the 2022 IR, but not the Draft 2024 IR. It has been a concern from 2006-2022.*

LAKE PALESTINE IMPAIRMENTS

Impairment Description	Assessment Units Listed	Impairment Category	Year First Listed
pH (high)	All Assessment Units	5b	2006

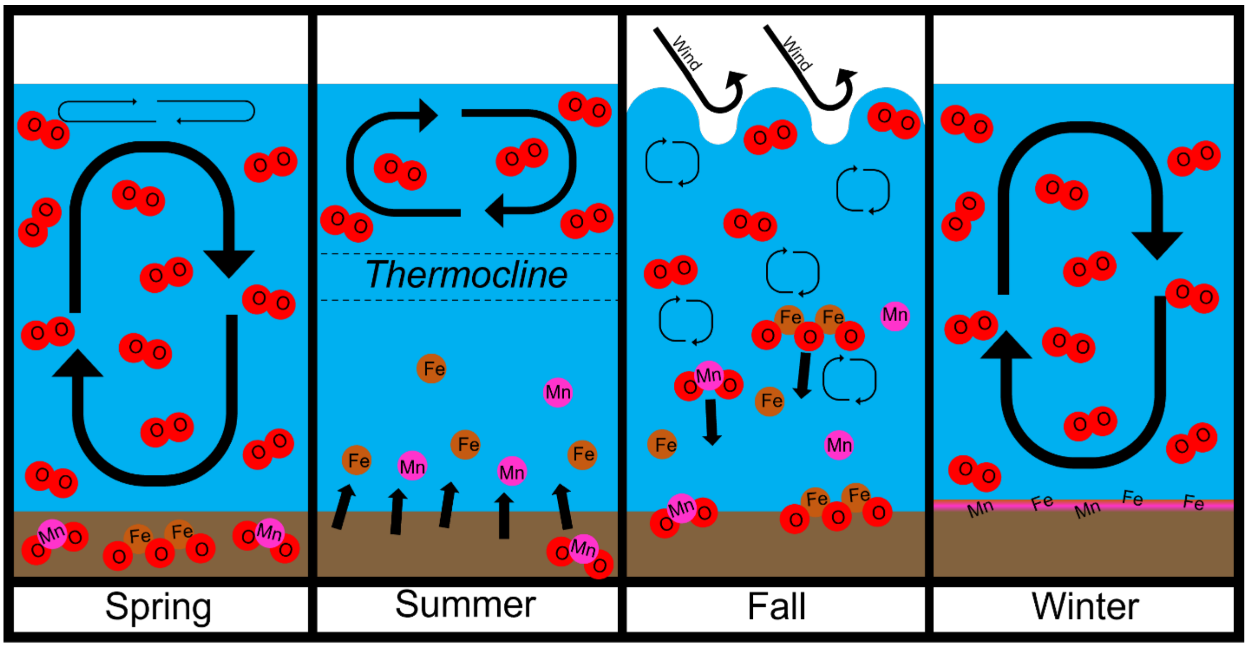
LAKE PALESTINE CONCERNS

Concern Description	Assessment Units Listed	Level of Concern
Manganese in sediment	All Assessment Units	CS
Depressed Dissolved Oxygen in Water	AU 01 (Main Pool/Dam)	CS
Excessive algal growth*	All Assessment Units	CS

**This concern was listed in the 2022 IR, but not the Draft 2024 IR. This is a newer type of concern, but chlorophyll-α concerns, which are related, have been present in this reservoir from 2008-2014.*

IRON AND MANGANESE IN SEDIMENT

Observing the 2022 and 2024 Integrated Report sections titled *Water Bodies with Concerns for Use Attainment and Screening Levels*, we can see that seven reservoirs across the state have concerns for iron and/or manganese in sediments. For the last ten years, only reservoirs have had these concerns for iron and manganese in sediment. These two metals can come from many sources, but one likely source is from natural sedimentation caused by biogeochemical reactions tied to reservoir stratification.

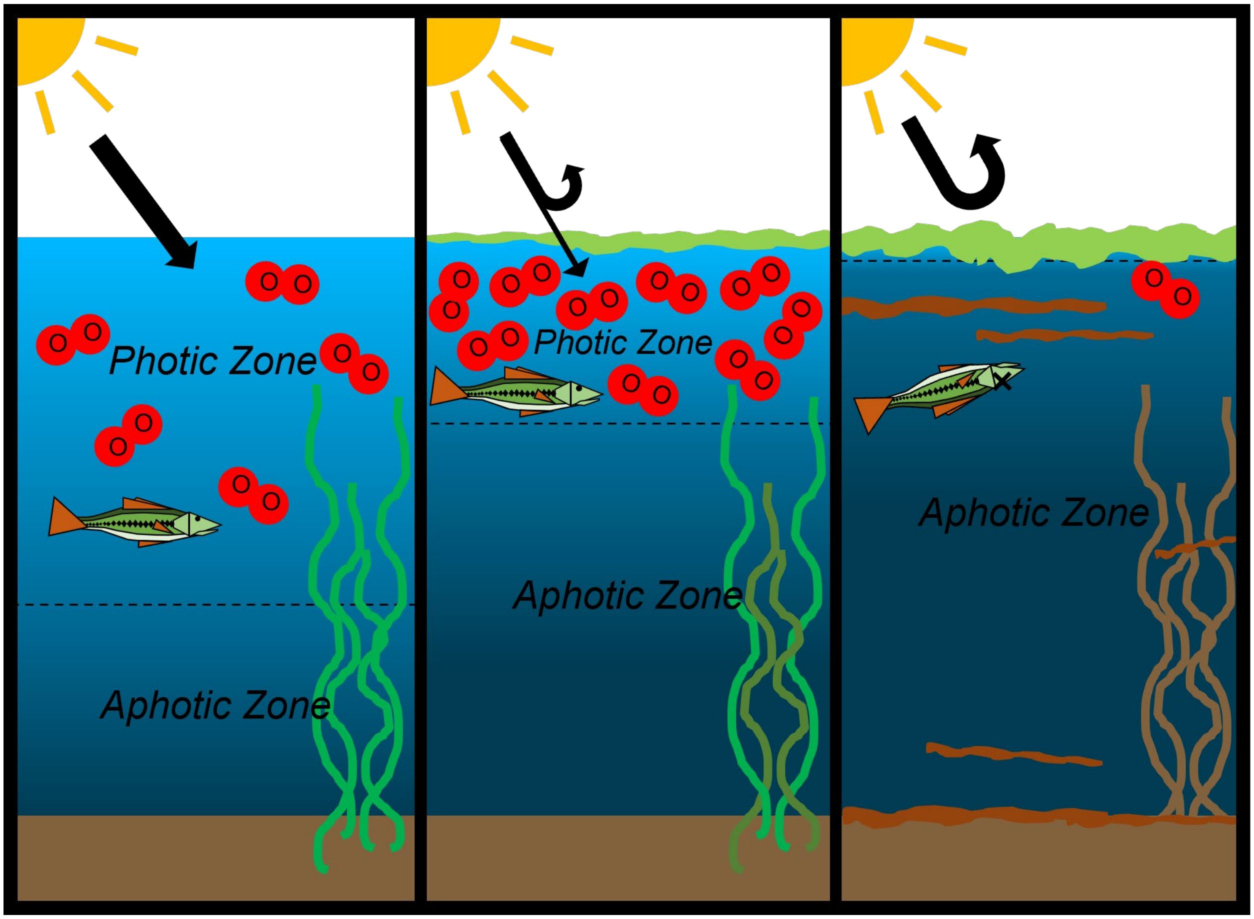


During spring, the entire water column is mixing, distributing oxygen generated by plant matter and absorption from the surface. Later into spring as temperatures rise, the topmost part of the water column begins heating up warmer than the lower sections of the water column. By summertime, the water column becomes stratified, where warmer, oxygen rich water circulates only at the top of the water column, and the lower part of the water column becomes anoxic. In these anoxic conditions, metals like iron and manganese within the underlying sediments go through a reduction reaction (losing oxygen molecules), which causes them to dissolve into the water. By late summer, concentrations of these metals can become high. By fall, an event called turnover occurs. Turnover is when a stratified lake begins to mix again, usually by wind churning the water surface and colder temperatures making water denser. Oxygen begins to distribute through the water column again, and by winter the entire water column becomes mixed again. As oxygen starts reaching the dissolved metals, it begins to “grab on” to them, bringing them out of solution into a solid state again, where they settle on the bottom of the lake. Then this cycle repeats itself. Yearly repetition of this process could lead to a buildup of iron and manganese rich sediment on the lake bottom, which could be a plausible reason for concerns of these metals occurring in some lakes across Texas.

This reaction process explained above may be the reason why we have concerns for iron and manganese in sediment in Sam Rayburn Reservoir, but one can see that the metals had to come *from somewhere* to accumulate as shown in the illustration above. Iron is one of the most common metals found in the earth’s crust, and it is especially common in the rock units of east Texas. Manganese is present in some of the rock units of east Texas, but not in as large of amounts as iron is. Manganese can come from several industrial sources such as: steel foundries, paper mill sludge, wastewater treatment plant sludge, cement production, and burning coal. Likely all of these factors contribute varying amounts of manganese to the environment in east Texas.

EXCESSIVE ALGAL GROWTH, LOW DISSOLVED OXYGEN

Excessive Algal Growth impairments and concerns are directly tied to the process of eutrophication. Eutrophication involves high levels of nutrients (such as nitrogen and phosphorous compounds) accumulating in a water body, leading to rapid algal growth and ultimately low dissolved oxygen concentrations.



Under normal conditions, water bodies have a photic zone and an aphotic zone. The photic zone is the area of the water column that light reaches, and this area commonly has all of the plant life and in turn, has most of the dissolved oxygen concentration. When eutrophic conditions occur, large mats of algae start to cover the water surface, greatly reducing the photic zone. However, since this algae is producing a lot of oxygen, respiring organisms are not yet affected. Certain plant life will begin to die off that can no longer access the light due to the algal mats blocking it out. When algal growth reaches a certain point, it will all begin to die off, and the dissolved oxygen levels will begin to plummet. As the organic matter breaks down the limited oxygen in the water is consumed by the decomposers further depleting the oxygen levels. This is often fatal to respiring aquatic organisms. The dying algae will fall in mats, coating everything in its path which also inhibits future plant growth.

A PHOTO OF AN ALGAL BLOOM IN A CREEK

EXCESSIVE ALGAL GROWTH (CONTINUED)

Based on the EPA's Pollutant Loading Estimate Tool (PLET), the Sam Rayburn Watershed generates five to six and a half times more nitrogen and phosphorous compared to the Lake Palestine watershed. When factoring in the capacities of the reservoirs (Rayburn storing approximately ten times more water), nutrient concentrations in Lake Palestine ends up being about twice as high as Rayburn's. In short, while the Sam Rayburn Watershed does create more nutrients than the Lake Palestine Watershed, Sam Rayburn Reservoir is able to dilute nutrients far better due to its sheer size, which likely leads to lower chlorophyll-α values.

When referencing the Draft 2024 Texas Integrated Report – *Supplemental Data for Reservoir Nutrient Assessment*, there are median chlorophyll-α values of 8.665 µg/L for Rayburn, and 29.0 µg/L for Palestine. The criteria for Lake Palestine of 24.29 µg/L is narrative, as the EPA disapproved the numeric criteria proposed by TCEQ in 2013. The criteria for Sam Rayburn Reservoir is 6.22 µg/L, which is numeric and accepted by the EPA. Their standards and nutrient loading are why they both have concerns or impairments despite being so different.

FISH KILL ON LAKE PALESTINE FROM 2005 - NOTE THE AMOUNT OF ALGAE ON THE WATER

TROPHIC CLASSIFICATION OF RESERVOIRS

The TCEQ classifies the trophic statuses of reservoirs in Texas as part of every Integrated Report, in a section titled *Trophic Classification of Reservoirs*. Assessors at TCEQ use the Carlson's Trophic Status Index (TSI) to classify reservoirs into four categories as defined in the table below. Carlson's Index involves a regression analysis of Secchi depth, total phosphorous, and chlorophyll-α to determine trophic states. For the 2024 IR cycle, 141 reservoirs had sufficient data to classify. Each reservoir was classed in Secchi depth, chlorophyll-α, and total phosphorous, and then ranked against the other assessed reservoirs based on each TSI category.

TROPHIC STATES AS DEFINED BY THE TCEQ

Trophic State	Water Quality Characteristics
Oligotrophic	Clear waters with extreme clarity, low nutrient concentrations, little organic matter or sediment, and minimal biological activity.
Mesotrophic	Waters with moderate nutrient concentrations and, therefore, more biological productivity. Waters may be lightly clouded by organic matter, sediment, suspended solids or algae.
Eutrophic	Waters relatively rich in nutrient concentrations, with high biological productivity. Waters more clouded by organic matter, sediment, suspended solids, and algae.
Hypereutrophic	Murkier, highly productive waters. Dense algae, very high nutrient concentrations.

Sam Rayburn Reservoir was classified as mesotrophic in the TCEQ's 2024 *Trophic Classification of Reservoirs*. It was given a chlorophyll-α rank of 23, a Secchi rank of 22, and a total phosphorous rank of 76 out of the 141 reservoirs assessed (lower numbers are better). Lake Palestine was classified as eutrophic by TCEQ's 2024 *Trophic Classification of Reservoirs*. Out of the 141 reservoirs assessed, Lake Palestine was given a chlorophyll-α rank of 117, a Secchi rank of 60, and a total phosphorous rank of 129, which puts it near the bottom of the pack.

TSI RANKINGS OF SAM RAYBURN RESERVOIR AND LAKE PALESTINE

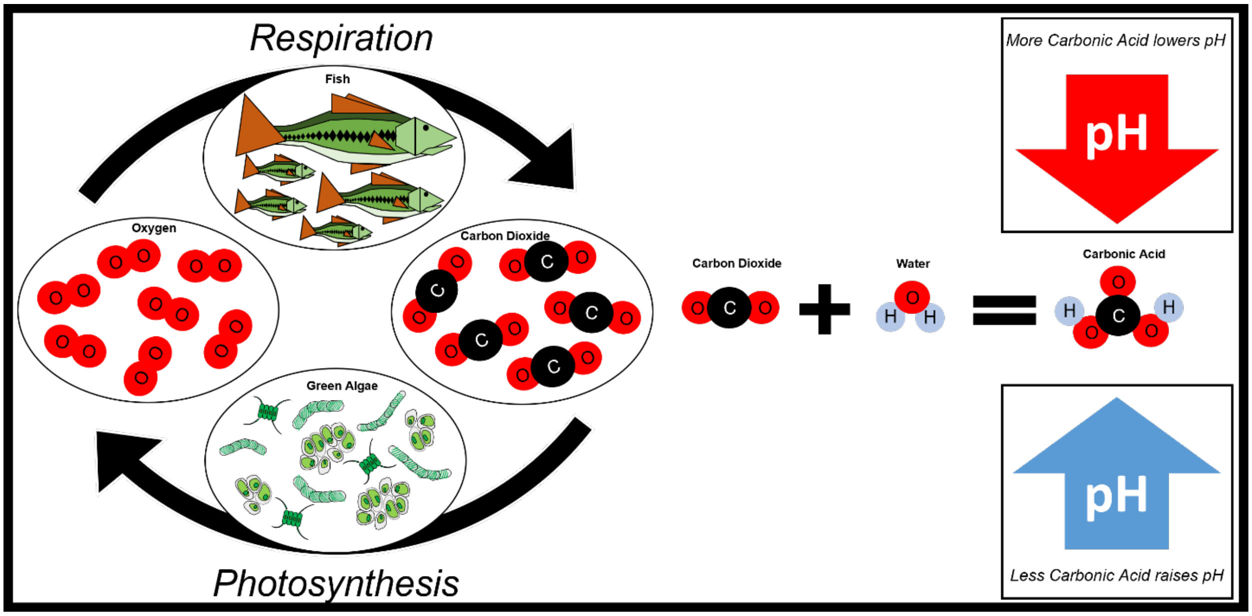
Name	Chl-α Rank	Chl-α Mean (ug/L)	Chl-α TSI	Chl-α TSI (2012)	10 Year Change	Secchi Rank	Secchi Mean (m)	Secchi TSI	TP Rank	TP Mean (mg/L)	TP TSI
Rayburn	23	6.64	49.18	48.58	0.6	22	1.72	52.12	76	0.04	59
Palestine	117	29.84	63.92	63.90	0.02	60	0.98	60.4	129	0.16	77.1

TP (total phosphorous), TSI (trophic status index), Secchi (Secchi depth, water clarity), Chl-α (chlorophyll-α)

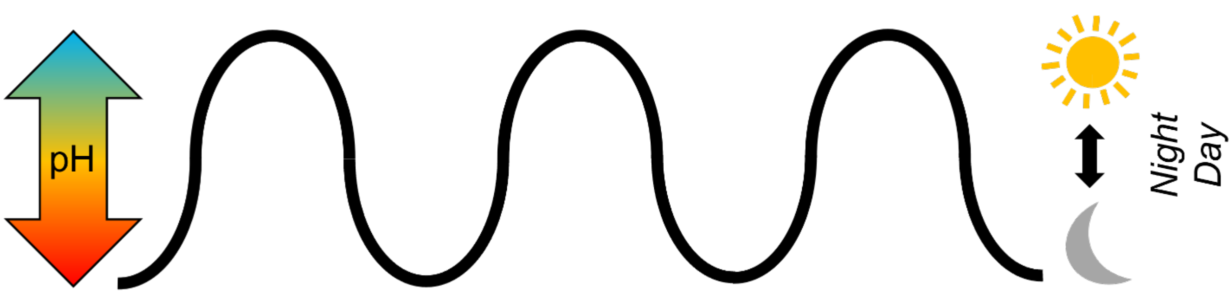
A SECCHI DISK, CHLOROPHYLL-A SAMPLE BOTTLE, AND A TOTAL PHOSPHOROUS SAMPLE BOTTLE

HIGH AND LOW PH

While there are many controls on the pH of water bodies, a predominant control is the presence or absence of carbon dioxide in the system. Respiration of aquatic organisms will add more carbon dioxide to the system, while photosynthesis of algae and plant matter will remove carbon dioxide from the system. During a diurnal (day/night) cycle, carbon dioxide builds up overnight due to the lack of photosynthesis while all the respiring organisms in the water are still breathing. When the sun comes out, photosynthesis resumes and begins using up available carbon dioxide. When eutrophic conditions exist in a water body, this cycle is increased significantly on the photosynthesis side. The presence of carbon dioxide allows for the reaction which forms carbonic acid, which lowers pH. When carbon dioxide is less available during the day, there is less carbonic acid being created, resulting in higher pH.



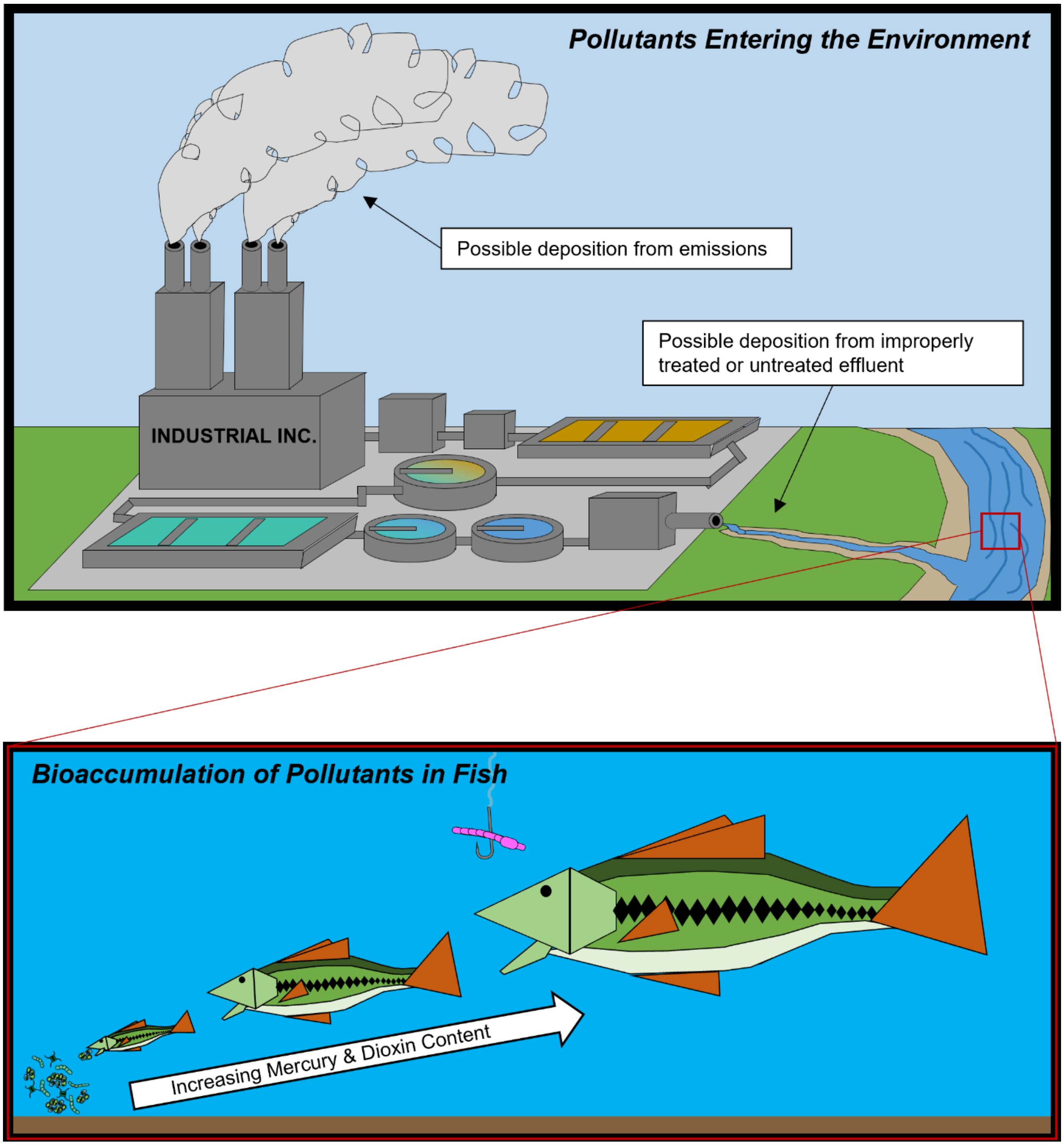
An important factor as to why this process affects east Texas lakes is due to a property called alkalinity. Alkalinity is a measure of calcium carbonate in water, which is correlated to a water's buffering capacity. Buffering capacity is the ability of a solution to resist rapid changes in pH. The higher the alkalinity, the higher the buffering capacity. Calcium carbonate (the mineral calcite) is the main component of the rock limestone. Limestone is an abundant substrate in central Texas, but is much sparser in east Texas. East Texas waters tend to have much lower alkalinities than their central Texas counterparts due to the lack of limestone bedrock.



A DIAGRAM SHOWING THE DIURNAL PH CYCLE OF LOW ALKALINITY WATER. A HIGH ALKALINITY WATER WOULD HAVE A MUCH GENTLER SLOPE – FEWER EXTREME VARIATIONS IN PH.

MERCURY AND DIOXIN IN EDIBLE FISH TISSUE

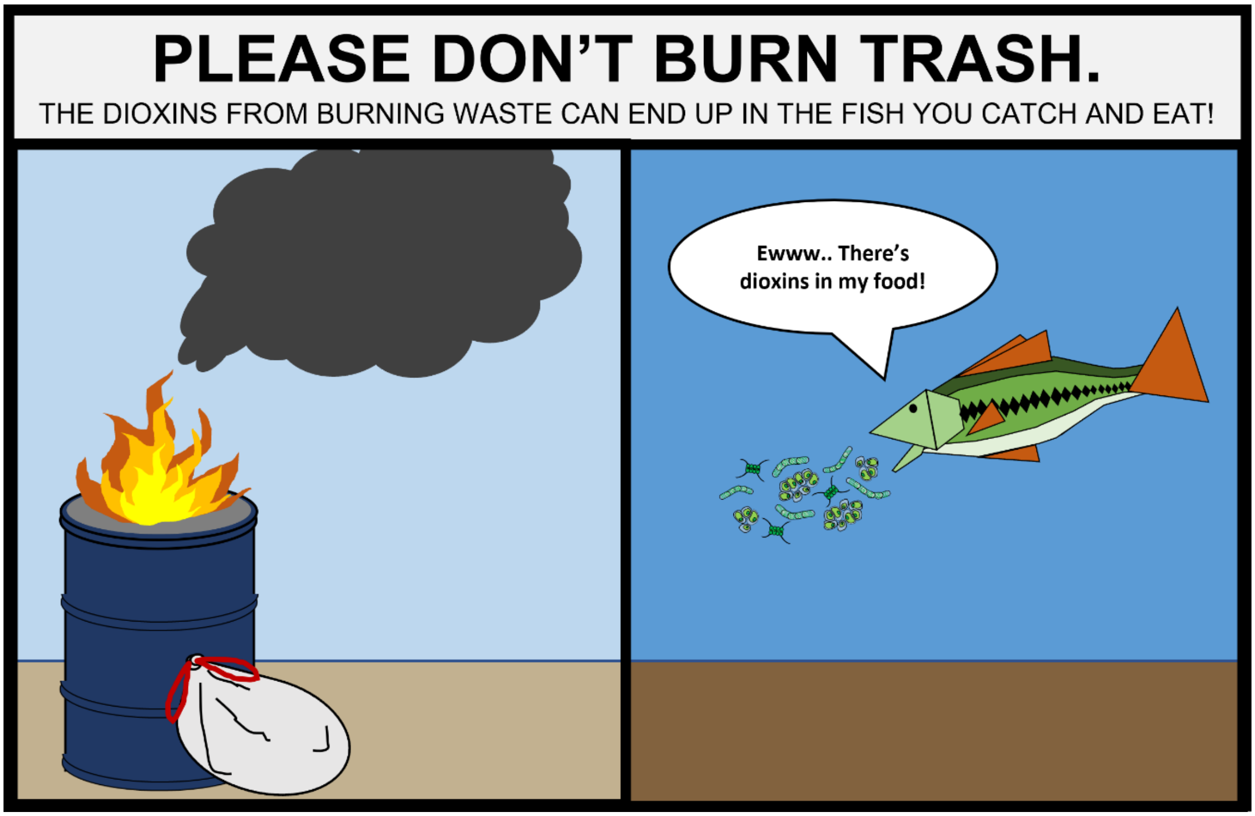
Unsafe levels of mercury and dioxins in edible fish tissue happen due to a process referred to as bioaccumulation or biomagnification. This process involves toxins which have made their way into a water body and then get consumed by microorganisms. These microorganisms are in turn consumed by aquatic insects or other macroinvertebrates, which are then consumed by smaller fish, which then get consumed by large predator fish such as bass or crappie. The higher up the food chain, the higher the concentration of toxins can be.



Pollutants like mercury and dioxins enter into the water, and subsequently the food chain from two main ways: from airborne emissions, and from effluent or runoff (wastewater).

MERCURY AND DIOXIN IN EDIBLE FISH TISSUE (CONTINUED)

The burning of coal is likely the main culprit for the mercury issues we have in our fish in east Texas, although newer regulations have reduced their impact. Mercury pollution can come from other sources such as industrial waste or waste incineration as well. This mercury starts as inorganic mercury, which is not as bioavailable (easily absorbed by an organism). Microorganisms will 'eat' the inorganic mercury, and process it into methylmercury, which is a much more bioavailable form of mercury. Then the mercury bioaccumulates in the process described on the previous page.



Dioxins are actually a group of chemicals that are persistent in the environment, hard to get rid of. One likely historical source for dioxins in east Texas were discharges from the paper industry, as dioxins are used in bleaching processes. Many industrial sources for dioxins like paper mills, leaded gasoline, or metal refinement/fabrication are now regulated, and are not polluting at the levels they once were. Today, the EPA lists individuals burning trash in their backyards as one of the largest quantifiable contributors to dioxin emissions. The EPA states that forest fires and landfill fires are two of the other major sources of current dioxin emissions, but are not as easily quantified. As with mercury, dioxins can bioaccumulate (they are fat soluble) in fish and become more concentrated as they move up the food chain.

DISCUSSION

Chemical, biological, and geological processes found in nature are more often than not, intertwined. The processes mentioned on the last few pages are all things that happen simultaneously. These issues all likely come from different forms of waste in the watershed. Excessive amounts of nutrients lead to excessive algal growth, which in turn affects pH and dissolved oxygen content. Industrial and municipal wastes are a likely source of the manganese present in the sediment, with iron likely being geologic in origin. These metals then collect on the bottom of the reservoir through biogeochemical processes tied to reservoir stratification. Industrial waste, improper waste incineration, and emissions lead to mercury and dioxin issues in fish. All of these factors play a key role in the health of a watershed and should be looked at individually as well as how they interact together.

RECCOMMENDATIONS FOR IMPROVING WATER QUALITY

In concept, improving water quality is as simple as reducing pollution. However, pollution comes from a wide variety of sources, both point and nonpoint sources. Reducing pollutants can be as simple as fixing a broken sewer pipe, or as difficult as collecting hundreds of bacteria samples across a watershed to figure out where the highest concentrations are sourced, then doing DNA analyses on the samples to figure out what animal(s) they come from, then produce a plan on how to reduce their waste input on the watershed, and then implementing that plan.

PHOTOS FROM LEFT TO RIGHT: A “NO LITTERING” SIGN, A BEACH CLEANUP AT SAM RAYBURN RESERVOIR, OSSF REPLACEMENT, AND A STREAM CLEANUP EVENT.

Ways to reduce bacteria and nutrient introduction into an ecosystem include Agricultural Best Management Practices such as filter strips, cover crops, or invasive feral hog eradication. Efforts to repair, replace, or upgrade OSSFs and WWTPs would have a great impact for nutrients and bacteria as well. Reducing these pollutants, which are a food source for photosynthetic organisms, would likely reduce chlorophyll-α concentrations (less algal growth), dissolved oxygen issues, and pH issues.

Metals and other toxins like dioxin have become heavily regulated over the past several decades. While some may be naturally occurring in small amounts, most of the impairments and concerns related to these toxins are caused by pollution. They come from a large variety of sources, such as petroleum emissions, waste incineration, mining activity, metal refinement (smelting), landfills, and industrial discharges (paper mills, chemical manufacturers, etc.). More stringent or completely new standards are being implemented on these discharges and emissions.

For example, coal emissions and municipal waste incineration are among the largest contributors to mercury pollution. In 1995 and 2000, the EPA set standards for municipal waste incineration, which caused mercury emission levels from waste incineration to drop by 88% from 1990 levels! Also, in 2011, the EPA released air quality standards which now regulate coal-fired power plants, reducing their overall pollutant loading.

More information on mercury emissions changes can be found here: https://www.epa.gov/mercury/what-epa-doing-reduce-mercury-pollution-and-exposures-mercury

The implementation of newer and more stringent standards is actively reducing pollutants such as mercury and dioxin. However, these materials often persist in the environment for a long time and are difficult to remove. This is why despite these new standards; we still have impairments such as mercury and dioxin in fish tissue or manganese in sediment. There is a high likelihood that some of these contaminants are left over from times when standards didn’t exist, and people either didn’t know or didn’t care what they were putting into the environment.

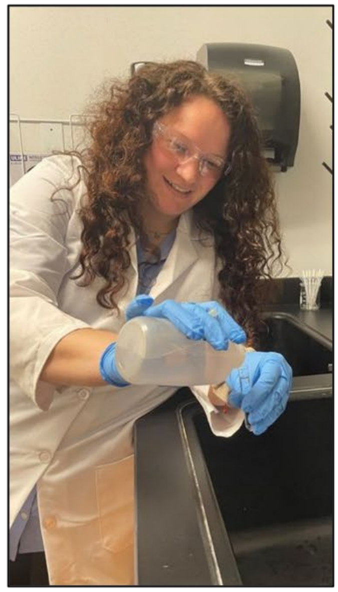
Education and outreach are also crucial steps in improving the environment. An informed public is a conscientious one. This is accomplished through things like public meetings, stream cleanups, and hosting workshops to help the public learn about water quality issues in their watersheds, and how they can participate in remediating them. The more pollutants we are able to keep from getting into the environment, the better off we all will be, and present and future generations can continue to enjoy the natural resources and scenic waterways of the Neches River Basin.

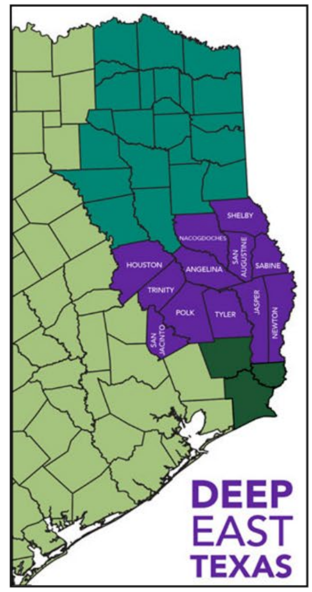
HIGHLIGHTS AND UPDATES OF THE YEAR

RECREATION, EDUCATION, AND OUTREACH UPDATES

SFASU CARRI PROGRAM INTERNSHIP PARTNERSHIP

STEPHEN F. AUSTIN STATE UNIVERSITY
THE UNIVERSITY OF TEXAS SYSTEM
NACOGDOCHES, TEXAS





CENTER FOR APPLIED RESEARCH AND RURAL INNOVATION

In late spring of 2023, ANRA began a partnership with Stephen F. Austin State University's Center for Applied Research and Rural Innovation (CARRI) Program. The CARRI program provided funding to SFA students to join the ANRA team for a semester to gain experience in the environmental industry. At the time of the release of this report, the CARRI/ANRA internship partnership has hired two Environmental Laboratory interns and two Clean Rivers Program interns. This program is currently active and applicants may qualify if they meet these requirements:

- Currently enrolled at Stephen F. Austin State University
- Are a graduate student or a senior-level undergraduate student (preferred)
- Have course-related experience in sciences and/or environmental fields
- Have a GPA of 2.75 or greater

If you meet these requirements and are interested in a paid internship opportunity in either the surface water quality or environmental laboratory industry, contact any of the following people below for more information.

Ms. Monica Loa at (loamm@sfasu.edu) – SFASU CARRI Program Director

Mr. Josh Fleming (Joshua.Fleming@sfasu.edu) – SFASU CARRI Program Project Coordinator

Ms. Kimberly Wagner at (kwagner@anra.org) – ANRA Executive Manager, Communications

Mr. Andrew Henry at (ahenry@anra.org) – ANRA Clean Rivers Program Coordinator

HOSTING THE NECHES RIVER RENDEZVOUS

The Neches River Rendezvous is a long-standing tradition in east Texas which involves paddling down the Neches River through ten miles of pristine waterway that passes through the Davy Crockett National Forest. The event had been hosted almost every year since 1997 by the Lufkin/Angelina County Chamber of Commerce, however, the last few attempts at the Rendezvous have been prevented by drought, flood, or Covid-19. ANRA has been a long-time sponsor of the event, and in 2023, the Lufkin/Angelina County Chamber of Commerce transferred stewardship of the event to ANRA. On May 18th of this year, ANRA was supposed to host the Rendezvous for the first time.

The Neches River Rendezvous was slated to have a great turnout, with all 100 available spots filled! Exciting new features such as food trucks, contests, games, and conservation education were planned. Unfortunately, due to high flow conditions, the event had to be cancelled for the year. But don't worry! We'll be even more ready for next year!

To find out more information about the upcoming 25th Annual Neches River Rendezvous, check our rendezvous page on the ANRA website at: https://www.anra.org/conservation-recreation/neches-river-rendezvous/

Or contact us via email at (recreation@anra.org) or by phone at (936)-632-7795

CLEAN RIVERS PROGRAM UPDATES

THE 2024 INTEGRATED REPORT

Every two years, the Texas Commission on Environmental Quality (TCEQ) releases an Integrated Report (IR), which utilizes water quality data from Clean Rivers Program partners across the state. TCEQ Data Analysts use the most recent seven years' worth of data to assess Texas waterbodies to determine if they meet their respective water quality standards. If a waterbody has not met its specified standards, it gets placed on the IR's 303(d) List. Much of the data referenced and discussed in this report comes from the latest release of the 2024 Integrated Report.

The 2024 Integrated Report can be found here: https://www.tceq.texas.gov/waterquality/assessment

NEW LISTINGS AND DELISTINGS IN THE UPPER AND MIDDLE NECHES BASIN

The 303(d) List is a portion of the TCEQ's IR, which lists out all the impaired waters in the state. Every state in the US is responsible for submitting a 303(d) List to the US Environmental Protection Agency (EPA) every two years. Each IR includes documents which list which segments have been added or 'listed' to the 303(d) List, and which list which segments have been removed or 'delisted' from the 303(d) List).

NEW LISTINGS

Name	Segment ID	AU ID	Impairment Description	Impairment Category
Angelina River/Sam Rayburn Reservoir	0615	01	Low pH	5c
Angelina River/Sam Rayburn Reservoir	0615	01	Bacteria in Water	5c

NEW DELISTINGS

Name	Segment ID	AU ID	Impairment Description	Previous Category	Current Category
Cedar Creek	0604A	02	Bacteria in Water	5a	4a
Hurricane Creek	0604B	01	Bacteria in Water	5a	4a
Jack Creek	0604C	01	Bacteria in Water	5a	4a
Piney Creek	0604D	02	Bacteria in Water	5b	-
Biloxi Creek	0604M	03	Bacteria in Water	5a	4a

THE 5R IMPAIRMENT CATEGORY

In the 2024 IR, a new impairment subcategory was introduced which is labeled as "5r" which is described in TCEQ's assessment guidance as follows:

> *"Impairments identified as Subcategory 5r have a WPP under development or EPA accepted nine element-WPPs that address multiple impairments and water quality concerns with a goal to restore and protect water quality. WPPs are community developed approaches that identify potential nonpoint sources of waterbody impairments throughout a watershed and provide a framework for implementation strategies to reduce pollution and improve overall water quality. Development of a WPP generally takes about three years, depending on the nature of the work required. Attainment of the standard is expected upon full implementation of the plan, although that may take many years or decades. An adaptive management approach is used that allows for periodic revisions of the WPP and assessment of progress towards meeting the goals."*

This new category will allow the reader to easily distinguish which assessment units on the 303(d) List are actively being remediated through Watershed Protection Plans specifically.

APPENDIX

MAJOR EVENTS IN THE SAM RAYBURN RESERVOIR AND LAKE PALESTINE WATERSHEDS

The tables below cover various milestones for both Sam Rayburn Reservoir and Lake Palestine. They span events ranging from their creation to the most recent water quality studies from federal, state, and private entities.

MAJOR WATERSHED EVENTS – SAM RAYBURN RESERVOIR

Year	Event or Report	Description
~1935	Planning and Initial USACE Surveys	The Sabine-Neches Conservation District began planning for the McGee Bend Reservoir, with the US Army Corps of Engineers (USACE) surveying the area for reservoir potential. Plans for the size, power generating capabilities, and ownership or the water would go on to be disputed for the next two decades. Funding for the construction of the reservoir was immense, which resulted in several setbacks over the course of its development. Other hinderances included land acquisition, and the second World War.
1956	Construction begins on the McGee Bend Reservoir and Dam	USACE began construction on the dam through the general contractor Paul Hardeman, Inc. The project cost nearly $66,000,000 and was funded by both USACE and the Lower Neches Valley Authority
1963	McGee Bend Reservoir has its name changed to Sam Rayburn Reservoir	Sam Rayburn, who served in the Texas Legislature, and later as the U.S. House of Representatives Speaker of the House, passed away in 1961. Rayburn was known for his efforts in soil and water conservation. The 88th Congress adopted a special resolution to change the reservoir's name from McGee Bend Reservoir to Sam Rayburn Reservoir
1965	Dam completed and impoundment begins on the reservoir	After completion of the dam, USACE began impounding water.
1965	Texas Parks and Wildlife Department begins stocking the reservoir	TPWD stocked the new reservoir for the first time with largemouth bass, white crappie, and warmouth and longear sunfish perch. They have stocked the reservoir nearly every year since then.
1966	The reservoir reaches full pool	The reservoir took a roughly a year to fill up.
1967	The USGS released a report on the water quality of the Neches Basin	The USGS, in cooperation with TWDB, released Geological Survey Water Supply Paper 1839-A: *Reconnaissance of the Chemical Quality of Waters of the Neches River Basin, Texas*. This study included Sam Rayburn Reservoir.
1971	The USGS released a report on the water quality of Sam Rayburn Reservoir	The USGS, in cooperation with USACE, released Geological Survey Water Supply Paper 1999-J: *The Water Quality of Sam Rayburn Reservoir, Eastern Texas*, which went into further detail about the water quality issues the reservoir was facing.
1972	The NRCD (ANRA) implemented its Control Zone Rayburn Program	ANRA began regulating OSSFs in a 2000ft buffer surrounding the reservoir.
1977	The EPA released a eutrophication survey report on Sam Rayburn Reservoir	The EPA began conducting eutrophication surveys in cooperation with the Texas Water Quality Board. The surveys were conducted at several reservoirs nationwide. Among the reservoirs surveyed was Sam Rayburn Reservoir, in a report titled: *Report on Sam Rayburn Reservoir Angelia, Jasper, Nacogdoches, Sabine, and San Augustine Counties Texas EPA Region VI Working Paper No. 657*
1991	The Texas Clean Rivers Program Begins collecting information on the reservoir	The reservoir was assessed by CRP Partners and the TCEQ, and has been continually monitored in some form since that time by the Clean Rivers Program.
1994	Sam Rayburn Reservoir listed on the 303(d) List	For the first time, Sam Rayburn Reservoir was listed on the 303(d) List, impaired for toxics, DO, nitrogen, phosphorous, high chlorophyll-a and pheophytin-a, and low Secchi depth
1995	Texas DSHS surveyed several east Texas lakes for mercury in fish tissue	The TxDSHS survey titled *Aggregate Risk Assessment for Consumption of Fish from East Texas Lakes* would be the first of many toxicities in fish tissue studies to survey fish on Sam Rayburn. Subsequent surveys occurred between 2007-2010, with reports/advisories being released in 2013

MAJOR WATERSHED EVENTS – SAM RAYBURN RESERVOIR (CONTINUED)

Year	Report or Event	Description
2003	Tetra Tech (private consultant) released a data review report pertaining to a possible TMDL	Tetra Tech, which subcontracted ANRA, released a report titled Historical Data Review for Sam Rayburn Reservoir, Texas. This report focused on gathering information to determine if the reservoir met state standards for aluminum, pH and DO, and whether or not a TMDL was needed to bring the reservoir back into compliance. Following the study, it was determined by TCEQ that a TMDL for these parameters was not necessary.
2006	The TWDB released a volumetric survey report on Sam Rayburn Reservoir	The TWDB, in cooperation with USACE, released a report titled *Volumetric Survey of Sam Rayburn Reservoir*. It involved conducting bathymetric surveys and the collection and creation of GIS data of the reservoir to quantify the capacity of the reservoir.
2006	TPWD begins releasing survey reports about the reservoir	TPWD survey reports are concerned with the statistics/management of the fish communities of the lake. TPWD has released seven survey reports total, in 2006, 2008, 2010, 2012, 2014, 2018, 2022.
2007	EPA collects National Lake Assessment Data from Rayburn	The EPA collected data at a site on Sam Rayburn Reservoir for the National Lake Assessment, which focuses on nutrient loading, lake drawdown, and cyanotoxins. Another data collection happened on the reservoir in 2012.
2017	USACE Updates the Sam Rayburn Reservoir Master Plan	USACE is required to create and periodically update master plans for their water resource projects. In 2015, they began to update the Sam Rayburn Reservoir Master Plan to bring it to the latest ecological, socio-demographic, and outdoor recreation trends.

A VIEW OF SAM RAYBURN RESERVOIR NEAR THE DAM

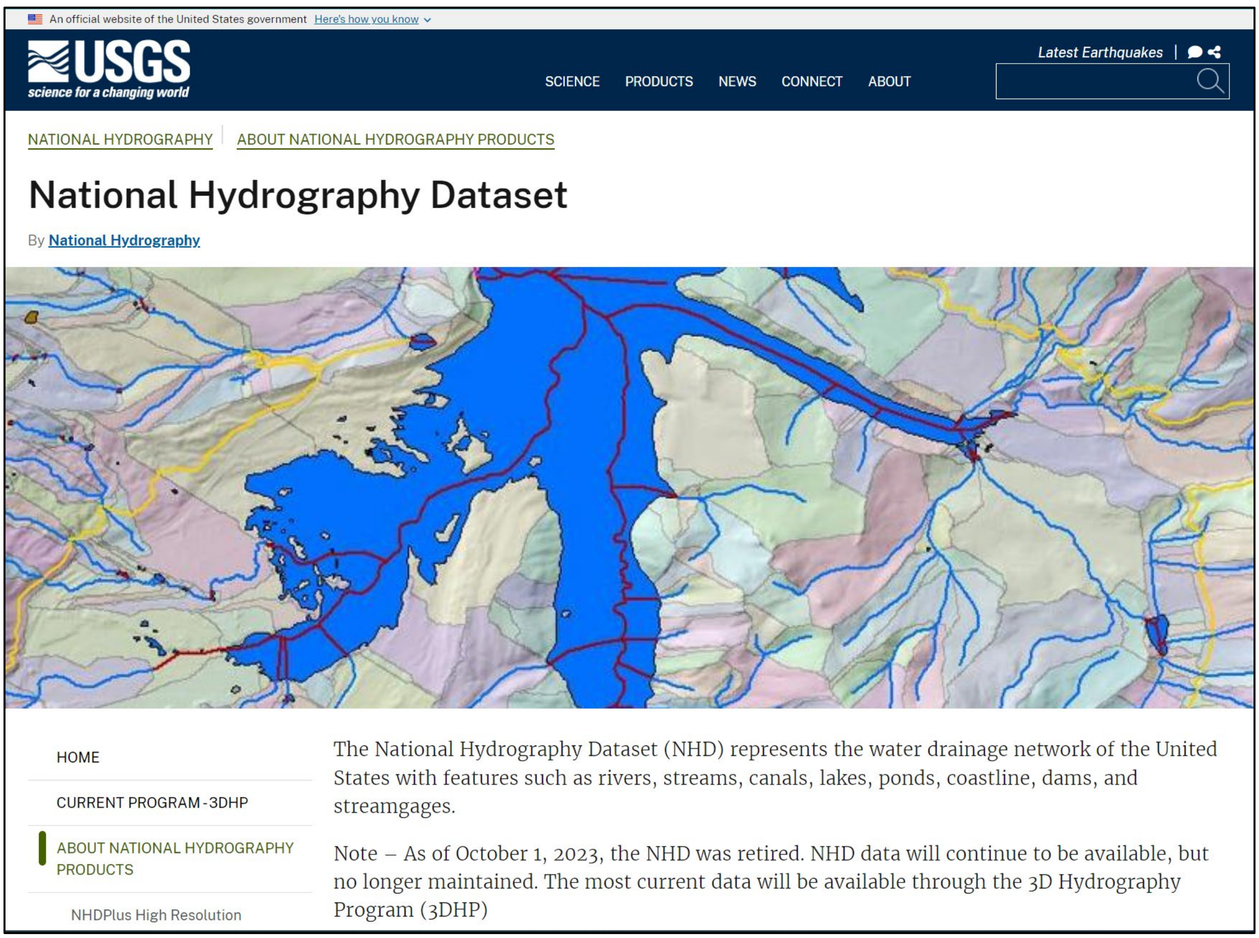
MAJOR WATERSHED EVENTS – PALESTINE

Year	Report or Event	Description
1938	Planning and Initial Surveys	The Sabine-Neches Conservation District and the Army Corps of Engineers were working to secure funding for this project, while the State Water Board and State Department of Reclamation surveyed the area for reservoir potential. Again, local politics, WWII, and lack of funding delayed this project for several years, with discussions and planning happening throughout the late 1940s to early 1950s.
1956	The reservoir was permitted	The newly formed UNRMWA received its permit to construct Lake Palestine in 1956
1960	The original dam began construction	Construction on the Blackburn Crossing Dam was completed by 1962.
1967	The USGS released a report on the water quality of the Neches Basin	The USGS, in cooperation with TWDB, released Geological Survey Water Supply Paper 1839-A: *Reconnaissance of the Chemical Quality of Waters of the Neches River Basin, Texas*. This study included Lake Palestine.
1969	The dam was expanded	By 1971, the expansion of the dam was completed, increasing the capacity of the reservoir to its present day storage levels.
1971	Texas Parks and Wildlife Department begins stocking the lake	TPWD stocked the lake for the first time with largemouth bass, and blue and channel catfish. They have stocked the reservoir nearly every year since then.
1973	The lake reaches full pool	By early 1973, the lake finally reached capacity based on TWDB data.
1977	The US EPA Released a Eutrophication Survey Report on Lake Palestine	The EPA began conducting eutrophication surveys in cooperation with the Texas Water Quality Board. The surveys were conducted at several reservoirs nationwide. Among the reservoirs surveyed was Lake Palestine, in a report titled: *Report on Palestine Reservoir Anderson, Cherokee, Henderson, and Smith Counties Texas EPA Region VI Working Paper No. 654*
1991	The Texas Clean Rivers Program Begins	The reservoir was assessed by CRP Partners and the TCEQ, and has been continually monitored in some form since that time by the Clean Rivers Program.
2000	The UNRMWA became the permitter for OSSFs surrounding the reservoir	A water quality zone surrounding Lake Palestine was established, wherein OSSFs within 525ft of the 355ft msl line of the lake are regulated by the UNRMWA.
2006	Lake Palestine Listed on the 303(d) List	For the first time, Lake Palestine was listed on the 303(d) List, impaired for high pH, category 5c.
2007	EPA collects National Lake Assessment Data from Lake Palestine	The EPA collected data at a site on Lake Palestine for the National Lake Assessment, which focuses on nutrient loading, lake drawdown, and cyanotoxins. Another data collection happened on the lake in 2012.
2008	TIAER releases a pH study which included Lake Palestine	The TCEQ TMDL Program contracted TIAER to conduct research on high pH impaired waters in Texas, which included Lake Palestine. TIAER produced a report titled *Texas pH Evaluation Project.* Their findings recommended a TMDL for Lake Palestine for pH.
2009	TPWD begins releasing survey reports about the lake	TPWD survey reports are concerned with the statistics/management of the fish communities of the lake. TPWD has released four survey reports in total, one in 2009, 2013, 2017, and 2021.
2012	The lake becomes part of the USGS Zebra Mussel Monitoring Project	In 2010, USGS began monitoring lakes in Texas for the invasive zebra mussels. The project focuses on the presence/absence, early detection, and spatial population dynamics of the mussels.
2014	The TWDB released a volumetric survey report on Lake Palestine	The TWDB released a report titled *Volumetric Survey of Lake Palestine*. It involved conducting bathymetric surveys and the collection and creation of GIS data of the reservoir to quantify the capacity of the reservoir.
2021	TRWD and DWU began construction on the Integrated Pipeline Project	This project involved the construction of a massive pipeline to draw water from Lake Palestine and pump it to the Dallas area for water supply. A portion of this pipeline was completed in 2022, and the project is set to be completed around 2030.

FLOW METHODOLOGY

Many regions in this report are remote and as such do not have existing water quality data, including flow data. ANRA uses National Hydrography Dataset Plus High Resolution (NHD Plus HR) model's Enhanced Unit Runoff Method – Mean Annual (EROMMA) to approximate flow in regions with data gaps. NHD Plus HR is a dataset which contains elevation, rainfall, and flow data from USGS Stream Gages where available. EROMMA is the calculation of this data to estimate stream flow. Keep in mind that these flow values are estimations and may vary in accuracy based on factors this method cannot discern. However, the flow values given by this dataset and calculation methodology are far better than no data at all. For more information on the NHD Plus HR and EROMMA, please visit: https://www.usgs.gov/national-hydrography/nhdplus-high-resolution

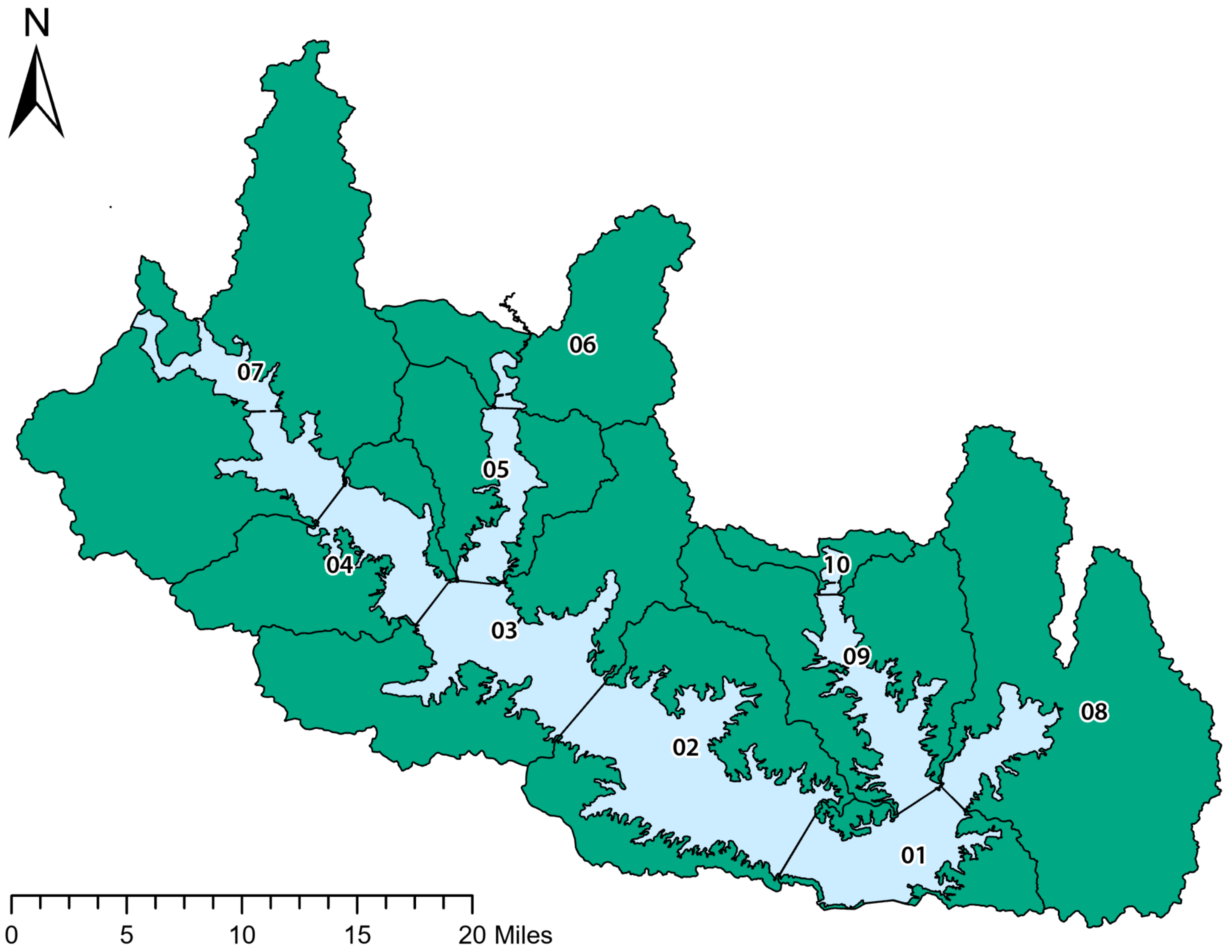
Where traditionally collected flow data or USGS Stream Gage flow data are available, those values will be used instead of the NHD Plus HR EROMMA values. Flow values reported are taken from the most downstream reach of a stream, either right before a confluence or right before entering the reservoirs. Streams are considered significant enough to report if their mean annual flow was greater than or equal to 5 cfs at their lowest reach before a confluence or before entering a reservoir.



A SCREENSHOT OF THE NHD WEBPAGE

SUBWATERSHEDS – SAM RAYBURN RESERVOIR WATERSHED

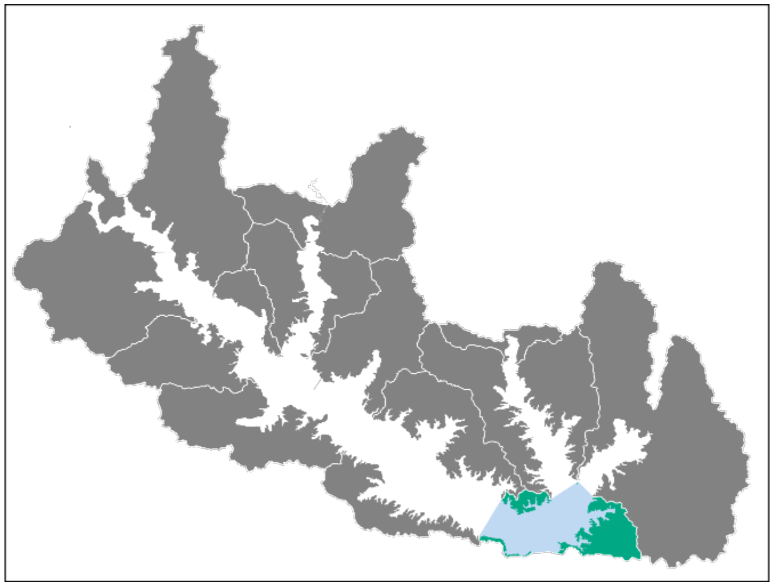
This section will talk about each individual subwatershed in the Sam Rayburn Reservoir watershed. Subwatersheds are delineated based on the reservoir assessment units, the boundaries follow HUC 12 lines where possible, and are based on elevation data or assessment unit boundaries otherwise. Data across these subwatersheds may appear similar, as some impairments and concerns are on a segment level, meaning they are applied to all assessment units within the segment. Flow values refer to the most downstream point of a stream before confluences or before discharging into the reservoir. Subwatersheds are named based on Assessment Unit numbers.



AU-01 – MAIN POOL/DAM

WATER QUALITY

This Subwatershed has one active SWQM station (14906), and five former SWQM stations (15451, 16785, 10611, 15672, 16786). There are two permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are two significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

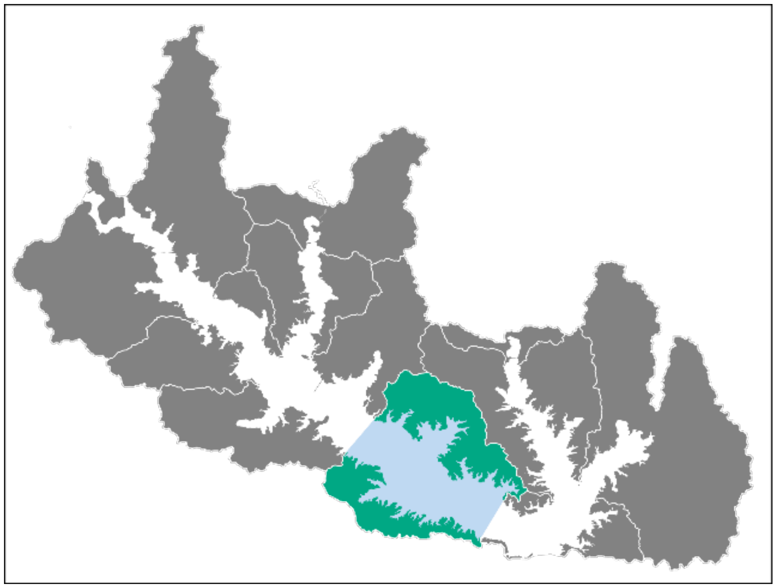
Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

STREAMS

Name	Flow (cfs)	Length (km)
Squirrel Creek	7.35	5.97
Tiger Creek	8.56	6.47

AU-02 – LOWER ANGELINA



WATER QUALITY

This Subwatershed has one active SWQM station (15671), and three former SWQM stations (15522, 16240, 15670). There is one permitted discharge in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are six significant inflowing streams, listed below.

IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

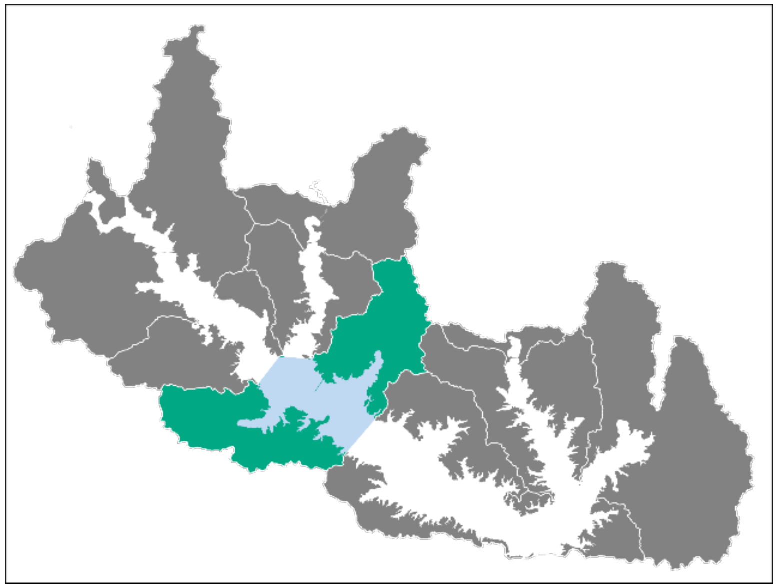
STREAMS

Name	Flow (cfs)	Length (km)
Bridge Creek	5.86	6.23
Caney Creek	6.42	5.99
Lucas Creek	6.44	4.63
Norris Creek	6.51	3.39
Parker Creek	6.97	7.89
UNT E of Bridge Creek	5.23	5.3

AU-03 – MIDDLE ANGELINA

WATER QUALITY

This Subwatershed has one active SWQM station (10612), and one former SWQM station (16790). There are three permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are fifteen significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

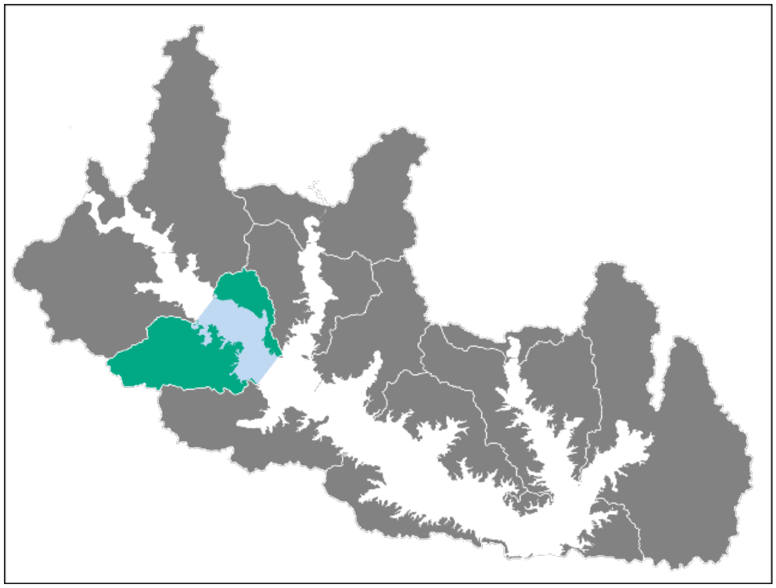
STREAMS

Name	Flow (cfs)	Length (km)
Caney Creek	5.35	5.61
Cedar Creek	9.56	5.04
Dry Creek	6.4	4.41
Franklin Branch	6.88	5.04
Harvey Creek	38.25	19.09
Herd Pen Creek	5.62	6.18
Indian Creek	6.71	5.84
Long Prairie Branch	10	5.46
Owl Creek	5.96	7.65
Pophers Creek	34.17	14.06
Rocky Creek	10.4	5.82
Scott Creek	8.6	7.3
Smith Branch	6.35	6.29
UNT NE of Pophers Creek	5.06	5.25
Walnut Branch	7.71	7.26

AU-04 – UPPER-MIDDLE ANGELINA

WATER QUALITY

This Subwatershed has one active SWQM station (15524), and three former SWQM stations (16492, 15669, 16793). There are no permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are six significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

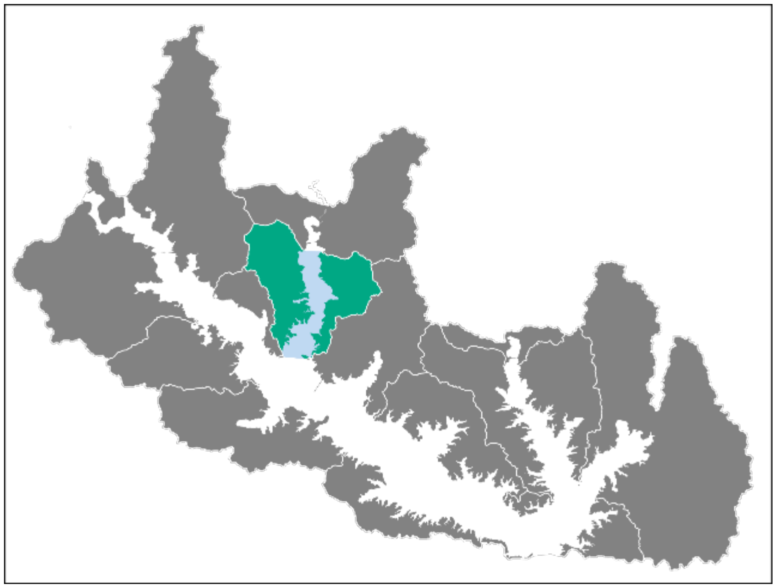
Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

STREAMS

Name	Flow (cfs)	Length (km)
Hanks Creek	11.74	6.35
Shirley Creek	9.75	9.98
Stanley Creek	29.55	15.2
UNT N of Shofner Cemetery	7.47	4.95
Unt of Stanley Creek	6.46	6
UNT S of Shofner Cemetery	7.47	4.95

AU-05 – LOWER ATTOYAC



WATER QUALITY

This Subwatershed has one active SWQM station (15523), and three former SWQM stations (16791, 15666, 15667). There are no permitted discharges in the subwatershed. There is a site specific impairment for the Assessment Unit, high pH. There are three significant inflowing streams, listed below.

IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996
pH	5c	2022

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

STREAMS

Name	Flow (cfs)	Length (km)
Boggy Creek	8.96	6.71
Prairie Creek	16.08	7.73
Sandy Creek	15.57	11.84

AU-06 – UPPER ATTOYAC

WATER QUALITY

This Subwatershed has one active SWQM station (10614), and no former SWQM stations. There are no permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are ten significant inflowing streams, listed below.

IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

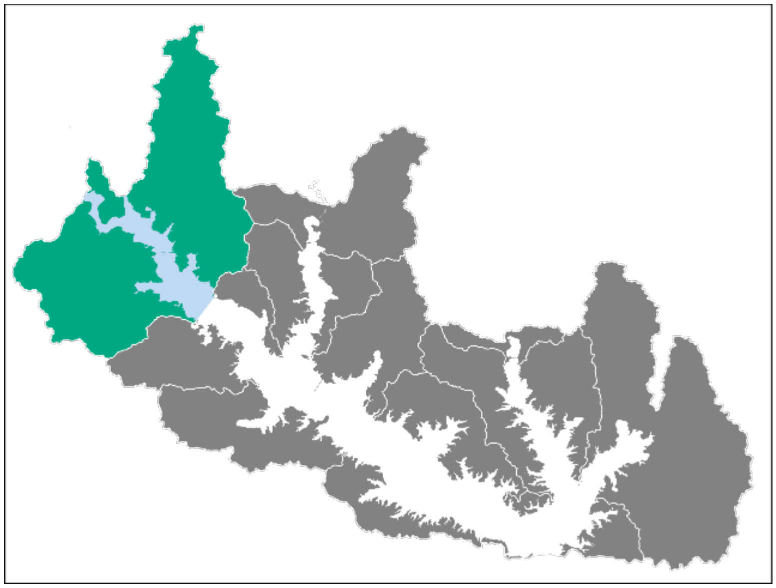
STREAMS

Name	Flow (cfs)	Length (km)
Brushy Creek	26.45	14.06
Dry Fork	5.34	5.62
Garret Branch	5.23	3.04
Johnson Creek	30.15	15.22
Lagroulle Creek	21.83	9.62
Rocky Creek	5.51	4.31
Running Branch	6.82	4.19
Sandy Creek	16.84	9.23
Spears Creek	46	9.72
UNT of Lagroulle Creek	10.84	6.36

AU-07 – UPPER ANGELINA

WATER QUALITY

This Subwatershed has one active SWQM station (10613), and six former SWQM stations (15668, 16788, 21100, 15525, 10615, 10616). There are no permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are twenty-two significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

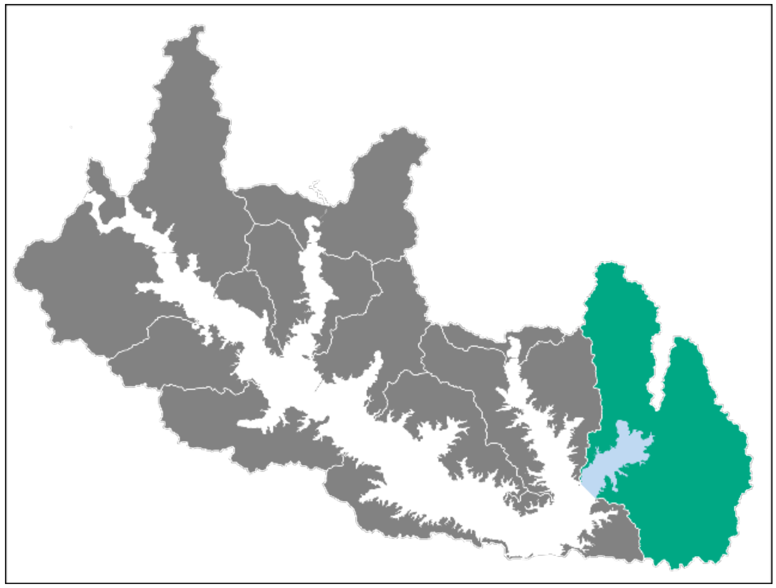
STREAMS

Name	Flow (cfs)	Length (km)
Anderson Creek	25.6	12.94
Beech Creek	6.55	6.39
Brush Creek	5.9	4.36
Brushy Creek	10.44	8.22
Duranzo Creek	34.93	3.6
Gilliland Creek	19.49	12.37
Lavaca Creek	14.46	6.46
Lick Creek	12.22	5.66
Linston Creek	22.37	12.1
Martin Creek	13.77	8.07
Mill Creek	9.27	8.37
Morton Creek	15.16	8.26
Moss Creek	77.48	38.22
Odell Creek	42.61	13.84
Oil Springs Branch	12.14	8.01
Rector Creek	12.83	9.88
Tubbs Creek	8.59	5.65
UNT of Anderson Creek 1	5.76	3.96
UNT of Anderson Creek 2	5.74	4.81
UNT of Duranzo Creek	8.05	7.17
UNT of Moss Creek 1	6.06	4.14
UNT of Moss Creek 2	6.96	5.23

AU-08 – BEAR CREEK

WATER QUALITY

This Subwatershed has one active SWQM station (15674), and two former SWQM stations (15527, 16787). There is one permitted discharge in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are twenty significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

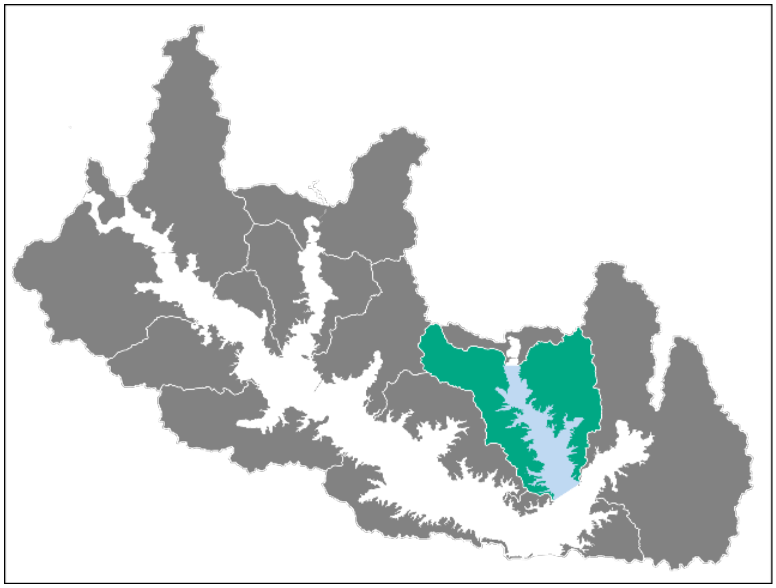
STREAMS

Name	Flow (cfs)	Length (km)
Bear Creek	75.66	31.68
Curry Creek	23.69	14.27
Devils Ford Creek	22.28	17.33
Dinkhorse Branch	6.68	5.07
Easley Creek	19.95	18.7
East Prong McKim Creek	21.49	14.38
Jack Williams Creek	10.66	9.14
Johnson Creek	8.3	5.72
Little Creek	19.66	11.04
UNT of Little Creek 1	6.41	5.7
McKim Creek	61.8	12.03
Mill Creek	36.78	17.65
Pomponaugh Creek	36.64	20.3
Rock Creek	25.4	20.01
Rush Branch	9.01	8.65
Sandy Creek	22.34	16.81
Steep Mile Creek	5.2	4.44
UNT of Little Creek 2	5.48	4.66
UNT of Mill Creek	5.84	5.86
West Prong McKim Creek	9.51	6.42

AU-09 – LOWER AYISH

WATER QUALITY

This Subwatershed has one active SWQM station (15673), and three former SWQM stations (15526, 15675, 16784). There are three permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are nine significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

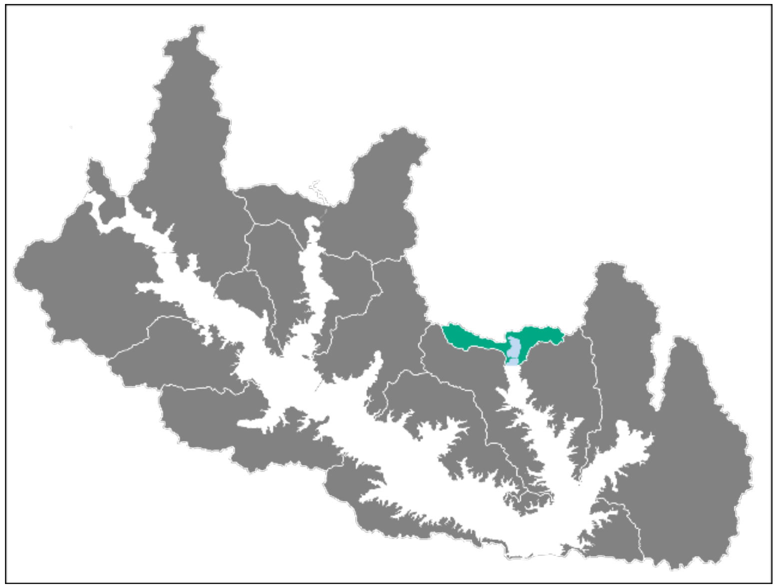
STREAMS

Name	Flow (cfs)	Length (km)
Briar Branch	11.79	6.95
Buck Branch	9.25	8.91
Couchatana Creek	25.36	15
Huckleberry Creek	5.52	5.43
Lane Creek	5.41	2.02
Little Creek	5.57	4.91
Sandy Creek	22.36	18.27
Tilde Creek	6.66	5.27
UNT E of Sandy Creek	5.69	5.29

AU-10 – UPPER AYISH

WATER QUALITY

This Subwatershed has one active SWQM station (14907), and no former SWQM stations. There are no permitted discharges. There are no assessment unit specific impairments or concerns, only segment-wide. There are two significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
Excessive algal growth in water	5n	2022
Dioxin in edible tissue	5a	2014
Mercury in edible tissue	5c	1996

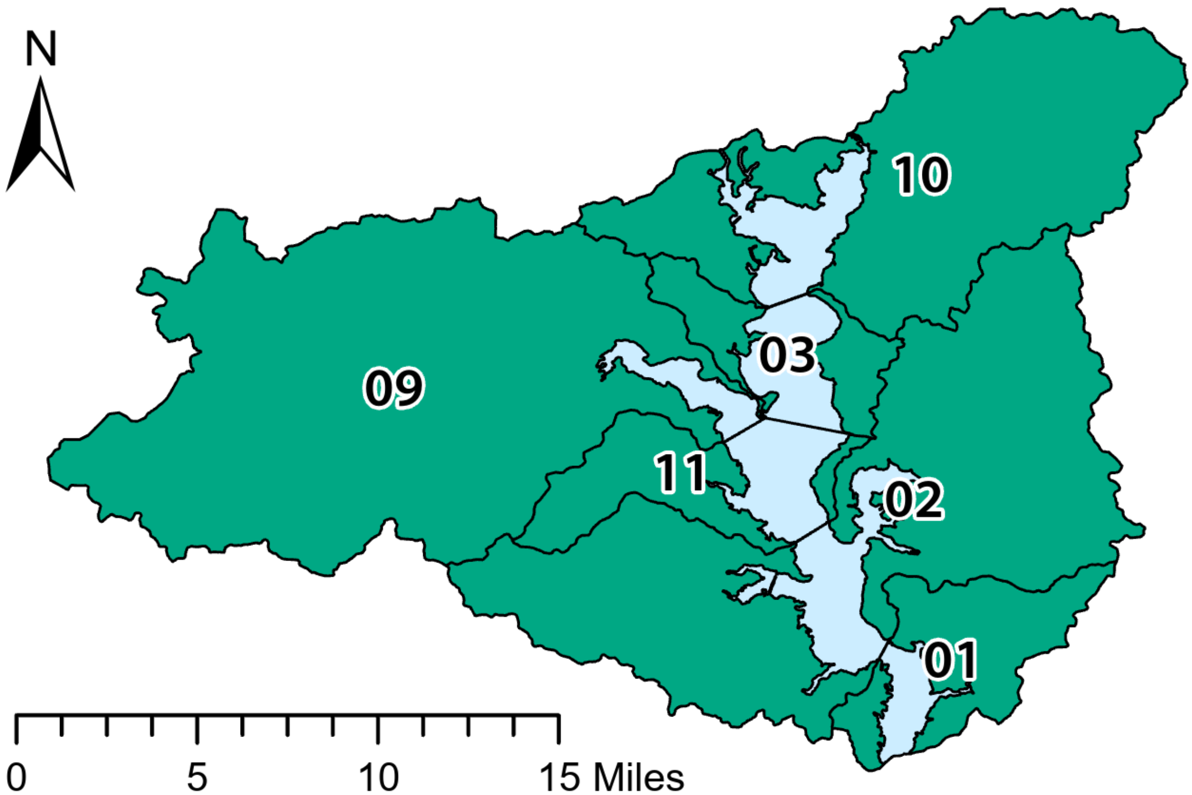
Concern Description	Level of Concern
Iron in sediment	CS
Manganese in sediment	CS

STREAMS

Name	Flow (cfs)	Length (km)
Copelle Creek	11.01	11.48
Little Creek	8.33	7.04

SUBWATERSHEDS – LAKE PALESTINE WATERSHED

This section will talk about each individual subwatershed in the Lake Palestine watershed. Subwatersheds were delineated by the reservoir assessment units, some boundaries following HUC 12 lines, other lines being drawn by hand based on elevation data. Data across these subwatersheds may appear similar, as some impairments and concerns are on a segment level, meaning they are applied to all assessment units within the segment. Flow values refer to the most downstream point of a stream before confluences or before discharging into the reservoir. Subwatersheds are named based on Assessment Unit numbers



AU-01 – MAIN POOL/DAM

WATER QUALITY

This Subwatershed has two active SWQM stations (22056, 16159), and two former SWQM stations (17966, 21339). There is one permitted discharge in the subwatershed. There is a site specific impairment for the Assessment Unit, low dissolved oxygen. There is one significant inflowing stream, listed below.

IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
pH	5b	2006

Concern Description	Level of Concern
Manganese in sediment	CS
Depressed Dissolved Oxygen in Water	CS

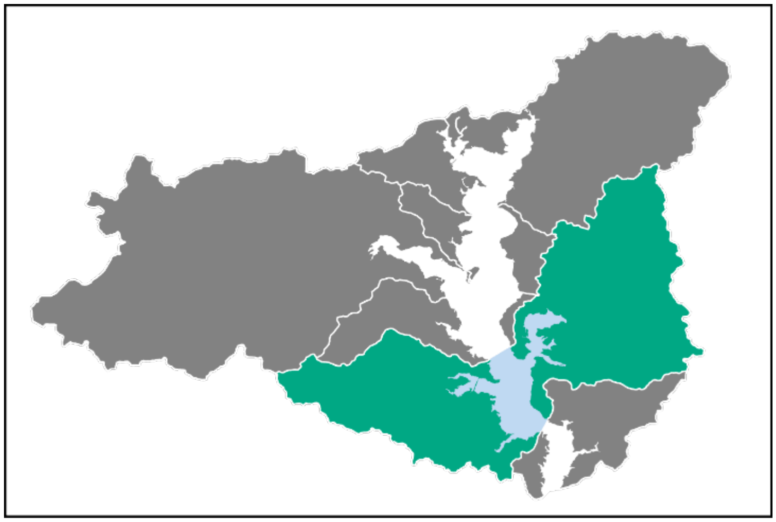
STREAMS

Name	Flow (cfs)	Length (km)
Stone Chimney Creek	10.52	7.15

AU-02 – LOWER NECHES

WATER QUALITY

This Subwatershed has one active SWQM station (20318), and two former SWQM stations (21338, 21340). There are two permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are twelve significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

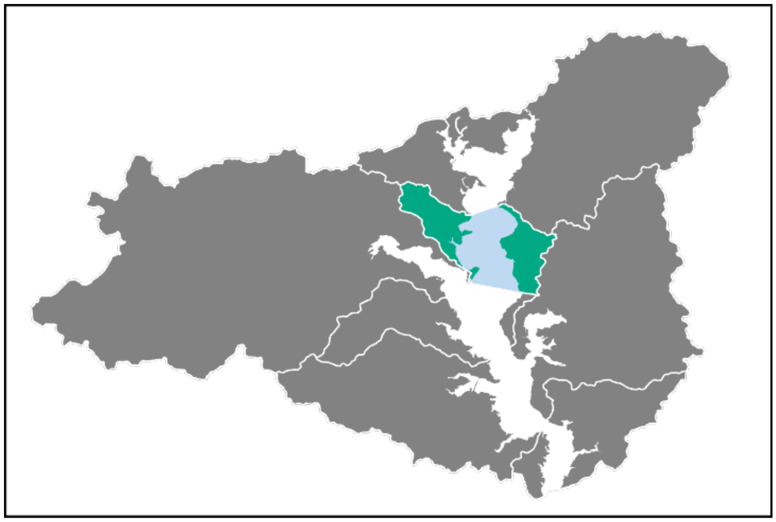
Impairment Description	Impairment Category	Year First Listed
pH	5b	2006

Concern Description	Level of Concern
Manganese in sediment	CS

STREAMS

Name	Flow (cfs)	Length (km)
Cobb Creek	8.8	3.44
Copperas Creek	5.51	5.13
County Line Creek	19.25	10.76
Dunn Creek	5.15	5.25
Highsaw Creek	11.96	7.88
Ledbetter Creek	19.56	14.95
Rose Branch	5.27	3.75
Saline Creek	37.44	15.17
UNT of County Line Creek	7.37	6.87
UNT of Saline Creek 1	7.41	7.08
UNT of Saline Creek 2	5.1	5.14
UNT of Saline Creek 3	5.31	4.51

AU-03 – UPPER-MIDDLE NECHES



WATER QUALITY

This Subwatershed has one active SWQM station (16346), and one former SWQM station (21342). There are no permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There is one significant inflowing stream, listed below.

IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
pH	5b	2006

Concern Description	Level of Concern
Manganese in sediment	CS

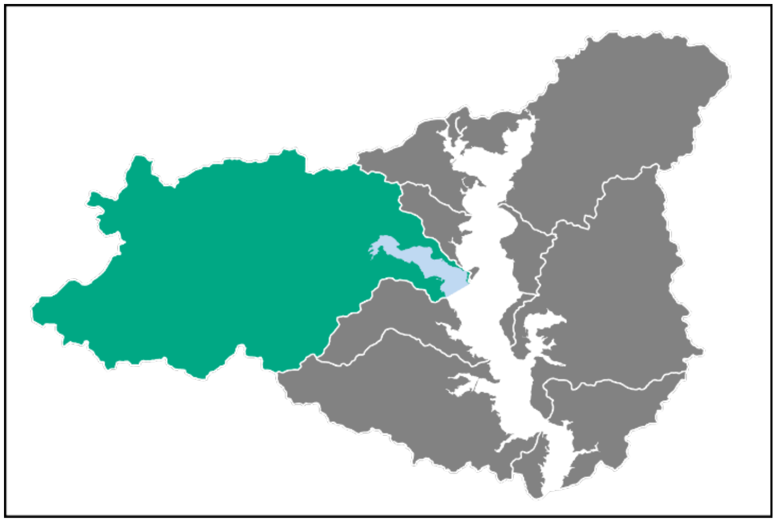
STREAMS

Name	Flow (cfs)	Length (km)
Gum Branch	5.06	4.54

AU-09 – FLAT CREEK

WATER QUALITY

This Subwatershed has one active SWQM station (18557), and two former SWQM stations (18371, 17549). There are no permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are thirteen significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
pH	5b	2006

Concern Description	Level of Concern
Manganese in sediment	CS

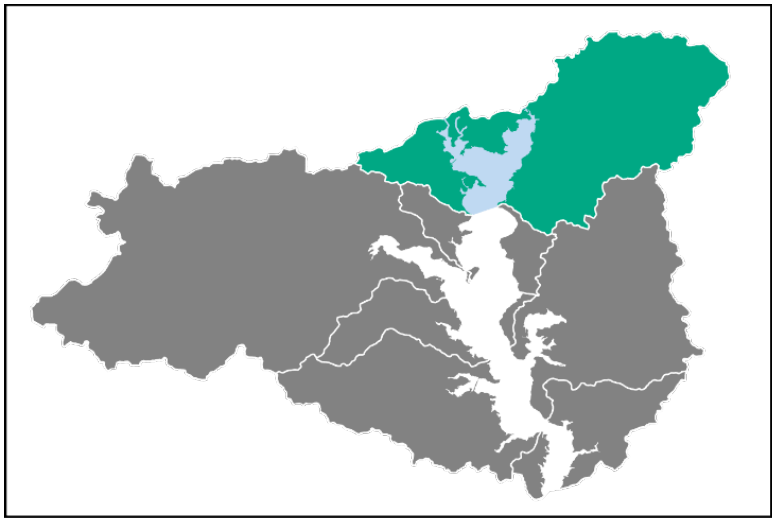
STREAMS

Name	Flow (cfs)	Length (km)
Adams Creek	20.15	8.26
Alligator Branch	9.29	6.01
Boggy Creek	9.34	7.8
Dunn Creek	9.86	10.79
Flat Creek	109.47	18.43
Maggie Creek	4.78	4.43
Mulberry Branch	8.68	7.34
Muscadine Branch	7.56	5.67
New York Creek	34.39	11.93
Panther Creek	7.41	7.9
Sandy Creek	6.71	4.29
Tindel Creek	15.98	11.17
UNT of Flat Creek	8.53	9.31

AU-10 – UPPER NECHES

WATER QUALITY

This Subwatershed has one active SWQM station (18643), and three former SWQM stations (17550, 10594, 16345, 10595). There is one permitted discharge in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There are four significant inflowing streams, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
pH	5b	2006

Concern Description	Level of Concern
Manganese in sediment	CS

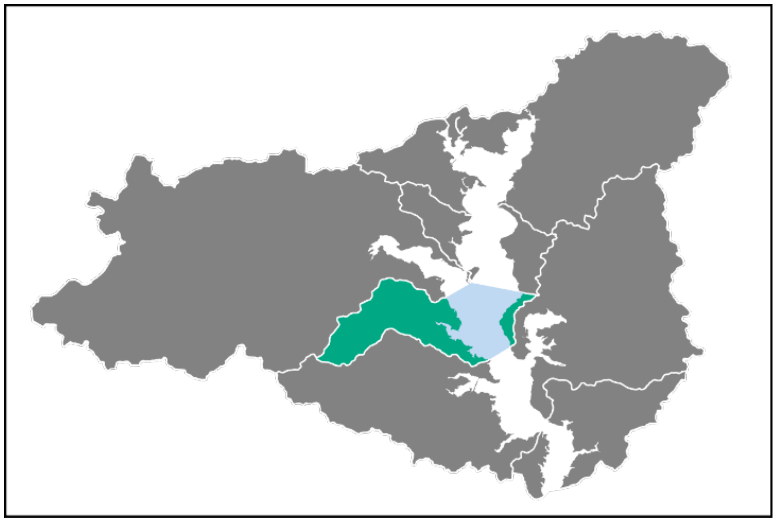
STREAMS

Name	Flow (cfs)	Length (km)
Butler Creek	21.06	12.1
Indian Creek	37.09	13.03
UNT of Indian Creek	5.2	4.66
UNT S of Butler Creek	11.29	5.88

AU-11 – MIDDLE NECHES

WATER QUALITY

This Subwatershed has one active SWQM station (20318), and two former SWQM stations (21338, 21340). There are no permitted discharges in the subwatershed. There are no assessment unit specific impairments or concerns, only segment-wide. There is one significant inflowing stream, listed below.



IMPAIRMENTS AND CONCERNS

Impairment Description	Impairment Category	Year First Listed
pH	5b	2006

Concern Description	Level of Concern
Manganese in sediment	CS

STREAMS

Name	Flow (cfs)	Length (km)
Caney Creek	14.1	11.82

ADDITIONAL INFORMATION

CONTACT INFORMATION

Andrew Henry,
Clean Rivers Program Coordinator
Email: ahenry@anra.org
Phone: (936) 633-7527

Hannah Crawford,
Laboratory Services Director
Email: hcrawford@anra.org
Phone: (936) 633-7542

Jeremiah Poling,
Deputy General Manager
Email: jpoling@anra.org
Phone: (936) 633-7551

Kimberly Wagner,
Executive Manager - Communications
Email: kwagner@anra.org
Phone: (936) 633-7507

ANRA OPERATIONS

The Angelina & Neches River Authority promotes public involvement in the Upper Neches 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 offering services to the public. Additionally, ANRA produces and sells biosolids compost through our Neches Compost Facility.

INFORMATIONAL LITERATURE

Numerous pamphlets, brochures, and other educational and informational literature on such topics as water quality, conservation, recreation, and on-site septic facilities are available to the public at ANRA's offices. ANRA supports the TPWD invasive species awareness campaign "Hello Giant Salvinia, Goodbye Texas Lakes" by making informational pamphlets available to the public.

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.

The 2024 Upper and Middle Neches Basin Highlights Report was prepared by ANRA in cooperation with the TCEQ under the authorization of the Texas Clean Rivers Act.

2024 Upper & Middle Neches Basin Highlights Report

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