WATERSHED BASED PLAN

FOR

EPA Region 6
Tom Steed Lake Watershed, OK

Prepared By:
Oklahoma Conservation Commission
Water Quality Division
2800 N Lincoln Blvd, Suite 160
Oklahoma City, OK 73105

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Contents

BACKGROUND

The Nonpoint Source Program and Grants Guidelines for States and Territories for FY 2024 and beyond requires a *Watershed Based Plan* (WBP) to be completed prior to implementation using incremental funds. The guidance defines the 9 key components to be addressed in a watershed-based plan: a) identification of causes and sources that will need to be controlled to achieve load reductions, b) estimate of load reductions expected from the management measures described, c) a description of the management measures that will need to be implemented to achieve load reductions, d) an estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources or authorities who will bear responsibility, e) an information/education component that will be used to enhance public understanding of the project and encourage early participation in the overall program, f) a schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious, g) a description of interim, measurable milestones for determining whether control actions are being implemented, h) a set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made or whether the Watershed Plan or Total Maximum Daily Load (TMDL) needs to be revised, and i) a monitoring component to evaluate the effectiveness of the implementation efforts over time.

INTRODUCTION

Tom Steed Lake watershed consists of three HUC 12 watersheds (111203030301, 111203030302, 11120303030303), located in southwestern Oklahoma. The lake drains into West Otter Creek, which drains into the North Fork Red River and is a high priority rank on Oklahoma's updated Unified Watershed Assessment (UWA). The Tom Steed Lake WBP is a plan to restore water quality in the watershed so that all designated uses are attained. It has been developed as a dynamic document that will be revised to incorporate the latest information, address new strategies, and define new partnerships between watershed shareholders. This WBP will be a collaborative effort with the Kiowa County Conservation District, Comanche County Conservation District, and the Natural Resources Conservation Service (NRCS) and will continue to evolve as the partnership develops. It is understood that the water quality goals set forth in this WBP, as well as the technical approach to address the goals, may not be comprehensive. Federal and state funding allocations for future water quality projects designed to protect the Tom Steed Lake watershed should not be based solely upon their inclusion in this WBP; rather, the WBP should be considered a focal point for initial planning and strategy development.

CAUSES AND SOURCES *(element a)*

Watershed Characterization

Tom Steed Lake (OK3115000020060_00) is a 25.9 km^2 (6,490-acre) reservoir located in Kiowa County (Figure 1). The watershed includes three USGS Hydrologic Unit Code (HUC) 12-digit watersheds (111203030301, 111203030302, 111203030303) which cover approximately 329.2 km^2. These are primarily in Kiowa County, but a small portion of the watershed extends into Comanche County. The formal NWQI Area comprises all three HUC-12 watersheds. Waters from West Otter Creek, Glen Creek, and diverted waters from Elk Creek flow into the lake.

Tom Steed is designated in Oklahoma's Water Quality Standards as a public and private water supply (PPWS) and is a primary body contact recreation (PBCR) waterbody. Additional listed benefits include aesthetics, agriculture, and fish and wildlife propagation (specifically warm water aquatic community [WWAC]). The reservoir is also designated as a sensitive water supply (SWS), which indicates that new or increased nutrient or pollutant loads are prohibited without approval from the proper state authorities (OWRB, 2016).

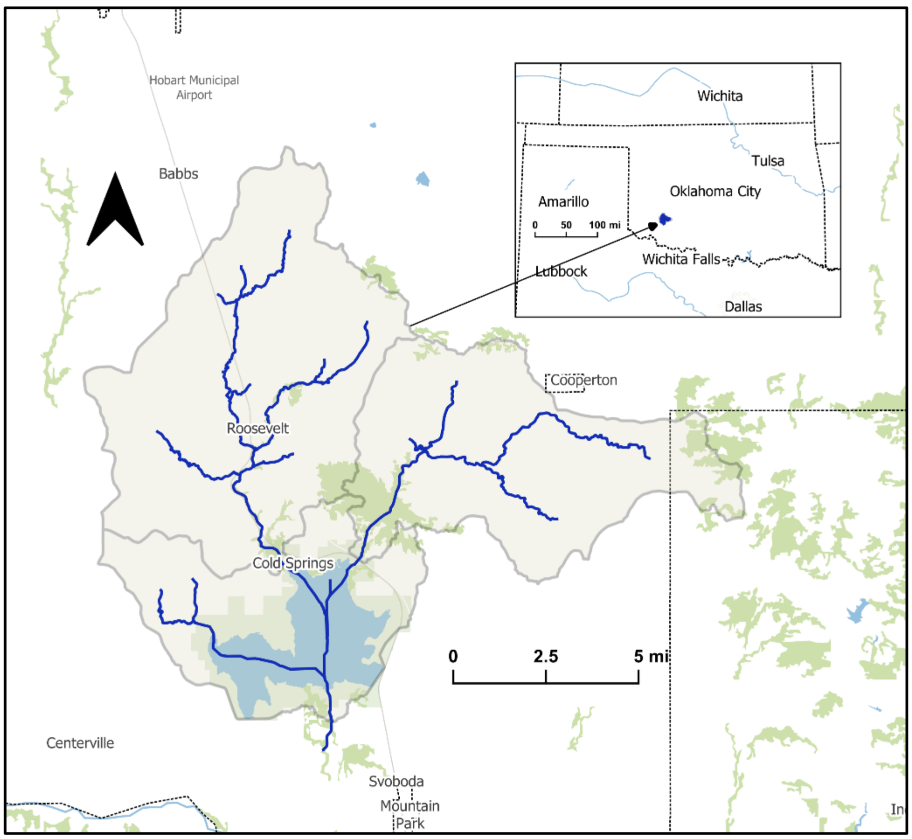

Figure 1. Tom Steed Watershed.

<u>Landscape Characteristics and Landuse:</u>

The Tom Steed Watershed occurs in the Central Great Plains ecotype characterized by mixed-grass prairie (see <u>Ecoregions of Oklahoma</u>). Three level four ecoregions overlap the Tom Steed Watershed. The central and eastern portions are in the Wichita Mountains and Red Prairie level four ecoregions, while the western portion is located in the Red River Tablelands level four ecoregion. The Wichita Mountains occur in this watershed. South-

facing slopes support scrubby woodlands are dominated by blackjack oak and post oak. North-facing slopes have denser tree cover. Lowlands are dominated by short-grass prairie with prickly pear scattered throughout. The Red Prairie ecoregion is nearly level in elevation and native mesquite-buffalograss dominates this area. The Red River Tablelands ecoregion is dominated by mesquite-buffalo grass, but mixed-grass prairie also occurs. Flora assemblages in both level four ecoregions are distinct from others in the Central Great Plains, with the highest proportion of southwest vegetation occurring in the Red River Tablelands. Major landuses in the watershed include cropland and rangeland. The rangeland is a composed of mixed grasses and grass/brush mixture. Crops are primarily cotton and winter wheat (Figure 2). The Wichita Mountains level four ecoregion is primarily used for recreation (The Wichita Mountains National Wildlife Refuge), military purposes, and grazing, while the Red River Tablelands and Red Prairie are primarily used for cropland. Rangeland is also common in these ecoregions, but mostly in less crop favorable areas. Red River
Tablelands is dominated by irrigated cropland. Overuse of aquifers for cotton irrigation in this portion of the watershed has led to serious depletion during periods of drought.

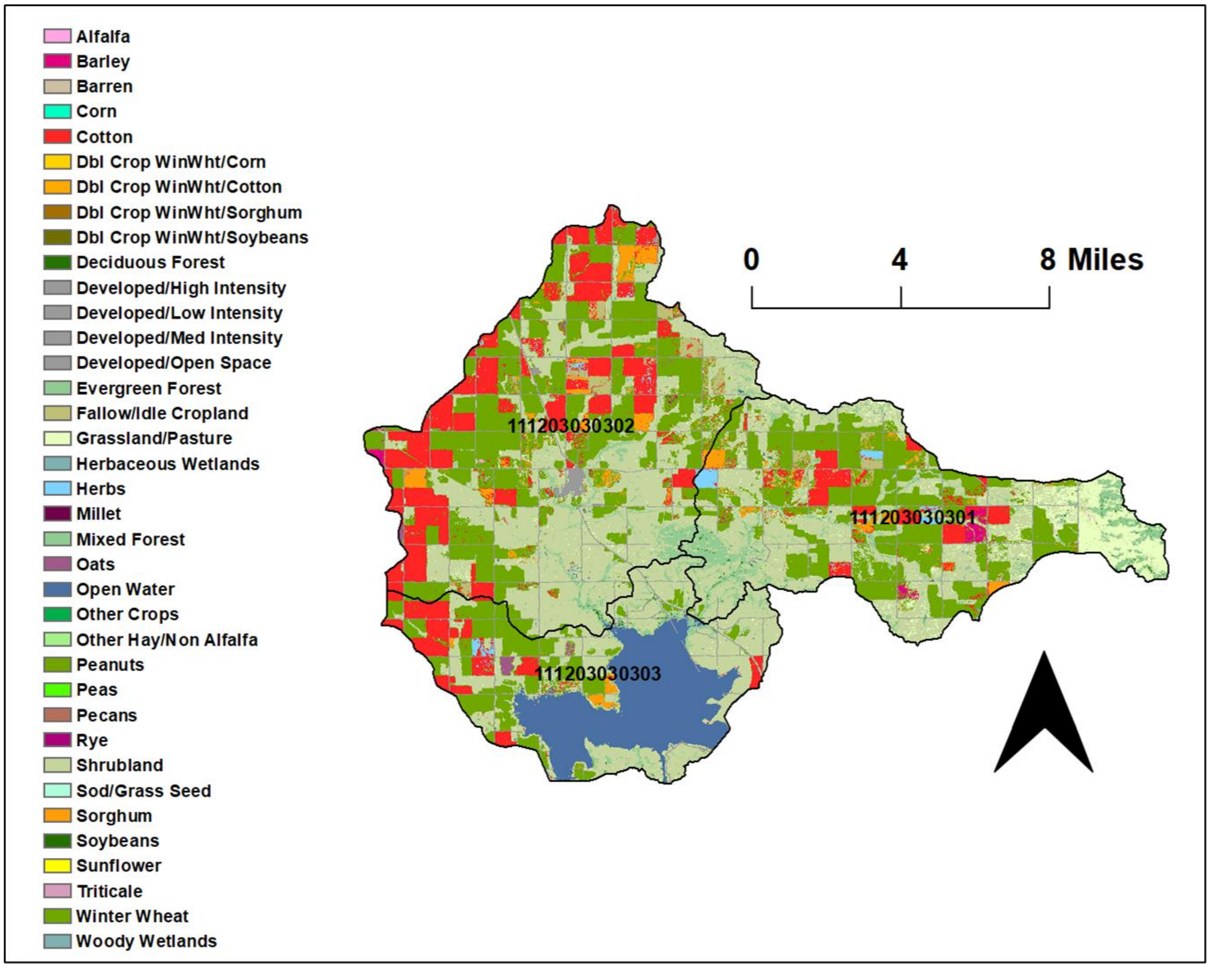

Figure 2. Land use in Tom Steed Res. Watershed, (source, OKHAWQS: NLCD/CDL date set).

The Major Land Resource Area (MLRA) classifies the land of the Tom Steed Lake as the Wichita Mountains and the Central Rolling Red Plains, Eastern part. In the Wichita Mountains portion, soils are mostly thermic, ustic Mollisols or Ustolls. A large portion of this area is covered by barren, highly fractured granite rock outcrop. This area supports diverse vegetation, including mid- and tall prairie grasses. Trees are interspersed with the native grasses, especially along fault lines. Most of the land in this area is privately owned and is used for livestock grazing in cow-calf operations. A smaller portion of the privately owned land is used as cropland. Principal crops include small grains, cotton, and sorghum. Federally owned land is used for recreation, grazing, and military operations (Figure 3). In the Central Red Rolling Plains, Eastern part portion of the watershed, soils are primarily thermic, ustic Alfisolos, Inceptisols, and Mollisols, and are deep to very deep and moderately to well-drained. This area is predominately mixed grass prairie and supports many grass species, including native grasses like buffalograss and little bluestem. Many hackberry trees and scattered infestations of mesquite trees are found here. Most of the land area in this portion of the watershed is used as rangeland. Farms and ranches grow a variety of crops and livestock. The primary resource concerns on cropland are water erosion and conservation soil moisture, while the primary resource concern on rangeland is overgrazing in both MRLAs.

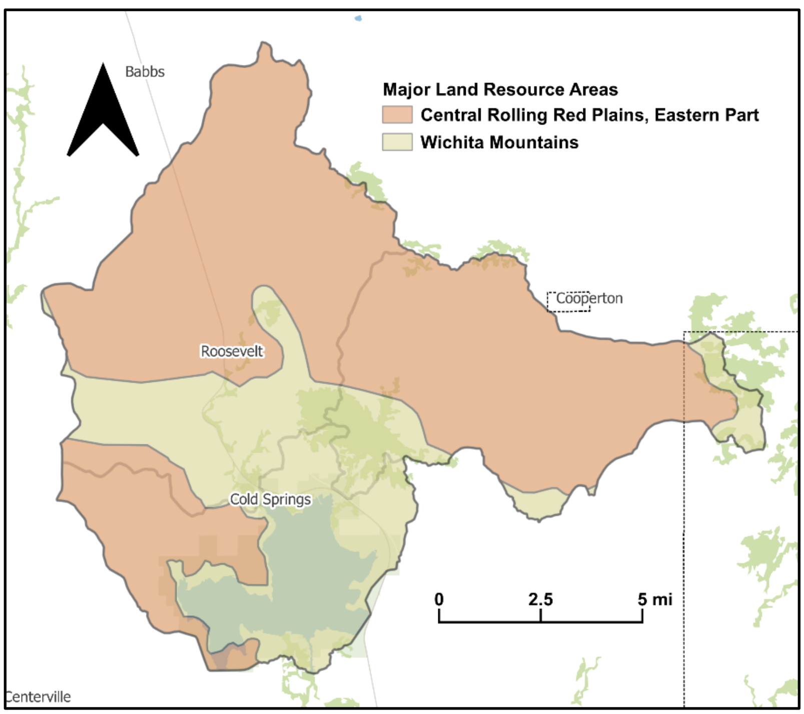

Figure 3. MLRA Ecoregions of Tom Steed watershed

<u>Climate:</u>

The Tom Steed watershed’s climate is in the transition zone between the humid subtropical in eastern Oklahoma to semi-arid in far western Oklahoma. Warm, moist air moving northward from the Gulf of Mexico often exerts much influence, particularly over the southern and eastern portions of the state, where humidity, cloudiness and precipitation are resultantly greater than in western and northern sections. Summers are typically hot and long, while winters tend to be shorter with less severe cold and frozen precipitation than the more northern Plains. While this region can experience extreme cold, those systems are usually short and infrequent. Annual rainfall for the watershed is around 30 inches per year

with two periods of increased rainfall coming in late spring to early summer and again increasing in the late summer through the fall. While the mean annual temperature is around 62F, the area sees an average of 98 days above 90F and about 25 days above 100F. Although the watershed does not cover much area, there is slightly less precipitation as you travel from east to west with some influence from the Wichita Mountains to the South. The average length of growing season, defined as frost free days, is a little over 200 (OCS, 2024).

Topography:
The Wichita Mountain Range protrudes upward throughout this watershed to produce the highest elevations (2482 ft). Flatter areas are found in the western most portion. Tom Steed Lake is in the southern most portion of the watershed (Figure 4) (USDA, 2006).
Many channels throughout the watershed are severely incised and eroded, and woody riparian vegetation is reduced or nonexistent.

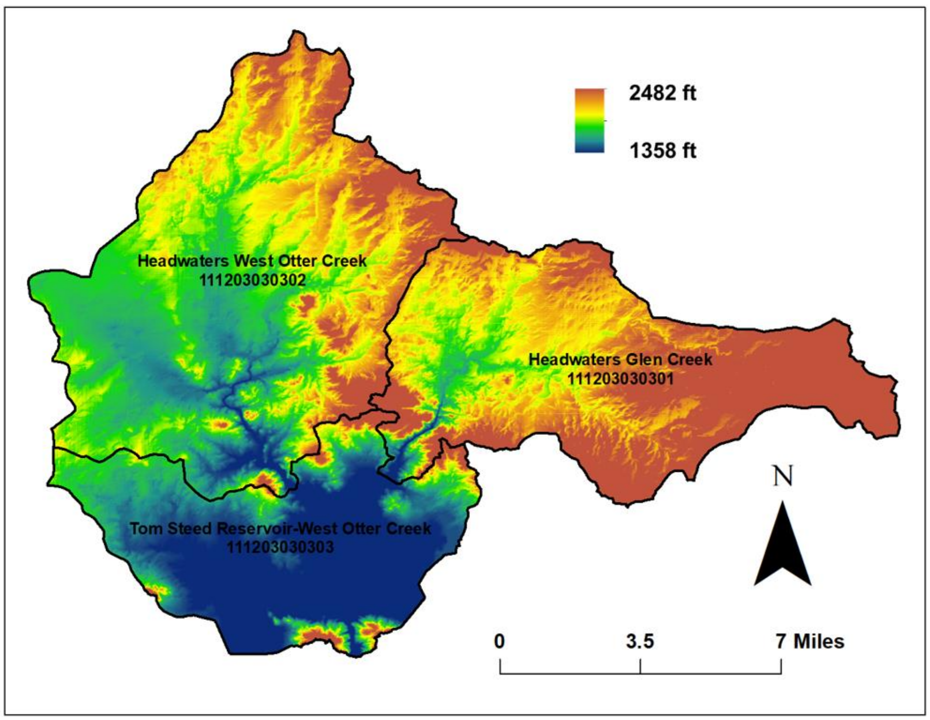

Figure 4 Digital elevation model of Tom Steed watershed.

Geology, Geomorphology, Soils:
Geologic formations of the Tom Steed Lake watershed are primarily a mix of sandstone and shale with sandy alluvium within the creek channel boundary and some Pleistocene sand deposits in the eastern upland areas (Figure 5). Weathering of the bedrock left deep loamy sediments from paleo-terrace deposits. Fifty percent of the land area are a mix of Tilman clay loams and Hollister silty clay loams (Figure 6). Soils tend to be in the C and D hydrologic group, which means they don’t drain particularly well, contributing to precipitation

and sediment runoff (Figure 7). Soils in the hydrologic class B are mostly found in riparian areas, likely from alluvial deposits. Figure 8 shows the distribution for erodibility of soils. Soils with a USLE K factor are typically considered highly erodible if they have a value above 0.40. The largest soil series is a Hollister silty clay loam, which has a K value at 0.32, which is not considered highly erodible. However, the Tillman clay loam makes up nearly 20% of the watershed and has a K value of 0.49, highly erodible.

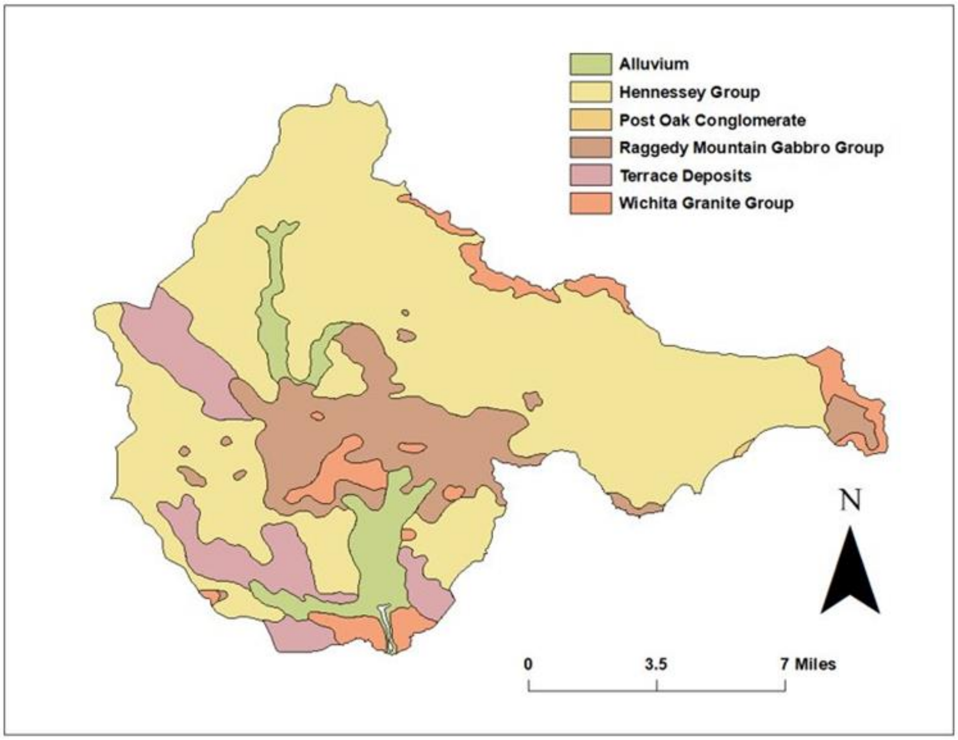

Figure 5. Geology of Tom Steed watershed

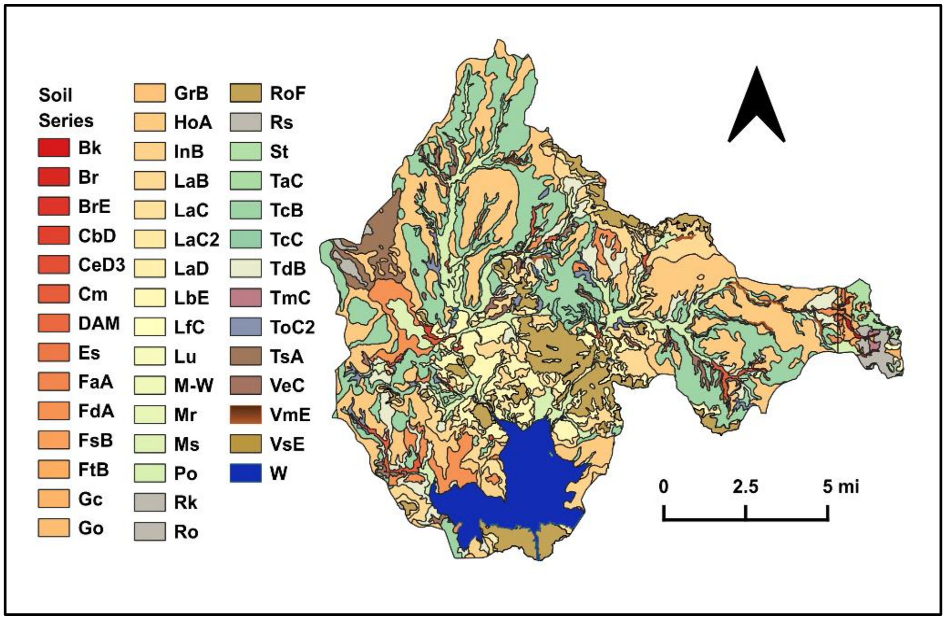

Figure 6. Soil Series Map (SSURGO)

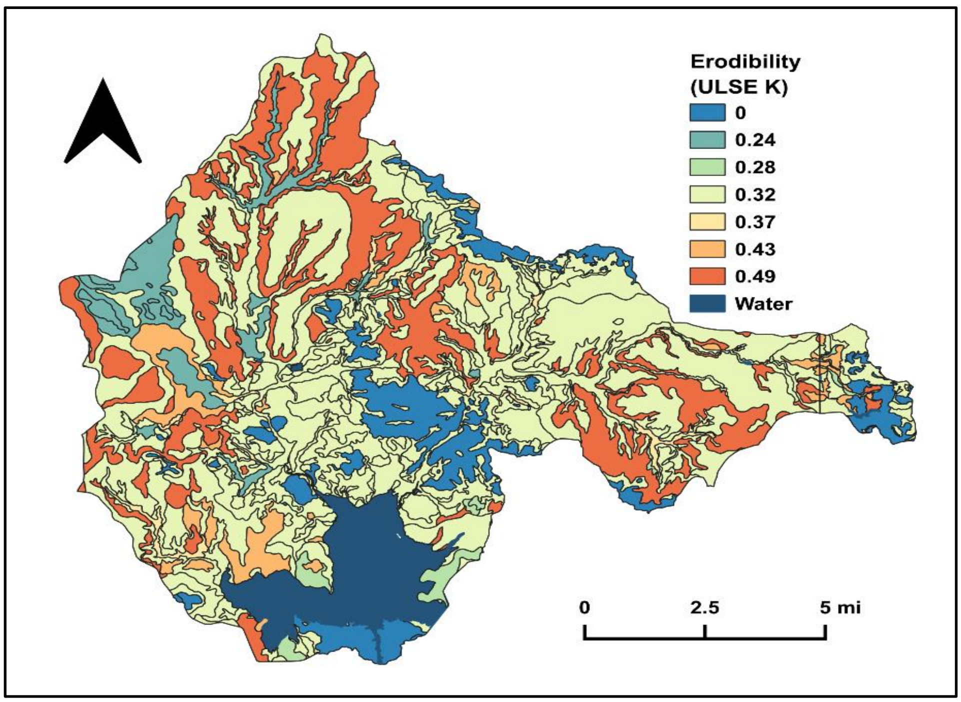

Figure 7. Soil Erodibility (ULSE K)

<u>Socioeconomic Conditions:</u>
The watershed is mostly rural with Roosevelt, Oklahoma being the largest municipality in the project area. Comanche County has the largest population of the two counties overlapping the Tom Steed watershed (Table 1), but most of the watershed is in Kiowa County. The population is predominately white, not Hispanic or Latino (Table 2), and mean

annual income is $38,019 (Table 3). The rate of poverty is 24% (Table 3), and approximately 72% of housing is occupied and owned (Table 4).

Table 1. Population by county, 2020 US Census

County	Kiowa	Comanche
Total Population	8,509	121,125

Table 2. Population by ethnicity, 2020 US Census

County	Kiowa	Comanche
White	6,519	69,301
African American	327	19,802
Asian	52	3,141
AIAN	559	7,237
NHPI	3	877
Some Other Race	312	5,222
Two or more Races	737	15,545

Table 3. Income and rate of poverty, 2020 US Census

County	Kiowa	Comanche
Median Income (USD)	$38,019	$51,300
Rate of Poverty (percent)	24	17.4

Table 4. Housing Statistics, 2020 US Census

County	Kiowa	Comanche
Total Housing	5,148	52,603
Occupied	3,571	44,720
Owner-Occupied	2,576	25,637
Renter-Occupied	995	19,083
Vacant Housing	1,577	7,883

The entirety of the Tom Steed watershed, which includes three HUC-12s, is considered disadvantaged according to the Climate and Economic Justice Screening Tool (CEJST). CEJST, developed by the Council on Environmental Quality, identifies disadvantaged communities based on a combination of eight categories of burden (i.e. climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development) and the associated socioeconomic threshold for low income. CEJST also classifies the lands of Federally Recognized Tribes (FRT) as disadvantaged. Tract 1, which encompasses most of the Tom Steed watershed, is considered disadvantaged because it meets four categories of burden, including climate change, health, housing, and legacy pollution and the associated socioeconomic threshold or low income. Additionally, 98% of this watershed is covered by lands of FRT, further designating it as disadvantaged. Tract 2 meets four categories of burden, including energy, health, housing, and workforce development, as well as the socioeconomic threshold for low income. The entirety of tract 2 is also considered disadvantaged based on 100% coverage of lands of FRT. Tract 3 is also deemed disadvantaged because although it does not meet any categories of burden, it is 100% covered by lands of FRT (Figure 8)

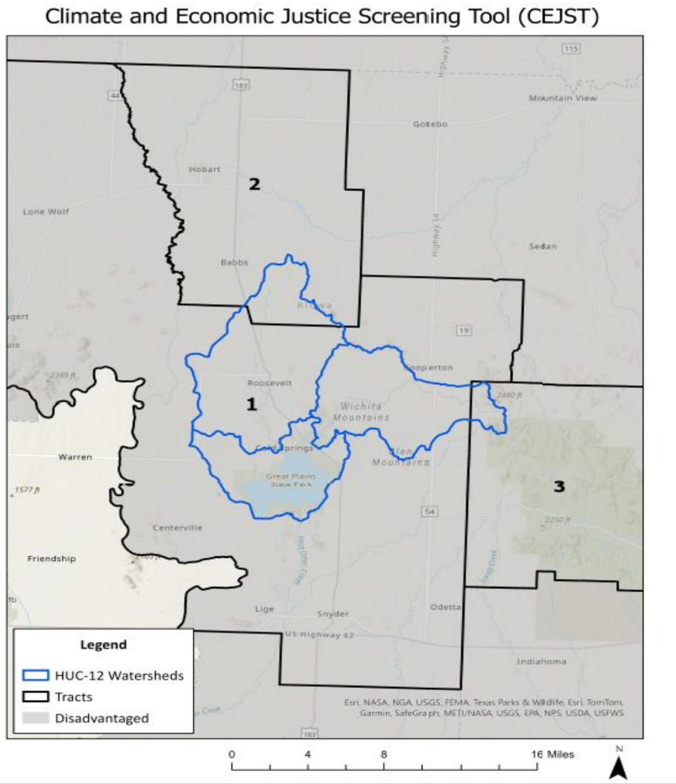

Figure 8. Presentation of Climate and Economic Justice Screening Tool (CEJST) analysis findings. The entirety of Tom Steed Lake watershed is considered disadvantaged.

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EJScreen, is an environmental justice mapping and screening tool developed by EPA to combine environmental and socioeconomic indicators. According to EJScreen, 100% of the Tom Steed watershed is considered disadvantaged. Of the 13 environmental indicators included in the tool, drinking water non-compliance is the one of the strongest indicators of disadvantaged communities in the Tom Steed watershed (Figure 9). Approximately 88% of the watershed is above the 80th percentile threshold for the drinking water non-compliance EJ index. This index combines the environmental burden indicator for drinking water non-compliance with the demographic index (% low-income and % people of color).

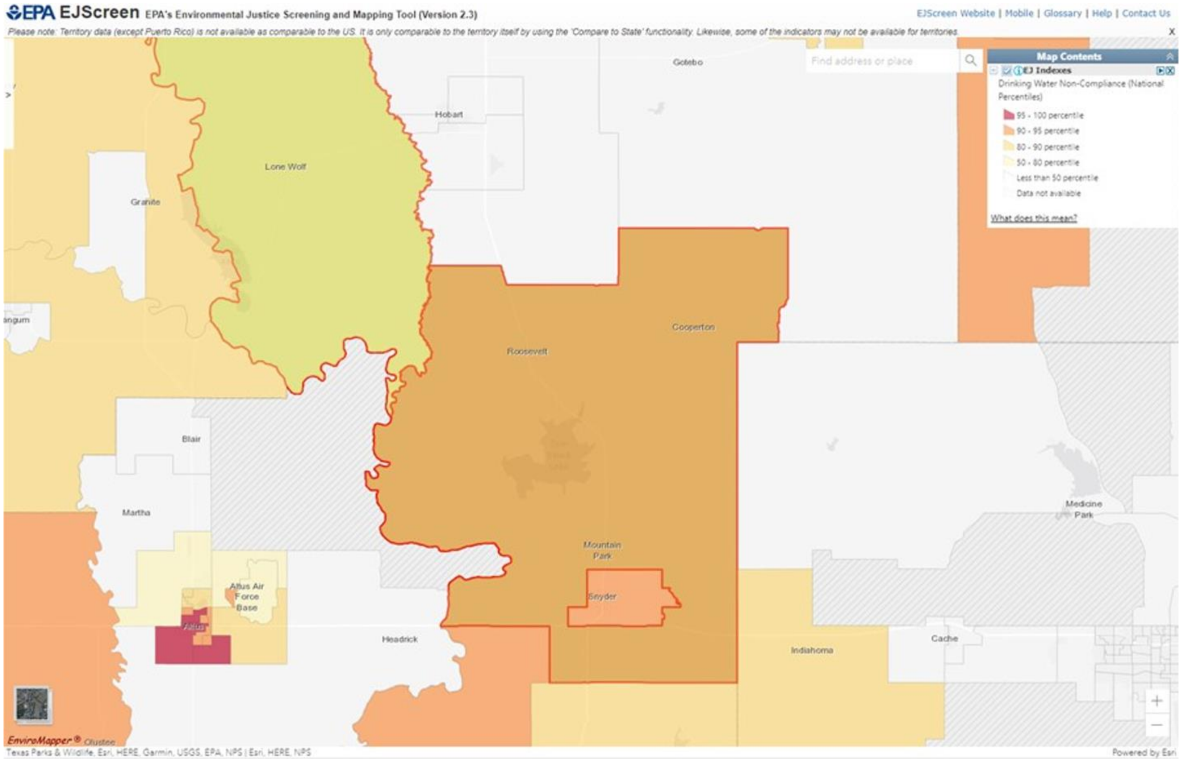

Figure 9.Presentation of the EPA's EJScreen Tool analysis findings related to 'Drinking Water Non-Compliance' in the Tom Steed Lake Watershed.

Disadvantaged communities, like the one in the target watershed, are considered when ranking OCC's priority watersheds (OCC Unified Watershed Assessment expected late 2024).

Current Efforts and Conditions

Resources compiled by others:
Water quality monitoring in the Tom Steed watershed is conducted by the Oklahoma Water Resource Board in Tom Steed Lake. The Oklahoma Department of Environmental Quality (ODEQ) compiles the State's biennial report (ODEQ 2022*)* and conducted a TMDL study for turbidity and bacteria that includes the project watershed (ODEQ 2011).

The Oklahoma Conservation Commission (OCC) does not have active sampling sites in this watershed. OCC is currently in the process of determining the best options to sample within the watershed for future monitoring. The creeks are mostly intermittent and there are disturbances in some of the channels that make sampling undesirable.

Lake Sampling
OWRB includes Tom Steed Lake in the BUMP lake monitoring program.

Runoff, Streamflow Hydrology and Irrigation:

The Tom Steed watershed drains an approximate area of a 126.74 mi^2 (USGS StreamStats). The average gradient is 3.4 percent, which would indicate a slow-moving meandering stream network. The mean of 3.4% is a little skewed by the rocky outcrops and foothills of the Witchita Mountains present in the watershed, However, the majority of the land has relatively low slopes. Historic erosion and sedimentation has contributed to incised channels that do not meander, which alters flow patterns and exacerbates erosion and sediment transport. Rainfall, and thus, flow peak in the late spring/early summer and then again in the late summer/early fall. Flow is otherwise significantly reduced (Figures 10-12). The majority of land is very flat, with steeper slopes near the rocky outcropping of the Wichita Mountains and near eroded stream banks. Although soils generally exhibit high infiltration, significant storm events can overwhelm capacity and result in high overland flow and erosion. Irrigation is present but not common throughout the watershed. The area of watershed covered by canopy as calculated by infrared satellite imagery is 2.88% (USGS Streamstats).

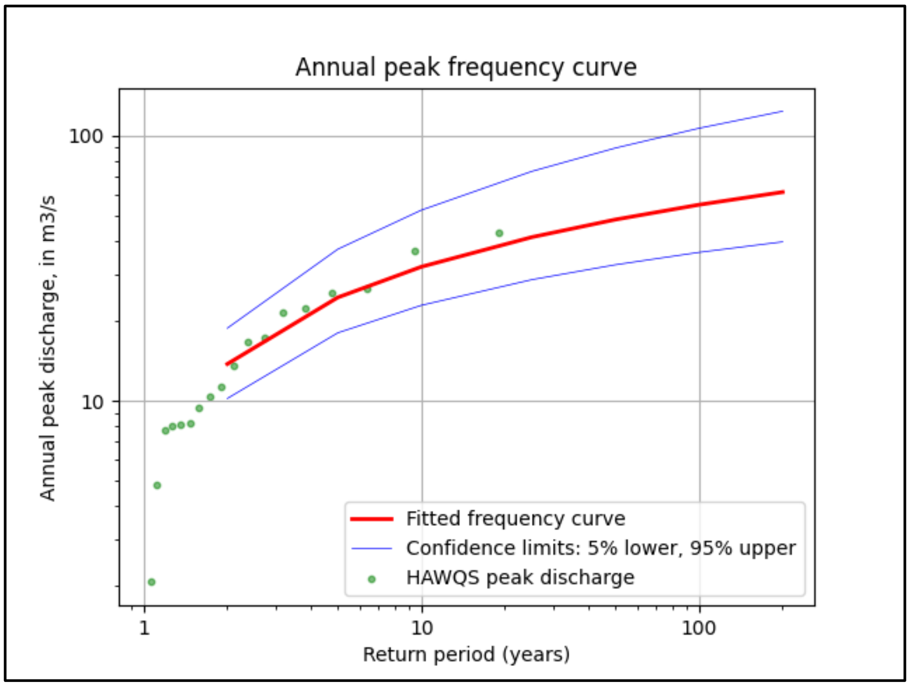

Figure 10. Flood Frequency analysis conducted in OKHAWQS as part of the default model run for 11203030301

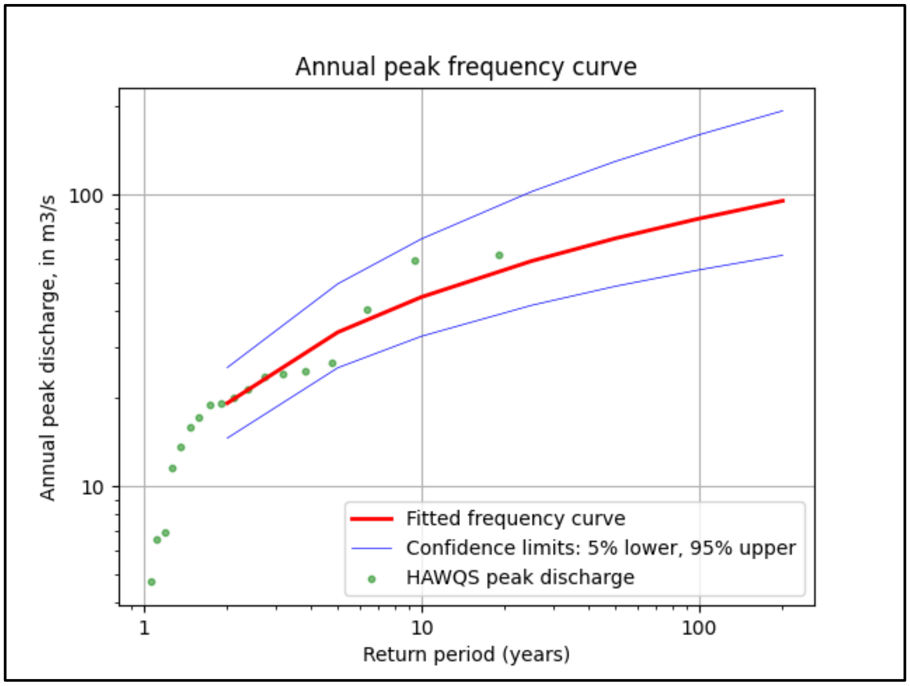

Figure 11. Flood Frequency analysis conducted in OKHAWQS as part of the default model run for 11203030302

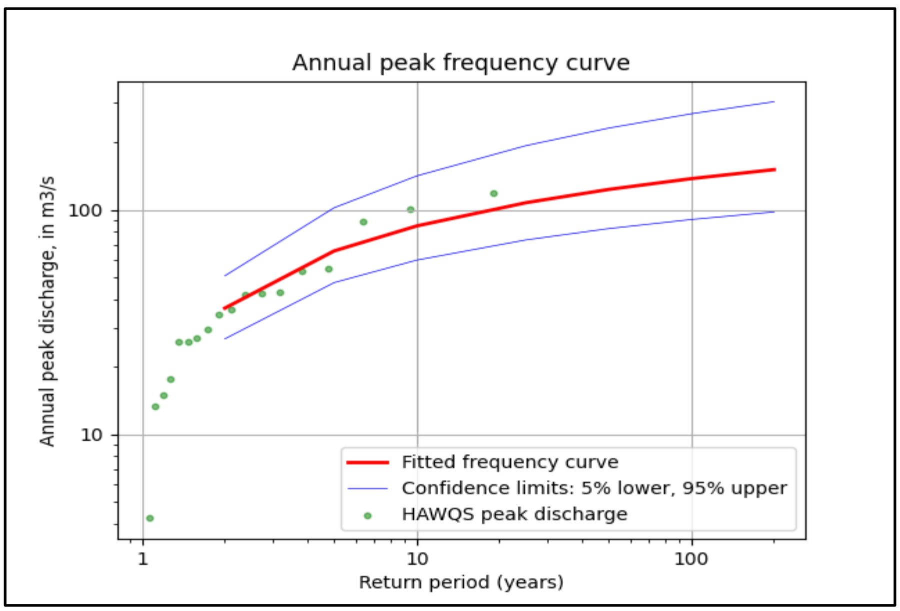

Figure 12. Flood Frequency analysis conducted in OKHAWQS as part of the default model run for 11203030303

Water Quality Conditions in the Watershed:

Causes

WBID	WB Name	Size (lake acres)	Type	Category	Aesthetic	Agriculture	Warm Water Aquatic Comm	Fish Consumption	Primary Body Contact	Public and Private Water Supply	Sensitive Water Supply
OK311500020060_00	Tom Steed Lake (Mountain Park)	6400	L	5a	I	F	N	N	F	N	*

Tom Steed Lake is designated as a Public and Private Water Supply (PPWS) Primary Body Contact Recreation (PBCR) and Sensitive Water Supply (SWS) waterbody. In addition, the stream has use designations for Aesthetics, Agriculture, Fish and Wildlife Propagation--Warm Water Aquatic Community (FWP-WWAC), and fish consumption. The stream also has a Sensitive Water Supply (SWS) designation, indicating that new or increased loads of any specified pollutant are prohibited without special approval from the Oklahoma Water Resources Board (OWRB).

Analysis Tools:

The watersheds (HUC 111203030301, 111203030302, 11120303030303, were analyzed and assessed using multiple analysis techniques. OKHAWQS was used to analyze potential erosion, sediment, total nitrogen, and total phosphorus delivered to the Tom Steed Lake. OKHAWQS is a web-based watershed analysis platform that uses the Soil and Water Assessment Tool (SWAT) (Arnold et al., 1998). It is free, open to the public, and can be accessed online here. OKHAWQS has been developed in partnership with the Oklahoma Conservation Commission, Texas A&M University AgriLife Research, and Oklahoma Water Resource Center at Oklahoma State University. The model has been customized to include more localized data inputs than the national HAWQS platform. The modeling platform is updated and modified as new data becomes available. Calibration for flow and water quality are based on best available data at a continuous monitoring gage located within a larger watershed. A detailed description can be found here. Additionally, a qualitative riparian assessment and unpaved roads assessment were performed. The riparian assessment is designed to qualitatively assess stream corridor stability (vegetative cover) and impacts (active erosion, gullying) as an index of overall riparian health. The unpaved roads assessment is an attempt to qualitatively assess potential impacts on water quality.

OKHAWQS/Soil and Watershed Assessment Tool (SWAT):
OKHAWQS was used to model the Tom Steed watershed. OKHAWQS has been set up using 10-meter Digital Elevation Model, 2020 NLCD for basic land use, Crop Data Layer (CDL) for the crop data and SSURGO as the soil layer. The Tom Steed Lake watershed model has been calibrated for flow, total phosphorus, and total nitrogen as part of the base model included in the platform. Details and any additional details can be found here. In addition, we store the scenarios used in this watershed-based plan on the website and they are available by request to anyone who has the desire to observe or critique our work.

The baseline model was set up using PRISM weather data and run daily from 01/01/2000-12/31/2020 with a two-year warm up. SWAT 2012 rev. 685 was used as the code version for these runs in OKHAWQS. HRU's were refined from 528 to 325 to simplify analysis and set the HRU area like the area of agriculture fields in that area. The SWAT model divides the watershed up into Hydrologic Response Units (HRU's) by grouping classes of landuse, slope and soil series by unique combinations for each subbasin. Every class of landuse is matched with every class of slope and soil series so that there are multiple HRU's spread across each subbasin. During set up of the model this process is refined to condense very small areas into a larger HRU so that analysis is more practical and efficient. All water and wetland landuse classes were excluded from the refining process so that the hydrologic function of these areas in maintained in the model. A relatively small pond or wetland still has a large capacity to trap nutrients, sediment, and excess water from runoff. Multiple scenarios were run for exploration of possible BMP solutions, only relevant scenarios will be presented here.

Results were compiled for the watershed as a whole and broken out by HUC 12, although the results are presented for the entire watershed. Overall, crops are contributing most to sediment loads (Figure 13). Figure 14 displays how various crops compare to other land uses. Winter wheat is the largest contributor at 5560 tons per year, with cotton the next largest contributor by single crop type at 2436 tons per year. The landuse inputs had a variety of small crops that were combined into all other crops. There are warm season row crops, and despite the smaller area, they were the second largest landuse class by sediment delivered to the stream reach. Winter wheat is the largest land use class by area, so the per acre loading is not excessively high. Cotton and all other crops however are relatively small areas with large contributions to the overall sediment loads. No grazing was considered in the default run of the model even though we know there is extensive cattle grazing in the watershed. Scenarios developed to assess the impact of grazing did not significantly change the loading of sediment or nutrients in by landuse. More work needs to be done to quantify the impact of grazing on water quality, as much of the land is apparently over-grazed. Many producers graze in the riparian areas, which we account for in the riparian assessment. I

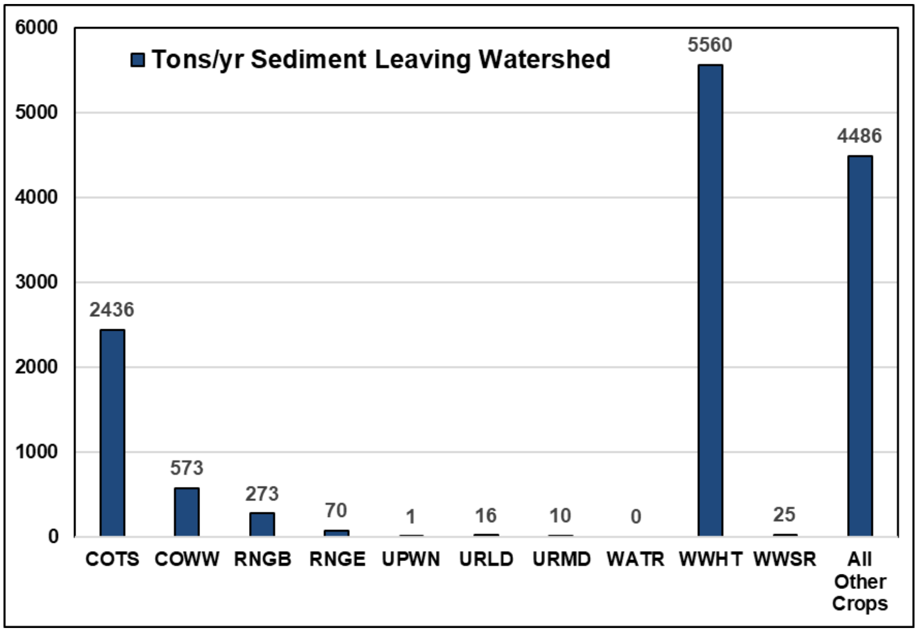

Figure 13. Tons of sediment leaving the watershed. Winter wheat is the largest contributor with all other crops contributing to the second highest amount of sediment.

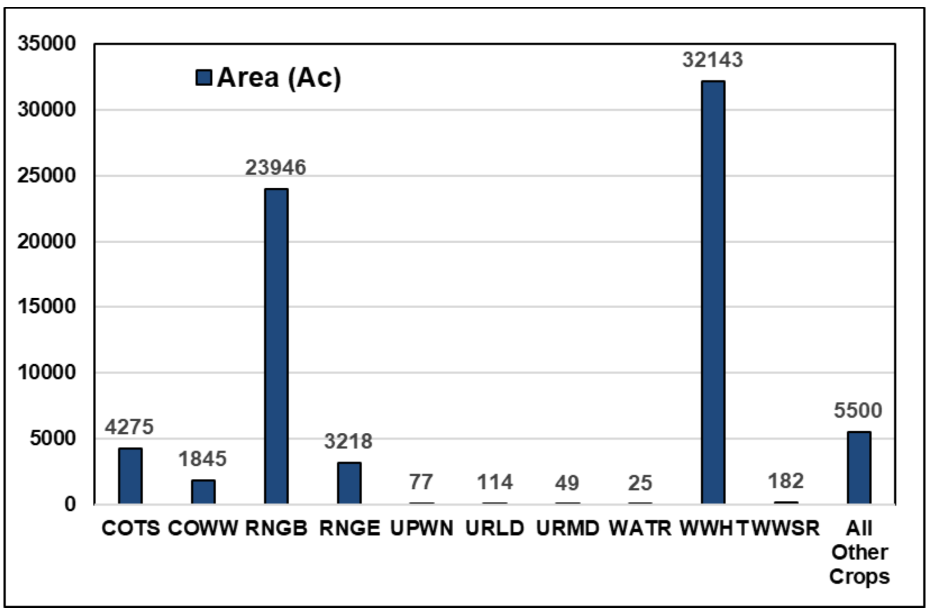

Figure 14. Landuse by area in Tom Steed Lake watershed (source OKHAWQS, CDL/NLCD 2020)

Riparian Assessment:

National Hydrography Dataset (NHD) Hi-res (USGS) flowline data was overlaid on to high resolution ortho-imagery (ESRI website live link) at a 1:3000 scale. A 15-meter (approx. 50

ft.) buffer was created on either side of the NHD flowline. Vegetative cover and general stability were estimated within the buffer for all stream reaches within the watershed. Vegetative cover assessment comprised of the level of apparent perennial woody vegetation (see explanation below). Stability was judged by the presence or absence of active erosion, gullying, and/or trailing (example, Figure 15 below).

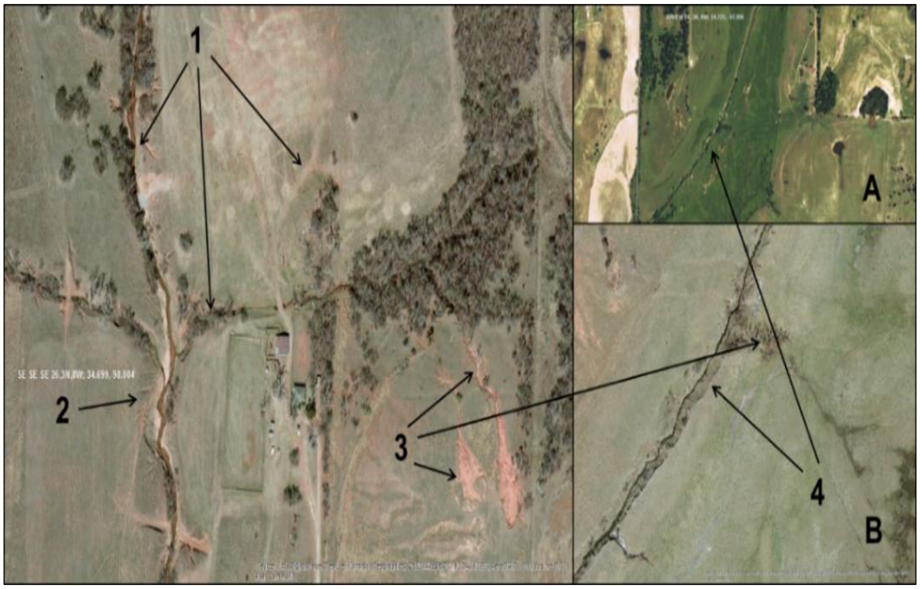

Figure 15. Number (1) Road though creek, (2) Cattle tracks, (3) Gullies, (4) Lack of Riparian Vegetation; Image B is a zoomed in image of A.

Figure 16: Example of cattle trails into creek and active bank erosion.

All NHS hi-res stream segments were assigned an initial numeric value based on the vegetation present in the buffer as follows:
1 - None apparent
2 - Some apparent
3 - Mostly fills buffer
4 - Exceeds buffer

Stream reaches were then assigned a secondary integer of “1” in instances of apparent active erosion in the form of trails, crossings, gullies (e.g., 11, 21, and 31). Overall riparian condition data were rendered into maps for Tom Steed Lake watersheds. All three watersheds exhibit significant lengths of stream with little to no riparian vegetation and active erosion (Figures 16-19) comprising a potentially significant source of sediment Tom Steed Lake.

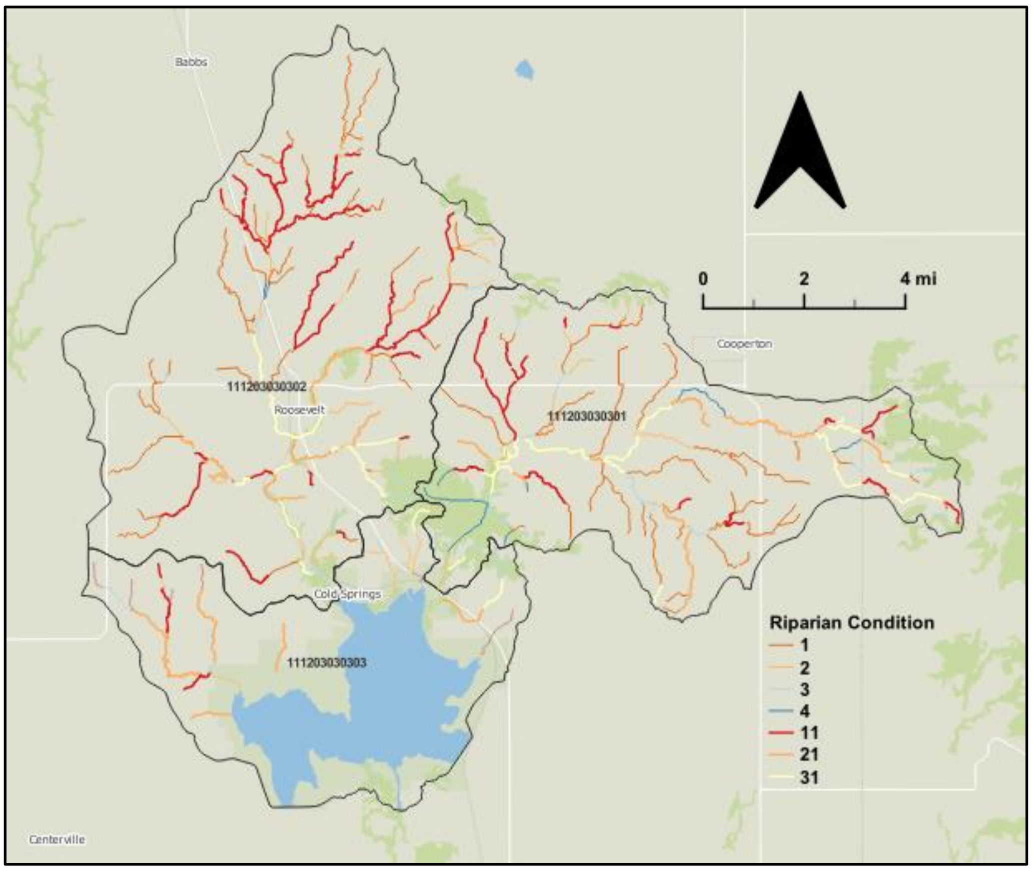

Figure 17. Riparian assessment of Tom Steed Watershed; from no apparent riparian cover (1) to full riparian cover in 15 meter buffer, double digits indicate active erosion, gullies and/or trailing.

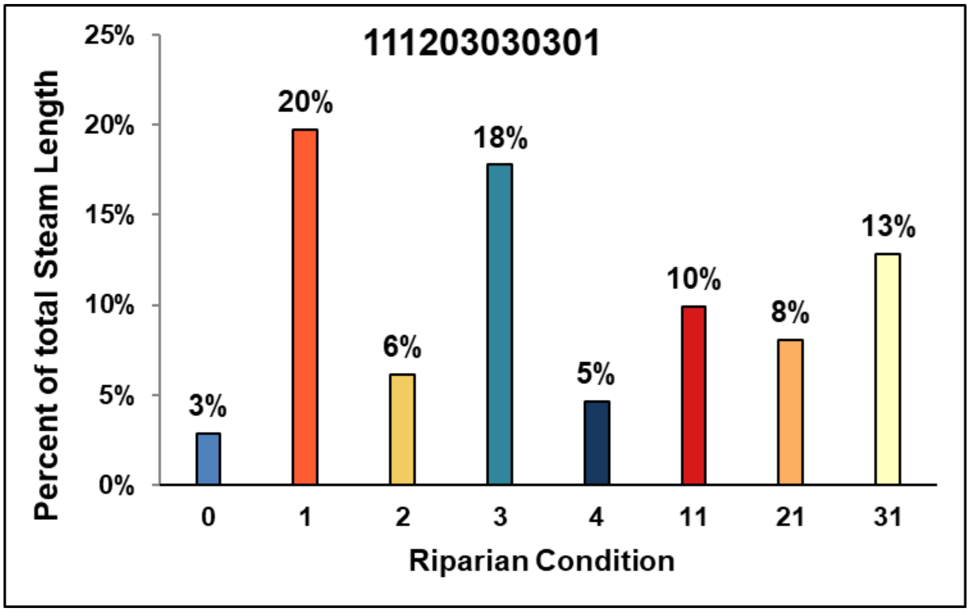

Figure 18. Riparian conditions for 11120300301 watershed. Around 30% of the riparian areas in this watershed are completely void of riparian vegetation which would help with steam bank stability, reduction of surface loading and in stream water quality and habitat. Around 30% has active erosion and signs of livestock in or near the stream.

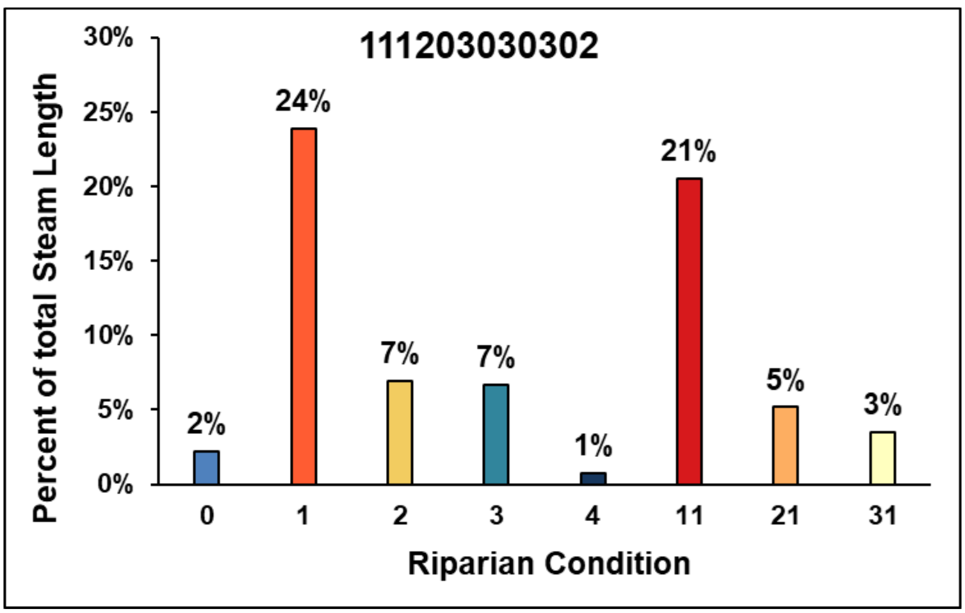

Figure 19. Riparian conditions for 11120300302 watershed. Over 40% of the riparian areas in this watershed are completely void of riparian vegetation which would help with steam bank stability, reduction of surface loading and in stream water quality and habitat. Again, about 30% has active erosion and signs of livestock in or near the stream.

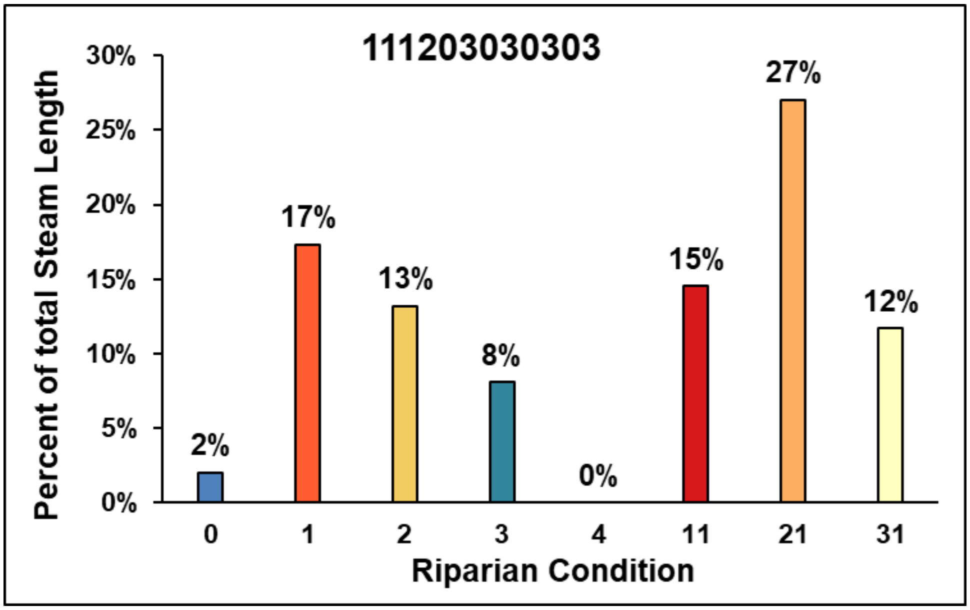

Figure 20. Riparian conditions for 11120300303 watershed. About 32% of the riparian areas in this watershed are completely void of riparian vegetation and another 40% are mostly free of desired riparian cover. This is needed to with steam bank stability, reduction of surface loading and in stream water quality and habitat. Over 50% of the riparian areas have active erosion and signs of livestock in or near the stream.

<u>Unpaved Roads</u>

Unpaved roads make up 176 miles of the 189 total miles of road in the watershed. Seventy-one miles of the unpaved roads have a dirt or gravel surface (Figure 20-21). Many areas of the watershed are very flat and the cropland has been planted up to the edge of the road. No drainage, shoulder, or any sort of field buffer is present for several areas. There is apparent evidence of runoff from fields draining directly on to the unpaved roads, which then become conduits for all that is included in surface runoff which flows into the closest streams. In these areas there is visible evidence of road runoff going into streams at the side of bridges, with signs of erosion related to runoff and altered hydraulics. At this time, we do not have a way to quantify the contribution of unpaved roads to runoff, sediment or nutrients reaching the streams, but it may be significant. Especially under high runoff events. The Oklahoma Conservation Commission has an unpaved roads program which provides education and advising to local road managers and maintenance workers on how best to manage this resource. It would be a benefit to Tom Steed Lake and its tributaries to improve management here.

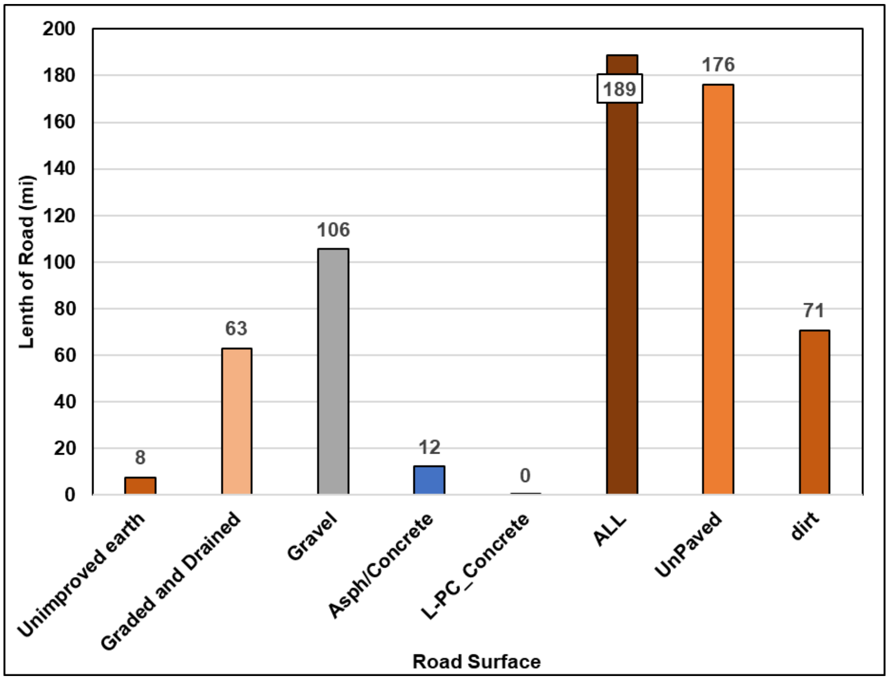

Figure 21. Length of road by Oklahoma Department of Transportation surface classification. Unpaved roads make up most of the roads with 40% of the unpaved roads having a dirt surface.

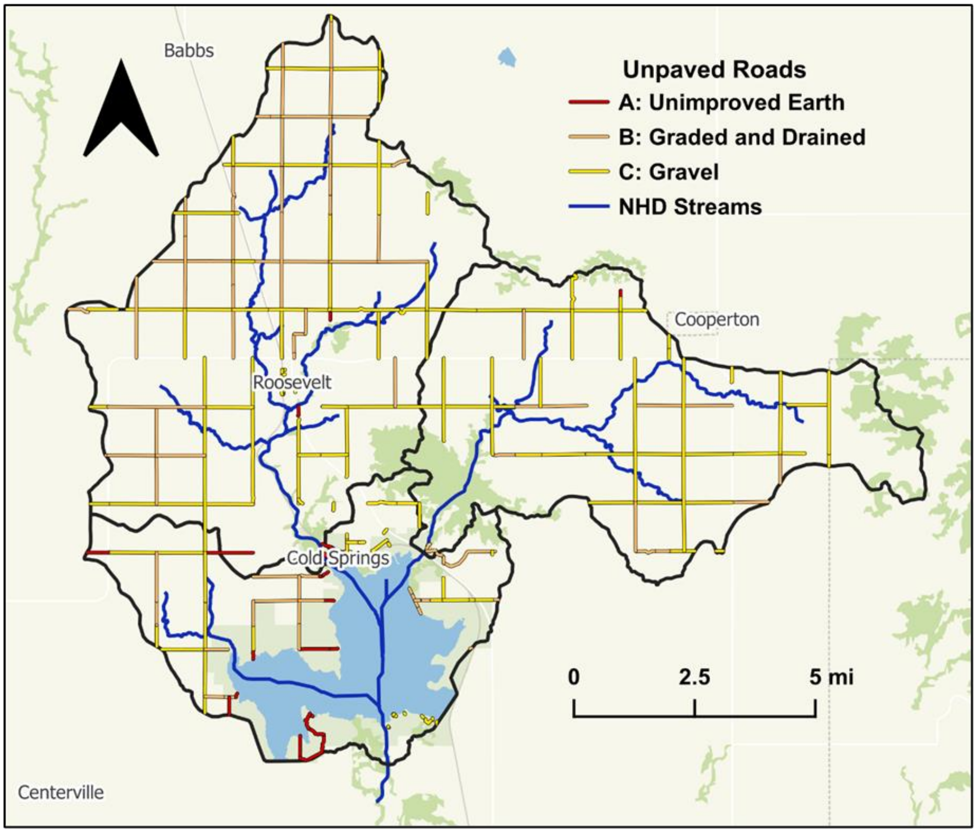

Figure 22. Unpaved road network in the Tom Steed Watershed. Many roads are unpaved, they are a mix Oklahoma Department of Transportation classes of gravel, graded and drained and unimproved earth.

Prioritizing Conservation Efforts:

At the completion of the model run, HRU's were ranked and assessed by per area and total sediment loads. Since the overall annual sediment load per area was small, the HRU's were ranked based on total annual sediment loads. The top ranking HRU's were analyzed to determine causes of the relatively higher sediment output. Cropland and highly erodible soils, based on the ULSE Kw value were determined to be the common feature of these HRUs as seen in Table 6. Based on the results of the HRU analysis, highly erodible soils on cropland, poor ranking riparian areas, and fields with no buffer between the road should be prioritized. While only cropland was considered for modeling reductions based on BMP's, we will also target critical areas in rangeland with poor riparian management scores (Table 5).

Table 5. Length of stream assessed to have critical riparian degradation separated by landuse and whether it has visual impacts from livestock. Total critical riparian length is not a sum of the column, it included other landuse not included here as well as the

Critical Riparian Length of stream	
Range	651212
Crops	264451
Length impacted by livestock	531459
Total Critical Riparian Length (ft)*	**1179731**

Table 6. Critical Source area from watershed model analysis. Modeled double cropping systems were included in winter wheat since the area was very small and they include winter wheat in the rotation. This area represents the area of the top sediment outputting hydrologic response units as predicted by OKHAWQS. The area represents nearly 80% of modeled total sediment loading contributed to the stream reach.

Critical Area for Conservation Practice Targets	
Cotton	3515
Winter Wheat	21439
All other Crops	2235
Total Critical Source Area (Ac)	**27189**

Sources

The Tom Steed Lake watershed and Tom Steed Lake have been included in a Total Maximum Daily Load (TMDL) studies for chlorophyll-*a* (ODEQ 2011). According to the 2011 study, the most likely sources contributing to the water quality impairments are nonpoint. Nonpoint sources are those which deliver pollutants to surface waters diffusely, rather than as a definite, measurable quantity from a single location. These sources typically result from land activities that contribute pollutants such as sediment, nutrients, and/or bacteria to surface water as a result of runoff during and following rainfall. Potential sources of concern in this watershed include grazing and related livestock activities in riparian or shoreline zones, on-site treatment systems (septic systems and similar decentralized systems), and rangeland grazing.

One no-discharge NPDES facility is in the Tom Steed Lake watershed. Although this type of facility normally should not be contributing to the chlorophyl- *a* load in the stream, discharges may occur during large rainfall events if the system's storage capacity is exceeded. In addition, sanitary sewer overflow (SSO) from wastewater collection systems can be a major source of nutrient in streams. No occurrences of SSOs were recorded at the Roosevelt Wastewater Treatment Facility during the TMDL study period.

Rangeland and Cropland comprise approximately 79% of the landuse in the watershed. Table 7 below indicates that cattle are the most abundant species of commercially raised farm animals in the watershed. Livestock grazing in pastures deposit manure containing fecal bacteria onto land surfaces, making it possible for both bacteria and nutrients to enter surface water with runoff. In addition, livestock often have direct access to waterbodies, providing a concentrated source of fecal loading directly into streams. Direct access by livestock also promotes bank trampling/destabilization and trail formation, which serve as direct conduits of pollutants through the sparse riparian area that might be present. In areas of depauperate riparian area, streambank erosion is a likely contributor of sediment and associated nutrient loads. Commercially raised farm animal manure, from any type of animal, is often applied to fields as fertilizer and can contribute to bacteria loading to the stream if washed into the water by runoff. Most crops are traditionally raised with multiple plow cycles, pesticides, and fertilizer additions. Winter wheat is typically grazed and may not be harvested so cattle can graze until the end of the growing season. Plowing disturbs the soil which contributes to increased sediment and nutrient loading. It also contributes to decreased soil biologic activity, soil organic carbon build-up, and increased moisture stress in the dry periods.

Pets and wildlife, such as deer, feral hogs, raccoons, turkeys, and geese and other avian species, are also potential contributors to fecal bacteria in the stream, either via direct defecation into the water or by feces washing into the stream during rain events. The TMDL for Tom Steed Lake did not estimate numbers for animals in the watershed.

LOAD REDUCTION EVALUATION CRITERIA *(element h)*

Designated uses for Tom Steed Lake include public and private water supply (PPWS), Warm Water Aquatic Community (FWP-WWAC), and Fish Consumption. The watershed is also designated "Sensitive Water Supply" (SWS). According to the State's 2016, 2018 & 2020 and 2022 Integrated Reports, Tom Steed Lake does not attain its PPWS and WWAC designated uses. In 2020 and 2022 it was not attaining for fish consumption due to mercury levels. The criteria and procedures used to assess the assigned uses are located in *Oklahoma's Water Quality Standards* (ODEQ 2023a), *Implementation of Oklahoma's Water Quality Standards* (OWRB 2023b), and the *Oklahoma Continuing Planning Process* (ODEQ 2012a). The ultimate goal of implementation of any project in this watershed is to restore all designated uses, so these criteria are the target values to achieve.

To attain the WWAC use for lakes, turbidity from other than natural sources shall be restricted to not exceed 25 Nephelometric Turbidity Units (NTU). Samples should not be considered after a runoff event as that is expected to increase turbidity for several days.

To attain the PPWS, specific criteria for chlorophyll-α and/or total phosphorus as specified in OAC 785:45-5-10(7) and (8). Attainment of these criteria will be evaluated using the specified criteria and the long-term average default protocol.

LOAD REDUCTIONS *(element b)*

The ODEQ is the state agency responsible for producing Total Maximum Daily Load (TMDL) goals for impaired waterbodies. A TMDL determines the pollutant loading a waterbody can assimilate without exceeding the water quality standard for that pollutant, as well as establishing the pollutant load allocation needed to meet the standard. Goals for improving the water quality in Tom Steed Lake were published as part of the "Chlorophyll-A Total Maximum Daily Loads for Rocky Lake (Ok311500030060_00) and Tom Steed Lake (Ok311500020060_00) (ODEQ, 2011c). The 2011 TMDL effort details process and associated load reduction goals rendered for total phosphorus and total nitrogen A SWAT model was employed for the TMDL and recommended the load reduction goal for total phosphorus and total nitrogen is 65 percent.

OKHAWQS was used to quantify and estimate potential reductions in total nitrogen, total phosphorus, and sediment loads. Area and conservation practices (CP) were chosen based on analysis of the SWAT outputs and riparian assessment, but CPs can be applied to the entire Tom Steed watershed. Reduction scenarios were chosen for their likely impact in the watershed and the ability of OKHAWQS to adequately represent the CP in this region. Outputs selected for final assessment of reduction were annual averages for sediment, total phosphorus and total nitrogen leaving the watershed. Currently, it is not possible to model filter strips with concern to their location in the watershed using OKHAWQS/SWAT. A field whose border is a riparian corridor is part of a batch calculation including other fields with the same characteristics. It is assumed that a riparian filter has more potential to reduce sediment and nutrient loading, as well as all the benefits expected from riparian buffers (i.e., increased resistance to stream bank erosion, improved habitat for aquatic life, decreased temperatures). In addition, this watershed has many miles of unpaved and unimproved roads that appear to be conduits for field runoff. Many producers are growing crops and grazing up to the edge of the road, which had removed any buffering of runoff that may have occurred with a grassed right of way or properly maintained drainage system. There are signs that the runoff uses the road itself, many of which are bare soil, as a pathway into creeks. Filter strips were the most effective CP in all the scenarios run. Scenarios with various combinations of filter strips, as the sole CP and in combination with reduced grazing and no-till cropping systems had the largest reductions. However, it takes a 15m buffer on all cropland to achieve the reduction goals stated in the TMDL for modeled scenarios. The results are presented in Table 7 below.

Table 7, Results for scenarios used to model reductions from the Default model run. The baseline model run was used to calculate the target of 65% reductions. Across all scenarios the 15 meter filter strip on all cropland was the only one to achieve reduction goals. While reduced grazing showed little effect in the models, it should still be utilized. No-till and filter strips on cropland with soils having high USLE K values (erosivity) was very close to achieving reduction goals.

Constituent leaving the watershed in the channel (average kg/yr)				
Annual Average Sediment out (kg)				
Scenario	**111203030301**	**111203030302**	**111203030303**	**Total**
Baseline	2987	5438	8496	16921
Target Reduction (65%)	1045	1903	2974	5922
Grazing on Range	3003	5388	8376	16766
5 m filter all crops	1281	2295	3623	7199
15 m filter all crops	624	1084	1745	3453
Grazing on Range w/5m fltr	2901	5305	8187	16393
Top HRU SED OUT(15m fltr)	1148	1927	3553	6628
Tp HRU/high K value 5m fltr	1955	3150	5419	10524
TpHRU high K fltr no till ct ww	1080	1927	3472	6479
All crops to LBLS	2101	2736	5148	9986
Annual Average TP (kg)				
Scenario	**111203030301**	**111203030302**	**111203030303**	**Total**
Baseline	3373	8604	12937	24913
Target Reduction (65%)	1181	3011	4528	8720
Grazing on Range	4298	9467	15019	28784
5 m filter all crops	1555	3738	5758	11051
15 m filter all crops	852	1861	2987	5700
Grazing on Range w/5m fltr	3547	8692	13219	25458
Top HRU SED OUT(15m fltr)	1454	3265	5571	10291
Tp HRU/high K value 5m fltr	2352	5254	8475	16080
TpHRU high K fltr no till ct ww	1420	3265	5534	10220
All crops to LBLS	2822	6320	10026	19169
Annual Average TN (kg)				
Scenario	**111203030301**	**111203030302**	**111203030303**	**Total**
Baseline	18737	42839	66352	127928
Target Reduction (65%)	6558	14994	23223	44775
Grazing on Range	19124	42799	66489	128413
5 m filter all crops	9083	19242	30968	59293
15 m filter all crops	5350	10132	17296	32779
Grazing on Range w/5m fltr	17510	41170	62750	121430
Top HRU SED OUT(15m fltr)	8697	17880	31305	57882
Tp HRU/high K value 5m fltr	13209	26630	44469	84308
TpHRU high K fltr no till ct ww	8442	17880	30993	57315
All crops to LBLS	15253	30602	50476	96331

NPS MANAGEMENT MEASURES *(element c)*

Specific CPs are listed in Table 7 and will follow guidelines specified in the NRCS conservation practice standards. Specific locations will be based on critical areas defined in element a, and the desire of the landowner/producer to participate.

The most common cropland practices include filter strips, residue management practices (no-till and reduced till), cover crops, and converting crop fields to permanent vegetation (forage and biomass plantings). Grazing land (range and pasture) efforts are focused on facilitating practices such as livestock watering systems (wells, tanks, pipelines, ponds) as well as fencing for riparian protection.

OCC and NRCS staff will provide technical assistance to landowners and operators in the target subbasins. This includes conservation planning, design of practices and technical assistance in installing specific practices.

Some CPs have been installed through Oklahoma's locally led cost-share program and through the local NRCS Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), and general technical assistance program. Eligible practices for cost-share include installation of ponds, watering facilities, wells, pipeline, fencing for pond and stream exclusion, critical area planting, and animal trails/walkways. The OCC will continue to promote CP implementation in this watershed through the local conservation districts, and the NRCS will also continue to offer financial and technical assistance through its various programs.

PUBLIC OUTREACH *(element e)*

The Oklahoma Conservation Commission's education programs, Blue Thumb, Soil Health, and Unpaved Roads will promote NPS pollution education in Tom Steed Lake watershed. Outreach efforts may include workshops, newsletters, exhibits at festivals and schools, newspaper articles, and contests. These activities provide vital education of the residents of the watershed and help facilitate changes in behavior. Active volunteer monitoring and education is continuing in the area.

The local conservation districts will organize a Watershed Advisory Group (WAG) which will provide input on conservation practice prioritization and assist with engaging landowners in the watershed. Fact sheets will be produced and distributed to explain the water quality and production benefits of planned conservation practices. Articles in newspapers and newsletters may be used to educate residents about the issues in the watershed and the ongoing project. Landowner education and support will be essential to successful implementation of CPs in the watershed.

TECHNICAL and FINANCIAL ASSISTANCE NEEDED *(element d)*

The OCC will provide support for the Blue Thumb and Soil Health educational programs in the watershed, which may include trainings for new volunteers, school programs, and presentations to residents. In addition, Clean Water Act (CWA) Section 319 funds may be offered to incentivize practices that are vital to load reductions yet difficult to persuade landowners to install. The need for use of these funds will be evaluated annually.

Costs of CPs are listed in Table 8 below. Practice codes and the price of the CPs are from NRCS conservation practice standards. Total costs will be paid through NRCS funds, CWA Section 319 funds and other assistance obtained for CP implementation.

Table 8. Estimates of technical and financial assistance needed to meet reduction goals.

Conservation Practice & Efficiency	Practice Code	Total Units	Unit	$/Unit	Total Cost
Range and Pasture					
Prescribed Grazing	528	0	acres	$9	$0
Watering Systems for Livestock*	614, 561, 642, 516	50	each	$5,000	$251,638
Nutrient Management (pasture)	590	7340	acres	$21	$154,140
Buffer Practices	(391, 393, 390) 386	747	acres	$400	$298,996
Fencing	382	1062918	feet	$2	$2,380,936
Range & Pasture Total					**$3,085,709**
Cropland					
Crop Rotation	328	13595	acres	$11	$149,540
Residue Management	345, 329	13595	acres	$14	$187,060
Conversion to Native Grass	512, 550	2266	acres	$328	$743,166
Cover Crops	340	13595	acres	$74	$1,000,963
Buffer Practices	(391, 393, 390) 386	304	acres	$400	$121,419
Cropland Total					**$2,202,148**
Project Total					**$5,287,857**
* not priced from current list					

IMPLEMENTATION SCHEDULE and INTERIM MILESTONES *(elements f and g)*

Conservation Practice implementation on a cost-share basis has been ongoing on a limited scale through NRCS programs and the local conservation districts/OCC. More intensive implementation will begin as the Soil Health team and a District Conservation Planner get familiar with the results of accepted watershed plan. The focus of activities in the watershed will be riparian management, filter strips, field buffers, grazing management, and reduced tillage on crops. Education will be vital to changes in producer practices, so the OCC and the Districts will host multiple field days and trainings on the CPs that will be promoted in this project. Estimated dates of milestones are reported below. WAG meetings will be held at least twice a year. Assessment of the water quality monitoring data will be assessed annually. If a decline in water quality is observed at any point, NRCS, OCC, and district staff will meet to investigate possible causes and determine further steps to improve project participation if necessary.

Table 9: Implementation and Milestone timeline.

Timeframe	Project Actions	Agency Responsible	Status	Outcome
June 2024 – May 2026	5th Cycle of Rotating Basin Monitoring, every 5 weeks	OCC	Active	RB 4.5 Report
2024	Develop WBP		Draft	Watershed based plan completed
2024; 2026	Blue Thumb training and education in community		Planned	Increased understanding of NPS pollution prevention
2025 – indefinitely	Volunteer stream monitoring		Planned	Additional data to document changes in water quality
2025 – indefinitely	Soil Health training and community education		Planned	Increased understanding of NPS pollution prevention
2025 – indefinitely	Unpaved roads workshop		Planned	Increased understanding of NPS pollution prevention
2025 – indefinitely	CP implementation		Planned	Improved water quality due to better land management
June 2029 – May 2031	6nd Cycle of Rotating Basin Monitoring, every 5 weeks		Planned	RB 4.5 Report

MONITORING PLAN *(element i)*

Baseline Data:
Baseline data will be collected during the 2024-2026 Rotating Basin Monitoring Period.

Current and Future Monitoring:

The 5th cycle of monitoring in the Rotating Basin Program commenced in June 2024 and continued through May 2026. Blue Thumb volunteers may also monitor some tributaries within the watershed.

Current and Planned Monitoring Dates:

June 2024- May2026	5th Cycle of Rotating Basin Monitoring, every 5 weeks
June 2029 – May 2031	6th Cycle of Rotating Basin Monitoring, every 5 weeks

CLIMATE RESILIENCE

CPs are designed and recommended with the goal of being resilient to all weather and climate fluctuations. In addition to the goal of reducing runoff and associated pollutants, reduced or no till, cover crops, grazing management returning some cropland to native prairie are all practices that increase infiltration of water into the soil and increased soil holding capacity. Efforts will be made to educate producers on better ways to manage cattle and to select crops and forage that is more appropriate for the local ecoregion as well as more resilient to the changing climate moving forward.

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