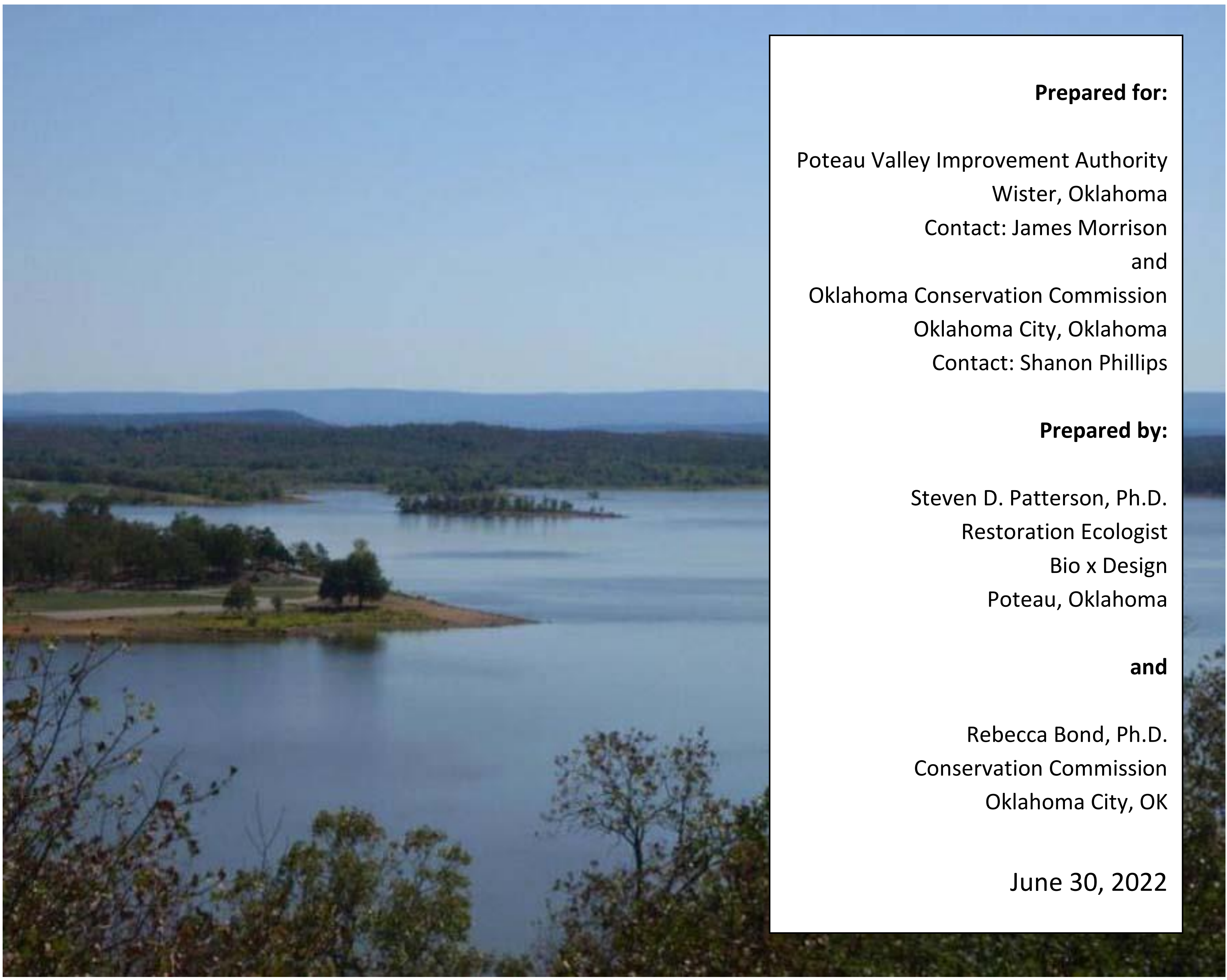
LAKE WISTER WATERSHED PLAN

A Nine-Element Watershed Based Plan



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CHAPTER 1: INTRODUCTION

This watershed based plan has been prepared to guide efforts to improve water quality in Lake Wister, Oklahoma. The plan has been drafted following US EPA recommendations for nine-element watershed based planning.

Lake Wister

Figure 1: Lake Wister aerial view (Photo: Google Earth, imagery date 2009)

Lake Wister is a 25.4 km^2 (6,288-acre) flood control, water supply, and recreation reservoir in LeFlore County in eastern Oklahoma (Figure 1). The focus area for this watershed planning effort is the Oklahoma portion of the Lake Wister watershed. Wister is a bistate watershed--approximately 60% of the Lake Wister watershed is in Oklahoma; the remaining 40% is in Arkansas, upstream of the Oklahoma portion. A separate watershed planning effort for the Arkansas portion of the Poteau River watershed is also underway. Although the Arkansas effort is completely separate from Oklahoma's watershed planning, individuals involved in both states are committed to sharing data and collaborating where possible.

Lake Wister is on the Oklahoma 303(d) list of impaired water bodies (ODEQ, 2018), identified as impaired for its beneficial uses of *Public and Private Water Supply*, *Fish and Wildlife Propagation, Fish Consumption*, and *Aesthetics*. Causes of impairment include excess chlorophyll-*a*, turbidity, pH, phosphorus, and mercury (see Chapter 3).

The Poteau Valley Improvement Authority (PVIA) is a State of Oklahoma-chartered trust founded in 1969 that produces potable water for drinking, commercial, and industrial uses for most of LeFlore County, Oklahoma (Figure 2) and portions of adjacent counties. PVIA treats water from Lake Wister and distributes it to sixteen cities and rural water districts. The quality of the water in Lake Wister directly affects the cost and difficulty of water treatment and therefore the ability of PVIA to supply safe, affordable drinking water to its customers.

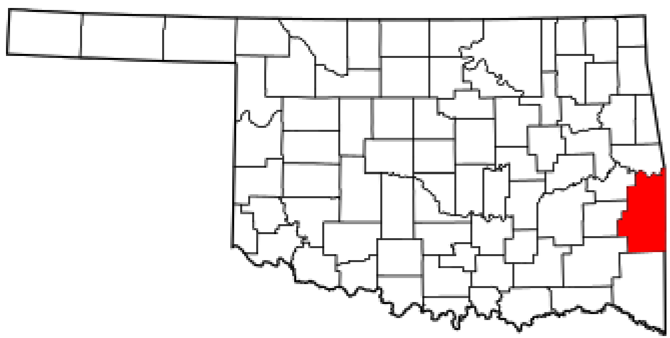

Figure 2: LeFlore County location in eastern Oklahoma

The benefits of high-quality water in Lake Wister accrue to a broad community of users--fishermen, boaters, recreationists, and other water users--and not only to PVIA customers. PVIA has, nevertheless, taken the lead in efforts to protect and restore water quality in the lake. In October 2019 PVIA completed and submitted to the Oklahoma Department of Environmental Quality a lake-modeling report that made recommendations for the promulgation of Total Maximum Daily Loads (TMDLs) for the lake (Scott and Patterson, 2019). The establishment of TMDLs has paved the way to begin to focus on implementation of projects necessary to achieve the load reductions that will restore water quality in the lake. The purpose of a watershed based plan is to identify the actions desirable and necessary to achieving water quality restoration. PVIA and the Oklahoma Conservation Commission are collaborating in the development of this watershed based plan. A watershed based plan establishes a framework for protecting and improving water quality in a watershed.

Watershed Planning Process

Actions envisioned in this watershed based plan are voluntary, non-regulatory, and ultimately require stakeholder collaboration to be successful in addressing the reduction of nonpoint source pollutants. An effective watershed approach requires the integration of a variety of scientific and descriptive information on a range of topics including land use, climate, hydrology, drainage, topography and vegetation (USEPA, 2012). A watershed based plan does not ascribe legal obligations; rather it is a general blueprint for a comprehensive, watershed-wide water quality restoration program.

Per US EPA recommendations, a watershed based plan consists of nine key elements (USEPA, 2008):

1. Identification of the causes and sources of NPS water pollution that will need to be controlled

2. An estimation of load reductions expected from the management measures used to achieve water quality goals

3. A description of the management measures that will need to be implemented to achieve pollution load reductions

4. Technical and funding needs to support the implementation and maintenance of restoration measures

5. A description of public outreach method(s) that will be used to engage and maintain public and governmental involvement including local, state, federal, and tribal governments

6. A schedule for implementation of needed restoration measures and identification of appropriate lead agencies to oversee implementation, maintenance, monitoring, and evaluation

7. A description of interim, measurable milestones for the actions to be taken and desired water quality goals and outcomes

8. Criteria that can be used to determine whether load reductions are being achieved over time and substantial progress is being made toward achieving water quality standards

9. A description of monitoring and evaluation activities needed to further define problems and/or assess progress towards achieving water quality goals

State of Oklahoma Water Quality Standards

Oklahoma's Water Quality Standards (WQS) were adopted by the State of Oklahoma in accordance with the federal Clean Water Act, applicable federal regulations, and state pollution control and administrative procedure statutes. WQS serve a dual role:

- They establish water quality benchmarks
- They provide the basis for the development of water quality pollution control programs, including discharge permits, which dictate specific treatment levels required of municipal and industrial wastewater dischargers

Water Quality Standards consist of three main components:

1) designation of beneficial uses,
2) water quality criteria to protect the designated uses, and
3) antidegradation policies.

Establishment of beneficial uses, water quality monitoring, and beneficial use assessment comprise the core of water quality standards implementation. Oklahoma's water quality standards include the following beneficial uses:

- Public and private water supply,
- Fish and wildlife propagation,
- Agriculture,
- Primary body contact recreation (such as swimming),
- Secondary body contact recreation (such as boating or fishing),
- Navigation,
- Aesthetics.

Physical, chemical, and biological data on Oklahoma's rivers, streams, and lakes are obtained primarily through field sampling. Beneficial use support is assessed by comparing data to narrative and numerical criteria specified in the WQS. The overarching purpose of WQS and assessment of beneficial uses is to protect the quality of the state's water resources.

Impairments of Concern

The targets of concern in this watershed plan are total phosphorus and total suspended solids, as identified in the proposed TMDLs for Lake Wister (Scott and Patterson, 2019).

2019 Total Maximum Daily Loads for Lake Wister

In October 2019 PVIA completed and submitted to the Oklahoma Department of Environmental Quality a lake-modeling report that made recommendations for the promulgation of Total Maximum Daily Loads (TMDLs) for the lake (Scott and Patterson, 2019)

Water quality modeling simulations indicated that a 78% reduction in the average total phosphorus (TP) load delivered to the lake will be required for the lake to meet the criterion of 10 µg/L of chlorophyll-*a* (chl-*a).* Model simulations also indicate that a 71% reduction in the average total suspended solids (TSS) load delivered to the lake will be required for no more than 10% of samples to exceed the turbidity criterion of 25 NTU.

The establishment of TMDLs for Lake Wister for phosphorus and sediment set the target loads for these constituents to support the designated beneficial uses for Lake Wister. The next step towards improving water quality is to establish a plan for how to achieve the required load reductions. That is the purpose of this document, a watershed based plan for the Lake Wister watershed, drafted in keeping with US EPA recommendations for nine-element watershed based planning.

CHAPTER 2: PROJECT AREA BACKGROUND

Geographic Location of Project Area

Figure 3: Lake Wister Dam

Lake Wister is located in LeFlore County in eastern Oklahoma. The lake was formed in 1949 by the completion of a dam on the Poteau River by the United States (US) Army Corps of Engineers (Figure 3). The Poteau River begins east of the town of Waldron in western Arkansas and the river flows west to Lake Wister. Leaving the lake, the Poteau River flows north to its confluence with the Arkansas River at Fort Smith, Arkansas. The Poteau River watershed (HUC 11110105) covers some 4,890 km^2 (1,888 mi^2) in Arkansas and Oklahoma (Figure 4).

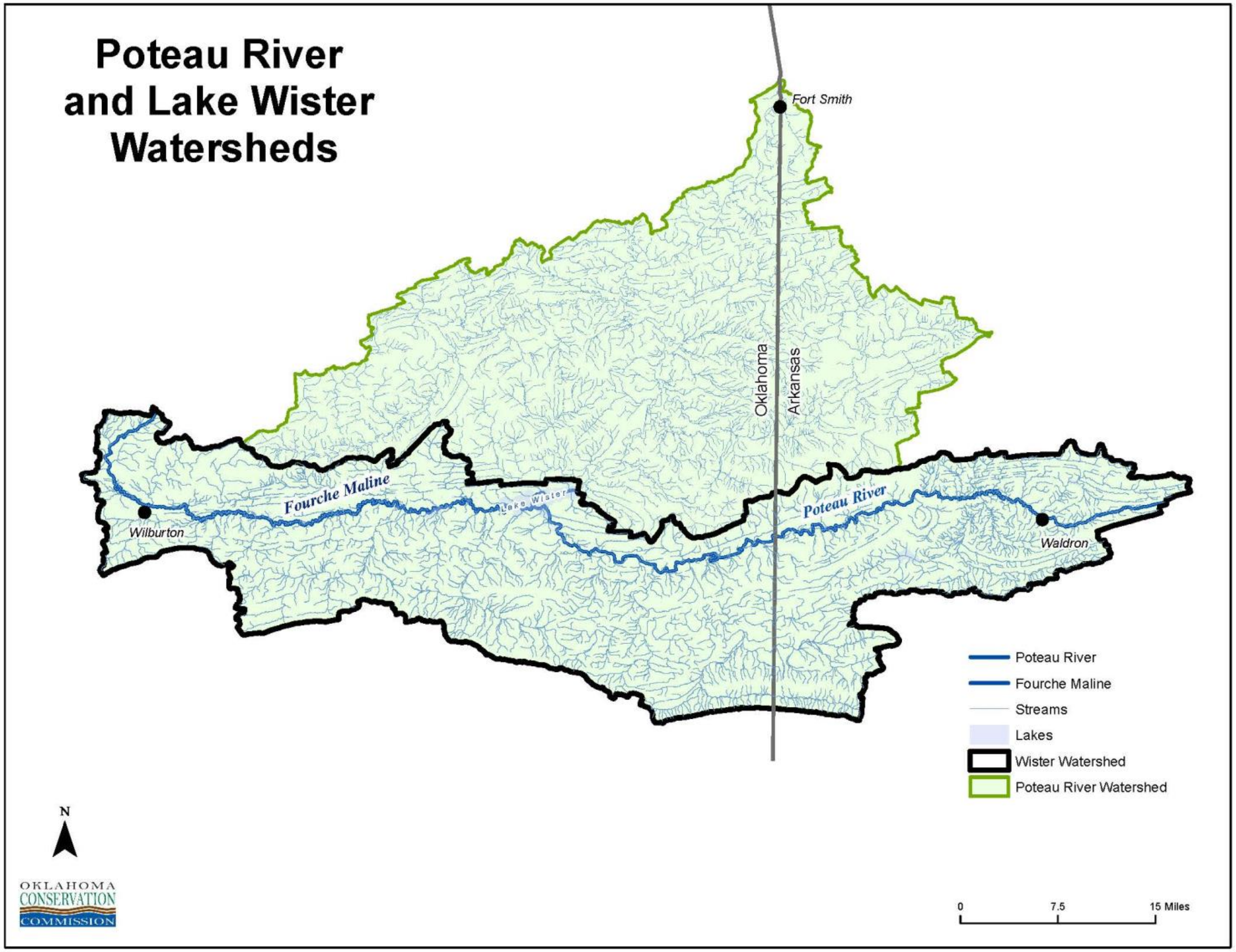

Figure 4: Poteau River and Lake Wister watersheds

The Lake Wister watershed, with an area of 2,572 km^2 (993 mi^2 or 635,520 acres) encompasses just over half of the Poteau River watershed area. The Oklahoma Lake Wister watershed is located in LeFlore and Latimer counties. Lake Wister and the Oklahoma portion of its watershed are located within the Choctaw Nation of Oklahoma.

Climate of Project Area

Climate in the Lake Wister watershed area is temperate, with a mean annual temperature of 60.3^0 F. On average, temperatures of 90^0 F or higher occur 60 days per year, while days where the highest temperature is less than 32^0 F occur three days per year. The total average annual precipitation in LeFlore County is 49.9 inches. The average growing season is 211 days (Oklahoma Climatological Survey, 2017).

Ecological context

Lake Wister is located in the Arkansas Valley ecoregion, #37 on the US EPA's Level III and Level IV Ecoregions map (USEPA, 2013) (Figure 5). Lake Wister lies just north of the Winding Stair Mountains, the northernmost range of the Ouachita Mountains (Ecoregion #36) in Oklahoma. The Poteau River begins in the Ouachita Mountains, but quickly descends into the Arkansas Valley. Some tributaries to the Poteau River also rise in the Ouachita Mountains before descending into the Arkansas Valley. The second major stream entering Lake Wister is the Fourche Maline (the "bad or evil fork"). The Fourche Maline rises on the slopes of the San Bois Mountains above the town of Wilburton, Oklahoma, and then like the Poteau, quickly descends into the lowlands at the foot of the hills. The Fourche Maline is located almost entirely within the Arkansas Valley ecoregion. The Fourche flows east to Lake Wister. Lake Wister was constructed just downstream of the former confluence of the Fourche Maline with the Poteau.

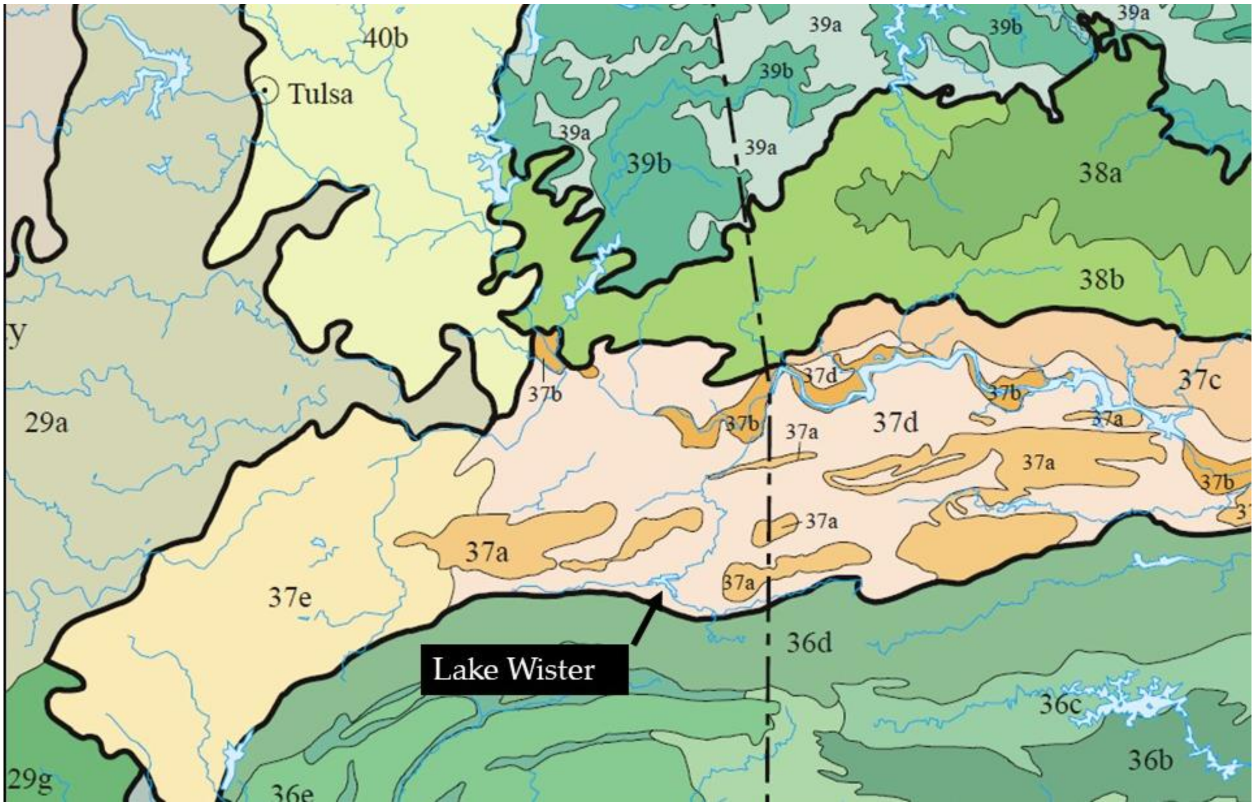

Figure 5: US EPA Level IV Ecoregions for the project area (USEPA, 2013)

Despite a long history of human use and degradation, streams in the Poteau River watershed remain ecologically rich. The Poteau River supports 35 species freshwater mussels (Vaughn & Spooner, 2004), which is over 60% of the 55 species known for the entirety of the State of Oklahoma. Oklahoma Conservation Commission fish sampling in the Fourche Maline indicates that fish diversity and biological integrity supported by the Fourche Maline are among the highest in the state (OCC, 2017).

The Arkansas Valley ecoregion is essentially the same area as the geological region known as the Arkoma Basin. The Arkoma Basin was created as the sinking front wave of the Ouachita Mountains as they were being pushed up from the south by plate tectonics. Landforms within the Arkoma Basin are an irregular series of ridges and valleys. Today the ridges are mostly forested and the valleys most pasture. Much of the pasture areas were formerly tallgrass prairie, and a few remnant patches of prairie remain, maintained by annual hay mowing.

All exposed rocks in the Lake Wister watershed are sedimentary in origin, and primarily consist of marine shales interbedded with sandstone and coal (Lindsay et al., 1974). The weathering of these shales produces clay particles that dominate in the lowland streams of the watershed, leading to high turbidities following storm events. This geology also contributes to the fact that even streams relatively unimpacted by human activities have considerably lower dissolved oxygen levels in the Arkansas Valley than adjacent ecoregions, and, hence, support different biological communities (USEPA, 2013).

Topographically, LeFlore County ranges from nearly level floodplains along major creeks and rivers to steep mountainous areas. The Poteau River watershed drains most of LeFlore County, north of the Winding Stair Mountains. (The southernmost portion of the county drains to the Kiamichi River and thence to the Red River.) The lowest point in the county is along the Arkansas River and is about 128 m (420 ft) above sea level. Elevation of the valley areas ranges from 142 m (465 ft) in the north end of the county to 280 m (920 ft) in the south end of the county. The ridges and mountains range in elevation from 213 m (700 ft) to nearly 732 m (2,400 ft) (USDA 1983).

Latimer County lies primarily within Arkansas Valley ecoregion. The topography ranges from level on the floodplains of Gaines Creek and Fourche Maline Creek to steep in the San Bois Mountains. The general slope is to the south and east. Most of the eastern part of Latimer County is drained by the Fouche Maline. The average elevation is approximately 366 m (1200 ft) and the lowest point in the county (155 m or 510 ft) is on the Latimer-LeFlore County line where the Fourche Maline leaves the county (USDA, 1981).

The Neff-Kenn-Ceda soil association is found along the floodplains of the Poteau River, Fourche Maline Creek, and other streams in the basin. These loamy floodplain soils are nearly level to gently sloping, and moderately well-drained to well-drained. They have loamy subsoils, with cobbly and loamy underlying layers. The south side of Lake Wister is dominated by the Stigler-Shermore-Wister association. These are deep, nearly level to sloping moderately well-drained loamy soils that consists of loamy or clayey subsoil. This soil is found over colluvium and shale on uplands (USDA, 1983).

Historical Description of Project Area

The waterways of the Poteau River watershed have been of major importance for human occupation for thousands of years. One period when high numbers of people occupied the area was from around 1500 BCE (Before Current Era = BC) to around 900 CE (Current Era = AD). This encompasses regional archaeological phases known as the Wister and the Fourche Maline (Shingleton, 2014, Galm, n.d., Vehik, n.d.) This was a time of abundant human occupation with people making significant use of stream and wetland habitats for subsistence. Dark, accretional midden mounds are (or were) a common feature along the Fourche Maline and the Poteau River in the Lake Wister area (Vehik, n.d.). Freshwater mussel shells are abundant in many of these middens and date to between 3,500 and 1,000 BP (White, 1977). Hundreds of archaeological sites have been found around Lake Wister that date to this time period. In 1975, most of the floodpool of Lake Wister was placed on the National Register of Historic Sites as the *Lake Wister Archaeological District* (SHPO, 2021).

Figure 6: Canoe paddler on engraved shell (replica). (Photo: Spiro] Mounds Archaeological Center, LeFlore County, Oklahoma)

Beginning around 900 CE, following the Fourche Maline Phase, the Mississippian-era city of Spiro was constructed near the floodplain of the Arkansas River about nine miles upstream on the Arkansas River from where the Poteau River enters the Arkansas. Spiro was one of the largest cities in North America in pre-European times, with a population in the city itself of some 10,000 people at its peak (Singleton and Reilly, 2020). Spiro was connected to most of the rest of North America via a vast trade and tribute network. Items found at Spiro include colored flint from New Mexico, copper from the Great Lakes, conch shells from the Gulf Coast, and mica from the Carolinas (Singleton and Reilly, 2020). Much of that transportation took place via dugout canoes rivers and streams (Hartmann, 1996) as depicted on the artwork in Figure 6.

Many changes have occurred to aquatic systems over the last 200 years. Bridges were constructed, stream channels straightened, and wetlands drained. We have no specific information to quantify the extent of local wetland drainage. By our best estimate, wetlands at the beginning of European occupation occupied some 6.4% of the area of Oklahoma (Dahl, 1990). By 1980 that had been reduced to 2.1% (Dahl, 1990). Since wetlands were more common in eastern than western Oklahoma, and, given the abundance of oxbow lakes in the Poteau River bottomlands, it is reasonable to suppose that the loss of wetlands in the Wister watershed equaled or exceeded the statewide average.

The completion of Lake Wister dam in 1949 by the US Army Corps of Engineers for flood control purposes dramatically changed Poteau River hydrology and ecology and ushered in a new era of water infrastructure in the region. Most of LeFlore County north of the Winding Stair Mountains now relies on Lake Wister to supply water for domestic, business, and industrial uses.

Watershed and Lake Hydrology

The Poteau River watershed is a USGS HUC 8 (Hydrologic Unit Code - 11110105) watershed, a subwatershed of the Arkansas River watershed. Within the Oklahoma portion of the Lake Wister watershed there are 26 HUC 12-scale subwatersheds that range in size from 42 to 125 km^2 (10,300 to 30,800 acres) (Figure 7). The Oklahoma Nonpoint Source Management Program Plan recognizes these smaller scale watershed areas to be an appropriate scale for watershed restoration action--for planning, implementation, and effectiveness monitoring (OCC, 2019). In support of this approach, OCC and PVIA sponsored approximately three years of baseflow water quality monitoring at the HUC 12 scale across the Oklahoma portion of the Lake Wister watershed (see Chapter 3 for more on this sampling effort).

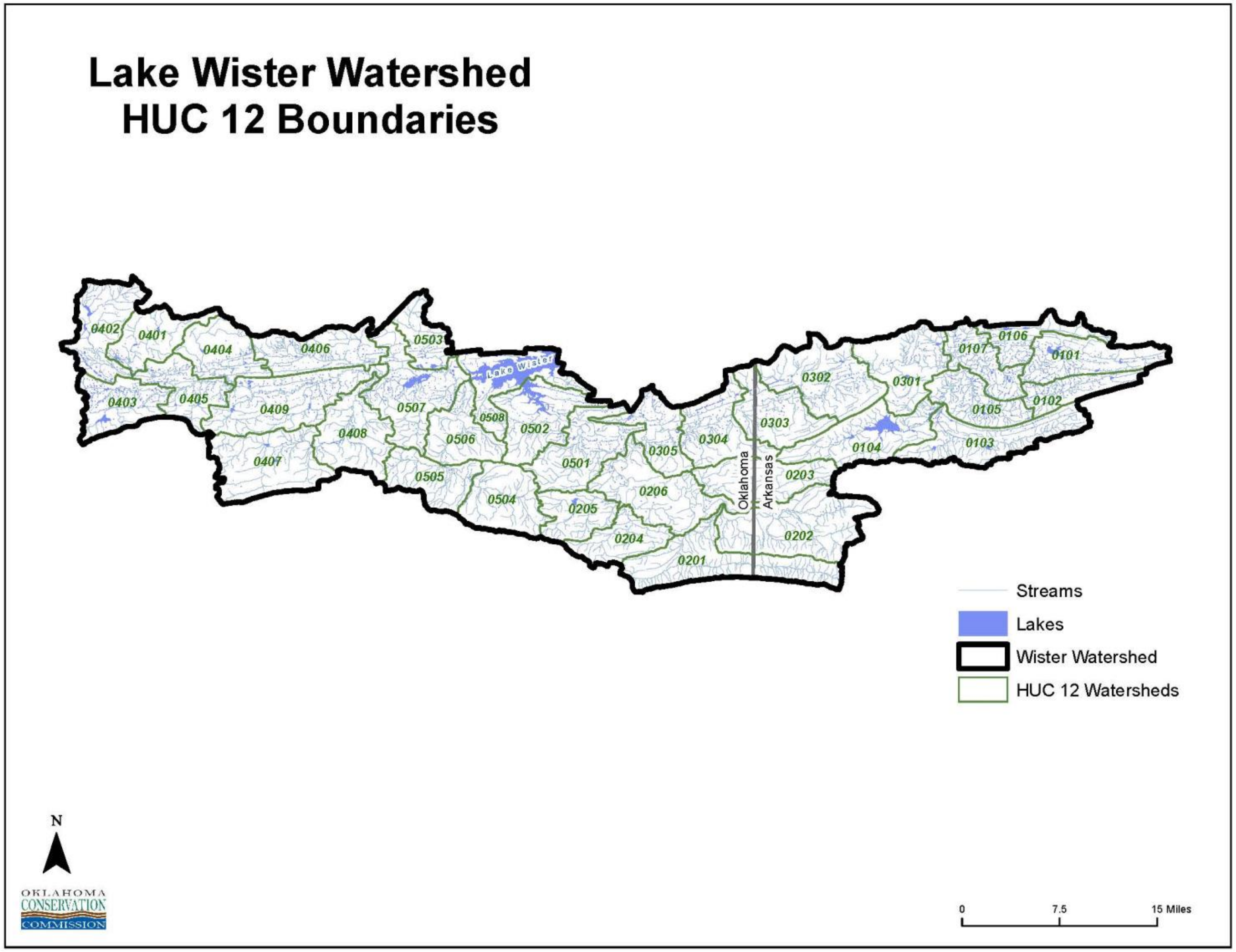

Figure 7: Lake Wister watershed HUC 12 boundaries

At its conservation pool elevation of 145.7 m (478 ft), Lake Wister has an average depth of 2.4 m (8 ft) resulting in storage of approximately 6.23 x 10^7 m^3 water (50, 529 acre-feet) (OWRB, 2011). The surface area of the lake can increase by almost four times at maximum flood pool (Figure 8), resulting in a potential cumulative storage of 4.81 x 10^8 m^3 (390,215 acre-feet) of water (USACE, 2021).

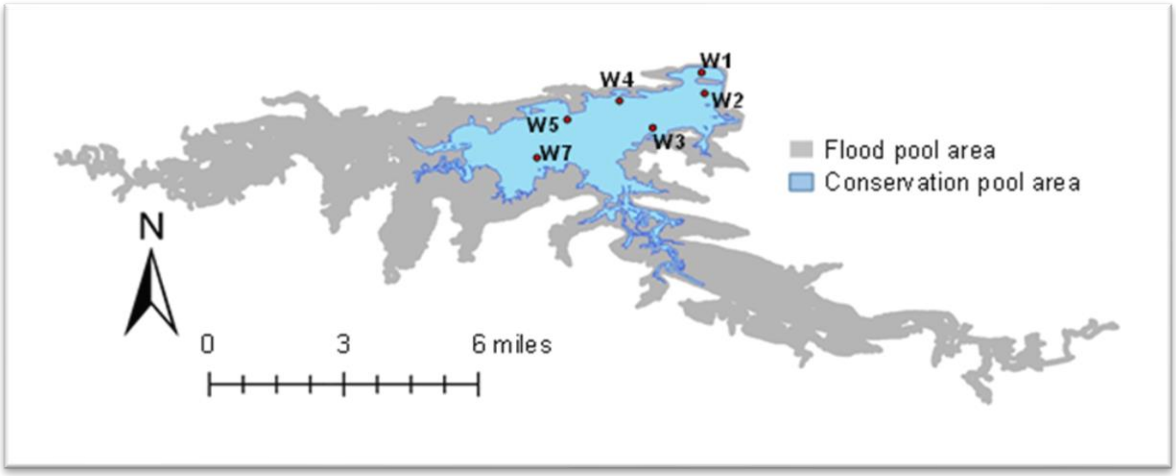

Figure 8: Lake Wister and its flood pool. Gray area represents flood pool of the lake and blue represents the conservation pool. Lake monitoring stations are also shown (W1-W7).

The ratio of watershed area to lake area provides an indication of the likelihood of water quality issues in a lake or reservoir. For instance, very clear, low nutrient Lake Tahoe has a ratio of less than 3:1. On the other hand, Lake Wister's watershed area to lake area ratio is approximately 100:1. Lake Wister receives water from approximately 2,572 km^2 (993 mi^2) (USACE, 2021) and the lake surface area is just under 6,400 acres. A watershed area to lake area ratio of 100:1 means that for every surface acre of the lake, runoff from 100 acres of land enters the lake; consequently, Lake Wister must process a high quantity of runoff relative to its size.

Land Use in the Watershed

The primary land uses and land cover across the Oklahoma Lake Wister watershed are forest (72%), agriculture (19%), and urban (4%) (Austin et al, 2018a) (Figure 9). The Ouachita National Forest comprises 234,326 acres of the Wister watershed (OWRB 1996); approximately 111,600 acres of this is in the Oklahoma portion. The 19% agriculture is composed almost entirely grassland and pasture; there is very little cropland. The category Urban as used here includes small amounts of barren, developed-open space, and low, medium, and high intensity development.

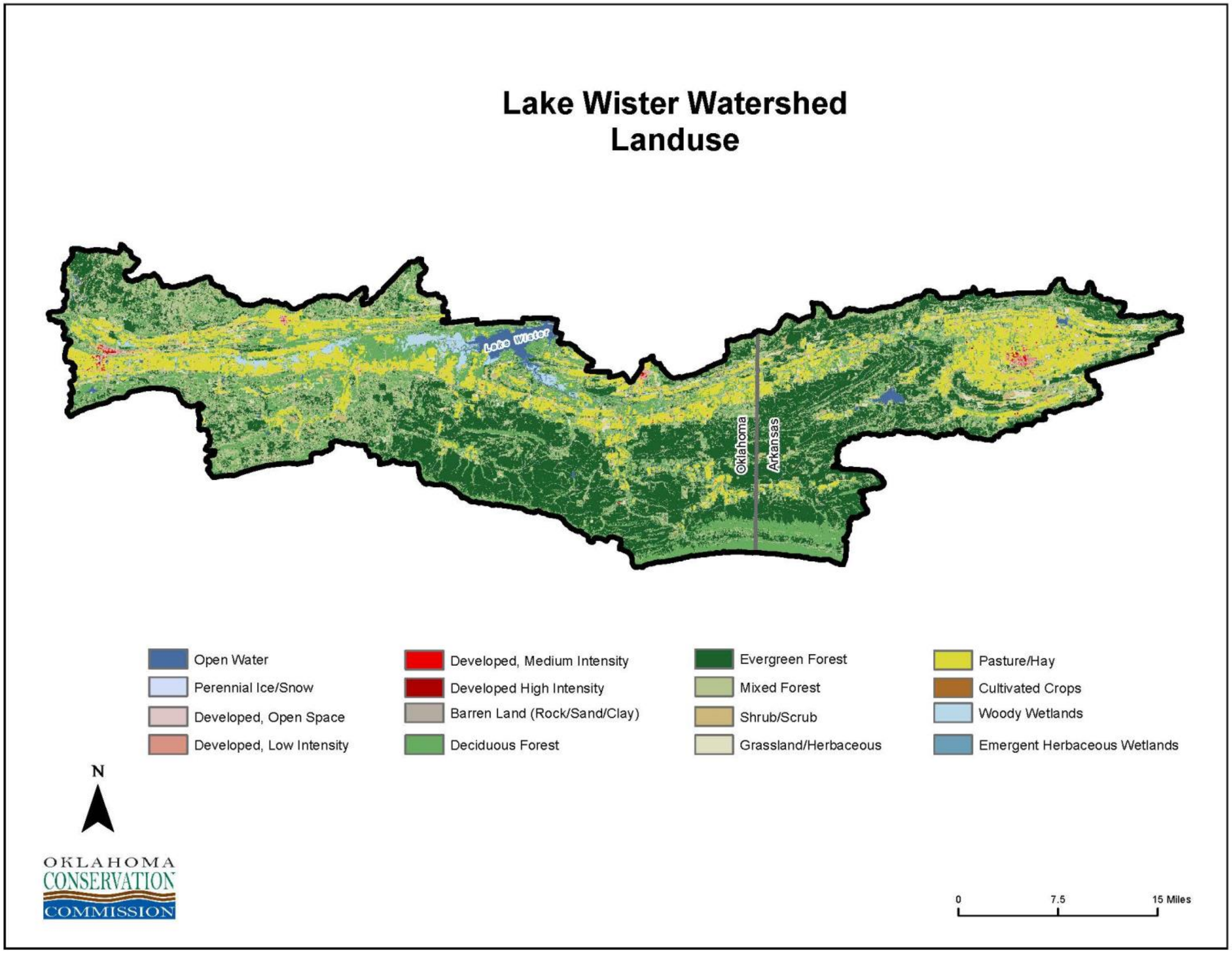

Figure 9: Lake Wister watershed landuse

Poultry and beef production are the main agricultural endeavors in the Lake Wister watershed, and the two activities are frequently related. A primary method of disposal of chicken litter has been application to pastures to improve grass production for cattle (see Chapter 3). In 2019, there were 47,000 head of beef cattle reported for LeFlore County and 17,000 for Latimer (NASS & ODAFF, 2019). The 2019 NASS & ODAFF report withholds poultry numbers for LeFlore County. As of June 2017, there were 142 farms, with 435 poultry houses, and a licensed bird capacity of 12,522,939 birds (not all houses are full at any one time) reported for LeFlore County; three farms, nine houses, and a 212,100 bird capacity were reported for Latimer County (ODAFF, 2017). In 2009, there were 451 poultry houses in the Lake Wister watershed—220 in Oklahoma and 231 in Arkansas (PVIA, 2009; based on a Google Earth aerial photo analysis). The number of houses may have declined since that time, though not necessarily the number of chickens produced, as some producers have gone out of business, but new poultry houses being constructed are significantly larger (J. Britton, pers. com.).

History of Water Quality Degradation

Lake Wister was created in 1949. So far as is known, the first water quality sampling in the lake took place about 25 years later in 1974 as part of a nationwide lake assessment project by the recently created US EPA (USEPA, 1977). Those samples indicate that Lake Wister would have met today's Oklahoma chlorophyll-*a* standard for drinking water supplies of 10 ug/l. The lake was sampled quarterly in two locations. The highest chlorophyll-*a* measurement was 8 ug/l; the average of all samples was 5 ug/l.

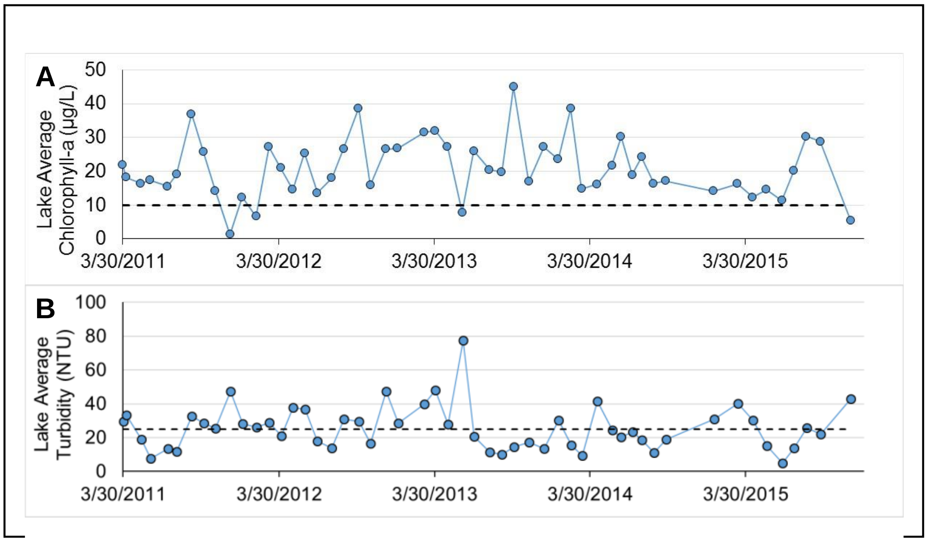

Figure 10: Whole lake average A) chl-*a* concentrations and B) turbidity from the five PVIA monitoring locations on Lake Wister from 2011-2015 (Scott and Patterson, 2019)

In the 45-plus years since that time, water quality in the lake has degraded significantly. The five-year average (2011-2015) for chlorophyll-*a*, analyzed for the TMDL report, was 20 ug/l, four times the 1974 level (Scott and Patterson, 2019). Both point source and nonpoint sources contributed to this decline.

By the early 1990s, water quality degradation in Lake Wister had become particularly noticeable and began to increase drinking water treatment costs and cause more frequent taste and odor problems in the finished water. A Federal Clean Water Act 314 Phase I Diagnostic-Feasibility Study documented problems in the reservoir, including low dissolved oxygen, excessive suspended solids, and nutrient pollution from the watershed (OWRB, 1996).

Since 1998, Lake Wister and stream segments in the watershed have been on Oklahoma's 303(d) list of impaired waters. A significant algae bloom in 1998, and additional blooms in 2003 and 2005, brought problems in the lake into public awareness (Figure 11). In 2006, Lake Wister was designated as a nutrient-limited watershed (NLW) and a chlorophyll-*a* criterion of 10 µg/L at a depth of 0.5 m below the surface was established (OAC 785:45-5-10(7)) (OWRB 2015). Also in 2006, Oklahoma State University completed watershed modeling that indicated pastureland was the dominant source of total phosphorus and sediment in the lake (Storm, White and Busteed, 2006).

Figure 11: 1998 algae bloom at Lake Wister

Since 2007 a significant portion of poultry litter produced in the watershed has been sold outside of the watershed (See Chapter 3, below). The apparent reduction in chicken litter application to watershed soils since around 2007 has contributed to an improvement in lake water quality. The 1998-2005 heavy blooms have not recurred in the lake since 2005.

However, in spite this apparent movement towards improvement and extensive research that has improved understanding of lake processes, Lake Wister continues to be impaired for sediment, total phosphorus, and chlorophyll-*a*. In 2019, Scott and Patterson completed a lake modeling effort and made recommendations for total maximum daily loads (TMDLs) for Lake Wister. The TMDL is currently under review by the Oklahoma Department of Environmental Quality.

CHAPTER 3: IDENTIFICATION OF CAUSES AND SOURCES OF IMPAIRMENTS

Causes of Impairments

Four designated beneficial uses for Lake Wister are currently listed as non-supported, as seen below in Table 1:

Table 1: Beneficial uses that are not supported and causes of impairment

Beneficial Uses that are Not Supported	**Cause of Impairment**
Public and Private Water Supply	Chlorophyll-*a*
Fish and Wildlife Propagation-Warm Water Aquatic Community (WWAC) Subcategory	Turbidity, pH
Aesthetics	Total Phosphorus
Fish Consumption	Mercury

(ODEQ, 2018)

Among the causes of these impairments, the chlorophyll-*a*, total phosphorus, and turbidity impairments are interrelated. Chlorophyll-*a* is measured as a way to estimate the amount of phytoplankton (that is, algae and cyanobacteria) in the lake. According to the lake model, total phosphorus is the primary driver of the chlorophyll-*a* impairment. As a result, the total phosphorus impairment and the chlorophyll-*a* impairment have the same sources.

Turbidity is caused by suspended materials in the water column. Those materials may be either mineral (i.e., sediment) or organic. To reduce turbidity, the quantity of these suspended solids must be reduced.

Phytoplankton biomass tends to increase as phosphorus increases and decrease as turbidity increases. Phytoplankton also contributes an organic component to turbidity. Increased turbidity tends to result in decreased chlorophyll-*a* because phytoplankton biomass is limited by the reduced light penetration into the water column. Turbidity and total phosphorus may also be positively correlated because phosphorus tends to attach to sediment particles.

Other Impairments and Potential Impairments

pH. This WBP does not address the pH or mercury impairments. Low pH in southeastern Oklahoma streams is widely considered by state biologists and water quality scientists to be the result of naturally acidic soils and low buffering capacity in waterbodies of the region rather than a true water quality impairment (cf. OWRB, 2009). Geology in the region is dominated by shale and sandstone with very little limestone to provide any buffering. The species richness and diversity of the fauna in southeast Oklahoma streams, particularly with regard to fishes, supports the general consensus that a relatively low pH is a natural condition, and not the result of a pollutant.

Mercury. The mercury impairment is categorized as a 5C impairment, which means that additional data should be collected prior to completing a TMDL. The mercury impairment is likely due to atmospheric deposition, but not enough data are available to definitively identify sources of impairments, required load reductions or best management practices necessary to achieve required load reductions (Wright, 2019).

Nitrogen. There is an increasing emphasis on nitrogen as a co-limiting nutrient in aquatic systems (Elser et al., 1990; Elser et al., 2007). Although there may be periods of the year when nitrogen is the limiting nutrient in Lake Wister, the results of the model used to develop TMDL recommendations for Lake Wister indicate that reducing nitrogen (either alone or in combination with total phosphorus) would have little effect on long-term chlorophyll-*a* values, beyond the effect expected from the reduction of total phosphorus alone. Therefore, nutrient reduction efforts in this WBP focus on phosphorus.

Dissolved Oxygen. Lake Wister is not listed for Dissolved Oxygen (DO) in the most recent Integrated Report (ODEQ, 2018). It has, however, been listed in some previous assessments, as, for example, in the 2006 Integrated Report (ODEQ). Low DO is a problem at the lake and is related to the total phosphorus and chlorophyll-*a* impairments.

High nutrients fuel algae and cyanobacterial growth in the lake. When these organisms die and fall to the bottom their subsequent decomposition leads to oxygen depletion when the lake is stratified. Lake Wister is considered a polymictic lake, that is, the lake mixes irregularly, and often more than once per year.

In some years, stratification is strong and low DO conditions persist throughout the summer, often from April through September. In other years, weaker stratification or strong storms may mix the lake one or more times during the summer. When the lake mixes, it allows oxygenated water to reach the bottom of the lake and temporarily improve DO conditions throughout the water column. Generally, stratification and low DO conditions begin to set up again very quickly once the storm or other mixing event is over. Therefore, the DO conditions in the lake at any point in time are strongly linked to how recently the lake has mixed, and mixing events occur at irregular and unpredictable times.

The Oklahoma Water Quality Standards consider low dissolved oxygen in relation to maintaining fish and wildlife habitat. Low DO also impacts water quality in ways that directly affect drinking water treatment. Water plant personnel must respond quickly when low oxygen water reaches plant intake pipes to ensure continued delivery of clean, safe drinking water.

Under low DO conditions iron, manganese, and hydrogen sulfide may be released and their removal during water treatment may cause problems for plant operation. If not addressed promptly, problems can cascade in the distribution system. Therefore, improvement in DO conditions in the lake is important for fish and wildlife and water supply. It is anticipated that improvement in DO conditions in the lake will occur as nutrient supply to the lake is reduced.

Identification of Sources

STEP-L Results

STEP-L was used to estimate existing loads of phosphorus and sediment from each landuse category for each HUC 12 watershed. These results are reported in Tables 6 and 7 of this document.

2019 TMDL

The TMDL for Lake Wister (Scott and Patterson, 2019) identifies the following target annual and daily loads for total phosphorus and total suspended solids:

Table 2: Loads and target loads identified in 2019 TMDL

Pollutant	Average Annual Load (2011-2015) (kg/yr)	Waste Load and Load Allocation (kg/yr)	10% Margin of Safety (kg/yr)	Target Annual Load (kg/yr)	Target Daily Load (kg/day)
Total Phosphorus	221,787	48,793	4,879	43,914	120
Total Suspended Solids	142,560,053	41,432,415	4,134,242	37,208,174	101,940

*Modified from Table ES-1 (Scott and Patterson, 2019).

The TMDL for Lake Wister (Scott and Patterson, 2019) identifies overgrazed pastures, unpaved roads, eroding streambanks, and lake shoreline erosion as likely sources of suspended solids in watershed streams and the lake, and therefore to the turbidity impairment. Because phosphorus is often attached to soil particles, these eroding soils also contribute to the total phosphorus impairment.

Beyond eroding soils, other sources of total phosphorus include point source contributions from wastewater treatment plants (WWTPs) and animal waste (primarily poultry and beef production). Cumulatively, WWTPs in the Wister watershed contribute approximately 8% of the total phosphorus load (Scott and Patterson, 2019).

Animal waste may runoff directly from cattle operations and from areas where chicken litter is spread to fertilize pasture. Phosphorous from land-applied poultry litter and cattle waste also enters the soil and attaches to soil particles. Soil erosion from pastures therefore carries phosphorous into watershed streams and Lake Wister.

The long history of chicken litter application to watershed soils has created one of the major sources of phosphorus in streams and the lake. Litter application started more than two decades before records began to be kept in 2001. Between 2001 and 2017 over 14.5 million pounds of phosphorus were applied to LeFlore County pasture soils via poultry litter (Table 3). Since 2017 the State of Oklahoma no longer compiles or releases chicken litter production and application records (Rice, 2021).

Table 3: Poultry litter produced and applied, LeFlore County, OK (OCC 2002-2015 and ODAFF 2017).

Year	Poultry Litter Produced (Tons)	Poultry Litter Applied (Tons)	Phosphorus Applied* (Pounds)	Phosphorus Applied (kg)
2001	58,469	57,278	1,718,340	781,064
2002	37,592	36,990	1,109,700	504,409
2003	31,998	32,207	966,210	439,186
2004	38,295	36,314	1,089,420	495,191
2005	46,714	42,419	1,272,570	578,441
2006	49,552	36,575	1,097,250	498,750
2007	46,512	53,824	1,614,720	733,964
2008	40,001	30,382	911,460	414,300
2009	45,270	32,025	960,750	436,705
2010	36,492	26,780	803,400	365,182
2011	34,030	23,714	711,420	323,373
2012	36,696	21,589	647,670	294,395
2013	78,767	9,596	287,880	130,855
2014	28,459	13,928	417,840	189,927
2015	45,244	16,150	484,500	220,227
2016	50,738	9,766	292,980	133,173
2017	35,045	6,359	190,770	86,714
Totals	**740,874**	**485,896**	**14,576,880**	**6,625,855**

*Phosphorous calculated at 1.5% by weight

The TMDL report (Scott and Patterson, 2019) likewise identifies beef and poultry production and pasture management (particularly the application of poultry litter to pastures) as important nonpoint sources of total phosphorus and sediment. The long history of chicken litter application to Wister watershed soils is the likely cause of the results seen in the SWAT modeling (cf. 2006 SWAT Model, below).

Unpaved roads and eroding ditches can be sources of sediment erosion, and efforts to address these will be a part of watershed restoration actions. In the Lake Wister watershed, most of the erosion resulting from unpaved roads occurs in forested areas. Much of the forestland in the watershed is federally managed (Ouachita National Forest). The United States Forestry Service has its own erosion control and watershed protection regulations. The Oklahoma Department of Agriculture, Food and Forestry (ODAFF) Forestry Division works with private forest landowners in the watershed and they have their own set of BMPs to minimize soil erosion from harvest activities including road building. These conclusions suggest that BMPs which address pasture management and the maintenance of unpaved roads should be prioritized.

2018 Integrated Report

The 2018 Integrated Report (ODEQ 2018) does not identify sources of any of the impairments for Lake Wister. Each impairment is coded as 140 which means "source code unknown."

2019 Oklahoma Lakes Report

The 2019 Oklahoma Lakes Report: Beneficial Use Monitoring Program (OWRB, 2019) includes 2015 and 2016 monitoring data for Lake Wister. Turbidity, pH and chlorophyll-*a* are identified as causes of impairment. The report does not attempt to document sources of impairment.

2006 SWAT Model

A SWAT model was completed for Lake Wister in 2006 (Storm, White and Busteed, 2006). The results indicated that while pastureland accounted for only 15% of the land area in the basin at that time, 90% of total phosphorus load and 85% of the sediment load originated from pastureland.

Oklahoma HUC 12 Subwatershed Monitoring

A water quality monitoring effort focused on the HUC 12-scale subwatersheds in the Oklahoma portion of the Lake Wister watershed was conducted from July 2016 through May 2019 by the University of Arkansas, under the direction of PVIA and OCC (Austin et al, 2018a; Austin et al, 2019a). Baseflow stream sampling was conducted monthly near the outflows of 21 of the 26 Oklahoma Lake Wister HUC 12 subwatersheds (Refer to Figure 7 in Chapter 2 for map of the HUC12 subwatershed boundaries).

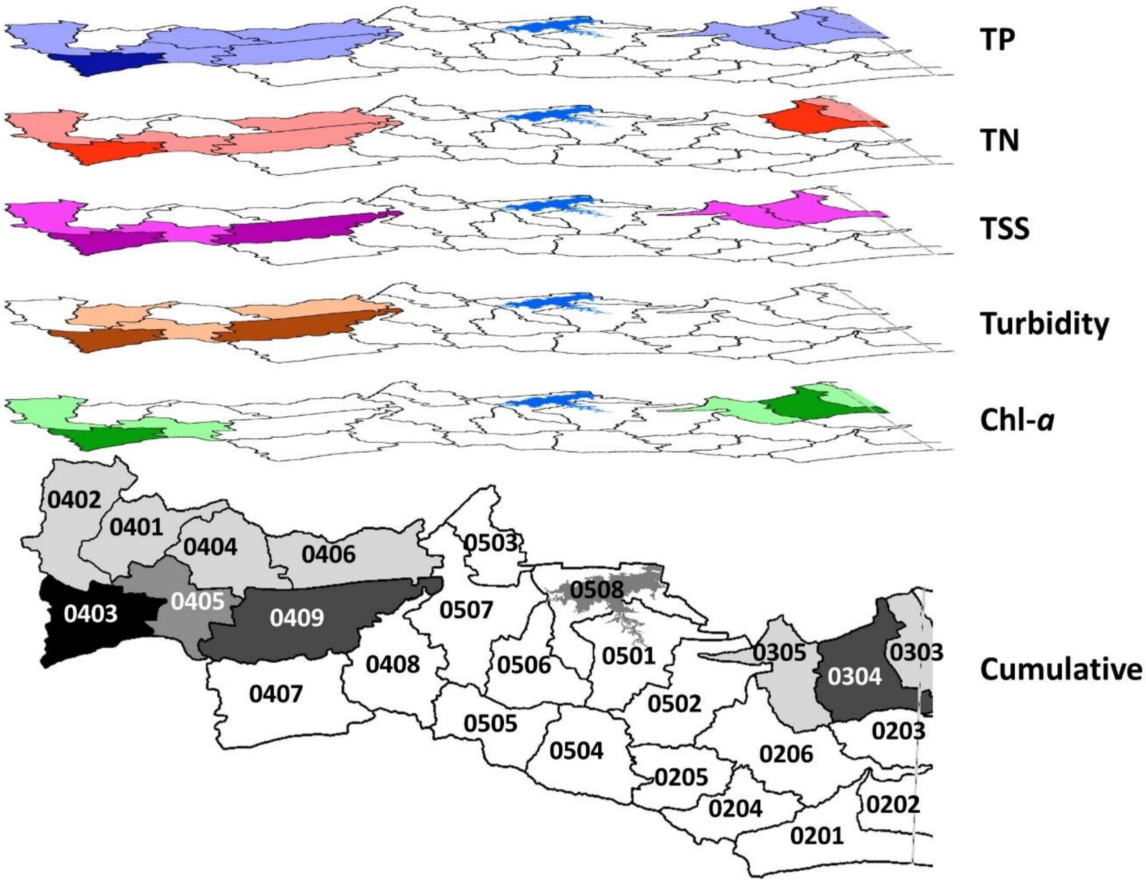

Figure 10: Potential prioritization of HUC 12 subwatersheds when chemical concentrations are available in streams. Using specific constituents to meet specific management needs, or using a cumulative approach, where priorities are added across multiple constituents. For each constituent shown and for the cumulative map the priority for nonpoint source management varies from lightest (low priority) to

Figure 12. Potential prioritization of Oklahoma Wister HUC12 subwatersheds, based on threshold response of constituents to a human development index (Source: Figure 10, Austin et al. 2019a).

The purpose of this sampling effort was to identify HUC 12s was to develop baseline water chemistry data and identify areas where implementation of watershed restoration actions could potentially be prioritized to reduce total suspended sediment (TSS) and nutrients (especially total phosphorus [TP]) entering Lake Wister. According to the threshold response of constituent concentrations to the human development index (HDI), the following subwatersheds will be prioritized for BMP implementation to treat nutrients and sediment. We will target three subwatershed in each of Lake Wister's two main tributaries.

Fourche Maline Watershed

Bandy Creek (0403)
Clear Creek (0405)

Pigeon Creek (0409)

Poteau River Watershed
Cane Creek (O303)
Sugar Creek (0304)
Hontubby Creek (0305)

These subwatersheds are assumed to be critical source areas (CSAs) for nutrient and sediment loads contributing to impairments in Lake Wister. (In addition to the two project reports cited above, this work is also described in three published reports (Austin et al, 2018b; Austin et al, 2018c; and Austin et al, 2019b).

Causes and Sources in the Arkansas Portion of the Watershed

As previously noted, the Lake Wister watershed is a bistate system. While this watershed based plan is focused on the Oklahoma component of the watershed, it is important to recognize that a significant portion of the Lake Wister watershed (ca. 40%) lies upstream in Arkansas.

The State of Arkansas has considered the Poteau River watershed within its borders as a priority watershed for many years. The Poteau River continues to be prioritized in the most recent Arkansas Annual Report (ADADNR, 2021).

2005 ADEQ TMDL

In 2005, Arkansas promulgated a TMDL for total phosphorus, as well as for zinc and copper, for a reach of the Poteau River in Arkansas (AR_11110105_031). A total phosphorous TMDL remains in place for this reach as a Category 4a waterbody—Impaired with a TMDL—in the most recent Arkansas Integrated Report (AEE, 2018).

The impaired reach is approximately 22 miles upstream of the Arkansas-Oklahoma state line. The total phosphorus TMDL developed was 47.73 lb./day, approximately equally apportioned between point sources and nonpoint (22.73 and 20.23 lb./day, respectively) (FTN, 2005). Based on this TMDL, phosphorous discharge limits were established for the City of Waldron WWTP and for the Tyson Foods Inc. Waldron Facility of 1.0 mg/l and 1.5 mg/l, respectively (FTN, 2005). An instream numeric criterion of 0.1 mg/L for total phosphorus was used to establish the TMDL. As in the Oklahoma portion of the watershed, cattle and poultry production were identified as important nonpoint sources of total phosphorus in the watershed. In the Integrated Report, the source of contamination is reported as *Industrial Point Source* (AEE 2018).

2018 Poteau River Monitoring and Assessment Report

A range of water quality sampling efforts were conducted in the Arkansas Poteau River watershed between January 2017 and May 2018 (GBMac, 2018). The primary objective was to collect physio-chemical data from the major drainages in the Arkansas portion of the Poteau River watershed, quantify loadings of nutrients and sediment, and delineate possible sources of impairments. This assessment concluded that the City of Waldron WWTP and the Tyson Foods facility in Waldron are point sources of nutrients and turbidity. Possible nonpoint sources of nutrients and turbidity identified varied between stream segments but included cattle land runoff, poultry runoff, mining site runoff, compromised riparian buffers, streambank erosion and urban runoff from Waldron. The results of this assessment will be used to develop a nine-element watershed management plan for the Poteau River in Arkansas with completion scheduled for December 2022 (ADADNR, 2021).

Conclusions of Data Analysis from Prior Studies and Recent Monitoring Efforts

PVIA has conducted monthly monitoring of Lake Wister continuously from March 2011 to the present, and the USGS has sampled the inflows to the lake on the Poteau River and the Fourche Maline since late 2010. The USGS summarized their methods and the results of their first three years of monitoring in a report (Buck, 2014). More information regarding lake monitoring protocols may be found in Patterson (2015).

The results of these sampling efforts from 2011 to 2015 were the basis on which the lake modeling and TMDL recommendations were developed. Monitoring results are summarized in the modeling report (Scott and Patterson, 2019). Data collected since 2015 (not included in the TMDL report) continue to support the conclusion that Lake Wister is impaired for turbidity, total phosphorus, and chlorophyll-*a*.

CHAPTER 4: TARGET LOADS FOR TOTAL PHOSPHORUS AND TOTAL SUSPENDED SOLIDS

Recommended TMDLs for phosphorous and suspended solids were developed using ELCOM-CAEDYM, a three-dimensional hydrodynamic and water quality model that simulates thermal stratification, mixing, horizontal and lateral hydraulic variation and water quality dynamics in lakes and reservoirs (Scott and Patterson, 2019). The model was calibrated and validated with five years of stream and lake data collected by the US Geological Service (stream inflows to the lake) and Bio x Design and PVIA (in-lake sampling). Please see Scott and Patterson (2019) for detailed descriptions of model development, calibration, validation, and results.

Applicable Thresholds and Criteria

The applicable threshold for total phosphorus and criteria for chlorophyll-*a* and turbidity are listed in Table 4:

Table 4: Beneficial uses and applicable criterion or threshold for assessment of use support

Designated Beneficial Use	Criterion or Threshold	Citation in OWQS
Public and Private Water Supply	Average chlorophyll-*a* concentration of no more than 10 µg/L 0.5 m below the surface	OAC 785:45-5-10(7)
Fish and Wildlife Propagation-Warm Water Aquatic Community (WWAC) Subcategory	No more than 10% of the measurements exceed a turbidity of 25 NTU	OAC 785:45-5-12(7)(A)(ii)
Aesthetics	Free of objectionable floating mater, suspended materials, and color.	OAC 785:45-5-19

Lake Wister is listed for chlorophyll-*a* because its average chlorophyll-*a* measurement exceeds the chlorophyll-*a* criterion of 10 µg/L established for Lake Wister and other designated lakes (OAC 785:45-5-10(7)) (OWRB 2015).

Lake Wister is listed for turbidity in accordance with OAC 785:45-5-12(7)(A)(ii). Turbidity is a measure of relative water clarity rather than a pollutant concentration, and so does not lend itself to the calculation of loads or load reductions. Total suspended solids (TSS) is used as a surrogate for turbidity.

The criteria for the Aesthetics beneficial use is a narrative standard (OAC 785:45-5-19) (OWRB 2015):

> (a) To be aesthetically enjoyable, the surface waters of the state must be free from floating materials and suspended substances that produce objectionable color and turbidity.

(b) The water must also be free from noxious odors and tastes, from materials that settle to form objectionable deposits, and discharges that produce undesirable effects or are a nuisance to aquatic life.

(c) The following criteria apply to protect this use: *Color*. Surface waters of the state shall be virtually free from all coloring materials which produce an aesthetically unpleasant appearance. [A second criteria is also listed that applies only to Scenic Rivers and therefore, not to Lake Wister.]

The Lake Wister watershed is also considered a "nutrient-limited watershed" (OAC 785:45-5-29(11)) (OWRB, 2015). In Oklahoma, a "nutrient-limited watershed" is the watershed of a waterbody with a designated beneficial use which is adversely affected by excess nutrients as determined by Carlson's Trophic State Index (using chlorophyll-*a*) of 62 or greater (OAC 785:45-1-2) (OWRB, 2015).

Existing and Target Loads

Data collected between 2011 and 2015 indicate an average chlorophyll-*a* concentration of 20.8 ± 11.1 µg/L, approximately twice the Oklahoma Water Quality Standards criterion. During the same period, 43% of the turbidity measurements were above the criterion. The average turbidity of samples above the criterion was 39.2 NTU.

Lake modeling simulations indicate that a 78% reduction in the average total phosphorus (TP) load delivered to the lake will be required for the lake to meet the water quality standard. Simulations indicate that a 71% reduction in the average total suspended solids (TSS) load delivered to the lake will be required to meet the Oklahoma water quality standard (Scott and Patterson, 2019). These target load reductions do not include a margin of safety. With a 10% margin of safety, the required load reductions are 80.2% for total phosphorus and 73.9% reduction in TSS. Estimated current loads, target loads and margins of safety are shown in Table 2.

Please see Table 5 for estimated existing loads of phosphorus and sediment for each HUC 12 watershed. Please see Table 6 for estimated existing phosphorus loads by landuse for each HUC 12 watershed and Table 7 for estimated existing sediment loads by landuse. These results were generated by running STEPL with default input data for each HUC 10 watershed and selecting "0 No BMP" and specifying 0 for "% Area BMP Applied" for each HUC 12. Due to reliance on default input data and the limitations of STEPL, these loads are rough estimates. Although these results may be useful in identifying relative contributions, the existing loads documented in the TMDL (Scott and Patterson, 2019) are much more robust.

Table 5: Estimated existing loads by subwatershed according to STEPL model

HUC 10 Name	HUC 10 or 12	HUC 12 Name	Existing Total P Load (kg/yr)	Existing Sediment Load (kg/yr)
Black Fork	**1111010502**			
	111101050201	Big Creek	4,290.85	715,822.21
	111101050202	Upper Black Fork	5,933.84	753,279.93
	111101050205	Cedar Creek	1,454.24	265,560.14
	111101050203	Haws Creek	2,608.24	389,342.08
	111101050204	Shawnee Creek	1,895.18	372,527.13
	111101050206	Lower Black Fork	6,053.16	939,681.68
Totals for Black Fork			22,235.51	3,436,213.16
Poteau River	**11111010503**			
	1111101050304	Sugar Creek	6,658.69	1,090,164.21
	1111101050305	Horntubby Creek	5,394.39	1,030,017.85
	1111101050305	Cane Creek	7,877.85	1,095,698.04
Totals for Poteau River			19,930.92	3,215,880.11
Fourche Maline	**1111010504**			
	111101050409	Pigeon Creek	7,453.92	2,088,946.58
	111101050404	Little Fourche Maline	3,494.30	1,032,971.94
	111101050406	Red Oak Creek	5,465.25	1,636,628.67
	111101050405	Clear Creek	4,248.69	1,393,949.83
	111101050403	Bandy Creek	5,005.86	1,608,898.84
	111101050402	Coon Creek	3,253.87	832,582.92
	111101050407	Upper Long Creek	4,143.29	909,386.57
	111101050408	Lower Long Creek	4,489.65	868,674.85
	111101050401	Cunneo Creek	2,202.85	570,997.76
Totals for Fourche Maline			39,757.68	10,943,037.97
Middle Poteau River	**1111010505**			
	111101050502	Upper Holson Creek	1,002.35	1,236,765.31
	111101050501	Coal Creek	680.12	1,096,151.64
	111101050503	Coal Creek	1,404.46	575,881.04
	111101050504	Middle Holson Creek	229.61	372,762.32
	111101050505	Lower Holson Creek	230.12	374,032.38
	111101050506	Cedar Creek	348.09	565,085.54
	111101050507	Baker Branch	2027.42	1,511,279.49
	111101050508	Wister Lake Dam	10,132.29	1,068,210.34
Totals for Middle Poteau River			16,054.75	6,800,168.04

Table 6: Estimated existing total phosphorus loads by landuse according to STEPL model

HUC 10 Name	HUC 10 or 12	HUC 12 Name	Existing Total Phosphorus Load by Landuse (kg/year)					
			Urban	**Cropland**	**Pastureland**	**Forest**	**Feedlots**	**Total**
Black Fork	**1111010502**							
	111101050201	Big Creek	930.59	8.21	406.50	2272.17	673.17	4290.64
	111101050202	Upper Black Fork	451.20	3.67	870.03	2513.84	2094.97	5933.71
	111101050205	Cedar Creek	283.31	1.16	38.36	1073.62	57.80	1454.24
	111101050203	Haws Creek	233.81	0.55	255.50	1565.14	553.20	2608.19
	111101050204	Shawnee Creek	535.75	0.87	128.91	1035.72	193.93	1895.18
	111101050206	Lower Black Fork	524.27	23.89	1423.58	1842.71	2238.72	6053.16
Totals for Black Fork			2958.93	38.34	3122.88	10303.20	5811.78	22235.13
Poteau River	**11111010503**							
	1111101050304	Sugar Creek	348.77	31.18	2031.15	1114.24	3131.97	6657.31
	1111101050305	Horntubby Creek	789.98	82.41	1470.59	823.13	2228.29	5394.40
	1111101050305	Cane Creek	469.10	74.14	1877.78	1111.25	4345.42	7877.68
Totals for Poteau River			1607.84	187.73	5379.52	3048.62	9705.68	19929.39
Fourche Maline	**1111010504**							
	111101050409	Pigeon Creek	448.47	195.00	4148.58	1621.12	1040.74	7453.92
	111101050404	Little Fourche Maline	313.19	11.01	1770.65	1051.84	347.60	3494.30
	111101050406	Red Oak Creek	730.47	11.10	3005.38	992.65	725.65	5465.25
	111101050405	Clear Creek	379.13	20.71	2601.19	740.05	507.61	4248.69
	111101050403	Bandy Creek	1026.05	22.98	2694.20	734.35	528.27	5005.86
	111101050402	Coon Creek	482.61	30.25	1074.42	1453.01	213.57	3253.86
	111101050407	Upper Long Creek	312.42	0.57	1342.46	2103.83	384.01	4143.29
	111101050408	Lower Long Creek	146.71	27.37	1398.38	1534.29	1382.90	4489.65
	111101050401	Cunneo Creek	66.87	0.00	834.99	1138.40	162.59	2202.85
Totals for Fourche Maline			3905.93	319.01	18870.25	11369.54	5292.94	39757.67
Middle Poteau River	**1111010505**							
	111101050502	Upper Holson Creek	430.33	13.59	2039.59	1162.64	3147.82	6793.98
	111101050501	Coal Creek	491.32	11.51	1670.49	1417.99	2596.43	6187.73
	111101050503	Coal Creek	267.06	9.45	852.86	726.57	1221.69	3077.63
	111101050504	Middle Holson Creek	253.78	1.11	195.83	1563.35	302.29	2316.37
	111101050505	Lower Holson Creek	352.05	0.00	329.92	1214.96	501.96	2398.88
	111101050506	Cedar Creek	277.34	1.42	743.07	1141.49	1130.87	3294.19
	111101050507	Baker Branch	731.83	8.62	2351.82	1551.09	3264.98	7908.34
	111101050508	Wister Lake Dam	404.24	37.12	1292.28	856.95	1951.41	4541.99
Totals for Middle Poteau River			3207.94	82.82	9475.87	9635.04	14117.44	36519.12

Table 7: Estimated existing sediment loads by landuse according to STEPL model

HUC 10 Name	HUC 10 or 12	HUC 12 Name	Existing Sediment Loads by Landuse (kg/year)					
			Urban	**Cropland**	**Pastureland**	**Forest**	**Feedlots**	**Total**
Black Fork	**1111010502**							
	111101050201	Big Creek	276609.78	5216.31	147562.71	286434.59	0.00	715823.40
	111101050202	Upper Black Fork	134118.23	2286.11	308578.98	308297.75	0.00	753281.06
	111101050205	Cedar Creek	84213.98	834.61	16338.40	164173.27	0.00	265560.27
	111101050203	Haws Creek	69499.44	371.95	100987.83	218486.44	0.00	389345.66
	111101050204	Shawnee Creek	159247.25	625.96	54775.83	157886.48	0.00	372535.52
	111101050206	Lower Black Fork	155845.31	15449.36	529351.52	239043.25	0.00	939689.44
Totals for Black Fork			879534.00	24784.29	1157595.28	1374321.77	0.00	3436235.34
Poteau River	**11111010503**							
	1111101050304	Sugar Creek	103673.10	21255.34	808383.48	156843.21	0.00	1090155.14
	1111101050305	Horntubby Creek	234815.77	58277.56	614073.53	122832.85	0.00	1029999.71
	1111101050305	Cane Creek	139434.33	50620.92	748844.93	156806.93	0.00	1095707.11
Totals for Poteau River			477923.20	130153.83	2171301.94	436482.99	0.00	3215861.96
Fourche Maline	**1111010504**							
	111101050409	Pigeon Creek	133274.55	130326.20	1605209.43	220137.51	0.00	2088947.68
	111101050404	Little Fourche Maline	93068.11	8028.59	767777.88	164091.62	0.00	1032966.20
	111101050406	Red Oak Creek	217080.30	7901.58	1262683.59	148968.85	0.00	1636634.31
	111101050405	Clear Creek	112672.38	15295.14	1147988.19	117997.55	0.00	1393953.26
	111101050403	Bandy Creek	304913.95	16791.99	1172155.59	115031.06	0.00	1608892.60
	111101050402	Coon Creek	143416.88	21491.21	450281.27	217388.74	0.00	832578.11
	111101050407	Upper Long Creek	92841.31	381.02	526067.51	290090.55	0.00	909380.39
	111101050408	Lower Long Creek	43599.31	19277.68	579419.06	226378.94	0.00	868675.00
	111101050401	Cunneo Creek	19876.42	0.00	369197.08	181926.88	0.00	571000.38
Totals for Fourche Maline			1160743.21	219493.41	7880779.60	1682011.71	0.00	10943027.92
Middle Poteau River	**1111010505**							
	111101050502	Upper Holson Creek	127913.09	9207.93	805734.50	162195.61	0.00	1105051.12
	111101050501	Coal Creek	146038.64	7674.79	645834.07	192740.53	0.00	992288.02
	111101050503	Coal Creek	79378.69	6949.04	375130.07	115584.44	0.00	577042.23
	111101050504	Middle Holson Creek	75432.43	752.96	77509.89	218613.44	0.00	372308.72
	111101050505	Lower Holson Creek	104643.79	0.00	136005.18	178479.58	0.00	419128.54
	111101050506	Cedar Creek	82435.90	988.83	306165.87	167584.29	0.00	557174.88
	111101050507	Baker Branch	217533.89	5606.40	880069.24	202746.78	0.00	1305956.31
	111101050508	Wister Lake Dam	120156.65	26435.37	544673.87	129355.51	0.00	820621.41
Totals for Middle Poteau River			953533.08	57615.32	3771122.69	1367300.16	0.00	6149571.25

Recommended Waste Load and Load Allocations

The total phosphorous and total suspended solid loads are primarily from nonpoint sources (Table 8), as discussed in Chapter 3. The recommended waste load allocation of total phosphorus for point sources is based on implementing a 1 mg/L total phosphorus discharge limit for all Oklahoma dischargers in the watershed.

Table 8: Target load and waste load recommendations to meet water quality standards in Lake Wister (Scott and Patterson, 2019)

	Total Phosphorus TMDL (kg/day)	**% Total Phosphorus TMDL**	**Total Suspended Solids TMDL** (kg/day)	**% TSS Total Load**
Waste Load Allocation	13.4	11.2	321.8	0.3
Load Allocation	94.6	78.8	91,339.5	89.7
Margin of Safety	12	10	10,184.6	10
Total	120.0	100.0	101,845.9	100.0

CHAPTER 5: MANAGEMENT MEASURES AND LOAD REDUCTIONS

Water quality modeling simulations developed for Lake Wister indicate that a 78% reduction in the average total phosphorus (TP) load delivered to the lake will be required for the lake to meet the Oklahoma Water Quality Standard of 10 µg/L of chlorophyll-*a* (chl-*a)*. Model simulations further indicate that a 71% reduction in the average total suspended solids (TSS) load delivered to the lake will be required for the lake to meet the Oklahoma Water Quality Standard of no more than 10% of samples exceeding 25 NTU turbidity.

Table 9: Required load reductions to meet water quality standards

Pollutant	**Average Annual Load** (kg/yr)	**Load Allocation** (kg/yr)	**Margin of Safety** (kg/yr)	**Target Annual Load Reduction** (kg/yr)	**Annual Load Reduction of 1%** (kg/yr)	**Annual Load Reduction of 2%** (kg/yr)
Total Phosphorus	221,787	48,793	4,879	177,873	1,779	3,557
Total Suspended Solids	142,560,053	41,342,415	4,134,242	105,351,879	1,053,519	2,107,038

Timeframe. These load reduction goals set a high bar. Achieving the necessary load reductions to achieve full support of beneficial uses for Lake Wister will not be achieved overnight. Rather, recognizing that it took many decades for water quality conditions in the lake to deteriorate to current conditions, we also recognize that it will likely take several decades to reverse degradation and achieve water quality standards.

However, lake modeling results also show that incremental improvements will benefit the lake. The lake model showed that the average chl-*a* concentration in the lake decreased by 0.12 µg/L for every 1% decrease in the external TP load and the long-term average turbidity decreased by 0.2 NTU in the lake for every one percent decrease in external sediment load (Scott and Patterson, 2019). Table 9 shows what the quantities of one percent and two percent load reductions are for both total phosphorus and total suspended sediment. A phosphorus load reduction averaging two percent per year would result in meeting water quality standards in 40 years. To improve Lake Wister, every little bit will help.

For example, the results of an early nutrient reduction effort in the Lake Wister watershed in the late 1990s was assessed through a SWAT model (Storm, White and Busteed, 2006). One successful reduction strategy was pond construction. It was estimated that construction of 134 ponds resulted in a reduction of total phosphorus to Lake Wister of approximately 1.8% (Storm, White and Busteed, 2006).

There are other relatively straightforward actions capable of achieving a two percent reduction (see discussion below). These achievable reduction strategies will be targeted in early years of the watershed restoration effort. In the future, new ideas or new technologies may be discovered that will allow reductions beyond current typical BMPs.

Internal Loading. Modeling results detailed in the TMDL report indicate addressing the internal phosphorus loads of the lake could contribute significantly to achieving water quality standards. A reduction of internal loading by 90% would be equivalent to an approximately 20% reduction in external load. This would be equivalent to 10 years of an annual two percent reduction, and reduce the time required to 30 years.

Point sources. Permitted point source dischargers in the Lake Wister watershed contributed an average of 5,831 kg TP per year during the lake modeling period. This represented approximately 2.6% of the average TP load to Lake Wister for the 5-year lake modeling period. If all Oklahoma dischargers adopted and achieved a 1 mg/L TP discharge limit, the TP load to Lake Wister would decrease by an average of 2,338 kg/yr, slightly more than one percent of the current total phosphorus load to the lake. As noted, a one percent reduction in the total phosphorus load will result in a decrease in the long-term average chlorophyll-*a* concentrations in the lake of 0.12 µg/ (Scott and Patterson, 2019). This reduction would therefore achieve one-half of one year's annual two percent per year target.

Spatial priorities. The implementation of management measures in the watershed will be informed by the results of the HUC 12 monitoring discussed in Chapter 3. It is anticipated that initial programs will be implemented in the HUC 12 watersheds identified as CSAs (see pages 28-29 of this document). Successful activities will then be expanded as appropriate to additional subwatersheds.

Domains of Watershed Actions

It is useful to consider six domains as conceptual organizing principles for BMP implementation and other actions in the Wister watershed:

1. Chicken Litter Management

- Reduce applications of chicken litter to watershed soils
    - sell chicken litter outside of the watershed
    - support this movement out via tax subsidies
    - improve tracking and transparency
    - know with assurance how much litter is being applied and where
- Reduce available phosphorus in watershed soils
    - apply water treatment residuals (WTR) where appropriate

- Improve soil testing
    - implement a watershed-wide soil testing program to better define soil phosphorus levels
    - identify areas that could potentially benefit from chicken litter applications (rather than already having an excess)
    - if required, modify regulations to reduce allowable litter application rates
- Research and identify alternative chicken raising methods (e.g., pastured chickens) that reduce litter accumulations
- Combine this with improved soil health and pasture management practices to reduce nutrient and sediment movement from fields

2. Soil Health and Pasture Management

- Reduce soil erosion from cattle pastures, especially those with history of chicken litter application
    - increase grass cover year-round to reduce soil erosion and movement of nutrients and sediments from fields
    - research, demonstrate and promote potential economic benefits of improved soils and grasses

3. Field Buffers

- Grass buffers at edge of field
- Native prairie grass buffers
    - provide additional benefits beyond filtering capacity
    - reduced width required compared to other grasses because native plants are better at reducing nutrient and sediment movement

4. Ponds and wetlands

- Capture and transform nutrients and sediments leaving fields before they reach streams
- Where appropriate, increase beaver population in the watershed to create ponds and wetlands and trap nutrients and sediments

5. Streams, Stream Banks, and Riparian Buffers

- Exclude cattle from streams
    - fencing, alternative water sources, etc.
- River cane buffers at pasture edge of riparian buffers
    - 10 feet (3.3 m)

    - where appropriate - not appropriate everywhere
- Riparian buffers
    - protect existing riparian buffers
    - add trees and width to existing buffers where necessary and possible
    - develop conservation easements to protect existing buffers
    - educate producers about the ways riparian buffers help reduce the cost of producing drinking water
    - seek funds to oversee management of riparian buffers

6. Unpaved Roads and Ditches

- Reduce erosion from unpaved roads and roadside ditches in the watershed
    - Hold workshops for decision makers on importance of reducing erosion and practices that can do so
    - Hold workshops for county road maintenance crews and supervisors on BMPs and maintenance practices that can reduce erosion
    - Implement demonstration projects of BMPs and practices

Typical Applicable BMPs

Table 10 lists a set of typical BMPs applicable to reducing phosphorus and sediment loads, their load reduction efficiencies, and NRCS codes. Note that implementation of many of these BMPs will address both nutrients and sediment.

Table 10: Typical BMPs to reduce phosphorus and sediment pollution from pasture (OCC, 2021)

Landuse	BMP	Load Reduction Efficiencies			NRCS code	Ref	Treatment area (acres)*
		N	P	Sediment			
Pastureland	alternative water supply	0.25	0.3	0.4	516, 642, 614, 533	1	contributing area or 40 acres default
Pastureland	Critical Area Planting	0.3	0.3	0.75	342	1	actual acreage implemented
Pastureland	Cross Fencing with grazing management	0.24	0.3	0.09	382	3	actual field acreage or linear ft/330*40 acres
Pastureland	Heavy Use Area	0.2	0.2	0.4	561	3	actual acreage implemented
Pastureland	Waste Storage, management	0.52	0.58	ND	313, 317, 633	1	assume 40 affected acres per unit
Pastureland	Pasture-Hayland Planting/Range Seeding	0.66	0.67	0.59	512, 550	1	actual acreage implemented
Pastureland	Pond	0.82	0.72	0.77	378	1	contributing area or 40 acres default
Pastureland	Precision Intensive Rotational/Prescribed Grazing	0.09	0.24	0.3	528		actual acreage implemented
Pastureland	Riparian area establishment/management/exclusion	0.75	0.75	0.83	472, 390, 391, 612, 516, 642, 614, 533	1	contributing area or 13 acres/acre BMP implemented (eastern OK)
Pastureland	Streambank stabilization and protection	0.75	0.75	0.75		2	actual linear feet implemented
Pastureland	Winter Feeding Facility	0.35	0.4	0.4	313		assume 40 affected acres per WFF unit

[1]Miller, et al. 2012.
[2]Waidler, et al. 2009.
[3]Comittee on the Evaluation of Chesapeake Bay Program Implementation for Nutrient Reduction to Improve Water Quality. 2011.
*Default areas used in STEPL for single instance of practice implementation when treatment area is unknown, OCC. 2021.

STEPL Model Calculations

A suite of potential load reduction estimates was calculated using the STEPL 4.4 Spreadsheet Model for 10 Watersheds (USEPA, 2020). The *Spreadsheet Tool for Estimating Pollutant Load* (STEPL) employs simple algorithms to calculate:

- nutrient and sediment loads from different land uses, and
- the load reductions that would result from the implementation of various best management practices (BMPs).

The model was populated with HUC 12 data from the EPA Input Data Server. Data from the Input Data Server can be downloaded from the same webpage. The model is available for download at https://www.epa.gov/nps/spreadsheet-tool-estimating-pollutant-loads-stepl#doc.

The STEPL model was run for each of the 26 HUC 12 watersheds in the Oklahoma portion of the Wister watershed. Output from model runs is included as Appendix II.

Prior studies (cf. Chapter 3) have concluded that nonpoint sources of sediment and phosphorus originate primarily from pastureland. As a result, we evaluated the likely effectiveness of pastureland best management practices (BMPs) in STEPL. We did not evaluate the effectiveness of cropland or urban BMPs as these represent minor sources in the Lake Wister watershed.

We also did not evaluate the effectiveness of forestland BMPs. As discussed earlier (Chapter 3), while forestland is the predominant land use in the watershed, it is not considered to be the main driver of nutrient pollution to the lake.

The load reduction estimates in Appendix II were calculated using default values for reductions efficiencies and acres treated. After many years of working with the STEPL model, implementing BMPs, and tracking actual improvements in water quality, the Oklahoma Conservation Commission has determined that STEPL underestimates load reductions for some BMPs under local conditions. As a result, they have developed adjustments to the STEPL calculations that they think better capture local results (some of those adjustments are noted in Table 10, above). For the purposes of this WBP, we used default values. In the design phase of specific future implementation projects, OCC adjusted treatment values will likely be incorporated into project design and implementation.

Potential load reductions for Bandy Creek (one of the five CSAs) are shown in Tables 11 and 12, below. Practices are listed from most effective to least effective for the given pollutant. LREs for each of the 26 HUC 12 watersheds can be found in Appendix II.

Table 11: LREs for Phosphorus in Bandy Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	101.03	202.07	404.13	808.26
Grass Buffer, min 35' wide	98.93	197.86	395.71	791.42
30 m Buffer w/Optimal Grazing	64.39	128.78	257.56	515.13
Forest Buffer, min 35' wide	58.69	117.37	234.74	469.49
Winter Feeding Facility	53.88	107.77	215.54	431.07
Livestock Exclusion Fencing	52.36	104.72	209.44	418.88
Streambank Protection w/o Fencing	42.45	84.90	169.81	339.62
Critical Area Planting	34.89	69.77	139.54	279.08
Prescribed Grazing	34.40	68.81	137.62	275.25
Heavy Use Area Protection	31.05	62.11	124.21	248.43
Grazing Land Management	25.93	51.87	103.74	207.47
Use Exclusion	25.21	50.42	100.83	201.67
Alternative Water Supply	18.09	36.18	72.37	144.73
Pasture and Hayland Planting	14.79	29.58	59.17	118.33
Litter Storage and Management	13.81	27.61	55.22	110.44

Table 12: LREs for Sediment in Bandy Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	43953.11	87915.30	175821.52	351643.05
Grass Buffer, min 35’ wide	37974.76	75958.60	151908.13	303825.33
30 m buffer w/Optimal Grazing	36332.76	72674.59	145349.18	290698.36
Forest Buffer, min 35’ wide	34518.39	69036.78	138082.63	276156.19
Winter Feeding Facility	33701.92	67394.77	134798.62	269597.24
Livestock Exclusion Fencing	31234.38	62477.83	124955.66	249902.25
Streambank Protection w/o Fencing	24611.93	49232.93	98456.79	196922.65
Critical Area Planting	23441.66	46883.32	93775.71	187542.36
Prescribed Grazing	19513.55	39036.17	78063.27	156135.61
Heavy Use Area Protection	19513.55	39036.17	78063.27	156135.61
Grazing Land Management	10958.79	21917.59	43835.18	87679.43
Use Exclusion	0.00	0.00	0.00	0.00
Alternative Water Supply	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00

According to STEPL model output, the five most effective BMPs to reduce total phosphorus loading (listed in order from most to least effective) are:

1. Streambank Stabilization and Fencing
2. Grass Buffer (minimum 35 feet wide)
3. 30 m Buffer with Optimal Grazing
4. Forest Buffer (minimum 35 feet wide)
5. Winter Feeding Facility

The five BMPs found to be most effective in reducing sediment loading (listed in order from most to least effective) are:

1. Streambank Stabilization and Fencing
2. Grass Buffer (minimum 35 feet wide)
3. Livestock Exclusion Fencing
4. Use Exclusion
5. Streambank Protection without Fencing

In practice BMPs are often planned and implemented together. For example, a common scenario could be:

> *Pastureland, Streambank Stabilization w/Fencing* would be planned along with *Pastureland, Livestock Exclusion Fencing* and *Pastureland, Prescribed Grazing*. Frequently, this would also require addressing *Pastureland, Alternative Water Supply*.

Another scenario might be:

> *Pastureland, Prescribed Grazing* in combination with *Pastureland, Pasture and Hayland Planting* (also called Forage Planting); these may also require *Pastureland, Alternative Water Supply*.

Because grass buffers effectively reduce both pollutants and are less expensive to implement than streambank stabilization and fencing (a BMP that also effectively treats both pollutants), these would make an appropriate target for emphasis in the first few years of the project. Other BMPs that require more human management, but less infrastructure (prescribed grazing and grazing land management, for example) may also be emphasized, even though these are not the most effective BMPs to reduce phosphorus and sediment.

STEPL (run with default input data) predicts the implementation of grass buffers (minimum 35’ wide) to treat 40% of the pastureland in the five CSAs would result in a 4,096 kg/year reduction in phosphorus and a 1,503,904 kg/year reduction in sediment. To put this into perspective, these values are 2.3% of the required load reduction for phosphorus and 1.4% of the required load reduction for sediment. It is important to note, however, that STEPL significantly underestimates annual loading compared to the model used to develop the TMDL (Scott and Patterson, 2019), and therefore should be expected to underestimate load reductions.

National Water Quality Success Stories

An analysis of national water quality improvement success stories from 2005 to 2021 (USEPA, 2021) lends further credence to the challenges of planning for large reductions in nutrients and sediments from nonpoint sources in large watersheds. “Success Stories” are waterbodies or segments of waterbodies that have been removed from the 303(d) list for one or more pollutants. It is important to note that nonpoint source pollution control is usually, but not always the primary driver in a delisting. The current database has some 560 entries. We sorted for waterbodies with a watershed size between 535,000 and 735,000 acres—that is, a size range that brackets the Lake Wister watershed (ca. 640,000 acres).

No lakes or reservoirs in the Wister watershed size range were found in the database with a successful delisting for reductions in phosphorus or sediment. There were eight success stories with watershed sizes similar to Lake Wister’s. These were all for stream segments. These eight watersheds were sorted for those delisted for a pollutant related to phosphorus or sediment (i.e., nutrients, phosphorus, chlorophyll-a, DO/organic enrichment, turbidity, sediment/siltation, and TSS). Five waterbodies were returned that have been delisted for a nutrient or sediment cause. Of these five stream segments, four were delisted for pollutants related to sediment and one was delisted for nutrients. The cost for delisting varied from $1,370,918 to $5,065,000.

Both the STEPL results and the analysis of success stories emphasize the challenges in making the large nonpoint source reductions that will be required to return Lake Wister to a state that meets Oklahoma water quality standards. However, as discussed earlier, lake modeling results indicate that every incremental reduction in sediment or phosphorus load to Lake Wister results in a corresponding improvement in lake condition. Therefore, setting and meeting annual small goals, and working consistently over the long term is a recipe for action that can lead to success.

Ideally, effectiveness monitoring would be completed in each of the HUC 12 watersheds were BMPs are implemented. PVIA does not have the funds to complete long-term monitoring at the HUC 12 level. This goal of this watershed based plan is an annual two percent reduction in phosphorus and sediment. It is likely that during the first five years of BMP implementation, improvements of this magnitude may not be distinguishable from natural variation in the lake monitoring data. As a result, this plan will be considered successful if lake data indicate an annual two percent reduction in phosphorus and sediment beginning in 2028 and moving forward.

CHAPTER 6: OUTREACH PROGRAM

The nutrient and sediment pollution degrading Lake Wister is derived primarily from nonpoint sources. Actions to address these pollutants will be largely voluntary and non-regulatory, therefore it is recognized that an ongoing education and outreach process will be key to efforts to improve water quality in the watershed and lake. A major component of watershed restoration actions will be to develop and implement a targeted education program that highlights the relationship between soil health and water quality and teaches landowners and other stakeholders practices that build soil health and protect waterways.

Public Participation

Education and outreach to residents of the Lake Wister watershed regarding water quality in Lake Wister and its watershed is not a new activity for PVIA. PVIA's current, ongoing education and outreach activities are described in sections below. The current suite of efforts began more than 12 years ago. These outreach efforts have included discussions with diverse stakeholders regarding water quality in the lake, and the development of TMDLs and a watershed based plan to address those issues.

The development of a water quality monitoring program to collect the data necessary to develop a robust lake model, TMDL recommendations, and a watershed based plan began in 2010. During the development of the monitoring program and throughout the time since, there have been multiple, ongoing interactions with diverse stakeholders in the Lake Wister watershed. One of the earliest efforts was a public meeting held in Poteau, OK to discuss water quality issues in Lake Wister and proposed efforts to address these including the development of a watershed based plan. Over 125 people attended that forum. Subsequently, a watershed symposium was held on March 15, 2013, advertised, open to, and attended by the public, and attended as well by a wide variety of staff from numerous state and federal agencies.

Through PVIA's outreach there have been regular articles published in the local newspaper, the Poteau Daily News, over the same timeframe. This ongoing information provision has generated numerous one-on-one discussions with landowners and residents of the watershed.

PVIA staff and consultants have attended meetings with the Board of the LeFlore County Conservation District, have met with local office NRCS staff, have participated in the annual LeFlore County Ag Trade Show, usually setting up a booth to facilitate discussions with farmers in attendance. PVIA worked with the local OSU Extension Office to bring demonstrations of new, innovative chicken litter application equipment to one of these ag days. PVIA board members and staff have met one-on-one with watershed landowners to discuss watershed restoration goals and needs and learn from them their concerns and perspectives.

PVIA has met with private forestry land owners in the watershed for direct discussions, and representatives of the forestry community have participated in various other activities such as the watershed symposium and the unpaved roads workshop.

The PVIA Board of Trustees is made up of representatives from 16 small cities and rural water districts covering the Lake Wister watershed area. Steve Patterson, PVIA's ecological and water quality consultant, has made regular monthly presentations to the Board of Trustees regarding restoration and protection activities in lake and watershed, kept them updated on the progress of the watershed based plan, and received questions and comments from them regarding the same. These board members return to their communities, share what they learned in the board meeting, and bring questions back to the next board meeting.

Steve Patterson has given periodic presentations to local civic organizations regarding lake water quality and efforts to develop a watershed based plan to improve it.

Steve Patterson has attended meetings of the LeFlore County Development Coalition to keep them up to date on watershed plans and activities and learn from them their perspectives and concerns.

The Choctaw Nation has been a partner to PVIA throughout this process. They were one of the first financial sponsors of the monitoring program on which everything else is based. They have been partners in various educational activities, including middle school children helping construct and plant a floating wetland for Lake Wister for Earth Day, as well as the first workshop on unpaved roads held in the watershed. They continue to be a partner in many Lake Wister-related activities and have indicated their interest in being a partner in a program to develop a watershed group and hire a watershed coordinator.

PVIA's Current Outreach Program

While PVIA regularly conducts various educational activities, as a small water treatment authority, they do not have the financial resources or staff to develop and sustain a comprehensive education program of the scale that will be required. The new educational activities described below will be implemented by OCC with support from PVIA, until a watershed group can be formed, at which time it is anticipated that group will take the lead.

Wister Watershed Alliance. PVIA intends to apply for funding to support the creation of a nonprofit watershed association—a Wister Watershed Alliance—that would take the lead in watershed improvement activities. Funding will be sought to hire a Watershed Coordinator who would coordinate and manage the outreach process.

Education and outreach activities will be required that address four primary sources of supply of excess nutrients to watershed streams and the lake:

- Poultry litter management, including moving litter out of the watershed
- Soil erosion and leaching of nutrients from watershed pastures
- Streambank erosion
- Soil erosion from unpaved roads and ditches

PVIA currently conducts and expects to continue to conduct several types of outreach and educational activities for residents of LeFlore County and the Wister watershed, including:

- Water plant tours—inform those who use the water about the process that is used to clean it and make it safe, and about issues and challenges that PVIA faces in producing clean, safe drinking water. Tours are given to school classes that request a tour, to several classes from Carl Albert State College, and to LeFlore County Leadership, a program designed to inform future leaders about important aspects of the regional economy.
- Visits to the lake and discussions of PVIA source water protection activities—these frequently are paired with plant tours.
- LeFlore County Ag Days—PVIA has a booth and distributes educational materials to producers and their families regarding water supply, treatment, and watershed activities.
- PVIA maintains a website with information on lake and watershed activities.
- Outreach through speaking at local service organization meetings
- Public meetings and watershed symposia—on an irregular basis and as needed, PVIA has organized and held meeting to inform stakeholders about important activities at the lake and in the watershed.
- Source water protection workdays—when appropriate PVIA has held educational activities where school children and employees of local organization have assisted in lake and watershed activities, for example constructing floating wetland for the lake (Figure 12).

Figure 13: PVIA Earth Day educational event building floating wetlands at Lake Wister, cosponsored by the Choctaw Nation of Oklahoma. Shown along with middle school students is Dr. Ken Hammond, long-time Chairman of the Board of PVIA (now deceased).

Outreach Program for Agricultural Producers

The outreach program described in this section will be implemented by OCC's Blue Thumb and Soil Health Programs with support from PVIA. Blue Thumb supports a network of citizen scientists who monitor local streams. Blue Thumb also provides education and outreach about reducing nonpoint source pollution statewide. In addition to providing education and outreach, the Soil Health Program works individually with agricultural producers to improve soil health and protect water quality on Oklahoma rangeland and farmland.

The initial education program will span two years and may be repeated as needed. During the first year, Soil Health and Blue Thumb will host a Full Circle Citizenship (FCC) Training in the watershed. This training will be by invitation with an effort to include a diverse group of stakeholders and community leaders. Potential stakeholders include landowners, county commissioners, agricultural producers, local government officials, people involved in the distribution of chicken litter, people representing tourism and recreation, road crews, Latimer and LeFlore County Conservation Districts, the Choctaw Nation, PVIA, NRCS and OCC. The training will last a half-day or a full day and will involve a trip to a local stream and/or a demonstration farm. The training will include a combination of lectures and hands-on experiences. Topics that will be covered include stream ecology, the ways poor soil health impact local water quality, and actions landowners can take to improve soil health and protect local waterways. The goal of Full Circle Citizenship trainings is to bring watershed community leaders together to explore the interface between soil health and water quality. An additional goal of the Lake Wister Full Circle Citizenship Training will be to form a core group of leaders who will assist in moving forward soil health education in the watershed.

Figure 14: Blue Thumb Volunteer Coordinator, Cheryl Cheadle, teaches students about stream ecology in the Poteau River watershed.

Within six months of the FCC training, the Soil Health Program will hold a general soil health training. This training will be larger, and attendants of FCC will be asked to invite other producers in the watershed. The general soil health training will occur at the farm or ranch of a producer in the watershed who is willing to implement BMPs and serve as a demonstration site for the duration of the project (two years). The Soil Health Program currently has relationships with producers in the watershed who may be willing to serve in this capacity. The general soil health training will include modules on plant identification, the WORMS app (a soil health data collection app), a demonstration of the rainfall simulator, and an exploration of BMPs that reduce the delivery of nutrients and sediment. Soil health data will be collected at the demonstration farm prior to the implementation of BMPs.

Within six months of the Full Circle Citizenship training, Blue Thumb will also hold a volunteer training event in the watershed. Volunteer trainings are two-day events during which participants receive 16 hours of training. The first day focuses on stream ecology (Figure 13) and the second day focuses on the nuts and bolts of collecting stream data. The purpose of the trainings is to prepare new volunteers to begin monitoring in the watershed. Historically, Blue

Thumb volunteers collected data at nine sites in the watershed, but there are currently no active volunteers collecting data in the watershed. The goal of these trainings will be to recruit one or more volunteers to resume data collection on watershed streams.

During the second year of the project, producers who completed the general soil health training will be offered a private consultation with an OCC or NRCS soil health expert. During these consultations, the soil health expert will visit the producer's operation and discuss practices that could be implemented to restore soil health, protect water quality and provide an economic benefit to the producer.

During the second year of the project, Blue Thumb staff will support new volunteers in the watershed. This may include hosting educational events, offering Mini-Academies for Monitoring or Mini-Academies for Education and being available to answer volunteer questions.

The second year of the project will conclude with a follow-up training at the demonstration site. During the follow-up training, participants will collect soil health data, discuss implemented BMPs and lessons learned. This will provide the opportunity for other producers to share their experience with soil health practices and brainstorm solutions to common obstacles.

If needed, the two-year education and outreach program may be repeated with a new demonstration farm and a new group of volunteers.

Cowboy Botany. A complementary educational program conducted by OCC and directed at improving grassland management are known as Cowboy Botany workshops. These may vary from a half day to a full day of discussion of plants. In a full day, basic botany principles are discussed in a classroom setting and then the rest of the day spent at a local producer's field, with identification of plant species and plant communities as the focus. Options for grazing and land management practices that can encourage healthy ecosystems are discussed.

Outreach Program for Road Crews

Because unpaved roads may be a significant source of sediment in the watershed, the education program will also provide training for employees who maintain unpaved county roads. PVIA and OCC have held such trainings in the past in the Poteau River watershed (see Figure 14), and these efforts would be expanded and continued. The training will likely be provided by a contractor and will focus on maintenance BMPs that reduce the delivery of sediment from unpaved roads and ditches to streams. This may be a one- or two-day training and may be repeated annually or as needed.

Figure 15: Flyer for 2013 training on the maintenance of unpaved roads, cosponsored by the Choctaw Nation of Oklahoma.

CHAPTER 7: TECHNICAL AND FINANCIAL ASSISTANCE

The necessary technical assistance is available through PVIA contractors, the OCC Soil Health Program, OCC contractors, the Poteau NRCS office, the LeFlore and Latimer County Conservation Districts, and the Oklahoma Blue Thumb Program.

It is impossible to accurately estimate necessary financial assistance because landowners have not been recruited and specific BMPs have not been selected for implementation. The following list includes the eight most effective BMPs to treat phosphorus **and/or** sediment according to the output from STEPL:

Phosphorus and sediment:

1. Streambank Stabilization and Fencing
2. Grass Buffer (minimum 35 ft wide)

Phosphorus:

3. 30 m Buffer with Optimal Grazing
4. Forest Buffer (minimum 35 ft wide)
5. Winter Feeding Facility

Sediment:

6. Livestock Exclusion Fencing
7. Use Exclusion
8. Streambank Protection without Fencing

Cost estimates for these practices shown in Table 13, below, These estimates are taken from Section I, State Payment Rates and Methods, Oklahoma Payment Schedules, Practice Scenarios (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/?cid=nrcseprd1328258). Each Practice Scenario includes a Scenario Typical Size, Scenario Total Cost, and Scenario Cost/Unit. (Note that default STEPL BMPs do not always align exactly with NRCS Conservation Practice designations. We have used the most similar categories available in Table 13.

Table 13: Cost estimates for conservation practices (NRCS, 2021)

Practice Identified in STEPL	NRCS Practice	Average Scenario Cost/Unit	Average Scenario Cost
Streambank Stabilization and Fencing	382-Fence*, Steep, Rocky **PLUS** 580-Streambank and Shoreline Protection, Shaping	$14.12/ft (Plus cost for fencing)	$14,122.96 (Plus cost for fencing)
	382-Fence, Steep, Rocky **PLUS** 580-Streambank and Shoreline Protection, Bioengineered	$48.66/ft (Plus cost for fencing)	$48,656.42 (Plus cost for fencing)
	382-Fence, Steep, Rocky **PLUS** 580-Streambank and Shoreline Protection, Structural	$101.32/yd³ of riprap (Plus cost for fencing)	$168,907.35 (Plus cost for fencing)
Grass Buffer (minimum 35 ft wide)	386-Field Border, Native Species	$155.44/acre	$155.44
	386-Field Border, Pollinator	$502.89/acre	$502.89
	393-Filter Strip, Native Species	$229.55/acre	$229.55
30 m Buffer with Optimal Grazing	386 or 393 **PLUS** 528-Prescribed Grazing, Standard	$9.90/acre (Plus cost for grass buffer)	$4,951.90 (Plus cost for grass buffer)
	386 or 393 **PLUS** 528-Prescribed Grazing, Intensive	$16.77/acre (Plus cost for grass buffer)	$8,384.42 (Plus cost for grass buffer)
Forest Buffer (minimum 35 ft wide)	391-Riparian Forest Buffer, Plant Using Direct Seeding	$236.02/acre	$2,360.18
	391-Riparian Forest Buffer, Plant Using Cuttings	$273.99/acre	$821.98
	391-Riparian Forest Buffer, Planting Bareroot Hardwood Seedlings	$1.06/seedling	$844.96
Winter Feeding Facility	Not listed as a 2021 reimbursable NRCS practice in Oklahoma	Not listed as a 2021 reimbursable NRCS practice in Oklahoma	Not listed as a 2021 reimbursable NRCS practice in Oklahoma
Livestock Exclusion Fencing	382-Fence, Steep, Rocky	$3.11/ft	$8,220.32
Use Exclusion	Not listed as a 2021 reimbursable NRCS practice in Oklahoma	Not listed as a 2021 reimbursable NRCS practice in Oklahoma	Not listed as a 2021 reimbursable NRCS practice in Oklahoma
Streambank Protection without Fencing	580-Streambank and Shoreline Protection, Shaping	$14.12/ft	$14,122.96
	580-Streambank and Shoreline Protection, Bioengineered	$48.66/ft	$48,656.42
	580-Streambank and Shoreline Protection, Structural	$101.32/ yd³ of riprap	$168,907.35

Although ponds are not a default pastureland BMP option in STEPL 4.4, according to the *Minnesota Stormwater Manual* (MPCA, 2016), the average removal efficiency for stormwater ponds is 50% for total phosphorus and 84% for TSS. Stormwater ponds may be functionally most similar to sediment basins (NRCS Practice 350) or water and sediment control basins (NRCS Practice 638), depending on design specifications. Water and sediment control basins are less likely to be implemented by ranchers than ponds or sediment basins because water and sediment control basins are not designed to create a permanent pool of water and therefore may not be useful for livestock watering.

For the purposes of this document, we have assumed that the removal efficiencies for ponds (NRCS Practice 378) are similar to those of sediment basins (NRCS Practice 350). The Oklahoma Practice Scenarios Fiscal Year 2021 cites an average cost of $1.94/yd^3$ of material excavated and a typical scenario cost of $2,912.84 for a sediment basin. The Practice Scenarios also describe eight scenarios for ponds (NRCS Practice 378). The average cost for pond construction varies from $4.49-$8.65/yd^3$ of embankment, for an average scenario cost of $11,230.34-$34,592.32.

Other practices likely to be implemented in the watershed but not among the five most effective BMPs to treat total phosphorus or sediment, include prescribed grazing (NRCS Practice 528), grazing management plans (NRCS Practice 110), soil health management plans (NRCS Practice 116) and pasture and hay planting (NRCS Practice 512). Please see Table 14 for associated costs.

Table 14: Other practices likely to be implemented in the watershed, but not among the five most effective BMPs in STEPL calculations

Practice Identified in STEPL	NRCS Practice	Average Scenario Cost/Unit	Average Scenario Cost
Prescribed Grazing	528-Prescribed Grazing, Standard	$9.90/acre	$4,951.90
	528-Prescribed Grazing, Intensive	$16.77/acre	$8,384.42
	110-Grazing Management Plans, Less Than or Equal to 100 acres	$2,350.80/plan	$2,350.80
	110-Grazing Management Plans, 101-500 acres	$3,134.40/plan	$3,134.40
	116-Soil Health Management Plan, Crops and Livestock	$4,014.50/plan	$4,014.50
Pasture and Hayland Planting	512-Forage and Biomass Planting, Native Perennial Grass	$208.92/acre	$8,356.69

Based on the information in Tables 13 and 14, here is a possible scenario for Years 1-5 of the program:

1. Install grass buffers that treat 100 acres of pasture at an average of $503 per acre ($50,300)
2. Complete 1,000 feet of bioengineered streambank stabilization and fencing at an average cost of $49 per foot ($49,000)

3. Build 10 ponds at an average cost of $11,230 per pond ($112,300)
4. Develop 20 grazing management plans for farms less than or equal to 100 acres at an average cost of $2,351 per plan ($47,020)
5. Develop five soil heath management plans at an average cost of $4,015 per plan ($20,076)
6. Hire a watershed coordinator ($50,000/year)

Estimated cost per year: **$328,696**

Estimated cost over five years: **$1,643,480**

Please see Table 15 for potential funding sources that may be used to fund tasks identified in this WBP.

Table 15: Potential funding sources

Potential Funding Sources	Activities that Might be Funded
Locally-led cost share through conservation districts	BMP implementation
NRCS cost share	BMP implementation
NRCS, through the National Water Quality Initiative (NWQI)	BMP implementation
CWA Section 319 match; non-federal dollars	State personnel to assist with project
PVIA	Monitoring, cost-sharing on projects
EPA Environmental Education grant	Education and outreach
BOR Cooperative Watershed Management Program Phase 1 grant	Hire a watershed coordinator
US Forest Service	BMPs related to healthy forests & drinking water
Cooperative programs with the Choctaw Nation of Oklahoma	Education and outreach, project implementation

CHAPTER 8: IMPLEMENTATION SCHEDULE AND MEASURABLE MILESTONES

Table 16: Implementation schedule and measurable milestones

Timeframe	Project Actions	Responsible Agency	Outcome
June 2022	Submit revised WBP to EPA for acceptance	OCC PVIA	EPA-accepted WBP
Fall 2022	Approval of TMDL	ODEQ	Approved TMDL
Fall 2022	Recruit volunteers to monitor two sites in the watershed	OCC	Collect additional data prior to, during and after BMP implementation to track changes in water quality
Spring 2023	Conduct Full Circle Citizenship Training	OCC	Build partnerships between stakeholders; connect with producers
Fall 2023	Conduct General Soil Health Training	OCC	Connect with producers; increase knowledge of the connections between soil health and water quality
Winter 2023	Blue Thumb Training	OCC	Raise awareness about NPS pollution and recruit additional volunteers to monitor in the watershed
Early 2024	Apply for a Bureau of Reclamation Cooperative Watershed Management Program Phase 1 grant to hire a watershed coordinator	PVIA/OCC	Obtain funding to hire a watershed coordinator
Spring/Summer 2024	Private consultations with producers interested in implementing BMPs	OCC NRCS	Recruit producers to implement practices that will improve water quality in tributaries to Lake Wister; recruit two producers to serve as demonstration sites

Timeframe	Project Actions	Responsible Agency	Outcome
Fall 2024	If funding is obtained, hire a watershed coordinator	PVIA	Build internal capacity for PVIA to eventually assume responsibility for long-term watershed education program

Timeframe	Project Actions	Responsible Agency	Outcome
Fall 2024	Host watershed symposium	PVIA	Educate community, producers and water resource professionals about Lake Wister's water quality impairments and potential solutions
Fall/Winter 2024	Recruit members to serve on the Wister Watershed Alliance	PVIA	Establish a watershed alliance to provide input on implementation of WBP and to assist with community education
Winter 2024	Host a training for road management crews	PVIA	Reduce the amount of sediment that reaches Lake Wister through improved management of unpaved roads
2024-2027	Each year, implement grass buffers to treat 100 acres of pasture, install 1,000 feet of streambank stabilization and fencing, and build 10 ponds. Prioritize implementation in CSAs.	NRCS Latimer CCD LeFlore CCD OCC	Reduce the amount of phosphorus and sediment that reaches Lake Wister.
2025-2027	Hold annual field days at demonstration sites	Private producers, NRCS, OCC	Showcase soil health improvements as the result of BMP implementation; recruit new producers to implement BMPs
Present and ongoing	Continue monitoring Lake Wister	PVIA	Monitor for improvements in water quality
2028	Revise WBP	PVIA, OCC	Revised WBP that incorporates new data and lessons learned during the first five years of the project

CHAPTER 9: EVALUATION CRITERIA AND MONITORING PLAN

The goal of watershed planning is to describe a path forward to improved water quality in Lake Wister. What actions can we take to reduce the supply of total phosphorus and sediment (total suspended solids) to Lake Wister and eventually achieve full support of beneficial uses?

Total Maximum Daily Loads (TMDLs) for both phosphorus and sediment have been developed for the lake; the required load reductions are very large. On the other hand, lake modeling efforts also show that incremental improvement is beneficial. For every 1% reduction in total phosphorus or sediment, there is a corresponding decrease in average chlorophyll-*a* or turbidity. Therefore, this plan envisions a steady incremental improvement over many years.

How will we track these improvements? A set of evaluation criteria and monitoring activities will allow assessment of progress.

Evaluation Criteria

The following evaluation criteria have been developed to track and assess progress toward project objectives.

- Overall Watershed Based Plan Performance
    - Are planned and preferred management measures being implemented as intended?
- Overall load reduction
    - Quantitatively, what is the impact of implemented management measures? Have these efforts reduced phosphorus or sediment entering Lake Wister?
- Management Measure Performance
    - Was a particular management measure or other activity implemented as intended?
    - How did it perform? What was the percent efficiency and effectiveness?

- How does this performance compare to expectations for load reduction for the practice?
- (If applicable) What was the performance of a management measure relative to other measures? How does it compare in terms of efficiency and economy?

Monitoring Program Goals and Objectives

The Lake Wister watershed is large (635,520 acres) and annual loads to the lake are very large (over 220,000 kg/yr total phosphorus, over 140,000,000 kg/yr total suspended sediments). The required reductions in phosphorus and sediment are similarly quite large. Given these realities, this plan sets an annual improvement goal of a 2% annual reduction in loads of phosphorus and sediment to the lake. However, given the magnitude of loads and of the inter-annual variability of those loads (cf. Scott and Patterson, 2019) it must be recognized that observing a 2% reduction and having confidence that it is real is extremely challenging. The only way to confidently demonstrate a 2% reduction under these conditions would be with large datasets and sophisticated statistical analysis. This level of effort is not feasible or financially viable on a frequent basis.

Therefore, this plan proposes a series of monitoring efforts and evaluation criteria. (1) In the first years of the project, based on the success of implementation of planned capacity building activities; (2) once actual on-the-ground project implementation begins, project specific monitoring will occur; (3) once a sufficient number of projects have been completed within a given subwatershed, water quality monitoring will be conducted at the outlet of that watershed; (4) After 5 years of project implementation, a new watershed and lake modeling effort will be undertaken. Model results will be used to assess the degree of success achieved to date; (5) annual loads to the lake and in-lake water quality characteristics will be monitored. It is here that ultimate success will be observed, though this will likely be many years, likely decades in the future.

1. Implementation Monitoring

This watershed based plan assumes that in the first years of the project progress will be measured by achievement of the planned activities as listed in Table 16.

An annual review and assessment of the successful implementation of watershed activities will be conducted.

Assessment here is straightforward and qualitative. Were activities conducted as planned?. If not, why not? Did they have the desired results? What will it take to conduct them successfully going forward, or what changes to the plan are required based on demonstrated results?

2. Project Specific Monitoring

As specific, on-the-ground, projects begin to be implemented, monitoring their effects on water quality will be a part of the project, as appropriate. Depending on the project, this may involve, for instance, edge of field monitoring of runoff, or monitoring outflow from created ponds or wetlands.

Results of project specific monitoring will be reported and evalutated on an annual basis, as well as at the conclusion of a project. Project specific monitoring will allow assessment of whether implementation of specific practices achieved or is anticipated to achieve the planned level of improvement. Can functioning be improved?

3. Project Specific Monitoring

When a large set of projects have been implemented within a specific subwatershed, water quality monitoring at the outlet of the subwatershed will be conducted, as appropriate. How many or the scale of projects that are required before this monitoring is implemented will be determined on a case by case basis, depending upon the anticipated level of change.

Monitoring results at the subwatershed scale will be compared with previously collected baseline data, and allow changes to be identified. We anticipate that this subwatershed monitoring may be where demonstrated improvement may first be detected, though even here, it will likely take multiple years to be confident of improvement.

StepL calculations may be rerun using measured results rather than average values; this would allow reassessment of the timetable and/or the scale of required efforts to meet project goals.

Watershed site-specific data collected may be utilized in future watershed modeling, to estimate changes in watershed conditions.

4. Watershed and lake modeling

After 5 years of successful project implementation, a new watershed and lake modeling effort will be undertaken. Model results will be used to assess the degree of success achieved to date.

The results of this modeling effort will be used to evaluate project success to date, and contribute to the planned 5 year revision of the watershed plan.

5. Lake load and in-lake water quality monitoring

Improvements to water quality in Lake Wister are the ultimate goal of the Lake Wister TMDL and this watershed based plan. We know, however, based on the results of the lake monitoring that has been conducted for the last decade, that inter-annual variation is very large. Therefore, observed year to year differences are relatively meaningless. When watershed restoration is successful, we expect to see these loads decrease over time. However, given the magnitude of current loads and the large inter-annual variation, it will likely be decades before changes in these loads can be detected with confidence. Only long-term trends will ultimately reveal real progress. Nevertheless, the results of lake load monitoring will be reviewed and assessed on an annual basis, and considered during watershed plan updates.

Since late 2010, PVIA has contracted with the US Geological Survey to conduct regular water quality monitoring of water entering Lake Wister from its two primary sources, the Poteau River and the Fourche Maline. These measured loads of nutrients and sediments to the lake were used in the lake TMDL modeling. Lake monitoring is currently conducted monthly by PVIA to provide information regarding the water quality characteristics of the lake, especially those relevant to their concerns for the water treatment process. The methods used going forward will be a continuation of what has been done since 2010, the data from which was used in development of the TMDL, which has been reviewed by USEPA.

REFERENCES

AEE. 2018. Integrated Water Quality Monitoring Assessment Report. Prepared pursuant to Section 305(b) and 303(d) of the Federal Pollution Control Act. Prepared by the Arkansas Department of Energy and Environment, Division of Environmental Quality, Office of Water Quality. North Little Rock, Arkansas.

Arkansas Department of Agriculture, Division of Natural Resources. 2021. The 2020 Arkansas Annual Report. Prepared pursuant to Section 319 (h) of the Federal Clean Water Act. Little Rock, AR. January 2021.

Austin, B.J., Smith, B.A. and B.E. Haggard. 2018a. Watershed investigative support to the Poteau Valley Improvement Authority: stream water quality to support HUC 12 prioritization in the Lake Wister Watershed, Oklahoma. Final Report to PVIA. Fayetteville, Arkansas. February 7, 2018.

Austin, B.J., Smith, B.A. and B.E. Haggard. 2018b. Watershed investigative support to the Poteau Valley Improvement Authority: stream water quality to support HUC 12 prioritization in the Lake Wister Watershed, Oklahoma. Arkansas Water Resources Center, Publication MSC385, Fayetteville, Arkansas. February 2018. Available at: https://awrc.uark.edu/publications/msc/

Austin, B.J., Patterson, S., and B.E. Haggard. 2018c. Water chemistry during baseflow helps inform watershed management: A case study of the Lake Wister watershed, Oklahoma. Journal of Contemporary Water Research & Education 165:42-58. December 2018.

Austin, B.J., Smith, B.A. and B.E. Haggard. 2019a. Watershed investigative support to the Poteau Valley Improvement Authority: stream water quality to support HUC 12 prioritization in the Lake Wister Watershed, Oklahoma, August 2017 through May 2019. Final Report to PVIA. Fayetteville, Arkansas. October 30, 2019.

Austin, B.J., Smith, B.A. and B.E. Haggard. 2019b. Watershed investigative support to the Poteau Valley Improvement Authority: stream water quality to support HUC 12 prioritization in the Lake Wister Watershed, Oklahoma, August 2017 through May 2019. Arkansas Water Resources Center, Publication MSC389, Fayetteville, Arkansas. November 2019. Available at: https://awrc.uark.edu/publications/msc/

Buck, S.D. 2014. Concentrations, Loads, and Yields of Total Phosphorus, Total Nitrogen, and Suspended Sediment and Bacteria Concentrations in the Wister Lake Basin, Oklahoma and Arkansas, 2011-13. USGS Scientific Investigations Report 2014-5170. US Department of the Interior. US Geological Survey.

Carlson, R.E. 1977. A trophic state index for lakes. *Limnology and Oceanography* **22**: 361-369.

Committee on the Evaluation of Chesapeake Bay Program Implementation for Nutrient Reduction to Improve Water Quality. 2011. Achieving nutrient and sediment reduction goals in the Chesapeake Bay. An Evaluation of Program Strategies and Implementation. The National Academies Press. Washington, D.C.

Dahl, T.E. 1990. Wetland losses in the United States 1780's to 1980's. US Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Elser, J., Marzolf, E.R., and C.R. Goldman. 1990. Phosphorus and nitrogen limitation of phytoplankton growth in the freshwaters of North America: a review and critique of experimental enrichments. *Canadian Journal of Fisheries and Aquatic Sciences* **47**: 1468-1477.

Elser, J.J., Bracken, M.E.S., Cleland, E.E., Gruner, D.S., Harpole, W.S., Hillebrand, H., Ngai, J.T., Seabloom, E.W., Shurin, J.B., and J.E. Smith. 2007. *Ecology Letters* **10**: 1-8.

FTN Associates. 2005. TMDLs for phosphorus, copper, and zinc for the Poteau River near Waldron, Arkansas. FTN Associates, Little Rock, Arkansas.

Galm, J. n.d. "Wister Phase," The Encyclopedia of Oklahoma History and Culture, https://www.okhistory.org/publications/enc/entry.php?entry=WI032.

GBMac. 2018. Final Report. Poteau River Monitoring and Assessment. Project Number: 16-1100. Prepared for: City of Waldron, Waldron, AR; Prepared by: GBMac & Associates, Bryant, AR. October 20, 2018.

Hartmann, M.J. 1996. The development of watercraft in the prehistoric southeastern United States. Dissertation. Texas A&M University, College Station, Texas. December 1996.

Lenhart, C. et al. 2017. Agricultural BMP Handbook for Minnesota, 2nd ed. St. Paul, MN: Minnesota Department of Agriculture.

Lindsay, H.L. et al. 1974. An environmental inventory and assessment of the Poteau River basin. Final Report. Prepared for the Department of the Army, US Army Corps of Engineers, Tulsa District. Prepared by the University of Tulsa. Contract No. DACW56-74-C-0220. December, 1974.

MCPA. 2016. Minnesota Stormwater Manual. Retrieved from stormwater.pca.state.mn.us/index.php/Main_Page on May 19, 2021.

Miller, T. P., J. R. Peterson, C. F. Lenhart, and Y. Nomura. 2012. The Agricultural BMP Handbook for Minnesota. Minnesota Department of Agriculture.

NASS & ODAFF. 2019. Oklahoma Agricultural Statistics 2019. Issued cooperatively by the National Agricultural Statistics Service and the Oklahoma Department of Agriculture, Food and Forestry. January 2019. Available online at https://quickstats.nass.usda.gov/results/BC5B5105-2C24-3B36-99D3-EE262C960CB4#F3655A95-E863-3561-93F0-466AB801F1FB.

NRCS. 2021. Oklahoma Practice Scenarios Fiscal Year 2021. Section I, State Payment Rates and Methods, Oklahoma Payment Schedules, Practice Scenarios. Available online at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/?cid=nrcseprd1328258.

OCC. 2002-2015. Annual Reports of Poultry Waste Produced and Applied in Conservation Districts by Certified Applicators. Oklahoma Conservation Commission, Oklahoma City.

OCC. 2006. Upper Poteau River and Wister Lake *Watershed Implementation Project: FY 2000 319(h) Task 1300* (Draft). Oklahoma Conservation Commission, Oklahoma City, Oklahoma.

OCC. 2009. Draft watershed based plan for the Lake Wister watershed. Oklahoma Conservation Commission, Oklahoma City, Oklahoma.

OCC 2017. Small watershed rotating basin monitoring program. Basin Group 3: Lower North Canadian, Lower Canadian, and Lower Arkansas Basins. Final Report. FY 13/14 §319(h), EPA Grant C9-996100-17. Project 3, Output 3.14. Oklahoma Conservation Commission. Water Quality Division. Oklahoma City, OK. March 2017.

OCC 2019. Oklahoma's Nonpoint Source Management Program Plan 2019-2029. Oklahoma Conservation Commission. Water Quality Programs. Oklahoma City, Oklahoma. 2019.

OCC 2021. Typical BMPs to reduce phosphorus and sediment pollution from pasture. Nonpublished table compiled by the Oklahoma Conservation Commission, with adjustments based on local experience. Oklahoma Conservation Commission. Water Quality Division. Oklahoma City, OK. March 2021.

ODAFF. 2017. Poultry Waste Movement Reports. Oklahoma Department of Agriculture, Food, and Forestry. Oklahoma City, OK. 2016 - 2017.

ODEQ. 2009. Lake Wister watershed and lake modeling report. (Summary of AMEC modeling results.) Oklahoma Department of Environmental Quality, Oklahoma City, Oklahoma.

ODEQ. 2018. Water quality in Oklahoma: 2018 integrated report. Oklahoma Department of Environmental Quality, Oklahoma City, Oklahoma.

Oklahoma Climatological Survey. 2017. LeFlore County climate summary. Available at http://climate.ok.gov/county_climate/Products/County_Climatologies/county_climate_leflore.pdf.

OWRB. 1996. Diagnostic and feasibility study of Wister Lake. Phase I of a Clean Lakes Project: Final Report. Oklahoma Water Resources Board, Oklahoma City, Oklahoma.

OWRB. 2009. Monitoring in support of TMDL development in the Upper Kiamichi, Upper Little, and Upper Mountain Fork Watersheds (FY-2003 Section 104(b)3 Supplemental, CA# X7-97625-01, Project 2. Oklahoma Water Resources Board, Oklahoma City, Oklahoma. June 26, 2009.

OWRB. 2011. Wister Lake bathymetry results. Bathymetric survey conducted in 2011 by OWRB for the US Army Corps of Engineers. Oklahoma Water Resources Board, Oklahoma City, Oklahoma.

OWRB. 2019. Oklahoma lakes report: beneficial use monitoring program. Oklahoma Water Resources Board, Oklahoma.

OWRB. 2015. Title 785. Oklahoma Water Resources Board Chapter 45. Oklahoma's Water Quality Standards. http://www.owrb.ok.gov/quality/standards/standards.php

Patterson, S.D. 2015. Lake Wister Monitoring Program. Poteau Valley Improvement Authority. June 2015.

PVIA. 2009. Restoring Lake Wister. PVIA's Strategic Plan to Improve Water Quality and Enhance the Lake Ecosystem. Prepared by Steve Patterson, Bio x Design, Poteau, Oklahoma. Prepared for the Poteau Valley Improvement Authority, Wister, Oklahoma.

Rice, S. 2021. Email from Shelby Rice, Assistant General Counsel, Oklahoma Department of Agriculture, Food, and Forestry, to Steve Patterson, 5-4-2021.

Scott, J.T. and S.D. Patterson. 2019. Lake Wister water quality modeling in support of nutrient and sediment TMDL development. Prepared for the Poteau Valley Improvement Authority. Prepared by Baylor University and Bio x Design. Waco, TX and Poteau, OK.

Shingleton, K. 2014. Cultural Resources at Lake Wister. Presentation to Poteau Valley Improvement Authority Board of Trustees, Poteau, OK. December 2, 2014. By US Army Corps of Engineers, Tulsa District Archaeologist.

SHPO. 2021. Oklahoma's National Register Handbook. State Historic Preservation Office. Oklahoma Historical Society. Oklahoma City, OK. April 1, 2021.

Singleton, E.D. and F.K. Reilly III. 2020. Recovering Ancient Spiro. National Cowboy & Western Heritage Museum. Oklahoma City, OK.

Storm, D., M. White, P. Busteed. 2006. Wister Lake basin targeting and cost share program evaluation (CA# C9-996100-08-0 FY 200 319(h) Project 1300). Oklahoma State University, Biosystems and Agricultural Engineering, Stillwater, Oklahoma.

USACE. 2021. Wister Lake (WSLO2). Available at https://www.swt-wc.usace.army.mil/WIST.lakepage.html. United States Army Corps of Engineers, Tulsa, Oklahoma.

USDA. 1981. Soil Conservation Service, *Soil Survey Latimer County, Oklahoma*.

USDA. 1983. Soil Conservation Service, *Soil Survey LeFlore County, Oklahoma*.

USDA-NASS. 2019. Oklahoma Agricultural Statistics 2019. Prepared by USDA-NASS, Southern Plains Regional Field Office. Austin, Texas. Available online at: www.nass.usda.gov%2FStatistics_by_State%2FOklahoma%2FPublications%2FAnnual_Statistical_Bulletin%2Fok-bulletin-2019.pdf

USEPA. 1977. Report on Wister Reservoir, LeFlore County, Oklahoma, EPA Region VI. National Eutrophication Survey. Working Paper No. 595. US Environmental Protection Agency. With the cooperation of the Oklahoma Department of Pollution Control and the Oklahoma National Guard. March 1977.

USEPA. 2008. Handbook for Developing Watershed Plans to Restore and Protect Our Water. United States Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch, WashingtonD.C.20460.EPA841-B-08-002. http://water.epa.gov/polwaste/nps/handbook_index.cfm

USEPA. 2012. Identifying and Protecting Healthy Watersheds: Concepts, Assessments and Management Approaches. United States Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans and Watersheds, Washington D.C. 20460. EPA 841-B-11-002. http://water.epa.gov/polwaste/nps/watershed/upload/hwi-watersheds-complete.pdf

USEPA. 2013. Level III and IV Ecoregions of the Continental United States (Revised 2013). Available at https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states. United States Environmental Protection Agency, Washington, DC.

USEPA. 2020. Spreadsheet Tool for Estimating Pollutant Loads (STEPL). https://www.epa.gov/nps/spreadsheet-tool-estimating-pollutant-loads-stepl Last updated: 10/27/2020.

USEPA. 2021. Success Stories about Restoring Water Bodies Impaired by Nonpoint Source Pollution. https://www.epa.gov/nps/success-stories-about-restoring-water-bodies-impaired-nonpoint-source-pollution. Last updated: 1/28/2021.

Vaughn, C.C. and D.E. Spooner. 2004. Status of the mussel fauna of the Poteau River and implications for commercial harvest. American Midland Naturalist 152:336-346.

Vehik, R. n.d. "Fourche Maline Focus," The Encyclopedia of Oklahoma History and Culture, https://www.okhistory.org/publications/enc/entry.php?entry=FO055.

Waidler, et al. 2009. Conservation Practice Modeling Guide for SWAT and APEX.

White, D.S. 1977. Changes in the freshwater mussel populations of the Poteau River system, LeFlore County, Oklahoma. Proceedings of the Oklahoma Academy of Science 57:103-105.

Wright, J. 2019. A Decade of Monitoring Mercury in Fish: What Have We Learned? Presentation for Oklahoma Clean Lakes and Watersheds Association. Available at http://www.oclwa.org/news.php/. Retrieved January 20, 2021.

APPENDIX I

Initial Next Steps

Specifically, what do we intend to do next?

Soil Health - Continue ongoing current efforts to implement:

- Soil health demonstration projects on 1-2 demonstration farms in the Wister watershed, including
  - Rotational grazing
  - Field buffers, including native prairie plant buffers, and river cane buffers
- Soil health field days, including
  - Field days to observe farms where soil health practices have already been implemented
  - “Cowboy botany” (plant identification workshops)

Unpaved Roads and Ditches - Continue ongoing current efforts to implement:

- Assessment of soil erosion potential from unpaved roads in one or more HUC 12s
- One or more specific demonstration projects of improved road maintenance practice

Small Ponds and Wetlands - Continue ongoing current efforts to:

- Develop a small ponds and wetland pilot project in one or more HUC 12s

Watershed Organization - Seek grants and other support to:

- Organize and create a formal, nonprofit Wister Watershed Alliance
- Hire a Watershed Coordinator for a minimum of a two-year term, to help oversee development of the watershed restoration program

Financial Support – Continue efforts to identify sources of funding to support watershed restoration activities

APPENDIX II

Table A II-1: Estimated load reductions of phosphorus for Big Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	15.25	30.49	60.98	121.95
Grass Buffer, min 35' wide	15.03	30.06	60.13	120.27
30 m Buffer w/Optimal Grazing	10.31	20.61	41.22	82.44
Forest Buffer, min 35' wide	8.74	17.47	34.94	69.88
Winter Feeding Facility	8.13	16.26	32.52	65.04
Livestock Exclusion Fencing	7.62	15.23	30.46	60.92
Streambank Protection w/o Fencing	6.09	12.17	24.34	48.68
Prescribed Grazing	5.09	10.19	20.38	40.76
Critical Area Planting	5.07	10.13	20.26	40.52
Heavy Use Area Protection	4.56	9.12	18.23	36.47
Grazing Land Management	4.15	8.30	16.60	33.20
Use Exclusion	3.31	6.62	13.23	26.47
Alternative Water Supply	2.66	5.33	10.66	21.32
Pasture and Hayland Planting	2.37	4.74	9.47	18.94
Litter Storage and Management	2.21	4.42	8.84	17.67

Table A II-2: Estimated load reductions of sediment for Big Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	5533.83	11067.66	22135.31	44270.63
Grass Buffer, min 35’ wide	4780.86	9561.73	19123.46	38246.92
Livestock Exclusion Fencing	4572.21	9144.42	18297.92	36595.84
Use Exclusion	4345.42	8690.83	17381.66	34763.33
Streambank Protection w/o Fencing	4245.63	8482.18	16973.43	33937.79
Forest Buffer, min 35’ wide	3928.11	7865.29	15730.59	31461.18
Critical Area Planting	3102.57	6196.07	12392.15	24793.37
Winter Feeding Facility	2948.35	5905.77	11802.48	23614.03
Heavy Use Area Protection	2458.47	4916.94	9824.81	19658.70
Prescribed Grazing	2458.47	4916.94	9824.81	19658.70
Alternative Water Supply	1378.92	2757.84	5515.68	11040.44
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-3: Estimated load reductions of phosphorus for Upper Black Fork (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	32.63	65.25	130.51	261.01
Grass Buffer, min 35' wide	32.20	64.40	128.80	257.61
30 m Buffer w/Optimal Grazing	22.20	44.40	88.80	177.60
Forest Buffer, min 35' wide	18.67	37.33	74.66	149.32
Winter Feeding Facility	17.40	34.80	69.60	139.21
Livestock Exclusion Fencing	16.23	32.45	64.91	129.82
Streambank Protection w/o Fencing	12.95	25.89	51.78	103.56
Prescribed Grazing	10.88	21.76	43.53	87.06
Critical Area Planting	10.79	21.58	43.16	86.33
Heavy Use Area Protection	9.73	19.45	38.90	77.81
Grazing Land Management	8.94	17.88	35.77	71.53
Use Exclusion	6.96	13.92	27.83	55.66
Alternative Water Supply	5.69	11.38	22.75	45.50
Pasture and Hayland Planting	5.10	10.20	20.40	40.80
Litter Storage and Management	4.76	9.52	19.04	38.08

Table A II-4: Estimated load reductions of sediment for Upper Black Fork (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	11575.68	23142.29	46284.58	92569.16
Grass Buffer, min 35' wide	9997.18	19994.36	39988.71	79986.50
Livestock Exclusion Fencing	9561.73	19132.53	38265.06	76530.13
Use Exclusion	9089.99	18170.92	36350.90	72701.81
Streambank Protection w/o Fencing	8872.27	17744.54	35489.08	70969.08
Forest Buffer, min 35' wide	8219.10	16447.26	32894.53	65789.06
Critical Area Planting	6477.30	12963.67	25918.28	51845.62
Winter Feeding Facility	6168.86	12346.79	24684.50	49369.01
Heavy Use Area Protection	5134.67	10278.41	20547.74	41104.55
Prescribed Grazing	5134.67	10278.41	20547.74	41104.55
Alternative Water Supply	2884.85	5769.70	11539.39	23078.79
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-5: Estimated load reductions of phosphorus for Cedar Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	1.44	2.88	5.75	11.51
Grass Buffer, min 35' wide	1.41	2.82	5.64	11.28
30 m Buffer w/Optimal Grazing	0.93	1.85	3.70	7.39
Forest Buffer, min 35' wide	0.83	1.67	3.34	6.67
Winter Feeding Facility	0.77	1.53	3.07	6.14
Livestock Exclusion Fencing	0.74	1.48	2.97	5.94
Streambank Protection w/o Fencing	0.60	1.20	2.40	4.80
Critical Area Planting	0.49	0.99	1.98	3.96
Prescribed Grazing	0.49	0.98	1.95	3.91
Heavy Use Area Protection	0.44	0.88	1.76	3.52
Grazing Land Management	0.37	0.74	1.49	2.98
Use Exclusion	0.35	0.71	1.41	2.83
Alternative Water Supply	0.26	0.51	1.03	2.05
Pasture and Hayland Planting	0.21	0.43	0.85	1.70
Litter Storage and Management	0.20	0.39	0.79	1.58

Table A II-6: Estimated load reductions of sediment for Cedar Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	616.89	1224.70	2449.40	4898.80
Grass Buffer, min 35’ wide	526.17	1061.41	2113.74	4236.55
Livestock Exclusion Fencing	508.02	1016.05	2023.02	4055.12
Use Exclusion	480.81	961.62	1923.23	3846.46
Streambank Protection w/o Fencing	471.74	943.47	1877.87	3755.75
Forest Buffer, min 35’ wide	435.45	870.90	1741.80	3483.59
Critical Area Planting	344.73	689.46	1369.85	2748.77
Winter Feeding Facility	326.59	653.17	1306.35	2612.69
Heavy Use Area Protection	272.16	544.31	1088.62	2177.24
Prescribed Grazing	272.16	544.31	1088.62	2177.24
Alternative Water Supply	15.42	308.44	607.81	1224.70
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-7: Estimated load reductions of phosphorus for Haws Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	9.58	19.16	38.32	76.65
Grass Buffer, min 35' wide	9.42	18.84	37.68	75.35
30 m Buffer w/Optimal Grazing	6.31	12.62	25.24	50.49
Forest Buffer, min 35' wide	5.52	11.05	22.09	44.19
Winter Feeding Facility	5.11	10.22	20.44	40.88
Livestock Exclusion Fencing	4.87	9.73	19.47	38.93
Streambank Protection w/o Fencing	3.91	7.83	15.66	31.32
Critical Area Planting	3.24	6.48	12.96	25.91
Prescribed Grazing	3.23	6.46	12.92	25.84
Heavy Use Area Protection	2.90	5.80	11.60	23.21
Grazing Land Management	2.54	5.08	10.16	20.33
Use Exclusion	2.22	4.44	8.87	11.90
Alternative Water Supply	1.69	3.39	6.77	13.54
Pasture and Hayland Planting	1.45	2.90	5.80	11.60
Litter Storage and Management	1.35	2.71	5.41	10.82

Table A II-8: Estimated load reductions of sediment for Haws Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	3782.96	7574.99	15149.99	30299.98
Grass Buffer, min 35’ wide	3274.94	6540.80	13090.68	26172.29
Livestock Exclusion Fencing	3129.79	6259.58	12519.15	25047.38
Use Exclusion	2975.57	5951.13	11893.20	35498.15
Streambank Protection w/o Fencing	2902.99	5805.98	11611.97	23223.94
Forest Buffer, min 35’ wide	2694.34	5379.61	10768.29	21527.50
Critical Area Planting	2122.81	4245.63	8482.18	16964.36
Winter Feeding Facility	2023.02	4036.97	8083.02	16156.96
Heavy Use Area Protection	1678.29	3365.66	6722.24	13453.55
Prescribed Grazing	1678.29	3365.66	6722.24	13453.55
Alternative Water Supply	943.47	1886.94	3773.89	7556.85
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-9: Estimated load reductions of phosphorus for Shawnee Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	4.84	9.67	19.34	38.67
Grass Buffer, min 35' wide	4.74	9.48	18.95	37.91
30 m Buffer w/Optimal Grazing	3.11	6.21	12.43	24.86
Forest Buffer, min 35' wide	2.80	5.61	11.21	22.42
Winter Feeding Facility	2.58	5.16	10.31	20.62
Livestock Exclusion Fencing	2.49	4.98	9.97	19.94
Streambank Protection w/o Fencing	2.02	4.03	8.07	16.13
Critical Area Planting	1.66	3.32	6.64	13.28
Prescribed Grazing	1.64	3.28	6.57	13.14
Heavy Use Area Protection	1.48	2.96	5.92	11.84
Grazing Land Management	1.25	2.50	5.01	10.01
Use Exclusion	1.18	2.37	4.74	9.47
Alternative Water Supply	0.86	1.72	3.45	6.90
Pasture and Hayland Planting	0.71	1.43	2.85	5.71
Litter Storage and Management	0.67	1.33	2.66	5.33

Table A II-10: Estimated load reductions of sediment for Shawnee Creek (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	2050.24	4109.55	8219.10	16429.12
Grass Buffer, min 35’ wide	1778.08	3547.09	7094.19	14197.45
Livestock Exclusion Fencing	1696.44	3392.87	6794.82	13580.56
Use Exclusion	1614.79	3229.58	6450.09	12900.17
Streambank Protection w/o Fencing	1578.50	3147.93	6295.86	12600.80
Forest Buffer, min 35’ wide	1460.57	2921.14	5842.27	11675.47
Critical Area Planting	1152.12	2304.25	4599.43	9198.86
Winter Feeding Facility	1097.69	2195.39	4381.70	8763.41
Heavy Use Area Protection	916.26	1823.44	3646.88	7293.77
Prescribed Grazing	916.26	1823.44	3646.88	7293.77
Alternative Water Supply	508.02	1025.12	2050.24	4100.48
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-11: Estimated load reductions of phosphorus for Lower Black Fork (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	53.38	106.77	213.54	427.07
Grass Buffer, min 35' wide	52.60	105.65	210.39	420.79
30 m Buffer w/Optimal Grazing	35.83	71.67	143.34	286.67
Forest Buffer, min 35' wide	30.64	61.28	122.56	245.12
Winter Feeding Facility	28.47	56.94	113.89	227.77
Livestock Exclusion Fencing	26.79	53.58	107.16	214.32
Streambank Protection w/o Fencing	21.45	42.90	85.79	171.58
Prescribed Grazing	17.89	35.77	71.55	143.09
Critical Area Planting	17.82	35.64	71.29	142.58
Heavy Use Area Protection	16.02	32.04	64.08	128.16
Grazing Land Management	14.43	28.86	57.73	115.46
Use Exclusion	11.80	23.60	47.19	94.38
Alternative Water Supply	9.36	18.72	37.44	74.87
Pasture and Hayland Planting	8.23	16.46	32.93	65.85
Litter Storage and Management	7.68	15.36	30.73	61.46

Table A II-12: Estimated load reductions of sediment for Lower Black Fork (Black Fork)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	19849.21	39698.42	79405.90	158802.73
Grass Buffer, min 35’ wide	17154.87	34300.66	68601.33	137202.66
Livestock Exclusion Fencing	16410.98	32821.95	65634.83	131278.74
Use Exclusion	15585.44	31179.95	62359.90	124710.72
Streambank Protection w/o Fencing	15222.56	30436.06	60872.11	121753.30
Forest Buffer, min 35’ wide	14106.73	28213.45	56426.91	112853.81
Critical Area Planting	11113.02	22235.10	44461.14	88931.35
Winter Feeding Facility	10586.85	21173.70	42347.40	84694.79
Heavy Use Area Protection	8817.84	17626.60	35253.21	70506.42
Prescribed Grazing	8817.84	17626.60	35253.21	70506.42
Alternative Water Supply	4953.23	9897.39	19794.78	39598.63
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-13: Estimated load reductions of phosphorus for Sugar Creek (Poteau River)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	76.17	152.34	304.67	609.35
Grass Buffer, min 35' wide	74.86	149.71	299.42	598.84
30 m Buffer w/Optimal Grazing	50.06	100.12	200.23	400.47
Forest Buffer, min 35' wide	43.93	87.87	175.74	351.47
Winter Feeding Facility	40.62	81.25	162.49	324.99
Livestock Exclusion Fencing	38.74	77.48	154.97	309.93
Streambank Protection w/o Fencing	31.18	62.36	124.72	249.45
Critical Area Planting	25.79	51.58	103.16	206.31
Prescribed Grazing	25.69	51.39	102.77	205.54
Heavy Use Area Protection	23.09	46.17	92.35	184.69
Grazing Land Management	20.16	40.32	80.64	161.29
Use Exclusion	17.73	35.46	70.93	141.85
Alternative Water Supply	13.47	26.94	53.89	107.64
Pasture and Hayland Planting	11.50	23.00	45.99	91.99
Litter Storage and Management	10.73	21.46	42.93	85.86

Table A II-14: Estimated load reductions of sediment for Sugar Creek (Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	30318.12	60627.17	121254.35	242517.77
Grass Buffer, min 35’ wide	26190.43	52380.86	104770.80	209532.52
Livestock Exclusion Fencing	25056.45	50121.97	100243.94	200478.81
Use Exclusion	23804.53	47618.14	95227.21	190454.42
Streambank Protection w/o Fencing	23242.08	46484.16	92968.32	185927.57
Forest Buffer, min 35’ wide	21545.64	43091.29	86173.50	172347.01
Critical Area Planting	16973.43	33955.93	67902.80	135805.59
Winter Feeding Facility	16166.04	32332.07	64673.22	129346.44
Heavy Use Area Protection	13462.63	26916.18	53841.43	107673.79
Prescribed Grazing	13462.63	26916.18	53841.43	107673.79
Alternative Water Supply	7556.85	15113.70	30236.48	60463.88
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-15: Estimated load reductions of phosphorus for Hontubby Creek (Poteau River)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	55.15	110.30	220.59	441.18
Grass Buffer, min 35' wide	54.09	108.18	216.37	432.74
30 m Buffer w/Optimal Grazing	35.67	71.33	142.65	285.31
Forest Buffer, min 35' wide	31.93	63.86	127.71	255.42
Winter Feeding Facility	29.41	58.82	117.65	235.30
Livestock Exclusion Fencing	28.33	56.66	113.32	226.64
Streambank Protection w/o Fencing	22.89	45.78	91.56	183.12
Critical Area Planting	18.86	37.73	75.47	150.93
Prescribed Grazing	18.70	37.39	74.78	149.57
Heavy Use Area Protection	16.84	33.68	67.36	134.71
Grazing Land Management	14.37	28.73	57.46	114.91
Use Exclusion	13.33	26.65	53.30	106.60
Alternative Water Supply	9.82	19.64	39.27	78.54
Pasture and Hayland Planting	8.19	16.38	32.77	65.54
Litter Storage and Management	7.65	15.29	30.59	61.17

Table A II-16: Estimated load reductions of sediment for Hontubby Creek (Poteau River)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	23024.36	46057.78	92115.56	184222.06
Grass Buffer, min 35’ wide	19894.57	39789.13	79587.34	159165.61
Livestock Exclusion Fencing	19032.74	38074.55	76149.11	152289.15
Use Exclusion	18080.20	36169.47	72338.93	144677.86
Streambank Protection w/o Fencing	17653.82	35307.64	70615.28	141239.63
Forest Buffer, min 35’ wide	16365.62	32731.23	65462.47	130924.94
Critical Area Planting	12891.10	25791.27	51582.54	103165.08
Winter Feeding Facility	12283.28	24566.57	49124.07	98248.14
Heavy Use Area Protection	10223.97	20447.95	40895.90	81791.80
Prescribed Grazing	10223.97	20447.95	40895.90	81791.80
Alternative Water Supply	5742.48	11484.96	22969.92	45930.78
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-17: Estimated load reductions of phosphorus for Cane Creek (Poteau River)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	70.42	140.83	281.67	563.33
Grass Buffer, min 35' wide	69.20	138.40	276.79	553.58
30 m Buffer w/Optimal Grazing	46.25	92.50	184.99	369.99
Forest Buffer, min 35' wide	40.62	81.25	162.49	324.99
Winter Feeding Facility	37.56	75.11	150.22	300.45
Livestock Exclusion Fencing	35.83	71.66	143.32	286.64
Streambank Protection w/o Fencing	28.84	57.69	115.38	230.75
Critical Area Planting	23.85	47.70	95.41	190.82
Prescribed Grazing	23.76	47.51	95.03	190.06
Heavy Use Area Protection	21.35	42.70	85.40	170.80
Grazing Land Management	18.63	37.25	74.51	149.01
Use Exclusion	16.42	32.84	65.67	131.34
Alternative Water Supply	12.46	24.92	49.83	99.66
Pasture and Hayland Planting	10.62	21.25	42.49	84.99
Litter Storage and Management	9.92	19.83	39.66	79.32

Table A II-18: Estimated load reductions of sediment for Cane Creek (Poteau River)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	28077.38	56163.82	112327.65	224655.29
Grass Buffer, min 35’ wide	24267.20	48525.33	97050.65	194101.30
Livestock Exclusion Fencing	23214.86	46429.73	92859.46	185718.91
Use Exclusion	22053.67	44107.33	88214.67	176429.34
Streambank Protection w/o Fencing	21527.50	43055.00	86119.07	172238.14
Forest Buffer, min 35’ wide	19958.07	39916.14	79823.21	159655.49
Critical Area Planting	15721.52	31452.10	62904.21	125808.42
Winter Feeding Facility	14977.62	29955.25	59910.50	119811.92
Heavy Use Area Protection	12464.72	24938.52	49877.03	99744.99
Prescribed Grazing	12464.72	24938.52	49877.03	99744.99
Alternative Water Supply	7003.47	14006.94	28004.80	56009.60
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-19: Estimated load reductions of phosphorus for Pigeon Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	155.57	311.15	622.29	1244.58
Grass Buffer, min 35' wide	153.06	306.12	612.23	1224.45
30 m Buffer w/Optimal Grazing	103.16	206.33	412.67	825.33
Forest Buffer, min 35' wide	89.55	179.10	358.19	716.38
Winter Feeding Facility	82.97	165.94	331.89	663.77
Livestock Exclusion Fencing	78.68	157.37	314.72	629.45
Streambank Protection w/o Fencing	63.19	126.37	252.74	505.49
Critical Area Planting	52.36	104.73	209.45	418.90
Prescribed Grazing	52.33	104.65	209.31	418.62
Heavy Use Area Protection	46.96	93.91	187.82	375.64
Grazing Land Management	41.55	83.10	166.21	332.41
Use Exclusion	35.44	70.88	141.76	283.52
Alternative Water Supply	27.42	54.83	109.66	219.31
Pasture and Hayland Planting	23.70	47.40	94.79	189.59
Litter Storage and Management	22.12	44.24	88.47	176.95

Table A II-20: Estimated load reductions of sediment for Pigeon Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	60191.72	120392.52	240785.04	481561.01
Grass Buffer, min 35’ wide	52008.92	104017.83	208035.66	416071.33
Livestock Exclusion Fencing	49759.10	99527.27	199045.46	398090.92
Use Exclusion	47273.41	94546.82	189093.64	378187.28
Streambank Protection w/o Fencing	46148.50	92297.00	184603.08	369197.08
Forest Buffer, min 35’ wide	42782.84	85556.62	171113.23	342226.47
Critical Area Planting	33710.99	67421.99	134834.91	269678.88
Winter Feeding Facility	32105.28	64210.55	128412.04	256833.15
Heavy Use Area Protection	26725.67	53451.34	106902.68	213814.43
Prescribed Grazing	26725.67	53451.34	106902.68	213814.43
Alternative Water Supply	15004.84	30018.75	60037.50	120065.93
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-21: Estimated load reductions of phosphorus for Little Fourche Maline (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	66.40	132.80	265.60	531.19
Grass Buffer, min 35' wide	65.03	130.05	260.10	520.20
30 m Buffer w/Optimal Grazing	42.25	84.74	169.48	338.96
Forest Buffer, min 35' wide	38.56	77.12	154.23	308.47
Winter Feeding Facility	35.41	70.82	141.65	283.30
Livestock Exclusion Fencing	34.39	68.77	137.55	275.09
Streambank Protection w/o Fencing	27.87	55.74	111.49	222.98
Critical Area Planting	22.91	45.82	91.63	183.27
Prescribed Grazing	22.60	45.20	90.41	180.83
Heavy Use Area Protection	20.40	40.80	81.59	163.18
Grazing Land Management	17.06	34.13	68.26	136.52
Use Exclusion	16.52	33.05	66.10	132.19
Alternative Water Supply	11.88	23.77	47.54	95.07
Pasture and Hayland Planting	9.73	19.46	38.93	77.86
Litter Storage and Management	9.09	18.17	36.34	72.67

Table A II-22: Estimated load reductions of sediment for Little Fourche Maline (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	28794.05	57579.03	115167.14	230334.27
Grass Buffer, min 35’ wide	24875.01	49750.03	99500.05	199009.17
Livestock Exclusion Fencing	23804.53	47600.00	95209.07	190409.06
Use Exclusion	22607.05	45223.17	90446.34	180892.69
Streambank Protection w/o Fencing	22071.81	44143.62	88296.32	176592.63
Forest Buffer, min 35’ wide	20457.02	40923.12	81846.23	163692.46
Critical Area Planting	16120.68	32250.43	64491.78	128983.56
Winter Feeding Facility	15358.64	30708.21	61425.50	122841.92
Heavy Use Area Protection	12782.24	25564.47	51138.02	102266.97
Prescribed Grazing	12782.24	25564.47	51138.02	102266.97
Alternative Water Supply	7175.83	14360.74	28712.41	57433.88
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-23: Estimated load reductions of phosphorus for Red Oak Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	112.70	225.40	450.81	901.61
Grass Buffer, min 35' wide	110.52	221.04	442.07	884.14
30 m Buffer w/Optimal Grazing	72.73	145.46	290.92	581.84
Forest Buffer, min 35' wide	65.28	130.56	261.12	522.24
Winter Feeding Facility	60.11	120.22	240.43	480.86
Livestock Exclusion Fencing	57.97	115.94	231.89	463.77
Streambank Protection w/o Fencing	46.87	93.73	187.46	374.92
Critical Area Planting	38.61	77.22	154.44	308.88
Prescribed Grazing	38.23	76.47	152.93	305.87
Heavy Use Area Protection	34.45	68.89	137.79	275.58
Grazing Land Management	29.29	58.59	117.17	234.34
Use Exclusion	27.36	54.72	109.45	218.89
Alternative Water Supply	20.08	40.16	80.32	160.65
Pasture and Hayland Planting	16.71	33.41	66.83	133.66
Litter Storage and Management	15.59	31.18	62.37	124.74

Table A II-24: Estimated load reductions of sediment for Red Oak Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	47355.06	94701.04	189402.08	378804.17
Grass Buffer, min 35’ wide	40914.04	81819.02	163647.10	327285.13
Livestock Exclusion Fencing	39145.03	78290.07	156571.06	313142.12
Use Exclusion	37185.51	74371.03	148742.05	297493.18
Streambank Protection w/o Fencing	36305.54	72602.02	145213.10	290417.13
Forest Buffer, min 35’ wide	33647.49	67304.06	134599.04	269207.15
Critical Area Planting	26517.02	53034.04	106068.07	212127.07
Winter Feeding Facility	25256.03	50502.99	101015.05	202030.10
Heavy Use Area Protection	21019.48	42048.02	84096.05	168192.10
Prescribed Grazing	21019.48	42048.02	84096.05	168192.10
Alternative Water Supply	11802.48	23614.03	47228.05	94447.03
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-25: Estimated load reductions of phosphorus for Clear Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	97.54	195.09	390.18	780.36
Grass Buffer, min 35' wide	95.45	190.91	381.82	763.63
30 m Buffer w/Optimal Grazing	61.84	123.68	247.36	494.72
Forest Buffer, min 35' wide	56.73	113.45	226.90	453.81
Winter Feeding Facility	52.02	104.05	208.09	416.19
Livestock Exclusion Fencing	50.71	101.42	202.85	405.69
Streambank Protection w/o Fencing	41.16	82.33	164.66	329.32
Critical Area Planting	33.79	67.58	135.16	270.33
Prescribed Grazing	33.27	66.54	133.08	266.17
Heavy Use Area Protection	30.05	60.11	120.21	240.41
Grazing Land Management	24.91	49.81	99.63	199.25
Use Exclusion	24.61	49.23	98.46	196.91
Alternative Water Supply	17.50	35.00	70.01	140.02
Pasture and Hayland Planting	14.21	28.41	56.82	113.64
Litter Storage and Management	13.26	26.52	53.03	106.07

Table A II-26: Estimated load reductions of sediment for Clear Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	43045.93	86100.93	172201.86	344394.64
Grass Buffer, min 35’ wide	37194.59	74389.17	148778.34	297556.68
Livestock Exclusion Fencing	35588.87	71177.74	142346.40	284701.87
Use Exclusion	33810.78	67612.50	135234.07	270468.14
Streambank Protection w/o Fencing	33003.39	66006.78	132022.63	264036.19
Forest Buffer, min 35’ wide	30590.28	61189.63	122379.26	244749.44
Critical Area Planting	24103.91	48216.88	96433.77	192858.46
Winter Feeding Facility	22960.85	45921.70	91843.41	183677.75
Heavy Use Area Protection	19114.39	38228.78	76457.55	152915.10
Prescribed Grazing	19114.39	38228.78	76457.55	152915.10
Alternative Water Supply	10732.00	21464.00	42937.07	85865.06
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-27: Estimated load reductions of phosphorus for Bandy Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	101.03	202.07	404.13	808.26
Grass Buffer, min 35' wide	98.93	197.86	395.71	791.42
30 m Buffer w/Optimal Grazing	64.39	128.78	257.56	515.13
Forest Buffer, min 35' wide	58.69	117.37	234.74	469.49
Winter Feeding Facility	53.88	107.77	215.54	431.07
Livestock Exclusion Fencing	52.36	104.72	209.44	418.88
Streambank Protection w/o Fencing	42.45	84.90	169.81	339.62
Critical Area Planting	34.89	69.77	139.54	279.08
Prescribed Grazing	34.40	68.81	137.62	275.25
Heavy Use Area Protection	31.05	62.11	124.21	248.43
Grazing Land Management	25.93	51.87	103.74	207.47
Use Exclusion	25.21	50.42	100.83	201.67
Alternative Water Supply	18.09	36.18	72.37	144.73
Pasture and Hayland Planting	14.79	29.58	59.17	118.33
Litter Storage and Management	13.81	27.61	55.22	110.44

Table A II-28: Estimated load reductions of sediment for Bandy Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	43953.11	87915.30	175821.52	351643.05
Grass Buffer, min 35’ wide	37974.76	75958.60	151908.13	303825.33
Livestock Exclusion Fencing	36332.76	72674.59	145349.18	290698.36
Use Exclusion	34518.39	69036.78	138082.63	276156.19
Streambank Protection w/o Fencing	33701.92	67394.77	134798.62	269597.24
Forest Buffer, min 35’ wide	31234.38	62477.83	124955.66	249902.25
Critical Area Planting	24611.93	49232.93	98456.79	196922.65
Winter Feeding Facility	23441.66	46883.32	93775.71	187542.36
Heavy Use Area Protection	19513.55	39036.17	78063.27	156135.61
Prescribed Grazing	19513.55	39036.17	78063.27	156135.61
Alternative Water Supply	10958.79	21917.59	43835.18	87679.43
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-29: Estimated load reductions of phosphorus for Coon Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	40.29	80.58	161.16	322.33
Grass Buffer, min 35' wide	39.51	79.03	158.05	316.11
30 m Buffer w/Optimal Grazing	26.02	52.05	104.09	208.19
Forest Buffer, min 35' wide	23.33	46.67	93.33	186.66
Winter Feeding Facility	21.49	42.98	85.96	171.91
Livestock Exclusion Fencing	20.72	41.43	82.85	165.71
Streambank Protection w/o Fencing	16.74	33.48	66.97	133.94
Critical Area Planting	13.79	27.59	55.18	110.36
Prescribed Grazing	13.67	27.33	54.66	109.32
Heavy Use Area Protection	12.31	24.62	49.24	98.48
Grazing Land Management	10.48	20.96	41.93	83.85
Use Exclusion	9.76	19.53	39.05	78.10
Alternative Water Supply	7.18	14.35	28.71	57.41
Pasture and Hayland Planting	5.98	11.96	23.91	47.82
Litter Storage and Management	5.58	11.16	22.32	44.63

Table A II-30: Estimated load reductions of sediment for Coon Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	16882.71	33774.50	67539.92	135088.92
Grass Buffer, min 35’ wide	14587.53	29175.07	58359.21	116718.42
Livestock Exclusion Fencing	13961.58	27914.08	55837.24	111674.47
Use Exclusion	13263.04	26526.09	53043.11	106086.21
Streambank Protection w/o Fencing	12945.53	25891.06	51782.12	103564.24
Forest Buffer, min 35’ wide	12002.06	24004.12	47999.16	95998.32
Critical Area Planting	9452.87	18914.81	37820.54	75650.16
Winter Feeding Facility	9008.35	18007.62	36024.32	72048.63
Heavy Use Area Protection	7493.35	14995.77	29991.54	59974.00
Prescribed Grazing	7493.35	14995.77	29991.54	59974.00
Alternative Water Supply	4209.34	8418.68	16837.35	33683.78
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-31: Estimated load reductions of phosphorus for Upper Long Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	50.34	100.68	201.37	402.74
Grass Buffer, min 35' wide	49.51	99.01	198.02	396.04
30 m Buffer w/Optimal Grazing	33.25	66.50	133.00	266.01
Forest Buffer, min 35' wide	29.00	58.01	116.02	232.03
Winter Feeding Facility	26.85	53.70	107.40	214.79
Livestock Exclusion Fencing	25.52	51.05	102.10	204.20
Streambank Protection w/o Fencing	20.52	41.04	82.08	164.15
Critical Area Planting	16.99	33.98	67.96	135.91
Prescribed Grazing	16.96	33.91	67.82	135.64
Heavy Use Area Protection	15.22	30.45	60.89	121.78
Grazing Land Management	13.39	26.78	53.57	107.13
Use Exclusion	11.58	23.16	46.32	92.64
Alternative Water Supply	8.89	17.77	35.54	71.09
Pasture and Hayland Planting	7.64	15.28	30.55	61.10
Litter Storage and Management	7.13	14.26	28.52	57.03

Table A II-32: Estimated load reductions of sediment for Upper Long Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	19731.27	39453.48	78906.95	157822.97
Grass Buffer, min 35’ wide	17046.01	34092.01	68174.95	136358.98
Livestock Exclusion Fencing	16311.19	32613.30	65235.67	130462.27
Use Exclusion	15494.72	30989.44	61969.81	123939.61
Streambank Protection w/o Fencing	15122.77	30245.55	60500.17	121000.34
Forest Buffer, min 35’ wide	14016.01	28041.09	56082.18	112155.28
Critical Area Planting	11049.51	22099.03	44188.98	88377.96
Winter Feeding Facility	10523.35	21046.69	42084.31	84168.62
Heavy Use Area Protection	8763.41	17517.74	35035.48	70070.97
Prescribed Grazing	8763.41	17517.74	35035.48	70070.97
Alternative Water Supply	4916.94	9833.89	19676.84	39353.69
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-33: Estimated load reductions of phosphorus for Lower Long Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	52.44	104.88	209.76	419.51
Grass Buffer, min 35' wide	51.45	102.91	205.81	411.62
30 m Buffer w/Optimal Grazing	34.01	68.01	136.01	272.03
Forest Buffer, min 35' wide	30.34	60.68	121.36	242.73
Winter Feeding Facility	27.97	55.94	111.87	223.74
Livestock Exclusion Fencing	26.89	53.79	107.58	215.16
Streambank Protection w/o Fencing	21.72	43.44	86.87	173.74
Critical Area Planting	17.91	35.82	71.64	143.28
Prescribed Grazing	17.76	35.53	71.06	142.11
Heavy Use Area Protection	15.99	31.99	63.97	127.94
Grazing Land Management	13.69	27.39	54.78	109.56
Use Exclusion	12.60	25.19	50.38	100.76
Alternative Water Supply	9.33	18.65	37.30	74.61
Pasture and Hayland Planting	7.81	15.62	31.24	62.49
Litter Storage and Management	7.29	14.58	29.16	58.32

Table A II-34: Estimated load reductions of sediment for Lower Long Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	21727.08	43454.16	86917.39	173825.72
Grass Buffer, min 35’ wide	18769.66	37548.39	75096.77	150184.48
Livestock Exclusion Fencing	17962.26	35924.53	71849.05	143698.10
Use Exclusion	17064.15	34128.30	68256.60	136513.20
Streambank Protection w/o Fencing	16655.92	33320.91	66632.74	133265.48
Forest Buffer, min 35’ wide	15440.29	30880.58	61770.23	123531.38
Critical Area Planting	12165.35	24339.77	48670.48	97340.95
Winter Feeding Facility	11584.75	23178.58	46357.15	92705.24
Heavy Use Area Protection	9643.38	19295.82	38591.65	77183.30
Prescribed Grazing	9643.38	19295.82	38591.65	77183.30
Alternative Water Supply	5415.89	10831.79	21672.65	43336.23
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-35: Estimated load reductions of phosphorus for Cunneo Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	31.31	62.62	125.25	250.50
Grass Buffer, min 35' wide	30.64	61.28	122.55	245.10
30 m Buffer w/Optimal Grazing	19.84	39.68	79.35	158.69
Forest Buffer, min 35' wide	18.21	36.42	72.85	145.70
Winter Feeding Facility	16.70	33.40	66.80	133.60
Livestock Exclusion Fencing	16.28	32.57	65.14	130.28
Streambank Protection w/o Fencing	13.22	26.44	52.88	105.77
Critical Area Planting	10.85	21.70	43.40	86.81
Prescribed Grazing	10.68	21.36	42.73	85.46
Heavy Use Area Protection	9.65	19.30	38.60	77.20
Grazing Land Management	7.99	15.98	31.96	63.92
Use Exclusion	7.91	15.83	31.65	63.30
Alternative Water Supply	5.62	11.24	22.48	44.96
Pasture and Hayland Planting	4.56	9.11	18.23	36.46
Litter Storage and Management	4.25	8.50	17.01	34.02

Table A II-36: Estimated load reductions of sediment for Cunneo Creek (Fourche Maline)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	13843.64	27687.29	55383.64	110758.22
Grass Buffer, min 35’ wide	11965.77	23922.47	47844.94	95698.95
Livestock Exclusion Fencing	11448.67	22888.28	45776.56	91562.18
Use Exclusion	10877.15	21745.22	43490.45	86980.90
Streambank Protection w/o Fencing	10614.06	21228.13	42456.26	84912.52
Forest Buffer, min 35’ wide	9842.96	19676.84	39353.69	78716.44
Critical Area Planting	7756.43	15503.79	31016.66	62024.24
Winter Feeding Facility	7384.49	14768.97	29537.94	59066.82
Heavy Use Area Protection	6150.71	12292.36	24584.71	49178.50
Prescribed Grazing	6150.71	12292.36	24584.71	49178.50
Alternative Water Supply	3456.37	6903.68	13807.36	27614.71
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-37: Estimated load reductions of phosphorus for Upper Holson Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	76.48	152.97	305.94	611.88
Grass Buffer, min 35' wide	75.19	150.37	300.75	601.50
30 m Buffer w/Optimal Grazing	50.39	100.77	201.55	403.10
Forest Buffer, min 35' wide	44.09	88.18	176.37	352.74
Winter Feeding Facility	40.79	81.58	163.17	326.34
Livestock Exclusion Fencing	38.85	77.69	155.37	310.75
Streambank Protection w/o Fencing	31.24	62.49	124.98	249.97
Critical Area Planting	25.85	51.71	103.42	206.85
Prescribed Grazing	25.78	51.56	103.12	206.24
Heavy Use Area Protection	23.16	46.31	92.62	185.25
Grazing Land Management	20.29	40.59	81.17	162.35
Use Exclusion	17.70	35.41	70.81	141.63
Alternative Water Supply	13.51	27.03	54.06	108.11
Pasture and Hayland Planting	11.58	23.15	46.30	92.60
Litter Storage and Management	10.80	21.60	43.21	86.42

Table A II-38: Estimated load reductions of sediment for Upper Holson Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	30218.33	60427.59	120864.26	241719.44
Grass Buffer, min 35’ wide	26108.78	52208.50	104426.07	208843.06
Livestock Exclusion Fencing	24974.80	49958.68	99908.28	199825.64
Use Exclusion	23731.96	47454.85	94918.77	189828.46
Streambank Protection w/o Fencing	23160.43	46329.94	92659.88	185319.75
Forest Buffer, min 35’ wide	21473.07	42946.14	85892.28	171784.55
Critical Area Planting	16919.00	33838.00	67685.07	135361.07
Winter Feeding Facility	16111.61	32232.28	64455.49	128920.06
Heavy Use Area Protection	13417.27	26834.53	53659.99	107319.99
Prescribed Grazing	13417.27	26834.53	53659.99	107319.99
Alternative Water Supply	7529.64	15068.34	30136.69	60264.30
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-39: Estimated load reductions of phosphorus for Coal Creek 1 (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	62.64	125.29	250.57	501.15
Grass Buffer, min 35' wide	61.63	123.26	246.53	493.06
30 m Buffer w/Optimal Grazing	41.55	83.10	166.21	332.41
Forest Buffer, min 35' wide	36.06	72.11	144.22	288.44
Winter Feeding Facility	33.41	66.82	133.64	267.28
Livestock Exclusion Fencing	31.68	63.35	126.71	253.42
Streambank Protection w/o Fencing	25.44	50.87	101.75	203.49
Critical Area Planting	21.08	42.16	84.32	168.65
Prescribed Grazing	21.07	42.14	84.27	168.55
Heavy Use Area Protection	18.91	37.81	75.62	151.24
Grazing Land Management	16.74	33.47	66.94	133.88
Use Exclusion	14.26	28.52	57.05	114.09
Alternative Water Supply	11.04	22.08	44.15	88.30
Pasture and Hayland Planting	9.54	19.09	38.18	76.36
Litter Storage and Management	8.91	17.82	35.63	71.27

Table A II-40: Estimated load reductions of sediment for Coal Creek 1 (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	24221.84	48434.61	96878.29	193747.50
Grass Buffer, min 35’ wide	20928.76	41848.44	83696.89	167402.85
Livestock Exclusion Fencing	20021.57	40043.15	80086.29	160163.51
Use Exclusion	19023.67	38038.27	75895.10	152162.14
Streambank Protection w/o Fencing	18570.08	37131.08	74271.24	148542.47
Forest Buffer, min 35’ wide	17209.30	34418.60	68846.27	137692.54
Critical Area Planting	13562.42	27124.83	54249.66	108499.33
Winter Feeding Facility	12918.31	25836.63	51664.19	103337.44
Heavy Use Area Protection	10750.14	21509.36	43009.64	86028.35
Prescribed Grazing	10750.14	21509.36	43009.64	86028.35
Alternative Water Supply	6041.85	12074.63	24158.34	48307.60
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-41: Estimated load reductions of phosphorus for Coal Creek 2 (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	31.98	63.97	127.93	255.86
Grass Buffer, min 35' wide	31.30	62.60	125.20	250.41
30 m Buffer w/Optimal Grazing	20.30	40.60	81.21	162.41
Forest Buffer, min 35' wide	18.59	37.19	74.38	148.75
Winter Feeding Facility	17.06	34.11	68.23	136.46
Livestock Exclusion Fencing	16.62	33.23	66.46	132.92
Streambank Protection w/o Fencing	13.49	26.97	53.93	107.86
Critical Area Planting	11.07	22.14	44.28	88.56
Prescribed Grazing	10.90	21.81	43.62	87.24
Heavy Use Area Protection	9.85	19.69	39.39	78.78
Grazing Land Management	8.18	16.35	32.70	65.41
Use Exclusion	8.05	16.10	32.20	64.39
Alternative Water Supply	5.74	11.47	22.94	45.89
Pasture and Hayland Planting	4.66	9.33	18.65	37.31
Litter Storage and Management	4.35	8.70	17.41	34.82

Table A II-42: Estimated load reductions of sediment for Coal Creek 2 (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	14070.44	28131.81	56272.69	112536.30
Grass Buffer, min 35’ wide	12156.28	24312.56	48616.04	97232.09
Livestock Exclusion Fencing	11630.11	23260.22	46520.45	93031.82
Use Exclusion	11049.51	22099.03	44188.98	88377.96
Streambank Protection w/o Fencing	10786.43	21572.86	43136.65	86282.37
Forest Buffer, min 35’ wide	9997.18	19994.36	39988.71	79977.43
Critical Area Planting	7874.37	15757.80	31506.54	63022.14
Winter Feeding Facility	7502.42	15004.84	30009.68	60019.36
Heavy Use Area Protection	6241.43	12491.94	24983.87	49967.75
Prescribed Grazing	6241.43	12491.94	24983.87	49967.75
Alternative Water Supply	3510.81	7012.54	14034.15	28059.23
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	44.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-43: Estimated load reductions of phosphorus for Middle Holson Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	7.34	14.69	29.37	58.75
Grass Buffer, min 35' wide	7.22	14.44	28.88	57.75
30 m Buffer w/Optimal Grazing	4.84	9.67	19.34	38.68
Forest Buffer, min 35' wide	4.23	8.47	16.94	33.87
Winter Feeding Facility	3.91	7.83	15.67	31.33
Livestock Exclusion Fencing	3.73	7.46	14.92	29.85
Streambank Protection w/o Fencing	3.00	6.01	12.01	24.01
Critical Area Planting	2.49	4.97	9.93	19.87
Prescribed Grazing	2.48	4.95	9.90	19.80
Heavy Use Area Protection	2.22	4.45	8.89	17.79
Grazing Land Management	1.95	3.90	7.79	15.58
Use Exclusion	1.70	3.41	6.81	13.62
Alternative Water Supply	1.30	2.59	5.19	10.38
Pasture and Hayland Planting	1.11	2.22	4.44	8.89
Litter Storage and Management	1.04	2.07	4.15	8.29

Table A II-44: Estimated load reductions of sediment for Middle Holson Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	2902.99	5815.06	11630.11	23251.15
Grass Buffer, min 35’ wide	2512.90	5025.80	10042.54	20094.15
Livestock Exclusion Fencing	2404.04	4808.08	9616.16	19223.25
Use Exclusion	2286.11	4563.14	9135.35	18261.63
Streambank Protection w/o Fencing	2231.68	4454.28	8917.63	17826.19
Forest Buffer, min 35’ wide	2068.38	4127.69	8264.46	16528.91
Critical Area Planting	1623.86	3256.79	6513.59	13018.10
Winter Feeding Facility	1551.29	3102.57	6205.15	12401.22
Heavy Use Area Protection	1288.20	2585.48	5161.88	10323.77
Prescribed Grazing	1288.20	2585.48	5161.88	10323.77
Alternative Water Supply	725.75	1451.50	2902.99	5796.91
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-45: Estimated load reductions of phosphorus for Lower Holson Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	12.37	24.74	49.49	98.97
Grass Buffer, min 35' wide	12.14	24.28	48.57	97.13
30 m Buffer w/Optimal Grazing	8.04	16.07	32.15	64.29
Forest Buffer, min 35' wide	7.16	14.31	28.62	57.24
Winter Feeding Facility	6.60	13.19	26.39	52.78
Livestock Exclusion Fencing	6.34	12.68	25.36	50.71
Streambank Protection w/o Fencing	5.12	10.23	20.47	40.93
Critical Area Planting	4.22	8.44	16.88	33.77
Prescribed Grazing	4.19	8.38	16.76	33.51
Heavy Use Area Protection	3.77	7.54	15.08	30.16
Grazing Land Management	3.24	6.47	12.95	25.90
Use Exclusion	2.96	5.92	11.84	23.68
Alternative Water Supply	2.20	4.40	8.80	17.59
Pasture and Hayland Planting	1.85	3.69	7.38	14.77
Litter Storage and Management	1.72	3.45	6.89	13.78

Table A II-46: Estimated load reductions of sediment for Lower Holson Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	5098.38	10196.76	20402.59	40805.18
Grass Buffer, min 35' wide	4408.92	8808.77	17626.60	35253.21
Livestock Exclusion Fencing	4218.41	8427.75	16864.57	33729.14
Use Exclusion	4009.76	8010.44	16020.89	32041.77
Streambank Protection w/o Fencing	3909.97	7819.93	15639.87	31279.74
Forest Buffer, min 35' wide	3628.74	7248.41	14496.82	28993.63
Critical Area Planting	2857.63	5715.27	11421.46	22851.99
Winter Feeding Facility	2721.56	5443.11	10877.15	21763.37
Heavy Use Area Protection	2267.96	4526.85	9053.71	18116.48
Prescribed Grazing	2267.96	4526.85	9053.71	18116.48
Alternative Water Supply	1270.06	2540.12	5089.31	10169.54
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-47: Estimated load reductions of phosphorus for Cedar Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	27.86	55.73	111.46	222.92
Grass Buffer, min 35' wide	27.35	54.69	109.39	218.78
30 m Buffer w/Optimal Grazing	18.10	36.21	72.42	144.83
Forest Buffer, min 35' wide	16.12	32.23	64.46	128.92
Winter Feeding Facility	14.86	29.72	59.45	118.89
Livestock Exclusion Fencing	14.27	28.55	57.10	114.20
Streambank Protection w/o Fencing	11.52	23.04	46.08	92.17
Critical Area Planting	9.51	19.01	38.02	76.04
Prescribed Grazing	9.43	18.86	37.73	75.47
Heavy Use Area Protection	8.49	16.98	33.96	67.93
Grazing Land Management	7.29	14.58	29.17	58.33
Use Exclusion	6.66	13.33	26.65	53.31
Alternative Water Supply	4.95	9.90	19.81	39.61
Pasture and Hayland Planting	4.16	8.32	16.63	33.27
Litter Storage and Management	3.88	7.76	15.53	31.05

Table A II-48: Estimated load reductions of sediment for Cedar Creek (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	11484.96	22960.85	45921.70	91852.48
Grass Buffer, min 35’ wide	9915.53	19840.14	39680.27	79360.54
Livestock Exclusion Fencing	9489.16	18978.31	37965.69	75931.38
Use Exclusion	9017.42	18034.84	36069.68	72130.28
Streambank Protection w/o Fencing	8799.69	17608.46	35207.85	70415.70
Forest Buffer, min 35’ wide	8155.59	16320.26	32640.52	65271.96
Critical Area Planting	6431.94	12854.81	25718.69	51437.39
Winter Feeding Facility	6123.50	12247.00	24494.00	48987.99
Heavy Use Area Protection	5098.38	10196.76	20393.52	40777.97
Prescribed Grazing	5098.38	10196.76	20393.52	40777.97
Alternative Water Supply	2866.70	5724.34	11448.67	22897.35
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	3.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-49: Estimated load reductions of phosphorus for Baker Branch (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	88.19	176.39	352.77	705.55
Grass Buffer, min 35' wide	86.88	173.75	347.51	695.01
30 m Buffer w/Optimal Grazing	59.08	118.17	236.35	472.69
Forest Buffer, min 35' wide	50.64	101.28	202.57	405.13
Winter Feeding Facility	47.04	94.07	188.15	376.29
Livestock Exclusion Fencing	44.31	88.63	177.25	354.50
Streambank Protection w/o Fencing	35.49	70.99	141.97	283.94
Prescribed Grazing	29.57	59.13	118.27	236.53
Critical Area Planting	29.48	58.96	117.92	235.85
Heavy Use Area Protection	26.49	52.98	105.96	211.92
Grazing Land Management	23.80	47.60	95.19	190.38
Use Exclusion	19.59	39.17	78.34	156.68
Alternative Water Supply	15.48	30.95	61.90	123.80
Pasture and Hayland Planting	13.57	27.15	54.29	108.58
Litter Storage and Management	12.67	25.34	50.67	101.34

Table A II-50: Estimated load reductions of sediment for Baker Branch (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	33003.39	66006.78	132013.56	264018.05
Grass Buffer, min 35’ wide	28512.82	56989.36	114060.37	228111.67
Livestock Exclusion Fencing	27279.05	54567.18	109125.28	218259.64
Use Exclusion	25918.28	51836.55	103673.10	207346.20
Streambank Protection w/o Fencing	25301.39	50602.78	101205.56	202420.19
Forest Buffer, min 35’ wide	23450.73	46910.54	93812.00	187633.07
Critical Area Planting	18479.36	36958.72	73926.51	147853.01
Winter Feeding Facility	17599.39	35198.78	70406.63	140813.26
Heavy Use Area Protection	14651.04	29302.08	58613.22	117226.45
Prescribed Grazing	14651.04	29302.08	58613.22	117226.45
Alternative Water Supply	8228.17	16456.34	32912.67	65825.34
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00

Table A II-51: Estimated load reductions of phosphorus for Wister Lake Dam (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	48.46	96.92	193.84	387.69
Grass Buffer, min 35' wide	47.51	95.03	190.06	380.12
30 m Buffer w/Optimal Grazing	31.24	62.48	124.95	249.91
Forest Buffer, min 35' wide	28.08	56.15	112.31	224.61
Winter Feeding Facility	25.85	51.69	103.38	206.77
Livestock Exclusion Fencing	24.94	49.89	99.78	199.55
Streambank Protection w/o Fencing	20.17	40.34	80.68	161.37
Critical Area Planting	16.62	33.23	66.46	132.91
Prescribed Grazing	16.45	32.89	65.78	131.56
Heavy Use Area Protection	14.82	29.64	59.28	118.56
Grazing Land Management	12.58	25.16	50.33	100.65
Use Exclusion	11.79	23.59	47.18	94.36
Alternative Water Supply	8.64	17.28	34.55	69.11
Pasture and Hayland Planting	7.18	14.35	28.70	57.41
Litter Storage and Management	6.70	13.39	26.79	53.58

Table A II-52: Estimated load reductions of sediment for Wister Lake Dam (Middle Poteau)

	Percent area BMP is Applied in Pasture Landuse			
	5	10	20	40
Practice	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Streambank Stabilization and Fencing	20429.81	40850.54	81701.08	163402.16
Grass Buffer, min 35’ wide	17644.75	35298.57	70588.06	141176.13
Livestock Exclusion Fencing	16882.71	33774.50	67539.92	135079.85
Use Exclusion	16039.03	32078.06	64165.20	128330.39
Streambank Protection w/o Fencing	15658.01	31316.03	62641.12	125273.18
Forest Buffer, min 35’ wide	14514.96	29029.92	58059.84	116128.75
Critical Area Planting	11439.60	22879.21	45749.34	91507.75
Winter Feeding Facility	10895.29	21790.58	43572.10	87144.19
Heavy Use Area Protection	9071.85	18134.63	36278.33	72547.58
Prescribed Grazing	9071.85	18134.63	36278.33	72547.58
Alternative Water Supply	5089.31	10187.69	20375.38	40741.68
30 m Buffer w/Optimal Grazing	0.00	0.00	0.00	0.00
Grazing Land Management	0.00	0.00	0.00	0.00
Litter Storage and Management	0.00	0.00	0.00	0.00
Pasture and Hayland Planting	0.00	0.00	0.00	0.00