

Little Beaver Creek WBP Accepted by EPA: May 28, 2019 Page 1 of 33

WATERSHED BASED PLAN

FOR

EPA Region 6 LITTLE BEAVER CREEK, OK



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BACKGROUND

The Nonpoint Source Program and Grants Guidelines for States and Territories for FY 2004 and beyond requires a Watershed Based Plan (WBP) to be completed prior to implementation using incremental funds. The guidance defines the 9 key components to be addressed in a watershed-based plan: 1) identification of causes and sources that will need to be controlled to achieve load reductions, 2) estimate of load reductions expected from the management measures described, 3) a description of the management measures that will need to be implemented to achieve load reductions, 4) an estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources or authorities who will bear responsibility, 5) an information/education component that will be used to enhance public understanding of the project and encourage early participation in the overall program, 6) a schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious, 7) a description of interim, measurable milestones for determining whether control actions are being implemented, 8) a set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made or whether the Watershed Plan or Total Maximum Daily Load (TMDL) needs to be revised, and 9) a monitoring component to evaluate the effectiveness of the implementation efforts over time.

INTRODUCTION

Little Beaver Creek is one of the major tributaries to Waurika Lake, the watershed with the highest priority rank in Oklahoma's updated Unified Watershed Assessment (UWA). The Little Beaver Creek WBP is a plan to restore water quality in the watershed so that all designated uses are attained. It has been developed as a dynamic document that will be revised to incorporate the latest information, address new strategies, and define new partnerships between watershed shareholders. In particular, this WBP will be a collaborative effort with the Stephens County Conservation District, Grady County Conservation District, the Waurika Lake Master Conservancy District, and the Natural Resources Conservation Service (NRCS) and will continue to evolve as the partnership develops. It is understood that the water quality goals set forth in this WBP, as well as the technical approach to address the goals, may not be comprehensive. Federal and state funding allocations for future water quality projects designed to protect the Little Beaver Creek watershed should not be based solely upon their inclusion in this WBP; rather, the WBP should be considered a focal point for initial planning and strategy development.

CAUSES AND SOURCES (element a)

Watershed Characterization

Little Beaver Creek (OK311210000050_00) originates in Grady County and extends 39 miles through the western part of Stephens County before emptying into Lake Waurika in Cotton County (Figure 1). The entire watershed comprises six USGS Hydrologic Unit Code (HUC) 12 digit watersheds (HUCs 111302080101 through 111302080106) covering approximately 157 square miles. Little Beaver Creek (hereafter "LBC") is one of two major



tributaries to Waurika Lake, which ranks as one of western Oklahoma's highest NPS management priorities (see http://bit.ly/npsplan14; p. 110). The formal National Water Quality Initiative (NWQI) Pilot area (hereafter, "Pilot") comprises the upper and lower most sub-watersheds (HUCs 111302080101, 111302080106) which added to the existing NWQI project, completes coverage of the entire Little Beaver Creek watershed. While the scope of the NWQI Pilot Project only necessitated address of the Pilot watersheds, partners have taken advantage of the effort to extend watershed based planning to the entire LBC watershed to expand efforts with the ongoing NWQI.

Little Beaver Creek is designated in Oklahoma's Water Quality Standards as a Public and Private Water Supply (PPWS) and is a Primary Body Contact Recreation (PBCR) waterbody. Additional beneficial uses include: Aesthetics, Agriculture, Fish and Wildlife Propagation (specifically warm water aquatic community [WWAC]), and Fish Consumption. The stream is also designated a Sensitive Water Supply (SWS), indicating that new or increased loads of any specified pollutant are prohibited without special approval from state authorities (OWRB 2016).



Figure 1. Little Beaver Creek Watershed (Note: included sub-watershed under existing NWQI project area).

Landscape Characteristics and Landuses:

The upper portion of the Little Beaver Creek watershed occurs in a finger of the Cross Timbers ecoregion and transitions to the Central Great Plains ecotype in the lower half (see <u>Ecoregions of Oklahoma</u>). Major landuses in the watershed are comprised of range (63%), crop cultivation (22%) and deciduous forest (10%). Oil and gas production is common here with over 1,400 oil and gas wells reported at the time of this report. The towns of Duncan and Marlow fringe the watershed on eastern side (USGS, 2011).

The lower half of the watershed is located in the Central Great Plains, Cross Timbers Transition level IV ecoregion, while the upper area is in the Cross Timbers level III ecoregion. According to Woods et al. (2005), the Cross Timbers ecoregion in this area is characterized by native tall grass prairies and blackjack oak-post oak savannah, with eastern red cedar common due to fire suppression. Cultivation and overgrazing has largely destroyed most of the native prairie. Most streams have fine sandy substrates and tend to be entrenched, wide, and shallow. The Cross Timbers Transition ecoregion "consists of rough plains that are covered by prairie grasses and eastern red cedar, scattered oaks, and elms" (OFS, 2010). The abundance of trees has been decreased from early settlement times, and riparian forests have been degraded or lost. Stream substrates may be rocky.

The Major Land Resource Area (MLRA) map classifies the majority of the land in the Central Rolling Red Prairies (CRRP) and a swath across the northern half and north eastern corner are in the North Cross Timbers (NCT) (Figure 2) (USDA, 2006). Soils in the CRRP are predominantly thermic, ustic Mollisols that are generally very deep within the Little Beaver watershed. Native tall and midgrass prairies are nearly absent in the watershed at this point. The majority of the land in the watershed is privately owned and is used for either farming or ranching. Most produce beef cattle, grass and grain crops. The primary resource concerns on cropland are water erosion, conservation of soil moisture and soil organic matter. According to the MLRA, plant health and vigor, invasive and noxious plants are primary concerns of the grasslands, although overgrazing and erosion are visible and predominant throughout the watershed. NCT have a slightly different soil make up although they are both ustic and thermic with a similar mineralogy, NCT include Alfisols, Entisols, and Inceptisols along with the Mollisols. They are also generally deep and well drained, however there are patches of clayey, poorly drained soils in part of the watershed. Native vegetation for the NCT are open stand oak forests with a mix of mid and tall grasses, forbs and low woody plants. Blackjack and post oak are the dominant tree species with eastern red cedar becoming more populous with lack of active management. The native vegetation for NCT is largely relegated to riparian areas or absent altogether. Resource concerns are the same as CRRP (USDA, 2006).



Figure 2. MLRA Ecoregions of Little Beaver HUC 10 watershed

Climate:

The Little Beaver Creek watershed's climate is in the transition zone between the humid subtropical in eastern Oklahoma to semi-arid in far western Oklahoma. Warm, moist air moving northward from the Gulf of Mexico often exerts much influence, particularly over the southern and eastern portions of the state, where humidity, cloudiness and precipitation are resultantly greater than in western and northern sections. Summers typically hot and long, while winters tend to be shorter with less severe cold and frozen precipitation than the more northern Plains. While this region can experience extreme cold, those systems are usually short and infrequent. Annual rainfall for the watershed is around 35 inches a year with two periods of increased rainfall coming in late spring early summer and again increasing in the late summer through the fall. Although the watershed does not cover much area, there is slightly less precipitation as you travel from east to west. Winters are mid summers are relatively dryer (USDA, 2006).

Topography:

Little Beaver Creek is the main stream channel of the overall HUC 10 running from the northeast to the southwest. The northeast corner of the watershed (Figure 3) is the highest elevation (around 1450 ft.) with a general trend down where Little Beaver Creek enters Waurika Lake (around 940 ft.). The watershed is marked by steep slopes coming off the uplands down to the floodplain around Little Beaver Creek. Flatter areas tend to be either on the upland or in the floodplain adjacent to the channel. Throughout the watershed, the channel is severely incised and eroded and woody riparian vegetation is reduced or



nonexistent. The steep slopes coming off upland areas result from and contribute to the sediment loading resulting from poor management practices (USDA, 2006).



Figure 3. Digital elevation model of Little Beaver Creek watershed.

Geology, Geomorphology, Soils:

Geologic formations of the Little Beaver Creek watershed are primarily a mix of sandstone and shale with sandy alluvium within the creek channel boundary and some Pleistocene sand deposits in the eastern upland areas (Figure 4). Weathering of the bedrock left deep loamy sediments from paleoterrace deposits. Soils are mostly silty and sandy, with a few heavy clay deposits in spots (STATSGO soil map, Figure 5). Depth to groundwater is high in the watershed and soils are mostly from the hydraulic group B. There is very little hydric soil in the watershed. More than half of the area of HUCs 101 and 106 are moderately to highly erodible. This contributes to high levels of sediment in runoff in addition to propensity for formation of rills, gullies and incised channels throughout the entire watershed.



Figure 3. Geology of Little Beaver Creek watershed (map reflects composite incongruence in data).



Figure 4. STATSGO soil map of Little Beaver Creek watershed.



Socioeconomic Conditions:

The watershed is mostly rural with Duncan Oklahoma being the largest city in or near the project area. Comanche County has the largest population of the four counties overlapping the Little Beaver Creek watershed (Table 1); however the majority of the watershed is within Grady and Stephens counties, with a small slice of Comanche and Cotton County overlapping the lower Little Beaver Creek (Figure 1, above). Approximately 25 percent of the population lives in rental housing within Grady and Stephens County (Table 2) and the population is predominantly white (Table 3) (US Census, 2010).

Table 1.	Population by	/ county, 2010 US	Census (https://www	.census.gov/2010cens	us/popmap/)
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County	Stephens	Grady	Comanche	Cotton
Total Population	45,048	52,431	124,098	6,193

Table 2. Housing Statistics, 2010 US Census

County	Stephens	Grady	Comanche	Cotton	
Total Housing	20,658	22,219	50,739	3,016	
Occupied Housing	18,127	19,892	44,982	2,483	
Owner-Occupied	13,128	15,133	25,400	1,880	
- Population	32,445	39,692	65,150	4,647	
Renter-Occupied	4,999	4,759	19,582	603	
- Population	12,063	11,657	48,605	1,498	
Housing with	5 725	7 031	16 / 36	821	
Minors	5,725	7,001	10,400	021	
Vacant Housing	2,531	2,327	5,757	533	
- For Rent	550	604	2,127	67	
- For Sale	296	289	639	36	
Occasional Use	241	118	362	47	
Housing					

Table 3. Population by ethnicity, 2010 US Census

County	Stephens	Grady	Comanche	Cotton
White	38,328	44,994	79,996	5,035
African American	870	1,268	21,669	128
Asian	221	196	2,777	13
AIAN	2,286	2,841	7,266	551
NHPI	14	36	686	13
Some Other Race	1,169	792	3,671	115
Two or more Races	2,160	2,304	8,033	338

Current Efforts and Conditions

Resources compiled by others:

Water quality monitoring in the Little Beaver Creek watershed is largely conducted between two state agencies, the Oklahoma Conservation Commission (wadeable streams data) and the Oklahoma Water Resource Board (Waurika Lake). The Oklahoma Department of Environmental Quality (ODEQ) compiles the State's biennial report (ODEQ 2016) and conducted a TMDL study for turbidity and bacteria that includes the project watershed (ODEQ 2012c).

The Oklahoma Conservation Commission (OCC) historically has monitored at multiple locations within the LBC watershed. The foundational site (0050D) was established as part

of the OCC's Rotating Basin Monitoring Program, which completes monitoring activities at designated sites on a five year cycle. This particular site has been monitored for the last three cycles from June 2004 to May 2006, from June 2009 to May 2011 and from June 2014 to May 2016. Sampling activities occur at five week intervals for a two year period and include: grab samples analyzed for total phosphorus, ortho-phosphorus, ammonia, nitrate, nitrite, chloride, sulfate, total suspended solids, and total dissolved solids; *in-situ* measurements of dissolved oxygen, pH, conductivity, flow, and water temperature, along with field tests for alkalinity, hardness, and turbidity; grab samples for analysis of *E. coli* and *Enterococcus* bacteria during the recreational season (May 1 through September 30); annual winter and summer index macroinvertebrate collections; one summer fish collection and instream habitat assessment each cycle.

NRCS Partner Sampling:

OCC (NRCS Partner) conducted and continues to conduct surface water monitoring as described in previous section throughout NWQI Pilot project period. The USGS has a gaging station (07313000) on Little Beaver Creek near Duncan (Latitude 34°29'35", Longitude 98°06'50") in Stephens County, Oklahoma. Drainage area is 157 square miles.

Surface and GW WQ monitoring sites:

OCC has three monitoring sites within the Little Beaver Creek watershed and there are no active groundwater monitoring sites.

Biological Monitoring:

Tables 4, 5, & 6 below give summary data (averages) from the first two cycles of the OCC Rotating Basin sampling at Little Beaver Creek. Additional details on this data can be obtained in the Rotating Basin Group 4 final reports, on file with EPA Region 6 and <u>located online</u>.

Table 4. Fish IBI metrics

Monitoring Date	Total Spp.	# Sensitive Benthic Spp.	# Sunfish Spp.	# Intolerant Spp.	Proportion Tolerant Individuals	Proportion Insect. Cyprinid Individuals	Proportion Lithophilic Spawner Individuals	IBI Total Score (OCC)	Percent of Reference	Score Interpretation
8/26/2004	13	1	4	1	0.95	0.05	0.00	21	0.95	excellent
8/11/2009	16	1	5	1	0.97	0.03	0.00	21	0.95	excellent
7/16/2014	16	0	6	0	1.00	0.00	0.00	14	0.64	fair

Table 5. Instream habitat metrics

Monitoring Date	Instream Cover	Pool Bottom Substrate	Pool Variability	Canopy Cover Shading	Presence of Rocky Runs or Riffles	Flow	Channel Alteration	Channel Sinuosity	Bank Stability	Bank Vegetation Stability	Streamside Cover	Total Points
8/26/2004	2.2	3.4	11.8	5.5	0	0.4	2.3	1.9	5.9	7	4.4	44.8
8/11/2009	3.3	2.7	15.4	1.4	2.2	9.3	1.4	2.0	3.1	5.3	9.3	55.4
7/16/2014	1.6	1.4	20.1	0.5	0.0	0.0	9.9	1.4	5.6	5.7	5.0	51.2

Table 6. Macroinvertebrate	metrics values determined	l for each monitoring site,	averaged per season and
habitat. NI = non-impaired,	SI = slightly impaired, MI =	moderately impaired.	

Monitoring Period	Sample Type	Winter or Summer	Total Species	ЕРТ Таха	Percent EPT	HBI	Percent dominant 2 taxa	Shannon Diversity	Total Points	% of Reference	Condition
	Riffle	S	16	7	0.45	1.98	4.37	0.64	30	1.07	NI
	Riffle	W	17	6	0.29	2.06	5.90	0.54	30	1.25	NI
June 2004 – May 2006	Vegetation	W	9	4	0.12	1.25	6.03	0.75	20	0.91	NI
	Woody debris	S	17	7	0.64	2.00	4.76	0.59	32	1.14	NI
	Woody debris	W	12.5	6	0.16	1.58	5.86	0.67	26	1.18	NI
	Riffle	S	15	6	0.47	5.40	0.48	2.08	27	1.04	NI
	Riffle	W	13	3	0.05	6.37	0.62	1.72	20	1.00	NI
June 2009 – May 2011	Vegetation	S	14	5	0.20	6.52	0.60	1.96	24	1.00	NI
	Woody debris	S	15	8	0.55	5.55	0.59	1.89	24	0.92	NI
	Woody debris	W	11	1	0.07	5.93	0.79	1.19	12	0.60	SI
	Riffle	S	9	3	0.20	4.52	0.76	1.23	12	0.46	MI
June 2014 – May 2016	Riffle	W	5	0	0.00	7.02	0.93	0.86	4	0.20	MI
	Woody debris	S	13	7	0.12	6.12	0.61	1.73	22	0.86	MI

Runoff, Streamflow Hydrology and Irrigation:

The LBC drains an approximate area of a 194.74 mi² (<u>USGS StreamStats</u>). The average gradient is 6.39 ft./mi which would should indicate a slow moving meandering stream network. Significant historic sedimentation has contributed to significantly incised channels that do not meander, which alters flow patterns and exacerbates erosion and sediment transport. Rainfall and thus flow peak in the late spring/early summer and then again in the late summer/early fall. Flow is otherwise significantly reduced. Although soils generally exhibit high infiltration, significant storm events can overwhelm capacity and result in high overland flow and erosion. Irrigation is present but not common throughout the watershed.





Figure 5. Hydrograph for Little Beaver Creek showing peak flow at the mouth of Waurika Lake. Data from Stream Stats.

Water Quality Conditions in the Watershed:

Stream data collected for Little Beaver Creek as part of the OCC's Rotating Basin Monitoring Program as described in the above section is reported in Figures 7 through 12 below.



Figure 6. Total suspended solids and turbidity values for three sampling periods for the OCC Rotating Basin Monitoring Program.





Figure 7. E. coli values for three sampling periods for the OCC Rotating Basin Monitoring Program.



Figure 8. Dissolved oxygen and water temperature for three sampling periods for the OCC Rotating Basin Monitoring Program.



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Figure 9. Ammonia, total Keldahl nitrogen, nitrate, nitrite and total nitrogen values for three sampling periods for the OCC Rotating Basin Monitoring Program.



Figure 10. Orthophosphate and total phosphorus for three sampling periods for the OCC Rotating Basin Monitoring Program.





Figure 11. Instantaneous discharge for three sampling periods for the OCC Rotating Basin Monitoring Program.

<u>Causes</u>

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

The PBCR beneficial use for Little Beaver Creek is listed as impaired on Oklahoma's 2012, 2014 and 2016 Integrated Reports for high levels of *Enterococcus* and *Escherichia coli* (*E. coli*) fecal indicator bacteria (Table 7). The geometric mean of samples taken during the recreation season (May 1 – Sept. 30) of *Enterococcus* and *E. coli* must not exceed the criterion listed (126 colonies/100 mL for *E. coli*, 33 colonies/100 mL for *Enterococcus*) in order to attain the PBCR beneficial use.

criterion ioi	sinenon for 2012, 2014, & 2010 Water Quanty in Oklanonia integrated Reports.									
Integrated	E. coli	E. coli	Enterococcus	Enterococcus	Attainment of PBCR					
Report	(colonies/100 mL)	(colonies/100 mL)	(colonies/100 mL)	(colonies/100 mL)	beneficial use					
Year	Samples	Criterion	Samples	Criterion						
2012	231	<126	278	<33	Not attaining					
2014	136	<126	298	<33	Not attaining					
2016	298	<126	*	<33	Not attaining					

 Table 7. Geometric means of Escherichia (E. coli) and Enterococcus bacteria compared to PBCR attainment criterion for 2012, 2014, & 2016 Water Quality in Oklahoma Integrated Reports.

*samples not taken during this sampling period

In addition, Lake Waurika, which Little Beaver flows into, has two impaired uses: the Public and Private Water Supply use is impaired by chlorophyll-*a*, and the FWP-WWAC use is impaired by turbidity. Between 2002 and 2008, chlorophyll-*a* samples in the lake averaged 13.4 μ g/L (TSI=56), higher than the numeric criterion of 10 μ g/L. From 1998 to 2011, total

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nitrogen averaged 0.81 mg/L and total phosphorus averaged 0.09 mg/L (ODEQ 2013). In 2013, a survey by the OWRB indicated that the water supply from the lake was jeopardized by a high amount of silt that had built up near the pump intake pipe; the result of erosion in the watershed. This was followed by an environmental assessment by the US Army Corps of Engineers (USACE) in preparation to dredge parts of the lake (USACE 2015).

Analysis Tools:

The Pilot watersheds (HUC 111302080101 and 111302080106, hereafter referred to as 101 and 106 respectively) were analyzed and assessed using the Soil and Water Assessment Tool (SWAT) (Arnold et al., 1998) and a qualitative riparian assessment. SWAT was used to analyze potential erosion and sediment delivered generally to Little Beaver Creek from surface erosion and runoff. The riparian assessment was designed to qualitatively assess stream corridor stability (vegetative cover) and impacts (active erosion, gullying) as an index of overall riparian health. The results from the assessment of these two HUCs can be used to estimate these factors in the entire Little Beaver Creek watershed.

Riparian Assessment:

National Hydrography Dataset (NHD) Hi-res (<u>USGS</u>) flowline data was overlaid on to high resolution ortho-imagery (ESRI website live link) at a 1:3000 scale. A 15 meter (approx. 50 ft.) buffer was created on either side of the NHD flowline. Vegetative cover and general stability were estimated within the buffer for all stream reaches within 101 and 106. Vegetative cover assessment comprised level of apparent perennial woody vegetation. Stability was judged by the presence or absence of active erosion, gullying, and/or trailing (example, Figure 13 below).



Figure 12. Number (1) Road though creek, (2) Cattle tracks, (3) Gullies, (4) Lack of Riparian Vegetation; Image B is a zoomed in image of A.

All NHS hi-res stream segments were assigned an initial numeric value based on the vegetation present in the buffer as follows:

- 1 None apparent
- 2 Some apparent
- 3 Mostly fills buffer
- 4 Exceeds buffer

Stream reaches were then assigned a secondary integer of "1" in instances of apparent active erosion in the form of trails, crossings, gullies (e.g., 11, 21, and 31). Overall riparian



condition data were rendered into maps for Pilot project watersheds 101 and 106, respectively. Both watersheds exhibit significant lengths of stream with little to no riparian vegetation and active erosion (Figures 14 and 15) comprising a significant potential source of sediment and potentially pathogens to Little Beaver Creek and Lake Waurika.



Figure 13. Riparian assessment of 101; from no apparent riparian cover (1) to full riparian cover in 15 meter buffer, double digits indicate active erosion, gullies and/or trailing.



Figure 14. Riparian assessment of 106; from no apparent riparian cover (1) to full riparian cover in 15 meter buffer, double digits indicate active erosion, gullies and/or trailing.

Soil and Watershed Assessment Tool (SWAT):

SWAT was run for a 30-year simulation (five-year warmup) using temperature and precipitation from weather station data in or near the watersheds. The years from 1980 through 2010 were used to better coincide with the selected landuse data. The National Land Cover Dataset (USGS, 2011) was used for the landuse layer. The landuses were generalized to remove minor contributors and all row crops were assigned the default SWAT landuse class 'general agriculture'. This was done for three reasons: crops grown can change from year to year, it is not possible to obtain accurate crop data in these watersheds and SWAT uses a static landuse input for the entire model run. A five-meter DEM was used for watershed delineation and hydrologic routing and slope classes using SWAT's Watershed Delineation tool. Slopes were classified into four categories, 0-2, 2-4, 4-6 and > 6. Finally, SSURGO data was used for the soil input layer. Input tolerances were set to 10% for all inputs (LU, Soils and slope); this minimizes the effects of minor inputs and simplify the computations.

Outputs were analyzed for sediment output by HRU and Subbasins. Subbasin is the term SWAT uses for subwatershed within the area processed by the model. It is used in reference to SWAT outputs and not the larger watersheds with NHD designations (i.e. HUC 10's and HUC 12's). Subbasins were ranked by total annual predicted sediment output (tons) and assigned a classification from most to least critical (Figures 16 and 17). SWAT has a number of outputs that can be useful in determining the factor or factors that are most likely contributing to high runoff and sediment loading into the streams.



Figure 15. Subwatershed 101 with subbasins classified by SWAT predicted total sediment output from most critical (1) to least critical (5).



Figure 16. Subwatershed 106 with subbasins classified by SWAT predicted total sediment output from most critical (1) to least critical (4).

Combining Tools for Prioritizing Conservation Efforts:

Length of critical riparian areas were determined by adding the length of reaches with ratings 1, 2, 11, 21, and 31 for each subbasin. The percent of total critical riparian length was used to rank each subbasin from most critical to least critical. The same process was repeated based on predicted total sediment output by subbasin. These were added and then the subbasins were re-ranked according to the combined percent of critical land. The new combined rankings were assigned classifications from one (most critical) to four (least critical) based on natural breaks in the data (Figures 18 and 19).



Figure 17. Subwatershed 101 with subbasins classified from most critical (1) to least critical (4) based on combined SWAT and Riparian assessment.



Figure 18. Subwatershed 106 with subbasins classified from most critical (1) to least critical (4) based on combined SWAT and Riparian assessment.

<u>Analysis:</u>

SWAT outputs were analyzed to determine the most likely factors contributing to sediment loading. There were many similarities between both subwatersheds. Soil series was not a significant factor in sediment delivery. This is likely due to the relative homogeneity of the soils throughout the watershed. While there are 50 - 60 separate soil complexes mapped, the texture and physical properties of the soils are similar. Generally, cropland produced



higher sediment loads per acre, with higher slope classes increasing the predicted load even more in HUC 101 (example Figures 20 and 21). In HUC 106, crops were the biggest contributor and slopes were less significant (Figure 22). The two highest subbasins based on predicted sediment, also have high USLE LS values.



Figure 19. HUC 101, subbasin 13, both crop and rangeland contribute to the critical acres, with higher slope classes increasing potential sediment delivery.



Figure 20. 101, subbasin 31, as with subbasin 13, both crops and range land contribute to the critical acres, with higher slope classes increasing potential sediment delivery.





Figure 21. HUC 106, subbasin 9, crop was highest potential for sediment delivery with slopes not significant. Rangeland was secondary in sediment delivered per acre; however, it is major contributor of total potential sediment delivered. Higher slope classes were a significant factor for increasing rangeland potential sediment yields.

In HUC 101, 17 percent of riparian areas have evidence of livestock; 10 percent exhibit severe erosion with cattle present and have little to no riparian vegetation. Another 28 percent have no riparian cover without cattle while only 13 percent of the riparian areas have vegetation cover and are livestock free (Figure 23).



Figure 22. Subwatershed 101; riparian conditions by percent of total length. Conditions 1, 2, 11, 21, and 31 are considered critical riparian areas.

In HUC 106, approximately 30 percent of riparian areas have evidence of livestock with 20 percent exhibiting severe erosion with cattle and little to no riparian vegetation. Seventeen percent of the area is severely eroded without cattle indicated with only 26 percent having apparent vegetative cover that is livestock free (Figure 24).



Figure 23. Subwatershed 106; riparian conditions by percent of total length. Conditions 1, 2, 11, 21, and 31 are considered critical riparian areas.

Sources

The Little Beaver Creek watershed and Lake Waurika have been included in Total Maximum Daily Load (TMDL) studies for *E. coli, Enterococcus*, and chlorophyll-*a* (ODEQ 2012c, ODEQ 2013). According to the 2012 study, the most likely sources contributing to the water quality impairments in Little Beaver Creek are nonpoint. Nonpoint sources are those which deliver pollutants to surface waters diffusely, rather than as a definite, measurable quantity from a single location. These sources typically result from land activities that contribute pollutants such as sediment, nutrients, and/or bacteria to surface waters are a result of runoff during and following rainfall. Potential sources of concern in this watershed include grazing and related livestock activities in riparian or shoreline zones, on-site treatment systems (septic systems and similar decentralized systems), and rangeland grazing.

Three no-discharge NPDES facilities are located in the Little Beaver Creek watershed. Although this type of facility normally should not be contributing to the bacteria load in the stream, discharges may occur during large rainfall events if the system's storage capacity is exceeded. In addition, sanitary sewer overflow (SSO) from wastewater collection systems can be a major source of bacteria in streams. From 1991 to 2003, thirteen occurrences of SSOs were recorded at the Marlow-West Wastewater Treatment Plant, which is located in the headwater region of the watershed. Additionally, Little Beaver Creek may be somewhat affected by bacteria loading associated with urban point source runoff from a Comanche County Phase II MS4. Failing or faulty septic systems in this rural watershed are additional potential sources of bacteria in waterbodies. The TMDL estimates that 1,687 households (about 45%) in the Little Beaver Creek watershed have septic tanks, of which approximately 8% are likely to be failing (ODEQ, 2012c).

Pasture and rangeland comprise approximately 63% of the landuse in the watershed. Table 8 below indicates that cattle are the most abundant species of commercially raised farm animals in the watershed. Livestock grazing in pastures deposit manure containing fecal bacteria onto land surfaces, making it possible for both bacteria and nutrients to enter surface water with runoff. In addition, livestock often have direct access to waterbodies, providing a concentrated source of fecal loading directly into streams. Direct access by livestock also promotes bank trampling/destabilization and trail formation, which serve as direct conduits of pollutants through the sparse riparian area that might be present. In areas of depauperate riparian area, streambank erosion is a likely contributor of sediment and associated nutrient loads. Commercially raised farm animal manure, from any type of animal, is often applied to fields as fertilizer and can contribute to bacteria loading to the stream if washed into the water by runoff.

Pets and wildlife, such as deer, feral hogs, raccoons, turkeys, and geese and other avian species, are also potential contributors to fecal bacteria in the stream, either via direct defecation into the water or by feces washing into the stream during rain events. The TMDL for Little Beaver Creek estimates that nearly 1,000 deer are likely in the watershed, along with 1,666 dogs and 1,880 cats (ODEQ, 2012c).

 Table 8. Estimates of commercially raised farm animals and manure application in the Little Beaver Creek watershed (ODEQ, 2012c).

Cattle & Calves	Dairy Cows	Hogs & Pigs	Chickens	Sheep & Lambs	Horses & Ponies	Turkeys	Ducks	Geese	Acres of Manure Application
16,741	653	1,502	388	173	440	6	36	19	573

LOAD REDUCTION EVALUATION CRITERIA (element h)

Designated uses for Little Beaver Creek include public and private water supply (PPWS), Primary Body Contact Recreation (PBCR), Aesthetics, Agriculture, Fish and Wildlife Propagation--Warm Water Aquatic Community (FWP-WWAC), and Fish Consumption. The watershed is also designated "Sensitive Water Supply" (SWS). According to the State's 2012, 2014 & 2016 Integrated Reports, Little Beaver Creek does not attain its PBCR designated use. The criteria and procedures used to assess the assigned uses are located in *Oklahoma's Water Quality Standards* (OWRB 2013a), *Implementation of Oklahoma's Water Quality Standards* (OWRB 2013b), and the *Oklahoma Continuing Planning Process* (ODEQ 2012a). The ultimate goal of implementation of any project in this watershed is to restore all designated uses, so these criteria are the target values to achieve.

To attain the **PBCR use** for streams, samples must be collected during the recreation season, from May 1 through September 30, and at least 10 samples are required to make an attainment assessment. Only one type of bacteria must be assessed, but all data must be used if more than one bacteria type is analyzed. Streams are considered to be attaining the PBCR use if:

- Enterococcus bacteria
 - o Geometric mean of less than 33 colonies/100 mL
- Escherichia coli (E. coli)
 - o Geometric mean of less than 126 colonies/100 mL

LOAD REDUCTIONS (element b)

The ODEQ is the state agency responsible for producing Total Maximum Daily Load (TMDL) goals for impaired waterbodies. A TMDL determines the pollutant loading a waterbody can assimilate without exceeding the water quality standard for that pollutant, as well as establishing the pollutant load allocation needed to meet the standard. Goals for improving the water quality in Little Beaver Creek were published as part of the "2012 Red River Bacteria and Turbidity TMDLs" document (ODEQ, 2012c). The 2012 TMDL effort details process and associated load reduction goals rendered for total suspended solids (proxy for turbidity, and for this assessment, sediment), *E. coli*, and *Enterococcus* necessary for non-impairment in Little Beaver Creek. A load duration curve method was employed by pairing the geometric mean of all bacteria observations from 2002 through 2009 with flows measured or estimated in Little Beaver Creek. Based on the calculations described in that document, the **load reduction goal for TSS is 75 percent**, *E. coli* is **31 percent and for** *Enterococcus* **is 86 percent**.

The estimated relative fecal bacteria loads for the four major nonpoint source categories that contribute to elevated bacteria concentrations in the Little Beaver Creek watershed are given in Table 9, below, in colony forming units per day (cfu/day).

 Table 9. Estimated percentage of total fecal bacteria loads for the major nonpoint source categories in the

 Little Beaver Creek watershed (ODEQ, 2012c)

Commercially Raised Farm Animals	Pets	Deer	Estimated Loads from Septic Tanks
99.58	0.36	0.03	0.04

Because of their numbers and animal unit production of bacteria, livestock are estimated to be the largest contributors of bacteria loading to land surfaces. The OCC expects that at least a 10% reduction in bacteria loading will be observed within three years, and it is reasonable that a 30% load reduction will be accomplished within the five year project period, based on the results of similar projects in the state.

STEPL model was used to quantify and estimate potential reductions in nitrogen, total phosphorus, and sediment loads. To simplify the analytical process and presentation, the conservation practices (CP's) were modeled for individual impact on nitrogen, total phosphorus, and sediment loads. Area and CPs were chosen based on analysis of the SWAT outputs and Riparian assessment but CPs can be applied to the entire Little Beaver Creek watershed. The results are presented in Table 10 below.



 Table 10. Predicted load reductions per STEPL for priority NPS pollutants using suggested conservation practices (CP's).

		Total Predicted Reduction			
Conservation Practice	Watershed	N Reduction	P Reduction	Sediment Reduction	
Range (landuse)	% total	lb/year	lb/year	t/year	
Prescribed Grazing	31.47	17466.0	1273.8	496.1	
Livestock Exclusion Fencing	1.78	1054.9	69.6	51.0	
Alternative Water Supply	8.12	1725.0	191.0	77.2	
Nutrient Management 1 (Determined Rate)	12.08	2287.2	310.2	0.0	
Grade Stabilization Structures	2.13	2448.0	264.2	81.2	
Diversion Terrace	12.08	2068.6	565.5	195.5	
Critical Area Planting	0.06	15.0	2.3	1.1	
Crop (landuse)					
Residue Management	8.50	4034.7	1064.3	622.2	
Convert Crops to Grass	5.58	3276.2	859.4	287.4	
Nutrient Management	8.50	572.3	297.8	0.0	
Cover Crops	8.50	1289.0	303.7	165.9	
Critical Area Planting	0.02	3.3	1.2	0.6	
Buffer Practices	0.69	227.3	71.8	34.4	
Summed Predicted Reductions		45,643	7,801	3,089	

NPS MANAGEMENT MEASURES (element c)

Specific CPs are listed in Table 10 and will follow guidelines specified in the NRCS conservation practice standards. Specific locations will be based on critical areas defined in Element a, and the desire of the land owner/producer to participate.

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

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

Some CPs have been installed through Oklahoma's locally-led cost-share program and through the local NRCS Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), and general technical assistance program. In 2011, the NRCS established a "Little Water" local emphasis area (LEA) in eastern Cotton and western Stephens and Jefferson counties, including the lower half of the Little Beaver Creek watershed. This program provided extra funding to install practices which specifically protect water quality and quantity. Emphasis is given to adoption of renewable energy resources and exclusion of livestock from streams, as well as cedar removal. Eligible practices for cost-share include installation of ponds, watering facilities, wells, pipeline, fencing for pond and stream exclusion, critical area planting, and animal trails/walkways. The OCC will continue to promote CP implementation in this watershed through the local conservation district, and the NRCS will also continue to offer financial and technical assistance through its various programs.

PUBLIC OUTREACH (element e)

The Oklahoma Conservation Commission's education program, Blue Thumb, has promoted NPS pollution education in part of Little Beaver Creek watershed and will continue to do so. Outreach efforts include newsletters, exhibits at festivals and schools, newspaper articles, and contests. These activities provide vital education of the residents of the watershed and help facilitate changes in behavior. Active volunteer monitoring and education is continuing in the area.

Soil health workshops will be utilized in addition to the Blue Thumb program to include populations that may not be interested in aquatic ecology or water quality. Soil health is another way to address the continuing need to maintain CP's after the projects are complete.

The local conservation districts will organize a Watershed Advisory Group (WAG) which will provide input on conservation practice prioritization and assist with engaging landowners in



the watershed. Fact sheets will be produced and distributed to explain the water quality and production benefits of planned conservation practices. Articles in newspapers and newsletters may be used to educate residents about the issues in the watershed and the ongoing project. Landowner education and support will be essential to successful implementation of CPs in the watershed.

TECHNICAL and FINANCIAL ASSISTANCE NEEDED (element d)

The two Pilot HUC 12's (111302080101, 111302080106) will complete an existing NWQI project area by bringing in the most upper and lower HUCs of the area. The current project is currently in its third year and only covers the middle four HUC's, however the original plans between OCC and its partners included expanding the effort to the entire Little Beaver Creek watershed (six total HUC 12's). This would allow OCC and partners efforts to expand, resulting in more success for the entire HUC 10 watershed, all contributing to Lake Waurika, which serves as water supply for seven communities. Efforts within the lake and contributing watersheds are needed. OCC partners, are working together to address the concerns identified, including the Army Corps of Engineers (COE), which dredged the lake to extend life of water supply. This watershed and Lake Waurika are also a Top 10 category 1 NPS management ranking. Inclusion of the two HUCS into the NWQI program ensures the majority of sediment loading (and therefore likely high bacteria loading) areas in the Waurika Lake Watershed were enrolled in the NWQI program. As a result, sediment, bacteria, and nutrient loading to Waurika Lake will be significantly reduced. The U.S. Army Corps of Engineers and U.S. Bureau of Reclamation have recently completed a dredging project on Waurika Lake to remove accumulated sediment and nutrients. This project could significantly improve the success and effective lifetime of those downstream efforts to maintain Waurika Lake as a drinking water supply in SW OK.

NRCS partnered with the Oklahoma Conservation Commission (OCC) in 2017 to support a shared position to assist with assessment, plan development, outreach and implementation. NRCS and partners (OCC and Local Conservation District) will identify producers in project area and work together on outreach activities within smaller communities. The OCC has two in-stream monitoring points already established within the watershed as part of state ambient monitoring and original NWQI project efforts and plans are to continue monitoring through and beyond this project timeframe.

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

Costs of CPs are listed in Table 11 below. Practice codes and the price of the CPs are from NRCS conservation practice standards. Total costs will paid through NRCS funds, CWA Section 319 funds and other assistance obtained for CP implementation.

OKLAHOMA CONSERVATION

I a D C I I L C C C C C C C C C C C C C C C C

Conservation Practice & Efficiency	Practice Code	Assumed Participation Rate	Total Units	Unit	\$/Unit	Total Cost
Range and Pasture						
Prescribed Grazing	528	50%	14779	acres	\$11	\$162,569
Watering Systems for Livestock	614, 561, 642, 516	50%	141	each	\$5,000	\$705,000
Nutrient Management (pasture)	590	40%	7340	acres	\$17	\$124,780
Grade Stabilization Structures	410	40%	8	each	\$12,000	\$96,000
Diversion Terrace	362	40%	17366	cyds	\$2	\$34,732
Critical Area Planting	342	40%	26	acres	\$275	\$7,150
Access Control	472	50%	305	acres	\$24	\$7,320
Fencing	382	50%	744726	feet	\$2	\$1,489,452
Range & Pasture Total						\$2,627,003
Cropland						
Crop Rotation	328	50%	4129	acres	\$13	\$53,677
Residue Management	345, 329	50%	4129	acres	\$17	\$70,193
Conversion to Grass	512, 550	50%	2484	acres	\$350	\$869,400
Nutrient Management	590	40%	6317	acres	\$49	\$309,533
Cover Crops	340	50%	6317	acres	\$80	\$505,360
Critical Area Planting	342	40%	8	acres	\$275	\$2,200
Buffer Practices	391, 393, 390	40%	322	acres	\$325	\$104,650
Cropland Total					\$1,915,013	
Project Total					\$4,542,016	

IMPLEMENTATION SCHEDULE and INTERIM MILESTONES (elements f and g)

Conservation Practice implementation on a cost-share basis has been ongoing on a limited scale through NRCS programs and the local conservation district/OCC. More intensive implementation through the NWQI will continue to Little Beaver Creek watershed in the summer of 2019 and continue for five years based on available funds to be applied for as a result of NWQI Pilot readiness phase effort. The focus of activities in the watershed will be riparian management and reduced tillage crops. Education will be vital to changes in producer practices, so the NRCS will host multiple field days and trainings on the CPs that will be promoted in this project.

Timeframe	Project Actions	Agency Responsible	Status	Outcome
June 2004 – May 2006	1 st Cycle of Rotating Basin Monitoring, every 5 weeks			RB 4.1 Report
June 2009 – May 2011	2 nd Cycle of Rotating Basin Monitoring, every 5 weeks		Complete	RB 4.2 Report
2006; 2019	Blue Thumb training and education in community		Complete; Planned	Increased understanding of NPS pollution prevention
2006 – present	Volunteer stream monitoring	OCC	Ongoing; may be expanded	Additional data to document changes in water quality
2015	Develop WBP		Draft	Approved WBP to enhance OCC/NRCS partnership
June 2014 – May 2016	3 rd Cycle of Rotating Basin Monitoring, every 5 weeks		Complete	RB 4.3 Report
June 2016 – Sept 2020	Monitor 2 sites in watershed approx. once a month		Ongoing	Data to assess effects of CP implementation
2015 – 2022	Implement CPs in watershed (NWQI and NWQI-Pilot); Provide field days/trainings	NRCS	Ongoing	Reduced pollutant loading by 2024
June 2019 – May 2021	4 th Cycle of Rotating Basin Monitoring, every 5 weeks	OCC	Planned	RB 4.4 Report, due Dec. 2021; documented bacteria delisting/full attainment of uses

 Table 12. Schedule for completed, current and future activities in Little Beaver Creek watershed.

Estimated dates of milestones are reported in Table 12. WAG meetings will be held at least twice a year. Assessment of the water quality monitoring data will be assessed annually. If a decline in water quality is observed at any point, NRCS, OCC, and district staff will meet to investigate possible causes and determine further steps to improve project participation if necessary.

MONITORING PLAN (element i)

Baseline Data:

Data was collected at a site on Little Beaver Creek as part of the OCC's Rotating Basin Monitoring Program every five weeks from June 2004 to May 2006, from June 2009 to May 2011 and from June 2014 to May 2016. Surface water quality samples were collected by grab sampling. Each water sample was analyzed for total phosphorus, ortho-phosphorus, ammonia, nitrate, nitrite, chloride, sulfate, total suspended solids, and total dissolved solids. *In-situ* measurements of dissolved oxygen, pH, conductivity, flow, and water temperature were taken, and field tests for alkalinity, hardness, and turbidity were performed. During the summer recreation months (May 1 through September 30), grab samples were assessed for *E. coli* and *Enterococcus* bacteria. Two winter and two summer macroinvertebrate collections were attempted each cycle, as well as a single summer fish collection and extensive habitat assessment each cycle. Additional details on this data can be obtained in the Rotating Basin Group 4 final reports, on file with EPA Region 6 and located <u>online</u>.

E. coli and *Enterococcus* species are bacteria common in animal waste and can cause human illness. These bacteria are used as an indicator of the possible presence of other harmful pathogens. Waterbodies with a geometric mean above 126 colonies/100 mL for *E. coli* and above 33 colonies/100 mL water for *Enterococcus* during the recreation season (May 1 – Sept. 30) are considered impaired for Primary Body Contact Recreation due to an unacceptably high health risk from waterborne diseases. Water quality assessment of Little Beaver Creek in 2012 showed a geometric mean of 231 colonies/100 mL for *E. coli* and 278 colonies/100 mL for *Enterococcus*, indicating nonattainment of the Primary Body Contact Recreation designated use. In 2014, the geometric means remained above criteria, at 136 colonies/100 mL for *E. coli* and 298 colonies/100 mL for *Enterococcus*. In 2016, samples were only taken for *E. coli* and the geometric means continued to remain above criteria, at 298 colonies/100 mL (Table 7).

Current and Future Monitoring:

The third cycle of monitoring in the Rotating Basin Program commenced in June 2014 and continued through May 2016. Additionally, the OCC added a monitoring site higher in the watershed in January 2015, and monitoring of both of these sites will continue monthly from June 2016 through September 2020 in order to more fully document changes in water quality due to CP implementation. Parameters will be collected as in the previous two cycles with two changes: 1) only *E. coli* bacteria will be assessed, and 2) ammonia will only be collected three times a year, during the summer season. Blue Thumb volunteers may also monitor some tributaries within the watershed. The fourth cycle in the Rotating Basin Monitoring program will begin in June 2019 and continue until May 2021.

Current and Planned Monitoring Dates:

June 2016 – Sept 2020	Monitor 2 sites in watershed approx. once a month
June 2019 – May 2021	4th Cycle of Rotating Basin Monitoring, every 5 weeks



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