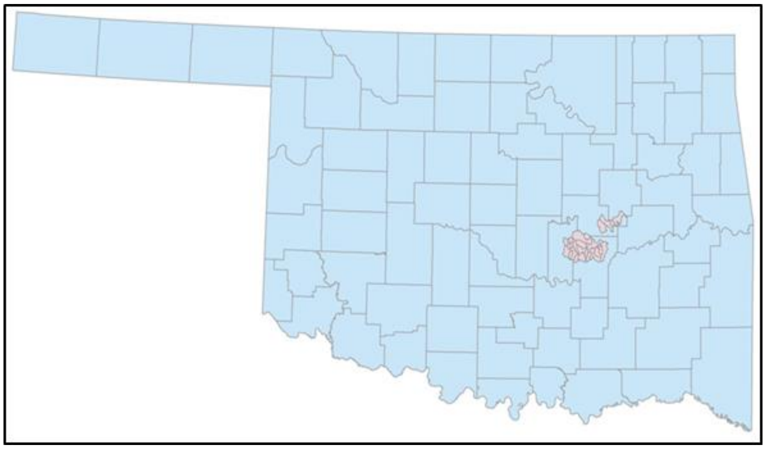
FINAL

2014 BACTERIAL AND TURBIDITY TOTAL MAXIMUM DAILY LOADS FOR OKLAHOMA STREAMS IN THE LOWER NORTH CANADIAN-DEEP FORK AREA (OK520500, OK520700)

Oklahoma Waterbody Identification Numbers

Bad Creek	OK520500010170_00
Alabama Creek	OK520500010200_00
Wewoka Creek	OK520500020010_00
Greasy Creek	OK520500020020_00
Little Wewoka Creek	OK520500020090_00
Coal Creek	OK520700010140_00



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OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

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ACRONYMS AND ABBREVIATIONS

AEMS	Agricultural Environmental Management Service
AFO	Animal Feeding Operation
AgPDES	Agriculture Pollutant Discharge Elimination System
ASAE	American Society of Agricultural Engineers
BMP	Best management practices
BOD	Biochemical Oxygen Demand
BUMP	Beneficial Use Monitoring Program
CAFO	Concentrated Animal Feeding Operation
CBOD	Carbonaceous Biochemical Oxygen Demand
CFR	Code of Federal Regulations
cfs	cubic feet per second
cfu	colony-forming unit
CPP	Continuing Planning Process
CWA	Clean Water Act
CWAC	Cool water aquatic community
DEQ	Oklahoma Department of Environmental Quality
DMR	Discharge monitoring report
E. coli	Escherichia coli
ENT	Enterococci
EPA	U.S. Environmental Protection Agency
HUC	Hydrologic unit code
IQR	Interquartile range
LA	Load allocation
LDC	Load duration curve
LOC	Line of organic correlation
mg	Million gallons
mgd	Million gallons per day
mg/L	Milligram per liter
mL	Milliliter
MOS	Margin of safety
MS4	Municipal separate storm sewer system
MSGP	Multi-Sector General Permit

NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
NRCS	Natural Resources Conservation Service
NRMSE	Normalized root mean square error
NTU	Nephelometric turbidity unit
OAC	Oklahoma Administrative Code
OCC	Oklahoma Conservation Commission
OLS	Ordinary least square
O.S.	Oklahoma statute
ODAFF	Oklahoma Department of Agriculture, Food and Forestry
OKWBID	Oklahoma Waterbody Identification Number
OPDES	Oklahoma Pollutant Discharge Elimination System
OSWD	Onsite wastewater disposal
OWQS	Oklahoma Water Quality Standards
OWRB	Oklahoma Water Resources Board
PBCR	Primary Body Contact Recreation
PRG	Percent reduction goal
r^2	Correlation coefficient
RMSE	Root mean square error
SH	State Highway
SSO	Sanitary sewer overflow
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WWAC	warm water aquatic community
WLA	wasteload allocation
WQ	Water Quality
WQM	Water quality monitoring
WQMP	Water Quality Management Plan
WQS	Water quality standard
WWTF	wastewater treatment facility

EXECUTIVE SUMMARY

ES - 1 OVERVIEW

As promulgated by Section 402 of the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) has delegated authority to the Oklahoma Department of Environmental Quality (DEQ) to partially oversee the National Pollutant Discharge Elimination System (NPDES) Program in the State of Oklahoma. Exceptions are agriculture (retained by State Department of Agriculture, Food, and Forestry), and the oil & gas industry (retained by the Oklahoma Corporation Commission) for which EPA has retained permitting authority. The NPDES Program in Oklahoma, in accordance with an agreement between DEQ and EPA, was implemented via the Oklahoma Pollutant Discharge Elimination System (OPDES) Act [Title 252, Chapter 606 (http://www.deq.state.ok.us/rules/606.pdf)].

This total maximum daily load (TMDL) report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria [*Escherichia coli (E. coli)* & Enterococci] and turbidity for certain waterbodies in the Lower North Canadian - Deep Fork Study Area in Oklahoma. Elevated levels of pathogen indicator bacteria in aquatic environments indicate that a waterbody is contaminated with human or animal feces and that a potential health risk exists for individuals exposed to the water. Elevated turbidity levels caused by excessive sediment loading and stream bank erosion impact aquatic communities

Data assessment and TMDL calculations were conducted in accordance with requirements of Section 303(d) of the CWA, Water Quality Planning and Management Regulations (40 CFR Part 130), EPA guidance, and DEQ guidance and procedures. DEQ is required to develop TMDLs for all impaired waterbodies which are on the 303(d) list. Then the draft TMDL goes to EPA for review before submitting it for public comment. After the public comment period, the TMDL was submitted to EPA for final approval. Once EPA approve the final TMDL, the waterbody is moved to Category 4a of the Integrated Report, where it remains until it reaches compliance with Oklahoma's water quality standards (WQS).

These TMDLs provide a load reduction to meet ambient water quality criterion with a given set of facts. The adoption of these TMDLs into the Water Quality Management Plan (WQMP) provides a mechanism to recalculate acceptable pollutant loads when information changes in the future. Updates to the WQMP demonstrate compliance with the water quality criterion. The updates to the WQMP are also useful when the water quality criterion changes and loading scenarios are reviewed to ensure that the predicted in-stream criterion will be met.

The purpose of this TMDL study was to establish pollutant load allocations for indicator bacteria and turbidity in impaired waterbodies, which is the first step toward restoring water quality and protecting public health. TMDLs determine the pollutant loading a waterbody can assimilate without exceeding the WQS for that pollutant. TMDLs also established the pollutant load allocation necessary to meet the WQS established for a waterbody based on the relationship between pollutant sources and in-stream water quality conditions. A TMDL consists of wasteload allocations (WLA), load allocations (LA), and a margin of safety (MOS). A WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under NPDES as point sources. An LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS can be implicit and/or explicit. The implicit MOS is achieved by using conservative assumptions in the

TMDL calculations. An explicit MOS is a percentage of the TMDL set aside to account for the lack of knowledge associated with natural process in aquatic systems, model assumptions, and data limitations.

This report does not stipulate specific control actions (regulatory controls) or management measures (voluntary best management practices) necessary to reduce bacteria or turbidity within each watershed. Watershed-specific control actions and management measures will be identified, selected, and implemented under a separate process.

ES - 2 Problem Identification and Water Quality Target

This TMDL report focused on waterbodies in the Lower North Canadian - Deep Fork Study Area, identified in **Table ES-1**, that DEQ placed in Category 5 [303(d) list] of the *Water Quality in Oklahoma, 2012 Integrated Report* for non-support of primary body contact recreation (PBCR) or warm water aquatic community (WWAC) subcategory of the Fish and Wildlife Propagation beneficial uses.

Elevated levels of bacteria or turbidity above the WQS necessitated the development of a TMDL. The TMDLs established in this report are a necessary step in the process to develop the pollutant loading controls needed to restore the PBCR and/or the Fish and Wildlife Propagation beneficial uses designated for each waterbody.

Table ES-2 summarizes water quality data collected during primary contact recreation season from the water quality monitoring (WQM) stations between 2003 and 2010 for each bacterial indicator. The data summary in **Table ES-2** provides a general understanding of the amount of water quality data available and the severity of exceedances of the water quality criteria. This data collected during the primary contact recreation season includes the data used to support the decision to place specific waterbodies within the Study Area on the DEQ 2012 303(d) list (DEQ 2013).

ES-2.1 Chapter 45: Definition of PBCR and Bacterial WQSs

The definition of PBCR and the bacterial WQSs for PBCR are summarized by the following excerpt from Title 785, Chapter 45-5-16 of the Oklahoma WQSs.

(a). *Primary Body Contact Recreation involves direct body contact with the water where a possibility of ingestion exists. In these cases the water shall not contain chemical, physical or biological substances in concentrations that are irritating to skin or sense organs or are toxic or cause illness upon ingestion by human beings.*

(b). *In waters designated for Primary Body Contact Recreation...limits...shall apply only during the recreation period of May 1 to September 30. The criteria for Secondary Body Contact Recreation will apply during the remainder of the year.*

(c). *Compliance with 785:45-5-16 shall be based upon meeting the requirements of one of the options specified in (1) or (2) of this subsection (c) for bacteria. Upon selection of one (1) group or test method, said method shall be used exclusively over the time period prescribed therefore. Provided, where concurrent data exist for multiple bacterial indicators on the same waterbody or waterbody segment, no criteria exceedances shall be allowed for any indicator group.* **(Chapter 45-5-16 continues on page ES-4)**

Table ES - 1 Excerpt from the 2012 Integrated Report – Oklahoma 303(d) List of Impaired Waters (Category 5)

Waterbody ID	Waterbody Name	Stream Miles	TMDL Date	Priority	ENT	*E. coli*	Designated Use Primary Body Contact Recreation	Turbidity	Designated Use Warm Water Aquatic Life
OK520500010170_00	Bad Creek	19.11	2017	2		X	N		F
OK520500010200_00	Alabama Creek	14.20	2017	2	X	X	N		F
OK520500020010_00	Wewoka Creek	42.99	2017	2		X	N		
OK520500020020_00	Greasy Creek	18.51	2023	4			I	X	N
OK520500020090_00	Little Wewoka Creek	20.44	2023	4	X	X	N		F
OK520700010140_00	Coal Creek	21.72	2017	2				X	N

ENT = Enterococci; N = Not attaining; X = Criterion exceeded; I = Insufficient information Source: 2012 Integrated Report, DEQ 2013

Table ES - 2 Summary of Indicator Bacterial Samples from Primary Body Contact Recreation Subcategory Season May 1 to September 30, 2003-2010

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Conc (cfu/100 ml)	Assessment Results
OK520500010170_00	Bad Creek	*E. coli*	19	157.6	TMDL Required
OK520500010200_00	Alabama Creek	*E. coli*	19	141.4	TMDL Required
		ENT	19	203.0	TMDL Required
OK520500020010_00	Wewoka Creek	*E. coli*	42	185.7	TMDL Required
OK520500020090_00	Little Wewoka Creek	*E. coli*	19	198.2	TMDL Required
		ENT	19	155.7	TMDL Required

Enterococci (ENT) water quality criterion = Geometric Mean of 33 counts/100 mL

(Text from Chapter 45-5-16 on page ES-2 continues below)

(1) Escherichia coli (E. coli): The E. coli geometric mean criterion is 126/100 ml. For swimming advisory and permitting purposes, E. coli shall not exceed a monthly geometric mean of 126/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 235/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 406/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 126/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

(2) Enterococci: The Enterococci geometric mean criterion is 33/100 ml. For swimming advisory and permitting purposes, Enterococci shall not exceed a monthly geometric mean of 33/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 61/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 108/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 33/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

ES-2.2 Chapter 46: Implementation of OWQS for PBCR

To implement Oklahoma's WQS for PBCR, OWRB promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2013a). The excerpt below from Chapter 46: 785:46-15-6, stipulates how water quality data was assessed to determine support of the PBCR use as well as how the water quality target for TMDLs was defined for each bacterial indicator.

(a). ***Scope.***

The provisions of this Section shall be used to determine whether the subcategory of Primary Body Contact of the beneficial use of Recreation designated in OAC 785:45 for a waterbody is supported during the recreation season from May 1 through September 30 each year. Where data exist for multiple bacterial indicators on the same waterbody or waterbody segment, the determination of use support shall be based upon the use and application of all applicable tests and data.

(b). ***Escherichia coli (E. coli).***

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(2) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(c). ***Enterococci.***

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(2) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

Where concurrent data exist for multiple bacterial indicators on the same waterbody, each indicator group must demonstrate compliance with the numeric criteria prescribed (OWRB 2013). As stipulated in the WQS, only the geometric mean of all samples collected over the recreation period were used to assess the impairment status of a stream. Therefore, only the geometric mean criteria were used to develop TMDLs for *E. coli* and Enterococci bacterial indicators.

It is worth noting that the Oklahoma Water Quality Standards (OWQS) prior to July 1, 2011 contained three bacterial indicators (fecal coliform, *E. coli* and Enterococci). Since July 1, 2011 the WQS address only *E. coli* and Enterococci bacteria. Therefore, bacterial TMDLs were developed only for *E. coli* and/or Enterococci impaired streams.

ES-2.3 Chapter 45: Criteria for Turbidity

The beneficial use of WWAC is one of several subcategories of the Fish and Wildlife Propagation Use established to manage the variety of communities of fish and shellfish throughout the State (OWRB 2013). The numeric criteria for turbidity to maintain and protect the use of "Fish and Wildlife Propagation" from Title 785:45-5-12(f)(7) is as follows:

(A) Turbidity from other than natural sources shall be restricted to not exceed the following numerical limits:

i. Cool Water Aquatic Community/Trout Fisheries: 10 NTUs;

ii. Lakes: 25 NTU; and

iii. Other surface waters: 50 NTUs.

(B) In waters where background turbidity exceeds these values, turbidity from point sources will be restricted to not exceed ambient levels.

(C) Numerical criteria listed in (A) of this paragraph apply only to seasonal base flow conditions.

(D) Elevated turbidity levels may be expected during, and for several days after, a runoff event.

ES-2.4 Chapter 46: Implementation of OWQS for Fish and Wildlife Propagation

Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2013a) describes Oklahoma's WQS for Fish and Wildlife Propagation. The excerpt below from Chapter 46: 785:46-15-5, stipulates how water quality data was assessed to determine support of fish and wildlife propagation as well as how the water quality target for TMDLs was defined for turbidity.

785:46-15-5 Assessment of Fish and Wildlife Propagation Support

(a). Scope. The provisions of this Section shall be used to determine whether the beneficial use of Fish and Wildlife Propagation or any subcategory thereof designated in OAC 785:45 for a waterbody is supported.

(e). Turbidity. The criteria for turbidity stated in 785:45-5-12(f)(7) shall constitute the screening levels for turbidity. The tests for use support shall follow the default protocol in 785:46-15-4(b).

785:46-15-4. Default protocols

(b). Short term average numerical parameters.

(1) Short term average numerical parameters are based upon exposure periods of less than seven days. Short term average parameters to which this Section applies include, but are not limited to, sample standards and turbidity.

(2) A beneficial use shall be deemed to be fully supported for a given parameter whose criterion is based upon a short term average if 10% or less of the samples for that parameter exceeds the applicable screening level prescribed in this Subchapter.

(3) A beneficial use shall be deemed to be fully supported but threatened if the use is supported currently but the appropriate state environmental agency determines that available data indicate that during the next five years the

use may become not supported due to anticipated sources or adverse trends of pollution not prevented or controlled. If data from the preceding two year period indicate a trend away from impairment, the appropriate agency shall remove the threatened status.

(4) A beneficial use shall be deemed to be not supported for a given parameter whose criterion is based upon a short term average if at least 10% of the samples for that parameter exceed the applicable screening level prescribed in this Subchapter.

Turbidity is a measure of water clarity and is caused by suspended particles in the water column. Because turbidity cannot be expressed as a mass load, total suspended solids (TSS) were used as a surrogate for the TMDLs in this report. Therefore, both turbidity and TSS data are presented.

Table ES-3 summarizes a subset of water quality data collected for turbidity and TSS under base flow conditions, which DEQ considers to be all flows less than the 25th flow exceedance percentile (i.e., the lower 75% of flows). Water quality samples collected under flow conditions greater than the 25th flow exceedance percentile (highest flows) were therefore excluded from the data set used for TMDL analysis.

Table ES - 3 Summary of Turbidity/TSS Data Minus High Flow Samples, 2009-2010

Waterbody ID	Waterbody Name	WQM Stations	Number of turbidity samples	Number of samples greater than 50 NTU	% samples exceeding criterion	Average Turbidity (NTU)	Assessment Results
OK520500020020_00	Greasy Creek	OK520500020020_00	12	0	0%	13	Delist: No violation
OK520700010140_00	Coal Creek	OK520700010140_00	12	0	0%	17	Delist: No violation

ES - 3 Pollutant Source Assessment

A pollutant source assessment characterizes known and suspected sources of pollutant loading to impaired waterbodies. Sources within a watershed were categorized and quantified to the extent that information was available. Bacteria originate from warm-blooded animals and sources may be point or nonpoint in nature. Nonpoint sources include those sources that cannot be identified as entering a waterbody at a specific location.Turbidity may originate from OPDES-permitted facilities, fields, construction sites, quarries, stormwater runoff and eroding stream banks.

Point sources are permitted through the OPDES program. OPDES-permitted facilities that discharge treated sanitary wastewater are required to monitor fecal coliform under the current permits and are required to monitor *E. coli* when their permits are renewed. These facilities are also required to monitor TSS in accordance with their permits. Nonpoint sources may emanate from land activities that contribute bacteria or TSS to surface water as a result of rainfall runoff. For the TMDLs in this report, all sources of pollutant loading not regulated by OPDES permits were considered nonpoint sources.

Sediment loading of streams can originate from natural erosion processes, including the weathering of soil, rocks, and uncultivated land; geological abrasion; and other natural phenomena. There was insufficient data available to quantify contributions of TSS from these natural processes. TSS or sediment loading can also occur under non-runoff conditions as a result of anthropogenic activities in riparian corridors which cause erosive conditions. Given the lack of data to establish the background conditions for TSS/turbidity, separating background loading from nonpoint sources whether it was from natural or anthropogenic processes was not feasible in this TMDL development.

Table ES-4 summarizes the list of TMDLs that were developed in this report and **Table ES-5** summarizes the point and nonpoint sources that contribute bacteria to each waterbody.

Table ES - 4 Stream and Pollutants for TMDL Development

Waterbody ID	HUC 8 Codes	Waterbody Name	Stream Miles	TMDL Date	Priority	ENT	E.coli
OK520500010170_00	11100302	**Bad Creek**	19.11	2017	2		X
OK520500010200_00	11100302	**Alabama Creek**	14.2	2017	2	X	X
OK520500020010_00	11100302	**Wewoka Creek**	42.99	2017	2		X
OK520500020090_00	11100302	**Little Wewoka Creek**	20.44	2023	4	X	X

Table ES - 5 Summary of Potential Pollutant Sources by Category

Waterbody ID	Waterbody Name	Municipal OPDES Facility	Industrial OPDES Facility	MS4	OPDES No Discharge Facility	CAFO	Mines	Construction Stormwater Permit	Multi-Sector General Permit	Nonpoint Source
Bad Creek	OK520500010170_00									Bacteria
Alabama Creek	OK520500010200_00									Bacteria
Wewoka Creek	OK520500020010_00									Bacteria
Little Wewoka Creek	OK520500020090_00									Bacteria

Facility present in watershed and potential as contributing pollutant source.
Facility present in watershed, but not recognized as pollutant source.
No facility present in watershed.

ES - 4 Using Load Duration Curves to Develop TMDLs

The TMDL calculations presented in this report were derived from load duration curves (LDC). LDCs facilitate rapid development of TMDLs. As a TMDL development tool, LDCs can provide some information for identifying whether impairments are associated with point or nonpoint sources. The LDC is a simple and efficient method to show the relationship between flow and pollutant load. LDCs graphically display changing water quality over changing flows that may not be apparent when visualizing raw data. The LDC has additional valuable uses in the post-TMDL implementation phase of the restoration of the water quality for a waterbody. Plotting future monitoring information on the LDC can show trends of improvement to sources that will identify areas for revision to the watershed restoration plan. The low cost of the LDC method allows accelerated development of TMDL plans on more waterbodies and the evaluation of the implementation of WLAs and BMPs. The technical approach for using LDCs for TMDL development includes the following steps:

1. Prepare flow duration curves for gaged and ungaged WQM stations.
2. Estimate existing loading in the waterbody using ambient bacterial water quality data.
3. Estimate loading in the waterbody using measured TSS water quality data and turbidity-converted data.
4. Use LDCs to identify the critical condition that will dictate loading reductions and the overall percent reduction goal (PRG) necessary to attain WQS.

Use of LDCs obviated the need to determine a design storm or selected flow recurrence interval with which to characterize the appropriate flow level for the assessment of critical conditions. For waterbodies impacted by both point and nonpoint sources, the "nonpoint source critical condition" would typically occur during high flows, when rainfall runoff would contribute the bulk of the pollutant load, while the "point source critical condition" would typically occur during low flows, when wastewater treatment facilities (WWTF) effluents would dominate the base flow of the impaired water. However, flow range is only a general indicator of the relative proportion of point/nonpoint contributions. Violations have been noted under low flow conditions in some watersheds that contain no point sources.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by a water quality criterion. The TMDL can be expressed as a continuous function of flow, equal to the line, or as a discrete value derived from a specific flow condition.

The following are the basic steps in developing a LDC:

1. Obtain daily flow data for the site of interest from the U.S. Geological Survey (USGS), or if unavailable, obtain projected flow from a nearby USGS site.
2. Sort the flow data and calculate the flow exceedance percentiles.
3. For bacterial TMDLs, obtain the water quality data from the primary contact recreation season (May 1 through September 30).
4. For turbidity TMDLs, obtain available turbidity and TSS water quality data.
5. Match the water quality observations with the flow data from the same date.
6. Display a curve on a plot that represents the allowable load determined by multiplying the actual or estimated flow by the WQS for each respective bacterial indicator.
7. Display a curve on a plot that represents the allowable load determined by multiplying the actual or estimated flow by the WQ_{goal} for TSS.
8. For bacterial TMDLs, display and differentiate another curve derived by plotting the geometric mean of all existing bacterial samples continuously along the full spectrum of flow exceedance percentiles which represents the observed load in the stream.
9. For turbidity TMDLs, match the water quality observations with the flow data from the same date and determine the corresponding exceedance percentile. Plot the flow exceedance percentiles and daily load observations in a load duration plot (Section 5).

ES-4.1 Bacterial LDC

For bacterial TMDLs the culmination of these steps is expressed in the following formula, which is displayed on the LDC as the TMDL curve:

TMDL (cfu/day) = WQS * flow (cfs) * unit conversion factor

Where:

WQS = 126 cfu/100 mL (E. coli); or 33 cfu/100 mL (Enterococci)

Unit conversion factor = 24,465,525

ES-4.2 TSS LDC

For turbidity (TSS) TMDLs the culmination of these steps is expressed in the following formula, which is displayed on the LDC as the TMDL curve:

$$TMDL\ (lb/day) = WQ_{goal} * flow\ (cfs) * unit\ conversion\ factor$$

Where:

WQ_{goal} ***= waterbody specific TSS concentration derived from regression analysis***

Unit conversion factor = 5.39377

ES-4.3 LDC Summary

The LDC approach recognizes that the assimilative capacity of a waterbody depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading and load reductions required to meet the TMDL water quality target can also be calculated under different flow conditions. The difference between existing loading and the water quality target was used to calculate the loading reductions required.

Historical observations of bacteria were plotted as a separate LDC based on the geometric mean of all samples. Historical observations of TSS and/or turbidity concentrations were paired with flow data and were plotted on the LDC for a stream. It was noted that the LDCs for bacteria were based on the geometric mean standards or geometric mean of all samples. It was inappropriate to compare single sample bacterial observations to a geometric mean water quality criterion in the LDC; therefore individual bacterial samples were not plotted on the LDCs.

Historical observations of TSS and/or turbidity concentrations were paired with flow data and were plotted on the LDC for a stream.

ES - 5 TMDL Calculations

A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for the lack of knowledge concerning the relationship between pollutant loading and water quality. This definition can be expressed by the following equation:

$$TMDL = WLA\_{WWTF} + WLA\_{MS4} + LA + MOS$$

The WLA is the portion of the TMDL allocated to existing and future point sources. The LA is the portion of the TMDL allocated to nonpoint sources, including natural background sources. The MOS is intended to ensure that WQSs will be met.

ES-5.1 Bacterial PRG

For each waterbody, the TMDLs presented in this report are expressed as colony forming units (cfu) per day across the full range of flow conditions. For information purpose, percent reductions are also provided. The difference between existing loading and the water quality target was used to calculate the loading reductions required. For bacteria, the PRG was calculated by reducing all samples by the same percentage until the geometric mean of the reduced sample values meets the corresponding bacterial geometric mean standard (126 cfu/100 ml for *E. coli* and 33 cfu/100 ml for Enterococci) with 10% of MOS. For turbidity, the PRG is the load reduction that ensures that no more than 10% of the samples under base-flow conditions exceed the TMDL.

Table ES-6 presents the percent reductions necessary for each bacterial indicator that caused nonsupport of the PBCR use in each waterbody of the Study Area.

Table ES - 6 Percent Reductions Required to Meet WQS for Indicator Bacteria

Waterbody ID	Waterbody Name	Required Reduction Rate	
		E. coli	ENT
OK520500010170_00	Bad Creek	20%	-
OK520500010200_00	Alabama Creek	11%	84%
OK520500020010_00	Wewoka Creek	32%	-
OK520500020090_00	Little Wewoka Creek	36%	79%

ES-5.2 Seasonal Variation

The TMDL, WLA, LA, and MOS vary with flow condition, and were calculated at every 5th flow interval percentile. The WLA component of each TMDL is the sum of all WLAs within each contributing watershed. The LA was then calculated as follows:

$$LA = TMDL - MOS - \Sigma WLA$$

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading.

The bacterial TMDLs established in this report adhere to the seasonal application of the Oklahoma WQS which limits the PBCR use to the period of May 1st through September 30th.

ES-5.3 MOS

Federal regulations [40 CFR §130.7(c)(1)] also require that TMDLs include an MOS. The MOS, which can be implicit or explicit, is a conservative measure incorporated into the TMDL equation that accounts for the lack of knowledge associated with calculating the allowable pollutant loading to ensure WQSs are attained. For bacterial TMDLs, an explicit MOS was set at 10%.

The TMDL represents a continuum of desired load over all flow conditions, rather than fixed at a single value, because loading capacity varies as a function of the flow present in the stream. The higher the flow is, the more wasteload the stream can handle without violating water quality standards. Regardless of the magnitude of the WLA calculated in these TMDLs, future new discharges or increased load from existing discharges will be considered consistent with the TMDL provided the OPDES permit requires in-stream criteria to be met.

ES - 6 Reasonable Assurance

Reasonable assurance is required by the EPA rules for a TMDL to be approvable only when a waterbody is impaired by both point and nonpoint sources and where a point source is given a less stringent WLA based on an assumption that nonpoint source load reductions will occur. In such a case, "reasonable assurances" that nonpoint (NPS) load reductions will actually occur must be demonstrated. In this report, all point source discharges either already have or will be given discharge limitations less than or equal to the water quality standard numerical criteria. This ensures that the impairments of the waterbodies in this report will not be caused by point sources. Since the point source WLAs in this TMDL report are not dependent on NPS load reduction, reasonable assurance does not apply.

ES - 7 Public Participation

A public notice was sent to local newspapers, to stakeholders in the Study Area affected by these draft TMDLs, and to stakeholders who have requested copies of all TMDL public notices. The public notice, draft TMDL report, and draft 208 Factsheet were posted at the following DEQ website: www.deq.state.ok.us/wqdnew/index.htm. The public had 45 days (July 10, 2014 to August 25, 2014) to review the draft TMDL report and make written comments. During that time period, DEQ received three letter requesting that the public comment period be extended. DEQ granted the request and extended the public comment period two weeks to September 8, 2014.

Over 40 written comments were received during the public notice period. These comments, along with DEQ's responses, are now part of the record of this TMDL report in **Appendix E**. These comments weres considered. In response to these comments, some changes were made to the final version of this TMDL Report.

There were no requests for a public meeting.

This TMDL report was finalized and submitted to EPA for final approval.

SECTION 1 INTRODUCTION

1.1 TMDL Program Background

As promulgated by Section 402 of the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) has delegated authority to the Oklahoma Department of Environmental Quality (DEQ) to partially oversee the National Pollutant Discharge Elimination System (NPDES) Program in the State of Oklahoma. Exceptions are agriculture (retained by State Department of Agriculture, Food, and Forestry), and the oil & gas industry (retained by the Oklahoma Corporation Commission) for which EPA has retained permitting authority. The NPDES Program in Oklahoma, in accordance with an agreement between DEQ and EPA, was implemented via the Oklahoma Pollutant Discharge Elimination System (OPDES) Act [Title 252, Chapter 606 (http://www.deq.state.ok.us/rules/606.pdf)].

Section 303(d) of the CWA and EPA Water Quality Planning and Management Regulations [40 Code of Federal Regulations (CFR) Part 130] require states to develop total maximum daily loads (TMDL) for all waterbodies and pollutants identified by the Regional Administrator as suitable for TMDL calculation. Waterbodies and pollutants identified on the approved 303(d) list as not meeting designated uses where technology-based controls are in place will be given a higher priority for development of TMDLs. TMDLs establish the allowable loadings of pollutants or other quantifiable parameters for a waterbody. TMDLs are based on the relationship between pollution sources and in-stream water quality conditions so that states can implement water quality-based controls to reduce pollution from point and nonpoint sources and restore and maintain water quality (EPA 1991).

This report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria [*Escherichia coli (E. coli),* Enterococci][1] and turbidity for selected waterbodies in the the Lower North Canadian-Deep Fork Area Watershed in Oklahoma. Elevated levels of pathogen indicator bacteria in aquatic environments indicate that a waterbody is contaminated with human or animal feces and that a potential health risk exists for individuals exposed to the water. Elevated turbidity levels caused by excessive sediment loading and stream bank erosion impact aquatic biological communities.

Data assessment and TMDL calculations are conducted in accordance with requirements of Section 303(d) of the CWA, Water Quality Planning and Management Regulations (40 CFR Part 130), EPA guidance, and Oklahoma Department of Environmental Quality (DEQ) guidance and procedures. DEQ is required to submit all TMDLs to EPA for review. Approved 303(d) listed waterbody-pollutant pairs or surrogates TMDLs will receive notification of the approval or disapproval action. Once the EPA approves a TMDL, then the waterbody may be moved to Category 4a of a state’s Integrated Water Quality Monitoring and Assessment Report, where it remains until compliance with water quality standards (WQS) is achieved (EPA 2003).

[1] All future references to bacteria in this document imply these two fecal pathogen indicator bacterial groups unless specifically stated otherwise.

These TMDLs provide a load reduction to meet ambient water quality criterion with a given set of facts. The adoption of these TMDLs into the Water Quality Management Plan (WQMP) provides a mechanism to recalculate acceptable pollutant loads when information changes in the future. Updates to the WQMP demonstrate compliance with the water quality criterion. The updates to the WQMP are also useful when the water quality criterion changes and loading scenarios are reviewed to ensure that the predicted in-stream criterion will be met.

The purpose of this TMDL study was to establish pollutant load allocations for indicator bacteria and turbidity in impaired waterbodies, which is the first step toward restoring water quality and protecting public health. TMDLs determine the pollutant loading a waterbody can assimilate without exceeding the WQS for that pollutant. TMDLs also establish the pollutant load allocation necessary to meet the WQS established for a waterbody based on the relationship between pollutant sources and in-stream water quality conditions. A TMDL consists of wasteload allocations (WLA), load allocations (LA), and a margin of safety (MOS). A WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under OPDES. An LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS can be implicit and/or explicit. An implicit MOS is achieved by using conservative assumptions in the TMDL calculations. An explicit MOS is a percentage of the TMDL set aside to account for the lack of knowledge associated with natural process in aquatic systems, model assumptions, and data limitations.

This report does not stipulate specific control actions (regulatory controls) or management measures (voluntary best management practices) necessary to reduce bacteria or turbidity within each watershed. Watershed-specific control actions and management measures will be identified, selected, and implemented under a separate process involving stakeholders who live and work in the watersheds, along with tribes, and local, state, and federal government agencies.

This TMDL report focused on waterbodies that DEQ placed in Category 5 [303(d) list] of the *Water Quality in Oklahoma, 2012 Integrated Report* (aka 2012 Integrated Report) for nonsupport of primary body contact recreation (PBCR) or Fish and Wildlife Propagation beneficial uses. The waterbodies considered for TMDL development in this report are listed in **Table 1-1**.

Table 1-1 TMDL Waterbodies

Waterbody Name	Oklahoma Waterbody Identification Number (OK WBID)
Bad Creek	OK520500010170_00
Alabama Creek	OK520500010200_00
Wewoka Creek	OK520500020010_00
Greasy Creek	OK520500020020_00
Little Wewoka Creek	OK520500020090_00
Coal Creek	OK520700010140_00

Figure 1-1 shows these Oklahoma waterbodies and their contributing watersheds. These maps also display locations of the water quality monitoring (WQM) stations used as the basis for placement of these waterbodies on the Oklahoma 303(d) list. These waterbodies and their surrounding watersheds are hereinafter referred to as the Study Area.

TMDLs are required to be developed whenever elevated levels of pathogen indicator bacteria or turbidity are above the WQS numeric criterion. The TMDLs established in this report are a necessary step in the process to develop the pollutant loading controls needed to restore the PBCR or Fish & Wildlife Propagation use designated for each waterbody. **Table 1-2** provides a description of the locations of WQM stations on the 303(d)-listed waterbodies.

Table 1-2 Water Quality Monitoring Stations used for Assessment of Streams

WQM Station	Waterbody Name	Waterbody ID
OK520500-01-0170L	Bad Creek	OK520500010170_00
OK520500-01-0170G		
OK520500-01-0200R	Alabama Creek	OK520500010200_00
OK520500-01-0200U		
OK520500-01-0200D		
OK520500-02-0010T	Wewoka Creek	OK520500020010_00
OK520500-02-0010E		
OK520500-02-0010C		
OK520500-02-0010M		
OK520500-02-0020G	Greasy Creek	OK520500020020_00
OK520500-02-0020T		
OK520500-02-0090A	Little Wewoka Creek	OK520500020090_00
OK520500-02-0090D		
OK520500-02-0090T		
OK520500-02-0090L		
520700010140-002SR	Coal Creek	OK520700010140_00

1.2 Watershed Description

1.2.1 General

The Lower North Canadian-Deep Fork study area is located in the eastern portion of Oklahoma. The waterbodies and their watersheds addressed in this report are scattered over Hughes, Okfuskee, Okmulgee, and Seminole counties. These counties are part of the South Central Plains Level III ecoregions (Woods, A.J, et al 2005). The watersheds in the Study Area are located in the Arbuckle Uplift, Arkoma Basin and the Cherokee Platform geological provinces. **Table 1-3**, derived from the 2010 U.S. Census, demonstrates that the counties in which these watersheds are located are mostly sparsely populated (U.S. Census Bureau 2010). **Table 1-4** lists major towns and cities located in each watershed.

Figure 1-1 Lower North Canadian River Watersheds Not Supporting Primary Body Contact Recreation or Fish and Wildlife Propagation Use

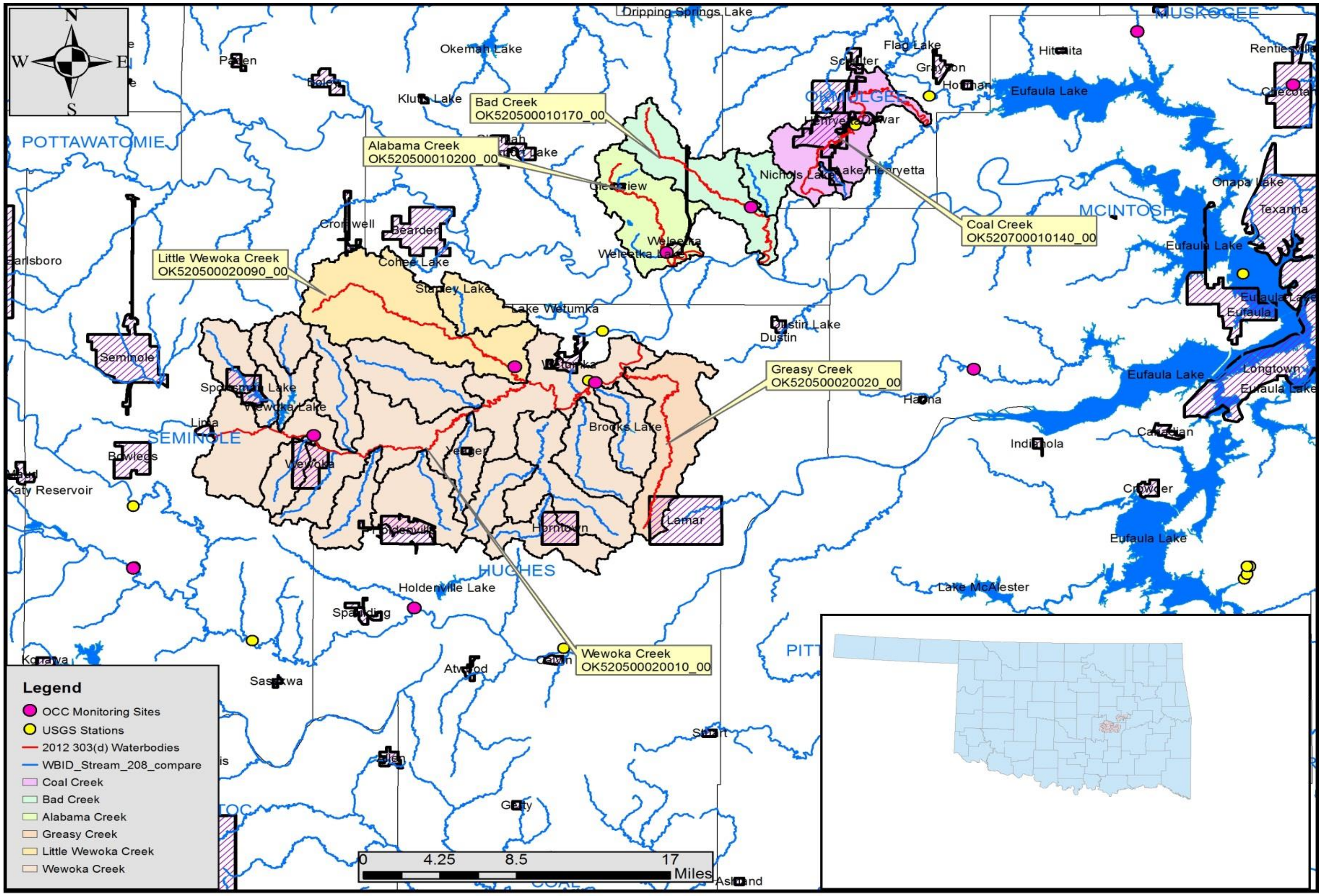


Table 1-3 County Population and Density

County Name	Population (2010 Census)	Population Density (per square mile)
Okfuskee	12,358	20
Hughes	13,836	17
Okmulgee	39,625	56
Seminole	25,450	40

Table 1-4 Major Municipalities by Watershed

Waterbody Name	Waterbody ID	Municipalities
Bad Creek	OK520500010170_00	Bryant, Pharoah
Alabama Creek	OK520500010200_00	Clearview, Weleetka
Wewoka Creek	OK520500020010_00	Wetumka, Wewoka,Holdenville, Horntown,Yeager
Greasy Creek	OK520500020020_00	Lamar
Little Wewoka Creek	OK520500020090_00	Cromwel
Coal Creek	OK520700010140_00	Henryetta, Dewar, Coalton

1.2.2 Climate

Table 1-5 summarizes the average annual precipitation for each Oklahoma waterbody derived from a geospatial layer developed to display annual precipitation using data collected from Oklahoma weather stations between 1971 through 2000. Average annual precipitation values among the watersheds in this portion of Oklahoma ranged between 42.1 and 43.6 inches (Oklahoma Climatological Survey 2005).

Table 1-5 Average Annual Precipitation by Watershed

Waterbody Name	Waterbody ID	Average Annual Precipitation (inches)
Bad Creek	OK520500010170_00	43.1
Alabama Creek	OK520500010200_00	42.9
Wewoka Creek	OK520500020010_00	42.1
Greasy Creek	OK520500020020_00	43.5
Little Wewoka Creek	OK520500020090_00	42.2
Coal Creek	OK520700010140_00	43.6

1.2.3 Land Use

Table 1-6 summarizes the percentages and acreages of the land use categories for the contributing watershed associated with each respective Oklahoma waterbody addressed in the Study Area. The land use/land cover data were derived from the U.S. Geological Survey (USGS) 2006 National Land Cover Dataset (USGS 2013). The percentages provided in **Table 1-6** were rounded so in some cases may not total exactly 100%. The land use categories are displayed in **Figure 1-2**. The most dominant land use category throughout the Study Area is deciduous forest. Greasy Creek (OK520500020020_00) watershed in the Study Area has the highest percentage of land use classified as decidous forest (approximately 81%). Grassland/herbaceous and pasture/hay are the next dominant land uses throughout the Study Area. The watersheds targeted for TMDL development in this Study Area range in size from 18,126 acres (Alabama Creek, OK520500010200_00) to 247,319 acres (Wewoka Creek, OK520500020010_00).

1.3 Stream Flow Conditions

Stream flow characteristics and data are key information when conducting water quality assessments, such as TMDLs. The USGS operates flow gages throughout Oklahoma from which long-term stream flow records were obtained. At various WQM stations, additional flow measurements were recorded. At the same time, bacteria, total suspended solids (TSS), and turbidity water quality samples were collected. Not all of the waterbodies in this Study Area had historical flow data available. Flow data from the surrounding USGS gage stations and the instantaneous flow measurement data taken with water quality samples were used to estimate flows for ungaged streams. Flow conditions recorded during the time of water quality sampling for turbidity are included in **Appendix A** along with corresponding water chemistry data results. A summary of the methods used to project flows for ungaged streams and flow exceedance percentiles from projected flow data are provided in **Appendix B**.

Figure 1-2 Land Use Map

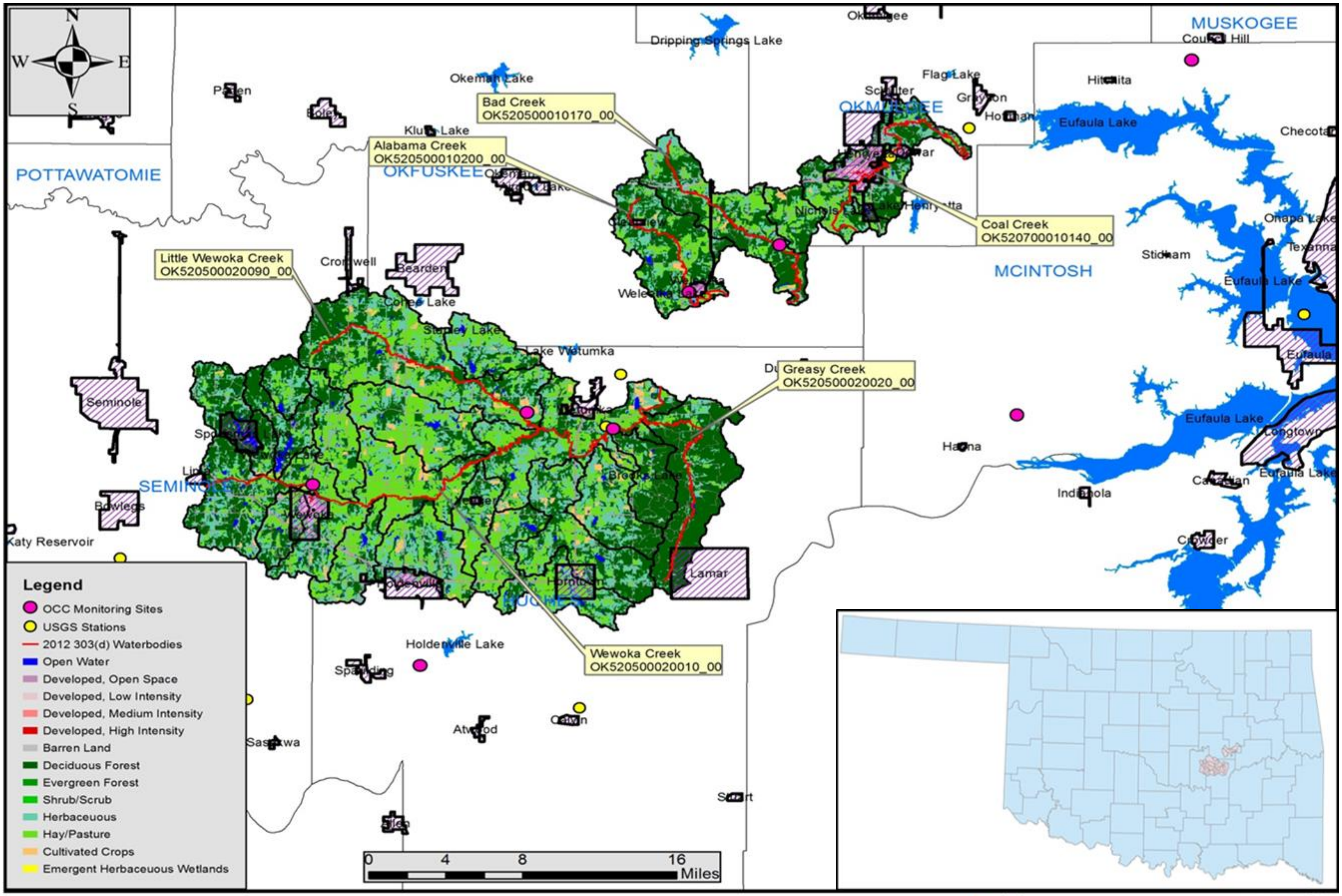


Table 1-6 Land Use Summaries by Watershed

Landuse Category	Watersheds					
	Bad Creek	Alabama Creek	Wewoka Creek	Greasy Creek	Little Wewoka Creek	Coal Creek
Waterbody ID	**OK520500010170_00**	**OK520500010200_00**	**OK520500020010_00**	**OK520500020020_00**	**OK520500020090_00**	**OK520700010140_00**
Open Water	108	215	4,538	133	503	570
Medium Intensity Residential	84	78	1,214	0	27	815
High Intensity Residential	0	4	90	0	0	150
Bare Rock/Sand/Clay	0	0	110	0	0	0
Deciduous Forest	11,312	8,716	91,525	15,996	14,334	8,223
Evergreen Forest	7	5	236	4	12	17
Mixed Forest	0	0	0	0	0	0
Shrubland	0	0	0	0	0	0
Grasslands/Herbaceous	5,128	4,747	63,531	1,942	11,913	5,485
Pasture/Hay	5,165	2,931	66,533	721	10,864	2,747
Cultivated Crops	319	242	5,688	0	1,172	24
Urban/Recreational Grasses	1,278	1,188	13,851	818	1,792	2,746
Woody Wetlands	0	0	0	0	0	3
Emergent Herbaceous Wetlands	0	0	3	0	0	5
Total (Acres)	**23,400**	**18,126**	**247,319**	**19,614**	**40,619**	**20,785**
Open Water	0.46%	1.19%	1.84%	0.68%	1.24%	2.74%
Medium Intensity Residential	0.36%	0.43%	0.49%	0.00%	0.07%	3.92%
High Intensity Residential	0.00%	0.02%	0.04%	0.00%	0.00%	0.72%
Bare Rock/Sand/Clay	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
Deciduous Forest	48.34%	48.08%	37.01%	81.55%	35.29%	39.56%
Evergreen Forest	0.03%	0.03%	0.10%	0.02%	0.03%	0.08%
Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Shrubland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Grasslands/Herbaceous	21.91%	26.19%	25.69%	9.90%	29.33%	26.39%
Pasture/Hay	22.07%	16.17%	26.90%	3.67%	26.75%	13.22%
Cultivated Crops	1.36%	1.33%	2.30%	0.00%	2.89%	0.12%
Urban/Recreational Grasses	5.46%	6.55%	5.60%	4.17%	4.41%	13.21%
Woody Wetlands	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
Emergent Herbaceous Wetlands	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
Total Percentage:	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

SECTION 2
PROBLEM IDENTIFICATION AND WATER QUALITY TARGET

2.1 Oklahoma Water Quality Standards

Title 785 of the Oklahoma Administrative Code contains Oklahoma Water Quality Standards (OWQS) and implementation procedures (OWRB 2013). The Oklahoma Water Resources Board (OWRB) has statutory authority and responsibility concerning establishment of State WQS, as provided under 82 Oklahoma Statute [O.S.], §1085.30. This statute authorizes the OWRB to promulgate rules …*which establish classifications of uses of waters of the state, criteria to maintain and protect such classifications, and other standards or policies pertaining to the quality of such waters.* [O.S. 82:1085:30(A)]. Beneficial uses are designated for all waters of the State. Such uses are protected through restrictions imposed by the antidegradation policy statement, narrative water quality criteria, and numerical criteria (OWRB 2013). An excerpt of the Oklahoma WQS (Title 785) summarizing the State of Oklahoma Antidegradation Policy is provided in **Appendix C**. **Table 2-1**, an excerpt from the 2012 Integrated Report (DEQ 2013), lists beneficial uses designated for each bacterial and/or turbidity impaired stream segment in the Study Area. The beneficial uses included:

- AES – Aesthetics
- AG – Agriculture Water Supply
- Fish and Wildlife Propagation
  - WWAC – Warm Water Aquatic Community
  - HLAC – Habitat Limited Aquatic Community
- FISH – Fish Consumption
- PBCR – Primary Body Contact Recreation
- SBCR – Secondary Body Contact Recreation
- PPWS – Public & Private Water Supply
- EWS -- Emergency Water Supply

Table 2-1 Designated Beneficial Uses for Each Stream Segment in the Study Area

Waterbody ID	Waterbody Name	AES	AG	WWAC	FISH	PBCR	PPWS	EWS
OK520500010170_00	**Bad Creek**	F	F	F	X	N	I	
OK520500010200_00	**Alabama Creek**	I	N	F	X	N	I	
OK520500020010_00	**Wewoka Creek**	F	N	HLAC	X	N	I	F
OK520500020020_00	**Greasy Creek**	F	F	N	X	I		
OK520500020090_00	**Little Wewoka Creek**	I	F	F	X	N	I	
OK520700010140_00	**Coal Creek**	I	X	N	X	SBCR		F

F – Fully supporting | **N – Not supporting** | **I – Insufficient information** | **X – Not assessed** | **Source: DEQ 2012 Integrated Report**

2.1.1 Chapter 45: Definition of PBCR and Bacterial WQSs

The definition of PBCR and the bacterial WQSs for PBCR are summarized by the following excerpt from Title 785, Chapter 45-5-16 of the Oklahoma WQSs.

(a). Primary Body Contact Recreation involves direct body contact with the water where a possibility of ingestion exists. In these cases the water shall not contain chemical, physical or biological substances in concentrations that are irritating to skin or sense organs or are toxic or cause illness upon ingestion by human beings.

(b). In waters designated for Primary Body Contact Recreation...limits...shall apply only during the recreation period of May 1 to September 30. The criteria for Secondary Body Contact Recreation will apply during the remainder of the year.

(c). Compliance with 785:45-5-16 shall be based upon meeting the requirements of one of the options specified in (1) or (2) of this subsection (c) for bacteria. Upon selection of one (1) group or test method, said method shall be used exclusively over the time period prescribed therefore. Provided, where concurrent data exist for multiple bacterial indicators on the same waterbody or waterbody segment, no criteria exceedances shall be allowed for any indicator group.

(1) Escherichia coli (E. coli): The E. coli geometric mean criterion is 126/100 ml. For swimming advisory and permitting purposes, E. coli shall not exceed a monthly geometric mean of 126/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 235/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 406/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 126/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

(2) Enterococci: The Enterococci geometric mean criterion is 33/100 ml. For swimming advisory and permitting purposes, Enterococci shall not exceed a monthly geometric mean of 33/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 61/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 108/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 33/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

2.1.2 Chapter 46: Implementation of OWQS for PBCR

To implement Oklahoma's WQS for PBCR, OWRB promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2013a). The excerpt below from Chapter 46: 785:46-15-6, stipulates how water quality data was assessed to determine support of the PBCR use as well as how the water quality target for TMDLs was defined for each bacterial indicator.

(a). ***Scope.***

The provisions of this Section shall be used to determine whether the subcategory of Primary Body Contact of the beneficial use of Recreation designated in OAC 785:45 for a waterbody is supported during the recreation season from May 1 through September 30 each year. Where data exist for multiple bacterial indicators on the same waterbody or waterbody segment, the determination of use support shall be based upon the use and application of all applicable tests and data.

(b). ***Escherichia coli (E. coli).***

(1) *The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).*

(2) *The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).*

(c). ***Enterococci.***

(1) *The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).*

(2) *The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).*

Compliance with the Oklahoma WQS is based on meeting requirements for both *E. coli* and Enterococci bacterial indicators in addition to the minimum sample requirements for assessment. Where concurrent data exist for multiple bacterial indicators on the same waterbody or waterbody segment, each indicator group must demonstrate compliance with the numeric criteria prescribed (OWRB 2013).

As stipulated in the WQS, only the geometric mean of all samples collected over the primary recreation period shall be used to assess the impairment status of a stream segment. Therefore, only the geometric mean criteria will be used to develop TMDLs for *E. coli* and Enterococci.

2.1.3 Chapter 45: Criteria for Turbidity

The beneficial use of WWAC is one of several subcategories of the Fish and Wildlife Propagation use established to manage the variety of communities of fish and shellfish throughout the State (OWRB 2013). The numeric criteria for turbidity to maintain and protect the use of "Fish and Wildlife Propagation" from Title 785:45-5-12(f)(7) is as follows:

(A) *Turbidity from other than natural sources shall be restricted to not exceed the following numerical limits:*

- *i. Cool Water Aquatic Community/Trout Fisheries: 10 NTUs;*
- *ii. Lakes: 25 NTU; and*
- *iii. Other surface waters: 50 NTUs.*

(B) *In waters where background turbidity exceeds these values, turbidity from point sources will be restricted to not exceed ambient levels.*

(C) *Numerical criteria listed in (A) of this paragraph apply only to seasonal base flow conditions.*

(D) *Elevated turbidity levels may be expected during, and for several days after, a runoff event.*

2.1.4 Chapter 46: Implementation of OWQS for Fish and Wildlife Propagation

Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2013a) describes Oklahoma's WQS for Fish and Wildlife Propagation. The following excerpt (785:46-15-5) stipulates how water quality data will be assessed to determine support of fish and wildlife propagation as well as how the water quality target for TMDLs will be defined for turbidity:

<u>Assessment of Fish and Wildlife Propagation support</u>

(a). *Scope. The provisions of this Section shall be used to determine whether the beneficial use of Fish and Wildlife Propagation or any subcategory thereof designated in OAC 785:45 for a waterbody is supported.*

(e). *Turbidity. The criteria for turbidity stated in 785:45-5-12(f)(7) shall constitute the screening levels for turbidity. The tests for use support shall follow the default protocol in 785:46-15-4(b).*

785:46-15-4. Default protocols

(b). *Short term average numerical parameters.*

(1) Short term average numerical parameters are based upon exposure periods of less than seven days. Short term average parameters to which this Section applies include, but are not limited to, sample standards and turbidity.

(2) A beneficial use shall be deemed to be fully supported for a given parameter whose criterion is based upon a short term average if 10% or less of the samples for that parameter exceeds the applicable screening level prescribed in this Subchapter.

(3) A beneficial use shall be deemed to be fully supported but threatened if the use is supported currently but the appropriate state environmental agency determines that available data indicate that during the next five years the use may become not supported due to anticipated sources or adverse trends of pollution not prevented or controlled. If data from the preceding two year period indicate a trend away from impairment, the appropriate agency shall remove the threatened status.

(4) A beneficial use shall be deemed to be not supported for a given parameter whose criterion is based upon a short term average if at least 10% of the samples for that parameter exceed the applicable screening level prescribed in this Subchapter.

2.1.5 Prioritization of TMDL Development

Table 2-2 summarizes the PBCR and WWAC use attainment status and the bacterial and turbidity impairment status for streams in the Study Area. The TMDL priority shown in **Table 2-2** is directly related to the TMDL target date. The TMDLs established in this report, which are a necessary step in the process of restoring water quality, only address bacterial and/or turbidity impairments that affect the PBCR and WWAC beneficial uses.

After the 303(d) list is compiled, DEQ assigns a four-level rank to each of the Category 5a waterbodies. This rank helps in determining the priority for TMDL development. The rank is based on criteria developed using the procedure outlined in the 2012 Continuing Planning Process (pp. 139-140). The TMDL prioritization point totals calculated for each watershed were broken down into the following four priority levels[1]:

Priority 1 watersheds - above the 90th percentile (32 watersheds)

Priority 2 watersheds - 70th to 90th percentile (64 watersheds)

Priority 3 watersheds - 40th to 70th percentile (81 watersheds)

Priority 4 watersheds - below the 40th percentile (141 watersheds)

Each waterbody on the 2012 303(d) list has been assigned a potential date of TMDL development based on the priority level for the corresponding HUC 11 watershed. Priority 1 watersheds are targeted for TMDL development within the next two years.

[1] Appendix C, 2012 Integrated Report

Table 2-2 Excerpt from the 2012 Integrated Report – Oklahoma 303(d) List of Impaired Waters (Category 5)

Waterbody ID	HUC 8	Waterbody Name	Stream Miles	TMDL Date	Priority	ENT	*E. coli*	Designated Use Primary Body Contact Recreation	Turbidity	Designated Use Warm Water Aquatic Life
OK520500010170_00	11100302	Bad Creek	19.11	2017	2		X	N		F
OK520500010200_00	11100302	Alabama Creek	14.20	2017	2	X	X	N		F
OK520500020010_00	11100302	Wewoka Creek	42.99	2017	2		X	N		
OK520500020020_00	11100302	Greasy Creek	18.51	2023	4			I	X	N
OK520500020090_00	11100302	Little Wewoka Creek	20.44	2023	4	X	X	N		F
OK520700010140_00	11100303	Coal Creek	21.72	2017	2				X	N

ENT = Enterococci; N = Not attaining; X = Criterion exceeded

Source: 2012 Integrated Report, DEQ 2013

2.2 Problem Identification

In this subsection, water quality data summarizing waterbody impairments caused by elevated levels of bacteria are summarized first followed by the data summarizing impairments caused by elevated levels of turbidity.

2.2.1 Bacterial Data Summary

Table 2-3 summarizes water quality data collected during primary contact recreation season from the WQM stations between 2003 and 2010 for each indicator bacteria. The data summary in **Table 2-3** provides a general understanding of the amount of water quality data available and the severity of exceedances of the water quality criteria. This data collected during the primary contact recreation season was used to support the decision to place specific waterbodies within the Study Area on the DEQ 2012 303(d) list (DEQ 2013). Water quality data from the primary contact recreation season are provided in **Appendix A**. For the data collected between 2003 and 2010, evidence of nonsupport of the PBCR use based on Enterococci and E.coli exceedances was observed in two waterbodies: Alabama Creek (OK520500010200_00) and Little Wewoka Creek (OK520500020090_00). Evidence of nonsupport of the PBCR use based on *E. coli* exceedances was observed in two waterbodies: Bad Creek (OK520500010170_00) and Little Wewoka Creek (OK520500020090_00). Rows highlighted in green in **Table 2-3** required TMDLs.

2.2.2 Turbidity Data Summary

Turbidity is a measure of water clarity and is caused by suspended particles in the water column. Because turbidity cannot be expressed as a mass load, total suspended solids (TSS) are used as a surrogate in this TMDL. Therefore, both turbidity and TSS data are presented in this subsection.

Table 2-4 summarizes water quality data collected from the WQM stations between 2009 and 2010 for turbidity. However, as stipulated in Title *785:45-5-12 (f)(7)(C)*, numeric criteria for turbidity only apply under base flow conditions. While the base flow condition is not specifically defined in the Oklahoma WQS, DEQ considers base flow conditions to be all flows less than the 25th flow exceedance percentile (i.e., the lower 75% of flows) which is consistent with the USGS Streamflow Conditions Index (USGS 2009). Therefore, **Table 2-5** was prepared to represent the subset of these data for samples collected during base flow conditions. In using TSS as a surrogate to support TMDL development, at least 10 TSS samples were required to conduct the regression analysis between turbidity and TSS. Samples collected from 2009-2010 showed that Greasy Creek and Coal Creek were not impaired for turbidity.The water quality data analyzed for turbidity and TSS are provided in **Appendix A**.

2.3 Water Quality Target

The Code of Federal Regulations (40 CFR §130.7(c)(1)) states that, "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards." The water quality targets for *E. coli* and Enterococci are geometric mean standards of 126 cfu/100ml and 33 cfu/100ml, respectively. The TMDL for bacteria will incorporate an explicit 10% margin of safety.

An individual water quality target established for turbidity must demonstrate compliance with the numeric criteria prescribed in the Oklahoma WQS (OWRB 2013). According to the Oklahoma WQS [785:45-5-12(f)(7)], the turbidity criterion for streams with WWAC beneficial use is 50 NTUs (OWRB 2013). The turbidity of 50 NTUs applies only to seasonal base flow conditions. Turbidity levels are expected to be elevated during, and for several days after, a storm event.

TMDLs for turbidity in streams designated as WWAC must take into account that no more than 10% of the samples may exceed the numeric criterion of 50 NTU. However, no turbidity TMDLs were developed in this report.

Table 2-3 Summary of Assessment of Indicator Bacterial Samples from Primary Body Contact Recreation Subcategory Season May 1 to September 30, 2003-2010

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Conc (cfu/100 ml)	Assessment Results
OK520500010170_00	Bad Creek	*E. coli*	19	157.6	TMDL Required
OK520500010200_00	Alabama Creek	*E. coli*	19	141.4	TMDL Required
		ENT	19	203.0	TMDL Required
OK520500020010_00	Wewoka Creek	*E. coli*	42	185.7	TMDL Required
OK520500020090_00	Little Wewoka Creek	*E. coli*	19	198.2	TMDL Required
		ENT	19	155.7	TMDL Required

Enterococci (ENT) water quality criterion = Geometric Mean of 33 counts/100 mL E.coli (EC) water quality criterion = Geometric Mean of 126 counts/100 mL

Table 2-4 Summary of All Turbidity Samples, 2009-2010

Waterbody ID	Waterbody Name	WQM Stations	Number of turbidity samples	Number of samples greater than 50 NTU	% samples exceeding criterion	Average Turbidity (NTU)
OK520500020020_00	Greasy Creek	OK520500020020_00	12	0	0%	13
OK520700010140_00	Coal Creek	OK520700010140_00	12	0	0%	17

Table 2-5 Summary of Turbidity Samples Excluding High Flow Samples, 2009-2010

Waterbody ID	Waterbody Name	WQM Stations	Number of turbidity samples	Number of samples greater than 50 NTU	% samples exceeding criterion	Average Turbidity (NTU)	Assessment Results
OK520500020020_00	Greasy Creek	OK520500020020_00	12	0	0%	13	Delist: No violation
OK520700010140_00	Coal Creek	OK520700010140_00	12	0	0%	17	Delist: No violation

SECTION 3 POLLUTANT SOURCE ASSESSMENT

3.1 OVERVIEW

A pollutant source assessment characterizes known and suspected sources of pollutant loading to impaired waterbodies. Sources within a watershed are categorized and quantified to the extent that information was available. Pathogen indicator bacteria originate from the digestive tract of warm-blooded animals, and sources may be point or nonpoint in nature. Turbidity may originate from OPDES-permitted facilities, fields, construction sites, quarries, stormwater runoff and eroding stream banks.

Point sources are permitted through the OPDES program. OPDES-permitted facilities that discharge treated wastewater are currently required to monitor for fecal coliform in accordance with their permits. The discharges with bacterial limits will be required to monitor for *E. coli* when their permits come to renew. Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody through a discrete conveyance at a single location. Nonpoint sources may emanate from land activities that contribute bacteria or TSS to surface water as a result of rainfall runoff. For the TMDLs in this report, all sources of pollutant loading not regulated by OPDES permits are considered nonpoint sources.

The potential nonpoint sources for bacteria were compared based on the fecal coliform load produced in each subwatershed. Although fecal coliform is no longer used as a bacterial indicator in the Oklahoma WQS, it is still valid to use fecal coliform concentration or loading estimates to compare the potential contributions of different nonpoint sources because *E. coli* is a subset of fecal coliform. Currently, there is insufficient data available in the scientific arena to quantify counts of *E. coli* in feces from warm-blooded animals.

The following nonpoint sources of bacteria were considered in this Report:

- Wildlife (deer)
- Non-Permitted Agricultural Activities and Domesticated Animals
- Pets (dogs and cats)
- Failing Onsite Wastewater Disposal (OSWD) Systems and Illicit Discharges

The 2012 Integrated Water Quality Assessment Report (DEQ 2013) listed potential sources of turbidity as:

- Clean sediment
- Grazing in riparian corridors of streams and creeks
- Highway/road/bridge runoff (non-construction related)
- Non-irrigated crop production
- Petroleum/natural gas activities
- Rangeland grazing
- Unknown sources

The following discussion describes what is known regarding point and nonpoint sources of bacteria in the impaired watersheds. Where information was available on point and nonpoint sources of indicator bacteria, data were provided and summarized as part of each category.

3.2 OPDES-Permitted Facilities

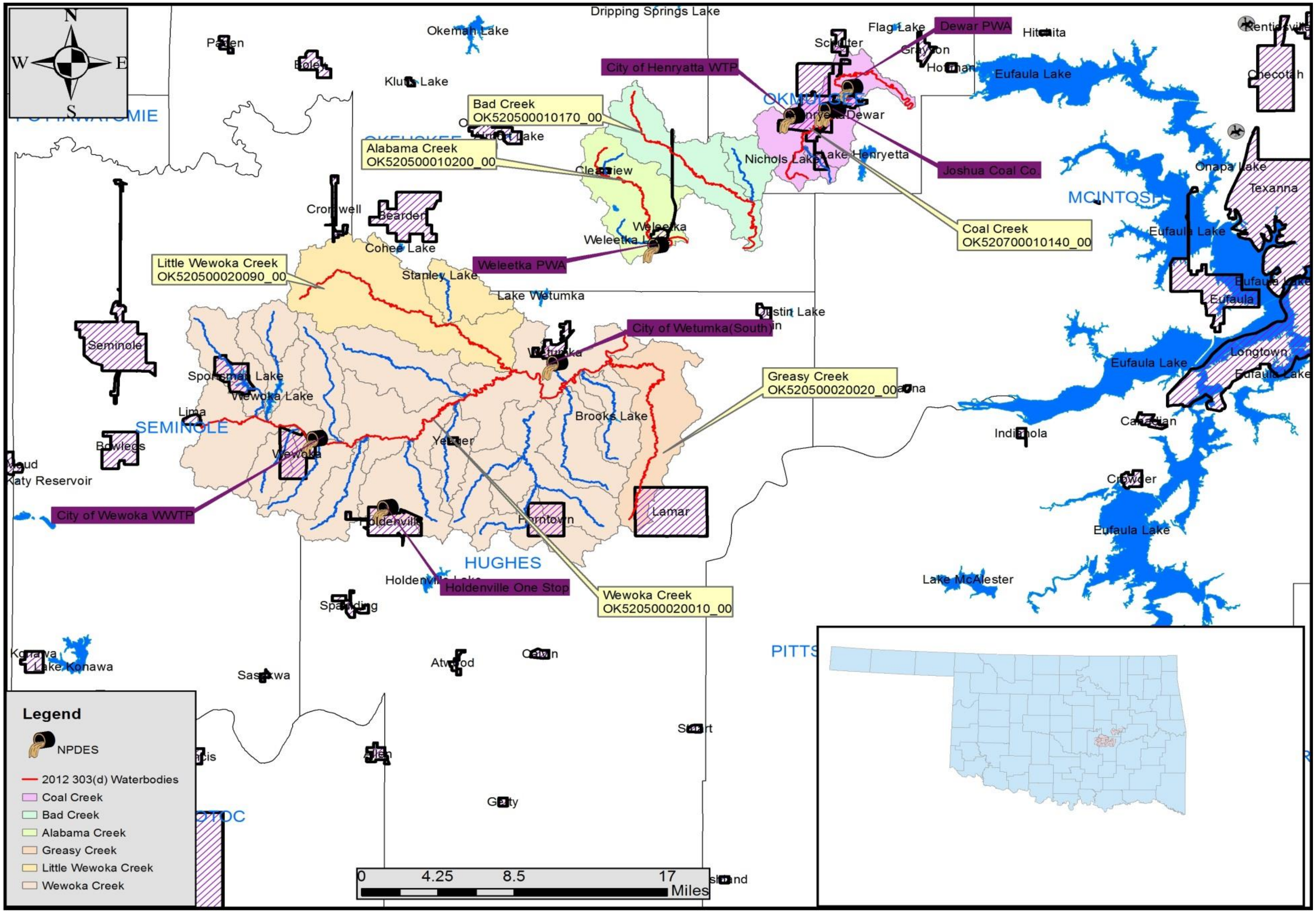
Under 40 CFR, §122.2, a point source is described as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. OPDES-permitted facilities classified as point sources that may contribute bacterial or TSS loading includes:

- Continuous Point Source Dischargers
  - OPDES municipal wastewater treatment facilities (WWTF)
  - OPDES Industrial WWTF Discharges
- OPDES-regulated stormwater discharges
  - Municipal separate storm sewer system (MS4) discharges
    - Phase 1 MS4
    - Phase 2 MS4 – OKR04
  - Multi-sector general permits (OKR05)
  - Construction stormwater discharges (OKR10)
- No-discharge WWTF
- Sanitary sewer overflow (SSO)
- NPDES Animal Feeding Operations (AFO)
  - Concentrated Animal Feeding Operations (CAFO)
  - Swine Feeding Operation (SFO)
  - Poultry Feeding Operation (PFO)

Three watersheds in the Study Area [Bad Creek, Greasy Creek, and Little Wewoka Creek] do not have any OPDES permitted facilities within their watershed. There is at least one OPDES-permitted facility in each of the remaining three watersheds in the Study Area [Alabama Creek, Wewoka Creek, and Coal Creek].

While the no-discharge facilities do not discharge wastewater directly to a waterbody, it is possible that the collection systems associated with each facility may be a source of bacterial loading to surface waters. AFOs are recognized by EPA as potential significant sources of pollution, and may have the potential to cause serious impacts to water quality if not properly managed (ODAFF 2014), as with all other pollutant sources in this report.

Figure 3-1 Location of the OPDES-Permitted Facility in the Study Area



3.2.1 Continuous Point Source Dischargers

Continuous point source discharges such as WWTFs could result in discharge of elevated concentrations of indicator bacteria if the disinfection unit is not properly maintained, is of poor design, or if flow rates are above the disinfection capacity. While the no-discharge facilities do not discharge wastewater directly to a waterbody, it is possible that continuous point source discharges from municipal and industrial WWTFs could result in discharge of elevated concentrations of TSS if a facility is not properly maintained, is of poor design, or flow rates exceed capacity. However, in most cases suspended solids discharged by WWTFs consist primarily of organic solids rather than inorganic suspended solids (i.e., soil and sediment particles from erosion or sediment resuspension). Discharges of organic suspended solids from WWTFs are addressed by DEQ through its permitting of point sources to maintain WQS for dissolved oxygen and are not considered a potential source of turbidity in this TMDL. Discharges of TSS will be considered to be organic suspended solids if the discharge permit includes a limit for Biochemical Oxygen Demand (BOD) or Carbonaceous Biochemical Oxygen Demand (CBOD). Only WWTF discharges of inorganic suspended solids were considered and received WLAs.

The locations of the OPDES-permitted facilities that discharge wastewater to surface waters addressed in these TMDLs are listed in **Table 3-1** and displayed in **Figure 3-1**. The three facilities highlighted in **Table 3-1** received WLAs. The other three point source dischargers did not receive a WLA because the receiving stream, Coal Creek, is not impaired for bacteria or turbidity.

Table 3-1 Point Source Discharges in the Study Area

Waterbody ID & Waterbody Name	OPDES Permit No.	Facility	SIC code	Facility Type	Design Flow (mgd)	Ave/Max FC cfu/100mL	Avg TSS mg/L	Expiration Date	Notes
Alabama Creek OK520500010200_00	OK0028525	**Weleetka PWA**	4952	Sewerage system	0.144	-	90	4/30/2016	Active
Wewoka Creek OK520500020010_00	OK0032417	**City of Wetumka**	4952	Sewerage system	0.102	200/400	90	12/31/2017	Active
	OK0028266	**Holdenville One Stop**	5541		NA	-	-	-	Inactive
	OK0022659	**City of Wewoka**	4952	Sewerage system	0.58	200/400	30	7/31/2015	Active
Coal Creek OK520700010140_00	OK0002551	**City of Henryetta**	4941	Water treatment plant	3.3	-	-	11/30/2015	Active
	OK0028266	**City of Henryetta**	4952	Sewerage system	2.18	200/400	30	5/31/2015	Active
	OK0027537	**Dewar PWA**	4952	Sewerage system	0.14	200/400	90	1/31/2017	Active

Waterbody ID & Waterbody Name	OPDES Permit No.	Facility	SIC code	Facility Type	Design Flow (mgd)	Ave/Max FC cfu/100mL	Avg TSS mg/L	Expiration Date	Notes
Coal Creek OK520700010140_00	OK003024	**Anchor Glass Container Corp Henryetta**	3221	Glass containers	NA	-	-	-	Discharges go to the City of Henryetta
	OKG040023	**Joshua Coal Co.-Joshua mine**	1221	Coal mining	NA	-	-	-	Inactive

NA = not available or not applicable.

3.2.1.1 Municipal OPDES WWTFs

In this Study Area there are six OPDES-permitted municipal facilities. However, only three received a WLA. The Weeletka PWA WWTF, City of Wetumka's WWTF, and the City of Wewoka's WWTF are municipal continuous point source facilities that discharge wastewater into Alabama and Wewoka Creeks. These facilities are listed in **Table 3-1** and displayed in **Figure 3-1**. The above mentioned WWTF facilities discharge TSS and have specific permit limits for TSS which is listed in **Table 3-1**. However, because municipal WWTFs designated with a Standard Industrial Code number 4952 discharge organic TSS; these facilities are not considered potential sources of turbidity within their respective watersheds.

3.2.1.2 Industrial OPDES WWTFs

There are two inactive OPDES industrial point source dischargers in the Study Area: Holdenville One Stop (OK0028266) and Joshua Coal Company (OKG040023) in Hughes and Okmulgee Counties respectively. Although Anchor Glass Container Corporation is located in the study area, the facility discharges to the City of Henryetta.

3.2.2 Stormwater Permits

Stormwater runoff from OPDES-permitted facilities (MS4s, facilities with multi-sector general permits, and construction sites) can contain impairments. EPA regulations [40 C.F.R. §130.2(h)] require that NPDES-regulated stormwater discharges must be addressed by the WLA component of a TMDL. However, any stormwater discharge by definition occurs during or immediately following periods of rainfall and elevated flow conditions when Oklahoma Water Quality Standard for turbidity does not apply. OWQS specify that the criteria for turbidity "apply only to seasonal base flow conditions" and go on to say "Elevated turbidity levels may be expected during, and for several days after, a runoff event" [OAC 785:45-5-12(f)(7)]. In other words, the turbidity impairment status is limited to base flow conditions so permitted stormwater discharges do not impair streams with TSS. Therefore, TSS WLAs for NPDES-regulated stormwater discharges were considered unnecessary in this TMDL report and were not included in the TMDL calculations. Stormwater runoff from permitted areas can contain high fecal coliform concentrations.

3.2.2.1 Municipal Separate Storm Sewer System Permit

3.2.2.1.1 Phase I MS4

In 1990, EPA developed Phase I of the NPDES Stormwater Program. This program was designed to prevent harmful pollutants in MS4s from being washed by stormwater runoff into local waterbodies (EPA 2005). Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality-related issues, including roadway runoff management, municipal-owned operations, and hazardous waste treatment. There are no Phase I MS4 communities in the Study Area.

3.2.2.1.2 Phase II MS4 (OKR04)

In 1999, Phase II began requiring certain small MS4s to comply with the NPDES stormwater program. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES Stormwater Program. Phase II requires operators of regulated small MS4s to obtain NPDES permits and develop a stormwater management program. Programs are designed to reduce discharges of pollutants to the "maximum extent practicable," to protect water quality, and to satisfy appropriate water quality requirements of the CWA. Phase II MS4 stormwater programs must address the following six minimum control measures:

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post- Construction Runoff Control
- Pollution Prevention/Good Housekeeping

In Oklahoma, the Phase II General Permit (OKR04) for small MS4 communities has been in effect since 2005. Information about DEQ's MS4 program can be found on-line at the following DEQ website: www.deq.state.ok.us/WQDnew/stormwater/ms4/. There are no Phase II MS4 communities in the Study Area.

3.2.2.2 Multi-Sector General Permits (MSGP)

A DEQ multi-sector industrial general permit (MSGP) is required for stormwater discharges from all industrial facilities (DEQ 2011) whose Standard Industrial Classification (SIC) code is listed on Table 1-2 of the MSGP. Stormwater discharges from all industrial facilities occur only during or immediately following periods of rainfall and elevated flow conditions. Since turbidity criteria do not apply during these periods, stormwater was not considered a potential source of turbidity impairment. There are no facilities within the Study Area with multi-sector general permits and no stream segments found to be impaired for turbidity.

3.2.2.2.1 Regulated Sector J Discharges

Sector J facilities include crushed stone, construction sand & gravel, and industrial sand mines. The activities in these facilities include the exploration and mining of minerals (e.g., stone, sand, clay, chemical and fertilizer minerals, non-metallic minerals, etc.). A "*mine*" refers to an area of land actively mined for the production of sand and gravel from natural deposits. Under the MSGP (OKR05), effluent from Sector J facilities include stormwater discharges associated with industrial activity from active and inactive mineral mining and mine dewatering. "*Mine dewatering*" is any water that is impounded or that collects in the mine and is pumped, drained, or otherwise removed from the mine through the efforts of the mine operator. This term also includes wet pit overflows caused solely by direct rainfall and uncontaminated ground water seepage. Specific requirements for Sector J stormwater discharges can be found in Part 12 of the MSGP. Specific effluent limitation guidelines for Sector J SIC codes (1422 - 1429, 1442, 1446) are referenced in Table 1-3 of the MSGP. The effluent guidelines [40 CFR part 436, Subpart B, C and D] are adopted by reference in the OPDES under OAC 252:606-1-3(b)(8).

Mine dewatering discharges can happen at any time and have the following specific effluent limitations:

- pH 6.0 to 9.0
- TSS Daily Maximum: 45 mg/L
- TSS Monthly Average: 25 mg/L

But none of the stream segments in this Study Area was impaired for turbidity.

3.2.2.2.2 Rock, Sand and Gravel Quarries

Stormwater from rock, sand and gravel quarries in Oklahoma fall under the MSGP. But **wastewater** generated at quarries is regulated under DEQ General Permit OKG950000. Wastewater discharges regulated by this Permit are process wastewater and stormwater runoff that comes in direct contact with active process areas associated with the mining of stone, sand, and gravel; cutting stone; crushing stone to size; washing and stockpiling of processed stone and sand; and washing and maintenance areas of vehicles and equipment. Permitted activities include discharge of industrial wastewater, construction or operation of industrial surface water impoundments, land application of industrial wastewater for dust suppression, and recycling of wastewater as wash water or cooling water.

Wastewater and stormwater runoff from mining activities have the potential to contain elevated suspended solids and elevated pH due to contact with minerals. Suspended solids, as well as fugitive dust from operations, are a potential source of metals. Oil and grease may be generated due to equipment washing activities.

General Permit OKG950000 does not allow discharge of wastewater into Outstanding Resource Waters, High Quality Waters, Sensitive Public & Private Water Supplies, and Appendix B Waters [OAC 785:45-5-25(c)(2)]. In addition, no discharge is allowed into waterbodies listed as impaired for turbidity in Oklahoma's 303(d) list for which a TMDL has not been performed. Discharges into turbidity-impaired streams are also not allowed if their TMDL indicated that discharge limits more stringent than 45 mg/l for TSS or 6.5-9.0 standard units for pH are required (DEQ 2013).

The General Permit contains technology-based effluent limits of 45 mg/L for TSS, 15 mg/L for oil and grease, and pH range of 6.0–9.0. However, the Permit includes a provision that when exceedances of water quality criteria are determined to be the result of a facility's discharge to receiving waters, DEQ may determine that the facility is no longer eligible for coverage under the General Permit. DEQ will then require the facility to apply for an individual discharge permit with additional chemical-specific limits or toxicity testing requirements as necessary to protect the beneficial uses of the receiving stream.

The General Permit isn't applicable in this TMDL report because there are no rock/sand/gravel quarries located in the Study Area.

3.2.2.3 General Permit for Construction Activities

A DEQ stormwater general permit for construction activities is required for any stormwater discharges in the State of Oklahoma associated with construction activities that result in land disturbance equal to or greater than one acre or less than one acre if they are part of a larger common plan of development or sale that totals at least one acre. The permit also authorizes any stormwater discharges from support activities (e.g. concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, and borrow areas) that are directly related to a construction site that is required to have permit coverage and is not a commercial operation serving unrelated different sites (DEQ 2012). Stormwater discharges occur only during or immediately following periods of rainfall and elevated flow conditions when the turbidity criteria do not apply. Therefore, stormwater was not considered possible contributor to turbidity impairment. The permits for construction projects that were active during the time period that samples were taken are summarized in **Table 3-2** and shown in **Figure 3-1**.

Table 3-2 Construction Permits Summary

Company Name	County	Permit ID	Date Issued	Waterbody ID	Receiving Water (Permit)	Estimated Acres
Davis Correctional Facility	Hughes	8236	9/27/2007	OK520500020010_00	Jacobs Creek, Trib to Wewoka Creek	10

3.2.3 No-Discharge Facilities

Certain municipal facilities are classified as no-discharge. These facilities are required to sign an affidavit of no discharge. For the purposes of these TMDLs, it was assumed that no-discharge facilities do not contribute indicator bacterial or TSS loading. While no-discharge facilities do not discharge wastewater directly to a waterbody, it was possible that the collection systems associated with each facility could be a source of bacterial loading to surface waters. For example, discharges from the wastewater facility may occur during large rainfall events that exceed the systems' storage capacities. The City of Henryetta's WWTF has a land application site in the Study Area (see **Table 3-3**). This facility is located in the Coal Creek (OK520700010140_00) watershed which is not impaired.

Table 3-3 OPDES No-Discharge Facilities in the Study Area

Facility	Facility ID	County	Facility Type	Type	Waterbody ID	Waterbody Name
Henryetta WWTF	S-20722	Okmulgee	Land Application	Municipal	OK520700010140_00	Coal Creek

3.2.4 Sanitary Sewer Overflows

Sanitary sewer overflow (SSO) from wastewater collection systems, although infrequent, can be a major source of indicator bacterial loading to streams. SSOs have existed since the introduction of separate sanitary sewers, and most are caused by blockage of sewer pipes by grease, tree roots, and other debris that clog sewer lines, by sewer line breaks and leaks, cross connections with storm sewers, and inflow and infiltration of groundwater into sanitary sewers. SSOs are permit violations that must be addressed by the responsible OPDES permittee. The reporting of SSOs has been strongly encouraged by EPA, primarily through enforcement and fines. While not all sewer overflows are reported, DEQ has some data on SSOs reported between 2000 and 2013. During that period, 386 overflows were reported ranging from a minimal quantity to over 90,000 gallons. **Table 3-4** summarizes the SSO occurrences by OPDES facilities. Historical data of reported SSOs are provided in **Appendix D**.

Table 3-4 Sanitary Sewer Overflow Summary (2000-2013)

Facility Name	OPDES Permit No.	Receiving Water	Facility ID	Number of Occurrences	Date Range		Amount (Gallons)	
					From	To	Min	Max
Weleetka PWA	OK0028525	Alabama Creek OK520500010200_00	S-20562	21	2002	2013	NA	50,000
City of Wewoka	OK0022659	Wewoka Creek OK520500020010_00	S-20558	186	2000	2013	NA	NA
City of Wetumka	OK0032417	Wewoka Creek OK520500020010_00	S-20560	1	2007	2013	NA	NA
City of Henryetta	OK0028266	Coal Creek OK520700010140_00	S-20722	151	2000	2013	NA	90,000
Dewar PWA	OK0027537	Coal Creek OK520700010140_00	S-20723	27	2003	2013	NA	1,000

NA = not available

3.2.5 Animal Feeding Operations

The Agricultural Environmental Management Services (AEMS) of the Oklahoma Department of Agriculture, Food and Forestry (ODAFF) was created to help develop, coordinate, and oversee environmental policies and programs aimed at protecting the Oklahoma environment from pollutants associated with agricultural animals and their waste. ODAFF is the NPDES-permitting authority for animal feeding operations in Oklahoma under what ODAFF calls the Agriculture Pollutant Discharge Elimination System (AgPDES). Through regulations (rules) established by the Oklahoma Concentrated Animal Feeding Operation (CAFO) Act (Title 2, Chapter 1, Article 20 – 40 to Article 20 – 64 of the State Statutes), Swine Feeding Operation (SFO) Act (Title 2, Chapter 1, Article 20 – 1 to Article 20 – 29 of the State Statutes), and Poultry Feeding Operation (PFO) Registration Act (Title 2, Chapter 10-9.1 to 10-9.25 of the State Statutes), AEMS works with producers and concerned citizens to ensure that animal waste does not impact the waters of the State. All of these animal feeding operations (AFO) require an Animal Waste Management Plan (AWMP) to prevent animal waste from entering any Oklahoma waterbody. These plans outline how the animal feeding operator will prevent direct discharges of animal waste into waterbodies as well as any runoff of waste into waterbodies. The rules for all of these AFOs recommend using the USDA NRCS' Agricultural Waste Management Field Handbook to develop their Plan. NRCS has developed Animal Waste Management software to develop this Plan.

3.2.5.1 CAFO

A CAFO[1] is an animal feeding operation that confines and feeds at least 1,000 animal units for 45 days or more in a 12-month period (ODAFF 2014). Animal Waste Management Plans (Section 35:17-4-12), as specified in Oklahoma's CAFO regulations, are designed to protect water quality through the use of best management practices (such as dikes, berms, terraces, ditches) to isolate animal waste from outside surface drainage, except for a 25-year, 24–hour rainfall event. AWMPs may include, but are not limited to, a Comprehensive Nutrient Management Plan per NRCS guidance or Nutrient Management Plan per EPA guidance.

CAFOs are designated by EPA as significant sources of pollution, and may have the potential to cause serious impacts to water quality if not managed properly (ODAFF 2014),as with all other pollutant sources in this report. Potential problems for CAFOs can include animal waste discharges to waters of the State and failure to properly operate wastewater lagoons. CAFOs are considered no-discharge facilities for the purpose of the TMDL calculations in this report. Runoff of animal waste into surface waterbodies or groundwater is prohibited. CAFOs are not considered a source of TSS loading.

Oklahoma CAFO Rules require CAFOs to submit a *Documentation of No Hydrologic Connection* (OAC 35:17-4-10[2]) for all retention structures designed to prevent any leakage of wastewater into waterbodies. Thus, the potential for pollutant loading from CAFOs to a receiving stream is almost non-existent.

There are no CAFOs located in this Study Area.

3.2.5.2 SFO

The purpose of the SFO Act is to provide for environmentally responsible construction and expansion of swine feeding operations and to protect the safety, welfare and quality of life of persons who live in the vicinity of a swine feeding operation.[3] According to the SFO Act, a "Concentrated swine feeding operation" is a lot or facility where swine kept for at least ninety (90) consecutive days or more in any twelve-month period and where crops, vegetation, forage growth or post-harvest residues are not grown during the normal growing season on any part of the lot.

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1 Concentrated Animal Feeding Operations (CAFO) Animal Waste Management Plan Requirements [Title 35 (ODAFF), Chapter 17 (Water Quality), Subchapter 4] can be found in 35:17-4-12.

2 USDA NRCS design specifications in the USDA NRCS Agricultural Waste Management Field Handbook Chapter 10 shall satisfy documentation of no hydrologic connection so long as the facility is designed by USDA NRCS and does not exceed one thousand (1,000) animal units.

3 A concentrated swine feeding operation has at least 750 swine that each weighs over 25 kilograms (about 55 pounds), 3,000 weaned swine weighing under 25 kilograms, or 300 swine animal units. A swine animal unit is a unit of measurement for any swine feeding operation calculated by adding the following numbers: The number of swine weighing over twenty-five (25) kilograms, multiplied by four-tenths (0.4), plus the number of weaned swine weighing under twenty-five (25) kilograms multiplied by one-tenth (0.1)

SFOs are required to develop a Swine Waste Management Plan[4], to prevent swine waste from being discharged into surface or groundwaters. This Plan includes the BMPs being used to prevent runoff & erosion. The Swine Waste Management Plan may include, but is not limited to, a Comprehensive Nutrient Management Plan (CNMP) per NRCS guidance or Nutrient Management Plan (NMP) per EPA guidance. SFOs are required to store wastewater in Waste Retention Structures (WRS) and either to land apply wastewater or make the WRS large enough to be total retention lagoons. SFOs are not allowed to discharge to State waterbodies.

For large SFO with more than 1,000 animal units, monitoring wells or leakage detection system for waste retention structures are required to install to monitor and control seepage/leakage (OAC 35:17-3-11 (e) (6). Oklahoma Rules requires SFOs submitting Documentation of No Hydrologic Connection (OAC 35:17-3-12) for all retention structures to prevent any leaking of wastewater to waterbodies. Thus, the potential for loading from SFOs to the receiving stream is almost non-existent. There are 15 SFOs in this Study Area. Most of the SFOs in Oklahoma are not operating at the capacity allowed in their license. The location of each SFO is shown in **Figure 3-2** and listed in **Table 3-5**.

Table 3-5 NPDES-Permitted SFOs in Study Area

ODAFF Owner ID	EPA Facility	ODAFF License #	Max # of Swine >55 lbs units at facility	Max # of Swine <55 lbs units at facility	Total # of Animal Units at Facility	County	Waterbody ID & Waterbody Name
WQ0000068	OKU000271	970036	0	1000	1000	Hughes	Wewoka Creek OK520500020010_00
WQ0000167	OKU000274	1467	1000	0	1000		
AGN025421	OKG010181	1224	960	0	960		
AGN025419	OKG010180	1222	800	0	800		
AGN028984	OKG010296	1296	0	1000	1000		
AGN025420	OKG010197	1223	900	100	1000		
AGN035233	OKU000230	1462	0	1000	1000		
AGN025899	OKG010253	1227	360	100	460		
AGN025418	OKG010179	1221	900	100	1000		
AGN031722	OKG010295	1377	2304	0	2304		
AGN034122		1452	250	0	250		
AGN035050	OKU000378	1461	560	0	560		
AGN034680		1457	308	0	308		
AGN025417	OKG010186	1220	980	0	980	Seminole	
WQ0000082	OKU000468	970037	0	1000	1000		

4 Swine Animal Waste Management Plan Requirements [Title 35 (ODAFF), Chapter 17 (Water Quality), Subchapter 3 (Swine Feeding Operations)] can be found in 35:17-3-14.

3.2.5.3 PFO

Poultry feeding operations not licensed under the Oklahoma Concentrated Animal Feeding Operation Act must register with the State Board of Agriculture. A registered PFO is an animal feeding operation which raises poultry and generates more than 10 tons of poultry waste (litter) per year. PFOs are required to develop an AWMP or an equivalent nutrient management plan (NMP) such as the ODAFF Nutrient Management Plan or EPA Nutrient Management Plan. These plans describe how litter will be stored and applied properly in order to protect water quality of streams and lakes located in the watershed. Applicable BMPs shall be included in the Plan. Per data provided by ODAFF in May 2011, there are no PFOs located in this Study Area.

3.2.6 Section 404 permits

Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Activities in waters of the United States regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports) and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States, unless the activity is exempt from Section 404 regulation (e.g. certain farming and forestry activities). Discharge of dredged or fill material in waters can be a significant source of turbidity/TSS. The State of Oklahoma uses its Section 401 Certification authority to ensure Section 404 Permits protect Oklahoma WQS.

Section 404 Permits are administrated by the U.S. Army Corps of Engineers (USACE). EPA reviews and provides comments on each permit application to make sure it adequately protects water quality and complies with applicable guidelines. Both USACE and EPA can take enforcement actions for violations of Section 404.

3.3 Nonpoint Sources

Nonpoint sources include those sources that cannot be identified as entering the waterbody at a specific location. The relatively homogeneous land use/land cover categories throughout the Study Area associated with rural agricultural, forest and range management activities has an influence on the origin and pathways of pollutant sources to surface water. Bacteria originate from warm-blooded animals in rural, suburban, and urban areas. These sources include wildlife, various agricultural activities and domesticated animals, land application fields, urban runoff, failing OSWD systems and domestic pets. Water quality data collected from streams draining urban communities often show existing concentrations of fecal coliform bacteria at levels greater than a state's water quality standards. A study under EPA's National Urban Runoff Project indicated that the average fecal coliform concentration from 14 watersheds in different areas within the United States was approximately 15,000/100 mL in stormwater runoff (EPA 1983). Runoff from urban areas not permitted under the MS4 program can be a significant source of fecal coliform bacteria. Water quality data collected from streams draining many of the non-permitted communities show a high level of fecal coliform bacteria. Various potential nonpoint sources of TSS as indicated in the 2012 Integrated Report include sediments originating from grazing in riparian corridors of streams and creeks, highway/road/bridge runoff, non-irrigated crop production, rangeland grazing and other sources of sediment loading (DEQ 2012). Elevated turbidity measurements can be caused by stream bank erosion processes, stormwater runoff events and other channel disturbances. The following section provides general information on nonpoint sources contributing bacterial or TSS loading within the Study Area.

3.3.1 Wildlife

Fecal coliform bacteria are produced by all warm-blooded animals, including wildlife such as mammals and birds. In developing bacterial TMDLs it is important to identify the potential for bacterial contributions from wildlife by watershed. Wildlife is naturally attracted to riparian corridors of streams and rivers due to habitat and resource availability. With direct access to the stream channel, wildlife can be a concentrated source of bacterial loading to a waterbody. Fecal coliform bacteria from wildlife are also deposited onto land surfaces, where it may be washed into nearby streams by rainfall runoff. Currently there are insufficient data available to estimate populations of wildlife and avian species by watershed. Consequently it was difficult to assess the magnitude of bacterial contributions from wildlife species as a general category.

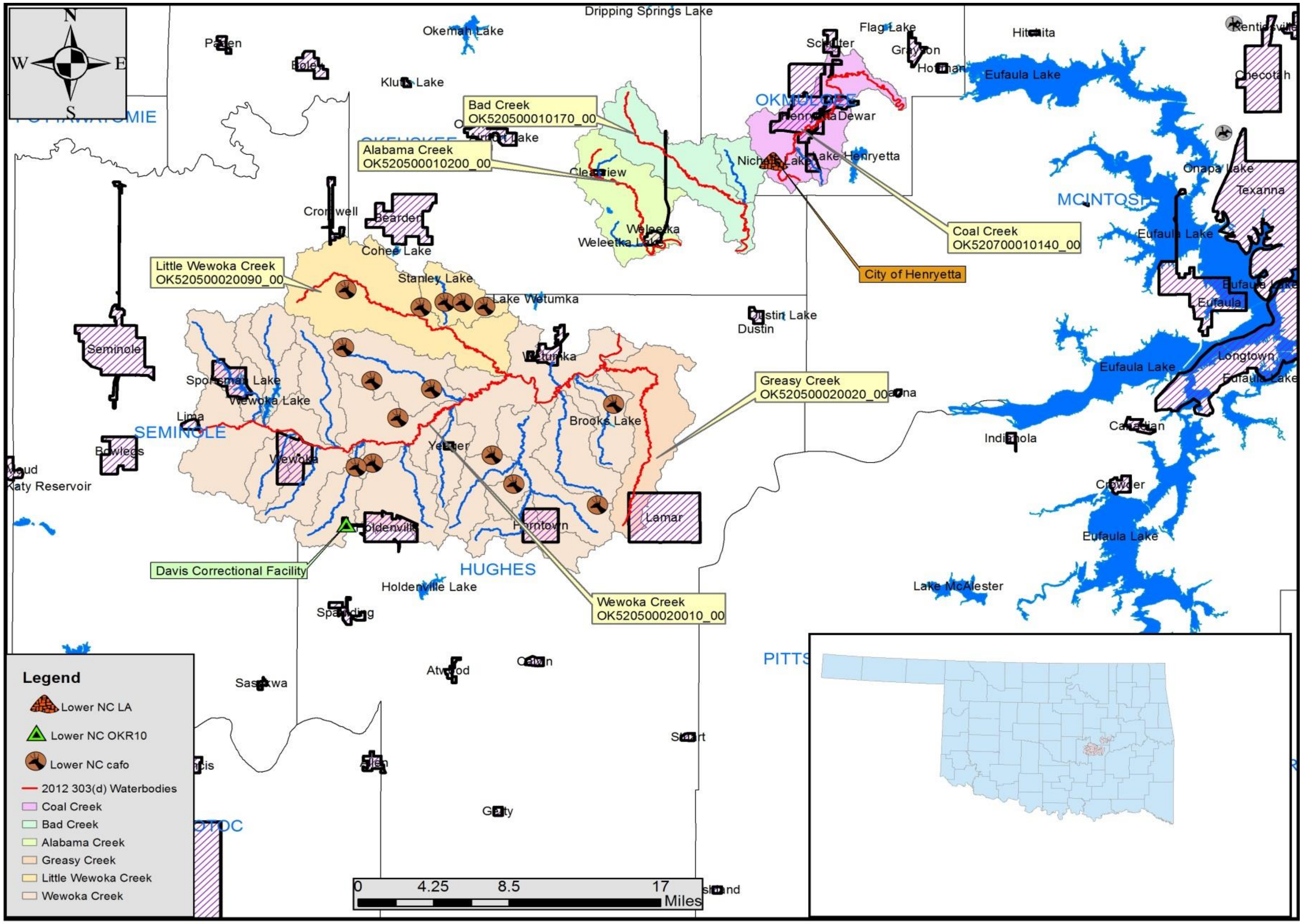
However, adequate data are available by county to estimate the number of deer by watershed. This report assumes that deer habitat includes forests, croplands, and pastures. Using Oklahoma Department of Wildlife and Conservation (ODWC) county data, the population of deer can be roughly estimated from the actual number of deer harvested and harvest rate estimates. Because harvest success varies from year to year based on weather and other factors, the average harvest from 2005 to 2009 was combined with an estimated annual harvest rate of 20% to predict deer population by county. Using the estimated deer population by county and the percentage of the watershed area within each county, a wild deer population can be calculated for each watershed.

According to a study conducted by the American Society of Agricultural Engineers (ASAE), deer release approximately 5×10^{8} fecal coliform units per animal per day (ASAE 1999). Although only a fraction of the total fecal coliform loading produced by the deer population may actually enter a waterbody, the estimated fecal coliform production based on the estimated deer population provided in **Table 3-6** in cfu/day provides a relative magnitude of loading in each of the TMDL watersheds impaired for bacteria.

Table 3-6 Estimated Population and Fecal Coliform Production for Deer

Waterbody ID	Waterbody Name	Watershed Area (acres)	Wild Deer Population	Estimated Wild Deer per acre	Fecal Production (x 10^9 cfu/day) of Deer Population
OK520500010170_00	**Bad Creek**	23,400	265	0.011	133
OK520500010200_00	**Alabama Creek**	18,125	168	0.009	84
OK520500020010_00	**Wewoka Creek**	247,319	2,804	0.011	1402
OK520500020090_00	**Little Wewoka Creek**	40,619	449	0.011	224

Figure 3-2 Locations of NPDES-Permitted AFOs and a Construction Activity Site in the Study Area



3.3.2 Non-Permitted Agricultural Activities and Domesticated Animals

There are a number of non-permitted agricultural activities that can also be sources of bacterial or TSS loading. Agricultural activities of greatest concern are typically those associated with livestock operations (Drapcho and Hubbs 2002). Examples of commercially raised farm animal activities that can contribute to bacterial sources include:

- Processed commercially raised farm animal manure is often applied to fields as fertilizer, and can contribute to fecal bacterial loading to waterbodies if washed into streams by runoff.
- Animals grazing in pastures deposit manure containing fecal bacteria onto land surfaces. These bacteria may be washed into waterbodies by runoff.
- Animals often have direct access to waterbodies and can provide a concentrated source of fecal bacterial loading directly into streams or can cause unstable stream banks which can contribute TSS.

Table 3-10 provides estimated numbers of commercially raised farm animals and estimated acreage where manure was applied by watershed. This was calculated using the 2007 U.S. Department of Agriculture (USDA) county Agricultural Census data (USDA 2007) and the percentage of the watershed within each county. Because the watersheds are generally much smaller than the counties, and commercially raised farm animals are not evenly distributed across counties or constant with time, these are rough estimates only. According to **Table 3-10**, cattle are clearly the most abundant species of commercially raised farm animals in the Study Area and often have direct access to the waterbodies and their tributaries.

Detailed information was not available to describe or quantify the relationship between in-stream concentrations of bacteria and land application or direct deposition of manure from commercially raised farm animals. There was also not sufficient information available to describe or quantify the contributions of sediment loading caused by commercially raised farm animals responsible for destabilizing stream banks or erosion in pasture fields. Despite the lack of specific data, for the purpose of these TMDLs, land application of commercially raised farm animal manure was considered a potential source of bacterial loading to the watersheds in the Study Area. **Table 3-7** gives the daily fecal coliform production rates by animal species:

Table 3-7 Daily Fecal Coliform Production Rates by Animal Species

Animal	Daily fecal coliform production rate counts per animal per day
Beef cattle*	1.04E+11
Dairy cattle*	1.01E+11
Horses*	4.20E+08
Goats	1.20E+10
Sheep*	1.20E+10
Swine*	1.08E+10
Ducks*	2.43E+09
Geese*	4.90E+10

Animal	Daily fecal coliform production rate counts per animal per day
Chickens*	1.36E+08
Turkey*	9.30E+07
Deer*	5x10^{8}
Dogs✱	3.3x10^{9}
Cats✱	5.4x10^{8}
* According to a livestock study conducted by the ASAE (1999)	
✱ Schueler 2000	

Using the estimated animal populations and the fecal coliform production rates from **Table 3-7**, an estimate of fecal coliform production from each group of commercially raised farm animal was calculated in each watershed of the Study Area. These estimates are presented in **Table 3-11**. Note that only a small fraction of these fecal coliform are expected to represent loading into waterbodies, either washed into streams by runoff or by direct deposition from wading animals. Because of their numbers, cattle again appear to represent the most likely commercially raised farm animal source of fecal bacteria.

3.3.3 Domestic Pets

Fecal matter from dogs and cats, which can be transported to streams by runoff from urban and suburban areas, is a potential source of bacterial loading. On average 37.2% of the nation's households own dogs and 32.4% own cats. In 2007, the average number of pets per household was 1.7 dogs and 2.2 cats (American Veterinary Medical Association 2007). Using the U.S. Census data at the block level (U.S. Census Bureau 2010), dog and cat populations can be estimated for each watershed. **Table 3-8** summarizes the estimated number of dogs and cats for the watersheds of the Study Area.

Table 3-8 Estimated Numbers of Pets

Waterbody ID	Waterbody Name	Dogs	Cats
OK520500010170_00	**Bad Creek**	1,314	1,701
OK520500010200_00	**Alabama Creek**	362	469
OK520500020010_00	**Wewoka Creek**	9,214	11,924
OK520500020090_00	**Little Wewoka Creek**	709	917

Table 3-9 provides an estimate of the fecal coliform production from pets. These estimates are based on estimated fecal coliform production rates from **Table 3-11**.

Table 3-9 Estimated Fecal Coliform Daily Production by Pets (x10^{9} counts/day)

Waterbody ID	Waterbody Name	Dogs	Cats	Total
OK520500010170_00	**Bad Creek**	4,337	918	5,255
OK520500010200_00	**Alabama Creek**	1,195	253	1,448
OK520500020010_00	**Wewoka Creek**	30,406	6,439	36,845
OK520500020090_00	**Little Wewoka Creek**	965	204	1,169

Table 3-10 Commercially Raised Farm Animals and Manure Application Area Estimates by Watershed

Waterbody ID	Waterbody Name	Cattle	Dairy Cows	Horses	Goats	Sheep	Hogs & Pigs	Ducks & Geese	Acres of Manure Application
OK520500010170_00	**Bad Creek**	2,553	5	96	0	27	840	3	85
OK520500010200_00	**Alabama Creek**	2,049	2	58	0	19	874	0	539
OK520500020010_00	**Wewoka Creek**	25,640	141	959	6	218	45,006	89	2,699
OK520500020090_00	**Little Wewoka Creek**	4,541	20	161	1	39	7,220	13	475

Table 3-11 Fecal Coliform Production Estimates for Commercially Raised Farm Animals ($x10^9$ number/day)

Waterbody ID	Waterbody Name	Cattle	Dairy Cows	Horses	Goats	Sheep	Hogs & Pigs	Ducks & Geese	Total
OK520500010170_00	**Bad Creek**	265,498	467	40	0	318	9,069	72	275,464
OK520500010200_00	**Alabama Creek**	213,135	233	25	0	231	9,442	0	223,066
OK520500020010_00	**Wewoka Creek**	2,666,560	14,241	403	72	2,616	486,065	2,287	3,172,244
OK520500020090_00	**Little Wewoka Creek**	472,305	2,056	68	11	472	77,972	322	553,205

3.3.4 Failing Onsite Wastewater Disposal Systems and Illicit Discharges

DEQ is responsible for implementing the regulations of Title 252, Chapter 641 of the Oklahoma Administrative Code, which defines design standards for individual and small public onsite sewage disposal systems (DEQ 2012). OSWD systems and illicit discharges can be a source of bacterial loading to streams and rivers. Bacterial loading from failing OSWD systems can be transported to streams in a variety of ways, including runoff from surface ponding or through groundwater. Fecal coliform-contaminated groundwater may discharge to creeks through springs and seeps.

To estimate the potential magnitude of OSWDs fecal bacterial loading, the number of OSWD systems was estimated for each watershed. The estimate of OSWD systems was derived by using data from the 1990 U.S. Census which was the last year in which there were Census questions about plumbing facilities (U.S. Department of Commerce, Bureau of the Census 1990). The density of OSWD systems within each watershed was estimated by dividing the number of OSWD systems in each census block by the number of acres in each census block. This density was then applied to the number of acres of each census block within a WQM station watershed. Census blocks crossing a watershed boundary required additional calculation to estimate the number of OSWD systems based on the proportion of the census block falling within each watershed. This step involved adding all OSWD systems for each whole or partial census block.

Over time, most OSWD systems operating at full capacity will fail. OSWD system failures are proportional to the adequacy of a state's minimum design criteria (Hall 2002). The 1990 American Housing Survey for Oklahoma conducted by the U.S. Census Bureau estimates that, nationwide, 10% of occupied homes with OSWD systems experience malfunctions during the year (U.S. Department of Commerce, Bureau of the Census 1990). A study conducted by Reed, Stowe & Yanke, LLC (2001) reported that approximately 12% of the OSWD systems in east Texas and 8% in the Texas Panhandle were chronically malfunctioning. Most studies estimate that the minimum lot size necessary to ensure against contamination is roughly one-half to one acre (Hall 2002). Some studies, however, found that lot sizes in this range or even larger could still cause contamination of ground or surface water (University of Florida 1987). It was estimated that areas with more than 40 OSWD systems per square mile (6.25 septic systems per 100 acres) can be considered to have potential contamination problems (Canter and Knox 1986). **Table 3-12** summarizes estimates of sewered and unsewered households and the average number of septic tanks per square mile for each watershed in the Study Area.

For the purpose of estimating fecal coliform loading in watersheds, an OSWD failure rate of 12% was used in the calculations made to characterize fecal coliform loads in each watershed. Fecal coliform loads were estimated using the following equation (EPA 2001):

$$\#\frac{counts}{day} = (\#Failing\_systems) \times \left(\frac{10^6\,counts}{100ml}\right) \times \left(\frac{70gal}{personday}\right) \times \left(\#\frac{person}{household}\right) \times \left(3785.2\frac{ml}{gal}\right)$$

Table 3-12 Estimates of Sewered and Unsewered Households

Waterbody ID	Waterbody Name	Public Sewer	Septic Tank	Other Means	Housing Units	# of Septic Tanks / Mile^2
OK520500010170_00	**Bad Creek**	517	248	8	773	6.8
OK520500010200_00	**Alabama Creek**	98	105	10	213	3.7
OK520500020010_00	**Wewoka Creek**	3,886	1,459	75	5,420	4.0
OK520500020090_00	**Little Wewoka Creek**	169	236	12	417	3.7

The average of number of people per household was calculated to be from 3.00 to 3.09 for counties in the Study Area (U.S. Census Bureau 2010). Approximately 70 gallons of wastewater were estimated to be produced on average per person per day (Metcalf and Eddy 1991). The fecal coliform concentration in septic tank effluent was estimated to be 10^6 per 100 mL of effluent based on reported concentrations from a number of publications (Metcalf and Eddy 1991; Canter and Knox 1985; Cogger and Carlile 1984). Using this information, the estimated load from failing septic systems within the watersheds was summarized in **Table 3-13**.

Table 3-13 Estimated Fecal Coliform Load from OSWD Systems

Waterbody ID	Waterbody Name	Acres	Septic Tank	# of Failing Septic Tanks	Estimated Loads from Septic Tanks (x 10^9 counts/day)
OK520500010170_00	**Bad Creek**	23,400	248	30	196
OK520500010200_00	**Alabama Creek**	18,126	105	13	83
OK520500020010_00	**Wewoka Creek**	247,319	1,459	175	1,151
OK520500020090_00	**Little Wewoka Creek**	40,619	236	28	186

3.4 Summary of Sources of Impairment

3.4.1 Bacteria

There are no continuous, permitted point sources of bacteria in the Bad Creek, Little Wewoka Creek, or Greasy Creek watersheds that required bacterial TMDLs; therefore, the conclusion was that nonsupport of PBCR use in these watersheds was caused by nonpoint sources of bacteria. Both Alabama Creek and Wewoka Creek have continuous point source discharger(s) that may contribute bacteria. However, available data suggests that the proportion of bacteria from those point sources was minor. Although there are point source discharges in the Coal Creek watershed, these facilities did not receive a WLA since Coal Creek is not impaired for bacteria. There are 15 SFOs which could possibly contribute bacterial loading to the Wewoka Creek watershed. SFOs are considered no-discharge facilities for the purpose of the TMDL calculations in this report. Therefore, various nonpoint sources are considered to be the major sources of bacterial loading in each watershed that requires a TMDL.

All the stream segments in **Table 3-14** required bacterial TMDLs. That table provides a summary of the estimated percentage of fecal coliform loads in cfu/day from the four major nonpoint source categories (commercially raised farm animals, pets, deer, and septic tanks) that contribute to the elevated bacterial concentrations in each watershed. Because of their numbers and animal unit production of bacteria, livestock are estimated to be the largest contributors of fecal coliform loading to land surfaces. It must be noted that while no data are available to estimate populations and fecal loading of wildlife other than deer, a number of bacterial source tracking studies around the nation demonstrate that wild birds and mammals represent a major source of the fecal bacteria found in streams.

Table 3-14 Percentage Contribution of Fecal Coliform Load Estimates from Nonpoint Sources to Land Surfaces

Waterbody ID	Waterbody Name	Commercially Raised Farm Animals	Pets	Deer	Estimated Loads from Septic Tanks
OK520500010170_00	**Bad Creek**	98.01%	1.87%	0.05%	0.07%
OK520500010200_00	**Alabama Creek**	99.28%	0.64%	0.04%	0.04%
OK520500020010_00	**Wewoka Creek**	98.77%	1.15%	0.04%	0.04%
OK520500020090_00	**Little Wewoka Creek**	99.75%	0.20%	0.03%	0.03%

The magnitude of loading to a stream may not reflect the magnitude of loading to land surfaces. While no studies have quantified these effects, bacteria may die off or survive at different rates depending on the manure characteristics and a number of other environmental conditions. Also, the structural properties of some manure, such as cow patties, may limit their washoff into streams by runoff. In contrast, malfunctioning septic tank effluent may be present in standing water on the surface, or in shallow groundwater, which may enhance its conveyance to streams.

3.4.2 Turbidity

Of the two watersheds in the Study Area that were on the 2012 303(d) list for turbidity, Greasy Creek and Coal Creek data showed that the streams meet water quality criteria. Therefore, no TMDLs were needed on these stream segments. Consequently, point sources in theses watershed did not necessitate a WLA.

SECTION 4 TECHNICAL APPROACH AND METHODS

4.1 POLLUTANT LOADS AND TMDLS

The objective of a TMDL is to estimate allowable pollutant loads and to allocate these loads to the known pollutant sources in the watershed so appropriate control measures can be implemented and the WQS achieved. A TMDL is expressed as the sum of three elements as described in the following mathematical equation:

$$TMDL = WLA\_{WWTF} + WLA\_{MS4} + LA + MOS$$

The WLA is the portion of the TMDL allocated to existing and future point sources. The LA is the portion of the TMDL allocated to nonpoint sources, including natural background sources. The MOS is intended to ensure that WQSs will be met.

For *E. coli* or Enterococci bacteria, TMDLs are expressed as colony-forming units per day, and represent the maximum one-day load the stream can assimilate while still attaining the WQS. Percent reduction goals are also calculated to aid to characterizing the possible magnitude of the effort to restore the segment to meeting water quality criterion. Turbidity TMDLs will be derived from TSS calculations and expressed in pounds (lbs) per day which will represent the maximum one-day load the stream can assimilate while still attaining the WQS, as well as a PRG.

4.2 STEPS TO CALCULATING TMDLS

The TMDL calculations presented in this report are derived from load duration curves (LDC). LDCs facilitate rapid development of TMDLs, and as a TMDL development tool can help identifying whether impairments are associated with point or nonpoint sources. The technical approach for using LDCs for TMDL development includes the three following steps that are described in Subsections 4.2.1 through 4.2.3:

1. Prepare flow duration curves for gaged and ungaged WQM stations.
2. Estimate existing loading in the waterbody using ambient bacterial water quality data.
3. Use LDCs to identify if there is a critical condition.

Historically, in developing WLAs for pollutants from point sources, it was customary to designate a critical low flow condition (*e.g.*, 7Q2) at which the maximum permissible loading was calculated. As water quality management efforts expanded in scope to quantitatively address nonpoint sources of pollution and types of pollutants, it became clear that this single critical low flow condition was inadequate to ensure adequate water quality across a range of flow conditions. Use of the LDC obviates the need to determine a design storm or selected flow recurrence interval with which to characterize the appropriate flow level for the assessment of critical conditions. For waterbodies impacted by both point and nonpoint sources, the “nonpoint source critical condition” would typically occur during high flows, when rainfall runoff would contribute the bulk of the pollutant load, while the “point source critical condition” would typically occur during low flows, when WWTF effluents would dominate the base flow of the impaired water. However, flow range is only a general indicator of the relative proportion of point/nonpoint contributions. It is not used in this report to quantify point source or nonpoint source contributions. Violations that occur during low flows may not be caused exclusively by point sources. Violations during low flows have been noted in some watersheds that contain no point sources.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by a water quality criterion. The TMDL can be expressed as a continuous function of flow, equal to the line, or as a discrete value derived from a specific flow condition.

4.2.1 Development of Flow Duration Curves

Flow duration curves (FDC) serve as the foundation of LDCs and are graphical representations of the flow characteristics of a stream at a given site. Flow duration curves utilize the historical hydrologic record from stream gages to forecast future recurrence frequencies. Many WQM stations throughout Oklahoma do not have long-term flow data and therefore, flow frequencies must be estimated. Four of the six waterbodies in the Study Area do not have USGS gage stations. The default approach used to develop flow frequencies necessary to establish flow duration curves considers watershed differences in rainfall, land use, and the hydrologic properties of soil that govern runoff and retention. A detailed explanation of the methods for estimating flow for ungaged streams is provided in **Appendix B**.

To estimate flows at an ungaged site:

- Identify an upstream or downstream flow gage.
- Calculate the contributing drainage areas of the ungaged sites and the flow gage.
- Calculate daily flows at the ungaged site by using the flow at the gaged site multiplied by the drainage area ratio.

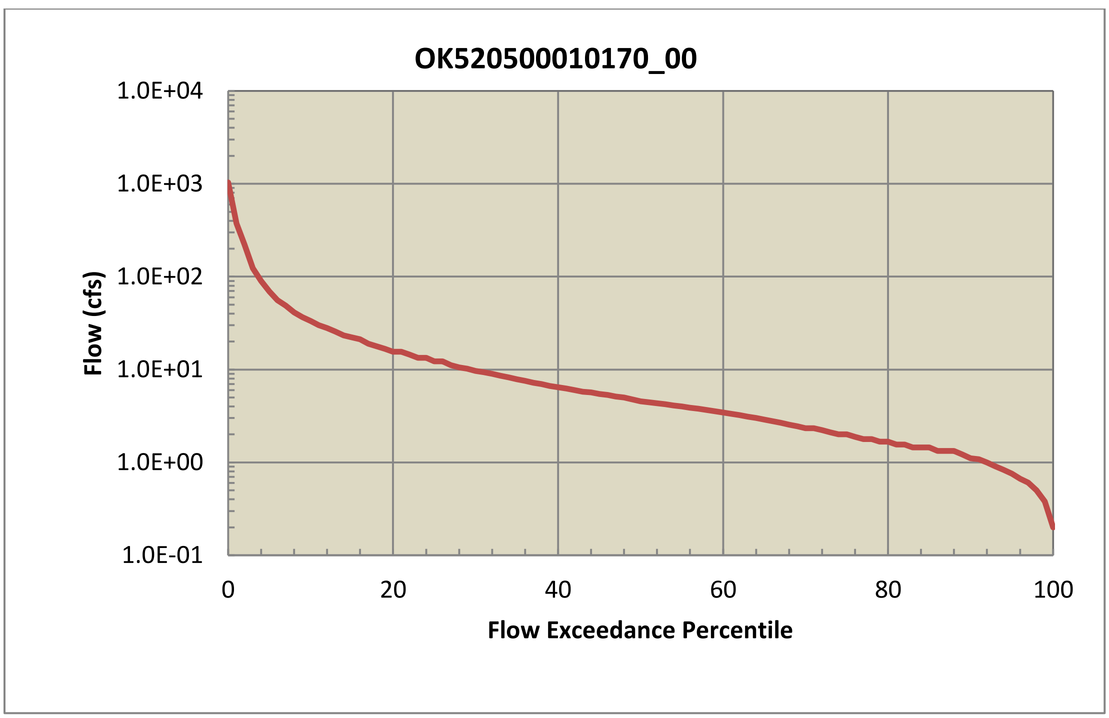
Flow duration curves are a type of cumulative distribution function. The flow duration curve represents the fraction of flow observations that exceed a given flow at the site of interest. The observed flow values are first ranked from highest to lowest, then, for each observation, the percentage of observations exceeding that flow is calculated. The flow value is read from the ordinate (y-axis), which is typically on a logarithmic scale since the high flows would otherwise overwhelm the low flows. The flow exceedance frequency is read from the abscissa (x-axis), which is numbered from 0% to 100%, and may or may not be logarithmic. The lowest measured flow occurs at an exceedance frequency of 100% indicating that flow has equaled or exceeded this value 100% of the time, while the highest measured flow is found at an exceedance frequency of 0%. The median flow occurs at a flow exceedance frequency of 50%. The flow exceedance percentiles for each waterbody addressed in this report are provided in **Appendix B**.

While the number of observations required to develop a flow duration curve is not rigorously specified, a flow duration curve is usually based on more than one year of observations, and encompasses inter-annual and seasonal variation. Ideally, the drought of record and flood of record are included in the observations. For this purpose, the long-term flow gaging stations operated by the USGS are utilized to support the Oklahoma TMDL Toolbox.

The USGS National Water Information System serves as the primary source of flow measurements for the Oklahoma TMDL Toolbox. All available daily average flow values for all gages in Oklahoma, as well as the nearest upstream and downstream gages in adjacent states, were retrieved for use in the Oklahoma TMDL Toolbox to generate flow duration curves for gaged and ungaged waterbodies. The application includes a data update module that automatically downloads the most recent USGS data and appends it to the existing flow database.

A typical semi-log flow duration curve exhibits a sigmoidal shape, bending upward near a flow exceedance frequency value of 0% and downward at a frequency near 100%, often with a relatively constant slope in between. For sites that on occasion exhibit no flow, the curve will intersect the abscissa at a frequency less than 100%. As the number of observations at a site increases, the line of the LDC tends to appear smoother. However, at extreme low and high flow values, flow duration curves may exhibit a “stair step” effect due to the USGS flow data rounding conventions near the limits of quantization. An example of a typical flow duration curve is shown in **Figure 4-1**. Flow duration curves for each impaired waterbody in the Study Area are provided in Section 5.1.

Figure 4-1 Flow Duration Curve for Bad Creek (OK520500010170_00)



4.2.2 Using Flow Duration Curves to Calculate Load Duration Curves

Existing in-stream loads can be estimated using the following steps to create FDCs for bacteria:

- Calculate the geometric mean of all water quality observations from the period of record selected for the waterbody.
- Convert the geometric mean concentration value to loads by multiplying the flow duration curve by the geometric mean of the ambient water quality data for each bacterial indicator.

4.2.3 Using Load Duration Curves to Develop TMDLs

The final step in the TMDL calculation process involves a group of additional computations derived from the preparation of LDCs. These computations are necessary to derive a PRG (which is one method of presenting how much pollutant loads must be reduced to meet WQSs in the impaired watershed).

4.2.3.1 Step 1 - Generate LDCs

LDCs are similar in appearance to flow duration curves. However, for bacteria, the ordinate is expressed in terms of a bacterial load in cfu/day. The bacterial curve represents the geometric mean water quality criterion for *E. coli* or Enterococci bacteria expressed in terms of a load through multiplication by the continuum of flows historically observed at the site. Bacterial TMDLs are not easily expressed in mass per day. The following equation calculates a load in the units of cfu per day. The cfu is a total for the day at a specific flow for bacteria, which is the best equivalent to a mass per day of a pollutant such as sulfate. Expressing bacterial TMDLs as cfu per day is consistent with EPA's *Protocol for Developing Pathogen TMDLs* (EPA 2001).

4.2.3.1.1 Basic steps to develop an LDC:

1. Obtain daily flow data for the site of interest from the USGS.
2. Sort the flow data and calculate flow exceedance percentiles.
3. For bacteria, obtain water quality data for the primary contact recreation season (May 1 through September 30).
4. Display a curve on a plot that represents the allowable load determined by multiplying the actual or estimated flow by the WQS numerical criterion for each parameter (geometric mean standard for bacteria).
5. For bacterial TMDLs, display another curve derived by plotting the geometric mean of all existing bacterial samples continuously along the full spectrum of flow exceedance percentiles which represents the LDC (See Section 5).

The flow exceedance frequency (x-value of each point) was obtained by looking up the historical exceedance frequency of the measured or estimated flow, in other words, the percent of historical observations that are equal to or exceed the measured or estimated flow.

As noted earlier, runoff has a strong influence on loading of nonpoint pollution. Flows do not always correspond directly to runoff. High flows may occur in dry weather (e.g., lake release to provide water downstream) and runoff influence may be observed with low or moderate flows (e.g., persistent high turbidity due to previous storm).

4.2.3.1.2 Bacterial LDC

For bacterial TMDLs, the culmination of these steps is expressed in the following formula which is displayed on the LDC as the TMDL curve:

TMDL (cfu/day) = WQS * flow (cfs) * unit conversion factor

Where:

WQS = 126 cfu/100 mL (E. coli); or 33 cfu/100 mL (Enterococci)

Unit conversion factor = 24,465,525

Historical observations of bacteria were plotted as a separate LDC based on the geometric mean of all samples. It is noted that the LDCs for bacteria were based on the geometric mean standards or geometric mean of all samples. It is inappropriate to compare single sample bacterial observations to a geometric mean water quality criterion in the LDC; therefore individual bacterial samples are not plotted on the LDCs.

4.2.3.2 Step 2 - Define MOS

The MOS may be defined explicitly or implicitly. A typical explicit approach would reserve some specific fraction of the TMDL as the MOS. In an implicit approach, conservative assumptions used in developing the TMDL are relied upon to provide an MOS to assure that WQSs are attained. For bacterial TMDLs in this report, an explicit MOS of 10% was selected. The 10% MOS has been used in other approved bacterial TMDLs.

4.2.3.3 Step 3 - Calculate WLA

As previously stated, the pollutant load allocation for point sources is defined by the WLA. For bacterial TMDLs a point source can be either a wastewater (continuous) or stormwater (MS4) discharge. Stormwater point sources are typically associated with urban and industrialized areas. Recent EPA guidance includes OPDES-permitted stormwater discharges as point source discharges and, therefore, part of the WLA.

The LDC approach recognizes that the assimilative capacity of a waterbody depends on the flow, and that maximum allowable loading will vary with flow condition. WLAs can be expressed in terms of a single load, or as different loads allowable under different flows. WLAs may be set to zero in cases of watersheds with no existing or planned continuous permitted point sources.

4.2.3.3.1 WLA for WWTF

For watersheds with permitted point sources discharging the pollutant of concern, OPDES permit limits are used to derive WLAs for evaluation as appropriate for use in the TMDL. The permitted flow rate used for each point source discharge and the water quality concentration defined in a permit are used to estimate the WLA for each wastewater facility. In cases where a permitted flow rate was not available for a WWTF, then the average of monthly flow rates derived from DMRs can be used. WLA values for each OPDES wastewater discharger are then summed to represent the total WLA for a given segment. Using this information, bacterial WLAs can be calculated using the approach as shown in the equations below.

4.2.3.3.2 WLA for bacteria

WLA = WQS * flow * unit conversion factor (cfu/day)

Where:

WQS = 126 cfu/100 mL (E. coli); or 33 cfu/100 mL (Enterococci)

Flow (mgd) = permitted flow unit conversion factor = 37,854,120

4.2.3.4 Step 4 - Calculate LA and WLA for MS4s

Given the lack of data and the variability of storm events and discharges from storm sewer system discharges, it was difficult to establish numeric limits on stormwater discharges that accurately address projected loadings. As a result, EPA regulations and guidance recommend expressing OPDES permit limits for MS4s as BMPs.

LAs can be calculated under different flow conditions. The LA at any particular flow exceedance is calculated as shown in the equation below.

LA = TMDL - WLA_WWTF - WLA_MS4 – MOS

For bacterial TMDLs, if there are no permitted MS4s in the Study Area, WLA_MS4 is set to zero. When there are permitted MS4s in a watershed, first calculate the sum of LA + WLA_MS4 using the above formula, then separate WLA for MS4s from the sum based on the percentage of a watershed that is under a MS4 jurisdiction. This WLA for MS4s may not be the total load allocated for permitted MS4s unless the whole MS4 area is located within the study watershed boundary. However, in most case the study watershed intersects only a portion of the permitted MS4 coverage areas.

4.2.3.5 Step 5 - Estimate Percent Load Reduction

Percent load reductions are not required items and are provided for informational purposes when making inferences about individual TMDLs or between TMDLs usually in regard to implementation of the TMDL.

The LDC approach recognizes that the assimilative capacity of a waterbody depends on stream flow and that the maximum allowable loading varies with flow condition. Existing loading and load reductions required to meet the TMDL can also be calculated under different flow conditions. The difference between existing loading and the TMDL is used to calculate the loading reductions required. For bacteria, percent reduction goals (PRG) are calculated through an iterative process of taking a series of percent reduction values applying each value uniformly to the measured concentrations of samples and verifying if the geometric mean of the reduced values of all samples is less than the geometric mean standards.

4.2.3.5.1 WLA Load Reduction

The WLA load reduction for bacteria was not calculated as it was assumed that continuous dischargers (OPDES-permitted WWTFs) are adequately regulated under existing permits to achieve WQS at the end-of-pipe and, therefore, no WLA reduction would be required. Currently, bacterial limits are not required for lagoon systems. Lagoon systems located within a sub-watershed of bacterially-impaired stream segment will be required to meet *E. coli* standards at the discharge when the permits are renewed.

MS4s are classified as point sources, but they are nonpoint sources in nature. Therefore, the percent reduction goal calculated for LA will also apply to the MS4 area within the bacterially-impaired sub-watershed. If there are no MS4s located within the Study Area requiring a TMDL, then there was no need to establish a PRG for permitted stormwater.

4.2.3.5.2 LA Load Reduction

After existing loading estimates are computed for each pollutant, nonpoint load reduction estimates for each segment are calculated by using the difference between the estimate of existing loading and the allowable loading (TMDL) under all flow conditions. This difference is expressed as the overall PRG for the impaired waterbody. The PRG serves as a guide for the amount of pollutant reduction necessary to meet the TMDL. For *E. coli* and Enterococci, WQSs are considered to be met if the geometric mean of all future data is maintained below the geometric mean criteria (TMDL).

SECTION 5
TMDL CALCULATIONS

5.1 FLOW DURATION CURVE

Following the same procedures described in Section 4.2.1, a flow duration curve for each stream segment requiring a TMDL in the Study Area was developed. These are shown in **Figure 5-1** through **Figure 5-4**.

No flow gage exists on Bad Creek (OK520500010170_00) or Alabama Creek (OK520500010200_00). Therefore, the flow duration curves for these waterbodies were estimated using the watershed area ratio method based on measured flows for neighboring Coal Creek (OK520700010140_00) at USGS gage station 07244100. The flow duration curves were based on flows measured from 1996 to 2004.

No flow gage exists on Little Wewoka Creek (OK520500020090_00) or Greasy Creek (OK520500020290_00). Therefore, flows for these waterbodies were estimated using the watershed area ratio method based on measured flows for the neighboring Wewoka Creek (OK520500020010_00) at USGS gage station 07242100. The flow duration curves were based on measured flows from 1959 to 1967.

Figure 5-1 Flow Duration Curve for Bad Creek (OK520500010170_00)

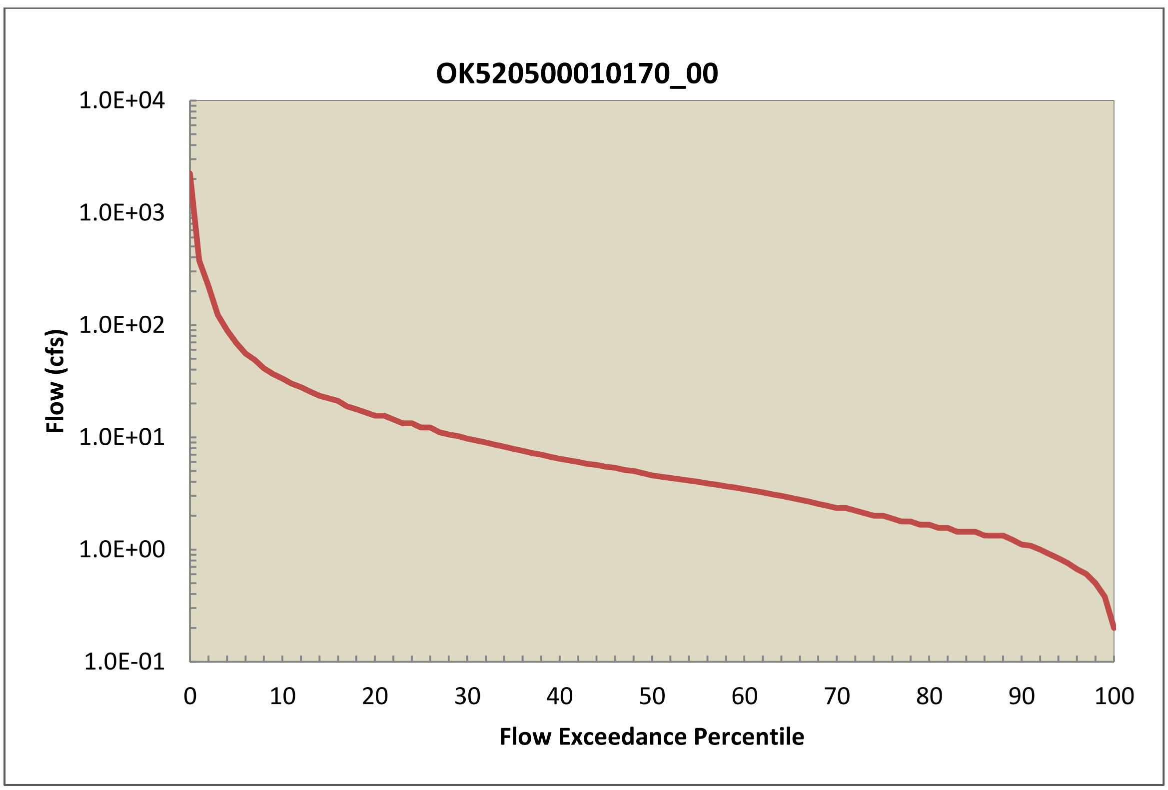


Figure 5-2 Flow Duration Curve for Alabama Creek (OK520500010200_00)

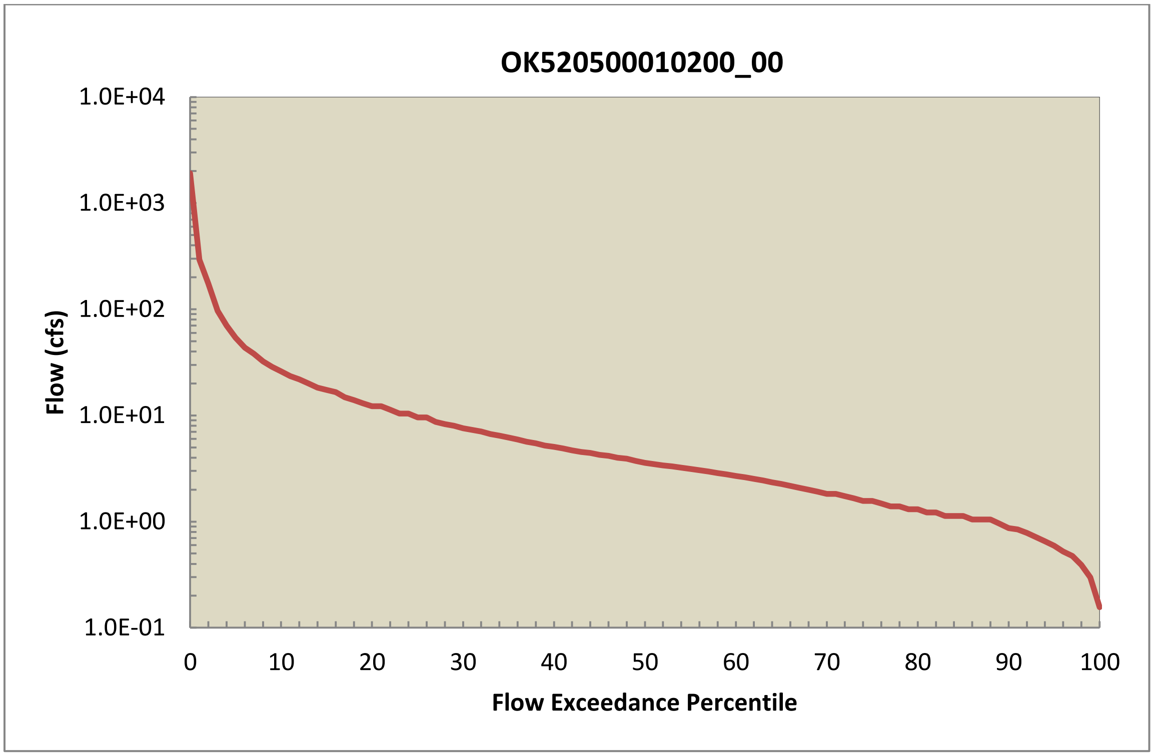


Figure 5-3 Flow Duration Curve for Wewoka Creek (OK520500020010_00)

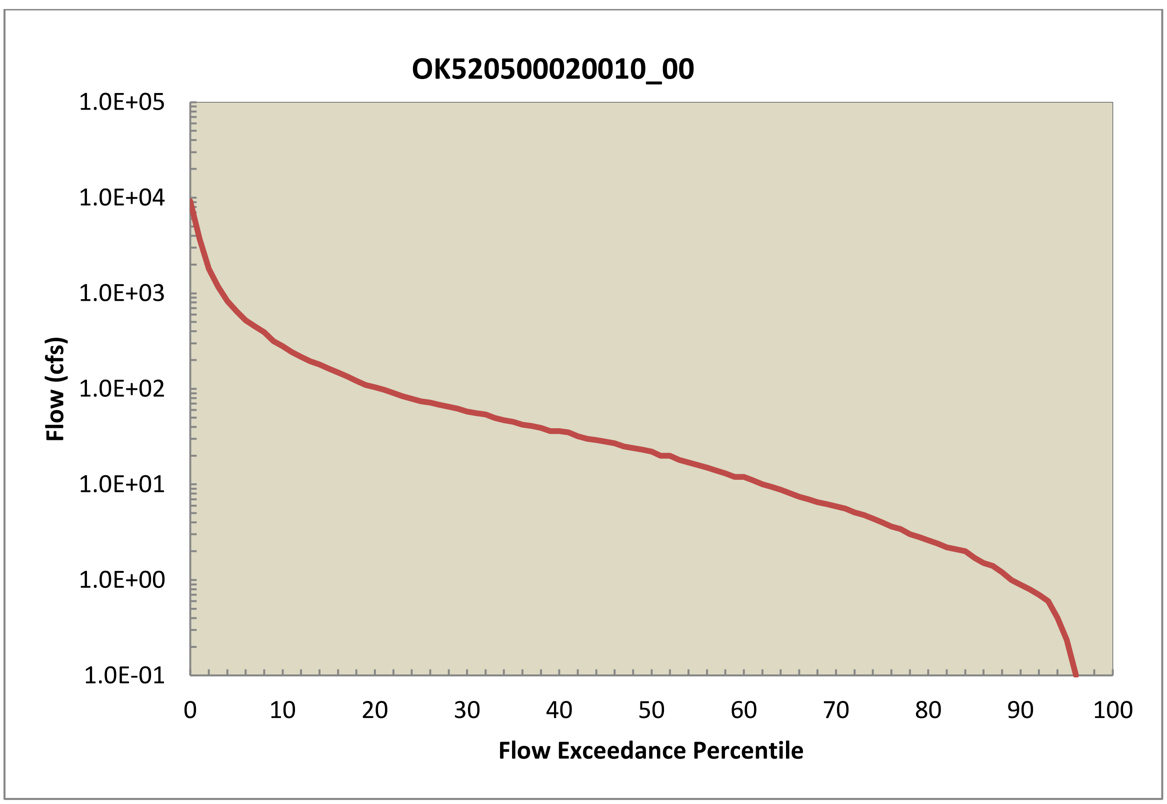
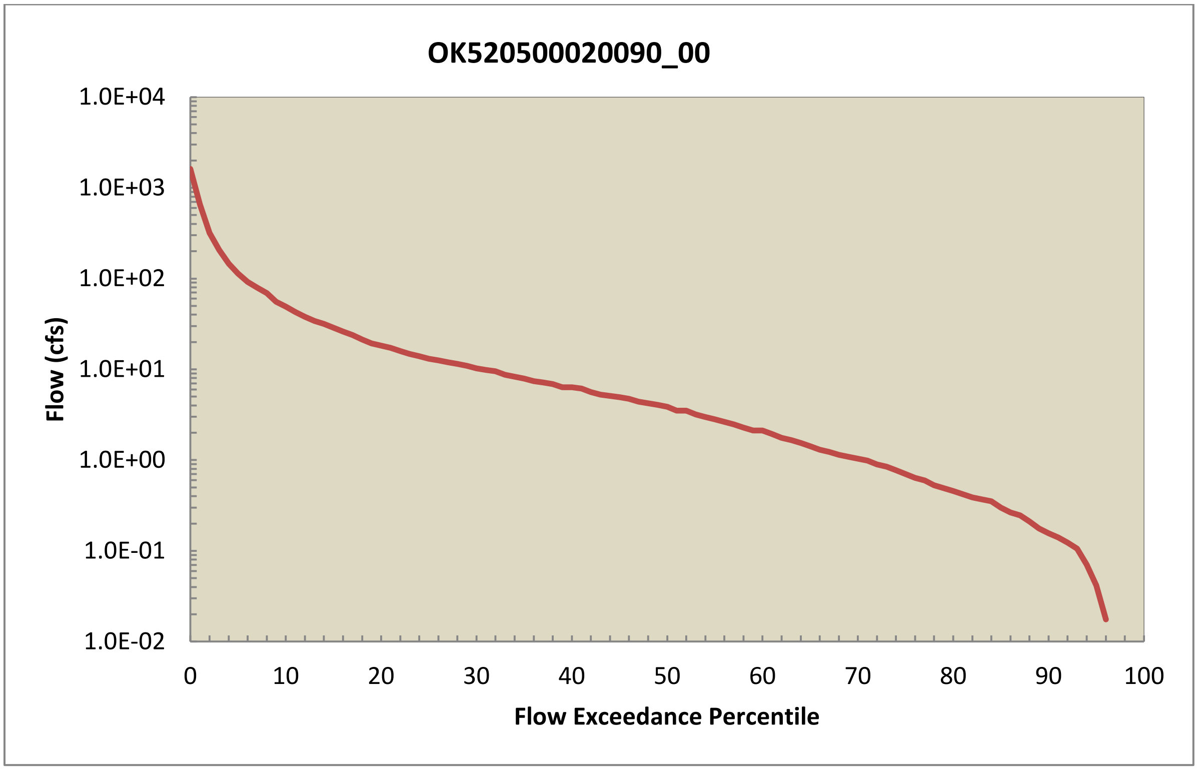


Figure 5-4 Flow Duration Curve for Little Wewoka Creek (OK520500020090_00)



5.2 Estimated Loading and Critical Conditions

EPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and all applicable WQS. To accomplish this, available in-stream WQM data were evaluated with respect to flows and magnitude of water quality criteria exceedance using LDCs.

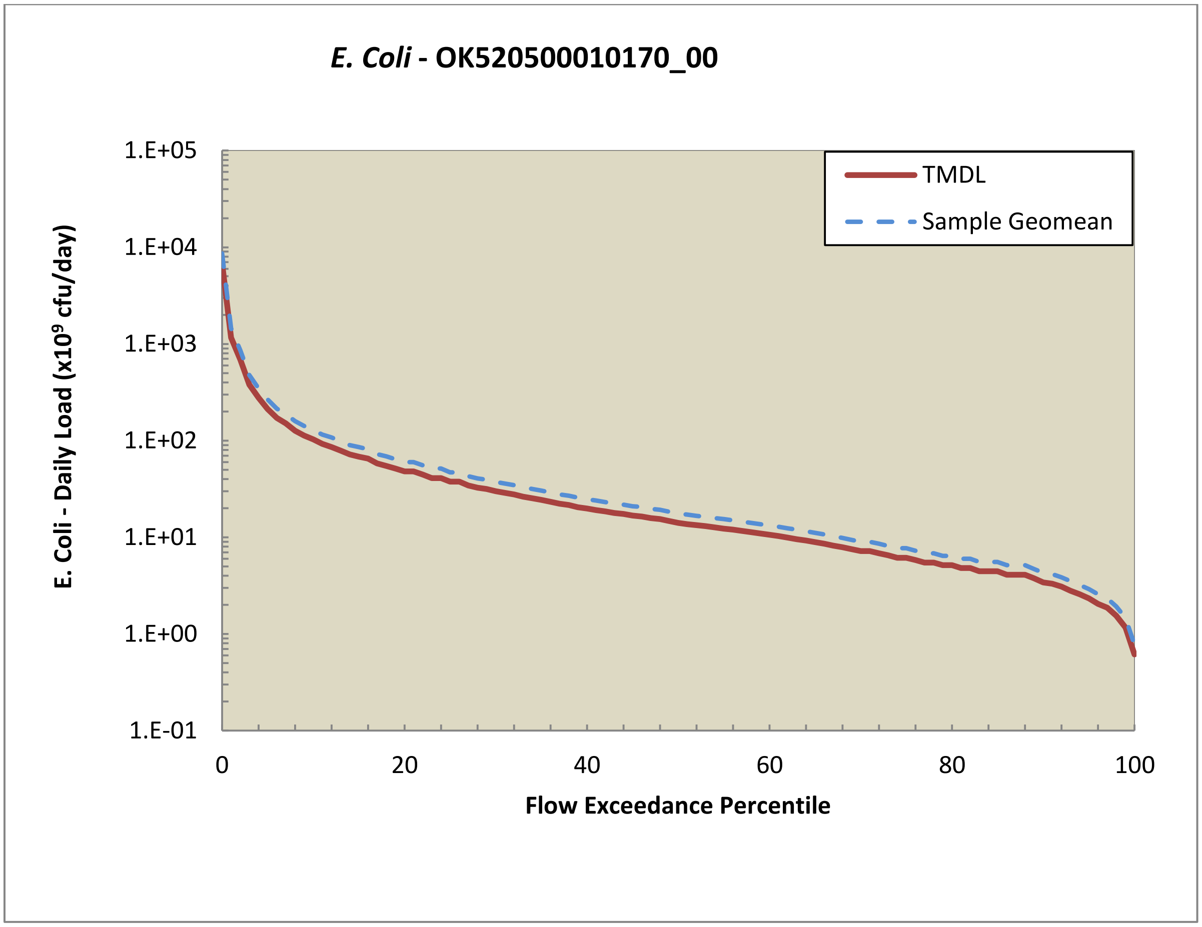
5.2.1 Bacterial LDC

To calculate the allowable bacterial load, the flow rate at each flow exceedance percentile was multiplied by a unit conversion factor (*24,465,525*) and the geometric mean water quality criterion for each bacterial indicator. This calculation produces the maximum bacterial load in the stream over the range of flow conditions. The allowable bacterial (*E. coli* or Enterococci) loads at the WQS establish the TMDL and are plotted versus flow exceedance percentile as a LDC. The x-axis indicates the flow exceedance percentile, while the y-axis was expressed in terms of a bacterial load.

To estimate existing loading, the geometric mean of all bacterial observations (concentrations) for the primary contact recreation season (May 1st through September 30th) from 2008 to 2010 are paired with the flows measured or estimated in that waterbody. Pollutant loads are then calculated by multiplying the measured bacterial concentration by the flow rate and the unit conversion factor of *24,465,525*. The bacterial LDCs developed for each impaired waterbody are shown in **Figures 5-5** through **5-10**. Each waterbody had an LDC for Enterococci.

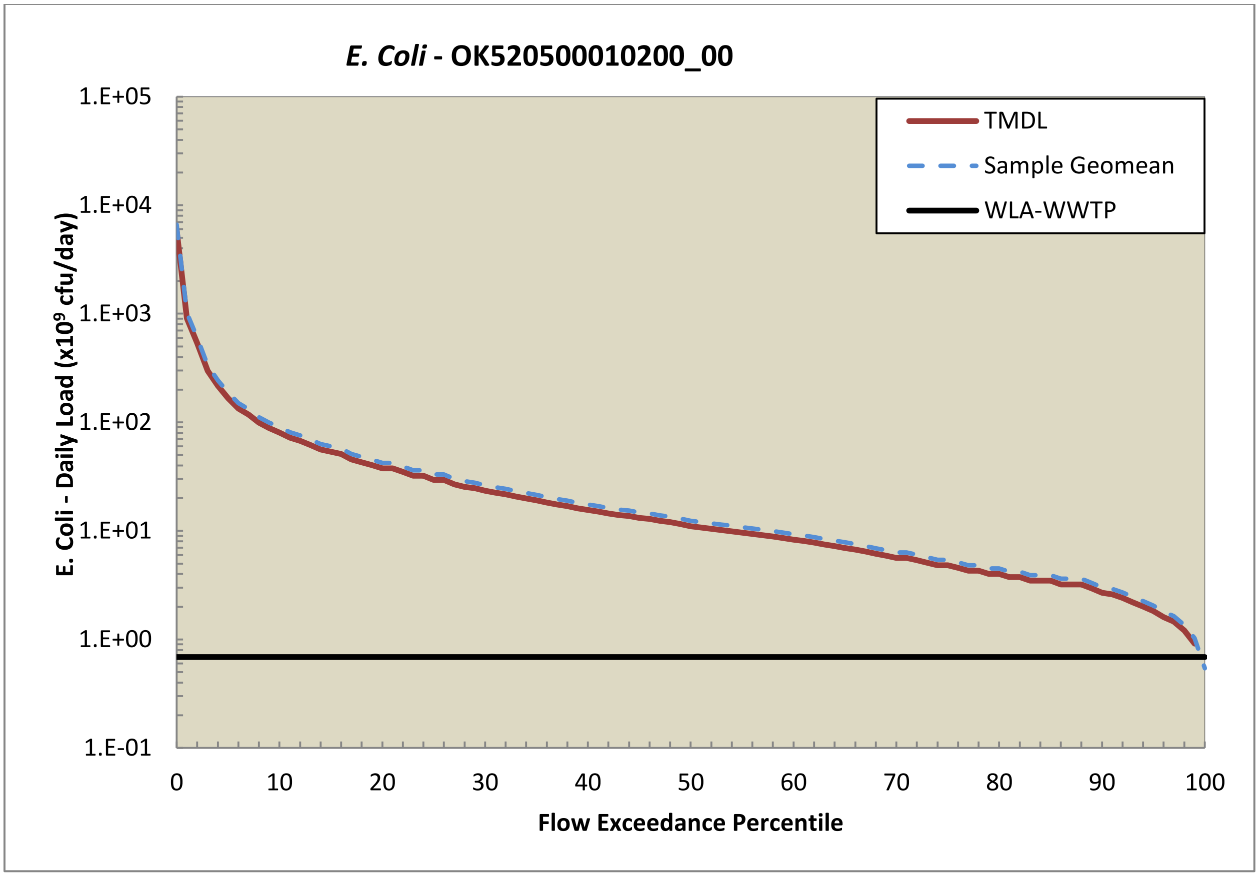
The LDC for Bad Creek (**Figure 5-5**) was based on *E. coli* bacterial measurements collected during primary contact recreation season at WQM station OK520500-01-0170L.

Figure 5-5 Load Duration Curve for *E.coli* in Bad Creek (OK520500010170_00)



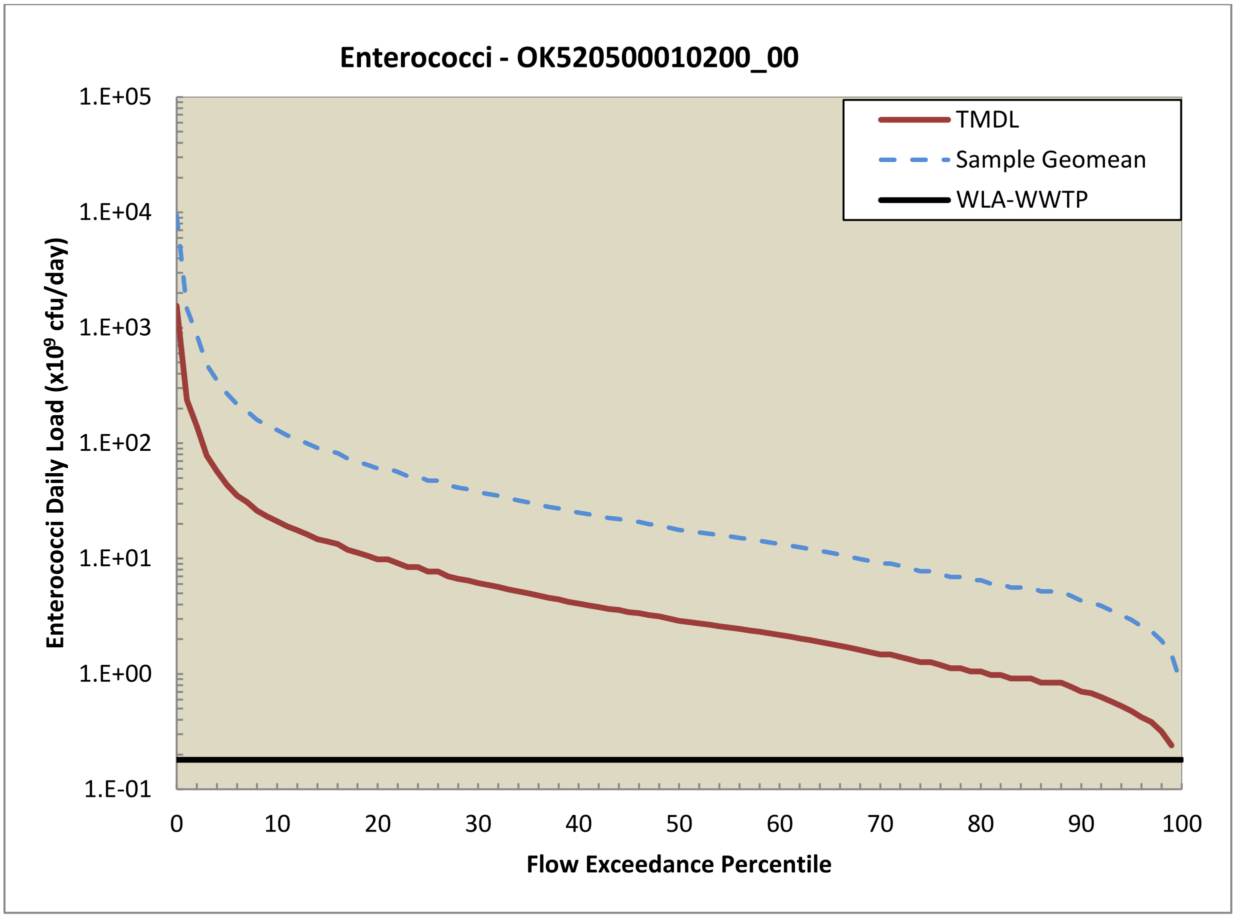
The LDC for Alabama Creek (**Figure 5-6**) was based on *E. coli* bacterial measurements collected during primary contact recreation season at WQM station OK520500-01-0200D.

Figure 5-6 Load Duration Curve for *E.coli* in Alabama Creek (OK520500010200_00)



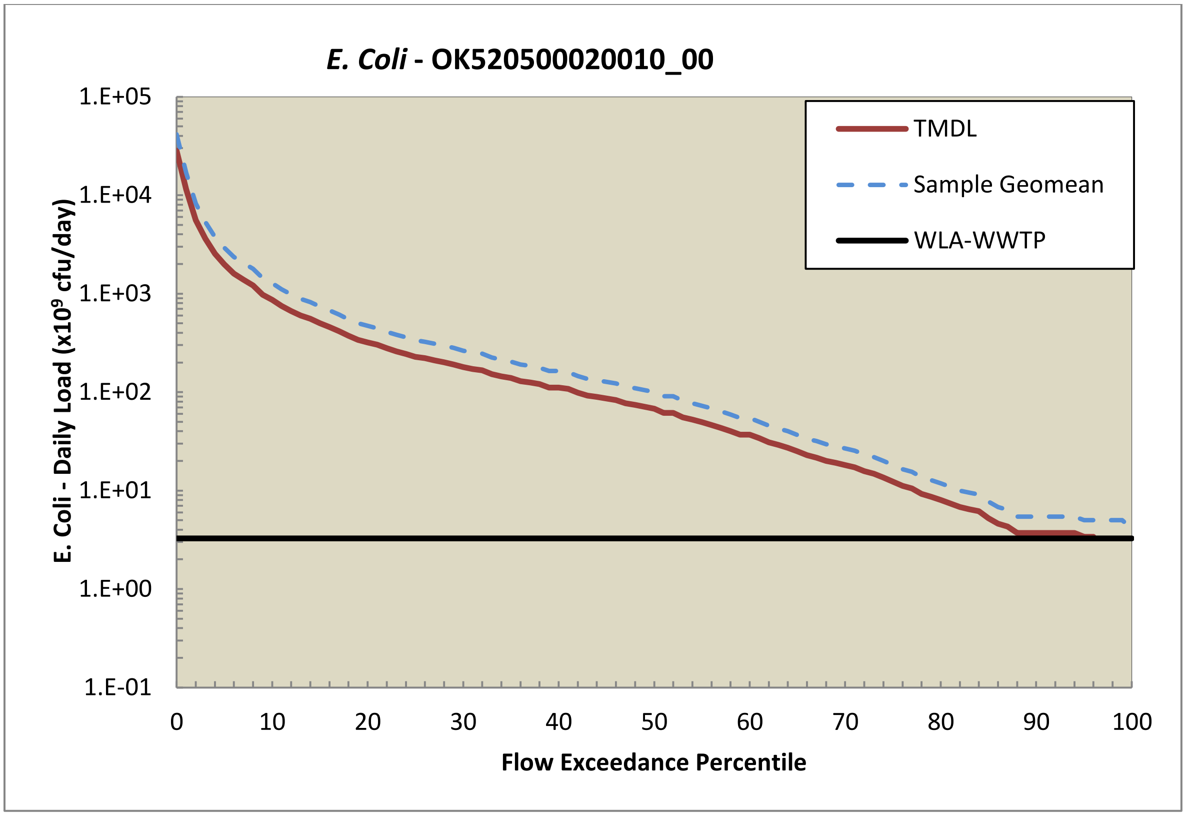
The LDC for Alabama Creek (**Figure 5-7**) was based on Enterococci measurements during primary contact recreation season at WQM stations OK520500-01-0200D.

Figure 5-7 Load Duration Curve for Enterococci in Alabama Creek (OK520500010200_00)



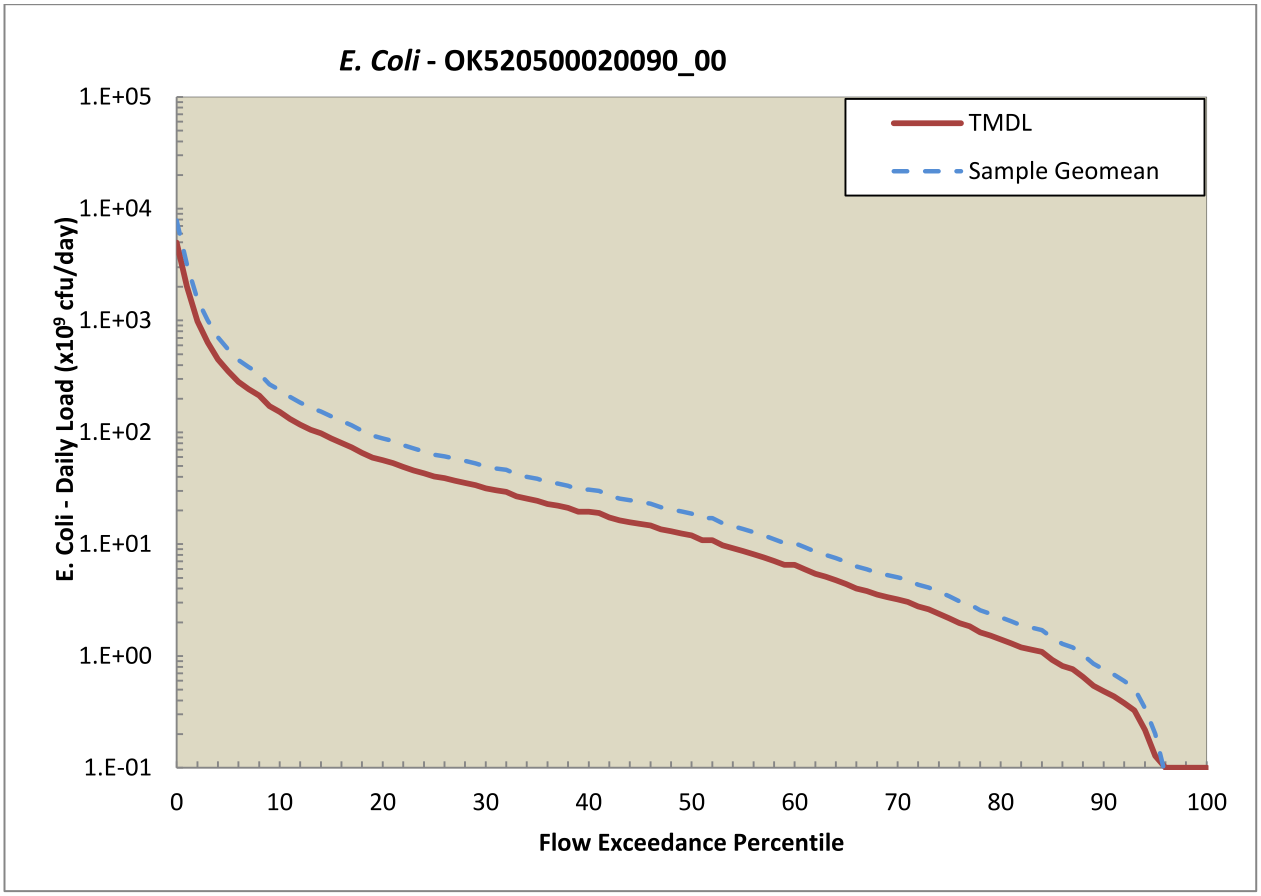
The LDC for Wewoka Creek (**Figure 5-8**) was based on *E.coli* measurements during primary contact recreation season at WQM stations OK520500-02-0010C and OK520500-02-0010M.

Figure 5-8 Load Duration Curve for *E.coli* in Wewoka Creek (OK520500020010_00)



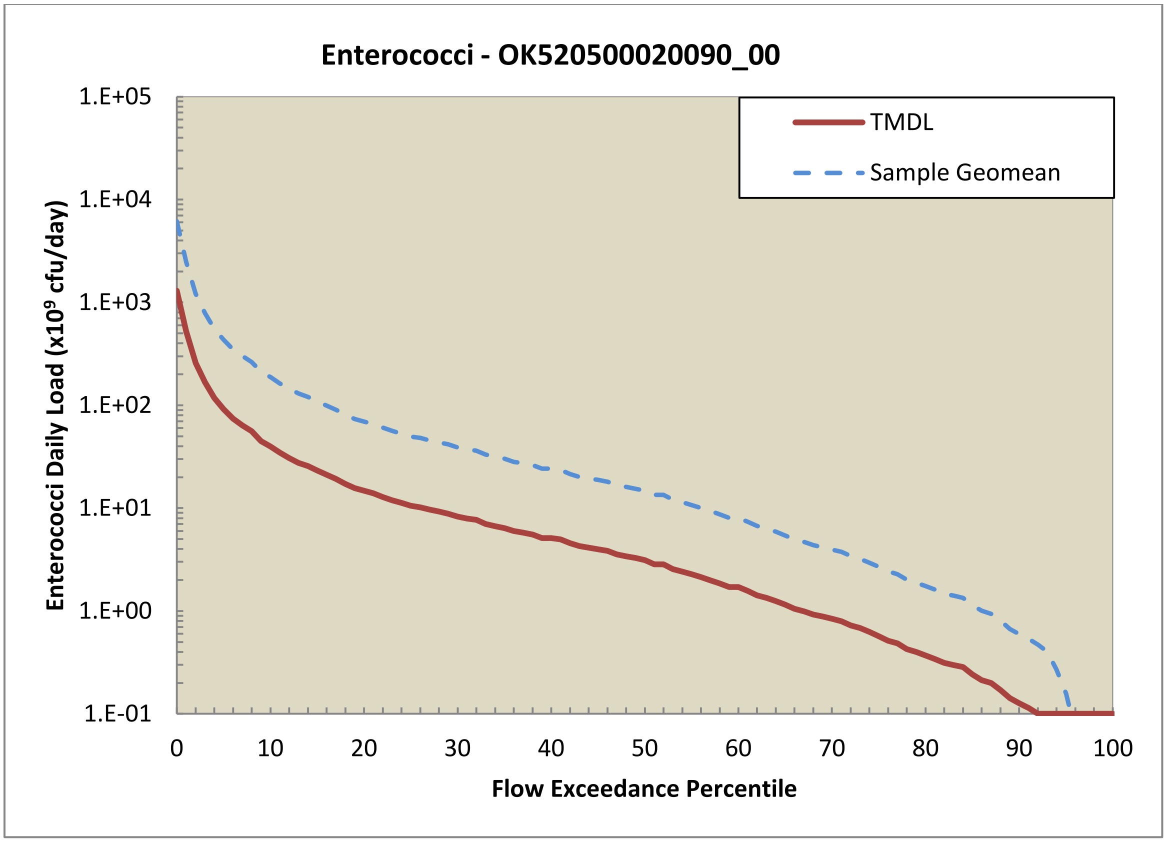
The LDC for Little Wewoka Creek (**Figure 5-9**) was based on *E.coli* measurements during primary contact recreation season at WQM stations OK520500-02-0090D.

Figure 5-9 Load Duration Curve for *E.coli* in Little Wewoka Creek (OK520500020090_00)



The LDC for Little Wewoka Creek (**Figure 5-10**) was based on Enterococci measurements during primary contact recreation season at WQM stations OK520500-02-0090D.

Figure 5-10 Load Duration Curve for Enterococci in Little Wewoka Creek (OK520500020090_00)



5.2.2 Establish Percent Reduction Goals

The LDC approach recognizes that the assimilative capacity of a waterbody depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading and load reductions required to meet the TMDL can also be calculated under different flow conditions. The difference between existing loading and the TMDL is used to calculate the loading reductions required. PRGs are calculated through an iterative process of taking a series of percent reduction values, applying each value uniformly to the concentrations of samples and verifying if the geometric mean of the reduced values of all samples was less than the WQS geometric mean. **Table 5-1** represents the percent reductions necessary to meet the TMDL water quality target for each bacterial indicator in each of the impaired waterbodies in the Study Area. The PRGs in this report ranged from 11% to 84%.

Table 5-1 TMDL Percent Reduction Required to Meet Water Quality Standards for Indicator Bacteria

Waterbody ID	Waterbody Name	Required Reduction Rate	
		E. coli	ENT
OK520500010170_00	**Bad Creek**	**20%**	**-**
OK520500010200_00	**Alabama Creek**	**11%**	**84%**
OK520500020010_00	**Wewoka Creek**	**32%**	**-**
OK520500020090_00	**Little Wewoka Creek**	**36%**	**79%**

5.3 WASTELOAD ALLOCATION

For bacterial TMDLs, OPDES-permitted facilities are allocated a daily wasteload calculated as their permitted flow rate multiplied by the in-stream geometric mean water quality criterion. In other words, the facilities are required to meet in-stream criteria in their discharge. **Table 5-2** summarizes the WLA for the OPDES-permitted facilities within the Study Area. The WLA for each facility discharging to a bacterially-impaired waterbody is derived from the following equation:

WLA = WQS * flow * unit conversion factor (cfu/day)

Where:

WQS = 33 and 126 cfu/100 mL for Enterococci and E. coli respectively

Flow (mgd) = permitted flow

Unit conversion factor = 37,854,120

When multiple OPDES facilities occur within a watershed, individual WLAs were summed and the total WLA for continuous point sources was included in the TMDL calculation for the corresponding waterbody. When there were no OPDES WWTFs discharging into the contributing watershed of a stream segment, then the WLA is zero. Compliance with the WLA will be achieved by adhering to the fecal coliform or *E. coli* limits and disinfection requirements of OPDES permits. Currently, facilities that discharge treated wastewater are currently required to monitor for fecal coliform. These discharges or any other discharges with a bacterial WLA will be required to monitor for *E. coli* as their permits are renewed.

Table 5-2 indicates which point source dischargers within the Study Area currently have a disinfection requirement in their permit. Certain facilities that utilize lagoons for treatment have not been required to provide disinfection since storage time and exposure to ultraviolet radiation from sunlight should reduce bacterial levels. In the future, all point source dischargers which are assigned a wasteload allocation but do not currently have a bacterial limit in their permit will receive a permit limit consistent with the wasteload allocation as their permits are reissued. Regardless of the magnitude of the WLA calculated in these TMDLs, future new discharges of bacteria or increased bacterial load from existing discharges will be considered consistent with the TMDL provided that the OPDES permit requires in-stream criteria to be met.

Permitted stormwater discharges are considered point sources. However, there aren't any MS4s within the watersheds of the Study Area impaired for bacteria. Therefore, there aren't any WLAs for MS4s.

Table 5-2 Bacterial Wasteload Allocations for OPDES-Permitted Facilities

Waterbody ID & Stream Name	Name	OPDES Permit No.	Dis-infection?	Design Flow (mg/d)	Wasteload Allocation ($x10^8$ cfu/day)	
					E. coli	ENT
Alabama Creek OK520500010200_00	**Weleetka PWA**	OK0028525	No	**0.144**	**6.87**	**1.8**
Wewoka Creek OK520500020010_00	**City of Wetumka**	OK0032417	Yes	**0.102**	**4.87**	-
	City of Wewoka	OK0022659	Yes	**0.580**	**27.7**	-

5.4 Load Allocation

As discussed in Section 3, nonpoint source bacterial loading to each waterbody emanate from a number of different sources. The data analysis and the LDCs indicate that exceedances for each waterbody are the result of a variety of nonpoint source loading. The LAs for each bacterial indicator in waterbodies not supporting the PBCR use are calculated as the difference between the TMDL, MOS, and WLA, as follows:

LA = TMDL – WLA_WWTF – WLA_MS4 – MOS

5.5 Seasonal Variability

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. The bacterial TMDLs established in this report adhere to the seasonal application of the Oklahoma WQS which limits the PBCR use to the period of May 1st through September 30th. Seasonal variation was also accounted for in these TMDLs by using five years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

5.6 Margin of Safety

Federal regulations [40 CFR §130.7(c)(1)] require that TMDLs include an MOS. The MOS is a conservative measure incorporated into the TMDL equation that accounts for the lack of knowledge associated with calculating the allowable pollutant loading to ensure WQSs are attained. EPA guidance allows for use of implicit or explicit expressions of the MOS, or both. For this report, an explicit MOS was set at 10%.

5.7 TMDL Calculations

The TMDLs for the 303(d)-listed waterbodies covered in this report were derived using LDCs. A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for the lack of knowledge concerning the relationship between pollutant loading and water quality.

This definition can be expressed by the following equation:

$$\boldsymbol{TMDL = \Sigma\ WLA + LA + MOS}$$

The TMDL represents a continuum of desired load over all flow conditions, rather than fixed at a single value, because loading capacity varies as a function of the flow present in the stream. The higher the flow is, the more wasteload the stream can handle without violating WQS. Regardless of the magnitude of the WLA calculated in these TMDLs, future new discharges or increased load from existing discharges will be considered consistent with the TMDL provided the OPDES permit requires in-stream criteria to be met.

The TMDL, WLA, LA, and MOS will vary with flow condition, and are calculated at every 5th flow interval percentile. **Table 5-3** summarizes the TMDL, WLA, LA and MOS loadings at the 50% flow percentile. **Tables 5-4** through **5-9** summarize the allocations for indicator bacteria. The bacterial TMDLs calculated in these tables apply to the recreation season (May 1 through September 30) only.

Table 5-3 Summaries of Bacterial TMDLs

Stream Name	Waterbody ID	Pollutant	TMDL (cfu/day)	$WLA_{\_WWTF}$ (cfu/day)	$WLA_{\_MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
Bad Creek	OK520500010170_00	***E. coli***	1.40E+10	0.00E+00	0.00E+00	1.26E+10	1.40E+09
Alabama Creek	OK520500010200_00	***E. coli***	1.10E+10	6.87E+08	0.00E+00	9.21E+09	1.10E+09
		ENT	2.88E+09	1.80E+08	0.00E+00	2.41E+09	2.88E+08
Wewoka Creek	OK520500020010_00	***E. coli***	6.78E+10	3.25E+09	0.00E+00	5.78E+10	6.78E+09
Little Wewoka Creek	OK520500020090_00	***E. coli***	1.19E+10	0.00E+00	0.00E+00	1.07E+10	1.19E+09
		ENT	3.13E+09	0.00E+00	0.00E+00	2.81E+09	3.13E+08

Table 5-4 *E.coli* TMDL Calculations for Bad Creek (OK520500010170_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTF} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	2233.0	6.88E+12	0	0	6.20E+12	6.88E+11
5	69.1	2.13E+11	0	0	1.92E+11	2.13E+10
10	33.3	1.03E+11	0	0	9.25E+10	1.03E+10
15	22.2	6.85E+10	0	0	6.16E+10	6.85E+09
20	15.6	4.79E+10	0	0	4.31E+10	4.79E+09
25	12.2	3.77E+10	0	0	3.39E+10	3.77E+09
30	9.7	2.99E+10	0	0	2.69E+10	2.99E+09
35	7.9	2.43E+10	0	0	2.19E+10	2.43E+09
40	6.4	1.99E+10	0	0	1.79E+10	1.99E+09
45	5.4	1.68E+10	0	0	1.51E+10	1.68E+09
50	4.6	1.40E+10	0	0	1.26E+10	1.40E+09
55	4.0	1.23E+10	0	0	1.11E+10	1.23E+09
60	3.4	1.06E+10	0	0	9.55E+09	1.06E+09
65	2.9	8.90E+09	0	0	8.01E+09	8.90E+08
70	2.3	7.19E+09	0	0	6.47E+09	7.19E+08
75	2.0	6.16E+09	0	0	5.55E+09	6.16E+08
80	1.7	5.14E+09	0	0	4.62E+09	5.14E+08
85	1.4	4.45E+09	0	0	4.01E+09	4.45E+08
90	1.1	3.42E+09	0	0	3.08E+09	3.42E+08
95	0.8	2.33E+09	0	0	2.10E+09	2.33E+08
100	0.2	6.16E+08	0	0	5.55E+08	6.16E+07

Table 5-5 *E. coli* TMDL Calculations for Alabama Creek (OK520500010200_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTF} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	1915.00	5.90E+12	6.87E+08	0.00E+00	5.31E+12	5.90E+11
5	54.09	1.67E+11	6.87E+08	0.00E+00	1.49E+11	1.67E+10
10	26.09	8.04E+10	6.87E+08	0.00E+00	7.17E+10	8.04E+09
15	17.39	5.36E+10	6.87E+08	0.00E+00	4.76E+10	5.36E+09
20	12.17	3.75E+10	6.87E+08	0.00E+00	3.31E+10	3.75E+09
25	9.57	2.95E+10	6.87E+08	0.00E+00	2.59E+10	2.95E+09
30	7.58	2.34E+10	6.87E+08	0.00E+00	2.04E+10	2.34E+09
35	6.17	1.90E+10	6.87E+08	0.00E+00	1.64E+10	1.90E+09
40	5.04	1.55E+10	6.87E+08	0.00E+00	1.33E+10	1.55E+09
45	4.26	1.31E+10	6.87E+08	0.00E+00	1.11E+10	1.31E+09
50	3.57	1.10E+10	6.87E+08	0.00E+00	9.21E+09	1.10E+09
55	3.13	9.65E+09	6.87E+08	0.00E+00	8.00E+09	9.65E+08
60	2.70	8.31E+09	6.87E+08	0.00E+00	6.79E+09	8.31E+08
65	2.26	6.97E+09	6.87E+08	0.00E+00	5.59E+09	6.97E+08
70	1.83	5.63E+09	6.87E+08	0.00E+00	4.38E+09	5.63E+08
75	1.57	4.83E+09	6.87E+08	0.00E+00	3.66E+09	4.83E+08
80	1.30	4.02E+09	6.87E+08	0.00E+00	2.93E+09	4.02E+08
85	1.13	3.49E+09	6.87E+08	0.00E+00	2.45E+09	3.49E+08
90	0.87	2.68E+09	6.87E+08	0.00E+00	1.73E+09	2.68E+08
95	0.59	1.82E+09	6.87E+08	0.00E+00	9.54E+08	1.82E+08
100	0.16	6.87E+08	6.87E+08	0.00E+00	0.00E+00	0.00E+00

Table 5-6 Enterococci TMDL Calculations for Alabama Creek (OK520500010200_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTF} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	1915.00	1.55E+12	1.8E+08	0	1.39E+12	1.55E+11
5	54.09	4.37E+10	1.8E+08	0	3.91E+10	4.37E+09
10	26.09	2.11E+10	1.8E+08	0	1.88E+10	2.11E+09
15	17.39	1.40E+10	1.8E+08	0	1.25E+10	1.40E+09
20	12.17	9.83E+09	1.8E+08	0	8.67E+09	9.83E+08
25	9.57	7.72E+09	1.8E+08	0	6.77E+09	7.72E+08
30	7.58	6.12E+09	1.8E+08	0	5.33E+09	6.12E+08
35	6.17	4.99E+09	1.8E+08	0	4.31E+09	4.99E+08
40	5.04	4.07E+09	1.8E+08	0	3.49E+09	4.07E+08
45	4.26	3.44E+09	1.8E+08	0	2.92E+09	3.44E+08
50	3.57	2.88E+09	1.8E+08	0	2.41E+09	2.88E+08
55	3.13	2.53E+09	1.8E+08	0	2.09E+09	2.53E+08
60	2.70	2.18E+09	1.8E+08	0	1.78E+09	2.18E+08
65	2.26	1.83E+09	1.8E+08	0	1.46E+09	1.83E+08
70	1.83	1.47E+09	1.8E+08	0	1.15E+09	1.47E+08
75	1.57	1.26E+09	1.8E+08	0	9.57E+08	1.26E+08
80	1.30	1.05E+09	1.8E+08	0	7.68E+08	1.05E+08
85	1.13	9.13E+08	1.8E+08	0	6.42E+08	9.13E+07
90	0.87	7.02E+08	1.8E+08	0	4.52E+08	7.02E+07
95	0.59	4.77E+08	1.8E+08	0	2.50E+08	4.77E+07
100	0.16	1.80E+08	1.8E+08	0	0.00E+00	0.00E+00

Table 5-7 *E. coli* TMDL Calculations for Wewoka Creek (OK520500020010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTF} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	9160.00	2.82E+13	3.25E+09	0	2.54E+13	2.82E+12
5	646.35	1.99E+12	3.25E+09	0	1.79E+12	1.99E+11
10	280.00	8.63E+11	3.25E+09	0	7.74E+11	8.63E+10
15	162.90	5.02E+11	3.25E+09	0	4.49E+11	5.02E+10
20	103.60	3.19E+11	3.25E+09	0	2.84E+11	3.19E+10
25	74.00	2.28E+11	3.25E+09	0	2.02E+11	2.28E+10
30	58.00	1.79E+11	3.25E+09	0	1.58E+11	1.79E+10
35	45.00	1.39E+11	3.25E+09	0	1.22E+11	1.39E+10
40	36.00	1.11E+11	3.25E+09	0	9.66E+10	1.11E+10
45	28.00	8.63E+10	3.25E+09	0	7.44E+10	8.63E+09
50	22.00	6.78E+10	3.25E+09	0	5.78E+10	6.78E+09
55	16.00	4.93E+10	3.25E+09	0	4.11E+10	4.93E+09
60	12.00	3.70E+10	3.25E+09	0	3.00E+10	3.70E+09
65	8.10	2.50E+10	3.25E+09	0	1.92E+10	2.50E+09
70	5.90	1.82E+10	3.25E+09	0	1.31E+10	1.82E+09
75	4.00	1.23E+10	3.25E+09	0	7.84E+09	1.23E+09
80	2.60	8.01E+09	3.25E+09	0	3.96E+09	8.01E+08
85	1.70	5.24E+09	3.25E+09	0	1.46E+09	5.24E+08
90	1.2	3.25E+09	3.25E+09	0	0.00E+00	0.00E+00
95	1.1	3.25E+09	3.25E+09	0	0.00E+00	0.00E+00
100	0.9	3.25E+09	3.25E+09	0	0.00E+00	0.00E+00

Table 5-8 *E. coli* TMDL Calculations for Little Wewoka Creek (OK520500020090_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTF} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	1612.40	4.97E+12	0	0	4.47E+12	4.97E+11
5	113.77	3.51E+11	0	0	3.16E+11	3.51E+10
10	49.29	1.52E+11	0	0	1.37E+11	1.52E+10
15	28.67	8.84E+10	0	0	7.96E+10	8.84E+09
20	18.24	5.62E+10	0	0	5.06E+10	5.62E+09
25	13.03	4.02E+10	0	0	3.61E+10	4.02E+09
30	10.21	3.15E+10	0	0	2.83E+10	3.15E+09
35	7.92	2.44E+10	0	0	2.20E+10	2.44E+09
40	6.34	1.95E+10	0	0	1.76E+10	1.95E+09
45	4.93	1.52E+10	0	0	1.37E+10	1.52E+09
50	3.87	1.19E+10	0	0	1.07E+10	1.19E+09
55	2.82	8.68E+09	0	0	7.81E+09	8.68E+08
60	2.11	6.51E+09	0	0	5.86E+09	6.51E+08
65	1.43	4.40E+09	0	0	3.96E+09	4.40E+08
70	1.04	3.20E+09	0	0	2.88E+09	3.20E+08
75	0.70	2.17E+09	0	0	1.95E+09	2.17E+08
80	0.46	1.41E+09	0	0	1.27E+09	1.41E+08
85	0.30	9.22E+08	0	0	8.30E+08	9.22E+07
90	0.16	4.83E+08	0	0	4.35E+08	4.83E+07
95	0.04	1.28E+08	0	0	1.15E+08	1.28E+07
100	0.00	0.00E+00	0	0	0.00E+00	0.00E+00

Table 5-9 Enterococci TMDL Calculations for Little Wewoka Creek (OK520500020090_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTF} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	1612.40	1.30E+12	0	0	1.17E+12	1.30E+11
5	113.77	9.19E+10	0	0	8.27E+10	9.19E+09
10	49.29	3.98E+10	0	0	3.58E+10	3.98E+09
15	28.67	2.32E+10	0	0	2.08E+10	2.32E+09
20	18.24	1.47E+10	0	0	1.33E+10	1.47E+09
25	13.03	1.05E+10	0	0	9.47E+09	1.05E+09
30	10.21	8.24E+09	0	0	7.42E+09	8.24E+08
35	7.92	6.40E+09	0	0	5.76E+09	6.40E+08
40	6.34	5.12E+09	0	0	4.60E+09	5.12E+08
45	4.93	3.98E+09	0	0	3.58E+09	3.98E+08
50	3.87	3.13E+09	0	0	2.81E+09	3.13E+08
55	2.82	2.27E+09	0	0	2.05E+09	2.27E+08
60	2.11	1.71E+09	0	0	1.53E+09	1.71E+08
65	1.43	1.15E+09	0	0	1.04E+09	1.15E+08
70	1.04	8.38E+08	0	0	7.55E+08	8.38E+07
75	0.70	5.68E+08	0	0	5.12E+08	5.68E+07
80	0.46	3.70E+08	0	0	3.33E+08	3.70E+07
85	0.30	2.42E+08	0	0	2.17E+08	2.42E+07
90	0.16	1.26E+08	0	0	1.14E+08	1.26E+07
95	0.04	3.35E+07	0	0	3.01E+07	3.35E+06
100	0.00	0.00E+00	0	0	0.00E+00	0.00E+00

5.8 TMDL Implementation

DEQ collaborates with other State agencies and local governments, working within the boundaries of State and local regulations, to target available funding and technical assistance to support implementation of pollution controls and management measures. Various water quality management programs and funding sources will be utilized so that the pollutant reductions, as required by these TMDLs, can be achieved; and water quality can be restored so that these waterbodies meet their designated uses. DEQ's Continuing Planning Process (CPP), required by the CWA §303(e)(3) and 40 CFR 130.5, summarizes Oklahoma's commitments and programs aimed at restoring and protecting water quality throughout the State (DEQ 2012). The CPP can be viewed at DEQ's website: www.deq.state.ok.us/wqdnew/305b_303d/Final%20CPP.pdf. **Table 5-10** provides a partial list of the State partner agencies DEQ collaborates with to address point and nonpoint source reduction goals established by TMDLs.

Table 5-10 Partial List of Oklahoma Water Quality Management Agencies

Agency	Web Link
Oklahoma Conservation Commission	www.ok.gov/conservation/Agency_Divisions/Water_Quality_Division
Oklahoma Department of Wildlife Conservation	www.wildlifedepartment.com/wildlifemgmt/endangeredspecies.htm
Oklahoma Department of Agriculture, Food, and Forestry	http://www.ok.gov/~okag/aems/
Oklahoma Water Resources Board	http://www.owrb.ok.gov/quality/index.php

5.8.1 Point Sources

Point source WLAs are outlined in the Oklahoma Water Quality Management Plan (aka the 208 Plan) under the OPDES program.

5.8.2 Nonpoint Sources

Nonpoint source pollution in Oklahoma is managed by the Oklahoma Conservation Commission. The Oklahoma Conservation Commission works with other agencies that collect water monitoring information and/or address water quality problems associated with nonpoint source pollution. These agencies are DEQ, OWRB, Corporation Commission, & ODAFF at the State level and EPA, USGS, U.S. Army Corps of Engineers (USACE) & the National Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) at the Federal level. The primary mechanisms used for management of nonpoint source pollution are incentive-based programs that support the installation of BMPs and public education and outreach. Other programs include regulations and permits for CAFOs. The CAFO Act, as administered by the ODAFF, provides CAFO operators the necessary tools and information to deal with the manure and wastewater animals produce so streams, lakes, ponds, and groundwater sources are not polluted.

The reduction rates called for in this TMDL report are as high as 84%. DEQ recognizes that achieving such high reductions can be a challenge, especially since unregulated nonpoint sources are a major cause of both bacterial and TSS loading.

The high reduction rates are not uncommon for pathogen-impaired waters. Similar reduction rates are often found in other pathogen TMDLs around the nation. The suitability of the current criteria for pathogens and the beneficial uses of a waterbody should be reviewed. For example, the Kansas Department of Health and Environment proposed to exclude certain high flow conditions during which pathogen standards will not apply though that exclusion was not approved by the EPA. Additionally, EPA has been conducting new epidemiology studies and may develop new recommendations for pathogen criteria in the future.

Revisions to the current pathogen provisions of Oklahoma's WQSs should be considered. There are three basic approaches that may apply to such revisions.

- **Remove the PBCR use**: This revision would require documentation in a Use Attainability Analysis that the use is not an existing use and cannot be attained. It is unlikely that this approach would be successful since there was evidence that people do swim in bacterially-impaired waterbodies, thus constituting an existing use. Existing uses cannot be removed.
- **Modify application of the existing criteria**: This approach would include considerations such as an exemption under certain high flow conditions, an allowance for wildlife or "natural conditions," a sub-category of the use or other special provision for urban areas, or other special provisions for storm flows. Since large bacterial violations occur over all flow ranges, it is likely that large reductions would still be necessary. However, this approach may have merit and should be considered.
- **Revise the existing numeric criteria**: Oklahoma's current pathogen criteria, revised in 2011, are based on EPA guidelines (See the *Recreational Water Quality Criteria*, Draft, December 2011 and *Ambient Water Quality Criteria for Bacteria-1986*). However, those guidelines have received much criticism and EPA studies that could result in revisions to their recommendations are ongoing. The numeric criteria values should also be evaluated using a risk-based method such as that found in EPA guidance.

Unless or until the WQSs are revised and approved by EPA, federal rules require that the TMDLs in this report must be based on attainment of the current standards. If revisions to the pathogen standards are approved in the future, reductions specified in these TMDLs will be re-evaluated.

5.9 Reasonable Assurances

Reasonable assurance is required by the EPA guidance for a TMDL to be approvable only when a waterbody is impaired by both point and nonpoint sources and where a point source is given a less stringent wasteload allocation based on an assumption that nonpoint source load reductions will occur. In such a case, "reasonable assurance" that the NPS load reductions will actually occur must be demonstrated. In this report, all point source discharges either already have or will be given discharging discharge limitations less than or equal to the water quality standards numerical criteria. This ensures that the impairments of the waterbodies in this report will not be caused by point sources. Since the point source WLAs in this TMDL report are not dependent on NPS load reduction, reasonable assurance does not apply.

SECTION 6
PUBLIC PARTICIPATION

The draft TMDL report was preliminarily reviewed by EPA before being sent out for public notice. The public notice and draft 208 Factsheet was sent to local newspapers, to stakeholders in the Study Area affected by these draft TMDLs, and to stakeholders who have requested copies of all TMDL public notices. The public notice, draft 208 Factsheet, and draft TMDL report was also posted at the following DEQ website: http://www.deq.state.ok.us/wqdnew/index.htm.

The public comment period lasted 45 days and was originally opened from July 10, 2014 to August 25, 2014. During that time, there were three requests to extend the public comment period. DEQ extended the public comment period two weeks to September 8, 2014.

The public had the opportunity to review the draft TMDL report and make written comments. The comments and DEQ responses are in **Appendix G**. The comments and response are part of the public record of this TMDL report. As a result of the public comments, some changes were made to the final version of the *Lower N. Canadian-Deep Fork Area Bacterial and Turbidity TMDL Report*.

There were no requests for a public meeting.

After EPA's final approval, the 208 Factsheet and each TMDL was adopted into Oklahoma's WQMP.

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APPENDIX A: AMBIENT WATER QUALITY DATA

Table Appendix A-1 Bacterial Data: 2003 to 2010

Waterbody Name	WQM Station	Date	*E. coli*	ENT[1]
Bad Creek	OK520500-01-0170L	7/22/2003	1000	
Bad Creek	OK520500-01-0170L	8/26/2003	10	
Bad Creek	OK520500-01-0170L	9/30/2003	20	
Bad Creek	OK520500-01-0170L	5/4/2004	120	
Bad Creek	OK520500-01-0170L	6/15/2004	<10	
Bad Creek	OK520500-01-0170L	8/17/2004	<10	
Bad Creek	OK520500-01-0170L	9/21/2004	<10	
Bad Creek	OK520500-01-0170L	5/25/2005	70	
Bad Creek	OK520500-01-0170L	6/2/2008	700	
Bad Creek	OK520500-01-0170L	6/23/2008	220	
Bad Creek	OK520500-01-0170L	7/7/2008	90	
Bad Creek	OK520500-01-0170L	8/11/2008	10000	
Bad Creek	OK520500-01-0170L	9/15/2008	1260	
Bad Creek	OK520500-01-0170L	6/1/2009	20	
Bad Creek	OK520500-01-0170L	7/6/2009	50	
Bad Creek	OK520500-01-0170L	8/10/2009	10	
Bad Creek	OK520500-01-0170L	9/14/2009	540	
Bad Creek	OK520500-01-0170L	5/4/2010	<10	
Alabama Creek	OK520500-01-0200D	7/22/2003	440	80
Alabama Creek	OK520500-01-0200D	8/26/2003	10	10
Alabama Creek	OK520500-01-0200D	9/30/2003	10	20
Alabama Creek	OK520500-01-0200D	5/4/2004	80	340
Alabama Creek	OK520500-01-0200D	6/15/2004	265	165
Alabama Creek	OK520500-01-0200D	7/13/2004	85	120
Alabama Creek	OK520500-01-0200D	8/17/2004	25	20
Alabama Creek	OK520500-01-0200D	9/21/2004	5	10
Alabama Creek	OK520500-01-0200D	5/25/2005	170	70
Alabama Creek	OK520500-01-0200D	6/2/2008	430	440
Alabama Creek	OK520500-01-0200D	6/23/2008	320	300
Alabama Creek	OK520500-01-0200D	7/7/2008	60	50
Alabama Creek	OK520500-01-0200D	8/11/2008	10000	10000
Alabama Creek	OK520500-01-0200D	9/15/2008	1540	1820
Alabama Creek	OK520500-01-0200D	6/1/2009	30	50
Alabama Creek	OK520500-01-0200D	7/6/2009	10	10
Alabama Creek	OK520500-01-0200D	8/10/2009	10	10
Alabama Creek	OK520500-01-0200D	9/14/2009	840	1800
Alabama Creek	OK520500-01-0200D	5/4/2010	10	110
Wewoka Creek	OK520500-02-0010M	5/4/2004	5	
Wewoka Creek	OK520500-02-0010T	8/22/2000	10	
Wewoka Creek	OK520500-02-0010E	8/22/2000	10	

Waterbody Name	WQM Station	Date	*E. coli*	ENT[1]
Wewoka Creek	OK520500-02-0010M	7/22/2003	80	
Wewoka Creek: Downstream	OK520500-02-0010C	7/22/2003	10	
Wewoka Creek: Downstream	OK520500-02-0010C	8/26/2003	10	
Wewoka Creek	OK520500-02-0010M	8/26/2003	60	
Wewoka Creek	OK520500-02-0010M	9/30/2003	210	
Wewoka Creek: Downstream	OK520500-02-0010C	9/30/2003	30	
Wewoka Creek: Downstream	OK520500-02-0010C	5/4/2004	10	
Wewoka Creek	OK520500-02-0010M	6/15/2004	35	
Wewoka Creek: Downstream	OK520500-02-0010C	6/15/2004	75	
Wewoka Creek	OK520500-02-0010M	7/13/2004	40	
Wewoka Creek: Downstream	OK520500-02-0010C	7/13/2004	40	
Wewoka Creek	OK520500-02-0010M	8/17/2004	35	
Wewoka Creek: Downstream	OK520500-02-0010C	8/17/2004	25	
Wewoka Creek	OK520500-02-0010M	6/9/2008	9900	
Wewoka Creek: Downstream	OK520500-02-0010C	6/23/2008	240	
Wewoka Creek	OK520500-02-0010M	6/23/2008	60	
Wewoka Creek: Downstream	OK520500-02-0010C	7/7/2008	10	
Wewoka Creek	OK520500-02-0010M	7/14/2008	150	
Wewoka Creek: Downstream	OK520500-02-0010C	8/11/2008	10000	
Wewoka Creek	OK520500-02-0010M	8/19/2008	1700	
Wewoka Creek: Downstream	OK520500-02-0010C	9/15/2008	1660	
Wewoka Creek	OK520500-02-0010M	9/16/2008	160	
Wewoka Creek	OK520500-02-0010M	5/4/2009	200	
Wewoka Creek: Downstream	OK520500-02-0010C	6/1/2009	300	
Wewoka Creek	OK520500-02-0010M	6/8/2009	30	
Wewoka Creek: Downstream	OK520500-02-0010C	7/6/2009	350	
Wewoka Creek: Downstream	OK520500-02-0010C	8/10/2009	10	
Wewoka Creek	OK520500-02-0010M	8/17/2009	20	
Wewoka Creek: Downstream	OK520500-02-0010C	9/14/2009	1400	
Wewoka Creek	OK520500-02-0010M	9/21/2009	100	
Wewoka Creek: Downstream	OK520500-02-0010C	5/4/2010	20	
Wewoka Creek	OK520500-02-0010M	5/4/2010	100	
Little Wewoka Creek	OK520500-02-0090D	7/22/2003	10	70
Little Wewoka Creek	OK520500-02-0090D	8/26/2003	20	20
Little Wewoka Creek	OK520500-02-0090D	9/30/2003	100	210
Little Wewoka Creek	OK520500-02-0090D	5/4/2004	10	275
Little Wewoka Creek	OK520500-02-0090D	6/15/2004	35	195
Little Wewoka Creek	OK520500-02-0090D	7/13/2004	70	180
Little Wewoka Creek	OK520500-02-0090D	8/17/2004	20	70
Little Wewoka Creek	OK520500-02-0090D	9/21/2004	10	40
Little Wewoka Creek	OK520500-02-0090D	5/25/2005	10	25
Little Wewoka Creek	OK520500-02-0090D	6/2/2008	950	500

Waterbody Name	WQM Station	Date	*E. coli*	ENT[1]
Little Wewoka Creek	OK520500-02-0090D	6/23/2008	120	120
Little Wewoka Creek	OK520500-02-0090D	7/7/2008	10	60
Little Wewoka Creek	OK520500-02-0090D	8/11/2008	10000	10000
Little Wewoka Creek	OK520500-02-0090D	9/15/2008	1620	1860
Little Wewoka Creek	OK520500-02-0090D	6/1/2009	60	10
Little Wewoka Creek	OK520500-02-0090D	7/6/2009	120	130
Little Wewoka Creek	OK520500-02-0090D	8/10/2009	10	20
Little Wewoka Creek	OK520500-02-0090D	9/14/2009	540	480
Little Wewoka Creek	OK520500-02-0090D	5/4/2010	130	10

[1] ENT = Enterococci; units = counts/100 mL

Table Appendix A-2 Turbidity and Total Suspended Solids Data (2009-2010)

Waterbody Name	Waterbody ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
Greasy Creek	OK520500020020_00	7/13/2009	< 10	0.37	0.851
Greasy Creek	OK520500020020_00	8/5/2009	< 10	3.44	<0.005
Greasy Creek	OK520500020020_00	9/29/2009	< 10	29.8	0.013
Greasy Creek	OK520500020020_00	10/20/2009	11	37.8	6.943
Greasy Creek	OK520500020020_00	12/7/2009	< 10	32.1	4.794
Greasy Creek	OK520500020020_00	1/20/2010	< 10	30.1	6.807
Greasy Creek	OK520500020020_00	3/3/2010	< 10	40.7	20.98
Greasy Creek	OK520500020020_00	3/29/2010	11	34.7	15.18
Greasy Creek	OK520500020020_00	4/12/2010	16	35.2	6.943
Greasy Creek	OK520500020020_00	4/29/2010	11	34.9	2.463
Greasy Creek	OK520500020020_00	5/26/2010	18	69.8	2.246
Greasy Creek	OK520500020020_00	6/24/2010	< 10	47.3	0.384
Coal Creek	OK520700010140_00	7/13/2009	< 10	13.9	1.657
Coal Creek	OK520700010140_00	8/4/2009	< 10	8.6	0.762
Coal Creek	OK520700010140_00	9/29/2009	< 10	16.4	4.265
Coal Creek	OK520700010140_00	11/9/2009	< 10	7.55	8.232
Coal Creek	OK520700010140_00	12/7/2009	< 10	6.8	7.318
Coal Creek	OK520700010140_00	1/20/2010	< 10	12.8	10.82
Coal Creek	OK520700010140_00	3/3/2010	11	24.5	14.95
Coal Creek	OK520700010140_00	3/29/2010	< 10	17.6	19.6
Coal Creek	OK520700010140_00	4/12/2010	17	16.6	7.218
Coal Creek	OK520700010140_00	4/29/2010	24	19.3	4.782
Coal Creek	OK520700010140_00	5/26/2010	22	31.7	0.663
Coal Creek	OK520700010140_00	6/30/2010	12	27.6	0.656

APPENDIX B: GENERAL METHOD FOR ESTIMATING FLOW FOR UNGAGED STREAMS AND ESTIMATED FLOW EXCEEDANCE PERCENTILES

Appendix B

General Method for Estimating Flow for Ungaged Streams

Flows duration curve were developed using existing USGS measured flow where the data existed from a gage on the stream segment of interest, or by estimating flow for stream segments with no corresponding flow record. Flow data to support flow duration curves and load duration curves were derived for each Oklahoma stream segment in the following priority:

A. In cases where a USGS flow gage occurred on, or within one-half mile upstream or downstream of the Oklahoma stream segment:

   1. If simultaneously collected flow data matching the water quality sample collection dates were available, those flow measurements were used.

   2. If flow measurements at the coincident gage were missing for some dates on which water quality samples were collected, the gaps in the flow record were filled, or the record was extended by estimating flow based on measured streamflows at a nearby gages. All gages within 150 km radius were identified. For each identified gage with a minimum of 99 flow measurements on matching dates, four different regressions were calculated including linear, log linear, logarithmic and exponential regressions. The regression with the lowest root mean square error (RMSE) was chosen for each gage. The potential filling gages were ranked by RMSE from lowest to highest. The record was filled from the first gage (lowest RMSE) for those dates that existed in both records. If dates remained unfilled in the desired timespan of the timeseries, the filling process was repeated with the next gage with the next lowest RMSE and proceeded in this fashion until all missing values in the desired timespan were filled.

   3. The flow frequency for the flow duration curves was based on measured flows only. The filled timeseries described above was used to match flows to sampling dates to calculate loads.

   4. On streams impounded by dams to form reservoirs of sufficient size to impact stream flow, only flows measured after the date of the most recent impoundment were used to develop the flow duration curve. This also applied to reservoirs on major tributaries to the streams.

B. In case no coincident flow data was available for a stream segment, but flow gage(s) were present upstream and/or downstream without a major reservoir between, flows were estimated for the stream segment from an upstream or downstream gage using a watershed area ratio method derived by delineating subwatersheds, and relying on the Natural Resources Conservation Service (NRCS) runoff curve numbers and antecedent rainfall condition. Drainage sub-basins were first delineated for all impaired 303(d)-listed streams, along with all USGS flow stations located in the 8-digit HUCs with impaired streams. Then all the USGS gage stations were identified upstream and downstream of the sub-watersheds with 303(d) listed streams.

1. Watershed delineations were performed using ESRI Arc Hydro with a 30-meter resolution National Elevation Dataset digital elevation model and National Hydrography Dataset (NHD) streams. The area of each watershed was calculated following watershed delineation.

2. The watershed average curve number was calculated from soil properties and land cover as described in the U.S. Department of Agriculture (USDA) Publication *TR-55: Urban Hydrology for Small Watersheds*. The soil hydrologic group was extracted from NRCS soil data, and land use category from the National Land Cover Dataset (NLCD). Based on land use and the hydrologic soil group, SCS curve numbers were estimated at the 30-meter resolution of the NLCD grid as shown in **Table Appendix B-1**. The average curve number was then calculated from all the grid cells within the delineated watershed.

Table Appendix B-1 Runoff Curve Numbers for Various Land Use Categories and Hydrologic Soil Groups

NLCD Land Use Category		Curve number for hydrologic soil group			
		A	B	C	D
0	In case of zero	100	100	100	100
11	Open Water	100	100	100	100
12	Perennial Ice/Snow	100	100	100	100
21	Developed, Open Space	39	61	74	80
22	Developed, Low Intensity	57	72	81	86
23	Developed, Medium Intensity	77	85	90	92
24	Developed, High Intensity	89	92	94	95
31	Barren Land (Rock/Sand/Clay)	77	86	91	94
32	Unconsolidated Shore	77	86	91	94
41	Deciduous Forest	37	48	57	63
42	Evergreen Forest	45	58	73	80
43	Mixed Forest	43	65	76	82
51	Dwarf Scrub	40	51	63	70
52	Shrub/Scrub	40	51	63	70
71	Grasslands/Herbaceous	40	51	63	70
72	Sedge/Herbaceous	40	51	63	70
73	Lichens	40	51	63	70
74	Moss	40	51	63	70
81	Pasture/Hay	35	56	70	77
82	Cultivated Crops	64	75	82	85
90-99	Wetlands	100	100	100	100

3. The average rainfall was calculated for each watershed from gridded average annual precipitation datasets for the period 1971-2000 (Spatial Climate Analysis Service, Oregon State University, http://www.ocs.oregonstate.edu/prism/, created February 20, 2004).

4. The method used to project flow from a gaged location to an ungaged location was adapted by combining aspects of two other flow projection methodologies developed by Furness (Furness 1959) and Wurbs (Wurbs 1999).

Furness Method

The Furness method has been employed by both the USGS and Kansas Department of Health and Environment to estimate flow-duration curves. The method typically uses maps, graphs, and computations to identify six unique factors of flow duration for ungaged sites. These factors include:

- The mean streamflow and percentage duration of mean streamflow
- The ratio of 1-percent-duration streamflow to mean streamflow
- The ratio of 0.1-percent-duration streamflow to 1-percent-duration streamflow
- The ratio of 50-percent-duration streamflow to mean streamflow
- The percentage duration of appreciable (0.10 ft /s) streamflow
- Average slope of the flow-duration curve

Furness defined appreciable flow as 0.10 ft/s. This value of streamflow was important because, for many years, this was the smallest non-zero streamflow value reported in most Kansas streamflow records. The average slope of the duration curve is a graphical approximation of the variability index, which is the standard deviation of the logarithms of the streamflows (Furness 1959, p. 202-204, figs. 147 and 148). On a duration curve that fits the log-normal distribution exactly, the variability index is equal to the ratio of the streamflow at the 15.87-percent-duration point to the streamflow at the 50-percent-duration point. Because duration curves usually do not exactly fit the log-normal distribution, the average-slope line is drawn through an arbitrary point, and the slope is transferred to a position approximately defined by the previously estimated points.

The method provides a means of both describing shape of the flow duration curve and scaling the magnitude of the curve to another location, basically generating a new flow duration curve with a very similar shape but different magnitude at the ungaged location.

Wurbs Modified NRCS Method

As a part of the Texas water availability modeling (WAM) system developed by Texas Natural Resources Conservation Commission(now known as the Texas Commission on Environmental Quality) and partner agencies, various contractors developed models of all Texas rivers. As a part of developing the model code to be used, Dr. Ralph Wurbs of Texas A&M University researched methods to distribute flows from gaged locations to ungaged locations (Wurbs 2006). His results included the development of a modified NRCS curve-number (CN) method for distributing flows from gaged locations to ungaged locations.

This modified NRCS method is based on the following relationship between rainfall depth, P in inches, and runoff depth, Q in inches (NRCS 1985; McCuen 2005):

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \textbf{(1)}$$

Where:

Q = runoff depth (inches)

P = rainfall (inches)

S = potential maximum retention after runoff begins (inches)

I_a = initial abstraction (inches)

If P < 0.2, Q = 0. Initial abstraction has been found to be empirically related to S by the equation

$$I_a = 0.2*S \qquad \textbf{(2)}$$

Thus, the runoff curve number equation can be rewritten:

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad \textbf{(3)}$$

S is related to the curve number (CN) by:

$$S = \frac{1000}{CN} - 10 \qquad \textbf{(4)}$$

P and Q in inches must be multiplied by the watershed area to obtain volumes. The potential maximum retention, S in inches, represents an upper limit on the amount of water that can be abstracted by the watershed through surface storage, infiltration, and other hydrologic abstractions. For convenience, S is expressed in terms of a curve number CN, which is a dimensionless watershed parameter ranging from 0 to 100. A CN of 100 represents a limiting condition of a perfectly impervious watershed with zero retention and thus all the rainfall becoming runoff. A CN of zero conceptually represents the other extreme with the watershed abstracting all rainfall with no runoff regardless of the rainfall amount.

First, S is calculated from the average curve number for the gaged watershed. Next, the daily historic flows at the gage are converted to depth basis (as used in **Equations 1 and 3**) by dividing by its drainage area, then converted to inches. **Equation 3** is then solved for daily precipitation depth of the gaged site, P_{gaged}. The daily precipitation depth for the ungaged site is then calculated as the precipitation depth of the gaged site multiplied by the ratio of the long-term average precipitation in the watersheds of the ungaged and gaged sites:

$$P_{ungaged} = P_{gaged}\left(\frac{M_{ungaged}}{M_{gaged}}\right) \quad \textbf{(5)}$$

Where:

M = the mean annual precipitation of the watershed in inches.

The daily precipitation depth for the ungaged watershed, along with the average curve number of the ungaged watershed, was then used to calculate the depth equivalent daily flow (Q) of the ungaged site. Finally, the volumetric flow rate at the ungaged site was calculated by multiplying by the area of the watershed of the ungaged site and converted to cubic feet.

In a subsequent study (Wurbs 2006), Wurbs evaluated the predictive ability of various flow distribution methods including:

- Distribution of flows in proportion to drainage area
- Flow distribution equation with ratios for various watershed parameters
- Modified NRCS curve-number method
- Regression equations relating flows to watershed characteristics
- Use of recorded data at gaging stations to develop precipitation-runoff relationships
- Use of watershed (precipitation-runoff) computer models such as SWAT

As a part of the analysis, the methods were used to predict flows at one gaged station to another gage station so that fit statistics could be calculated to evaluate the efficacy of each of the methods. Based upon similar analyses performed for many gaged sites which reinforced the tests performed as part of the study, Wurbs observed that temporal variations in flows are dramatic, ranging from zero flows to major floods. Mean flows are reproduced reasonably well with the all flow distribution methods and the NRCS CN method reproduces the mean the closest. Accuracy in predicting mean flows is much better than the accuracy of predicting the flow-frequency relationship. Performance in reproducing flow-frequency relationships is better than for reproducing flows for individual flows.

Wurbs concluded that the NRCS CN method, the drainage area ratio method, and drainage area – CN – mean annual precipitation depth (MP) ratio methods all yield similar levels of accuracy. If the CN and MP are the same for the gaged and ungaged watersheds, the three alternative methods yield identical results. Drainage area is the most important watershed parameter. However, the NRCS method adaptation is preferable in those situations in which differences in CN (land use and soil type) and long-term MP are significantly different between the gaged and ungaged watersheds. The CN and MP are usually similar but not identical.

Generalized Flow Projection Methodology

In the first several versions of the Oklahoma TMDL Toolbox, all flows at ungaged sites that required projection from a gaged site were performed with the Modified NRCS CN method. This led a number of problems with flow projections in the early versions. As described previously, the NRCS method, in common with all others, reproduces the mean or central tendency best but the accuracy of the fit degrades towards the extremes of the frequency spectrum. Part of the degradation in accuracy is due to the quite non-linear nature of the NRCS equations. On the low flow end of the frequency spectrum, **Equation 2** (on page B-5) constitutes a low flow limit below which the NRCS equations are not applicable at all. Given the flashy nature of most streams in locations for which the TMDL Toolbox was developed, high and low flows are relatively more common and spurious results from the limits of the equations abounded.

In an effort to increase the flow prediction efficacy and remedy the failure of the NRCS CN method at the extremes of the flow spectrum, a hybrid of the NRCS CN method and the Furness method was developed. Noting the facts that all tested projection methods, particularly the NRCS CN method, perform best near the central tendency or mean and that none of the methods predict the entire flow frequency spectrum well, an assumption that is implicit in the Furness method is applied. The Furness method implicitly assumes that the shape of the flow frequency curve at an upstream site is related to and similar to the shape of the flow frequency curve at a site downstream. As described previously, the Furness method employs several relationships derived between the mean flows and flows at differing frequencies to replicate the shape of the flow frequency curve at the projected site, while utilizing other regressed relationships to scale the magnitude of the curve. Since, as part of the Toolbox calculations, the entire flow frequency curve at a 1% interval is calculated for every USGS gage utilizing very long periods of record, this vector in association with the mean flow was used to project the flow frequency curve.

In the ideal situation flows are projected from an ungaged location from a downstream gaged location. The Toolbox also has the capability to project flows from and upstream gaged location if there is no useable downstream gage.

C. In the rare case where no coincident flow data was available for a WQM station and no gages were present upstream or downstream, flows will be estimated for the WQM station from a gage on an adjacent watershed of similar size and properties, via the same procedure described previously for upstream or downstream gages.

References

Furness, L.W., 1959, *Kansas Streamflow Characteristics- Part 1, Flow Duration*: Kansas Water Resources Board Technical Report No. 1.

Wurbs, R.A., and E.D. Sisson, *Evaluation of Methods for Distributing Naturalized Streamflows from Gaged Watersheds to Ungaged Subwatersheds*, Technical Report 179, Texas Water Resources Institute and Texas Natural Resource Conservation Commission, August 1999.

Wurbs, R.A. 2006. *Methods for Developing Naturalized Monthly Flows at Gaged and Ungaged Sites*. Journal of Hydrologic Engineering, January/February 2006, ASCE

Table Appendix B-2 Estimated Flow Exceedance Percentiles

Stream Name	Bad Creek	Alabama Creek	Wewoka Creek	Little Wewoka Creek
WBID Segment	OK520500010170_00	OK520500010200_00	OK520500020010_00	OK520500020090_00
USGS Gage Reference	07244100	07244100	07242100	07242100
Drainage Area (mi^2)	36.56	28.32	359.38	63.47
Percentile	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
0	2233	1915	9160	1612
1	376	294	3713	654
2	222	174	1807	318
3	123	97	1175	207
4	90	70	828	146
5	69	54	646	114
6	56	44	520	92
7	49	38	449	79
8	41	32	392	69
9	37	29	315	56
10	33	26	280	49
11	30	23	243	43
12	28	22	216	38
13	26	20	194	34
14	23	18	180	32
15	22	17	163	29
16	21	17	149	26

Stream Name	Bad Creek	Alabama Creek	Wewoka Creek	Little Wewoka Creek
WBID Segment	OK520500010170_00	OK520500010200_00	OK520500020010_00	OK520500020090_00
USGS Gage Reference	07244100	07244100	07242100	07242100
Drainage Area (mi^2)	36.56	28.32	359.38	63.47
Percentile	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
17	19	15	135	24
18	18	14	121	21
19	17	13	110	19
20	16	12	104	18
21	16	12	98	17
22	14	11	90	16
23	13.3	10.4	84.0	14.8
24	13.3	10.4	79.0	13.9
25	12.2	9.6	74.0	13.0
26	12.2	9.6	71.6	12.6
27	11.1	8.7	68.0	12.0
28	10.6	8.3	65.0	11.4
29	10.2	8.0	62.0	10.9
30	9.7	7.6	58.0	10.2
31	9.3	7.3	55.7	9.8
32	9.0	7.0	54.0	9.5
33	8.6	6.7	49.4	8.7
34	8.2	6.4	47.0	8.3
35	7.9	6.2	45.0	7.9
36	7.6	5.9	42.0	7.4
37	7.2	5.7	40.7	7.2
38	7.0	5.5	39.0	6.9
39	6.7	5.2	36.0	6.3
40	6.4	5.0	36.0	6.3
41	6.2	4.9	35.0	6.2
42	6.0	4.7	32.0	5.6
43	5.8	4.5	30.0	5.3
44	5.7	4.4	29.0	5.1
45	5.4	4.3	28.0	4.9
46	5.3	4.2	27.0	4.8
47	5.1	4.0	25.0	4.4
48	5.0	3.9	24.0	4.2
49	4.8	3.7	23.0	4.0
50	4.6	3.6	22.0	3.9
51	4.4	3.5	20.0	3.5
52	4.3	3.4	20.0	3.5
53	4.2	3.3	18.0	3.2
54	4.1	3.2	17.0	3.0
55	4.0	3.1	16.0	2.8
56	3.9	3.0	15.0	2.6
57	3.8	3.0	14.0	2.5
58	3.7	2.9	13.0	2.3
59	3.6	2.8	12.0	2.1
60	3.4	2.7	12.0	2.1
61	3.3	2.6	11.0	1.9

Stream Name	Bad Creek	Alabama Creek	Wewoka Creek	Little Wewoka Creek
WBID Segment	OK520500010170_00	OK520500010200_00	OK520500020010_00	OK520500020090_00
USGS Gage Reference	07244100	07244100	07242100	07242100
Drainage Area (mi^2)	36.56	28.32	359.38	63.47
Percentile	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
62	3.2	2.5	10.0	1.8
63	3.1	2.4	9.4	1.7
64	3.0	2.3	8.8	1.5
65	2.9	2.3	8.1	1.4
66	2.8	2.2	7.4	1.3
67	2.7	2.1	7.0	1.2
68	2.6	2.0	6.5	1.1
69	2.4	1.9	6.2	1.1
70	2.3	1.8	5.9	1.0
71	2.3	1.8	5.6	1.0
72	2.2	1.7	5.1	0.9
73	2.1	1.7	4.8	0.8
74	2.0	1.6	4.4	0.8
75	2.0	1.6	4.0	0.7
76	1.9	1.5	3.6	0.6
77	1.8	1.4	3.4	0.6
78	1.8	1.4	3.0	0.5
79	1.7	1.3	2.8	0.5
80	1.7	1.3	2.6	0.5
81	1.6	1.2	2.4	0.4
82	1.6	1.2	2.2	0.4
83	1.4	1.1	2.1	0.4
84	1.4	1.1	2.0	0.4
85	1.4	1.1	1.7	0.3
86	1.3	1.0	1.5	0.3
87	1.3	1.0	1.4	0.2
88	1.3	1.0	1.2	0.2
89	1.2	1.0	1.2	0.2
90	1.1	0.9	1.2	0.2
91	1.1	0.8	1.2	0.1
92	1.0	0.8	1.2	0.1
93	0.9	0.7	1.2	0.1
94	0.8	0.7	1.2	0.1
95	0.8	0.6	1.1	0.0
96	0.7	0.5	1.1	0.0
97	0.6	0.5	1.1	0.0
98	0.5	0.4	1.1	0.0
99	0.4	0.3	1.1	0.0
100	0.2	0.2	0.9	0.0

APPENDIX C: STATE OF OKLAHOMA ANTIDEGRADATION POLICY

Appendix C

State of Oklahoma Antidegradation Policy

785:45-3-1. Purpose; Antidegradation policy statement

(a) Waters of the state constitute a valuable resource and shall be protected, maintained and improved for the benefit of all the citizens.

(b) It is the policy of the State of Oklahoma to protect all waters of the state from degradation of water quality, as provided in OAC 785:45-3-2 and Subchapter 13 of OAC 785:46.

785:45-3-2. Applications of antidegradation policy

(a) Application to outstanding resource waters (ORW). Certain waters of the state constitute an outstanding resource or have exceptional recreational and/or ecological significance. These waters include streams designated "Scenic River" or "ORW" in Appendix A of this Chapter, and waters of the State located within watersheds of Scenic Rivers. Additionally, these may include waters located within National and State parks, forests, wilderness areas, wildlife management areas, and wildlife refuges, and waters which contain species listed pursuant to the federal Endangered Species Act as described in 785:45-5-25(c)(2)(A) and 785:46-13-6(c). No degradation of water quality shall be allowed in these waters.

(b) Application to high quality waters (HQW). It is recognized that certain waters of the state possess existing water quality which exceeds those levels necessary to support propagation of fishes, shellfishes, wildlife, and recreation in and on the water. These high quality waters shall be maintained and protected.

(c) Application to beneficial uses. No water quality degradation which will interfere with the attainment or maintenance of an existing or designated beneficial use shall be allowed.

(d) Application to improved waters. As the quality of any waters of the state improve, no degradation of such improved waters shall be allowed.

785:46-13-1. Applicability and scope

(a) The rules in this Subchapter provide a framework for implementing the antidegradation policy stated in OAC 785:45-3-2 for all waters of the state. This policy and framework includes three tiers, or levels, of protection.

(b) The three tiers of protection are as follows:

(1) Tier 1. Attainment or maintenance of an existing or designated beneficial use.

(2) Tier 2. Maintenance or protection of High Quality Waters and Sensitive Public and Private Water Supply waters.

(3) Tier 3. No degradation of water quality allowed in Outstanding Resource Waters.

(c) In addition to the three tiers of protection, this Subchapter provides rules to implement the protection of waters in areas listed in Appendix B of OAC 785:45. Although

Appendix B areas are not mentioned in OAC 785:45-3-2, the framework for protection of Appendix B areas is similar to the implementation framework for the antidegradation policy.

(d) In circumstances where more than one beneficial use limitation exists for a waterbody, the most protective limitation shall apply. For example, all antidegradation policy implementation rules applicable to Tier 1 waterbodies shall be applicable also to Tier 2 and Tier 3 waterbodies or areas, and implementation rules applicable to Tier 2 waterbodies shall be applicable also to Tier 3 waterbodies.

(e) Publicly owned treatment works may use design flow, mass loadings or concentration, as appropriate, to calculate compliance with the increased loading requirements of this section if those flows, loadings or concentrations were approved by the Oklahoma Department of Environmental Quality as a portion of Oklahoma's Water Quality Management Plan prior to the application of the ORW, HQW or SWS limitation.

785:46-13-2. Definitions

The following words and terms, when used in this Subchapter, shall have the following meaning, unless the context clearly indicates otherwise:

"Specified pollutants" means

(A) Oxygen demanding substances, measured as Carbonaceous Biochemical Oxygen Demand (CBOD) and/or Biochemical Oxygen Demand (BOD);

(B) Ammonia Nitrogen and/or Total Organic Nitrogen;

(C) Phosphorus;

(D) Total Suspended Solids (TSS); and

(E) Such other substances as may be determined by the Oklahoma Water Resources Board or the permitting authority.

785:46-13-3. Tier 1 protection; attainment or maintenance of an existing or designated beneficial use

(a) General.

(1) Beneficial uses which are existing or designated shall be maintained and protected.

(2) The process of issuing permits for discharges to waters of the state is one of several means employed by governmental agencies and affected persons which are designed to attain or maintain beneficial uses which have been designated for those waters. For example, Subchapters 3, 5, 7, 9 and 11 of this Chapter are rules for the permitting process. As such, the latter Subchapters not only implement numerical and narrative criteria, but also implement Tier 1 of the antidegradation policy.

(b) Thermal pollution. Thermal pollution shall be prohibited in all waters of the state. Temperatures greater than 52 degrees Centigrade shall constitute thermal pollution and shall be prohibited in all waters of the State.

(c) Prohibition against degradation of improved waters. As the quality of any waters of the state improves, no degradation of such improved waters shall be allowed.

785:46-13-4. Tier 2 protection; maintenance and protection of High Quality Waters and Sensitive Water Supplies

(a) General rules for High Quality Waters. New point source discharges of any pollutant after June 11, 1989, and increased load or concentration of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "HQW". Any discharge of any pollutant to a waterbody designated "HQW" which would, if it occurred, lower existing water quality shall be prohibited. Provided however, new point source discharges or increased load or concentration of any specified pollutant from a discharge existing as of June 11, 1989, may be approved by the permitting authority in circumstances where the discharger demonstrates to the satisfaction of the permitting authority that such new discharge or increased load or concentration would result in maintaining or improving the level of water quality which exceeds that necessary to support recreation and propagation of fishes, shellfishes, and wildlife in the receiving water.

(b) General rules for Sensitive Public and Private Water Supplies. New point source discharges of any pollutant after June 11, 1989, and increased load of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "SWS". Any discharge of any pollutant to a waterbody designated "SWS" which would, if it occurred, lower existing water quality shall be prohibited. Provided however, new point source discharges or increased load of any specified pollutant from a discharge existing as of June 11, 1989, may be approved by the permitting authority in circumstances where the discharger demonstrates to the satisfaction of the permitting authority that such new discharge or increased load will result in maintaining or improving the water quality in both the direct receiving water, if designated SWS, and any downstream waterbodies designated SWS.

(c) Stormwater discharges. Regardless of subsections (a) and (b) of this Section, point source discharges of stormwater to waterbodies and watersheds designated "HQW" and "SWS" may be approved by the permitting authority.

(d) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds of waterbodies designated "HQW" or "SWS" in Appendix A of OAC 785:45.

785:46-13-5. Tier 3 protection; prohibition against degradation of water quality in outstanding resource waters

(a) General. New point source discharges of any pollutant after June 11, 1989, and increased load of any pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "ORW" and/or "Scenic River", and in any waterbody located within the watershed of any waterbody designated with the limitation "Scenic River". Any discharge of any pollutant to a waterbody designated "ORW" or "Scenic River" which would, if it occurred, lower existing water quality shall be prohibited.

(b) Stormwater discharges. Regardless of 785:46-13-5(a), point source discharges of stormwater from temporary construction activities to waterbodies and watersheds designated "ORW" and/or "Scenic River" may be permitted by the permitting authority. Regardless of 785:46-13-5(a), discharges of stormwater to waterbodies and watersheds designated "ORW" and/or "Scenic River" from point sources existing as of June 25, 1992, whether or not such stormwater discharges were permitted as point sources prior to June 25, 1992, may be permitted by the permitting authority; provided, however, increased load of any pollutant from such stormwater discharge shall be prohibited.

(c) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds of waterbodies designated "ORW" in Appendix A of OAC 785:45, provided, however, that development of conservation plans shall be required in sub-watersheds where discharges or runoff from nonpoint sources are identified as causing or significantly contributing to degradation in a waterbody designated "ORW".

(d) LMFO's. No licensed managed feeding operation (LMFO) established after June 10, 1998 which applies for a new or expanding license from the State Department of Agriculture after March 9, 1998 shall be located...[w]ithin three (3) miles of any designated scenic river area as specified by the Scenic Rivers Act in 82 O.S. Section 1451 and following, or [w]ithin one (1) mile of a waterbody [2:9-210.3(D)] designated in Appendix A of OAC 785:45 as "ORW".

785:46-13-6. Protection for Appendix B areas

(a) General. Appendix B of OAC 785:45 identifies areas in Oklahoma with waters of recreational and/or ecological significance. These areas are divided into Table 1, which includes national and state parks, national forests, wildlife areas, wildlife management areas and wildlife refuges; and Table 2, which includes areas which contain threatened or endangered species listed as such by the federal government pursuant to the federal Endangered Species Act as amended.

(b) Protection for Table 1 areas. New discharges of pollutants after June 11, 1989, or increased loading of pollutants from discharges existing as of June 11, 1989, to waters within the boundaries of areas listed in Table 1 of Appendix B of OAC 785:45 may be approved by the permitting authority under such conditions as ensure that the recreational and ecological significance of these waters will be maintained.

(c) Protection for Table 2 areas. Discharges or other activities associated with those waters within the boundaries listed in Table 2 of Appendix B of OAC 785:45 may be restricted through agreements between appropriate regulatory agencies and the United States Fish and Wildlife Service. Discharges or other activities in such areas shall not substantially disrupt the threatened or endangered species inhabiting the receiving water.

(d) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds located within areas listed in Appendix B of OAC 785:45.

APPENDIX D: DEQ SANITARY SEWER OVERFLOW REPORT DATA

Table Appendix D-1 DEQ Sanitary Sewer Overflow Report Data

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
WELEETKA	4/7/2002	S20562	0.00	6TH & CHEROKEE		X		RAIN
WELEETKA	10/15/2002	S20562	0.00	CLEARVIEW RD.	10,000	X		PUMPS FAILED
WELEETKA	3/24/2003	S20562	19.00	6TH & 7TH AT WICHITA	300	X		COLLAPSED LINE
WELEETKA	6/27/2003	S20562	6.30	AT 8TH & 9TH ON OSAGE	1,500	X		GREASE
WELEETKA	7/16/2003	S20562	0.80	8TH & 9TH & OSAGE	300	X		GREASE
WELEETKA	10/31/2004	S20562	0.00	5TH & CHOCTAW	2,000	X		BLOCKAGE
WELEETKA	1/3/2005	S20562	2.00	7TH & CHEROKEE	1,200	X		I&I
WELEETKA	1/5/2005	S20562	5.00	100 FT. N. OF 7TH & CHEROKEE	50,000	X		I&I
WELEETKA	1/28/2005	S20562	0.00	7TH & CHEROKEE	25,000	X		OVERLOW
WELEETKA	1/29/2005	S20562	24.00	7TH & CHEROKEE	50,000	X		OVERFLOW
WELEETKA	1/31/2005	S20562	24.00	7TH & CHEROKEE				OVERFLOW
WELEETKA	4/5/2005	S20562	24.60	SENECA ST. AT HWY 75 & 8TH	1,200	X		LINE BREAK
WELEETKA	6/8/2005	S20562	1.00	500 BLK. OF E. 6TH	600	X		OBSTRUCTION
WELEETKA	8/6/2005	S20562	1.50	HWY 75 & OSAGE AVE.	600	X		OBSTRUCTION
WELEETKA	10/6/2005	S20562	0.50	CHOCTAW AT 10TH & JACK JOHNSON DR.		X		OBSTRUCTION IN LINE
WELEETKA	8/30/2007	S20562	3.00	4TH & SEMINOLE		X		BLOCKAGE
WELEETKA	9/13/2007	S20562	0.00	9TH & 10TH ON CHEROKEE		X		BLOCKAGE
WELEETKA	8/19/2011	S20562	1.00	LAGOONS	5	X		SPLIT IN HOSE
WELEETKA	8/23/2011	S20562	1.00	HIGH SCHOOL	25	X		TRASH, GREASE & DEBRIS
WELEETKA	1/14/2013	S20562	23.00	BETWEEN 8TH & 9TH & OSAGE	2,000	X		BLOCKAGE
WELEETKA	3/25/2013	S20562	1.00	300 S. CHOCTAW, APT. 6B	100	X		ELECTRICAL FAILURE
WETUMKA	1/20/2007	S20560	69.00	SAVANNAH APTS. AT 604 S. WASHITA		X		ICE STORM
WEWOKA	4/9/2000	S20558		14TH & SUNNYMEADE		X		MAIN CLOGGED
WEWOKA	4/21/2000	S20558		14TH & SUNNYMEAD		X		STOPPAGE
WEWOKA	4/24/2000	S20558	22.00	6TH & S. JACKSON		X		STOPPED MAIN
WEWOKA	4/24/2000	S20558	22.00	6TH & S. JACKSON		X		STOPPAGE
WEWOKA	5/2/2000	S20558		201 W. PARK / 8TH & S. OCHEESE		X		RAIN
WEWOKA	5/21/2000	S20558		1115 S. HITCHITE		X		SEWER STOPPAGE
WEWOKA	6/29/2000	S20558	7.00	17TH & S. WEWOKA		X		RAIN
WEWOKA	10/10/2000	S20558	10.00	7TH & S. OCHESE		X		STOPPED MAIN
WEWOKA	11/5/2000	S20558		7TH & MUSKOGEE		X		STOPPED MAIN

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
WEWOKA	11/6/2000	S20558	224.00	125 W. PARK		X		RAIN
WEWOKA	11/6/2000	S20558	8.00	PARK & MEKOSOKEY		X		RAIN
WEWOKA	12/14/2000	S20558	15.00	414 E. 4TH		X		SEWER STOPPED
WEWOKA	1/23/2001	S20558	4.50	17 TEDFORD WAY	UNKNOWN	X		SEWER MAIN STOPPED UP
WEWOKA	2/23/2001	S20558		125 W PARK	UNKNOWN	X		HEAVY RAINS/I & I PROBLEM
WEWOKA	2/23/2001	S20558		201 W PARK	UNKNOWN	X		HEAVY RAINS/I & I PROBLEM
WEWOKA	2/24/2001	S20558		1226 S OCHEESE	UNKNOWN	X		COLLAPSED SEWER LINE IN FRONT OF 1202 S OCHEESE
WEWOKA	2/24/2001	S20558		216 S HITCHITE	UNKNOWN	X		OLD SEWER LINE NOT PROPERLY SEALED WHEN ABANDONED
WEWOKA	1/23/2002	S20558	11.00	200 BLK W. PARK ST		X		I&I
WEWOKA	4/22/2004	S20558	0.00	200 W. PARK		X		RAIN
WEWOKA	7/26/2004	S20558	0.00	4TH & MEKOSUKEY		X		LINE COLLAPSED
WEWOKA	1/3/2005	S20558	0.00	125 W. PARK		X		RAINS
WEWOKA	1/3/2005	S20558	0.00	200 W. PARK		X		RAINS
WEWOKA	3/18/2008	S20558	48.00	200 W. PARK		X		RAINS
WEWOKA	4/10/2008	S20558	48.00	200 W PARK	UNKNOWN	X		RAIN
WEWOKA	6/17/2008	S20558	0.00	200 W. PARK		X		RAIN
WEWOKA	8/11/2008	S20558	22.00	200 BLOCK W. PARK ST.				I&I
WEWOKA	8/19/2008	S20558	22.00	200 BLK. W. PARK ST.				I&I
WEWOKA	2/11/2009	S20558		200 BLK. W. PARK		X		I&I
WEWOKA	3/29/2009	S20558	10.00	200 BLK. W. PARK ST.		X		I&I
WEWOKA	4/13/2009	S20558	8.00	100 BLK. W. PARK		X		I&I
WEWOKA	4/29/2009	S20558	8.00	200 BLK. W. PARK ST.				I&I
WEWOKA	5/2/2009	S20558	29.00	100 BLK. W. PARK		X		I&I
WEWOKA	5/10/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	6/3/2009	S20558	21.50	121 W. PARK ST.		X		I&I
WEWOKA	8/3/2009	S20558	0.00	INDIAN RD.				LIFT STATION FAILURE
WEWOKA	8/11/2009	S20558	25.50	121 W. PARK ST.				I&I
WEWOKA	8/13/2009	S20558	0.00	END OF INDIAN RD.				LIFT STATION PUMP OUT
WEWOKA	9/14/2009	S20558	0.00	INDIAN RD. LIFT STATION		X		MOTORS MALFUNCTION
WEWOKA	9/15/2009	S20558	0.00	INDIAN RD. L.S.				PUMP FAILURE
WEWOKA	9/17/2009	S20558	0.00	115 W. PARK				I&I
WEWOKA	9/21/2009	S20558	0.00	120 W. PARK ST.				I&I
WEWOKA	10/6/2009	S20558	0.00	120 W. PARK				I&I

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
WEWOKA	10/8/2009	S20558	0.00	200 BLK. W. PARK				I&I
WEWOKA	10/8/2009	S20558	0.00	100 W. PARK				I&I
WEWOKA	10/9/2009	S20558	0.00	INDIAN RD. LIFT STATION				NEW PUMP INSTALLATION
WEWOKA	10/13/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	10/13/2009	S20558	0.00	200 BLK. W. PARK				I&I
WEWOKA	10/13/2009	S20558	0.00	100 BLK. W. PARK				I&I PROBLRM
WEWOKA	10/15/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	10/16/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	10/22/2009	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	10/22/2009	S20558	0.00	INDIAN RD. L.S.				MALFUNCTION
WEWOKA	10/22/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	10/22/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	10/26/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	10/29/2009	S20558	0.00	100 BLK. W. PARK				RAIN
WEWOKA	10/29/2009	S20558	0.00	9TH & MUSKOGEE				RAIN
WEWOKA	10/29/2009	S20558	0.00	200 BLK. W. PARK				RAIN
WEWOKA	10/29/2009	S20558	0.00	6TH & JACKSON				RAIN
WEWOKA	10/30/2009	S20558	0.00	100 BLK. W. PARK				RAIN
WEWOKA	12/2/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	12/8/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	12/24/2009	S20558	0.00	200 BLK. W. PARK				I&I
WEWOKA	12/24/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	12/26/2009	S20558	0.00	100 W. PARK				I&I
WEWOKA	12/26/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	12/27/2009	S20558	0.00	100 W. PARK				
WEWOKA	12/28/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	12/30/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	12/31/2009	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	1/11/2010	S20558	0.40	6TH & MCKUSUKEY	75	X		GREASE
WEWOKA	1/12/2010	S20558	0.40	19 WILLOW RD.	150	X		GREASE
WEWOKA	1/21/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	1/22/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	1/23/2010	S20558	0.00	100 BLK. W. PARK		X		I&I

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
WEWOKA	1/29/2010	S20558	0.00	200 BLK. W. PARK				I&I
WEWOKA	1/29/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	1/30/2010	S20558	0.00	200 BLK. W. PARK				I&I
WEWOKA	1/31/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/2/2010	S20558	0.00	200 BLK. W. PARK				I&I
WEWOKA	2/2/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/3/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/4/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/4/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/5/2010	S20558	0.00	7TH & MCKUSUKEY				GREASE
WEWOKA	2/5/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/6/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/8/2010	S20558	0.00	200 BLK. W. PARK				I&I
WEWOKA	2/8/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/9/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/10/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/11/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/12/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/13/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/14/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/15/2010	S20558	0.00	100 BLK. W. PARK				I&I
WEWOKA	2/16/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/21/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/22/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/22/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	2/24/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/25/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/26/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	2/26/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/27/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/28/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/1/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/1/2010	S20558	0.00	205 W. PARK		X		POND FULL

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
WEWOKA	3/2/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	3/2/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/3/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/8/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	3/8/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/9/2010	S20558	0.00	205 W. PARK				FULL POND
WEWOKA	3/9/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/9/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	3/10/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/10/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/12/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/13/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/20/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/20/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	3/21/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/22/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/23/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/24/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	3/25/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	4/17/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	4/18/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	4/18/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	4/19/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	4/20/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	5/14/2010	S20558	0.00	100 BLK. PARK		X		I&I
WEWOKA	5/14/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	5/15/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	5/16/2010	S20558	0.00	100 BLK. W. PAEK		X		I&I
WEWOKA	5/17/2010	S20558	0.00	205 W. PARK ST.				POND FULL
WEWOKA	5/17/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	5/20/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	5/20/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	5/21/2010	S20558	0.00	100 BLK. W. PARK		X		I&I

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
WEWOKA	6/9/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	6/9/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	6/14/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	6/15/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	6/15/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	7/3/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	7/3/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	7/4/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	7/8/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	7/8/2010	S20558	0.00	200 BLK. W. PARK		X		I&I
WEWOKA	7/12/2010	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	8/16/2010	S20558	0.00	SEWER PLANT		X		PUMP FAILURE
WEWOKA	8/17/2010	S20558	0.00	SEWER PLANT		X		PUMP FAILURE
WEWOKA	8/18/2010	S20558	0.00	SEWER PLANT				PUMP FAILURE
WEWOKA	9/29/2010	S20558	5.50	6TH & MCKUSUKEY		X		GREASE
WEWOKA	9/30/2010	S20558	0.00	6TH & MCKUSUKEY		X		BLOCKAGE
WEWOKA	4/25/2011	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	4/25/2011	S20558	0.00	17 TEDFORD WAY		X		I&I
WEWOKA	5/17/2011	S20558	0.00	INDIAN RD.		X		PUMP LOST PRIME
WEWOKA	8/22/2011	S20558	1.00	504 E. 5TH		X		CLOGGED LINE
WEWOKA	8/29/2011	S20558	0.00	INDIAN ROAD		X		CLOGGED MAIN
WEWOKA	10/27/2011	S20558		100 BLK. WEST PARK		X		I&I PROBLEM
WEWOKA	11/8/2011	S20558	0.00	100 BLK. W. PARK		X		I&I PROBLEMS
WEWOKA	11/8/2011	S20558	0.00	200 BLK. W. PARK		X		I&I PROBLEMS
WEWOKA	11/28/2011	S20558	0.00	100 BLK. W. PARK		X		CLOGGED LINE
WEWOKA	11/28/2011	S20558	0.00	11TH & OCHEESE		X		CLOGGED MAIN
WEWOKA	1/31/2012	S20558	0.00	INDIAN ROAD		X		BROKEN MAIN
WEWOKA	3/21/2012	S20558	0.00	200 BLK. WEST PARK		X		I&I
WEWOKA	3/21/2012	S20558	0.00	14TH & WEWOKA		X		I&I
WEWOKA	3/21/2012	S20558	0.00	100 BLK. WEST PARK		X		I&I
WEWOKA	3/21/2012	S20558	0.00	10TH & OCHEESE		X		I&I
WEWOKA	3/21/2012	S20558	0.00	8TH & OCHEESE		X		I&I
WEWOKA	3/22/2012	S20558	0.00	8TH & OCHEESE		X		CLOGGED MAIN

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
WEWOKA	3/22/2012	S20558	0.00	14TH & WEWOKA		X		CLOGGED MAIN
WEWOKA	3/22/2012	S20558	0.00	100 BLK. WEST PARK		X		I&I
WEWOKA	3/23/2012	S20558	0.00	8TH & OCHEESE		X		CLOGGED MAIN
WEWOKA	3/23/2012	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	4/20/2012	S20558	0.00	ALLEY E. OF 9TH & WEWOKA		X		CLOGGED MAIN
WEWOKA	2/4/2013	S20558	26.50	8TH & OCHEESE		X		COLLAPSED LINE
WEWOKA	2/21/2013	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	2/22/2013	S20558	0.00	6TH 7 MCKUSUKEY				CLOGGED MAIN
WEWOKA	4/5/2013	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	5/24/2013	S20558	0.00	100 BLK. W. PARK		X		I&I
WEWOKA	7/15/2013	S20558	1.50	100 BLK. W. PARK		X		I&I
WEWOKA	12/30/2013	S20558	0.00	9TH & OCHEESE		X		CLOGGED MAIN
HENRYETTA	2/28/2000	S20722		MONTICELLO AT ORENDORFF & ANTES	5,000	X		RAINFALL
HENRYETTA	3/22/2000	S20722		SCOTT ST. AT 1ST & 2ND	2,000	X		LINE BLOCKAGE
HENRYETTA	3/31/2000	S20722		10TH & CORPORATION	5,000	X		GASKET NEEDED REPLACING
HENRYETTA	4/3/2000	S20722		10TH & CORPORATION				LEAKING
HENRYETTA	4/9/2000	S20722	24.00	WEST OF 14TH & WARREN RD.	5,000	X		BLOCKAGE
HENRYETTA	5/9/2000	S20722		MONTECELLO AT ORENDORFF & ANTES	5,000	X		RAIN
HENRYETTA	6/5/2000	S20722		1ST & CORPORATION	5,000	X		LINE BLOCKAGE
HENRYETTA	6/21/2000	S20722		MONTECELLO AT ORENDORFF & ANTES	5,000	X		RAIN
HENRYETTA	6/21/2000	S20722		1ST & CORPORATION	5,000	X		RAIN
HENRYETTA	6/21/2000	S20722		SCOTT AT 1ST & 2ND	5,000	X		RAIN
HENRYETTA	6/26/2000	S20722		MONTICELLO AT ORENDORFF & ANTES	5,000	X		RAIN
HENRYETTA	6/26/2000	S20722		1ST & CORPORATION	5,000	X		RAIN
HENRYETTA	6/26/2000	S20722		SCOTT AT LAKE RD. & 1ST	5,000	X		RAIN
HENRYETTA	10/27/2000	S20722		4TH ST L.S. ON BOTH SIDES OF I-40		X		POWER FAILURE
HENRYETTA	11/3/2000	S20722		BETWEEN MAIN & TRUDGEON ON 11TH	5,000	X		LINE BLOCKAGE
HENRYETTA	11/4/2000	S20722		2ND & JEFFERSON / 1ST & SCOTT				RAINFALL
HENRYETTA	11/8/2000	S20722		ORENDORFF & ANTES ON MONTECELLO	5,000	X		RAIN
HENRYETTA	2/15/2001	S20722		ORENDORFF & MONTICELLO	5,000	X		RAIN
HENRYETTA	4/9/2002	S20722	0.20	814 W. BROADWAY	1	X		STOPPED UP
HENRYETTA	3/13/2003	S20722	0.00	4TH & LOUISE	20,000			PUMP FAILURE
HENRYETTA	3/17/2003	S20722	0.00	KINGS RD. & GENTRY	40,000	X		BLOCKAGE

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
HENRYETTA	3/19/2003	S20722	0.00	KINGS RD. & GENTRY		X		BLOCKAGE
HENRYETTA	9/18/2003	S20722	0.00	1 BLK W. OF WISE ON CENTER ST.	1,000	X		LINE BLOCKAGE
HENRYETTA	9/22/2003	S20722	0.00	BLK WEST OF WISE ST.	1,000	X		BLOCKAGE
HENRYETTA	10/1/2003	S20722	0.00	I BLK WEST OF WISE & CENTER	1,000	X		BLOCKAGE
HENRYETTA	3/15/2006	S20722	0.00	18TH & MEACHUM W. OF HWY 62	1,000	X		GREASE
HENRYETTA	5/8/2006	S20722	0.00	15TH & DIVISION, 1409 DIVISION & 1407 W.	5,000	X		RAIN
HENRYETTA	5/8/2006	S20722	0.00	1ST & CORPORATION		X		RAIN
HENRYETTA	5/18/2006	S20722	0.00	9TH & CORPORATION	1,000	X		LEAK
HENRYETTA	5/18/2006	S20722	168.00	8TH AT MAIN & BROADWAY	10,000	X		PIPE COLLAPSED
HENRYETTA	6/2/2006	S20722	0.00	N. OF ELEMENTARY SCHOOL	2,000	X		BLOCKAGE
HENRYETTA	6/15/2006	S20722	0.00	17TH & MEACHAM AT HWY 62	500	X		CRACKED PIPE
HENRYETTA	12/19/2006	S20722	0.00	404 N. 4TH	1,000	X		COLLAPSED MAIN
HENRYETTA	1/3/2007	S20722	0.00	N.E. OF HWY 75 & TRUDGEON	400	X		BLOCKAGE
HENRYETTA	1/13/2007	S20722	0.00	WWTP	10,000	X		POWER FAILURE
HENRYETTA	1/14/2007	S20722	0.00	RAW WATER PUMP STATION	10,000	X		POWER FAILURE
HENRYETTA	3/14/2007	S20722	0.00	S. OF 8TH & CORPORATION	10,000	X		TIRES
HENRYETTA	3/14/2007	S20722	0.00	E. OF HIGH SCHOOL	5,000	X		BLOCKAGE
HENRYETTA	5/7/2007	S20722	0.00	1ST CORPORATION	1,000	X		RAIN
HENRYETTA	5/7/2007	S20722	0.00	15TH & DIVISION	1,000	X		RAIN
HENRYETTA	5/7/2007	S20722	0.00	2ND BARCLAY	1,000	X		RAIN
HENRYETTA	5/7/2007	S20722	0.00	2ND & LOUISE	1,000	X		RAIN
HENRYETTA	5/7/2007	S20722	0.00	1ST & SCOTT	1,000	X		RAIN
HENRYETTA	6/19/2007	S20722	0.00	1ST & SCOTT;1ST & CORPORATION;5TH &	10,000	X		RAIN
HENRYETTA	6/23/2007	S20722	0.00	1ST & CORPORATION;14TH & 15TH &	5,000	X		RAIN
HENRYETTA	6/23/2007	S20722	0.00	N.E. 5TH & CENTER;1 BLK W. OF WISE ON	5,000	X		RAIN
HENRYETTA	6/23/2007	S20722	0.00	LAKE RD. & SCOTT; 2ND & BARCLAY; 5TH &	5,000	X		RAIN
HENRYETTA	6/27/2007	S20722	0.00	LAKE RD & SCOTT;2ND & 5TH & BARCLAY;1ST	5,000			RAIN
HENRYETTA	6/27/2007	S20722	0.00	15TH & DIVISION; 11TH & MERRICK	5,000	X		RAIN
HENRYETTA	7/12/2007	S20722	0.00	LAKE RD. & SCOTT;15TH & DIVISION; 1ST &	5,000	X		RAIN
HENRYETTA	8/19/2007	S20722	0.00					
HENRYETTA	8/19/2007	S20722	0.00	15TH & DIVISION; 3RD GENTRY; 1ST	10,000	X		RAIN
HENRYETTA	8/19/2007	S20722	0.00	LAKE RD. & SCOTT; 2ND BARCLAY; 2ND	10,000	X		RAINFALL
HENRYETTA	12/12/2007	S20722	0.00	305 N. 2ND	1,000	X		BLOCKAGE

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
HENRYETTA	12/12/2007	S20722	0.00	LAKE RD & SCOTT; 1ST & CORPORATION;	10,000	X		RAINFALL
HENRYETTA	12/12/2007	S20722	0.00	12TH & GENTRY; 15TH & DIVISION	10,000	X		RAINFALL
HENRYETTA	3/3/2008	S20722	4.00	LAKE RD & SCOTT/15TH & DIVISION/5TH &	5,000	X		I&I
HENRYETTA	3/4/2008	S20722	0.00	2ND @ SCOTT & BARCLAY	2,000			BLOCKAGE
HENRYETTA	4/17/2008	S20722	0.00	LAKE RD SCOTT/ 15TH & DIVISION	5,000	X		RAIN
HENRYETTA	4/21/2008	S20722	0.00	ALLEY @ 404 E. GUNN	5,000	X		BLOCKAGE
HENRYETTA	5/7/2008	S20722	0.00	1ST & WHEELING	5,000			BLOCKAGE
HENRYETTA	9/26/2008	S20722	0.00	N. OF ELEMENTARY SCHOOL @ TROY	300	X		COLLAPSED PIPE
HENRYETTA	10/25/2008	S20722	2.20	MAIDEN LN. & WILSON RD.	1,000	X		BLOCKAGE
HENRYETTA	10/27/2008	S20722	0.00	1800 N. 5TH	500	X		BLOCKAGE
HENRYETTA	11/18/2008	S20722	20.60	904 E. TRUDGEON	500	X		BLOCKAGE
HENRYETTA	12/5/2008	S20722	0.00	2ND & GENTRY	1,000	X		PIPE LEAK
HENRYETTA	1/5/2009	S20722	0.00	E. OF ELDER ST.	1,000	X		BLOCKAGE
HENRYETTA	1/6/2009	S20722	0.00	101 E. CORPORATION	100	X		BLOCKAGE
HENRYETTA	1/30/2009	S20722	0.00	11TH & MERRICK	1,000	X		BLOCKAGE
HENRYETTA	2/2/2009	S20722	0.00	13TH & GENTRY		X		COLLAPSED LINE
HENRYETTA	2/11/2009	S20722	0.00	14TH ST. @ DIVISION & GENTRY	1,000	X		RAIN
HENRYETTA	4/19/2009	S20722	0.00	8TH & HIGH ST.	1,000	X		BLOCKAGE
HENRYETTA	5/5/2009	S20722	0.00	6TH & BARCLAY	1,000	X		RAIN
HENRYETTA	5/5/2009	S20722	0.00	1405 W. TRUDGEON	1,000			RAIN
HENRYETTA	5/5/2009	S20722	0.00	SCOTT & LAKE RD.	1,000	X		RAIN
HENRYETTA	5/5/2009	S20722	0.00	14TH & DIVISION	1,000	X		RAIN
HENRYETTA	5/5/2009	S20722	0.00	15TH & DIVISION	1,000	X		RAIN
HENRYETTA	5/5/2009	S20722		710 W. GENTRY	1,000	X		RAIN
HENRYETTA	5/14/2009	S20722	0.00	1510 W. TRUDGEON	1,000	X		RAIN
HENRYETTA	5/14/2009	S20722	0.00	4TH & SCOTT	1,000	X		RAIN
HENRYETTA	5/14/2009	S20722	0.00	6TH & BARKLEY	1,000	X		RAIN
HENRYETTA	5/21/2009	S20722	0.00	1408 BRIARWOOD LN.	1,000	X		BLOCKAGE
HENRYETTA	9/22/2009	S20722	0.00	NORTH OF 11TH & MERRICK	1,000	X		BLOCKAGE
HENRYETTA	9/22/2009	S20722	0.00	LAKE RD. & SCOTT ST.	1,000	X		RAINFALL
HENRYETTA	9/22/2009	S20722	0.00	5TH & BARCLAY	1,000	X		RAIN
HENRYETTA	9/22/2009	S20722	0.00	15TH & DIVISION	1,000	X		RAIN

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
HENRYETTA	10/9/2009	S20722	0.00	16TH ST. @ TRUDGEON & DIVISION	1,000	X		I&I
HENRYETTA	10/9/2009	S20722	0.00	7TH ST. @ GENTRY & CUMMINGS	1,000	X		BLOCKAGE & I&I
HENRYETTA	10/9/2009	S20722	0.00	LAKE RD. & SCOTT ST.	1,000	X		RAIN
HENRYETTA	10/9/2009	S20722	0.00	6TH & BARCLAY	1,000	X		RAIN
HENRYETTA	10/9/2009	S20722	0.00	15TH & DIVISION	1,000	X		RAIN
HENRYETTA	10/9/2009	S20722	0.00	1ST & CORPORATION	1,000	X		RAIN
HENRYETTA	10/13/2009	S20722	0.00	S. OF THE HOSPITAL	1,000	X		BLOCKAGE
HENRYETTA	10/21/2009	S20722	0.00	12TH & GENTRY	300	X		RAIN
HENRYETTA	10/22/2009	S20722	0.00	N. OF 11TH & MERRICK	500	X		BLOCKAGE
HENRYETTA	10/22/2009	S20722	0.00	LAKE RD. & SCOTT ST.	200	X		BLOCKAGE
HENRYETTA	12/23/2009	S20722	4.60	N. 5TH	2,000	X		BLOCKAGE
HENRYETTA	12/27/2009	S20722	0.00	6TH @ CUMMINGS & MERRICH	1,000	X		BLOCKAGE
HENRYETTA	12/28/2009	S20722	0.00	10TH & GRANDVIEW	1,000	X		BLOCKAGE
HENRYETTA	12/30/2009	S20722	0.00	7TH @ GENTRY & CUMMINGS	1,000	X		BLOCKAGE
HENRYETTA	12/31/2009	S20722	0.00	"B" ST.@ MIAMI & CHICKASAW	200	X		BLOCKAGE
HENRYETTA	4/14/2010	S20722	48.00	4TH & LOUIS LIFT STATION	1,500	X		POWER FAILURE
HENRYETTA	5/21/2010	S20722	0.00	306 N. 2ND	100	X		BLOCKAGE
HENRYETTA	7/29/2010	S20722	0.00	BOLLINGER & DEWAR AVE.	300	X		BLOCKAGE
HENRYETTA	8/28/2010	S20722	1.00	101 E. CORPORATION	500	X		BLOCKAGE
HENRYETTA	9/14/2010	S20722	0.00	8TH @ MAIN & BROADWAY	500	X		BLOCKAGE
HENRYETTA	11/30/2010	S20722	0.00	5TH & NORTHRIDGE TERR.	1,000	X		BLOCKAGE
HENRYETTA	1/17/2011	S20722	0.00	WWTP	100		X	DEBRIS
HENRYETTA	1/17/2011	S20722	1.70	12TH & GENTRY	500	X		BLOCKAGE
HENRYETTA	2/28/2011	S20722	5.00	W. OF NORTHRIDGE TERR	400	X		BLOCKAGE
HENRYETTA	4/12/2011	S20722	2.10	701 E. FRISCO AVE.	2,500	X		BLOCKAGE
HENRYETTA	4/18/2011	S20722	0.00	N. OF 14TH & WARREN RD.	1,000	X		BLOCKAGE
HENRYETTA	4/23/2011	S20722	1.10	WWTP	30,000	X		RAINS
HENRYETTA	4/25/2011	S20722	0.00	@ 1ST & 2ND & CORPORATION	1,000	X		RAIN & FLOODING
HENRYETTA	4/26/2011	S20722	0.00	ORENDOFF & MONTECELLO	1,000	X		LIGHTNING MAY HAVE DAMAGED PUMPS
HENRYETTA	4/26/2011	S20722	0.00	N. OF 11TH & MERRICK IN WOODED AREA	300	X		BLOCKAGE
HENRYETTA	4/26/2011	S20722	0.00	8TH @ MAIN & TRUDGEON	500	X		RAIN
HENRYETTA	5/9/2011	S20722	0.00	N. OF 11TH & MERRICK	200	X		BLOCKAGE
HENRYETTA	5/9/2011	S20722	100.00	106 W. SMITH IN ALLEY	100	X		COLLAPSED LINE

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
HENRYETTA	8/10/2011	S20722	3.60	WWTP	90,000	X		GENERATOR FAIL TO START
HENRYETTA	8/23/2011	S20722	0.00	N. OF 11TH & MERRICK	300	X		BLOCKAGE
HENRYETTA	11/2/2011	S20722	3.40	N.W. WWTP	2,000	X		BLOCKAGE
HENRYETTA	11/8/2011	S20722	0.00	5TH ST. @ HIGH & WARREN RD.	500	X		RAIN
HENRYETTA	11/8/2011	S20722	0.00	3RD & GENTRY	500	X		RAIN
HENRYETTA	11/8/2011	S20722	0.00	8TH ST. @ TRUDGEON & DIVISION	500	X		RAIN
HENRYETTA	11/8/2011	S20722	0.00	9TH & REAGAN	500	X		RAIN
HENRYETTA	11/8/2011	S20722	0.00	8TH & HIGH ST.	500	X		RAIN
HENRYETTA	11/8/2011	S20722	0.00	11TH & WADE WELLS DR.	500	X		RAIN
HENRYETTA	11/8/2011	S20722	0.00	NORTH OF 11TH & MERRICK	500	X		RAIN
HENRYETTA	1/25/2012	S20722	0.00	3RD & DIVISION	500	X		BLOCKAGE
HENRYETTA	1/25/2012	S20722	0.00	8TH & HIGH ST	500	X		BLOCKAGE
HENRYETTA	3/20/2012	S20722	0.00	8TH & WOODLAND	500	X		RAIN
HENRYETTA	3/20/2012	S20722	0.00	11TH & GRANDVIEW	500	X		RAIN
HENRYETTA	3/20/2012	S20722	0.00	707 HIGH ST.		X		RAIN
HENRYETTA	3/20/2012	S20722	0.00	WEST OF NORTHRIDGE TERRACE	500	X		BLOCKAGE
HENRYETTA	3/26/2012	S20722	0.00	N. OF 15TH & WARREN RD.	1,000	X		BLOCKAGE
HENRYETTA	5/11/2012	S20722	0.00	1705 N. 5TH	500	X		BLOCKAGE
HENRYETTA	6/7/2012	S20722	0.00	N. OF 15TH & WARREN RD.	5,000	X		DEBRIS
HENRYETTA	8/22/2012	S20722	0.00	9TH & CORPORATION	1,000	X		CONTRACTOR PUT HOLE MAIN
HENRYETTA	10/21/2012	S20722	0.00	5TH & HIGH ST.	200	X		BLOCKAGE
HENRYETTA	12/3/2012	S20722	0.00					
HENRYETTA	12/3/2012	S20722	2.30	N.W. OF O.J. MCKAY'S PROPERTY	57,660	X		BLOCKAGE
HENRYETTA	2/6/2013	S20722	0.00	18TH & DIVISION S. SIDE OF ELEMENTARY	200	X		BLOCKAGE
HENRYETTA	2/10/2013	S20722	0.00	411 S. 17TH	400	X		BLOCKAGE
HENRYETTA	9/5/2013	S20722	0.00	11TH & GRANDVIEW	200	X		BLOCKAGE
HENRYETTA	11/19/2013	S20722	0.00	E. OF US 75 & TRUDGEON BEHIND TAG	200	X		BLOCKAGE
HENRYETTA	12/11/2013	S20722	0.00	N. OF WILSON RD. & WOODLAND	500	X		ROOTS
HENRYETTA	12/17/2013	S20722	0.00	1005 DOLLINS	100	X		DEBRIS
HENRYETTA	12/21/2013	S20722		11TH DIVISION	200	X		BLOCKAGE CAUSED BY DEBRIS
HENRYETTA	12/21/2013	S20722	1.00	3RD & GENTRY	500	X		BLOCKAGE
HENRYETTA	12/22/2013	S20722		8TH & MERRICK	1500	X		LINE COLLAPSED
DEWAR	2/2/2003	S20723	1.10	206 N. CHARLES				BLOCKAGE

Facility Name	Date	Facility ID	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
DEWAR	8/15/2003	S20723	0.00	609 W. 7TH		X		STOPPAGE
DEWAR	2/6/2005	S20723	25.00	DEAL & BERKEY				BLOCKAGE
DEWAR	11/17/2006	S20723	5.50	203 W. 6TH	1,000	X		BLOCKAGE
DEWAR	6/16/2007	S20723	0.00	266 & "B" ST	1,000	X		BLOCKAGE
DEWAR	7/25/2007	S20723	0.00	W. 5TH & N. ASH, S.W. CORNER	10	X		BROKEN LINES
DEWAR	8/19/2007	S20723	0.00	4TH @ M.D. DEAL & BERKEY	20	X		CLOGGED MAIN
DEWAR	9/20/2007	S20723	0.00	9TH & PECAN	10	X		BLOCKAGE
DEWAR	10/17/2007	S20723	0.00	5TH & CEDAR LIFT STATION	1,000	X		BUSTED LINE
DEWAR	10/30/2007	S20723	12.00	5TH & CEDAR UNDER BRIDGE IN CREEK		X		BROKEN MAIN
DEWAR	2/25/2008	S20723	1.00	601 & 611 E. 6TH TO L.S. #3	50	X		LEAK FROM OLD SEWER
DEWAR	7/17/2009	S20723	8.50	L.S. #4 @ MR. SPROUSE'S LAND	5	X		BREAKER IN OFF POSITION
DEWAR	9/10/2009	S20723	1.50	5TH @ CHARLES & LUELLA	50	X		BLOCKAGE
DEWAR	12/1/2009	S20723	0.00	5TH @ CHARLES & LUELLA	30	X		BLOCKAGE
DEWAR	8/25/2010	S20723	3.40	601 E. 6TH	15	X		BLOCKAGE
DEWAR	1/28/2011	S20723	1.40	707 E. 6TH	5	X		BLOCKAGE
DEWAR	4/26/2011	S20723	1.00	LIFT STATION #3 - 707 E. 6TH	20	X		POWER FAILURE FROM STORM
DEWAR	10/26/2011	S20723	1.00	N. MAPLE & DIVISION ST.	25	X		REPLACING SEWER LINE
DEWAR	11/5/2011	S20723	0.00	LIFT STATION	100	X		PUMP FAILURE
DEWAR	12/13/2011	S20723	0.00	208 S. BERKY	100	X		STOPPED MAIN
DEWAR	2/22/2012	S20723	2.00	209 S. MAPLE	100	X		SEWER LINE TORN AWAY TORN DOWN HOUSE
DEWAR	7/3/2012	S20723	4.00	15075 E. 266TH HWY	75	X		BLOCKAGE
DEWAR	2/25/2013	S20723	0.00	208 S. BERKEY	100	X		BACKUP
DEWAR	3/15/2013	S20723	0.00	210 S. MAPLE		X		BLOCKAGE
DEWAR	4/11/2013	S20723	0.20	1409 W. 7TH	5	X		DIRT
DEWAR	6/1/2013	S20723	7.50	5TH & CEDAR		X		FLOODING
DEWAR	7/16/2013	S20723	0.20	811 E. 6TH	10	X		CONTROLLER OUT

APPENDIX E: RESPONSES TO PUBLIC COMMENTS

Scott A. Thompson
Executive Director

OKLAHOMA
DEPARTMENT OF ENVIRONMENTAL QUALITY

Mary Fallin
Governor

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Response to Public Comments Received for the Draft Bacterial and Turbidity TMDL Report for the Lower North Canadian/Deep Fork Study Area

September 22, 2014

1. Comment sent via email from Sandy Stafford:

My comments are that this proposed study seems directly aimed at the cattle industry and it disturbs me greatly the impact this might have on it if cattle are kept from drinking from the creeks and grazing on land adjoining them. This seems the [sic] *be right on target with the EPA "waters of the U.S." conflict now at the forefront of everybody's attention. We, and many cattle ranchers like us, are strongly opposed to this study. We also disagree that cattle are the main source of "impairments" as stated. The loss of the cattle industry to this area and to Oklahoma as a whole would be catastrophic to the economy. Without water and a place for cattle to graze, there will be no cattle left. This seems a harsh and unrealistic price to pay for what amounts to safe swimming in these streams. We can only hope that somewhere common sense will come into play regarding this study.*

DEQ Response:

This TMDL study does not prohibit cattle from grazing or drinking from creeks. It does recommend that agricultural best management practices be used to curb pollution of streams from elevated bacteria levels. Under the Clean Water Act, implementation of these practices is voluntary, not mandatory.

This report is not dependent on or connected in any way to the proposed EPA/Corps of Engineers rule regarding a definition of waters of the US.

Cattle were determined to be a major potential source of bacteria within these watersheds based on estimates of their fecal coliform production. According to a 1999 study conducted by the American Society of Agricultural Engineers (ASAE), cattle produce about 10 times more fecal coliform than swine (about 100 billion fecal coliform per animal per day for cattle compared to 11 billion fecal coliform per animal per day for swine) as noted in Table 3-7. Table 3-8 presents estimates for the various types of animals in each watershed based on USDA Agricultural Census data. These numbers are combined in Table 3-9 to estimate the bacteria production for each type of agricultural animal. Bacteria production estimates from all potential sources are summarized in Table 3-14. Cattle are estimated to produce from 98% to more than 99% of the total bacteria from all nonpoint sources in these watersheds.

No changes were made.

2. Comment sent via email from Michael Kelsey, Executive Vice President, Oklahoma Cattlemen's Association:

On behalf of the Oklahoma Cattlemen's Association (OCA), thank you for the opportunity to meet this morning to discuss the "Proposed Modification to Incorporate Lower North Canadian/Deep Fork Study Area Bacterial and Turbidity TMDLs into Oklahoma's Water

Quality Management Plan" issued via public notice by the Department of Environmental Quality on July 10, 2014. According to the proposed rule, the comment period closes on August 25, 2014.

We respectfully request an extension to the comment period. OCA, on behalf of our membership will submit comments but would appreciate the time allowed by an extension in order to further evaluate the data and processes utilized in the creation of the proposed rule. An extension would also allow for more communication to our membership in the area covered by the proposed rule to encourage comment.

DEQ Response:

We considered your comment and extended the comment period to September 8, 2014. The revised Public Notice was posted on the DEQ website at:

www.deq.state.ok.us/wqdnew/tmdl/LowerNorthCanadianDeepFork2014RevPublicNoticeBactTurb_TMDL.pdf.

We e-mailed you the approval of your extension request on August 20, 2014.

3. Comment sent via email from Roy Lee Lindsey, Jr., Executive Director, Oklahoma Pork Council:

Please accept this letter as a formal request for an extension of the comment period on the Draft Bacterial and Turbidity TMDLs for the Lower North Canadian River/Deep Fork River Study Area. An extension of at least 30 days would allow the Oklahoma Pork CounciI to better review the entire draft TMDL and to prepare and submit comments on the draft TMDL.

DEQ Response:

See the response to Comment #2.

4. Comment sent via email from Tyler Norvell, The Poultry Federation of Oklahoma:

The Poultry Federation of Oklahoma respectfully requests that the Oklahoma Department of Environmental Quality extend the public comment period beyond August 25, 2014 for the TMDL for the Lower North Canadian River/Deep Fork River. Thank you for your consideration.

DEQ Response:

See the response to Comment #2.

5. Comment sent via email from Quang Pham, ODAFF AgPDES Deputy Director:

The following comments on sub-section of 3.2.5.2 for SFO of the Lower North Canadian/Deep Fork Bacterial & Turbidity TMDL Draft Report are submitted to you for your consideration:

The "can" languages used in this report regarding SFO (Swine Feeding Operations) at subsection 3.2.5.2, second paragraph, of the report do not reflect the actual condition. All SFOs are required to develop Animal Waste Management Plan (AWMP), Nutrient Management Plan (NMP) or Comprehensive Nutrient Management Plan (CNMP). They are required to store wastewater in Waste Retention Structure(WRS) and either to land apply wastewater or make the WRS large enough to be total retention lagoons. They are not allowed to discharge to creeks or waters of the State or of the U.S. I recommend that second paragraph of sub-section 3.2.5.2 regarding SFO of the reports be removed.

1- Recommend to remove the second paragraph of this sub-section as shown below

The purpose of the SFO Act is to provide for environmentally responsible construction and expansion of swine feeding operations and to protect the safety, welfare and quality of life of persons who live in the vicinity of a swine feeding operation. According to the SFO Act, a "Swine feeding operation" is a lot or facility where swine kept for at least ninety (90) consecutive days or more in any twelve month period and where crops, vegetation, forage growth or postharvest residues are not grown during the normal growing season on any part of the lot.

~~*A "concentrated swine feeding operation " has a certain number of swine [2] and either discharges its pollutants into nearby waterbodies through a ditch, flushing system or other constructed device, or the pollutants flow directly into waterbodies that flow through or come into direct contact with swine at the facility.*~~

2- Recommend to add languages to the last paragraph of this sub-section as follows:

SFOs are required to develop a Swine Waste Management Plan to prevent swine waste from being discharged into surface or groundwaters. This Plan includes the BMPs being used to prevent runoff & erosion. The Swine Waste Management Plan may include, but is not limited to, a Comprehensive Nutrient Management Plan per NRCS guidance or Nutrient Management Plan per EPA guidance. For large SFO [sic] with more than 1,000 animal units, monitoring wells or leakage detection system for waste retention structures are required to install to monitor and control seepage/leakage (OAC 35:17-3-11 (e) (6). Oklahoma Rules requires SFOs submitting Documentation of No Hydrologic Connection (OAC 35:17-3-12) for all retention structures to prevent any leaking of wastewater to water-bodies. Thus, the potential for loading from SFOs to the receiving stream is almost non-existent. There are 15 SFOs in this Study Area. Most of the SFOs in Oklahoma are not operating at capacities allowed in the licenses. The location of each SFO is shown in ***Figure 3-2*** *and listed in* ***Table 3-5****.*

DEQ Response:

Those changes were made in this Report.

6. Comment sent via email from Andrea Jones , Hughes County Conservation District :

My name is Andrea Jones, I live in Holdenville, OK. I work for the Hughes County Conservation District and have worked with OCC's Blue Thumb Program for water quality testing.

After reviewing the material, I do not believe that adequate testing was performed both ABOVE and BELOW waste treatment facilities within the study area. I fail to see how you can determine that these facilities were NOT a source of the excessive TMDLs of E. coli within these watersheds without testing the waters before and after the point of contact. In the water testing we have performed locally, I have found that waste treatment facilities are a PRIMARY source of highly contaminated water. My suggestion would be that more extensive testing be performed to get a strong data collections on these facilities, as well as landfills.

Another consideration is that we have been deeply entrenched in an extended drought period for approximately a decade. This would reduce the flow along these streams, which in turn would slow the flow of contaminents [sic]. This would lead to an increase in levels of pollution along these streams. Also, was testing performed at the outermost edge of the watershed area to see if these excessive levels were ALREADY flowing into the watershed from upstream sources (i.e. Shawnee *[sic]*, oklahoma city *[sic]*, etc.).

DEQ Response:

All the data used in this report were obtained from the Oklahoma Conservation Commission (OCC) and comply with the minimum data requirements specified in Oklahoma's Use Support Assessment Protocols (OAC 785:46, Subchapter 15).

Wastewater treatment plants are permitted and regulated through the Oklahoma Pollutant Discharge Elimination System (OPDES). As a result, facilities discharging to these impaired streams must have a disinfection system and were imposed a wasteload allocation. These allocations are enforceable as required permit limits and facilities that do not meet these limits face enforcement actions including fines.

Sanitary sewer overflow (SSOs) from facilities was also taken into consideration and facilities with such issues are required to make prompt improvements. DEQ requires that WWTFs report all bypasses or overflows on Wastewater Bypass Forms (data from these forms for the watersheds in this TMDL Report can be found in Appendix D). DEQ also requires that facilities submit monthly discharge monitoring reports (DMRs). DMRs indicate what pollutants facilities are discharging, how much they are discharging, and where they are discharging. This information can be found on-line at http://cfpub.epa.gov/dmr/.

Due to funding, not all streams have upstream and downstream monitoring locations. However, since data for the streams in this report were not collected in any mixing zones and the streams are headwater tributaries, upstream influence is very minimal.

Federal regulations [40 CFR §130.7(c)(1)] require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. This TMDLs report adhered to the seasonal application of the Oklahoma WQS which limits the PBCR use to the period of May 1st through September 30th. Seasonal variation was also accounted for in these TMDLs by using five years of water quality data as set forth in OAC 785:46-15-3(c)(2).

No changes were made as a result of this comment.

7. Comment sent via email from Joy Johnson:

We were unable to make the meeting on Sept 3rd but my husband and I would like it to go on record how we feel about the water issue. We have a cattle ranch south east of Wetumka. His family has run on this land for several years. There are creeks that run through our place and several ponds and one large flood control lake. This water is used to water our livestock. A few years ago we were forced to sell the majority of our cattle herd due to the drought that dried up the ponds and most of the creeks. We are against the government controlling our waters. We feel that the water, like the grass, is provided by God for our livestock.

DEQ Response:

This TMDL report does not address any government control of State waters. This Report is the first step in developing a plan to help the restore these waters to meet their designated uses and attain water quality standards. This would result in cleaner water for both you and your cattle.

No changes were made as a result of this comment.

8. Comment sent via email from Mr. and Mrs. Donald Hardwick:

We filed a complaint with a field inspector on July 31, 2014, after a large rain that carries runoff from the above commercial soil farm and the creek was murky and dark. The inspector took samples of water before it reached the soil farm and after it dumped into it and from the creek as it goes through our property. We received a letter from the Corporation Commission *recommending referral to Pollution Abatement on August 4, 2014. They stated the facility had been "red tagged and all land applications had been shut down until further notice from Pollution Abatement." This has happened before.*

When the wind is out of the south we often smell oilfield gassy smells. I have never smelled cattle waste smells and we have lived here since 1959. I have smelled hog waste smell at times since the soil farm went in. I don't know what the analysis showed was in the water samples that the corporation inspector took but it should be on record at the corporation commission [sic].

DEQ Response:

Oil and gas drilling wastes and soil farming operations are not expected to be a source of bacteria. Other pollutants are beyond the scope of this study.

No changes were made as a result of this comment.

9. Comment sent via email from Will Stafford, Stafford Family Limited Partnership:

The proposal that I have seen would require ranchers to fence out the Wewoka Creek, this would devastate our operation. The cost in fencing and the lost grazing would be significant to the point of possibly putting us out of business.

I believe the research that has been done on this matter is misleading and unfounded. There is no-way to keep out all the animals out of this water system. Have you ever tried to fence out deer and hogs; it can't be done without significant cost? I believe this would be a slippery slope and would wipe out a lot of the cattle producers in the state of Oklahoma.

DEQ Response:

Please see the response to Comment #1. No changes were made as a result of this comment.

10. Comment sent via email on behalf of the Oklahoma Cattleman's Association, Oklahoma Farm Bureau, Oklahoma Pork Council and the Poultry Federation:

We have reviewed the TMDL report and offer the following comments.

a. *As noted in the executive summary (pg.ES-1) and again on pg.1-2 of the TMDL report "Watershed-specific control actions and management measures will be identified, selected and implemented under a separate process…" The undersigned interested parties would like to participate in that process and request that we be notified at such time as the process is begun.*

DEQ Response:

This comment was forwarded to the Oklahoma Conservation Commission, which manages the Nonpoint Source Pollution program in Oklahoma. No changes were made as a result of this comment.

b. *<u>We realize that the procedure to add a waterbody</u> to the 303(d) list is separate from the TMDL that has been publicly noticed. However, we do not think that a discussion of the data used for decision making (Appendix A of the TMDL report) is pertinent because it is also a starting point basis for the percent reductions called for as part of the TMDL. Using the bacterial data contained in Appendix A, which we understood was the basis for the waterbody listings, we recalculated the E. coli geometric means for Alabama, Bad, and Wewoka Creeks. The TMDL discusses the bacterial data in Section 2.21 and states that* *those data are found in Appendix A of the report. Table 2.3 provides summary of the data including the number of samples and the geometric means of each data set. For Bad Creek the Table 2.3 number of samples and the geometric mean for E. coli are 19 and 157.6 cfu/1 00 ml, respectively. However, when the Appendix A data for Bad Creek was checked, the actual number of samples listed is 18 and the geometric mean of the data set was 79.4 (units not provided in Appendix A for E. coli), which is below the criterion of 126 cfu/100ml. E. coli geometric means calculations for two of the other creeks, when checked, yielded similar information as shown in Table 1. (Data for Wewoka Creek was not checked, nor was enterococci).*

Waterbody Name	Indicator	Number of samples provided in Appendix A	Geometric Mean of Appendix A Data	Geometric Mean reported in the TMDL report (cfu/100ml)
Bad Creek	*E. coli*	18	79.4	157.6
Alabama Creek	*E. coli*	19	85.8	141.4
Little Wewoka Creek	*E. coli*	19	69.2	198.2

Since the geometric means listed in the TMDL could not be reproduced using the data provided in the report we request that the bacterial data used in the TMDL be re-examined by ODEQ and an explanation of the difference in geometric means cited in the report and calculated using the data in appendix A be provided. The calculated geometric means of the E.coli data provide din the TMDL Report for the streams checked were all less the required geometric mean criteria, which if accurate, is important to all aspects of the TMDL.in the event that these inconsistencies prove to be data or data analysis issue we recommend that the entire data sets be further evaluated and the TMDL be revised or withdrawn as warranted.

Additionally, when reviewing the bacterial data we noted that on 8/11/2008 each E. coli data set, for each stream, had exactly the same value reported (10,000). That value was the highest bacterial count reported for each of the streams and it seems unusual that the highest bacterial counts would be found at every stream on the same day. We ask that ODEQ review the data and confirm that it is accurate.

DEQ Response:

Federal regulations [40 CFR §130.7(c)(1)] require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. This report adhered to the seasonal application of the Oklahoma WQS which limits the PBCR use to the period of May 1st through September 30th. Seasonal variation was also accounted for in these TMDLs by using five years of water quality data as set forth in OAC 785:46-15-3(c)(1)&(2) and (d)(1). An excerpt of the rule has been reproduced below:

(c) ***Temporal coverage.***

(1) ***General****. Observations, samples or other data collected for purposes of assessing use support shall be taken to avoid temporal bias, and seasonality shall be represented in the sampling scheme.*

(2) ***Streams.*** *Data no older than five years old shall be utilized in assessing use support for a stream unless*

(A) The data available from the preceding five year period is insufficient to satisfy the requirements of 785:46-15-3(d) or other more specific minimum requirements provided in this Subchapter, in which case data older than five years old may be utilized, or

(B) The provisions of 785:46-15-4(b)(3) or 785:46-15-4(c)(3) apply.

(d) ***Minimum number of samples.***

(1) ***Streams****. Except when (f) of this Section or any of subsections (e), (h), (i), (j), (k), (l), or (m) of 785:46-15-5 applies, a minimum of 10 samples shall be required to assess beneficial use support due to field parameters including but not limited to DO, pH and temperature, and due to routine water quality constituents including but not limited to coliform bacteria, dissolved solids and salts. Analyses may be aggregated to meet the 10 sample minimum requirements in non-wadable stream reaches that are 25 miles or less in length, and in wadable stream reaches that are 10 miles or less in length, if water quality conditions are similar at all sites. Provided, a minimum of 10 samples shall not be necessary if the existing samples already assure exceedance of the applicable percentage of a prescribed screening level.*

Using Bad Creek as an example, although 18 samples were collected there was not enough data (less than ten) within the five year (2014-2009) window per the OAC rule above. As a result, samples from the previous year (2008) were added to satisfy the minimum 10 sample criteria per section (d) of the rule above. Data collected prior to 2008 were not considered. In all three cases, the geometric mean was calculated in a similar manner using only the most current measurements for that stream in compliance with the rule. This accounts for the difference in geometric means.

Concerning bacterial data collected on 8/11/2008 for the three streams, those samples were collected by the Oklahoma Conservation Commission. At DEQ request, OCC reviewed the data to confirm that there were no quality assurance issues and that it is accurate. No problems with the data were identified. Their records indicate the samples were taken during a runoff event, which could account for the elevated levels. The three results for samples collected on that day were above the maximum reporting level and were reported as >10,000cfu/100ml. Whenever the bacteria count exceeds the maximum detectable limit, a value of 10,000cfu/100ml is used.

No changes were made as a result of this comment.

c. *In Section 3.2.1, page 3-4 ODEQ provides a general statement regarding TSS discharged from wastewater treatment facilities (WWTF). There is an assumption that the TSS discharged from WWTFs that are also permitted for BOD or CBOD is organic in nature and therefore will not be a potential source of turbidity. Is this assumption something that ODEQ has data to support?*

DEQ Response:

There are two general types of TSS, organic and inorganic. The TSS discharged from sewage treatment facilities, as several studies have shown, comprises mostly organic TSS. (For example, see <u>Wastewater Engineering: Treatment and Reuse</u>, Metcalf and Eddy) Permit limits for BOD or CBOD are used as an indicator that the wastewater is organic in nature. As a result an internal policy was instituted to exclude TSS from WWTFs with a limit for BOD or CBOD as a contributor to turbidity.

No changes were made as a result of this comment.

d. *On page 3-4 the second sentence of the first paragraph remarks that if not managed properly CAFOs have the potential to cause serious impacts to water quality. While the statement is not altogether incorrect it appears that CAFOs were targeted with particularly strong language, whereas other sources of potential pollutants were characterized less aggressively. Since all of the sources of pollutants could be problematic if not managed properly it seems editorially inappropriate to single out just* *one source. We request that ODEQ modify the language used regarding CAFOs similar to other potential sources discussed in the TMDL report.*

DEQ Response:

The language in question has been revised as shown below.

> "CAFOs are designated by EPA as significant sources of pollution, and may have the potential to cause serious impacts to water quality if not managed properly (ODAFF 2014), as with all other pollutant sources in this report."

e. *On pages 3-11, Section 3.2.5.2 the second paragraph describes concentrated swine feeding operations and the discharge of pollutants from them. This paragraph does not characterize water management for these operations accurately. The third paragraph, which describes swine waste management plans does not accurately characterize the operations and contradicts the second paragraph. We request that the second paragraph be removed from the TMDL report.*

DEQ Response:

The paragraph in question has been removed. See the responses to Comment #5

f. *Section 3.2.2, pages 3-15 through 3-18, including Tables 3-7, 3-8, and 3-9, provides agricultural information on livestock in the watersheds, based on county census data provided by USDA (USDA 2007). The watershed proportioning of animals and manure application based on county data seems a reasonable estimation procedure, and as noted in the TMDL Report "these are rough estimates only." However, we would like to review the numbers using the same calculation process ODEQ used and there was not enough information in the TMDL report to recreate those calculations. We would like review an example calculation for the data contained in Table 3-8 for one of the watersheds so that we can evaluate the process used. We request that an example calculation be added to the Section 3.2.2, or included as an appendix to the TMDL Report. It would also be useful to understand if any animal size information was considered for the commercially raised animals listed in the TMDL Report.*

Because of drought, cattle numbers in the watersheds have fluctuated dramatically during the data collection period used for the TMDL. The TMDL Report states that cattle, because of their numbers, are the most likely commercially raised farm animal source of bacteria. Since these numbers appear important in the TMDL we think that more accurate numbers of cattle in the watersheds should be developed. These could be derived by averaging the agricultural census data from 2002, 2007, and 2012 rather than just using the 2007 data. The census data is readily available and we request that the TMDL be amended to use averaged cattle data that better reflect watershed cattle numbers during the study period.

DEQ Response:

In order to estimate the number of cattle in each watershed, a ratio of the size of the watershed area of interest to the size of the county (or counties) in which the watershed is located is multiplied by the total number of cattle in the county.

Example:

Bad Creek = 23,400 acres but lies within two counties (17,175 acres in Okfuskee and 6225 acres in Okmulgee County)

Okfuskee County = 402,562 acres; # of cattle in county (2007 USDA) = 43,122

Okmulgee County = 449,280 acres; # of cattle in county (USDA 2007) = 51,310

# of cattle Bad Creek watershed in Okfuskee County: (17,175÷402,562) × 43,122 = 1,840

# of cattle Bad Creek watershed in Okmulgee County: (6,225÷449,280) × 51,310 = 711

Total # of cattle in Bad Creek watershed (2007 USDA) =1,840+711= 2,551 cattle

Please note that the number of cattle in the actual report differs by two head. This is due to accumulated rounding error. Estimates for other farm animals are derived in the same manner.

Concerning using USDA agricultural census for 2002, 2007 and 2012 for estimations, the report uses the 2007 census numbers. These were the most recent available when the report preparation began. In our judgment, it is most appropriate to use current values for these estimates rather than a historical average. Future TMDL reports will be based on the 2012 census, which was released in May 2014.

No changes were made as a result of this comment.

g. *Following our review of Section 4 "Technical Approach and Methods" and Section 5 "TMDL Calculations" we have comments or questions for ODEQs consideration. Although we speculate that a great deal of time and effort were put into these sections of the report, in general, it does not appear to us that the flow and load duration curve process outlined in Sections 4 and 5 were necessary or even helpful in completing or understanding the TMDL.*

First, it does not appear that each of the steps listed to calculate TMDLs in Section 4.2 were followed. Completing Step 3 of Section 4.2 in load duration curve method based TMDLs is typically useful for the reason stated in the report, "to identify if there is a critical condition" for an identified water quality problem. However, potentially useful flow and pollutant relationship information was not developed or provided in the TMDL. The TMDL Report explains why these relationships were not explored; stating that low flow violations may not be caused by point sources and that violations have been noted in low flow situations in watersheds that do not have point sources. The point remains, why go through the trouble of developing flow duration curves and then dismiss flow influence or relationship with water quality? We recommend that the actual flows measured (or calculated) for each bacteria sample be used to develop a chart that would show actual bacteria loading along the flow duration curve.

Because only the geometric mean (a single value representing data collected over several years) was considered in TMDL load duration curve development the resulting curves suggest that the water quality criterion for bacteria is exceeded at all flows. The charts shown in Figures 5-5 through 5-10 illustrate this point. We understand that the Water Quality Standards require use of the geometric mean of all samples in order gauge compliance with the criteria. However, using a single geometric mean to develop the load duration curves yields information that is misleading to the reader. This process implies that reductions are needed at all points along the hydrograph; which has not been tested and is likely not correct.

Table 5-1 describes the percent reduction required to meet water quality standards for indicator bacteria. The process to determine the percent reductions followed an iterative process of taking a series of percent reduction values, applying each value uniformly to the concentration of samples and verifying if the geometric mean of the reduced values of all samples is less than the WQS geometric mean." We could not follow this process *using the E. coli data In Appendix A since the geometric means for the data sets we examined were already less than the WQS geometric mean. We did simply take the percent difference between the TMDL reported geometric means and the WQS geometric means for both types of Indicator bacteria from all four of the streams and arrived at exactly the same required reductions as specified in the TMDL. For example, for Bad Creek the TMDL reported E. coil geometric mean was 157.6 cfu/100 ml and a reduction to the WQS geometric mean is 126 is 20%, the same reduction called for in the TMDL Report. Is this a coincidence?*

DEQ Response:

Where possible, actual flows measured during sample collection were used. When measured flows were not available, flow was estimated using nearby USGS gage stations based on the flow projection methodology in Appendix B. Flow projections used in this TMDL may be found in Table Appendix B-2.

In order to show the relationship between flow and pollutant loading, two curves where plotted. A curve derived by plotting the geometric mean of all existing bacterial samples continuously along the full spectrum of flow exceedance percentiles which represents the LDC and the allowable load which is determined by multiplying the estimated flow by the WQS geometric mean.

OAC 785:46-15-6 requires that the geometric mean based on the samples collected be used to make as assessment.

The method you describe to determine the percent reductions for bacteria is not accurate since it does not account for the margin of safety.

Discrepancies in the calculation of the geometric mean are explained above in the response to Comment #10b

No changes were made as a result of this comment.

h. *Page 3-19 contains a duplicate paragraph.*

DEQ Response:

The duplicate paragraph has been removed.

11. <u>Comment sent via email from Angela Stafford for Jared Stafford:</u>

I do not agree with the Clean Water Act.

DEQ Response:

No response is necessary and no changes were made as a result of this comment.

12. <u>Comment sent via email from Angela Stafford for Ron Stafford:</u>

Agriculture is a very significant part of American prosperity, great care should be taken affecting agriculture. Did the clean water study include wildlife such as wild hogs, deer, turkey, duck and geese? Nothing in nature is perfectly benign but taken as a whole they provide food and shelter for the world. Regulations will restrict and hinder production causing strife for all. Nature's process cleanses water, please don't hinder nature with regulations.

DEQ Response:

Yes, this study did consider the impact of wildlife, to the extent that data are available. Section 3.3.1 discusses possible impacts from wildlife populations and limitations of available data. Deer are considered as a surrogate for wildlife since some data are available. Table 3-7 in the report shows the magnitude of difference in the fecal coliform (FC) production rates for different animals. From that table, one can see that cattle produce 10x more fecal coliform that swine or geese and 100x more fecal coliform than ducks. Cattle produce 200x more fecal coliform than deer. In the four bacterially-impaired watersheds in the Study Area, an estimated 3686 deer deposit about 1.8 trillion FC (Section 3.3.1 of the TMDL Report).

Other commenters also mentioned wild hogs so some additional research was done regarding their impact. Using estimates from a survey conducted by the Oklahoma Department of Wildlife Conservation, the Natural Resources Conservation Service, Oklahoma State University Extension, and ODAFF Wildlife Services, there would be – at most – around 11,000 feral hogs in the Study Area. This is a maximum number because in sparse areas where the estimated number is less than 13 per square mile, 13 per square mile was used in the estimate. In areas considered to have moderate numbers of feral hogs (13 – 58 per square mile), 58 per square mile was used. Since swine deposit about 11 billion fecal coliform per animal per day, this means all the feral hogs in all five watersheds in the Study Area might deposit around 121 trillion FC (11 billion x 11,000 = 121,000,000,000,000).

By way of comparison, in the four bacterially-impaired watersheds in the Study Area, there are about 34,783 cattle (Table 3-10). That means there are about 3x more cattle than feral hogs and cattle deposit 10 times more FC than swine. The cattle in the four bacterially-impaired watersheds deposit over 3½ quadrillion FC per day (104 hundred billion x 34,783 = 3,617,432,000,000,000).

Compared to the other sources, cattle are considered to be the largest potential contributor of bacteria in the study areas.

No changes were made as a result of this comment.

13. Comment sent Individually via mail from Alice Olivo, Scott Olivo, Tonya Olivo, Kyle Cates, David Wingo, Shelton Foster, John Chastain, Wendell Dilday, Dallas Pryor, James Stafford, Doyle Wilson, Richard Nolen, Earl Ingram, and Alvin Foster (paraphrased):

I understand that the TMDL is based on data that was collected from 2003-2010. I am concerned that some of this data may not be accurate today. For example, in the past couple years we've had good rainfall to ease our drought. The data should be collected over a longer period of time to account for climate fluctuations.

I am also concerned that the data may not accurately reflect the source where the bacterial counts originate, such as municipal and industrial wastewater treatment. The report seems to blame "cattle in particular" because they are "thought to contribute the most." It seems to be a rush in judgment at this point to assume that just because there are cattle in the area, they are the source of the bacteria, especially with lower cattle numbers in Oklahoma in recent years. More detailed studies are needed. As your report even states, "the specific sources from which the bacteria come cannot be determined without additional study."

DEQ Response:

Please see the response to Comment #10b for a discussion of the required time period for the data.

Please see the response to Comment #6 for a discussion of wastewater treatment facilities as a potential source.

Please see the responses to Comments #1 and #12 for a discussion of the estimated bacteria produced by cattle compared to other potential sources.

No changes were made as a result of this comment.

14. Comment sent via email from John C. Slater, Hughes County:

I understand that the TMDL is based upon data that was collected from 2003 to 2010. I have concerns that the proposed rule is based on accurate data. For example, at Slater Farms, we have decreased the number of cattle during that time period because of the drought. During this time we went from 130 cows down to present 100 cows. Also I don't believe the study reflects the changing wildlife population because there are more deer and lots of feral hogs in this area now than in 2003.

I also have concerns that the data is not able to accurately reflect the source where the bacterial counts originate. On page 10 the study says, "the specific source from where the bacteria come cannot be determined without additional study." A few sentences later the report says, "Cattle, in particular, are thought to contribute the most to bacterial nonpoint source pollution..." It seems premature to publish a TMDL without knowing the source of the bacteria.

I request that before this TMDL is finalized, a more formal study is completed because you don't know the source of the bacteria or how the drought has affected the bacterial counts. And therefore the "thought" of cattle being a major source cannot be proven.

DEQ Response:

Please see the response to Comment #13. No changes were made as a result of this comment.

15. Comment sent via mail from Leon C. Barrett (paraphrased):

My name is Leon C. Barrett and I live on my ranch North of Holdenville in Hughes County. I want to thank you for accepting my comments on the proposed TMDL for the Lower North Canadian and Deep Fork areas. I have been ranching for the past 30 years while also working as the County Executive Director for the Farm Service Agency of the United States Department of Agriculture until retiring approximately 3 years ago. Now I ranch fulltime running 120 cows and 300 stockers on 1200 acres of owned and lease land. Most of the cattle are marketed at the Holdenville Livestock Market.

It is my understanding that the TMDL is based upon data that was collected from 2003 to 2010. My concern is that the proposed rule is being based on that is not current nor accurate. As the County Executive Director for FSA, USDA I was charged with administering numerous Drought Assistance Programs for livestock during the 2003 through 2010 timeframe. My concern is that data collected during drought periods from low stagnant areas of water des not accurately reflect current conditions.

In addition, the study states that the specific sources from which the bacteria come cannot be determined without additional studies. It seems premature to publish a TMDL without knowing the source of the bacteria.

Therefore, I am requesting that before this TMDL is finalized, a more formal and more current study be completed to gather actual facts on which to propose this TMDL.

DEQ Response:

Please see the response to Comment #13. No changes were made as a result of this comment.

16. Comment sent via mail from Coy Woodall (paraphrased):

I feel the TMDL is based on inaccurate data.

The report seems to be attempting to blame cattle but there many more things that pollute the water as much or more than cattle. There are deer, feral hogs, coyotes, raccoons, wild ducks and nasty wild geese and other wild creatures that get in the water.

Was your test taken in running water, pools of clear water or pools of stagnant water and was the drought taken into account?

The worse pollution in the water is the sewer systems in all the municipalities that are out dated or not properly cared for. The next worse pollution comes from the hog farms that are scattered all over the state [sic].

DEQ Response:

Please see the response to Comment #13. No changes were made as a result of this comment.

17. Comment sent via mail from John Brooks (paraphrased):

The TMDL study as presented requires more study and research in my opinion due to increased wildlife populations including but not limited to feral hogs, deer, and birds.

Please consider further testing and research to collect more current, accurate data the report as presented is flawed and should be further studied or eliminated.

DEQ Response:

Please see the response to Comment #13. No changes were made as a result of this comment.

18. Comment sent via mail from Randy Brown (paraphrased):

The study was conducted when there was the least amount of rainfall in the past 50 years. We have had an explosion in the amount of wild hogs. These wild hogs spend a lot of time in mud holes and streams. There is not enough data to make a law concerning this matter.

DEQ Response:

Please see the response to Comment #13. No changes were made as a result of this comment.

19. Comment sent via mail from Gil Turpin (paraphrased):

To decide on rules to improve the environment (which I'm for) based on any study done during the course of these natural events is both arbitrary and capricious.

Cattle (unless concentrated as in a feedlot) have not changed the environment since overgrazing has stopped.

DEQ Response:

Please see the response to Comment #1. No changes were made as a result of this comment.

20. Comment sent via mail from Judy Keesee (paraphrased):

I am concerned about the data collected for the TMDL study. I can attest to an explosion in the numbers of wildlife (feral hogs, deer, etc) during the testing period from 2003-2010. This wildlife surely contributes to fecal coliform and turbidity in the study areas.

Please consider extra study and monitoring before imposing regulations that may be based on flawed data.

DEQ Response:

Please see the response to Comment #12.

No changes were made as a result of this comment.

21. Comment sent via mail from Michael Kelsey:

OCA members reported that cattle numbers have decreased significantly since 2003 and that drought conditions caused differences in stream flow conditions thereby bringing into question the data collection which was accumulated from 2003 to 2010.

Additional concern that local OCA members highlighted was doubt regarding cattle being the primary cause of the bacterial counts. It is the opinion of many that the wildlife population estimation does not reflect accurate numbers. Feral swine population has increased over the past dozen years and their population is not reflected in the report. Further, the cattle in the study are are grazed on improved and native grasslands. How does the study account for the natural filtering actions of the vegetation and soil before the waters reach a stream?

DEQ Response:

Please see the response to Comment #10b for a discussion of the required time period for the data.

Please see the responses to Comments #1 and #12 for a discussion of the estimated bacteria produced by cattle compared to other potential sources.

Please refer to Section 3.3.2 of the report for a discussion of the relationship between manure deposition in fields and bacterial loading to streams.

No changes were made as a result of this comment.

22. Comment sent via mail from Michael Brown (paraphrased):

I don't believe the data accurately reflects the increasing wildlife population. Feral hogs and deer numbers have increased significantly during the years of the study. I find it hard to believe that cattle are contributing more pollution than wildlife.

DEQ Response:

Please see the response to Comments #1 and #12.

No changes were made as a result of this comment.

23. Comment sent via mail from Steven R. Barkhimer (paraphrased):

During the time period that the data was collected we were in a drought condition which decreases the ability of Mother Nature to purify run-off water naturally.

I have had to decrease my herd size by over half and others around here have done the same. The amount of manure and animal waste has followed in accordance with the herd reduction. I think the numbers of cattle reported on this report are incorrect.

The study did not include feral hogs. On my property the animal control services trapped and shot 38 feral hogs in one day. Over the past four years we have shot and killed 368 feral hogs on my property alone. I hope that DEQ takes this into consideration that the increase in wildlife also contributed to the pollutants.

I feel that before any regulations or recommendations are made, this study should be screened for accuracy.

DEQ Response:

Please see the response to Comments #1 and #12.

No changes were made as a result of this comment.

24. Comment sent via mail from Jack and Beverly Chapman (paraphrased):

I have concerns that the proposed rule is based on accurate data. We have fewer cows now due to the drought that we have experienced the last few years. There has also been an increase in wildlife, deer, wild hogs and other critters such as coyotes, skunks, raccoons and opossum.

I also have concerns that the data is not able to accurately reflect the source of the bacteria. On page 10, the study says" the specific sources from which the bacteria come cannot be determined without additional study". A few sentences later the report says "cattle in particular are thought to contribute the most to bacterial nonpoint source pollution." I think it would be helpful to know what is actually meant by "farm animals", would this mean confined operations like hog farms, feed yards or does this mean all animals. It seems premature to me to publish a TMDL without knowing the source of the bacteria

DEQ Response:

Please see the response to Comment #13. Commercially raised farm animals as mentioned in the Report refers animals raised for agricultural business.

No changes were made as a result of this comment.

25. Comment sent via mail from David H. Christ (paraphrased):

The oil industries are the main problem and still are with the oil leaks and salt water issues.

Without water our cattle will not survive and neither will you. We need our ponds to supply our cattle with water to drink and cool off in the summer.

It appears to me that DEQ ids the real problem. What DEQ needs to do is leave ranchers, cattlemen and our water sources alone.

DEQ Response:

Please see the response to Comments #1 and #8. No changes were made as a result of this comment.

26. <u>Comment sent via mail from Chester Streater (paraphrased):</u>

In the last ten years we have seen an explosion in the number of feral hogs on my property and all the lands along the streams. These hogs live in and around the streams and despite efforts to get rid of them, they keep increasing in numbers.

I am greatly concerned about the TMDL study for the Lower North Canadian and Deep Fork watersheds. I question the science behind this study and feel like much more study is needed before any action is taken. Please do not act on this study alone without further investigation into changes such as drought, drop in cattle numbers, increase in feral hogs etc.

DEQ Response:

See the response to Comment #13. No changes were made as a result of this comment.

27. <u>Comment sent via mail from Lance Wilson (paraphrased):</u>

I personally feel that this study is invalid. The family farmer cares more about the environment than anybody. Government regulations are going to make it impossible for the family farm to say in business.

DEQ Response:

No changes were made as a result of this comment.

28. <u>Comment sent via mail from Kevin Nolen, Richard Nolen (individually):</u>

There is more wildlife like hogs and deer in our creeks and ponds than cattle.

DEQ Response:

See the response to Comment #12. No changes were made as a result of this comment.