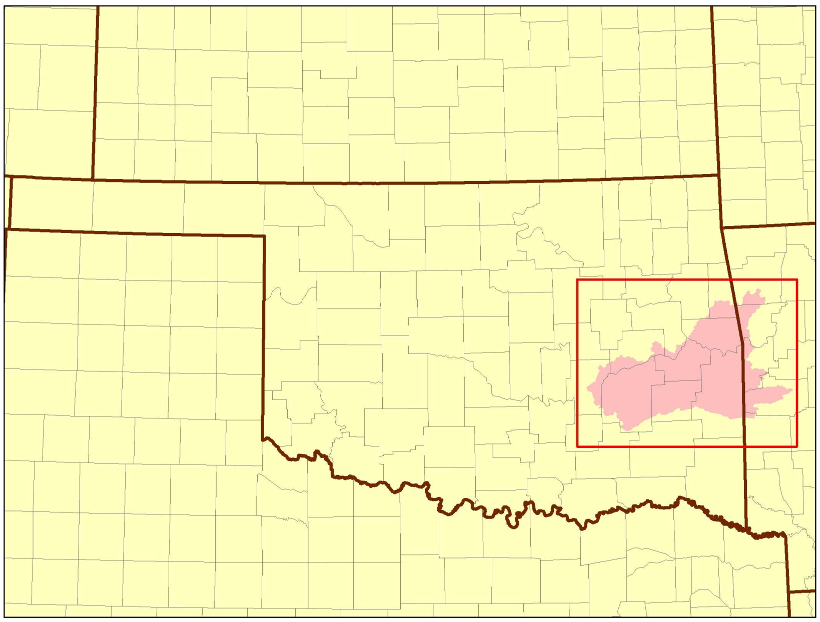
FINAL

BACTERIA TOTAL MAXIMUM DAILY LOADS FOR OK220100, OK220200, OK220600 IN THE SANS BOIS CREEK AREA, OKLAHOMA



Prepared for:

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Prepared by:

PARSONS

SEPTEMBER 2008

DRAFT

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OKWBID

OK220100040020, OK220200040010, OK220200040050, OK220600010070, OK220600010100, OK220600030010, OK22060030010, OK220600030020, OK220600030050, OK220600040030

Prepared for:

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SEPTEMBER 2008

Oklahoma Department of Environmental Quality: FY07 106 Grant (CA# I-006400-05) Project 24 – Bacteria TMDL Development

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ACRONYMS AND ABBREVIATIONS

ASAE	American Society of Agricultural Engineers
BMP	best management practice
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cfu	Colony-forming unit
CPP	Continuing planning process
CWA	Clean Water Act
DMR	Discharge monitoring report
LA	Load allocation
LDC	Load duration curve
mg	Million gallons
mgd	Million gallons per day
mL	Milliliter
MOS	Margin of safety
MS4	Municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
O.S.	Oklahoma statutes
ODAFF	Oklahoma Department of Agriculture, Food and Forestry
ODEQ	Oklahoma Department of Environmental Quality
OPDES	Oklahoma Pollutant Discharge Elimination System
OSWD	Onsite wastewater disposal
OWRB	Oklahoma Water Resources Board
PBCR	Primary body contact recreation
PRG	Percent reduction goal
SSO	Sanitary sewer overflow
TMDL	Total maximum daily load
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	Wasteload allocation
WQM	Water quality monitoring
WQS	Water quality standard
WWTP	Wastewater treatment plant

Executive Summary

This report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria fecal coliform, *Escherichia coli (E. coli),* or Enterococci for certain waterbodies in the Sans Bois Creek area of the Arkansas River Basin. Elevated levels of pathogen indicator bacteria in aquatic environments indicate that a receiving water is contaminated with human or animal feces and that there is a potential health risk for individuals exposed to the water. 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), USEPA guidance, and Oklahoma Department of Environmental Quality (ODEQ) guidance and procedures. ODEQ is required to submit all TMDLs to USEPA for review and approval. Once the USEPA 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 (USEPA 2003).

The purpose of this report is to establish pollutant load allocations for indicator bacteria 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. A TMDL consists of a wasteload allocation (WLA), load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES) as point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL set aside to account for the uncertainty 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 loadings within each watershed. Watershed-specific control actions and management measures will be identified, selected, and implemented under a separate process.

E.1 Problem Identification and Water Quality Target

A decision was made to place specific waterbodies in this Study Area, listed in Table ES-1, on the ODEQ 2004 303(d) list because evidence of nonsupport of primary body contact recreation (PBCR) was observed.

Elevated levels of bacteria above the WQS for one or more of the bacterial indicators result in the requirement that a TMDL be developed. The TMDLs established in this report are a necessary step in the process to develop the bacteria loading controls needed to restore the primary body contact recreation use designated for each waterbody.

Table ES-1 Excerpt from the 2004 Integrated Report – Comprehensive Waterbody Assessment Category List

Waterbody ID	Waterbody Name	Stream Miles	Category	TMDL Date	Primary Body Contact Recreation
OK220100040020_00	Fourche Maline Creek	36.942	5	2005	N
OK220200040010_40	Sans Bois Creek	27.8	5	2008	N
OK220200040050_00	Sans Bois Creek-Mountain Fork	18.84	5	2008	N
OK220600010070_00	Longtown Creek	25.71	5	2006	N
OK220600010100_20	Mill Creek	24.16	5	2005	N
OK220600030010_00	Brushy Creek, Off U.S. 270	5.68	5	2005	N
OK220600030010_10	Brushy Creek	25.33	5	2005	N
OK220600030020_00	Blue Creek	14	5	2010	N
OK220600030050_00	Peaceable Creek	17.14	5	2006	N
OK220600040030_00	Beaver Creek	12.26	5	2006	N

N = Not Attaining; Source: 2004 Integrated Report, ODEQ 2004

For the data collected between 1999 and 2003, evidence of nonsupport of the PBCR use based only on fecal coliform concentrations was observed in all waterbodies except Fourche Maline Creek and Brushy Creek off U.S. 270. Evidence of nonsupport of the PBCR use based on Enterococci concentrations was observed in Fourche Maline Creek and Brushy Creek off U.S. 270. There was no evidence of nonsupport of the PBCR used based on *E. coli* for any of the waterbodies in the Sans Bois Creek Study Area. In Appendix C of the ODEQ 2004 Integrated Report, total fecal coliform is also identified as a pollutant of concern for some 303(d) listed waterbodies. This indicator is typically associated with evaluating use impairment for waterbodies with drinking water as a designated use. However, because there are no drinking water intakes within 5 miles of the WQM stations associated with total fecal coliform samples collected, the listing of this bacterial indicator in Category 5 of the 2004 Integrated Report does not require the development of a TMDL. Table ES-2 summarizes the waterbodies requiring TMDLs for not supporting PBCR.

Table ES-2 Waterbodies Requiring TMDLs for Not Supporting Primary Body Contact Recreation Use

WQM Station	Waterbody ID	Waterbody Name	Indicator Bacteria		
			FC	ENT	*E. coli*
OK220100040020-001AT	OK220100040020_00	Fourche Maline Creek		X	
OK220200040010W	OK220200040010_40	Sans Bois Creek	X		
OK220200040050J	OK220200040050_00	Sans Bois Creek-Mountain Fork	X		
OK220600010070G	OK220600010070_00	Longtown Creek	X		
OK220600010100P	OK220600010100_20	Mill Creek	X		

WQM Station	Waterbody ID	Waterbody Name	Indicator Bacteria		
			FC	ENT	*E. coli*
OK220600030010-001AT	OK220600030010_00	Brushy Creek, Off U.S. 270		X	
OK220600030010T	OK220600030010_10	Brushy Creek	X		
OK220600030020-002SR	OK220600030020_00	Blue Creek	X		
OK220600030050M	OK220600030050_00	Peaceable Creek	X		
OK220600040030G	OK220600040030_00	Beaver Creek	X		

ENT = enterococci; FC = fecal coliform

The definition of PBCR is summarized by the following excerpt from Chapter 45 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.*

To implement Oklahoma's WQS for PBCR, OWRB promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2007). The excerpt below from Chapter 46: 785:46-15-6, stipulates how water quality data will be assessed to determine support of the PBCR use as well as how the water quality target for TMDLs will be 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) Screening levels.

(1) The screening level for fecal coliform shall be a density of 400 colonies per 100ml.

(2) The screening level for Escherichia coli shall be a density of 235 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 406 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(3) The screening level for enterococci shall be a density of 61 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 108 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(c) Fecal coliform:

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to fecal coliform if the geometric mean of 400 colonies per 100 ml is met and no greater than 25% of the sample concentrations from that waterbody exceed the screening level prescribed in (b) of this Section.

(2) The parameter of fecal coliform is not susceptible to an assessment that Primary Body Contact Recreation is partially supported.

(3) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to fecal coliform if the geometric mean of 400 colonies per 100 ml is not met, or greater than 25% of the sample concentrations from that waterbody exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(d) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(2) The parameter of E. coli is not susceptible to an assessment that Primary Body Contact Recreation is partially supported.

(3) 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 and any of the sample concentrations from that waterbody taken during the recreation season exceed a screening level prescribed in (b) of this Section.

(e) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(2) The parameter of enterococci is not susceptible to an assessment that Primary Body Contact Recreation is partially supported.

(3) 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 and any of the sample concentrations from that waterbody taken during the recreation season exceed a screening level prescribed in (b) of this Section.

Compliance with the Oklahoma WQS is based on meeting requirements for all three bacterial indicators. 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 2006).

As stipulated in the WQS, utilization of the geometric mean to determine compliance for any of the three indicator bacteria depends on the collection of five samples within a 30-day period. For most WQM stations in Oklahoma there are insufficient data available to calculate the 30-day geometric mean since most water quality samples are collected once a month. As a result, waterbodies placed on the 303(d) list for not supporting the PBCR are the result of individual samples exceeding the instantaneous criteria or the long-term geometric mean of individual samples exceeding the geometric mean criteria for each respective bacterial indicator. Targeting the instantaneous criterion established for the primary contact recreation season (May 1st to September 30th) as the water quality goal for TMDLs corresponds to the basis for 303(d) listing and may be protective of the geometric mean criterion as well as the criteria for the secondary contact recreation season. However, both the instantaneous and geometric mean criteria for *E. coli* and Enterococci will be evaluated as water quality targets to ensure the most protective goal is established for each waterbody.

All TMDLs for fecal coliform must take into account that no more than 25 percent of the samples may exceed the instantaneous numeric criteria. For *E. coli* and Enterococci, no more than 10% of samples may exceed instantaneous criteria. Since the attainability of stream beneficial uses for *E. coli* and Enterococci is based on the compliance of either the instantaneous or a long-term geometric mean criterion, percent reductions goals will be calculated for both criteria. TMDLs will be based on the percent reduction required to meet either the instantaneous or the long-term geometric mean criterion, whichever is less.

E.2 Pollutant Source Assessment

There are no NPDES permitted facilities of any type in the contributing watershed of Sans Bois Creek-Mountain Fork, Longtown Creek, Brushy Creek off U.S. 270, Brushy Creek, Peaceable Creek, and Beaver Creek. Four of the watersheds in the Study Area OK220100040020_00 (Fourche Maline Creek), OK220200040010_40 (Sans Bois Creek), OK220600010100_20 (Mill Creek), and OK220600030020_00 (Blue Creek) have a continuous point source discharger. There were 157 SSO occurrences, ranging from 100 to 53,000 gallons, reported in the Sans Bois Creek Study Area between October 1991 and January 2007. NPDES-permitted facilities operate in a few of the watersheds in the Study Area but most of the point sources are relatively minor and for the most part tend to meet instream water quality criteria in their effluent. Thus, nonpoint sources are considered to be the major source of bacteria loading in each watershed.

Nonpoint source bacteria loading to the receiving streams of each waterbody emanate from a number of different sources including wildlife, various agricultural activities and domesticated animals, land application fields, urban runoff, failing onsite wastewater disposal (OSWD) systems, and domestic pets. The data analysis and the load duration curves (LDC) demonstrate that exceedances at the WQM stations are the result of a variety of nonpoint source loading occurring during a range of flow conditions. Low flow exceednaces are likely due to a combination of non-point sources, uncontrolled point sources and permit noncompliance. .

E.3 Using Load Duration curves to Develop TMDLs

The TMDL calculations presented in this report are derived from LDCs. LDCs facilitate rapid development of TMDLs and as a TMDL development tool, are effective in identifying whether impairments are associated with point or nonpoint sources.

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 treatment plant 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 have been noted in some watersheds that contain no point sources. Research has show that bacteria loading in streams during low flow conditions may be due to direct deposit of cattle manure into streams and faulty septic tank/lateral field systems.

The basic steps to generating an LDC involve:

- obtaining daily flow data for the site of interest from the USGS;
- sorting the flow data and calculating flow exceedance percentiles for the time period and season of interest;
- obtaining the water quality data from the primary contact recreation season (May 1 through September 30);
- matching the water quality observations with the flow data from the same date;
- display a curve on a plot that represents the allowable load multiply the actual or estimated flow by the WQS for each respective indicator;
- multiplying the flow by the water quality parameter concentration to calculate daily loads; then
- plotting the flow exceedance percentiles and daily load observations in a load duration plot.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by the 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.

E.4 TMDL Calculations

As indicated above, the bacteria TMDLs for the 303(d)-listed WQM stations 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 uncertainty concerning the relationship between effluent limitations and water quality.

This definition can be expressed by the following equation:

$$TMDL = \Sigma\, WLA + \Sigma\, LA + MOS$$

For each waterbody the TMDLs presented in this report are expressed as a percent reduction across the full range of flow conditions (See Table ES-3). The difference between existing loading and the water quality target is used to calculate the loading reductions required. Percent reduction goals (PRG) are calculated for each WQM site and bacterial indicator species as the reductions in load required in order that no more than 25 percent of the existing instantaneous fecal coliform observations and no more than 10 percent of the existing instantaneous *E. coli* or Enterococci observations would exceed the water quality target.

Table ES-3 presents the percent reductions necessary for each bacterial indicator causing nonsupport of the PBCR use in each waterbody of the Study Area. Attainment of WQS in response to TMDL implementation will be based on results measured at each of these WQM stations. Selection of the appropriate PRG for each waterbody in Table ES-3 is denoted by the bold text. The TMDL PRG will be the lesser of that required to meet the geometric mean or instantaneous criteria for *E. coli* and Enterococci because WQ standards are considered to be met if 1) either the geometric mean of all data is less than the geometric mean criteria, or 2) no more than 10% of samples exceed the instantaneous criteria. Based on this table, the TMDL PRGs for Fourche Maline Creek and Brushy Creek segment OK220600030010_00 will be based on Enterococci; the TMDL PRGs for Sans Bois Creek, Sans Bois Creek-Mountain Fork, Longtown Creek, Mill Creek, Brushy Creek segment OK220600030010_10, Blue Creek, Peaceable Creek, and Beaver Creek will be based on fecal coliform.

Table ES-3 TMDL Percent Reduction Goals Required to Meet Water Quality Standards for Impaired Waterbodies in the Sans Bois Creek Study Area

Waterbody ID	WQM Station	Waterbody Name	Percent Reduction Required		
			FC	ENT	
			Instant-aneous	Instant-aneous	Geo-mean
OK220100040020_00	OK220100040020-001AT	Fourche Maline Creek		99%	**86%**
OK220200040010_40	OK220200040010W	Sans Bois Creek	**10%**		
OK220200040050_00	OK220200040050J	Sans Bois Creek-Mountain Fork	**10%**		
OK220600010070_00	OK220600010070G	Longtown Creek	**55%**		
OK220600010100_20	OK220600010100P	Mill Creek	**28%**		
OK220600030010_00	OK220600030010-001AT	Brushy Creek, off U.S. 270		98%	**69%**
OK220600030010_10	OK220600030010T	Brushy Creek	**33%**		
OK220600030020_00	OK220600030020-002SR	Blue Creek	**86%**		
OK220600030050_00	OK220600030050M	Peaceable Creek	**49%**		
OK220600040030_00	OK220600040030G	Beaver Creek	**28%**		

The TMDL, WLA, LA, and MOS vary with flow condition, and are calculated at every 5^{th} flow interval percentile. For illustrative purposes, the TMDL, WLA, LA, and MOS are calculated for the median flow at each site in Table ES-4. The WLA component of each TMDL is the sum of all WLAs within the contributing watershed of each WQM station. The sum of the WLAs can be represented as a single line below the LDC. The LDC and the simple equation of:

$$\textit{Average LA = average TMDL – MOS} - \sum \textit{WLA}$$

can provide an individual value for the LA in counts per day which represents the area under the TMDL target line and above the WLA line. There are no permitted MS4s in the study area. Where there are no continuous point sources the WLA is zero.

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs include a MOS. The MOS is a conservative measure incorporated into the TMDL equation that accounts for the uncertainty associated with calculating the allowable pollutant loading to ensure WQSs are attained. USEPA guidance allows for use of implicit or explicit expressions of the MOS, or both. When conservative assumptions are used in development of the TMDL, or conservative factors are used in the calculations, the MOS is implicit. When a specific percentage of the TMDL is set aside to account for uncertainty, then the MOS is considered explicit.

For the explicit MOS the water quality target was set at 10 percent lower than the water quality criterion for each pathogen which equates to 360 cfu/100 mL, 365.4 cfu/100 mL, and 97.2/100 mL for fecal coliform, *E. coli*, and Enterococci, respectively. The net effect of the TMDL with MOS is that the assimilative capacity or allowable pollutant loading of each waterbody is slightly reduced. These TMDLs incorporate an explicit MOS by using a curve representing 90 percent of the TMDL as the average MOS. The MOS at any given percent flow exceedance, therefore, can be defined as the difference in loading between the TMDL and the TMDL with MOS. The use of instream bacteria concentrations to estimate existing loading is another conservative element utilized in these TMDLs that can be recognized as an implicit MOS. This conservative approach to establishing the MOS will ensure that both the 30-day geometric mean and instantaneous bacteria standards can be achieved and maintained.

Table ES-4 TMDL Summaries Examples

Waterbody ID	WQM Station	Waterbody Name	Indicator Bacteria Species	TMDL† (cfu/day)	WLA† (cfu/day)	LA† (cfu/day)	MOS† (cfu/day)
OK220100040020_00	OK220100040020-001AT	Fourche Maline Creek	Enterococci	1.69E+10	1.12E+08	1.51E+10	1.69E+09
OK220200040010_40	OK220200040010W	Sans Bois Creek	Fecal Coliform	5.16E+10	8.40E+08	4.56E+10	5.16E+09
OK220200040050_00	OK220200040050J	Sans Bois Creek-Mountain Fork	Fecal Coliform	4.35E+10	0	3.91E+10	4.35E+09
OK220600010070_00	OK220600010070G	Longtown Creek	Fecal Coliform	3.89E+10	0	3.5E+10	3.89E+09
OK220600010100_20	OK220600010100P	Mill Creek	Fecal Coliform	4.14E+10	0	3.73E+10	4.14E+09
OK220600030010_00	OK220600030010-001AT	Brushy Creek, Off U.S. 270	Enterococci	9.27E+09	0	8.34E+09	9.27E+08
OK220600030010_10	OK220600030010T	Brushy Creek	Fecal Coliform	1.76E+10	0	1.59E+10	1.76E+09
OK220600030020_00	OK220600030020-002SR	Blue Creek	Fecal Coliform	5.94E+09	3.03E+09	2.32E+09	5.94E+08
OK220600030050_00	OK220600030050M	Peaceable Creek	Fecal Coliform	1.08E+10	0	9.69E+09	1.08E+09
OK220600040030_00	OK220600040030G	Beaver Creek	Fecal Coliform	8.29E+09	0	7.46E+09	8.29E+08

† Derived for illustrative purposes at the median flow value

E.5 Reasonable Assurance

As authorized by Section 402 of the CWA, ODEQ has delegation of the NPDES in Oklahoma, except for certain jurisdictional areas related to agriculture and the oil and gas industry retained by the Oklahoma Department of Agriculture and Oklahoma Corporation Commission, for which the USEPA has retained permitting authority. The NPDES program in Oklahoma is implemented via Title 252, Chapter 606 of the Oklahoma Pollution Discharge Elimination System (OPDES) Act, and in accordance with the agreement between ODEQ and USEPA relating to administration and enforcement of the delegated NPDES program. Implementation of WLAs for point sources is done through permits issued under the OPDES program.

SECTION 1
INTRODUCTION

1.1 TMDL Program Background

Section 303(d) of the Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) Water Quality Planning and Management Regulations (40 Code of Federal Regulations [CFR] Part 130) require states to develop total maximum daily loads (TMDL) for waterbodies not meeting designated uses where technology-based controls are in place. TMDLs establish the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so states can implement water quality-based controls to reduce pollution from point and nonpoint sources and restore and maintain water quality (USEPA 1991).

This report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria fecal coliform, *Escherichia coli (E. coli)*, or Enterococci for certain waterbodies in the Sans Bois Study Area of the Arkansas River Basin. Elevated levels of pathogen indicator bacteria in aquatic environments indicate that a receiving water is contaminated with human or animal feces and that there is a potential health risk for individuals exposed to the water. 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), USEPA guidance, and Oklahoma Department of Environmental Quality (ODEQ) guidance and procedures. ODEQ is required to submit all TMDLs to USEPA for review and approval. Once the USEPA 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 (USEPA 2003).

The purpose of this TMDL report is to establish pollutant load allocations for indicator bacteria 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 a wasteload allocation (WLA), load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES) as point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL set aside to account for the uncertainty 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 loadings 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, tribes, and local, state, and federal government agencies.

This TMDL report focuses on waterbodies that ODEQ placed in Category 5 of the 2004 Integrated Report [303(d) list] for nonsupport of primary body contact recreation (PBCR):

- Fourche Maline Creek (OK220100040020_00),
- Sans Bois Creek (OK220200040010_40),
- Sans Bois Creek-Mountain Fork (OK220200040050_00),
- Longtown Creek (OK220600010070_00),
- Mill Creek (OK220600010100_20),
- Brushy Creek off U.S. 270 (OK220600030010_00)
- Brushy Creek (OK22060030010_10),
- Blue Creek (OK220600030020_00),
- Peaceable Creek (OK220600030050_00), and
- Beaver Creek (OK220600040030_00).

Figure 1-1 is a location map showing the impaired segments of these Oklahoma waterbodies and their contributing watersheds. This map also displays the 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.

Elevated levels of bacteria above the WQS also result in the requirement that a TMDL be developed. The TMDLs established in this report are a necessary step in the process to develop the bacteria loading controls needed to restore the contact recreation use designated for each waterbody. Table 1-1 provides a description of the locations of the WQM stations on the 303(d)-listed waterbodies.

Table 1-1 Water Quality Monitoring Stations used for 2004 303(d) Listing Decision

Waterbody Name	Waterbody ID	WQM Station	WQM Station Locations Descriptions
Fourche Maline Creek	OK220100040020_00	OK220100040020-001AT	Fourche Maline Creek
Sans Bois Creek	OK220200040010_40	OK220200040010W	Sans Bois Creek
Sans Bois Creek-Mountain Fork	OK220200040050_00	OK220200040050J	Sans Bois Creek-Mountain Fork
Longtown Creek	OK220600010070_00	OK220600010070G	Longtown Creek
Mill Creek	OK220600010100_20	OK220600010100P	Mill Creek
Brushy Creek off U.S. 270	OK220600030010_00	OK220600030010-001AT	Brushy Creek, off U.S. 270, Haileyville
Brushy Creek	OK220600030010_10	OK220600030010T	Brushy Creek
Blue Creek	OK220600030020_00	OK220600030020-002SR	Blue Creek U.S. 270
Peaceable Creek	OK220600030050_00	OK220600030050M	Peaceable Creek
Beaver Creek	OK220600040030_00	OK220600040030G	Beaver Creek

1.2 Watershed Description

General. The watersheds in the Sans Bois Creek Study Area of the Arkansas River Basin in this TMDL are located in eastern Oklahoma. The majority of the waterbodies included in this report are located in McIntosh, Haskell, Le Flore, Latimer and Pittsburg Counties. A small portion of Mill Creek (OK220600010100) is located in Hughes County.

All watersheds in the Sans Bois Study Area are in the Arkansas Valley ecoregion. The watersheds are a part of the Ouachita Mountain Uplift and Arkoma Basin geological provinces. The southeastern portion of the Fourche Maline Creek watershed is in the northwestern portion of the Ouachita National Forest. Table 1-2, derived from the 2000 U.S. Census, demonstrates that the counties in which these watersheds are located are sparsely populated (U.S. Census Bureau 2000).

Table 1-2 County Population and Density

County Name	Population (2000 Census)	Population Density (per square mile)
McIntosh	19,456	31
Haskell	11,792	20
Le Flore	48,109	30
Latimer	10,692	15
Pittsburg	43,953	34
Hughes	14,154	18

Climate. Table 1-3 summarizes the average annual precipitation for each WQM station. Average annual precipitation values among the WQM stations in this portion of Oklahoma range between 45.2 and 50.7 inches (Oklahoma Climate Survey 2005).

Table 1-3 Average Annual Precipitation by WQM Station

Sans Bois River Precipitation Summary		
Waterbody Name	**Waterbody ID**	**Average Annual (Inches)**
Fourche Maline Creek	OK220100040020_00	50.7
Sans Bois Creek	OK220200040010_40	47.7
Sans Bois Creek-Mountain Fork	OK220200040050_00	50.0
Longtown Creek	OK220600010070_00	47.0
Mill Creek	OK220600010100_20	45.2
Brushy Creek off U.S. 270	OK220600030010_00	47.0
Brushy Creek	OK220600030010_10	47.6
Blue Creek	OK220600030020_00	47.9
Peaceable Creek	OK220600030050_00	46.0
Beaver Creek	OK220600040030_00	48.3

Land Use. Table 1-4 summarizes the acreages and the corresponding percentages of the land use categories for the contributing watershed associated with each respective Oklahoma waterbody. The land use/land cover data were derived from the U.S. Geological Survey (USGS) 2001 National Land Cover Dataset (USGS 2007). The land use categories are displayed in Figure 1-2.

The dominant land use throughout all of the Study Area is deciduous forest. The second most prevalent land use in all watersheds, except for one, is the combination of pasture/hay and grassland/herbaceous. The exception is Sans Bois Creek-Mountain Fork where evergreen forest is the second most prevalent land use category.

There are two cities in Fourche Maline Creek watershed, Le Flore and Red Oak, and two cities in Blue Creek watershed, Hartshorne and Haileyville. Hanna is the only city located in Mill Creek watershed, and Quinton is the only city located in the Sans Bois Creek watershed. The other five watersheds have no urban areas. Low, medium, and high intensity developed land account for less than 3 percent of the land use in each watershed.

Table 1-4 Land Use Summaries by Watershed

Landuse Category	WQM Station									
	Fourche Maline Creek	Sans Bois Creek	Sans Bois Creek-Mountain Fork	Longtown Creek	Mill Creek	Brushy Creek off U.S. 270	Brushy Creek	Blue Creek	Peaceable Creek	Beaver Creek
Waterbody ID	OK220100040020_00	OK220200040010_40	OK220200040050_00	OK220600010070_00	OK220600010100_20	OK220600030010_00	OK220600030010_10	OK220600030020_00	OK220600030050_00	OK220600040030_00
Percent of Open Water	0.3	0.2	0.2	0.6	0.3	1.7	0.4	0.7	0.3	0.1
Percent of Developed, Open Space	2.8	2.8	1.4	2.0	3.3	8.4	2.4	9.3	2.9	2.0
Percent of Developed, Low Intensity	0.1	0.4	0.1	0.0	0.2	0.9	0.2	1.4	0.1	0.1
Percent of Developed, Medium Intensity	0.0	0.1	0.0	0.0	0.0	0.3	0.1	0.5	0.0	0.0
Percent of Developed, High Intensity	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.0	0.0
Percent of Barren Land (Rock/Sand/Clay)	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.1	0.0
Percent of Deciduous Forest	47.3	39.3	47.9	38.5	54.1	43.5	44.0	38.7	40.7	37.3
Percent of Evergreen Forest	11.0	13.0	16.2	2.0	0.5	0.4	5.7	5.6	0.0	17.2
Percent of Mixed Forest	10.6	8.9	8.1	4.6	0.0	1.6	3.0	7.6	0.0	8.1
Percent of Shrub/Scrub	1.4	1.4	1.6	2.4	0.0	1.2	2.3	0.8	0.0	0.6
Percent of Grassland/Herbaceous	6.2	10.0	9.6	11.5	24.2	17.1	10.8	6.6	31.3	5.0
Percent of Pasture/Hay	17.4	22.3	14.1	37.1	16.7	21.5	30.1	26.7	24.5	27.8
Percent of Cultivated Crops	0.1	0.4	0.2	0.0	0.7	0.3	0.1	0.0	0.0	0.0

Landuse Category	WQM Station									
	Fourche Maline Creek	**Sans Bois Creek**	**Sans Bois Creek-Mountain Fork**	**Longtown Creek**	**Mill Creek**	**Brushy Creek off U.S. 270**	**Brushy Creek**	**Blue Creek**	**Peaceable Creek**	**Beaver Creek**
Waterbody ID	OK220100040020_00	OK220200040010_40	OK220200040050_00	OK220600010070_00	OK220600010100_20	OK220600030010_00	OK220600030010_10	OK220600030020_00	OK220600030050_00	OK220600040030_00
Percent of Woody Wetlands	2.6	1.2	0.7	1.1	0.0	3.0	0.8	1.4	0.1	1.8
Percent of Emergent Herbaceous Wetlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acres Open Water (percent of total)	463	117	86	261	158	216	344	101	101	11
Acres Developed, Open Space	4,034	1,605	675	865	1,671	1,090	2,272	1,372	928	206
Acres Developed, Low Intensity	155	210	24	5	87	113	170	210	22	12
Acres Developed, Medium Intensity	34	33	2	4	13	34	103	70	6	2
Acres Developed, High Intensity	8	14	0	0	2	16	0	56	2	0
Acres Barren Land (Rock/Sand/Clay)	198	13	80	8	0	0	3	42	19	0
Acres Deciduous Forest	67,532	22,413	23,319	16,396	27,261	5,661	41,272	5,710	12,909	3,823
Acres Evergreen Forest	15,655	7,434	7,879	845	236	54	5,342	823	14	1,760
Acres Mixed Forest	15,097	5,089	3,927	1,961	0	208	2,856	1,115	0	832
Acres Shrub/Scrub	2,024	819	760	1,010	0	161	2,179	113	2	58
Acres Grassland/ Herbaceous	8,908	5,689	4,701	4,894	12,174	2,225	10,152	980	9,916	512
Acres Pasture/Hay	24,761	12,685	6,855	15,798	8,428	2,794	28,184	3,945	7,771	2,853
Acres Cultivated Crops	115	215	100	21	330	40	69	0	0	2

Landuse Category	WQM Station									
	Fourche Maline Creek	**Sans Bois Creek**	**Sans Bois Creek-Mountain Fork**	**Longtown Creek**	**Mill Creek**	**Brushy Creek off U.S. 270**	**Brushy Creek**	**Blue Creek**	**Peaceable Creek**	**Beaver Creek**
Waterbody ID	OK220100040020_00	OK220200040010_40	OK220200040050_00	OK220600010070_00	OK220600010100_20	OK220600030010_00	OK220600030010_10	OK220600030020_00	OK220600030050_00	OK220600040030_00
Acres Woody Wetlands	3,670	658	321	489	2	396	781	211	35	180
Acres Emergent Herbaceous Wetlands	26	1	0	0	6	4	8	0	0	0
Total (Acres)	**142,682**	**56,995**	**48,731**	**42,557**	**50,368**	**13,015**	**93,736**	**14,751**	**31,725**	**10,251**

Figure 1-1 Watersheds Not Supporting Primary Body Contact Recreation Use within the Study Area

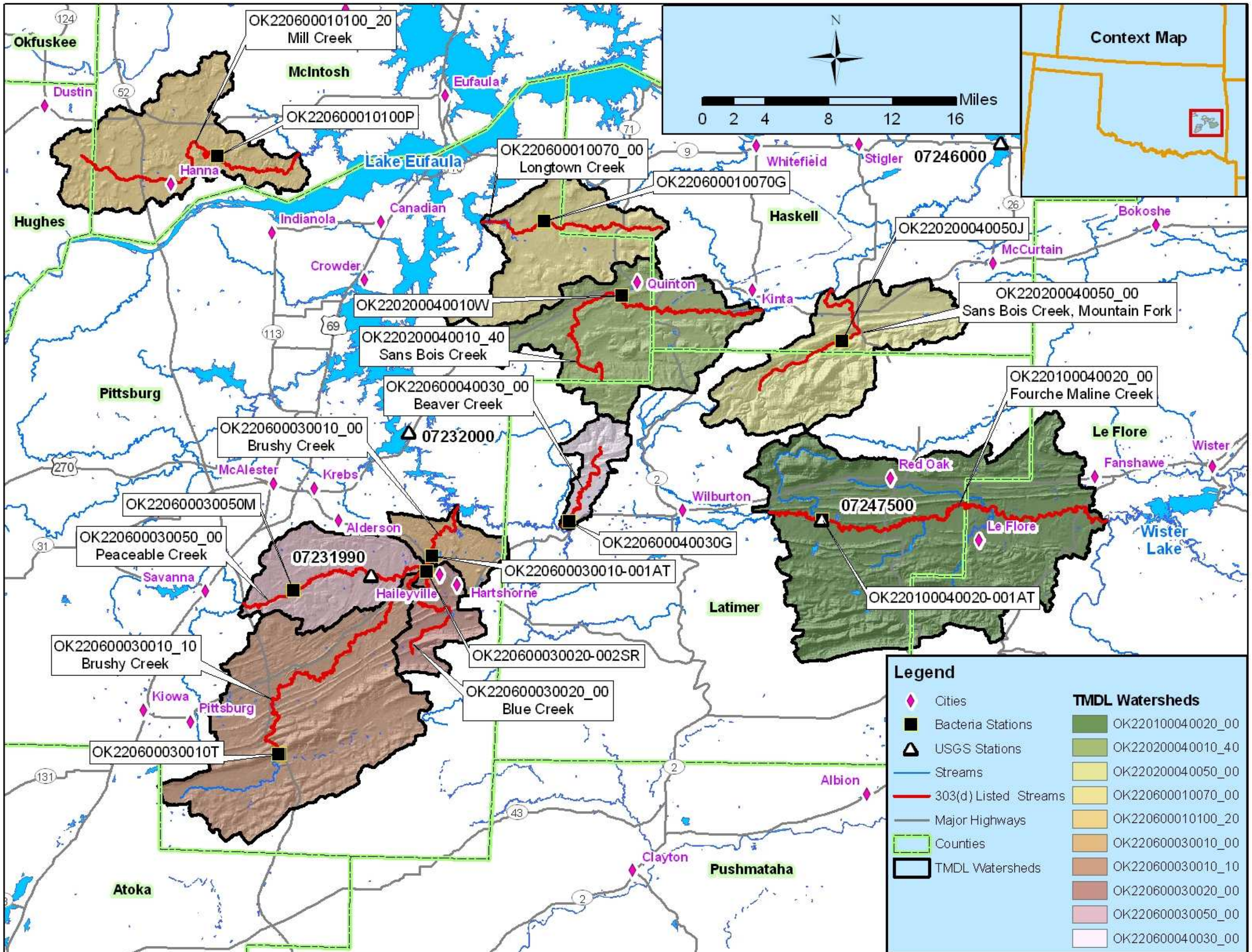
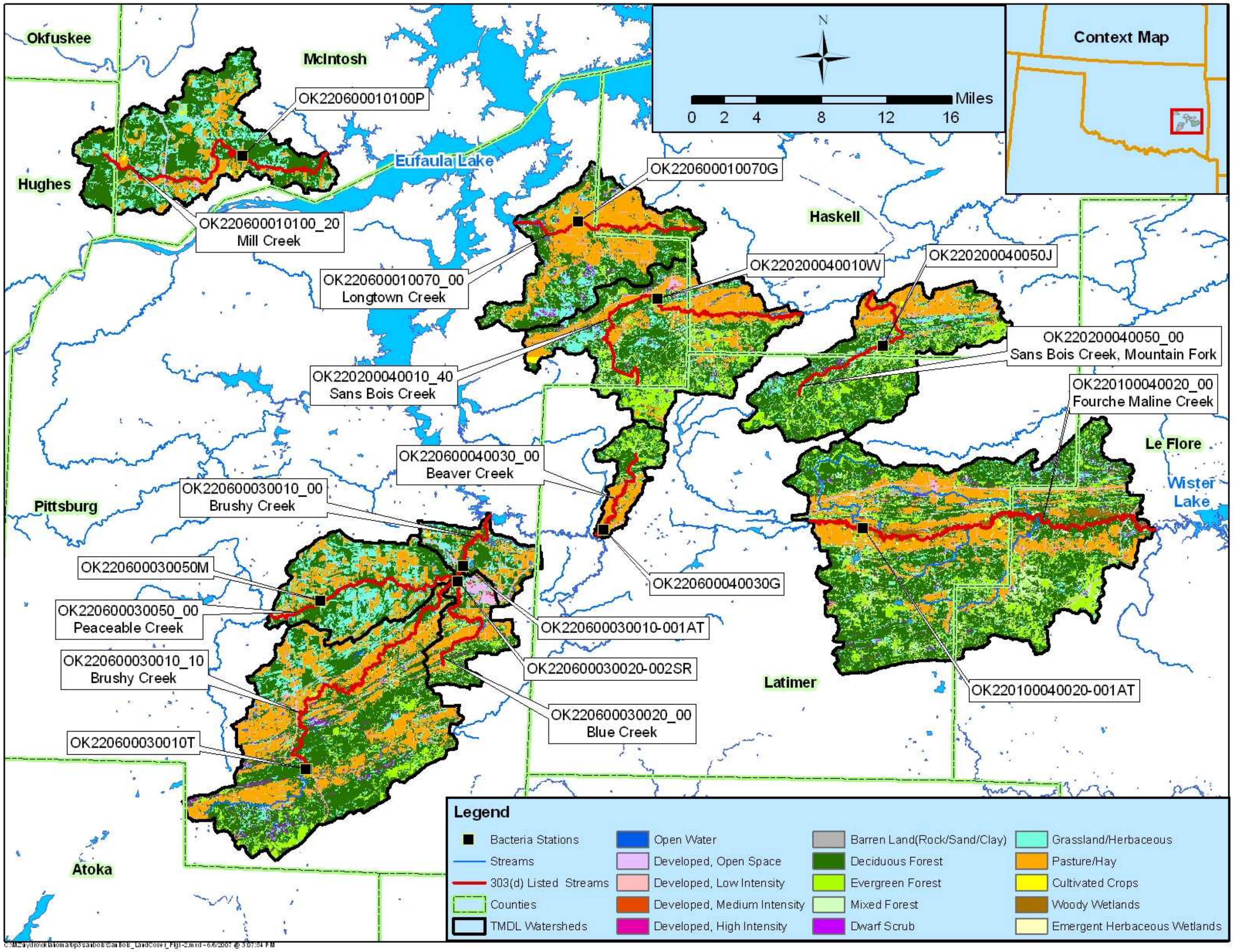


Figure 1-2 Land Use Map by Watershed



SECTION 2
PROBLEM IDENTIFICATION AND WATER QUALITY TARGET

2.1 Oklahoma Water Quality Standards

Title 785 of the Oklahoma Administrative Code authorizes the Oklahoma Water Resources Board (OWRB) to promulgate Oklahoma's water quality standards (OWRB 2006). The OWRB has statutory authority and responsibility concerning establishment of state water quality standards, 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 2006). The beneficial uses designated for the Fourche Maline Creek (OK220100040020), Sans Bois Creek (OK220200040010), Sans Bois Creek-Mountain Fork (OK220200040050), Longtown Creek (OK220600010070), Mill Creek (OK220600010100), Brushy Creek (OK220600030010), Blue Creek (OK220600030010), Peaceable Creek (OK220600030050), and Beaver Creek (OK220600040030) include PBCR, public/private water supply, warm water aquatic community, industrial and municipal process and cooling water, agricultural water supply, public and private water supply, fish consumption, and aesthetics. The TMDLs in this report only address the PBCR-designated use. Table 2-1, an excerpt from Appendix B of the 2004 Integrated Report (ODEQ 2004), summarizes the PBCR use attainment status for the waterbodies of the Study Area and targeted TMDL date. The TMDL date for a stream segment indicates the priority of the stream segment for which a TMDL needs to be developed. The TMDLs established in this report are a necessary step in the process to restore the PBCR use designation for each waterbody.

Table 2-1 Excerpt from the 2004 Integrated Report – Comprehensive Waterbody Assessment Category List

Waterbody ID	Waterbody Name	Stream Miles	Category	TMDL Date	Primary Body Contact Recreation
OK220100040020_00	Fourche Maline Creek	36.942	5	2005	N
OK220200040010_40	Sans Bois Creek	27.8	5	2008	N
OK220200040050_00	Sans Bois Creek-Mountain Fork	18.84	5	2008	N
OK220600010070_00	Longtown Creek	25.71	5	2006	N
OK220600010100_20	Mill Creek	24.16	5	2005	N
OK220600030010_00	Brushy Creek, Off U.S. 270	5.68	5	2005	N
OK220600030010_10	Brushy Creek	25.33	5	2005	N
OK220600030020_00	Blue Creek	14	5	2010	N
OK220600030050_00	Peaceable Creek	17.14	5	2006	N
OK220600040030_00	Beaver Creek	12.26	5	2006	N

N = Not Supporting; Source: 2004 Integrated Report, ODEQ 2004

The definition of PBCR is summarized by the following excerpt from Chapter 45 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.

To implement Oklahoma's WQS for PBCR, OWRB promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2007). The excerpt below from Chapter 46: 785:46-15-6, stipulates how water quality data will be assessed to determine support of the PBCR use as well as how the water quality target for TMDLs will be 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) Screening levels.

(1) The screening level for fecal coliform shall be a density of 400 colonies per 100ml.

(2) The screening level for Escherichia coli shall be a density of 235 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 406 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(3) The screening level for enterococci shall be a density of 61 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 108 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(c) Fecal coliform:

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to fecal coliform if the geometric mean of 400 colonies per 100 ml is met and no greater than 25% of the sample concentrations from that waterbody exceed the screening level prescribed in (b) of this Section.

(2) The parameter of fecal coliform is not susceptible to an assessment that Primary Body Contact Recreation is partially supported.

(3) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to fecal coliform if the geometric mean of 400 colonies per 100 ml is not met, or greater than 25% of the sample concentrations from that

waterbody exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(d) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(2) The parameter of E. coli is not susceptible to an assessment that Primary Body Contact Recreation is partially supported.

(3) 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 and any of the sample concentrations from that waterbody taken during the recreation season exceed a screening level prescribed in (b) of this Section.

(e) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(2) The parameter of enterococci is not susceptible to an assessment that Primary Body Contact Recreation is partially supported.

(3) 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 and any of the sample concentrations from that waterbody taken during the recreation season exceed a screening level prescribed in (b) of this Section.

Compliance with the Oklahoma WQS is based on meeting requirements for all three bacterial indicators. 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 2006).

As stipulated in the WQS, utilization of the geometric mean to determine compliance for any of the three indicator bacteria depends on the collection of five samples within a 30-day period. For most WQM stations in Oklahoma there are insufficient data available to calculate the 30-day geometric mean since most water quality samples are collected once a month. As a result, waterbodies placed on the 303(d) list for not supporting the PBCR are the result of individual samples exceeding the instantaneous criteria or the long-term geometric mean of individual samples exceeding the geometric mean criteria for each respective bacterial indicator. Targeting the instantaneous criterion established for the primary contact recreation season (May 1st to September 30th) as the water quality goal for TMDLs corresponds to the basis for 303(d) listing and may be protective of the geometric mean criterion as well as the criteria for the secondary contact recreation season. However, both the instantaneous and geometric mean criteria for *E. coli* and Enterococci will be evaluated as water quality targets to ensure the most protective goal is established for each waterbody.

The specific data assessment method for listing indicator bacteria based on instantaneous or single sample criterion is detailed in Oklahoma's 2004 Integrated Report. As stated in the report, a minimum of 10 samples collected between May 1st and September 30th (during the primary recreation season) is required to list a segment for *E. coli* and Enterococci.

A sample quantity exception exists for fecal coliform that allows waterbodies to be listed for nonsupport of PBCR if there are less than 10 samples. The assessment method states that if there are less than 10 samples and the existing sample set already assures a nonsupport determination, then the waterbody should be listed for TMDL development. This condition is true in any case where the small sample set demonstrates that at least three out of six samples exceed the single sample fecal coliform criterion. In this case if four more samples were available to meet minimum of 10 samples, this would still translate to >25 percent exceedance or nonsupport of PBCR (*i.e.,* three out of 10 samples = 33 percent exceedance). For *E. coli* and Enterococci, the 10-sample minimum was used, without exception, in attainment determination.

2.2 Problem Identification

Table 2-2 summarizes water quality data collected during primary contact recreation season from the WQM stations between 1999 and 2003 for each indicator bacteria. All the data within this time frame were used to support the decision to place specific waterbodies within the Study Area on the ODEQ 2004 303(d) list (ODEQ 2004). Water quality data from the primary and secondary contact recreation seasons are provided in Appendix A. For the data collected between 1999 and 2003, evidence of nonsupport of the PBCR use based only on fecal coliform concentrations was observed in all waterbodies except Fourche Maline Creek and Brushy Creek off U.S. 270. Evidence of nonsupport of the PBCR use based on Enterococci concentrations was observed in Fourche Maline Creek and Brushy Creek off U.S. 270. There was no evidence of nonsupport of the PBCR used based on *E. coli* for any of the waterbodies in the Sans Bois Creek Study Area. In Appendix C of the ODEQ 2004 Integrated Report, total fecal coliform is also identified as a pollutant of concern for some 303(d) listed waterbodies. This indicator is typically associated with evaluating use impairment for waterbodies with drinking water as a designated use. However, because there are no drinking water intakes within 5 miles of the WQM stations associated with total fecal coliform samples collected, the listing of this bacterial indicator in Category 5 of the 2004 Integrated Report does not require the development of a TMDL. Table 2-3 summarizes the waterbodies requiring TMDLs for not supporting PBCR.

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." For the WQM stations requiring TMDLs in this report, defining the water quality target is somewhat complicated by the use of three different bacterial indicators with three different numeric criterion for determining attainment of PBCR use as defined in the Oklahoma WQSs. An individual water quality target is established for each bacterial indicator since each indicator group must demonstrate compliance with the numeric criteria prescribed in the Oklahoma WQS (OWRB 2006). As previously stated, because available bacteria data were collected on an approximate monthly basis (see Appendix A) instead of at least five samples over a 30–day period, data for these TMDLs are analyzed and presented in relation to the instantaneous criteria for fecal coliform and both the instantaneous and a long-term geometric mean for both *E. coli* and Enterococci.

All TMDLs for fecal coliform must take into account that no more than 25 percent of the samples may exceed the instantaneous numeric criteria. For *E. coli* and Enterococci, no more than 10 percent of samples may exceed instantaneous criteria. Since the attainability of stream beneficial uses for *E. coli* and Enterococci is based on the compliance of either the instantaneous or a long-term geometric mean criterion, percent reductions goals will be calculated for both criteria. TMDLs will be based on the percent reduction required to meet either the instantaneous or long-term geometric mean criterion, whichever is less.

The water quality target for each waterbody will also incorporate an explicit 10 percent MOS. For example, if fecal coliform is utilized to establish the TMDL, then the water quality target is 360 organisms per 100 milliliters (mL), 10 percent lower than the instantaneous water quality criteria (400/100 mL). For *E. coli* the instantaneous water quality target is 365 organisms/100 mL, which is 10 percent lower than the criterion value (406/100 mL), and the geometric mean water quality target is 113 organisms/100 mL, which is 10 percent lower than the criterion value (126/100 mL). For Enterococci the instantaneous water quality target is 97/100 mL, which is 10 percent lower than the criterion value (108/100 mL) and the geometric mean water quality target is 30 organisms/100 mL, which is 10 percent lower than the criterion value (33/100 mL).

Each water quality target will be used to determine the allowable bacteria load which is derived by using the actual or estimated flow record multiplied by the instream criteria minus a 10 percent MOS. The line drawn through the allowable load data points is the water quality target which represents the maximum load for any given flow that still satisfies the WQS.

Table 2-2 Summary of Indicator Bacteria Samples from Primary Body Contact Recreation Season, 1999-2003

Waterbody ID	Waterbody Name	Indicator Bacteria	Single Sample Water Quality Criterion (#/100ml)	Geometric Mean Concentration (count/100ml)	Number of Samples	Number of Samples Exceeding Single Sample Criterion	% of Samples Exceeding Single Sample Criterion	Reason for Listing Change
OK220100030010_00	Brazil Creek	FC	400	181	14	1	17%	
		EC	406	117	3	1	33%	Delist: Low Sample Count
		ENT	108	1414	2	2	100%	
OK220100040020_00	Fourche-Maline Creek, off U.S. 270, Red Oak	FC	400	144	24	6	25%	
		EC	406	103	24	5	21%	
		ENT	108	215	24	16	67%	
OK220200040010_40	Sans Bois Creek	FC	400	184	10	3	30%	
		EC	406	150	2	1	50%	
		ENT	108	4000	1	1	100%	
OK220200040050_00	Sans Bois Creek - Mountain Fork	FC	400	900	9	2	22%	List: >Geo mean
		EC	406	669	2	2	100%	Delist: Low Sample Count
		ENT	108	1200	2	2	100%	
OK220600010070_00	Longtown Creek	FC	400	324	9	4	44%	
		EC	406	152	2	1	50%	Delist: Low Sample Count
		ENT	108	6000	1	1	100%	Delist: Low Sample Count
OK220600010100_20	Mill Creek: Trib. To Eufaula	FC	400	186	9	3	33%	
		EC	406	120	2	1	50%	
		ENT	108	1000	1	1	100%	
OK220600030010_00	Brushy Creek, off U.S. 270	FC	400	107	26	6	23%	Delist: <25%
		EC	406	66	26	5	19%	
		ENT	108	97	26	10	38%	
OK220600030010_10	Brushy Creek	FC	400	187	8	3	38%	
		EC	406	187	1	0	0%	
		ENT	108	34000	1	1	100%	
OK220600030020_00	Blue Creek, SH 63	FC	400	781	13	7	54%	
		EC	406	144	9	1	11%	
		ENT	108	747	9	9	100%	

Waterbody ID	Waterbody Name	Indicator Bacteria	Single Sample Water Quality Criterion (#/100ml)	Geometric Mean Concentration (count/100ml)	Number of Samples	Number of Samples Exceeding Single Sample Criterion	% of Samples Exceeding Single Sample Criterion	Reason for Listing Change
OK220600030020_00	Blue Creek, U.S. 270	FC	400	834	5	3	60%	
		EC	406	163	4	1	25%	Delist: Low Sample Count
		ENT	108	372	4	3	75%	Delist: Low Sample Count
OK220600030050_00	Peaceable Creek	FC	400	365	8	4	50%	
OK220600040030_00	Beaver Creek	FC	400	340	9	3	33%	
		EC	406	1117	2	1	50%	Delist: Low Sample Count
		ENT	108	23000	1	1	100%	

EC = E. coli; ENT = enterococci; FC = fecal coliform

Highlighted bacterial indicators require TMDL

Table 2-3 Waterbodies Requiring TMDLs for Not Supporting Primary Body Contact Recreation Use

WQM Station	Waterbody ID	Waterbody Name	Indicator Bacteria		
			FC	ENT	*E. coli*
OK220100040020-001AT	OK220100040020_00	Fourche Maline Creek		X	
OK220200040010W	OK220200040010_40	Sans Bois Creek	X		
OK220200040050J	OK220200040050_00	Sans Bois Creek-Mountain Fork	X		
OK220600010070G	OK220600010070_00	Longtown Creek	X		
OK220600010100P	OK220600010100_20	Mill Creek	X		
OK220600030010-001AT	OK220600030010_00	Brushy Creek, Off U.S. 270		X	
OK220600030010T	OK220600030010_10	Brushy Creek	X		
OK220600030020-002SR	OK220600030020_00	Blue Creek	X		
OK220600030050M	OK220600030050_00	Peaceable Creek	X		
OK220600040030G	OK220600040030_00	Beaver Creek	X		

ENT = enterococci; FC = fecal coliform

SECTION 3
POLLUTANT SOURCE ASSESSMENT

A 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 is available. Bacteria originate from warm-blooded animals; some plant life and sources may be point or nonpoint in nature.

Point sources are permitted through the NPDES program. NPDES-permitted facilities that discharge treated wastewater are required to monitor for one of the three bacterial indicators (fecal coliform, *E coli*, or Enterococci) in accordance with its permit. Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources may involve land activities that contribute bacteria to surface water as a result of rainfall runoff. For the TMDLs in this report, all sources of pollutant loading not regulated by NPDES are considered nonpoint sources. The following discussion describes what is known regarding point and nonpoint sources of bacteria in the impaired watersheds.

3.1 NPDES-Permitted Facilities

Under 40CFR, §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. Certain NPDES-permitted municipal plants are classified as no-discharge facilities. NPDES-permitted facilities classified as point sources that may contribute bacteria loading include:

- NPDES municipal wastewater treatment plants (WWTP);
- NPDES municipal no-discharge WWTP;
- NPDES municipal separate storm sewer discharge (MS4); and
- NPDES Concentrated Animal Feeding Operation (CAFO).

Continuous point source discharges such as WWTPs, could result in discharge of elevated concentrations of fecal coliform 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 the collection systems associated with each facility may be a source of bacteria loading to surface waters. Stormwater runoff from MS4 areas, which is now regulated under the USEPA NPDES Program, can also contain high fecal coliform bacteria concentrations. There are no permitted MS4s within the study area. CAFOs are recognized by USEPA as significant sources of pollution, and may have the potential to cause serious impacts to water quality if not properly managed.

There are no NPDES permitted facilities of any type in the contributing watershed of Sans Bois Creek-Mountain Fork, Longtown Creek, Brushy Creek off U.S. 270, Brushy Creek, Peaceable Creek, and Beaver Creek.

Four of the watersheds in the Study Area OK220100040020_00 (Fourche Maline Creek), OK220200040010_40 (Sans Bois Creek), OK220600010100_20 (Mill Creek), and OK220600030020_00 (Blue Creek) have a continuous point source discharger.

3.1.1 Continuous Point Source Discharges

The location of the NPDES permitted facilities which discharge wastewater to surface waters addressed in these TMDLs are shown in Figure 3-1 and is listed in Table 3-1. For the purposes of the TMDLs calculated in Chapter 5, only facility types identified in Table 3-1 as Sewerage Systems are assumed to contribute bacteria loads within the watersheds of the impaired waterbodies.

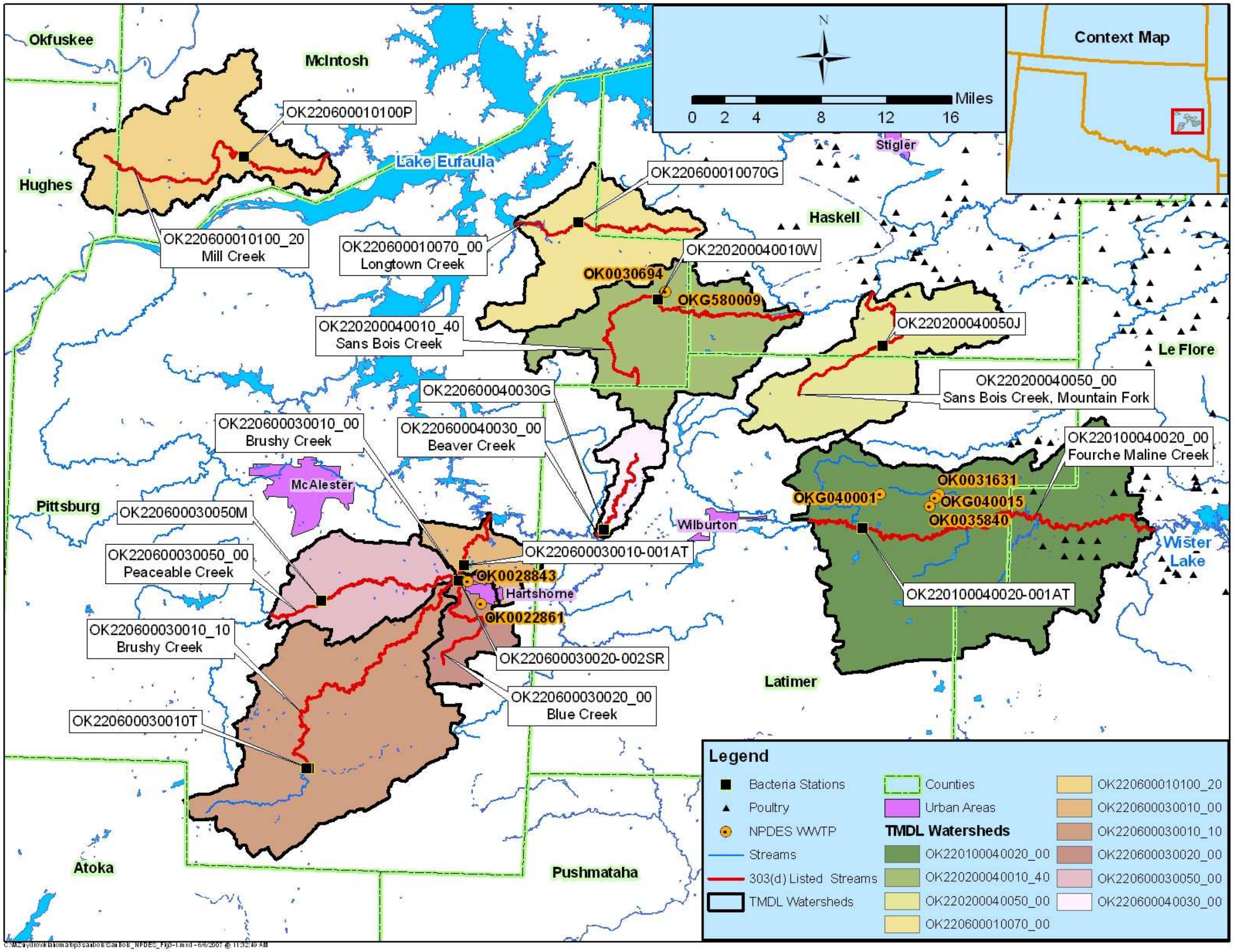
Table 3-1 Point Source Discharges in the Study Area

NPDES Permit No.	Name	Receiving Water	Facility Type	County Name	Design Flow (mgd)	Active/ Inactive	Facility ID
OK0030694	Quinton, City of	Ok220200040010_40 Sans Bois Creek	Sewerage Services	Pittsburg	0.11	Active	S20202
OK0022861	City of Hartshorne	Ok220600030020_00 Blue Creek	Sewerage Systems	Pittsburg	0.27	Active	S20633
OK0028843	City of Haileyville	Ok220600030020_00 Blue Creek	Sewerage Systems	Pittsburg	0.13	Active	S20634
OK0031631	Red Oak Public Works Authority	Ok220100040020_00 Fourche Maline Creek	Sewerage Systems	Latimer	0.09	Active	S20106
OKG040001	Farrell-cooper Mining Co.-Red Oak West	Ok220100040020_00 Fourche Maline Creek	Bituminous Coal & Lig, Surface	Latimer	N/A	Active	
OKG040015	Farrell-cooper-red Oak Mine	Ok220100040020_00 Fourche Maline Creek	Bituminous Coal & Lig, Surface	Latimer	N/A	Active	
OKG580009	Town of Quinton	Ok220200040010_40 Sans Bois Creek	Sewerage Systems	Pittsburg	N/A	Inactive	
OK0035840	Buckhorn Mining Co-Red Oak	Ok220100040020_00 Fourche Maline Creek	Coal Mining	Latimer	N/A	N/A	

N/A = not available

Discharge Monitoring Reports (DMR) were used to determine the number of fecal coliform analyses performed from 1998 through 2006, the maximum concentration during this period, the number of violations occurring when the monthly geometric mean concentration exceeded 200 colony-forming units (cfu)/100 mL, and the number of violations when a daily maximum concentration exceeded 400 cfu/100 mL. DMR data for fecal coliform were only available for the City of Hartshorne and the City of Haileyville (see Appendix B). The City of Hartshorne WWTP discharge violated the monthly average permit limits for fecal coliform 17 percent of the time over the 101 month period from May 1998 to September 2005 with monthly average geometric mean concentrations ranging from 239 cfu/100mL to 2,800 cfu/100 mL. The City of Haileyville WWTP discharge violated the monthly average permit limits for fecal coliform 13 percent of the time over the 101 month period from September 1998 to July 2006 with monthly average geometric mean concentrations ranging from 350 cfu/100 mL to 4,700 cfu/100 mL.

Figure 3-1 Locations of NPDES-Permitted Facilities and Poultry Operations in the Study Area



3.1.2 NPDES No-Discharge Facilities and SSOs

There is one NPDES-permitted no-discharge facility in the Brushy Creek watershed (OK220600030010_00). For the purposes of these TMDLs, it is assumed that no-discharge facilities do not contribute bacteria loading to the Brushy Creek. However, it is possible the wastewater collection systems associated with this WWTP could be a source of bacteria loading, or that discharges may occur during large rainfall events that exceed the system's storage capacity.

Table 3-2 NPDES No-Discharge Facilities in the Study Area

Facility	Facility ID	County	Facility Type	Type	Watershed
Jones Academy	S20660	Pittsburg	Lagoon	Municipal	OK220600030010_00 Brushy Creek off U.S. 270

Sanitary sewer overflows (SSO) from wastewater collection systems, although infrequent, can be a major source of fecal coliform 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 NPDES permittee. The reporting of SSOs over the last 6 years has been strongly encouraged by USEPA, primarily through enforcement and fines. While not all sewer overflows are reported, ODEQ has some data on SSOs available. There were 157 SSO occurrences, ranging from 100 to 53,000 gallons, reported in the Sans Bois Creek Study Area between October 1991 and January 2007. A summary of the reported SSOs in the Sans Bois Creek Study Area are provided in Table 3-3. Additional data on each individual SSO event are provided in Appendix B.

Table 3-3 Sanitary Sewer Overflow Summary

Facility Name	NPDES Permit No.	Receiving Water	Facility ID	Number of Occurrences	Date Range		Amount (Gallons)	
					From	To	Min	Max
Haileyville	OK0028843	OK220600030020_00 Blue Creek	S20634	51	01/26/1998	03/04/2004	150	53,000
Hartshorne	OK0022861	OK220600030020_00 Blue Creek	S20633	35	08/06/1992	01/12/2007	0	12,000
Quinton	OK0030694	Ok220200040010_40 Sans Bois Creek	S20202	4	12/13/1992	11/19/2002	0	2,200
Red Oaks	OK0031631	OK220100040020_00 Fourche Maline Creek	S20106	67	10/25/1991	03/09/2006	0	100

SSOs are a common result of the aging wastewater infrastructure around the state. DEQ has been ahead of other states and, in some cases, EPA itself in its handling of SSOs. Due to the widespread nature of the SSO problem, DEQ has focused its limited resources to first target SSOs that result in definitive environmental harm, such as fish kills, or lead to citizen complaints. All SSOs falling in these two categories are addressed through DEQ's formal enforcement process. A Notice of Violation (NOV) is first issued to the owner of the collection system and a Consent Order (CO) is negotiated between the owner and DEQ to establish a schedule for necessary collection system upgrades to eliminate future SSOs.

Another target area for DEQ is chronic SSOs from OPDES major facilities, those with a total design flow in excess of 1 MGD. DEQ periodically reviews the bypass reports submitted by these major facilities and identifies problem areas and chronic SSOs. When these problems are attributable to wet weather, DEQ endeavors to enter into a CO with the owner of the collection system to establish a schedule for necessary repairs. When the problems seem to be dry weather-related, DEQ will encourage the owner of the collection system to implement the proposed Capacity, Management, Operation, and Maintenance (CMOM) guidelines aimed at minimizing or eliminating dry weather SSOs. This is often accomplished through entering into a Consent Order to establish a schedule for implementation and annual auditing of the CMOM program.

All SSOs are considered unpermitted discharges under State statute and DEQ regulations. The smaller towns have a smaller reserve, are more likely to use utility revenue for general purposes, and/or tend to budget less for ongoing and/or preventive maintenance. If and when DEQ becomes aware of chronic SSOs (more than one from a single location in a year) or receives a complaint about an SSO in a smaller community, DEQ will pursue enforcement action. Enforcement almost always begins with the issuance of an NOV and, if the problem is not corrected by a long-term solution, DEQ will enter into a CO with the facility for a long-term solution. Long-term solutions usually begin with sanitary sewer evaluation surveys (SSESs). Based on the result of the SSES, the facilities can prioritize and take corrective action.

3.1.3 NPDES Municipal Separate Storm Sewer Discharge

Phase I MS4

In 1990 the USEPA developed rules establishing Phase I of the NPDES Stormwater Program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4) and then discharged into local water bodies (USEPA 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 permits in the Study Area.

Phase II MS4

Phase II of the rule extends coverage of the NPDES Stormwater Program to certain small MS4s. 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," protect water quality, and satisfy appropriate water quality requirements of the CWA. Small MS4 stormwater programs must address the following minimum control measures:

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

The small MS4 General Permit for communities in Oklahoma became effective on February 8, 2005. There are no permitted MS4s within the study area. ODEQ provides information on the current status of its MS4 program on its website, found at:

http://www.deq.state.ok.us/WQDnew/stormwater/ms4/

3.1.4 Concentrated Animal Feeding Operations

There are no NPDES-permitted CAFO facilities within the Study Area.

3.2 Nonpoint Sources

Nonpoint sources include those sources that cannot be identified as entering the waterbody at a specific location. Bacteria originate from rural, suburban, and urban areas. The following section describes possible major nonpoint sources contributing fecal coliform loading within the Study Area.

These sources include wildlife, various agricultural activities and domesticated animals, land application fields, urban runoff, failing onsite wastewater disposal (OSWD) systems, and domestic pets. As previously stated in Subsection 3.1, there are no NPDES permitted facilities of any type in the contributing watershed of Sans Bois Creek-Mountain Fork, Longtown Creek, Brushy Creek, Peaceable Creek, and Beaver Creek; therefore, nonsupport of PBCR use is caused by nonpoint sources of bacteria only.

Bacteria associated with urban runoff can emanate from humans, wildlife, comercially raised farm animals, 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 instantaneous standards. A study under USEPA'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 (USEPA 1983). Water quality data collected from streams draining many of the nonpermitted communities show existing loads of fecal coliform bacteria at levels greater than the State's instantaneous standards. Best management practices (BMP) such as buffer strips, repair of leaking sewage collection systems, elimination of illicit discharges and proper disposal of domestic animal waste, can reduce bacteria loading to waterbodies.

3.2.1 Wildlife

Fecal coliform bacteria are produced by all warm-blooded animals, including wildlife such as mammals and birds. In developing bacteria TMDLs it is important to identify the potential for bacteria contributions from wildlife by watershed. Wildlife is naturally attracted to riparian corridors of streams and rivers. With direct access to the stream channel, wildlife can be a concentrated source of bacteria 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 and spatial distribution of wildlife and avian species by watershed. Consequently it is difficult to assess the magnitude of bacteria 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 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 1999 to 2003 was combined with an estimated annual harvest rate of 20 percent 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. Table 3-4 provides the estimated number of deer for each watershed.

Table 3-4 Estimated Deer Populations

Waterbody ID	Waterbody Name	Deer	Acre
OK220100040020_00	Fourche Maline Creek	809	142,675
OK220200040010_40	Sans Bois Creek	694	57,005
OK220200040050_00	Sans Bois Creek-Mountain Fork	575	48,743
OK220600010070_00	Longtown Creek	539	42,542
OK220600010100_20	Mill Creek	482	50,365
OK220600030010_00	Brushy Creek off U.S. 270	155	13,042
OK220600030010_10	Brushy Creek	1,116	93,792
OK220600030020_00	Blue Creek	176	14,743
OK220600030050_00	Peaceable Creek	378	31,711
OK220600040030_00	Beaver Creek	92	10,236

According to a study conducted by ASAE (the American Society of Agricultural Engineers), deer release approximately $5x10^8$ 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 for deer provided in Table 3-5 in cfu/day provides a relative magnitude of loading in each watershed.

Table 3-5 Estimated Fecal Coliform Production for Deer

Waterbody ID	Waterbody Name	Watershed Area (acres)	Wild Deer Population	Estimated Wild Deer per acre	Fecal Production (x 10^8 cfu/day) of Deer Population
OK220100040020_00	Fourche Maline Creek	142,675	809	0.006	4,046
OK220200040010_40	Sans Bois Creek	57,005	694	0.012	3,470
OK220200040050_00	Sans Bois Creek-Mountain Fork	48,743	575	0.012	2,876
OK220600010070_00	Longtown Creek	42,542	539	0.013	2,694
OK220600010100_20	Mill Creek	50,365	482	0.010	2,412
OK220600030010_00	Brushy Creek off U.S. 270	13,042	155	0.012	773
OK220600030010_10	Brushy Creek	93,792	1116	0.012	5,579
OK220600030020_00	Blue Creek	14,743	176	0.012	878
OK220600030050_00	Peaceable Creek	31,711	378	0.012	1,888
OK220600040030_00	Beaver Creek	10,236	92	0.009	458

3.2.2 Non-Permitted Agricultural Activities and Domesticated Animals

There are a number of non-permitted agricultural activities that can also be sources of fecal bacteria loading. Agricultural activities of greatest concern are typically those associated with livestock operations (Drapcho and Hubbs 2002). The following are examples of commercially raised farm animal activities that can contribute to bacteria sources:

- Processed commercially raised farm animal manure is often applied to fields as fertilizer, and can contribute to fecal bacteria 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 bacteria loading directly into streams.

Table 3-6 provides estimated numbers of commercially raised farm animal by watershed based on the 2002 U.S. Department of Agriculture (USDA) county agricultural census data (USDA 2002). The estimated animal populations in Table 3-6 were derived by using 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. Poultry birds are the most abundant species in the Study Area; however, beef cattle generate the largest amount of fecal coliform and often have direct access to the impaired waterbodies.

Detailed information is not available to describe or quantify the relationship between instream concentrations of bacteria and land application of manure. The estimated acreage by watershed where manure was applied in 2002 is shown in Table 3-6. These estimates are also based on the county level reports from the 2002 USDA county agricultural census, and thus represent approximations of the land application area in each watershed. Because of the lack of specific data, for the purpose of these TMDLs, land application of animal manure is not quantified in Table 3-7 but is considered a potential source of bacteria loading to the waterbodies in the Sans Bois Creek Study Area. Most poultry feeding operations are regulated by ODAFF, and are required to land apply chicken waste in accordance with their Animal Waste Management Plans or Comprehensive Nutrient Management Plans. While these plans are not designed to control bacteria loading, best management practices and conservation measures, if properly implemented, could reduce the contribution of bacteria from this group of animals to the watershed.

According to a study conducted by the ASAE, the daily fecal coliform production rates by species were estimated as follows (ASAE 1999):

- Beef cattle release approximately 1.04E+11 fecal coliform counts per animal per day;
- Dairy cattle release approximately 1.01E+11 per animal per day
- Swine release approximately 1.08E+10 per animal per day
- Chickens release approximately 1.36E+08 per animal per day
- Sheep release approximately 1.20E+10 per animal per day
- Horses release approximately 4.20E+08 per animal per day;
- Turkey release approximately 9.30E+07 per animal per day
- Ducks release approximately 2.43E+09 per animal per day
- Geese release approximately 4.90E+10 per animal per day

Using the estimated animal populations and the fecal coliform production rates from ASAE, an estimate of fecal coliform production from each group of commercially raised farm animals was calculated in each watershed of the Study Area in Table 3-7. 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. Cattle appear to represent the largest source of fecal bacteria.

For informational purposes, data on poultry operations provided by Oklahoma Department of Agriculture, Food and Forestry (ODAFF) are provided in Table 3-8. This poultry data was last updated on April 17, 2004. Table 3-8 lists an estimated number of birds within select watersheds for which data are available. These numbers are considered more representative since they are based on the number of contract poultry operations within the selected watershed because they are derived from an ODAFF geographic information system inventory. The general location of poultry operations are shown in Figure 3-1. However, for consistency, estimated fecal coliform production for the general category of poultry is based on USDA county agriculture census numbers as summarized in Table 3-7.

Table 3-6 Commercially Raised Farm Animals and Manure Application Area Estimates by Watershed

Waterbody ID	Waterbody Name	Cattle & Calves-all	Dairy Cows	Horses & Ponies	Goats	Sheep & Lambs	Hogs & Pigs	Ducks & Geese	Chicken & Turkeys	Acres of Manure Application
OK220100040020_00	Fourche Maline Creek	10,531	13	434	250	80	2,114	37	601,110	1,797
OK220200040010_40	Sans Bois Creek	6,029	24	200	78	40	735	25	119,256	553
OK220200040050_00	Sans Bois Creek-Mountain Fork	5,141	15	170	66	27	1,221	20	178,941	657
OK220600010070_00	Longtown Creek	4,669	21	152	58	33	386	20	79,666	405
OK220600010100_20	Mill Creek	5,597	46	226	41	10	1,794	6	51	267
OK220600030010_00	Brushy Creek off U.S. 270	1,288	6	45	18	11	14	5	292	53
OK220600030010_10	Brushy Creek	9,302	44	325	129	77	76	39	2,136	388
OK220600030020_00	Blue Creek	1,464	7	51	20	12	12	6	336	61
OK220600030050_00	Peaceable Creek	3,148	15	110	44	26	26	13	723	131
OK220600040030_00	Beaver Creek	742	1	32	15	4	159	2	3	17

Table 3-7 Fecal Coliform Production Estimates for Commercially Raised Farm Animals ($x10^9$ number/day)

Waterbody ID	Waterbody Name	Cattle & Calves-all	Dairy Cows	Horses & Ponies	Goats	Sheep & Lambs	Hogs & Pigs	Ducks & Geese	Chickens & Turkeys	Total
OK220100040020_00	Fourche Maline Creek	1,095,190	1,327	182	N/A	955	22,827	577	81,750	1,202,810
OK220200040010_40	Sans Bois Creek	627,018	2,399	84	N/A	484	7,934	340	16,219	654,479
OK220200040050_00	Sans Bois Creek-Mountain Fork	534,672	1,476	71	N/A	319	13,184	260	24,336	574,318
OK220600010070_00	Longtown Creek	485,559	2,114	64	N/A	401	4,170	273	10,834	503,415
OK220600010100_20	Mill Creek	582,094	4,692	95	N/A	123	19,374	202	7	606,586
OK220600030010_00	Brushy Creek off U.S. 270	133,977	602	19	N/A	127	151	80	40	134,996
OK220600030010_10	Brushy Creek	967,452	4,394	137	N/A	922	817	579	290	974,590
OK220600030020_00	Blue Creek	152,276	692	21	N/A	145	129	91	46	153,399
OK220600030050_00	Peaceable Creek	327,347	1,487	46	N/A	312	276	196	98	329,762
OK220600040030_00	Beaver Creek	77,179	58	14	N/A	54	1,717	38	0	79,059

Table 3-8 Estimated Poultry Numbers for Contract Growers Inventoried by ODAFF

Waterbody ID	Waterbody Name	County	Type	Estimated Birds
OK220100040020_00	Fourche Maline Creek	Latimer	Broilers	45,000
OK220100040020_00	Fourche Maline Creek	Le Flore	Broilers	430,000
OK220200040010_40	Sans Bois Creek	Haskell	Layers	18,000
OK220200040010_40	Sans Bois Creek	Pittsburg	Broilers	70,000
OK220200040050_00	Sans Bois Creek-Mountain Fork	Haskell	Broilers	116,000

3.2.3 Failing Onsite Wastewater Disposal Systems and Illicit Discharges

ODEQ is responsible for implementing the regulations of Title 252, Chapter 641 of the Oklahoma Administrative Code, which define design standards for individual and small public onsite sewage disposal systems (ODEQ 2004a). OSWD systems and illicit discharges can be a source of bacteria loading to streams and rivers. Bacteria 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 discharges to creeks through springs and seeps.

To estimate the potential magnitude of OSWDs fecal bacteria 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 (U.S. Census Bureau 2000). 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 tracking 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 1995 American Housing Survey conducted by the U.S. Census Bureau estimates that, nationwide, 10 percent of occupied homes with OSWD systems experience malfunctions during the year (U.S. Census Bureau 1995). A study conducted by Reed, Stowe & Yanke, LLC (2001) reported that approximately 12 percent of the OSWD systems in northeast Texas (adjacent to the study area) 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 is 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 3-9 summarizes estimates of sewered and unsewered households for each watershed in the study area.

Table 3-9 Estimates of Sewered and Unsewered Households

Waterbody ID	Waterbody Name	Public Sewer	Septic Tank	Other Means	Housing Units	% Sewered
OK220100040020_00	Fourche Maline Creek	165	362	22	549	30%
OK220200040010_40	Sans Bois Creek	83	149	6	239	35%
OK220200040050_00	Sans Bois Creek-Mountain Fork	54	234	29	318	17%
OK220600010070_00	Longtown Creek	36	113	5	155	24%
OK220600010100_20	Mill Creek	5	60	5	70	7%
OK220600030010_00	Brushy Creek off U.S. 270	30	18	1	49	60%
OK220600030010_10	Brushy Creek	204	154	8	366	56%
OK220600030020_00	Blue Creek	35	21	1	57	61%
OK220600030050_00	Peaceable Creek	47	32	1	81	58%
OK220600040030_00	Beaver Creek	41	30	1	72	57%

For the purpose of estimating fecal coliform loading in watersheds, an OSWD failure rate of 8 percent was used. Using this 8 percent failure rate, calculations were made to characterize fecal coliform loads in each watershed.

Fecal coliform loads were estimated using the following equation (USEPA 2001):

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

The average of number of people per household was calculated to be 2.44 for counties in the Study Area (U.S. Census Bureau 2000). Approximately 70 gallons of wastewater was 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 published reports (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 below in Table 3-10.

Table 3-10 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)
OK220100040020_00	Fourche Maline Creek	142,675	362	43	281
OK220200040010_40	Sans Bois Creek	57,005	149	18	116
OK220200040050_00	Sans Bois Creek-Mountain Fork	48,743	234	28	181
OK220600010070_00	Longtown Creek	42,542	113	14	88
OK220600010100_20	Mill Creek	50,365	60	7	46
OK220600030010_00	Brushy Creek off U.S. 270	13,042	18	2	14
OK220600030010_10	Brushy Creek	93,792	154	18	119
OK220600030020_00	Blue Creek	14,743	21	3	16
OK220600030050_00	Peaceable Creek	31,711	32	4	25
OK220600040030_00	Beaver Creek	10,236	30	4	23

3.2.4 Domestic Pets

Fecal matter from dogs and cats, which is transported to streams by runoff from urban and suburban areas can be a potential source of bacteria loading. On average nationally, there are 0.58 dogs per household and 0.66 cats per household (American Veterinary Medical Association 2004). Using the U.S. census data at the block level (U.S. Census Bureau 2000), dog and cat populations can be estimated for each watershed. Table 3-11 summarizes the estimated number of dogs and cats for the watersheds of the Study Area.

Table 3-11 Estimated Numbers of Pets

Waterbody ID	Waterbody Name	Dogs	Cats
OK220100040020_00	Fourche Maline Creek	308	363
OK220200040010_40	Sans Bois Creek	134	158
OK220200040050_00	Sans Bois Creek-Mountain Fork	178	210
OK220600010070_00	Longtown Creek	87	102
OK220600010100_20	Mill Creek	39	46
OK220600030010_00	Brushy Creek off U.S. 270	27	32
OK220600030010_10	Brushy Creek	205	242
OK220600030020_00	Blue Creek	32	38
OK220600030050_00	Peaceable Creek	45	53
OK220600040030_00	Beaver Creek	40	48

Table 3-12 provides an estimate of the fecal coliform load from pets. These estimates are based on estimated fecal coliform production rates of $5.4\text{x}10^8$ per day for cats and $3.3\text{x}10^9$ per day for dogs (Schueler 2000).

Table 3-12 Estimated Fecal Coliform Daily Production by Pets (x 10^9)

Waterbody ID	Waterbody Name	Dogs	Cats	Total
OK220100040020_00	Fourche Maline Creek	1,015	196	1,211
OK220200040010_40	Sans Bois Creek	442	85	527
OK220200040050_00	Sans Bois Creek-Mountain Fork	587	113	700
OK220600010070_00	Longtown Creek	286	55	341
OK220600010100_20	Mill Creek	129	25	154
OK220600030010_00	Brushy Creek off U.S. 270	91	17	108
OK220600030010_10	Brushy Creek	677	131	808
OK220600030020_00	Blue Creek	106	20	126
OK220600030050_00	Peaceable Creek	149	29	178
OK220600040030_00	Beaver Creek	133	26	159

3.3 Summary of Bacteria Sources

NPDES-permitted facilities operate in a few of the watersheds in the Study Area but most of the point sources are relatively minor and for the most part tend to meet instream water quality criteria in their effluent. Thus, nonpoint sources are considered to be the major source of bacteria loading in each watershed. Table 3-13 summarizes the suspected sources of bacteria loading in each impaired watershed.

Table 3-13 Estimated Major Source of Bacteria Loading by Watershed

Waterbody ID	Waterbody Name	Point Sources	Nonpoint Sources	Major Source
OK220100040020_00	Fourche Maline Creek	Yes	Yes	Nonpoint
OK220200040010_40	Sans Bois Creek	Yes	Yes	Nonpoint
OK220200040050_00	Sans Bois Creek-Mountain Fork	No	Yes	Nonpoint
OK220600010070_00	Longtown Creek	No	Yes	Nonpoint
OK220600010100_20	Mill Creek	Yes	Yes	Nonpoint
OK220600030010_10	Brushy Creek	No	Yes	Nonpoint
OK220600030010_00	Brushy Creek off U.S. 270	No	Yes	Nonpoint
OK220600030020_00	Blue Creek	Yes	Yes	Nonpoint
OK220600030050_00	Peaceable Creek	No	Yes	Nonpoint
OK220600040030_00	Beaver Creek	No	Yes	Nonpoint

Table 3-14 below provides a summary of the estimated fecal coliform loads in percentage for the four major nonpoint source categories (commercially raised farm animals, pets, deer and septic tanks) that are contributing to the elevated bacteria concentrations in each watershed. Commercially raised farm animals are estimated to be the primary 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 bacteria source tracking studies demonstrate that wild birds and mammals represent a major source of the fecal bacteria found in streams.

The magnitude of loading to a stream may not reflect the magnitude of loading to land surfaces. While no studies quantify these effects, bacteria may die off or survive at different rates depending on the manure characteristics and a number of other environmental conditions. Manure handling practices, use of BMPs, and relative location to streams can also affect stream loading. Also, the structural properties of some manures, such as cow patties, may limit their washoff into streams by runoff. Because litter is applied in a pulverized form, it could be a larger source during storm runoff events. The Shoal Creek report showed that poultry litter was about 71% of the high flow load and cow pats contributed only about 28% of it (Missouri Department of Natural Resources, 2003). The Shoal Creek report also showed that poultry litter was insignificant under low flow conditions up to 50% frequency. In contrast, malfunctioning septic tank effluent may be present in pools on the surface, or in shallow groundwater, which may enhance its conveyance to streams.

Table 3-14 Summary of Daily Fecal Coliform Load Estimates from Nonpoint Sources to Land Surfaces

Waterbody ID	Waterbody Name	Commercially Raised Farm Animals	Pets	Deer	Septic Tanks
OK220100040020_00	Fourche Maline Creek	99.84%	0.10%	0.03%	0.02%
OK220200040010_40	Sans Bois Creek	99.85%	0.08%	0.05%	0.02%
OK220200040050_00	Sans Bois Creek-Mountain Fork	99.80%	0.12%	0.05%	0.03%
OK220600010070_00	Longtown Creek	99.86%	0.07%	0.05%	0.02%
OK220600010100_20	Mill Creek	99.93%	0.03%	0.04%	0.01%
OK220600030010_00	Brushy Creek off U.S. 270	99.85%	0.08%	0.06%	0.01%
OK220600030010_10	Brushy Creek	99.85%	0.08%	0.06%	0.01%
OK220600030020_00	Blue Creek	99.85%	0.08%	0.06%	0.01%
OK220600030050_00	Peaceable Creek	99.88%	0.05%	0.06%	0.01%
OK220600040030_00	Beaver Creek	99.71%	0.20%	0.06%	0.03%

SECTION 4
TECHNICAL APPROACH AND METHODS

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 = Σ WLA + Σ 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. Thus, the allowable pollutant load that can be allocated to point and nonpoint sources can then be defined as the TMDL minus the MOS.

40 CFR, §130.2(1), states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For fecal coliform, *E. coli*, or Enterococci bacteria, TMDLs are expressed as colony-forming units per day, where possible, or as a percent reduction goal (PRG), and represent the maximum one-day load the stream can assimilate while still attaining the WQS.

4.1 Using Load Duration Curves to Develop 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 are effective at identifying whether impairments are associated with point or nonpoint sources. The technical approach for using LDCs for TMDL development includes the four following steps that are described in Subsections 4.2 through 4.4 below:

- Preparing flow duration curves for gaged and ungaged WQM stations;
- Estimating existing bacteria loading in the receiving water using ambient water quality data;
- Using LDCs to identify the critical condition that will dictate loading reductions necessary to attain WQS; and
- Interpreting LDCs to derive TMDL elements – WLA, LA, MOS, and PRG.

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 WWTP 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 have been noted in some watersheds that contain no point sources. Research has show that bacteria loading in streams during low flow conditions may be due to direct deposit of cattle manure into streams and faulty septic tank/lateral field systems.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by the 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 Development of Flow Duration Curves

Flow duration curves 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. The most basic method to estimate flows at an ungaged site involves 1) identifying an upstream or downstream flow gage; 2) calculating the contributing drainage areas of the ungaged sites and the flow gage; and 3) calculating daily flows at the ungaged site by using the flow at the gaged site multiplied by the drainage area ratio. The more complex approach used here in this TMDL report, also considers watershed differences in rainfall, land use, and the hydrologic properties of soil that govern runoff and retention. More than one upstream flow gage may also be considered. A more detailed explanation of the methods for estimating flow at ungaged WQM stations is provided in Appendix C.

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, which is numbered from 0 to 100 percent, and may or may not be logarithmic. The lowest measured flow occurs at an exceedance frequency of 100 percent, indicating that flow has equaled or exceeded this value 100 percent of the time, while the highest measured flow is found at an exceedance frequency of 0 percent. The median flow occurs at a flow exceedance frequency of 50 percent. The flow exceedance percentiles for each WQM station addressed in this report are provided in Appendix C.

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 1 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 (USGS 2007a).

A typical semi-log flow duration curve exhibits a sigmoidal shape, bending upward near a flow exceedance frequency value of 0 percent and downward at a frequency near 100 percent, 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 percent. 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 quantitation.

Figures 4-1 through 4-10 are flow duration curves for each impaired waterbody during the primary contact recreation season. The flow duration curve for Fourche Maline Creek segment OK220100040020_00 (Figure 4-1), was based on measured flows at USGS gage station 07247500 (Fourche Maline near Red Oak, OK). This gage is co-located at WQM station OK220100040020-001AT. The flow period used for this station was 1939 through 2006.

No flow gages exist on Sans Bois Creek segment OK220200040010_40 or Sans Bois Creek-Mountain Fork, segment OK220200040050_00. Flows for these waterbodies were estimated using the watershed area ratio method based on flows at a downstream USGS gage station 07246000 (Sans Bois Creek near Keota, OK). The flow period of record for this gage was from 1938 through 1942. A point source outfall contributes a significant fraction of total flow to segment OK220200040010_40 under low flow. Thus, the permitted wastewater flow rates were added to the projected natural flows.

No flow gages exist on Longtown Creek segment OK220600010070_00, Mill Creek segment OK220600010100_20, or Beaver Creek segment OK220600040030_00. Flows for these waterbodies were estimated using the watershed area ratio method based on measured flows at USGS gage station 07247500 (Fourche Maline near Red Oak, OK), for the period of 1939 through 2006.

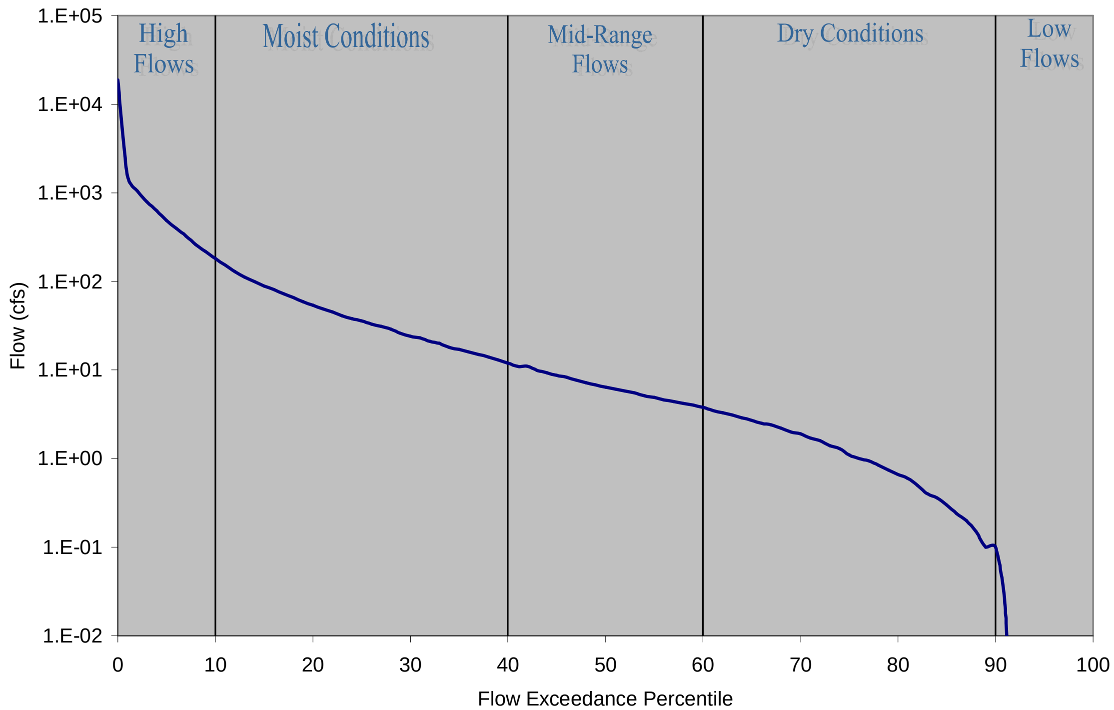
The flow duration curve for Brushy Creek segment OK220600030010_10, was based on measured flows at USGS gage station 07231975 (Brushy Creek near Haileyville, OK). The flow period of record for this gage was from 1978 through 1982.

The flow duration curve for Peaceable Creek, segment OK220600030050_00, was based on measured flows at USGS gage station 07231990 (Peaceable Creek near Haileyville, OK). The flow period of record for this gage was from 1978 through 1982.

No flow gage exists on Brushy Creek segment OK220600030010_00. However, flow gages did exist on its two major tributaries just upstream of this segment. Thus, flows in this segment were estimated to be the sum of measured flows at USGS gage station 07231975 (Brushy Creek near Haileyville, OK) and USGS gage station 07231990 (Peaceable Creek near Haileyville, OK). The flow period of record for both of these gages was from 1978 through 1982.

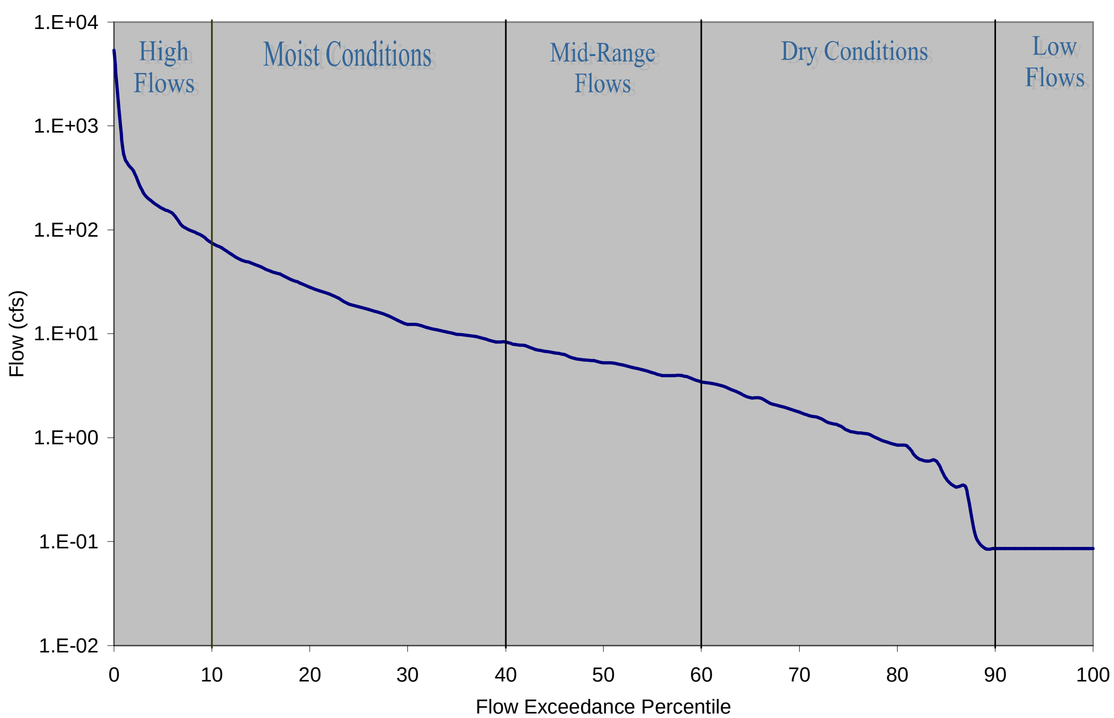
No flow gage exists on Blue Creek segment OK220600030020_00. Natural runoff flows for this waterbody were estimated using the watershed area ratio method based on measured flows on an adjacent stream at USGS gage station 07231975 (Brushy Creek near Haileyville, OK). The flow period of record for this gage was from 1978 through 1982. However, two point source outfalls contribute a significant fraction of total flow to this waterbody under low flow and dry weather conditions. Thus, the permitted wastewater flow rates were added to this natural runoff flow.

Figure 4-1 Flow Duration Curve for Fourche Maline Creek (OK220100040020_00)



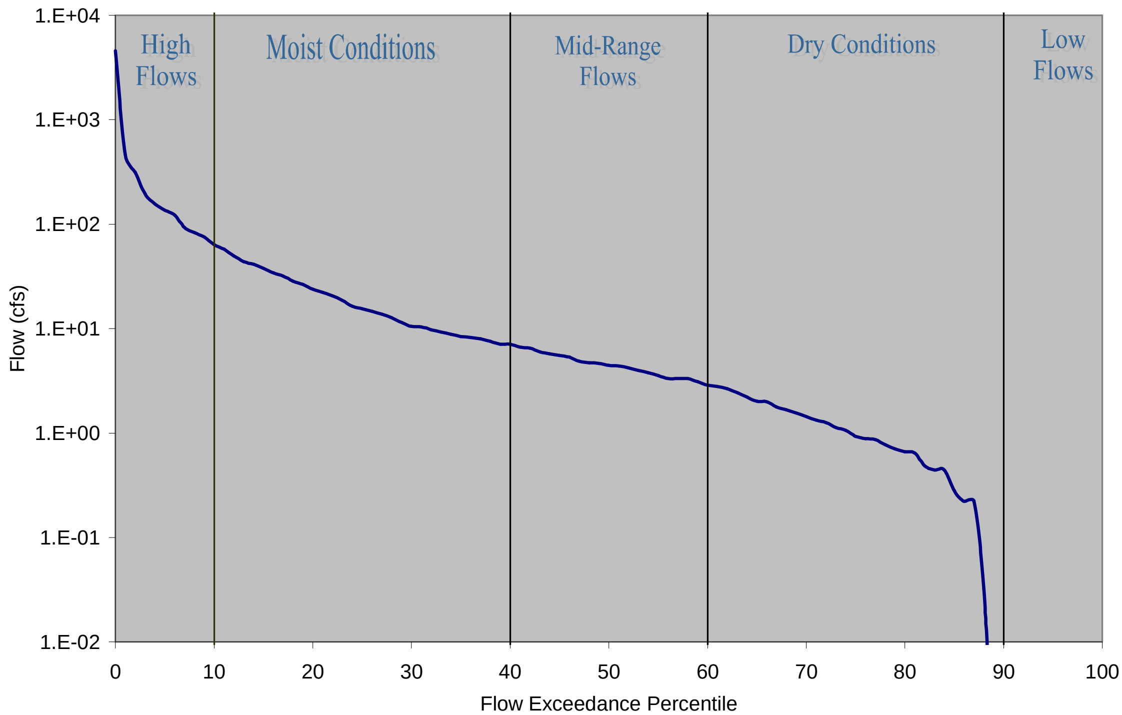
Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-2 Flow Duration Curve for Sans Bois Creek (OK220200040010_40)



Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-3 Flow Duration Curve for Sans Bois Creek-Mountain Fork (OK220200040050_00)



Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-4 Flow Duration Curve for Longtown Creek (OK220600010070_00)

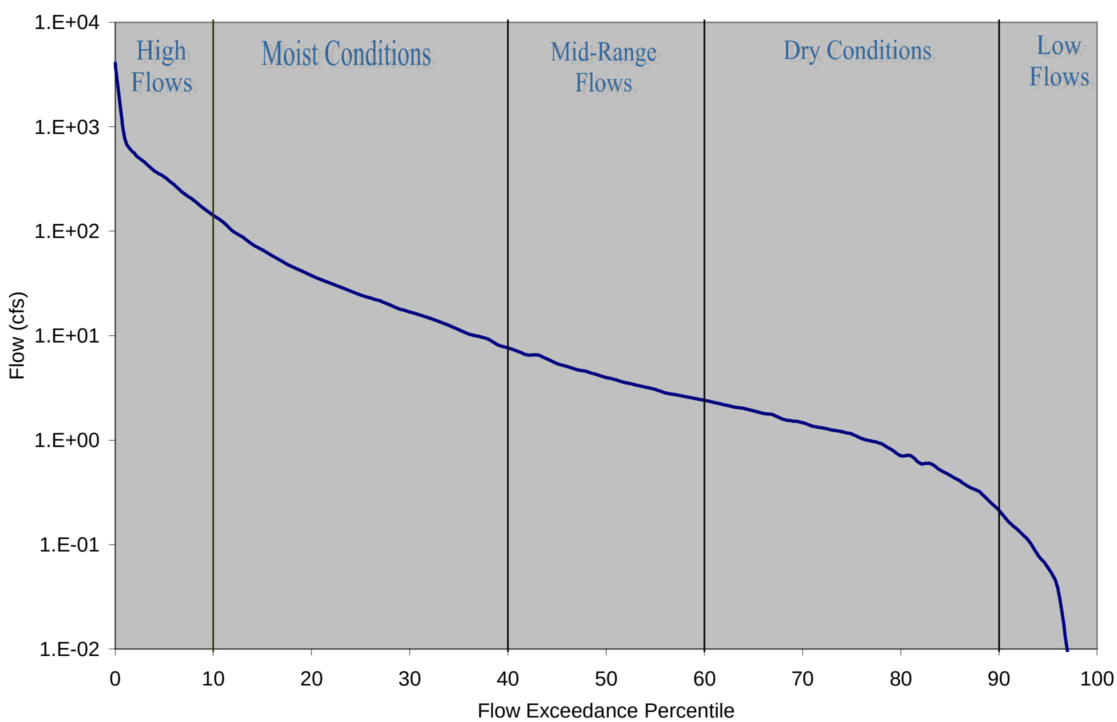


Figure 4-5 Flow Duration Curve for Mill Creek (OK220600010100_20)

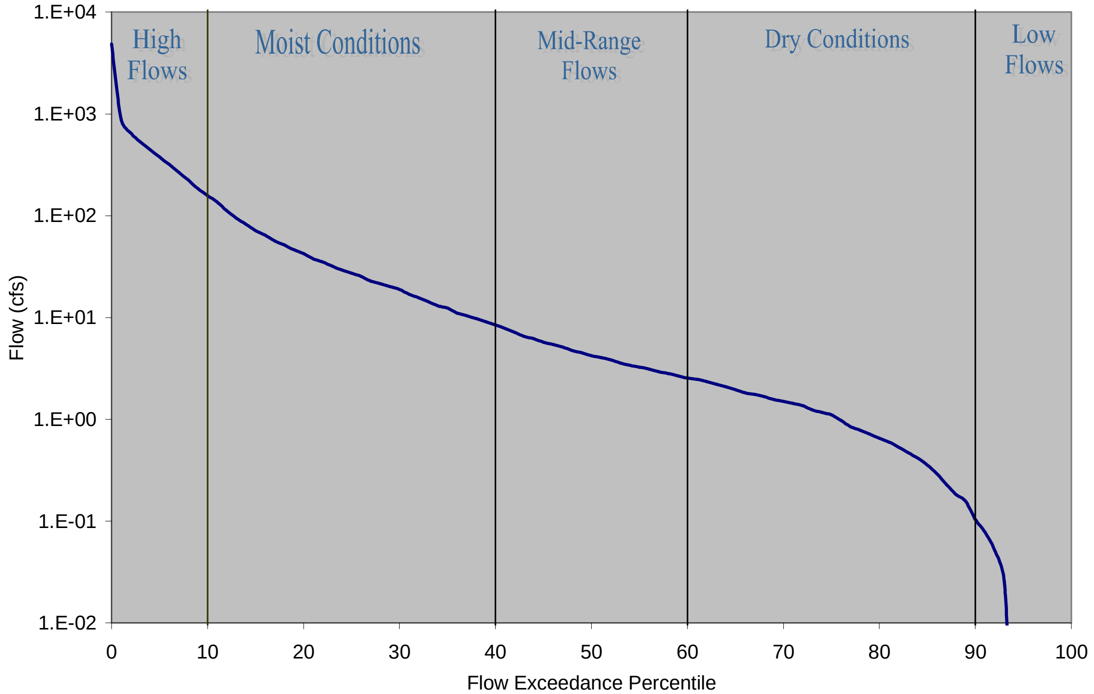


Figure 4-6 Flow Duration Curve for Brushy Creek off U.S. 270 (OK220600030010_00)

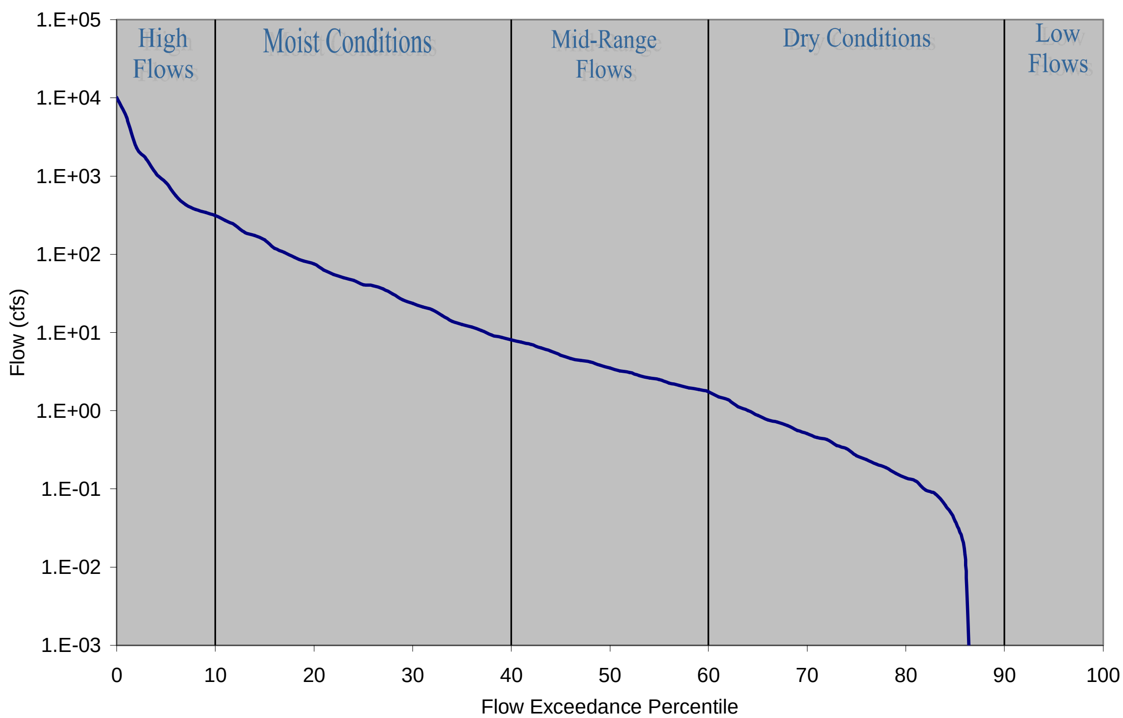


Figure 4-7 Flow Duration Curve for Brushy Creek (OK220600030010_10)

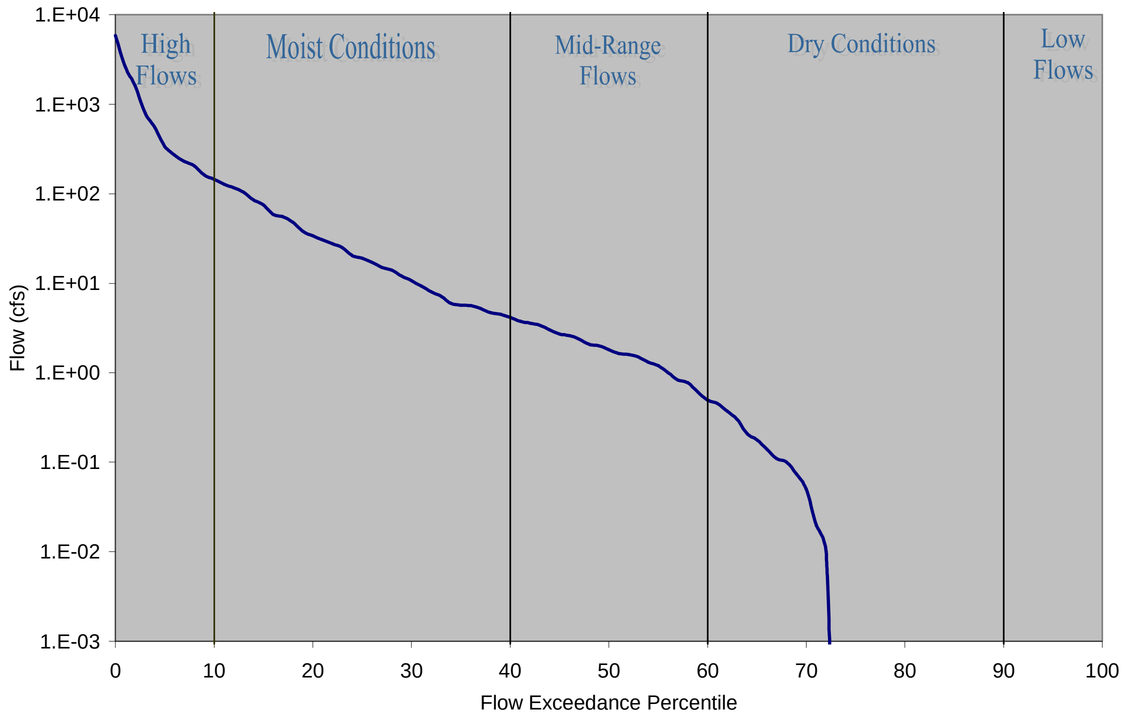


Figure 4-8 Flow Duration Curve for Blue Creek (OK220600030020_00)

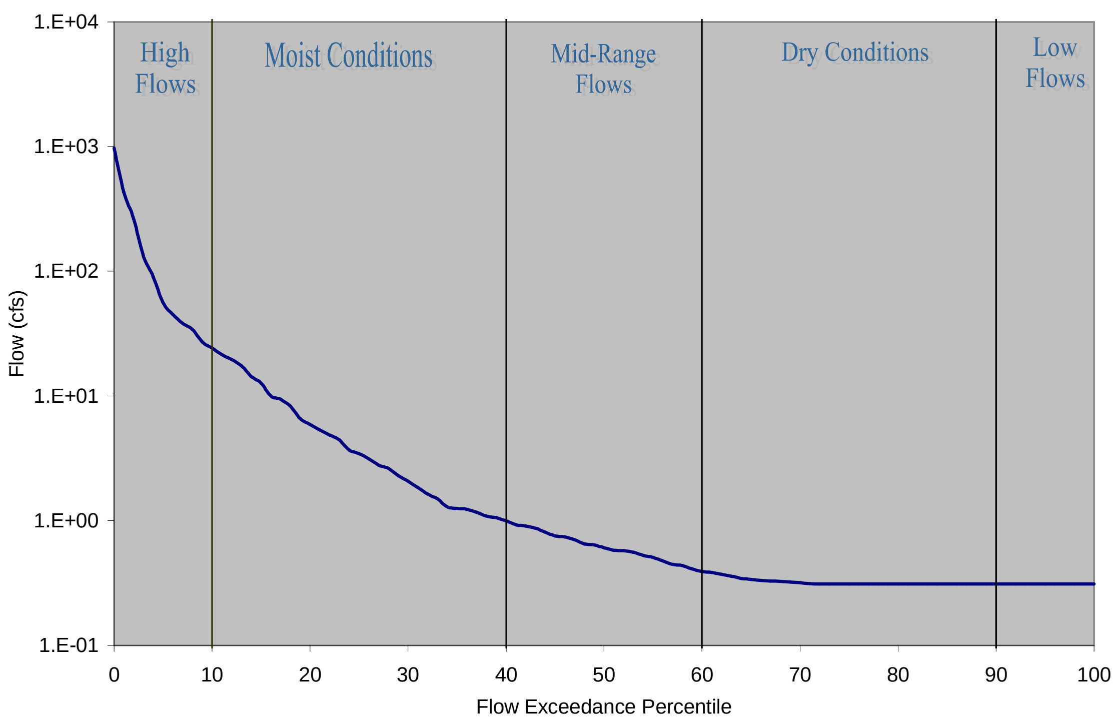


Figure 4-9 Flow Duration Curve for Peaceable Creek (OK220600030050_00)

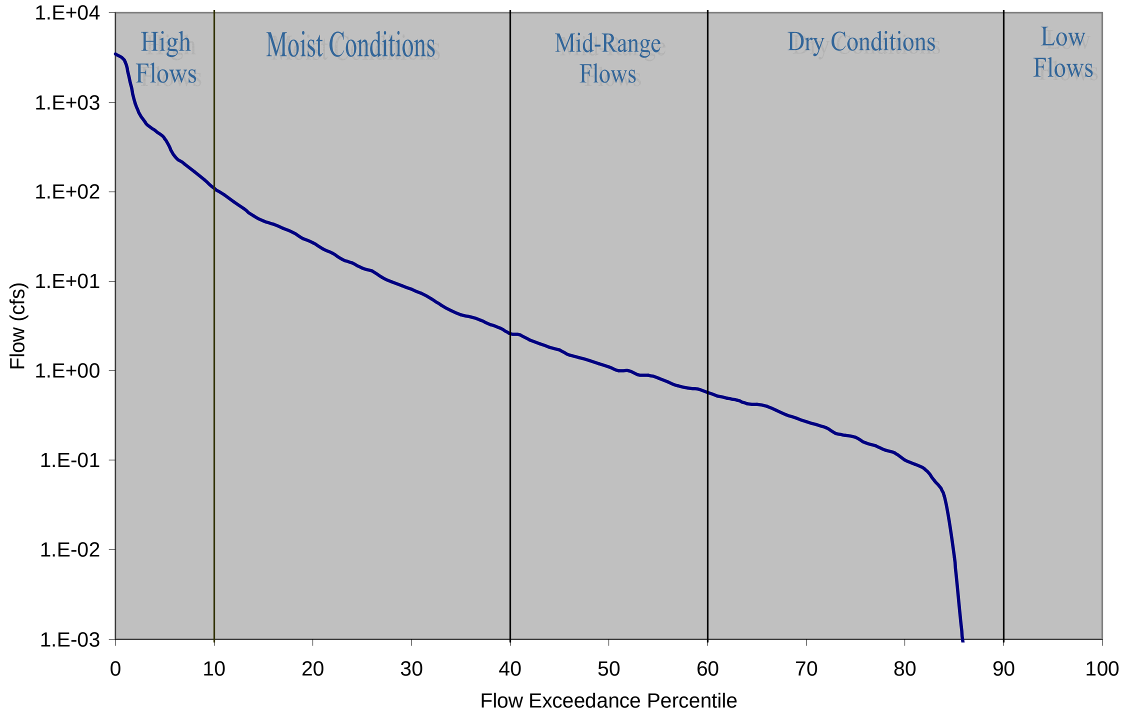
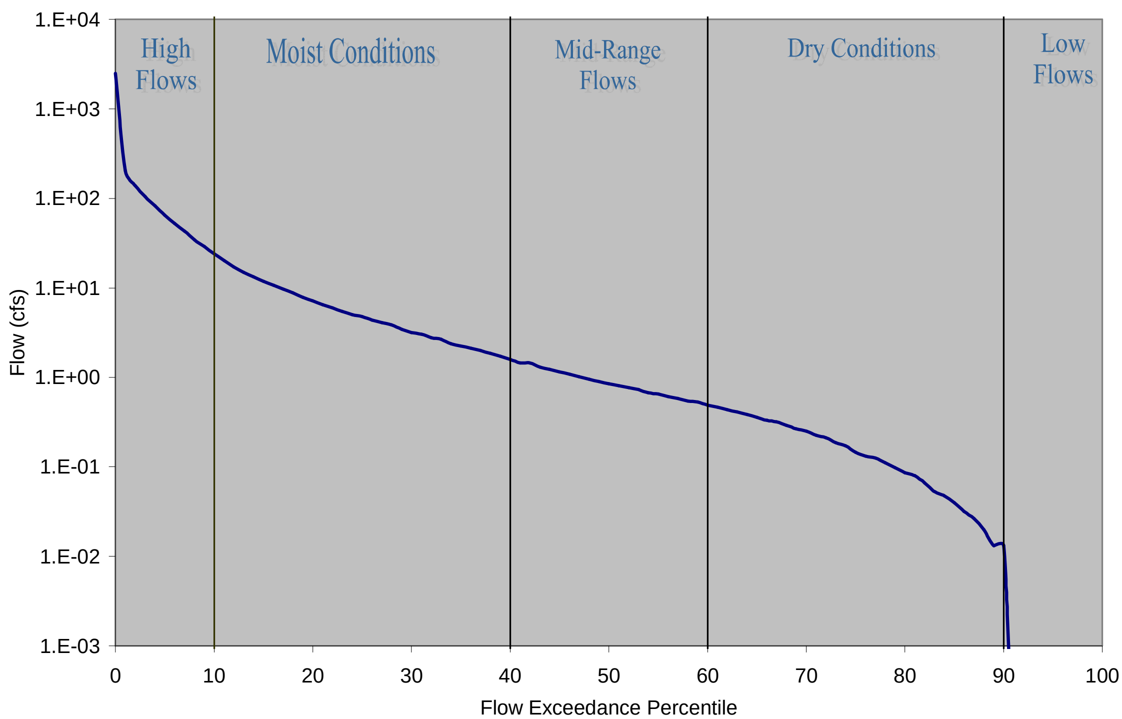


Figure 4-10 Flow Duration Curve for Beaver Creek (OK220600040030_00)



Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Flow duration curves can be subdivided into hydrologic condition classes to facilitate the diagnostic and analytical uses of flow and LDCs. The hydrologic classification scheme utilized in this application is similar to that described by Cleland (2003):

Table 4-1 Hydrologic Classification Scheme

Flow Exceedance Percentile	Hydrologic Condition Class
0-10	High flows
10-40	Moist Conditions
40-60	Mid-Range Conditions
60-90	Dry Conditions
90-100	Low Flows

Flow duration curves are generated using an ODEQ automated application referred to as the bacteria LDC toolbox. A step-by-step procedure on how to generate flow duration curves and flow exceedance percentiles is provided in Appendix C.

The USGS National Water Information System serves as the primary source of flow measurements for the application. 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 application. The application includes a data update module that automatically downloads the most recent USGS data and appends it to the existing flow database.

Some instantaneous flow measurements were available from various agencies. These were not combined with the daily average flows or used in calculating flow percentiles, but were matched to bacteria grab measurements collected at the same site and time. When available, these instantaneous flow measurements were used in lieu of the daily average flow to calculate instantaneous bacteria loads.

4.3 Estimating Current Point and Nonpoint Loading

Another key step in the use of LDCs for TMDL development is the estimation of existing bacteria loading from point and nonpoint sources and the display of this loading in relation to the TMDL. In Oklahoma, WWTPs that discharge treated sanitary wastewater must meet the state WQSs for fecal bacteria at the point of discharge. However, for TMDL analysis it is necessary to understand the relative contribution of WWTPs to the overall pollutant loading and its general compliance with required effluent limits. The monthly bacteria load for continuous point source dischargers is estimated by multiplying the monthly average flow rates by the monthly geometric mean using a conversion factor. The current pollutant loading from each permitted point source discharge is calculated using the equation below.

*Point Source Loading = monthly average flow rates (mgd) * geometric mean of corresponding fecal coliform concentration * unit conversion factor*

Where:

unit conversion factor = 37,854,120 100-ml/million gallons

It is difficult to estimate current nonpoint loading due to lack of specific water quality and flow information that would assist in estimating the relative proportion of non-specific sources within the watershed. Therefore, existing instream loads minus the point source loads were used as an estimate for nonpoint loading.

4.4 Development of TMDLs Using Load Duration Curves

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 bacteria loading must be reduced to meet WQSs in the impaired watershed).

Step 1: Generate Bacteria LDCs. LDCs are similar in appearance to flow duration curves; however, the ordinate is expressed in terms of a bacteria load in cfu/day. The curve represents the single sample water quality criterion for fecal coliform (400 cfu/100 mL), *E. coli* (406 cfu/100 mL), or Enterococci (108 cfu/100 mL) expressed in terms of a load through multiplication by the continuum of flows historically observed at this site. The basic steps to generating an LDC involve:

- obtaining daily flow data for the site of interest from the USGS;
- sorting the flow data and calculating flow exceedance percentiles for the time period and season of interest;
- obtaining the water quality data from the primary contact recreation season (May 1 through September 30);
- matching the water quality observations with the flow data from the same date;
- display a curve on a plot that represents the allowable load multiply the actual or estimated flow by the WQS for each respective indicator;
- multiplying the flow by the water quality parameter concentration to calculate daily loads; then
- plotting the flow exceedance percentiles and daily load observations in a load duration plot.

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 = 400 cfu /100 ml (Fecal coliform); 406 cfu/100 ml (E. coli); or 108 cfu/100 ml (Enterococci)

unit conversion factor = 24,465,525 ml*s / ft3*day

The flow exceedance frequency (x-value of each point) is obtained by looking up the historical exceedance frequency of the measured or estimated flow, in other words, the percent of historical observations that equal or exceed the measured or estimated flow. Historical observations of bacteria concentration are paired with flow data and are plotted on the LDC. The fecal coliform load (or the y-value of each point) is calculated by multiplying the fecal coliform concentration (colonies/100 mL) by the instantaneous flow (cubic feet per second) at the same site and time, with appropriate volumetric and time unit conversions. Fecal coliform/*E. coli*/Enterococci loads representing exceedance of water quality criteria fall above the water quality criterion line.

Only those flows and water quality samples observed in the months comprising the primary contact recreation season are used to generate the LDCs. It is inappropriate to compare single sample bacteria observations and instantaneous or daily flow durations to a 30-day geometric mean water quality criterion in the LDC.

As noted earlier, runoff has a strong influence on loading of nonpoint pollution. Yet flows do not always correspond directly to local runoff; high flows may occur in dry weather and runoff influence may be observed with low or moderate flows.

Step 2: Develop LDCs with MOS. An LDC depicting slightly lower estimates than the TMDL is developed to represent the TMDL with MOS. The MOS may be defined explicitly or implicitly. A typical explicit approach would reserve some fraction of the TMDL (*e.g.,* 10%) 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 the TMDLs in this report, an explicit MOS of 10 percent of the TMDL value (10% of the instantaneous water quality criterion) has been selected to slightly reduce assimilative capacity in the watershed. The MOS at any given percent flow exceedance, therefore, is defined as the difference in loading between the TMDL and the TMDL with MOS.

Step 3: Calculate WLA. As previously stated, the pollutant load allocation for point sources is defined by the WLA. A point source can be either a wastewater (continuous) or stormwater (MS4) discharge. Stormwater point sources are typically associated with urban and industrialized areas, and recent USEPA guidance includes NPDES-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. TMDLs can be expressed in terms of maximum allowable concentrations, or as different maximum loads allowable under different flow conditions, rather than single maximum load values. This concentration-based approach meets the requirements of 40 CFR, 130.2(i) for expressing TMDLs “in terms of mass per time, toxicity, or other appropriate measures” and is consistent with USEPA’s Protocol for Developing Pathogen TMDLs (USEPA 2001).

WLA for WWTP. WLAs may be set to zero for watersheds with no existing or planned continuous permitted point sources. For watersheds with permitted point sources, WLAs may be derived from NPDES permit limits. A WLA may be calculated for each active NPDES wastewater discharger using a mass balance approach as shown in the equation below. The permitted average flow rate used for each point source discharge and the water quality criterion concentration are used to estimate the WLA for each wastewater facility. All WLA values for each NPDES wastewater discharger are then summed to represent the total WLA for the watershed.

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

Where:

Where: WQS = 200 cfu /100 ml (Fecal coliform); 126 cfu/100 ml (E. coli); or 33 cfu/100 ml (Enterococci)

flow (10^6 gal/day) = permitted flow

unit conversion factor = 37,854,120-10^6gal/day

Step 4: Calculate LA and WLA for MS4s. LAs can be calculated under different flow conditions as the water quality target load minus the WLA. The LA is represented by the area under the LDC but above the WLA. The LA at any particular flow exceedance is calculated as shown in the equation below.

LA = TMDL – MOS - ∑WLA

WLA for MS4s. When there are permitted MS4s in the watershed, WLAs for MS4s will be caluculated based on area prorated LA. 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 boundry. However, in most case the study watershed intersects only a portion of the permitted MS4 coverage areas.

Step 5: Estimate WLA Load Reduction. The WLA load reduction was not calculated as it was assumed that continuous dischargers (NPDES-permitted WWTPs) are adequately regulated under existing permits to achieve water quality standards at the end-of-pipe and, therefore, no WLA reduction would be required. All SSOs are considered unpermitted discharges under State statute and DEQ regulations. For any MS4s that are located within a watershed requiring a TMDL the load reduction will be equal to the PRG established for the overall watershed.

Step 6: Estimate LA Load Reduction.

After existing loading estimates are computed for each bacterial indicator, nonpoint load reduction estimates for each WQM station are calculated by using the difference between estimated existing loading and the allowable load expressed by the LDC (TMDL-MOS). This difference is expressed as the overall percent reduction goal for the impaired waterbody. For fecal coliform the PRG which ensures that no more than 25 percent of the samples exceed the TMDL based on the instantaneous criteria allocates the loads in a manner that is also protective of the geometric mean criterion. For *E. coli* and Enterococci, because WQ standards are considered to be met if 1) either the geometric mean of all data is less than the geometric mean criteria, or 2) no sample exceeds the instantaneous criteria, the TMDL PRG will be the lesser of that required to meet the geometric mean or instantaneous criteria.

SECTION 5
TMDL CALCULATIONS

5.1 Estimated Loading and Critical Conditions

USEPA regulations at 40 CFR 130.7(c) (1) require TMDLs to take into account critical conditions for stream flow, loading, and all applicable water quality standards. To accomplish this, available instream WQM data were evaluated with respect to flows and magnitude of water quality criteria exceedance using LDCs. Furthermore, TMDLs are derived for all bacterial indicators at any given WQM station placed on the 303(d) list.

To calculate the bacteria load at the WQS, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,525 ml*s / ft^3*day*) and the criterion specific to each bacterial indicator. This calculation produces the maximum bacteria load in the stream without exceeding the instantaneous standard over the range of flow conditions. The allowable bacteria (fecal coliform, *E. coli*, or Enterococci) loads at the WQS establish the TMDL and are plotted versus flow exceedance percentile as an LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a bacteria load.

To estimate existing loading, bacteria observations for the primary contact recreation season (May 1st through September 30th) from 1999 to 2003 are paired with the flows measured or estimated in that segment on the same date. Pollutant loads are then calculated by multiplying the measured bacteria concentration by the flow rate and a unit conversion factor of *24,465,525 ml*s / ft^3*day*. The associated flow exceedance percentile is then matched with the measured flow from the tables provided in Appendix C. The observed bacteria loads are then added to the LDC plot as points. These points represent individual ambient water quality samples of bacteria. Points above the LDC indicate the bacteria instantaneous standard was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample met the WQS.

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 is used to calculate the loading reductions required. Percent reduction goals are calculated for each watershed and bacterial indicator species as the reductions in load required in order that no more than 10 percent of the existing instantaneous water quality observations would exceed the water quality target. This is because for the PBCR use to be supported, criteria for each bacterial indicator must be met in each impaired waterbody.

Table 5-1 presents the percent reductions necessary for each bacterial indicator in each of the impaired waterbodies in the Study Area. Attainment of WQSs in response to TMDL implementation will be based on results measured at each of these WQM stations. Based on this table, the TMDL PRGs for Fourche Maline Creek and Brushy Creek segment OK220600030010_00 will be based on Enterococci; the TMDL PRGs for Sans Bois Creek, Sans Bois Creek-Mountain Fork, Longtown Creek, Mill Creek, Brushy Creek segment OK220600030010_10, Blue Creek, Peaceable Creek, and Beaver Creek will be based on fecal coliform.

Table 5-1 TMDL Percent Reductions Required to Meet Water Quality Standards for Impaired Waterbodies in the Sans Bois Creek Watershed

Waterbody ID	WQM Station	Waterbody Name	Percent Reduction Required		
			FC	ENT	
			Instant-aneous	Instant-aneous	Geo-mean
OK220100040020_00	OK220100040020-001AT	Fourche Maline Creek		99%	**86%**
OK220200040010_40	OK220200040010W	Sans Bois Creek	**10%**		
OK220200040050_00	OK220200040050J	Sans Bois Creek-Mountain Fork	**10%**		
OK220600010070_00	OK220600010070G	Longtown Creek	**55%**		
OK220600010100_20	OK220600010100P	Mill Creek	**28%**		
OK220600030010_00	OK220600030010-001AT	Brushy Creek, off U.S. 270		98%	**69%**
OK220600030010_10	OK220600030010T	Brushy Creek	**33%**		
OK220600030020_00	OK220600030020-002SR	Blue Creek	**86%**		
OK220600030050_00	OK220600030050M	Peaceable Creek	**49%**		
OK220600040030_00	OK220600040030G	Beaver Creek	**28%**		

LDCs for each impaired waterbody (for the contact recreation season from 1999 through 2006) for the WQM stations and indicator bacteria species with the largest PRGs are shown in Figures 5-1 through 5-10.

The LDC for Fourche Maline Creek (Figure 5-1) is based on Enterococci bacteria measurements during primary contact recreation season at WQM station OK220100040020-001AT. The LDC indicates that Enterococci levels exceed the instantaneous water quality criteria under various flow conditions, but the greatest exceedances of criteria occurred under moist conditions and mid-range flows. This implies that nonpoint sources are a major cause of impairment.

The LDC for Sans Bois Creek (Figure 5-2) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220200040010W. Fecal coliform measurements collected during secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria primarily under lower than average flows, indicating possible pollution may be due to point sources, failing onsite systems, or direct deposition of animal manure.

The LDC for Sans Bois Creek-Mountain Fork (Figure 5-3) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220200040050J. Fecal coliform measurements collected during secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria under a variety of flow conditions, indicating nonpoint sources.

The LDC for Longtown Creek (Figure 5-4) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220600010070G. Fecal coliform measurements collected during secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under the primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria under a variety of flow conditions, indicating nonpoint sources.

The LDC for Mill Creek (Figure 5-5) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220600010100P. Fecal coliform measurements collected during the secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria under a variety of flow conditions, indicative of nonpoint sources.

The LDC for Brushy Creek segment OK220600030010_00 (Figure 5-6) is based on Enterococci bacteria measurements during primary contact recreation season at WQM station OK220600030010-001AT (Brushy Creek off U.S. 270 in Haileyville). The LDC indicates that Enterococci levels exceed the instantaneous water quality criteria primarily under above average flow conditions, indicative of nonpoint sources.

The LDC for Brushy Creek segment OK220600030010_10 (Figure 5-7) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220600030010T. Fecal coliform measurements collected during secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria under a variety of flow conditions, indicative of nonpoint sources.

The LDC for Blue Creek (Figure 5-8) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220600030020-002SR (Blue Creek). Fecal coliform measurements collected during secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria under above average flow conditions, indicative of nonpoint sources.

The LDC for Peaceable Creek (Figure 5-9) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220600030050M. Fecal coliform measurements collected during the secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria only during high flows and moist conditions, indicative of nonpoint sources.

The LDC for Beaver Creek (Figure 5-10) is based on fecal coliform bacteria measurements during primary contact recreation season at WQM station OK220600040030G. Fecal coliform measurements collected during secondary contact recreation season (October – April) are also displayed on the figure, although the load at the secondary contact recreation criterion is not shown. The PRG is calculated so the measurements under primary contact recreation season are met; however, this percent reduction is sufficient to ensure that secondary contact recreation criteria are also met. The LDC indicates that fecal coliform levels exceed the instantaneous water quality criteria under a variety of flow conditions, indicative of nonpoint sources.

Figure 5-1 Load Duration Curve for Enterococci in Fourche Maline Creek (OK220100040020_00)

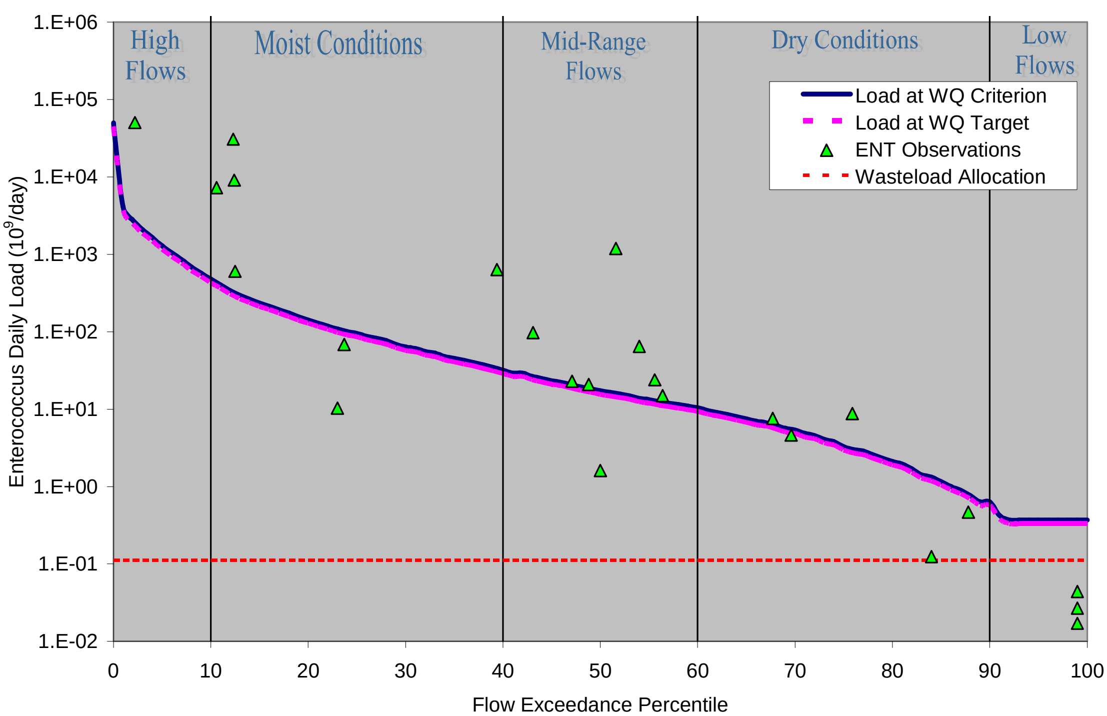


Figure 5-2 Load Duration Curve for Fecal Coliform in Sans Bois Creek (OK220200040010_40)

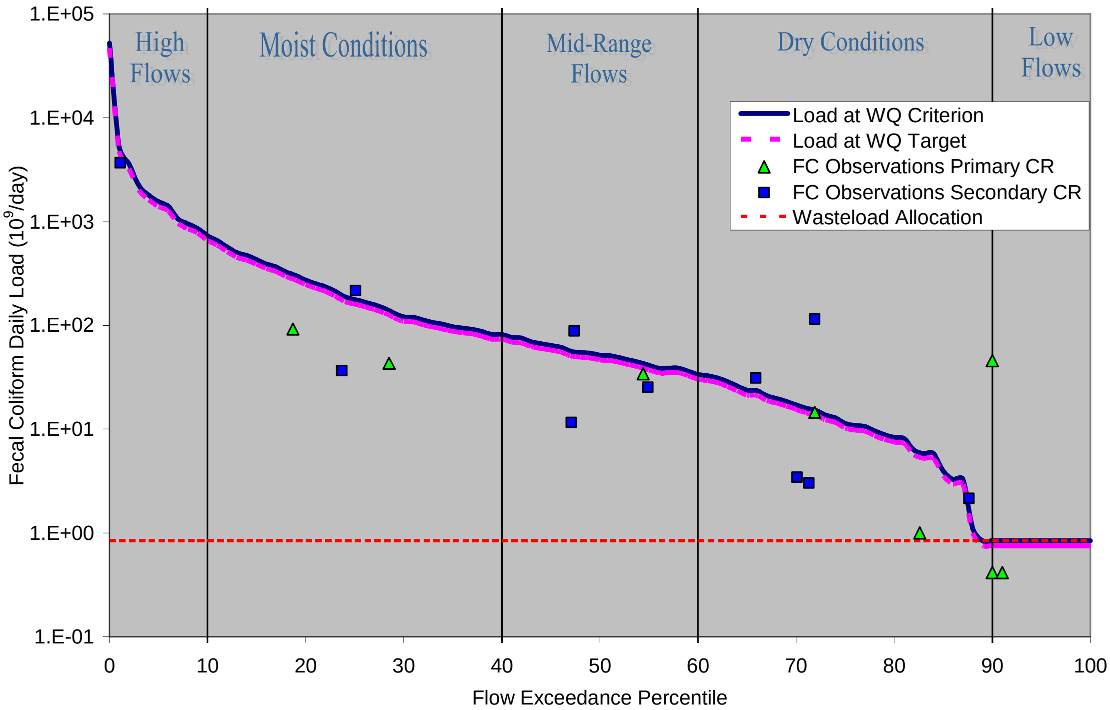
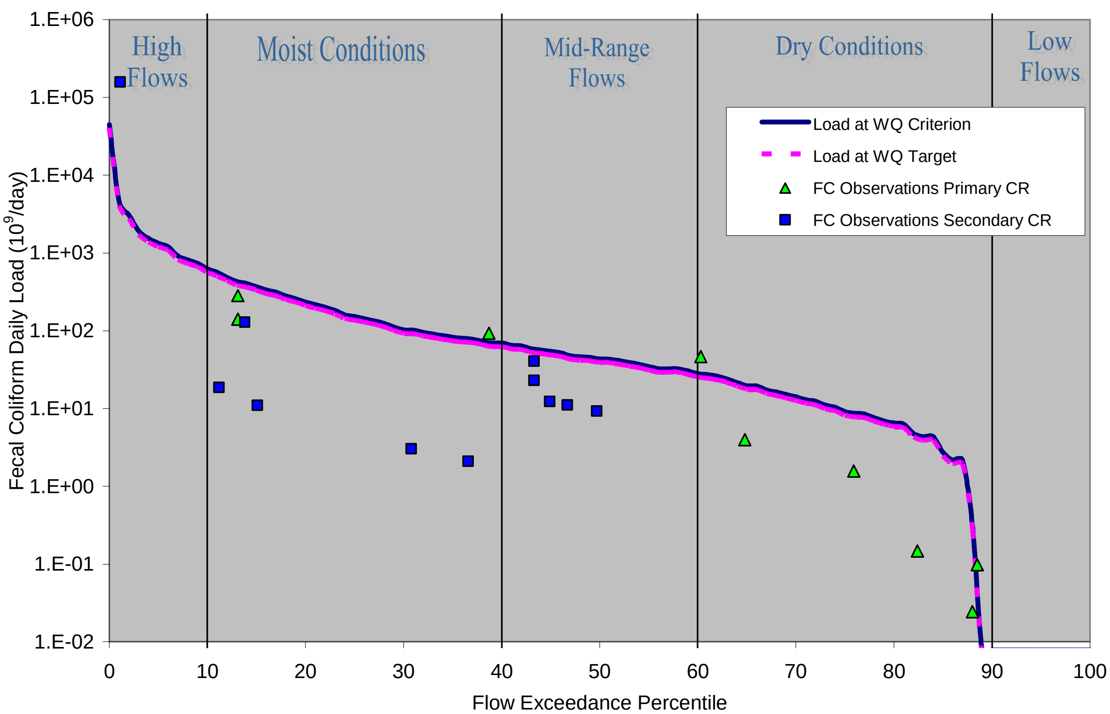
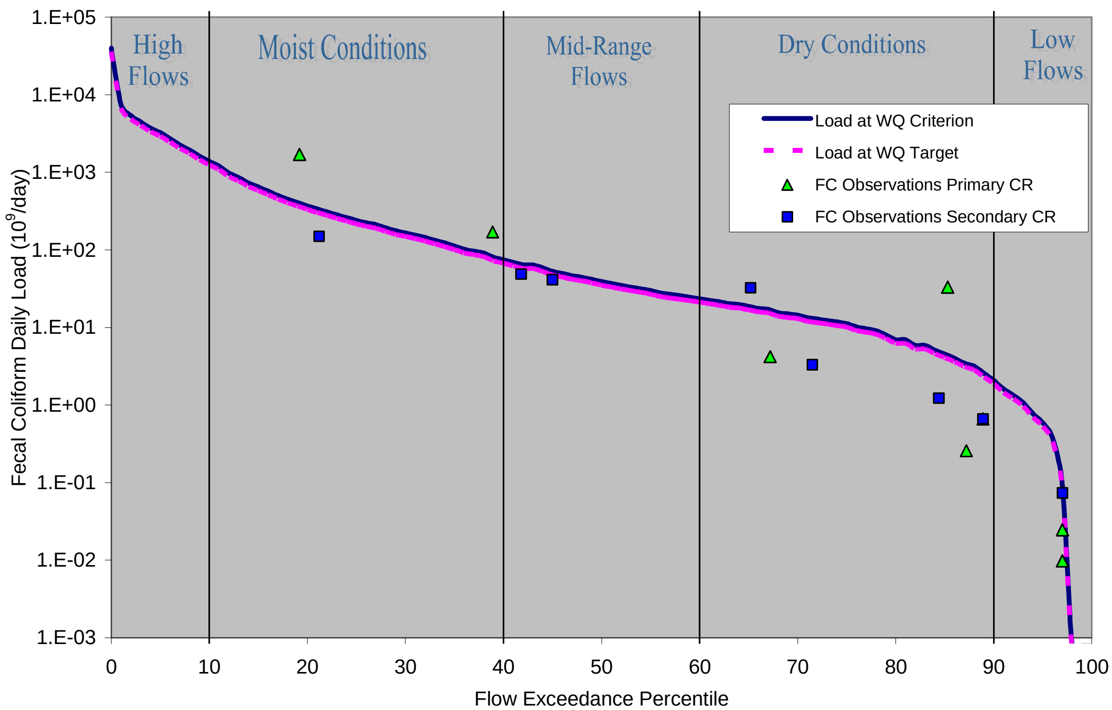


Figure 5-3 Load Duration Curve for Fecal Coliform in Sans Bois Creek-Mountain Fork (OK220200040050_00)



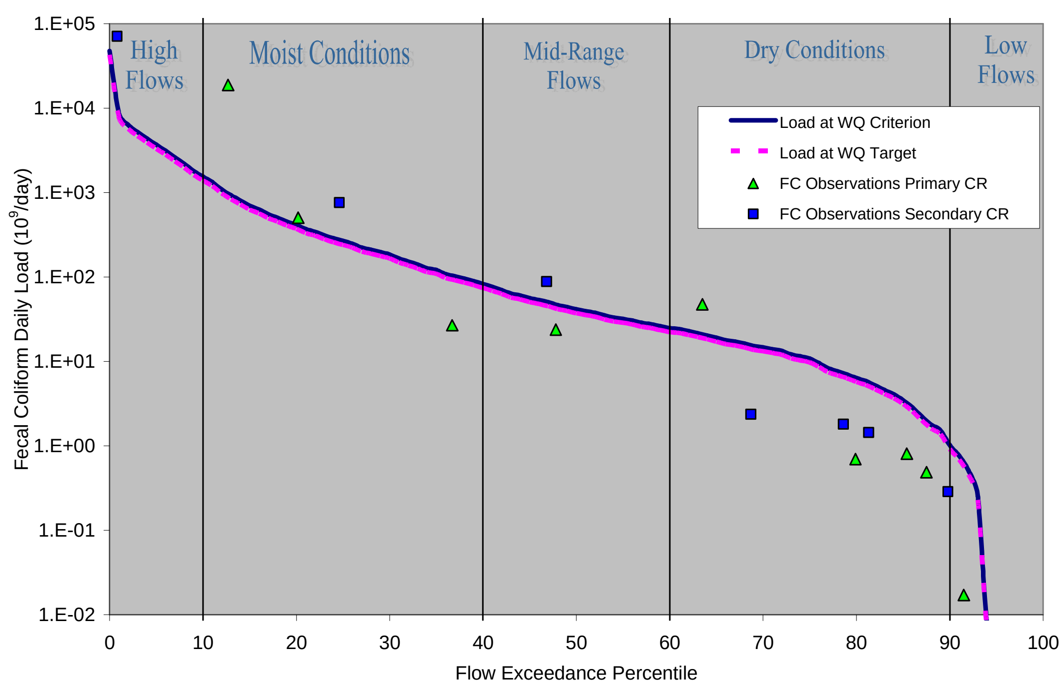
* there is no wasteload allocation for this waterbody

Figure 5-4 Load Duration Curve for Fecal Coliform in Longtown Creek (OK220600010070_00)



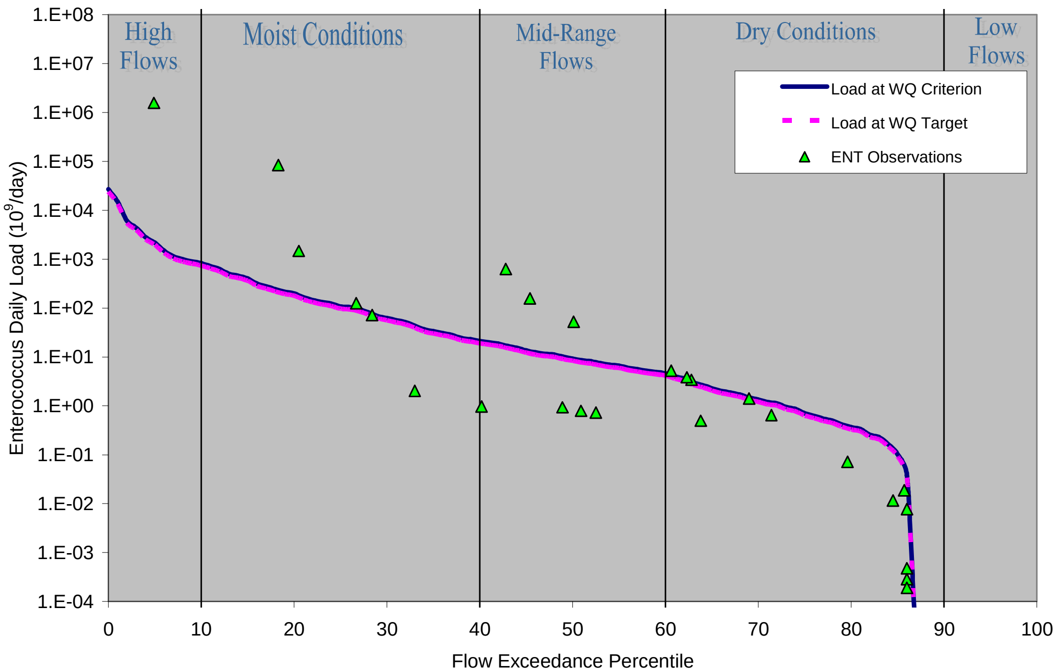
* there is no wasteload allocation for this waterbody

Figure 5-5 Load Duration Curve for Fecal Coliform in Mill Creek (OK220600010100_20)



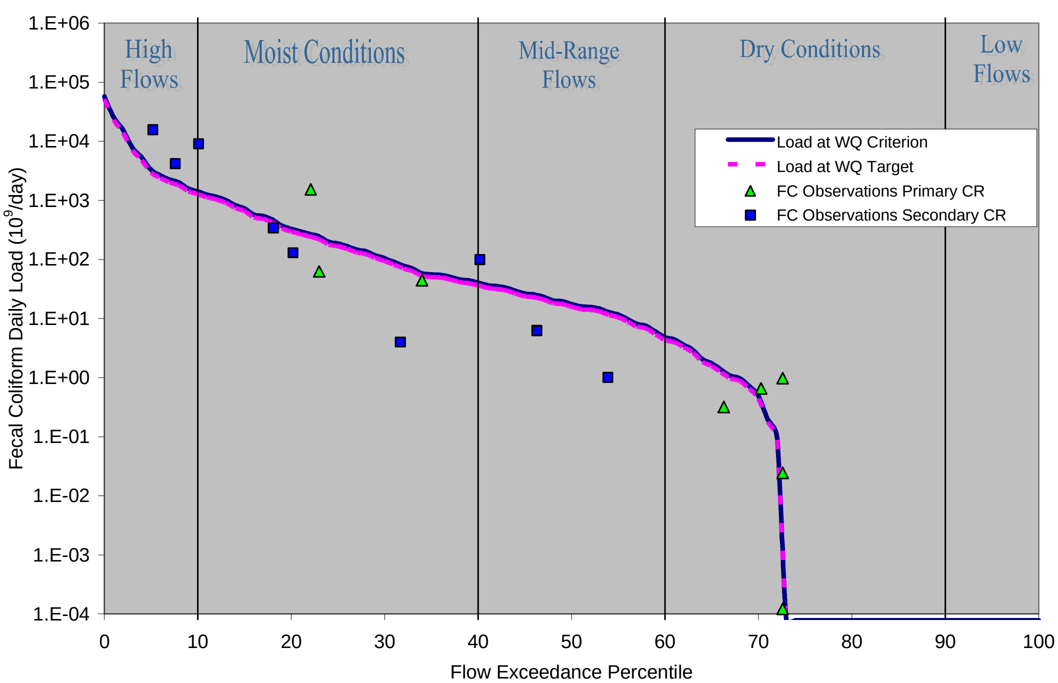
* there is no wasteload allocation for this waterbody

Figure 5-6 Load Duration Curve for Enterococci in Brushy Creek off U.S. 270 (OK220600030010_00)



* there is no wasteload allocation for this waterbody

Figure 5-7 Load Duration Curve for Fecal Coliform in Brushy Creek (OK220600030010_10)



* there is no wasteload allocation for this waterbody

Figure 5-8 Load Duration Curve for Fecal Coliform in Blue Creek (OK220600030020_00)

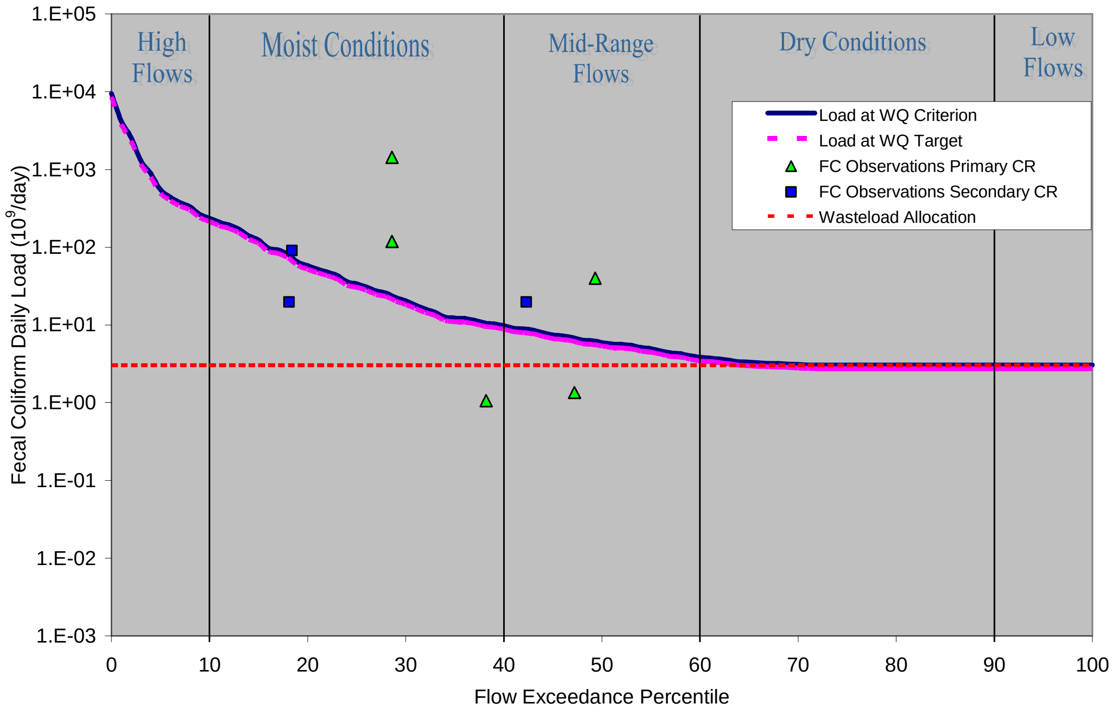
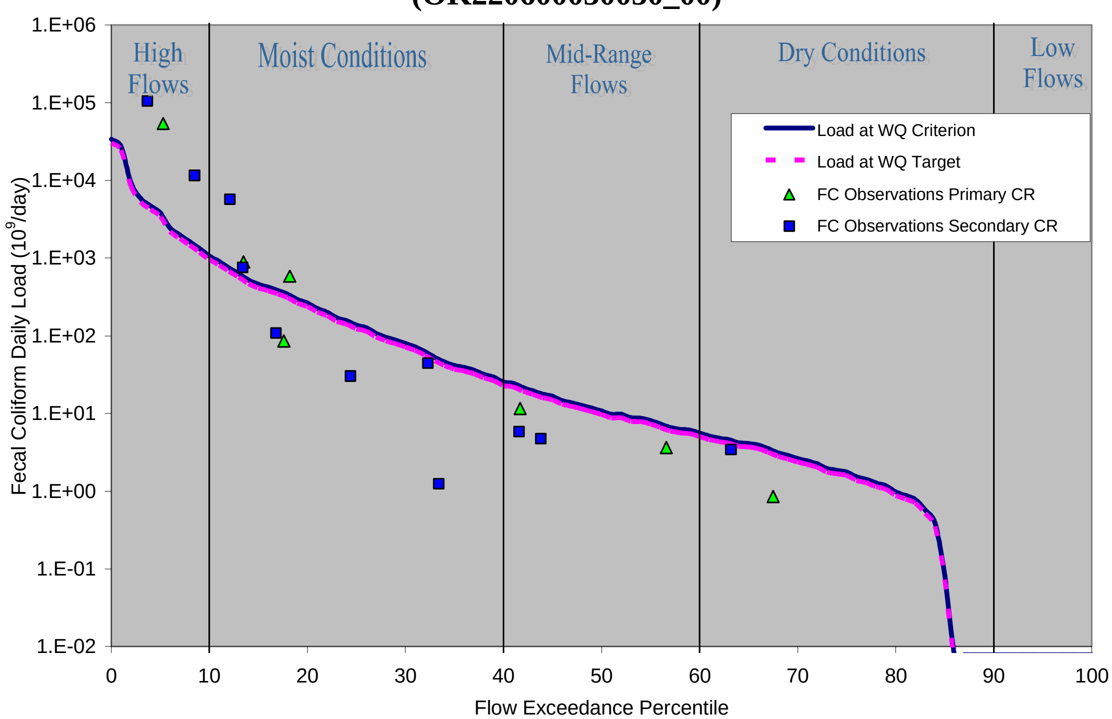
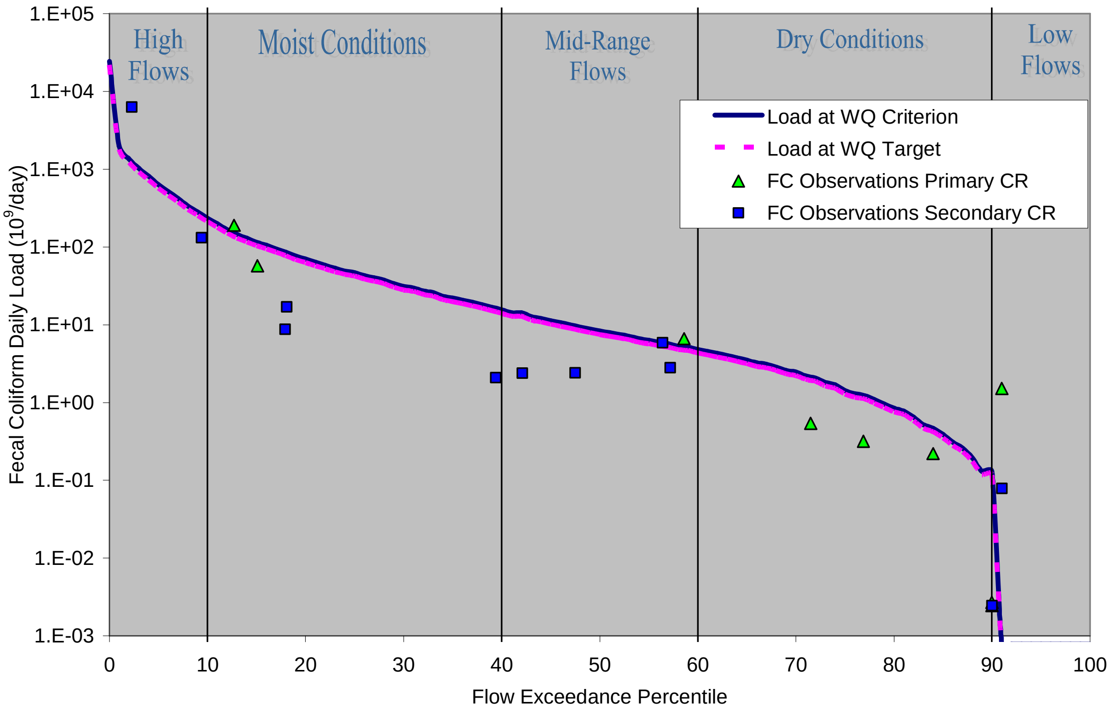


Figure 5-9 Load Duration Curve for Fecal Coliform in Peaceable Creek (OK220600030050_00)



* there is no wasteload allocation for this waterbody

Figure 5-10 Load Duration Curve for Fecal Coliform in Beaver Creek (OK220600040030_00)



* there is no wasteload allocation for this waterbody

5.2 Wasteload Allocation

NPDES-permitted facilities are allocated a daily wasteload calculated as their permitted daily average discharge flow rate multiplied by the instream single-sample water quality criterion. In other words, the facilities are required to meet instream criteria in their discharge. Table 5-2 summarizes the WLA of the NPDES-permitted facilities within the Sans Bois Creek watershed. The WLA for each facility is derived from the following equation:

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

Where:

Where: WQS = 200 cfu /100 ml (Fecal coliform); 126 cfu/100 ml (E. coli); or 33 cfu/100 ml (Enterococci)

flow (10^6 gal/day) = permitted flow

unit conversion factor = 37,854,120-10^6gal/day

When multiple NPDES facilities occur within a watershed, individual WLAs are summed and the total WLA for continuous point sources is included in the TMDL calculation for the corresponding waterbody. When there are no NPDES WWTPs discharging into the contributing watershed of a WQM station, then the WLA is zero. Compliance with the WLA will be achieved by adhering to the fecal coliform limits and disinfection requirements of NPDES permits. Table 5-2 indicates which point source dischargers within Oklahoma 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 bacteria levels. In the future, all point source dischargers which are assigned a wasteload allocation but do not currently have a bacteria limit in their permit will receive a permit limit consistent with the wasteload allocation as their permits are reissued.

Table 5-2 Wasteload Allocations for NPDES-Permitted Facilities

Waterbody ID	NPDES Permit No.	Name	Design Flow (mgd)	Disin-fection	Wasteload Allocation (cfu/day)	
					Fecal Coliform	Enterococci
OK220200040010_40 Sans Bois Creek	OK0030694	Quinton, City of	0.11	No	8.40E+08	1.39E+08
OK220600030020_00 Blue Creek	OK0022861	City of Hartshorne	0.27	Yes	2.04E+09	3.37E+08
	OK0028843	City of Haileyville	0.13	Yes	9.84E+08	1.62E+08
OK220100040020_00 Fourche Maline Creek	OK0031631	Red Oak Public Works Authority	0.09	No	6.81E+08	1.12E+08

Permitted storm water discharges are considered point sources. There are no permitted MS4s within the study area; therefore, a specific wasteload allocation is not calculated for MS4s.

5.3 Load Allocation

As discussed in Section 3, nonpoint source bacteria loading to the receiving streams of each waterbody emanate from a number of different sources. The data analysis and the LDCs demonstrate that exceedances at the WQM stations are the result of a variety of nonpoint source loading. The LAs for each stream segment are calculated as the difference between the TMDL, MOS, and WLA, as follows:

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

5.4 Seasonal Variability

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. The 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 more than 5 years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

5.5 Margin of Safety

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs include a MOS. The MOS is a conservative measure incorporated into the TMDL equation that accounts for the uncertainty associated with calculating the allowable pollutant loading to ensure WQSs are attained. USEPA guidance allows for use of implicit or explicit expressions of the MOS, or both. When conservative assumptions are used in development of the TMDL, or conservative factors are used in the calculations, the MOS is implicit. When a specific percentage of the TMDL is set aside to account for uncertainty, then the MOS is considered explicit.

For the explicit MOS the water quality target was set at 10 percent lower than the water quality criterion for each pathogen which equates to 360 cfu/100 mL, 365.4 cfu/100 mL, and 97.2/100 mL for fecal coliform, *E. coli*, and Enterococci, respectively. The net effect of the TMDL with MOS is that the assimilative capacity or allowable pollutant loading of each waterbody is slightly reduced. These TMDLs incorporate an explicit MOS by using a curve representing 90 percent of the TMDL as the average MOS. The MOS at any given percent flow exceedance, therefore, can be defined as the difference in loading between the TMDL and the TMDL with MOS. The use of instream bacteria concentrations to estimate existing loading is another conservative element utilized in these TMDLs that can be recognized as an implicit MOS. This conservative approach to establishing the MOS will ensure that both the 30-day geometric mean and instantaneous bacteria standards can be achieved and maintained.

5.6 TMDL Calculations

The bacteria TMDLs for the 303(d)-listed WQM stations 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 uncertainty concerning the relationship between effluent limitations and water quality.

This definition can be expressed by the following equation:

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

For each stream segment the TMDLs presented in this report are expressed as a percent reduction across the full range of flow conditions. The TMDL, WLA, LA, and MOS will vary with flow condition, and are calculated at every 5th flow interval percentile (Tables 5-4 through 5-13). For illustrative purposes, the TMDL, WLA, LA, and MOS are calculated for the median flow at each site in Table 5-3. The WLA component of each TMDL is the sum of all WLAs within the contributing watershed of each WQM station. The sum of the WLAs can be represented as a single line below the LDC. The LDC and the simple equation of:

$$Average\ LA = average\ TMDL - MOS - \sum WLA$$

can provide an individual value for the LA in counts per day, which represent the area under the TMDL target line and above the WLA line. There are no permitted MS4s within the study area. Where there are no continuous point sources the WLA is zero.

Table 5-3 TMDL Summary Examples

Waterbody ID	WQM Station	Waterbody Name	Indicator Bacteria Species	TMDL† (cfu/day)	WLA† (cfu/day)	LA† (cfu/day)	MOS† (cfu/day)
OK220100040020_00	OK220100040020-001AT	Fourche Maline Creek	Enterococci	1.69E+10	1.12E+08	1.51E+10	1.69E+09
OK220200040010_40	OK220200040010W	Sans Bois Creek	Fecal Coliform	5.16E+10	8.40E+08	4.56E+10	5.16E+09
OK220200040050_00	OK220200040050J	Sans Bois Creek-Mountain Fork	Fecal Coliform	4.35E+10	0	3.91E+10	4.35E+09

Waterbody ID	WQM Station	Waterbody Name	Indicator Bacteria Species	TMDL† (cfu/day)	WLA† (cfu/day)	LA† (cfu/day)	MOS† (cfu/day)
OK220600010070_00	OK220600010070G	Longtown Creek	Fecal Coliform	3.89E+10	0	3.5E+10	3.89E+09
OK220600010100_20	OK220600010100P	Mill Creek	Fecal Coliform	4.14E+10	0	3.73E+10	4.14E+09
OK220600030010_00	OK220600030010-001AT	Brushy Creek, Off U.S. 270	Enterococci	9.27E+09	0	8.34E+09	9.27E+08
OK220600030010_10	OK220600030010T	Brushy Creek	Fecal Coliform	1.76E+10	0	1.59E+10	1.76E+09
OK220600030020_00	OK220600030020-002SR	Blue Creek	Fecal Coliform	5.94E+09	3.03E+09	2.32E+09	5.94E+08
OK220600030050_00	OK220600030050M	Peaceable Creek	Fecal Coliform	1.08E+10	0	9.69E+09	1.08E+09
OK220600040030_00	OK220600040030G	Beaver Creek	Fecal Coliform	8.29E+09	0	7.46E+09	8.29E+08

† Derived for illustrative purposes at the median flow value

Table 5-4 Enterococci TMDL Calculations for Fourche Maline Creek (OK220100040020_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	18900	4.99E+13	1.12E+08	4.49E+13	4.99E+12
5	490	1.29E+12	1.12E+08	1.16E+12	1.29E+11
10	181	4.78E+11	1.12E+08	4.30E+11	4.78E+10
15	89	2.35E+11	1.12E+08	2.12E+11	2.35E+10
20	54	1.43E+11	1.12E+08	1.28E+11	1.43E+10
25	36	9.51E+10	1.12E+08	8.55E+10	9.51E+09
30	24	6.34E+10	1.12E+08	5.70E+10	6.34E+09
35	17	4.49E+10	1.12E+08	4.03E+10	4.49E+09
40	12	3.17E+10	1.12E+08	2.84E+10	3.17E+09
45	8.7	2.30E+10	1.12E+08	2.06E+10	2.30E+09
50	6.4	1.69E+10	1.12E+08	1.51E+10	1.69E+09
55	4.9	1.29E+10	1.12E+08	1.15E+10	1.29E+09
60	3.8	1.00E+10	1.12E+08	8.92E+09	1.00E+09
65	2.7	7.13E+09	1.12E+08	6.31E+09	7.13E+08
70	1.9	5.02E+09	1.12E+08	4.41E+09	5.02E+08
75	1.1	2.91E+09	1.12E+08	2.50E+09	2.91E+08
80	0.66	1.74E+09	1.12E+08	1.46E+09	1.74E+08
85	0.30	7.93E+08	1.12E+08	6.01E+08	7.93E+07
90	0.10	2.64E+08	1.12E+08	1.25E+08	2.64E+07
95	0	1.25E+08	1.12E+08	0.00E+00	1.25E+07
100	0	1.25E+08	1.12E+08	0.00E+00	1.25E+07

Table 5-5 Fecal Coliform TMDL Calculations for Sans Bois Creek (OK220200040010_40)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	5344	5.23E+13	8.40E+08	4.71E+13	5.23E+12
5	159	1.56E+12	8.40E+08	1.40E+12	1.56E+11
10	75	7.30E+11	8.40E+08	6.56E+11	7.30E+10
15	44	4.32E+11	8.40E+08	3.88E+11	4.32E+10
20	28	2.74E+11	8.40E+08	2.46E+11	2.74E+10
25	18	1.78E+11	8.40E+08	1.59E+11	1.78E+10
30	12	1.21E+11	8.40E+08	1.08E+11	1.21E+10
35	9.9	9.70E+10	8.40E+08	8.65E+10	9.70E+09
40	8.4	8.18E+10	8.40E+08	7.28E+10	8.18E+09
45	6.5	6.41E+10	8.40E+08	5.68E+10	6.41E+09
50	5.3	5.16E+10	8.40E+08	4.56E+10	5.16E+09
55	4.2	4.13E+10	8.40E+08	3.63E+10	4.13E+09
60	3.4	3.37E+10	8.40E+08	2.95E+10	3.37E+09
65	2.42	2.37E+10	8.40E+08	2.05E+10	2.37E+09
70	1.76	1.72E+10	8.40E+08	1.46E+10	1.72E+09
75	1.16	1.14E+10	8.40E+08	9.40E+09	1.14E+09
80	0.85	8.34E+09	8.40E+08	6.67E+09	8.34E+08
85	0.40	3.93E+09	8.40E+08	2.70E+09	3.93E+08
90	0.09	9.34E+08	8.40E+08	0	9.34E+07
95	0.09	9.34E+08	8.40E+08	0	9.34E+07
100	0.09	9.34E+08	8.40E+08	0	9.34E+07

Table 5-6 Fecal Coliform TMDL Calculations for Sans Bois Creek-Mountain Fork (OK220200040050_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	4570	4.47E+13	0	4.02E+13	4.47E+12
5	136	1.33E+12	0	1.20E+12	1.33E+11
10	64	6.23E+11	0	5.61E+11	6.23E+10
15	38	3.68E+11	0	3.32E+11	3.68E+10
20	24	2.34E+11	0	2.10E+11	2.34E+10
25	15	1.52E+11	0	1.36E+11	1.52E+10
30	10	1.03E+11	0	9.24E+10	1.03E+10
35	8.4	8.23E+10	0	7.41E+10	8.23E+09
40	7.1	6.93E+10	0	6.24E+10	6.93E+09
45	5.5	5.42E+10	0	4.87E+10	5.42E+09
50	4.4	4.35E+10	0	3.91E+10	4.35E+09
55	3.5	3.47E+10	0	3.12E+10	3.47E+09
60	2.9	2.82E+10	0	2.53E+10	2.82E+09
65	2.01	1.96E+10	0	1.77E+10	1.96E+09
70	1.44	1.41E+10	0	1.27E+10	1.41E+09
75	0.93	9.10E+09	0	8.19E+09	9.10E+08
80	0.66	6.50E+09	0	5.85E+09	6.50E+08
85	0.28	2.73E+09	0	2.46E+09	2.73E+08
90	0	0	0	0	0
95	0	0	0	0	0
100	0	0	0	0	0

Table 5-7 Fecal Coliform TMDL Calculations for Longtown Creek (OK220600010070_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	4075	3.99E+13	0	3.59E+13	3.99E+12
5	331	3.24E+12	0	2.92E+12	3.24E+11
10	141	1.38E+12	0	1.25E+12	1.38E+11
15	66	6.47E+11	0	5.82E+11	6.47E+10
20	38	3.68E+11	0	3.31E+11	3.68E+10
25	24	2.40E+11	0	2.16E+11	2.40E+10
30	17	1.65E+11	0	1.49E+11	1.65E+10
35	11	1.12E+11	0	1.01E+11	1.12E+10
40	7.6	7.46E+10	0	6.72E+10	7.46E+09
45	5.4	5.28E+10	0	4.75E+10	5.28E+09
50	4.0	3.89E+10	0	3.50E+10	3.89E+09
55	3.1	2.99E+10	0	2.69E+10	2.99E+09
60	2.4	2.35E+10	0	2.11E+10	2.35E+09
65	1.9	1.87E+10	0	1.68E+10	1.87E+09
70	1.5	1.44E+10	0	1.30E+10	1.44E+09
75	1.1	1.12E+10	0	1.01E+10	1.12E+09
80	0.71	6.93E+09	0	6.23E+09	6.93E+08
85	0.46	4.53E+09	0	4.08E+09	4.53E+08
90	0.21	2.08E+09	0	1.87E+09	2.08E+08
95	0.06	5.86E+08	0	5.28E+08	5.86E+07
100	0.00	0.00E+00	0	0.00E+00	0.00E+00

Table 5-8 Fecal Coliform TMDL Calculations for Mill Creek (OK220600010100_20)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	4,869	4.77E+13	0	4.29E+13	4.77E+12
5	377	3.69E+12	0	3.32E+12	3.69E+11
10	158	1.55E+12	0	1.39E+12	1.55E+11
15	72	7.01E+11	0	6.31E+11	7.01E+10
20	42	4.14E+11	0	3.73E+11	4.14E+10
25	27	2.67E+11	0	2.41E+11	2.67E+10
30	19	1.85E+11	0	1.66E+11	1.85E+10
35	12	1.21E+11	0	1.09E+11	1.21E+10
40	8.5	8.28E+10	0	7.45E+10	8.28E+09
45	5.7	5.61E+10	0	5.05E+10	5.61E+09
50	4.2	4.14E+10	0	3.73E+10	4.14E+09
55	3.3	3.19E+10	0	2.87E+10	3.19E+09
60	2.5	2.48E+10	0	2.24E+10	2.48E+09
65	2.0	1.91E+10	0	1.72E+10	1.91E+09
70	1.5	1.46E+10	0	1.32E+10	1.46E+09
75	1.1	1.08E+10	0	9.74E+09	1.08E+09
80	0.65	6.37E+09	0	5.73E+09	6.37E+08
85	0.35	3.47E+09	0	3.13E+09	3.47E+08
90	0.10	1.02E+09	0	9.17E+08	1.02E+08
95	0	0	0	0	0
100	0	0	0	0	0

Table 5-9 Enterococci TMDL Calculations for Brushy Creek off U.S. 270 (OK220600030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	10131	2.68E+13	0	2.41E+13	2.68E+12
5	827	2.19E+12	0	1.97E+12	2.19E+11
10	313	8.26E+11	0	7.43E+11	8.26E+10
15	152	4.02E+11	0	3.62E+11	4.02E+10
20	76	2.00E+11	0	1.80E+11	2.00E+10
25	41	1.08E+11	0	9.73E+10	1.08E+10
30	24	6.23E+10	0	5.61E+10	6.23E+09
35	13	3.36E+10	0	3.03E+10	3.36E+09
40	8.0	2.12E+10	0	1.91E+10	2.12E+09
45	5.1	1.36E+10	0	1.22E+10	1.36E+09
50	3.5	9.27E+09	0	8.34E+09	9.27E+08
55	2.5	6.62E+09	0	5.96E+09	6.62E+08
60	1.7	4.60E+09	0	4.14E+09	4.60E+08
65	0.87	2.29E+09	0	2.06E+09	2.29E+08
70	0.51	1.34E+09	0	1.21E+09	1.34E+08
75	0.27	7.04E+08	0	6.34E+08	7.04E+07
80	0.14	3.65E+08	0	3.29E+08	3.65E+07
85	0.04	1.03E+08	0	9.23E+07	1.03E+07
90	0	0	0	0	0
95	0	0	0	0	0
100	0	0	0	0	0

Table 5-10 Fecal Coliform TMDL Calculations for Brushy Creek (OK220600030010_10)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	5870	5.74E+13	0	5.17E+13	5.74E+12
5	337	3.30E+12	0	2.97E+12	3.30E+11
10	144	1.41E+12	0	1.27E+12	1.41E+11
15	75	7.32E+11	0	6.58E+11	7.32E+10
20	34	3.31E+11	0	2.98E+11	3.31E+10
25	19	1.86E+11	0	1.67E+11	1.86E+10
30	11	1.05E+11	0	9.42E+10	1.05E+10
35	5.7	5.58E+10	0	5.02E+10	5.58E+09
40	4.2	4.07E+10	0	3.66E+10	4.07E+09
45	2.7	2.65E+10	0	2.38E+10	2.65E+09
50	1.8	1.76E+10	0	1.59E+10	1.76E+09
55	1.2	1.17E+10	0	1.05E+10	1.17E+09
60	0.5	4.83E+09	0	4.35E+09	4.83E+08
65	0.18	1.75E+09	0	1.57E+09	1.75E+08
70	0.05	4.89E+08	0	4.40E+08	4.89E+07
75	0	0	0	0	0
80	0	0	0	0	0
85	0	0	0	0	0
90	0	0	0	0	0
95	0	0	0	0	0
100	0	0	0	0	0

Table 5-11 Fecal Coliform TMDL Calculations for Blue Creek (OK220600030020_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	971	9.50E+12	3.03E+09	8.55E+12	9.50E+11
5	56	5.49E+11	3.03E+09	4.91E+11	5.49E+10
10	24	2.37E+11	3.03E+09	2.10E+11	2.37E+10
15	13	1.24E+11	3.03E+09	1.09E+11	1.24E+10
20	5.9	5.78E+10	3.03E+09	4.90E+10	5.78E+09
25	3.5	3.38E+10	3.03E+09	2.74E+10	3.38E+09
30	2.1	2.04E+10	3.03E+09	1.53E+10	2.04E+09
35	1.3	1.23E+10	3.03E+09	8.00E+09	1.23E+09
40	1.0	9.76E+09	3.03E+09	5.76E+09	9.76E+08
45	0.76	7.41E+09	3.03E+09	3.64E+09	7.41E+08
50	0.61	5.94E+09	3.03E+09	2.32E+09	5.94E+08
55	0.51	4.96E+09	3.03E+09	1.44E+09	4.96E+08
60	0.39	3.83E+09	3.03E+09	4.17E+08	3.83E+08
65	0.34	3.36E+09	3.03E+09	0.00E+00	3.36E+08
70	0.32	3.36E+09	3.03E+09	0.00E+00	3.36E+08
75	0.31	3.36E+09	3.03E+09	0.00E+00	3.36E+08
80	0.31	3.36E+09	3.03E+09	0.00E+00	3.36E+08
85	0.31	3.36E+09	3.03E+09	0.00E+00	3.36E+08
90	0.31	3.36E+09	3.03E+09	0.00E+00	3.36E+08
95	0.31	3.36E+09	3.03E+09	0.00E+00	3.36E+08
100	0.31	3.36E+09	3.03E+09	0.00E+00	3.36E+08

Table 5-12 Fecal Coliform TMDL Calculations for Peaceable Creek (OK220600030050_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	3460	3.39E+13	0	3.05E+13	3.39E+12
5	391	3.82E+12	0	3.44E+12	3.82E+11
10	109	1.07E+12	0	9.59E+11	1.07E+11
15	47	4.60E+11	0	4.14E+11	4.60E+10
20	27	2.64E+11	0	2.38E+11	2.64E+10
25	14	1.37E+11	0	1.23E+11	1.37E+10
30	8.1	7.97E+10	0	7.17E+10	7.97E+09
35	4.2	4.14E+10	0	3.73E+10	4.14E+09
40	2.6	2.54E+10	0	2.29E+10	2.54E+09
45	1.7	1.66E+10	0	1.50E+10	1.66E+09
50	1.1	1.08E+10	0	9.69E+09	1.08E+09
55	0.83	8.12E+09	0	7.31E+09	8.12E+08
60	0.57	5.60E+09	0	5.04E+09	5.60E+08
65	0.42	4.11E+09	0	3.70E+09	4.11E+08
70	0.27	2.64E+09	0	2.38E+09	2.64E+08
75	0.18	1.76E+09	0	1.59E+09	1.76E+08
80	0.10	9.79E+08	0	8.81E+08	9.79E+07
85	0.01	8.07E+07	0	7.27E+07	8.07E+06
90	0	0	0	0	0
95	0	0	0	0	0
100	0	0	0	0	0

Table 5-13 Fecal Coliform TMDL Calculations for Beaver Creek (OK220600040030_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	2502	2.45E+13	0	2.20E+13	2.45E+12
5	64.7	6.33E+11	0	5.70E+11	6.33E+10
10	24.0	2.34E+11	0	2.11E+11	2.34E+10
15	11.8	1.15E+11	0	1.04E+11	1.15E+10
20	7.1	6.99E+10	0	6.30E+10	6.99E+09
25	4.8	4.66E+10	0	4.20E+10	4.66E+09
30	3.2	3.11E+10	0	2.80E+10	3.11E+09
35	2.3	2.20E+10	0	1.98E+10	2.20E+09
40	1.6	1.55E+10	0	1.40E+10	1.55E+09
45	1.2	1.13E+10	0	1.01E+10	1.13E+09
50	0.8	8.29E+09	0	7.46E+09	8.29E+08
55	0.6	6.35E+09	0	5.71E+09	6.35E+08
60	0.5	4.79E+09	0	4.31E+09	4.79E+08
65	0.36	3.50E+09	0	3.15E+09	3.50E+08
70	0.25	2.46E+09	0	2.21E+09	2.46E+08
75	0.15	1.42E+09	0	1.28E+09	1.42E+08
80	0.09	8.42E+08	0	7.58E+08	8.42E+07
85	0.04	3.89E+08	0	3.50E+08	3.89E+07
90	0.01	1.30E+08	0	1.17E+08	1.30E+07
95	0	0	0	0	0
100	0	0	0	0	0

5.7 Reasonable Assurances

ODEQ will collaborate with a host of 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 provide reasonable assurance that the pollutant reductions as required by these TMDLs can be achieved and water quality can be restored to maintain designated uses. ODEQ'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 (ODEQ 2002). The CPP can be viewed from ODEQ's website at http://www.deq.state.ok.us/WQDnew/pubs/2002_cpp_final.pdf. Table 5-14 provides a partial list of the state partner agencies ODEQ will collaborate with to address point and nonpoint source reduction goals established by TMDLs.

Table 5-14 Partial List of Oklahoma Water Quality Management Agencies

Agency	Web Link
Oklahoma Conservation Commission	http://www.okcc.state.ok.us/WQ/WQ_home.htm
Oklahoma Department of Wildlife Conservation	http://www.wildlifedepartment.com/watchabl.htm
Oklahoma Department of Agriculture, Food, and Forestry	http://www.oda.state.ok.us/water-home.htm
Oklahoma Water Resources Board	http://www.owrb.state.ok.us/quality/index.php

The Oklahoma Conservation Commission (OCC) is the lead agency for Nonpoint Source Pollution in Oklahoma. 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. In addition, financial incentives are currently available to assist qualified applicants with construction of fences to create riparian buffers, ponds, wells, livestock watering facilities and stream crossings through the USDA, Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Programs (EQIP) and the Wildlife Habitat Incentives Program (WHIP).

As authorized by Section 402 of the CWA, the ODEQ has delegation of the NPDES Program in Oklahoma, except for certain jurisdictional areas related to agriculture and the oil and gas industry retained by State Department of Agriculture and Oklahoma Corporation Commission, for which the USEPA has retained permitting authority. The NPDES Program in Oklahoma is implemented via Title 252, Chapter 606 of the Oklahoma Pollution Discharge Elimination System (OPDES) Act and in accordance with the agreement between ODEQ and USEPA relating to administration and enforcement of the delegated NPDES Program. Implementation of point source WLAs is done through permits issued under the OPDES program.

The reduction rates called for in this TMDL report are as high as 86 percent. The ODEQ recognizes that achieving such high reductions may not be realistic, especially since unregulated nonpoint sources are a major cause of the impairment. 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 the receiving stream should be reviewed. For example, the Kansas Department of Environmental Quality has proposed to exclude certain high flow conditions during which pathogen standards will not apply, although that exclusion was not approved by the USEPA. Additionally, USEPA has been conducting new epidemiology studies and may develop new recommendations for pathogen criteria in the near future.

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

- **Removing the PBCR use**: This revision would require documentation in a Use Attainability Analysis that the use is not existing and cannot be attained. It is unlikely this approach would be successful since there is evidence that people do swim in these waterbodies, thus constituting an existing use. Existing uses cannot be removed.
- **Modifying 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 bacteria 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.
- **Revising the existing numeric criteria**: Oklahoma's current pathogen criteria are based on USEPA guidelines (See Implementation Guidance for Ambient Water Quality Criteria for Bacteria, May 2002 Draft; and Ambient Water Quality Criteria for Bacteria-1986, January 1986). However, those guidelines have received much criticism and USEPA studies that could result in revisions to their recommendations are ongoing. The use of the three indicators specified in Oklahoma's standards should be evaluated. The numeric criteria values should also be evaluated using a risk-based method such as that found in USEPA guidance.

Unless or until the WQSs are revised and approved by USEPA, 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.

SECTION 6
PUBLIC PARTICIPATION

This TMDL report was sent to other related state agencies and local government agencies for peer review. Then the report was submitted to the EPA for technical review. The report was technically approved by the EPA on July 20, 2007. A public notice was published on January 16, 2008 and the report was made available for public review and comments. The public comment period started on January 16, 2008 and ended on March 2, 2008. Three written comments were received. They are from Poteau Valley Improvement Authority (PVIA), the other from Oklahoma Department of Agriculture, Food and Forestry, and Natual Resources Conservation Service, USDA.

All comments were responded and the report was updated accordingly. The response to comments was included in Appendix E of this report.

SECTION 7
REFERENCES

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APPENDIX A
AMBIENT WATER QUALITY BACTERIA DATA – 1999 TO 2003

Appendix A

Ambient Water Quality Bacteria Data – 1999 to 2003

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220100030010T	Brazil Creek: Latimer Co.	8/21/2000	10	EC	406
OK220100030010T	Brazil Creek: Latimer Co.	8/21/2000	10	EC	406
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	3076	EC	406
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	3076	EC	406
OK220100030010T	Brazil Creek: Latimer Co.	9/26/2000	52	EC	406
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	201	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	85	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	201	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	10	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	41	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	10	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	1/16/2001	10	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	95	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	183	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	95	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	31	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	10	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	31	EC	2030
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	1000	ENT	108
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	1000	ENT	108
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	1000	ENT	108
OK220100030010T	Brazil Creek: Latimer Co.	9/26/2000	2000	ENT	108
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	800	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	80	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	800	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	800	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	20	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	50	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	20	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	20	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	1/16/2001	40	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	80	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	100	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	80	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	80	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	60	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	20	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	60	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	60	ENT	540
OK220100030010T	Brazil Creek: Latimer Co.	4/26/1999	2000	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	4/26/1999	2000	FC	2000

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220100030010T	Brazil Creek: Latimer Co.	4/26/1999	2000	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	4/27/1999	2000	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	6/21/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	6/21/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	6/21/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/19/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/19/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/19/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/20/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	8/23/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	8/23/1999	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	8/24/1999	300	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	11/9/1999	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/13/1999	2200	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/13/1999	2200	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/13/1999	2200	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/14/1999	4000	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	1/18/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	1/18/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	1/19/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	2/21/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	3/28/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	3/28/2000	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	3/28/2000	1200	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	5/8/2000	400	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	5/8/2000	400	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	5/8/2000	400	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	5/9/2000	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	6/12/2000	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	6/12/2000	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	6/13/2000	100	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/17/2000	110	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/17/2000	110	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/17/2000	110	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	7/18/2000	400	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	8/21/2000	30	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	8/21/2000	30	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	8/21/2000	30	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	13000	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	13000	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	9/25/2000	13000	FC	400
OK220100030010T	Brazil Creek: Latimer Co.	9/26/2000	190	FC	400

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	200	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	300	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	200	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	10/30/2000	200	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	120	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	90	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	120	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	12/4/2000	120	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	1/16/2001	10	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	180	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	100	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	180	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	2/20/2001	180	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	20	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	50	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	20	FC	2000
OK220100030010T	Brazil Creek: Latimer Co.	3/26/2001	20	FC	2000
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/14/1999	2900	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/12/1999	110	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/10/1999	40	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/20/1999	60	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/10/2000	750	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/13/2000	100	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/19/2000	80	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/23/2001	900	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/20/2001	50	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/25/2001	100	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/20/2001	160	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/18/2001	700	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/20/2002	400	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/17/2002	90	FC	400

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/22/2002	70	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/9/2002	20	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/5/2003	400	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/9/2003	500	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/24/2003	100	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/14/2003	1000	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/28/2003	10	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/18/2003	20	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/3/2003	100	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/22/2003	130	FC	400
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/14/1999	4884	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/12/1999	41	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/10/1999	41	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/20/1999	426	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/10/2000	733	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/13/2000	109	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/19/2000	85	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/23/2001	717	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/20/2001	41	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/25/2001	74	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/20/2001	63	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/18/2001	459	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/20/2002	262	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/17/2002	85	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/22/2002	20	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/9/2002	10	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/5/2003	240	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/9/2003	10	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/24/2003	146	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/14/2003	350	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/28/2003	20	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/18/2003	20	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/3/2003	85	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/22/2003	74	EC	406
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/14/1999	10000	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/12/1999	70	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/10/1999	10	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/20/1999	10	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/10/2000	1800	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/13/2000	120	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/19/2000	90	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/23/2001	2100	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/20/2001	130	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/25/2001	110	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/20/2001	130	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/18/2001	3000	ENT	108

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/20/2002	10	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/17/2002	200	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/22/2002	500	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/9/2002	60	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	5/5/2003	2000	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/9/2003	120	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	6/24/2003	200	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/14/2003	8000	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	7/28/2003	30	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	8/18/2003	70	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/3/2003	400	ENT	108
OK220100040020-001AT	Fourche-Maline Creek, Off US 270, Red Oak	9/22/2003	300	ENT	108
OK220200040010W	Sans Bois Creek	4/27/1999	4000	FC	2000
OK220200040010W	Sans Bois Creek	5/25/1999	100	FC	400
OK220200040010W	Sans Bois Creek	6/22/1999	500	FC	400
OK220200040010W	Sans Bois Creek	7/20/1999	100	FC	400
OK220200040010W	Sans Bois Creek	8/24/1999	100	FC	400
OK220200040010W	Sans Bois Creek	10/5/1999	200	FC	2000
OK220200040010W	Sans Bois Creek	11/9/1999	400	FC	2000
OK220200040010W	Sans Bois Creek	12/14/1999	400	FC	2000
OK220200040010W	Sans Bois Creek	1/19/2000	100	FC	2000
OK220200040010W	Sans Bois Creek	2/21/2000	100	FC	2000
OK220200040010W	Sans Bois Creek	3/28/2000	700	FC	2000
OK220200040010W	Sans Bois Creek	5/9/2000	100	FC	400
OK220200040010W	Sans Bois Creek	6/13/2000	100	FC	400
OK220200040010W	Sans Bois Creek	7/18/2000	400	FC	400
OK220200040010W	Sans Bois Creek	8/22/2000	10	FC	400
OK220200040010W	Sans Bois Creek	9/26/2000	11000	FC	400
OK220200040010W	Sans Bois Creek	10/30/2000	700	FC	2000
OK220200040010W	Sans Bois Creek	12/4/2000	300	FC	2000
OK220200040010W	Sans Bois Creek	2/20/2001	60	FC	2000
OK220200040010W	Sans Bois Creek	3/26/2001	90	FC	2000
OK220200040010W	Sans Bois Creek	8/22/2000	10	EC	406
OK220200040010W	Sans Bois Creek	9/26/2000	2247	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220200040010W	Sans Bois Creek	10/30/2000	10140	EC	2000
OK220200040010W	Sans Bois Creek	12/4/2000	228	EC	2000
OK220200040010W	Sans Bois Creek	2/20/2001	31	EC	2000
OK220200040010W	Sans Bois Creek	3/26/2001	63	EC	2000
OK220200040010W	Sans Bois Creek	9/26/2000	4000	ENT	108
OK220200040010W	Sans Bois Creek	10/30/2000	1000	ENT	540
OK220200040010W	Sans Bois Creek	12/4/2000	110	ENT	540
OK220200040010W	Sans Bois Creek	2/20/2001	40	ENT	540
OK220200040010W	Sans Bois Creek	3/26/2001	1500	ENT	540
OK220200040050J	Sans Bois Creek- Mountain Fork	4/27/1999	10000	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	6/22/1999	500	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	7/20/1999	100	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	8/24/1999	100	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	12/14/1999	100	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	1/19/2000	100	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	2/21/2000	100	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	3/28/2000	100	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	5/9/2000	100	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	5/9/2000	200	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	6/13/2000	100	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	7/18/2000	20	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	8/22/2000	400	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	9/26/2000	900	FC	400
OK220200040050J	Sans Bois Creek- Mountain Fork	10/30/2000	300	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	10/30/2000	170	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	12/4/2000	10	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	1/16/2001	10	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	2/20/2001	10	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	3/26/2001	10	FC	2000
OK220200040050J	Sans Bois Creek- Mountain Fork	8/22/2000	1439	EC	406
OK220200040050J	Sans Bois Creek- Mountain Fork	9/26/2000	669	EC	406
OK220200040050J	Sans Bois Creek- Mountain Fork	10/30/2000	98	EC	2030
OK220200040050J	Sans Bois Creek- Mountain Fork	12/4/2000	10	EC	2030
OK220200040050J	Sans Bois Creek- Mountain Fork	1/16/2001	10	EC	2030
OK220200040050J	Sans Bois Creek- Mountain Fork	2/20/2001	10	EC	2030
OK220200040050J	Sans Bois Creek- Mountain Fork	3/26/2001	10	EC	2030
OK220200040050J	Sans Bois Creek- Mountain Fork	9/26/2000	3000	ENT	108
OK220200040050J	Sans Bois Creek- Mountain Fork	9/26/2000	1200	ENT	108
OK220200040050J	Sans Bois Creek- Mountain Fork	10/30/2000	3000	ENT	540
OK220200040050J	Sans Bois Creek- Mountain Fork	10/30/2000	110	ENT	540
OK220200040050J	Sans Bois Creek- Mountain Fork	12/4/2000	10	ENT	540
OK220200040050J	Sans Bois Creek- Mountain Fork	12/4/2000	20	ENT	540
OK220200040050J	Sans Bois Creek- Mountain Fork	1/16/2001	20	ENT	540
OK220200040050J	Sans Bois Creek- Mountain Fork	2/20/2001	10	ENT	540

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220200040050J	Sans Bois Creek- Mountain Fork	3/26/2001	10	ENT	540
OK220600010070G	Longtown Creek	6/22/1999	100	FC	400
OK220600010070G	Longtown Creek	7/20/1999	100	FC	400
OK220600010070G	Longtown Creek	8/24/1999	100	FC	400
OK220600010070G	Longtown Creek	11/9/1999	300	FC	2000
OK220600010070G	Longtown Creek	12/14/1999	700	FC	2000
OK220600010070G	Longtown Creek	1/19/2000	100	FC	2000
OK220600010070G	Longtown Creek	2/21/2000	100	FC	2000
OK220600010070G	Longtown Creek	3/28/2000	100	FC	2000
OK220600010070G	Longtown Creek	5/9/2000	1700	FC	400
OK220600010070G	Longtown Creek	6/13/2000	800	FC	400
OK220600010070G	Longtown Creek	7/18/2000	30	FC	400
OK220600010070G	Longtown Creek	8/22/2000	40	FC	400
OK220600010070G	Longtown Creek	9/26/2000	3000	FC	400
OK220600010070G	Longtown Creek	12/4/2000	300	FC	2000
OK220600010070G	Longtown Creek	2/20/2001	180	FC	2000
OK220600010070G	Longtown Creek	3/26/2001	310	FC	2000
OK220600010070G	Longtown Creek	8/22/2000	20	EC	406
OK220600010070G	Longtown Creek	9/26/2000	1153	EC	406
OK220600010070G	Longtown Creek	12/4/2000	183	EC	2030
OK220600010070G	Longtown Creek	2/20/2001	228	EC	2030
OK220600010070G	Longtown Creek	3/26/2001	269	EC	2030
OK220600010070G	Longtown Creek	9/26/2000	6000	ENT	108
OK220600010070G	Longtown Creek	12/4/2000	500	ENT	540
OK220600010070G	Longtown Creek	2/20/2001	100	ENT	540
OK220600010070G	Longtown Creek	3/26/2001	50	ENT	540
OK220600010100P	Mill Creek: Trib. To Eufaula	4/27/1999	3000	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	5/25/1999	100	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	6/22/1999	200	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	7/20/1999	100	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	8/24/1999	100	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	11/9/1999	100	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	12/14/1999	700	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	1/19/2000	100	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	2/21/2000	100	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	3/28/2000	1100	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	5/9/2000	7500	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	6/13/2000	500	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	7/18/2000	40	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	8/22/2000	10	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	9/26/2000	900	FC	400
OK220600010100P	Mill Creek: Trib. To Eufaula	12/4/2000	60	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	2/20/2001	0	FC	2000
OK220600010100P	Mill Creek: Trib. To Eufaula	3/26/2001	0	FC	2000

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600010100P	Mill Creek: Trib. To Eufaula	8/22/2000	10	EC	406
OK220600010100P	Mill Creek: Trib. To Eufaula	9/26/2000	1445	EC	406
OK220600010100P	Mill Creek: Trib. To Eufaula	12/4/2000	52	EC	2030
OK220600010100P	Mill Creek: Trib. To Eufaula	9/26/2000	1000	ENT	108
OK220600010100P	Mill Creek: Trib. To Eufaula	12/4/2000	70	ENT	540
OK220600010100P	Mill Creek: Trib. To Eufaula	2/20/2001	0	ENT	540
OK220600010100P	Mill Creek: Trib. To Eufaula	3/26/2001	0	ENT	540
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/15/1999	330	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/13/1999	20	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/11/1999	4500	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/21/1999	90	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/10/2000	20000	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/13/2000	1300	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/19/2000	5	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/15/2000	50	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/12/2000	30	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/22/2001	8000	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/18/2001	10	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/23/2001	5	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/24/2001	5	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/20/2001	100	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/17/2001	80	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/10/2002	500	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/17/2002	40	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/11/2002	20	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/5/2003	400	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/9/2003	50	FC	400

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/25/2003	200	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/14/2003	60	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/30/2003	10	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/18/2003	10	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/3/2003	3900	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/22/2003	200	FC	400
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/15/1999	368	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/13/1999	31	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/11/1999	813	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/21/1999	41	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/10/2000	5794	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/13/2000	677	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/19/2000	10	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/15/2000	10	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/12/2000	5	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/22/2001	2909	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/18/2001	41	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/23/2001	5	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/24/2001	10	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/20/2001	52	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/17/2001	107	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/10/2002	285	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/17/2002	31	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/11/2002	10	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/5/2003	240	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/9/2003	10	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/25/2003	73	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/14/2003	10	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/30/2003	10	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/18/2003	74	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/3/2003	1012	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/22/2003	86	EC	406
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/15/1999	140	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/13/1999	5	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/11/1999	60	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/21/1999	10	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/10/2000	40000	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/13/2000	610	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/19/2000	20	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/15/2000	20	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/12/2000	50	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/22/2001	73000	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/18/2001	5	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/23/2001	40	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/24/2001	30	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/20/2001	120	ENT	108

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/17/2001	100	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/10/2002	900	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/17/2002	120	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/11/2002	10	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	5/5/2003	4000	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/9/2003	10	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	6/25/2003	130	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/14/2003	10	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	7/30/2003	30	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	8/18/2003	20	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/3/2003	1300	ENT	108
OK220600030010-001AT	Brushy Creek, Off US 270, Haileyville	9/22/2003	100	ENT	108
OK220600030010T	Brushy Creek	4/26/1999	2000	FC	2000
OK220600030010T	Brushy Creek	6/21/1999	300	FC	400
OK220600030010T	Brushy Creek	7/19/1999	100	FC	400
OK220600030010T	Brushy Creek	8/23/1999	100	FC	400
OK220600030010T	Brushy Creek	12/13/1999	800	FC	2000
OK220600030010T	Brushy Creek	1/18/2000	100	FC	2000
OK220600030010T	Brushy Creek	2/20/2000	100	FC	2000
OK220600030010T	Brushy Creek	3/27/2000	2600	FC	2000
OK220600030010T	Brushy Creek	5/8/2000	100	FC	400
OK220600030010T	Brushy Creek	6/12/2000	2300	FC	400
OK220600030010T	Brushy Creek	7/17/2000	540	FC	400
OK220600030010T	Brushy Creek	8/21/2000	0	FC	400
OK220600030010T	Brushy Creek	9/25/2000	4000	FC	400
OK220600030010T	Brushy Creek	10/31/2000	1000	FC	2000
OK220600030010T	Brushy Creek	12/6/2000	20	FC	2000
OK220600030010T	Brushy Creek	1/17/2001	160	FC	2000
OK220600030010T	Brushy Creek	2/21/2001	300	FC	2000
OK220600030010T	Brushy Creek	3/27/2001	30	FC	2000
OK220600030010T	Brushy Creek	9/25/2000	187	EC	406
OK220600030010T	Brushy Creek	10/31/2000	1401	EC	2030
OK220600030010T	Brushy Creek	12/6/2000	31	EC	2030
OK220600030010T	Brushy Creek	1/17/2001	272	EC	2030

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600030010T	Brushy Creek	2/21/2001	74	EC	2030
OK220600030010T	Brushy Creek	3/27/2001	20	EC	2030
OK220600030010T	Brushy Creek	9/25/2000	34000	ENT	108
OK220600030010T	Brushy Creek	10/31/2000	6000	ENT	540
OK220600030010T	Brushy Creek	12/6/2000	20	ENT	540
OK220600030010T	Brushy Creek	1/17/2001	900	ENT	540
OK220600030010T	Brushy Creek	2/21/2001	160	ENT	540
OK220600030010T	Brushy Creek	3/27/2001	10	ENT	540
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	6/18/2001	160	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	6/18/2001	600	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	7/31/2001	330	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	8/28/2001	510	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	9/25/2001	120	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	11/27/2001	300	FC	2000
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	2/25/2002	210	FC	2000
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	4/3/2002	50	FC	2000
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	400	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	500	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	7/31/2002	3000	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	8/26/2002	90	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	7701	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	9804	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	7/31/2002	24192	FC	400
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	6/18/2001	145	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	6/18/2001	272	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	7/31/2001	97	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	8/28/2001	131	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	9/25/2001	52	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	331	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	282	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	7/31/2002	554	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	8/26/2002	20	EC	406
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	6/18/2001	300	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	6/18/2001	400	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	7/31/2001	300	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	8/28/2001	7000	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	9/25/2001	400	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	3000	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	5/30/2002	400	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	7/31/2002	3000	ENT	108
OK220600030020-001SR	Blue Creek, SH 63, Haileyville	8/26/2002	200	ENT	108
OK220600030020-002SR	Blue Creek, US 270, Haileyville	7/31/2001	2600	FC	400
OK220600030020-002SR	Blue Creek, US 270, Haileyville	8/28/2001	80	FC	400
OK220600030020-002SR	Blue Creek, US 270, Haileyville	9/25/2001	40	FC	400
OK220600030020-002SR	Blue Creek, US 270, Haileyville	11/27/2001	900	FC	2000
OK220600030020-002SR	Blue Creek, US 270, Haileyville	2/25/2002	500	FC	2000
OK220600030020-002SR	Blue Creek, US 270, Haileyville	4/3/2002	100	FC	2000
OK220600030020-002SR	Blue Creek, US 270, Haileyville	7/31/2002	2000	FC	400
OK220600030020-002SR	Blue Creek, US 270, Haileyville	7/31/2002	24192	FC	400
OK220600030020-002SR	Blue Creek, US 270, Haileyville	7/31/2001	1850	EC	406
OK220600030020-002SR	Blue Creek, US 270, Haileyville	8/28/2001	31	EC	406
OK220600030020-002SR	Blue Creek, US 270, Haileyville	9/25/2001	31	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600030020-002SR	Blue Creek, US 270, Haileyville	7/31/2002	399	EC	406
OK220600030020-002SR	Blue Creek, US 270, Haileyville	7/31/2001	200	ENT	108
OK220600030020-002SR	Blue Creek, US 270, Haileyville	8/28/2001	40	ENT	108
OK220600030020-002SR	Blue Creek, US 270, Haileyville	9/25/2001	600	ENT	108
OK220600030020-002SR	Blue Creek, US 270, Haileyville	7/31/2002	4000	ENT	108
OK220600030050M	Peaceable Creek	4/26/1999	3000	FC	2000
OK220600030050M	Peaceable Creek	5/24/1999	600	FC	400
OK220600030050M	Peaceable Creek	6/21/1999	700	FC	400
OK220600030050M	Peaceable Creek	7/19/1999	200	FC	400
OK220600030050M	Peaceable Creek	8/23/1999	100	FC	400
OK220600030050M	Peaceable Creek	10/4/1999	300	FC	2000
OK220600030050M	Peaceable Creek	12/13/1999	3100	FC	2000
OK220600030050M	Peaceable Creek	1/18/2000	100	FC	2000
OK220600030050M	Peaceable Creek	2/20/2000	100	FC	2000
OK220600030050M	Peaceable Creek	3/27/2000	8400	FC	2000
OK220600030050M	Peaceable Creek	5/8/2000	100	FC	400
OK220600030050M	Peaceable Creek	6/12/2000	6000	FC	400
OK220600030050M	Peaceable Creek	7/17/2000	210	FC	400
OK220600030050M	Peaceable Creek	10/31/2000	300	FC	2000
OK220600030050M	Peaceable Creek	12/6/2000	10	FC	2000
OK220600030050M	Peaceable Creek	1/17/2001	110	FC	2000
OK220600030050M	Peaceable Creek	2/21/2001	500	FC	2000
OK220600030050M	Peaceable Creek	3/27/2001	80	FC	2000
OK220600030050M	Peaceable Creek	10/31/2000	98	EC	2030
OK220600030050M	Peaceable Creek	12/6/2000	30	EC	2030
OK220600030050M	Peaceable Creek	1/17/2001	109	EC	2030
OK220600030050M	Peaceable Creek	2/21/2001	272	EC	2030
OK220600030050M	Peaceable Creek	3/27/2001	74	EC	2030
OK220600030050M	Peaceable Creek	10/31/2000	800	ENT	540
OK220600030050M	Peaceable Creek	12/6/2000	40	ENT	540
OK220600030050M	Peaceable Creek	1/17/2001	130	ENT	540
OK220600030050M	Peaceable Creek	2/21/2001	70	ENT	540
OK220600030050M	Peaceable Creek	3/27/2001	60	ENT	540
OK220600040030G	Beaver Creek	4/26/1999	2000	FC	2000
OK220600040030G	Beaver Creek	5/24/1999	500	FC	400
OK220600040030G	Beaver Creek	6/21/1999	500	FC	400
OK220600040030G	Beaver Creek	7/19/1999	100	FC	400
OK220600040030G	Beaver Creek	8/23/1999	100	FC	400
OK220600040030G	Beaver Creek	11/8/1999	100	FC	2000
OK220600040030G	Beaver Creek	12/13/1999	200	FC	2000

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacterial Indicator	Single Sample Criteria * (#/100ml)
OK220600040030G	Beaver Creek	1/18/2000	100	FC	2000
OK220600040030G	Beaver Creek	2/20/2000	200	FC	2000
OK220600040030G	Beaver Creek	3/27/2000	400	FC	2000
OK220600040030G	Beaver Creek	5/8/2000	200	FC	400
OK220600040030G	Beaver Creek	6/12/2000	100	FC	400
OK220600040030G	Beaver Creek	7/17/2000	180	FC	400
OK220600040030G	Beaver Creek	8/21/2000	110	FC	400
OK220600040030G	Beaver Creek	9/25/2000	62000	FC	400
OK220600040030G	Beaver Creek	10/31/2000	3200	FC	2000
OK220600040030G	Beaver Creek	12/6/2000	50	FC	2000
OK220600040030G	Beaver Creek	1/17/2001	40	FC	2000
OK220600040030G	Beaver Creek	2/21/2001	80	FC	2000
OK220600040030G	Beaver Creek	3/27/2001	70	FC	2000
OK220600040030G	Beaver Creek	8/21/2000	96	EC	406
OK220600040030G	Beaver Creek	9/25/2000	12996	EC	406
OK220600040030G	Beaver Creek	10/31/2000	1850	EC	2030
OK220600040030G	Beaver Creek	12/6/2000	31	EC	2030
OK220600040030G	Beaver Creek	1/17/2001	74	EC	2030
OK220600040030G	Beaver Creek	2/21/2001	148	EC	2030
OK220600040030G	Beaver Creek	3/27/2001	97	EC	2030
OK220600040030G	Beaver Creek	9/25/2000	23000	ENT	108
OK220600040030G	Beaver Creek	10/31/2000	19000	ENT	540
OK220600040030G	Beaver Creek	12/6/2000	600	ENT	540
OK220600040030G	Beaver Creek	1/17/2001	900	ENT	540
OK220600040030G	Beaver Creek	2/21/2001	130	ENT	540
OK220600040030G	Beaver Creek	3/27/2001	140	ENT	540

EC = E. coli; ENT = enterococci; FC = fecal coliform

* Single sample criterion for secondary contact recreation season is shown for all samples collected between October 1st and April 30th.

APPENDIX B
NPDES PERMIT DISCHARGE MONITORING REPORT DATA AND SANSITARY SEWER OVERFLOW DATA

Appendix B

NPDES Permit Discharge Monitoring Report Data 1998-2006

NPDES	Monthly Average Concentration (cfu/100ml)	Monthly Maximum Concentration (cfu/100ml)	Outfall	Report Date	Parameter Code	Parameter	Monthly Average Flow (MGD)	Monthly Maximum Flow (MGD)	Parameter Code	Parameter
OK0022861	600	1100	001	5/31/1998	74055	FC	0.222	0.35	50050	Flow
OK0022861	67	200	001	6/30/1998	74055	FC	0.225	0.3	50050	Flow
OK0022861	33	100	001	7/31/1998	74055	FC	0.215	0.225	50050	Flow
OK0022861	67	150	001	8/31/1998	74055	FC	0.213	0.225	50050	Flow
OK0022861	100	200	001	9/30/1998	74055	FC	0.217	0.35	50050	Flow
OK0022861	400	450	001	5/31/1999	74055	FC	0.26	0.35	50050	Flow
OK0022861	270	400	001	6/30/1999	74055	FC	0.273	0.375	50050	Flow
OK0022861	100	100	001	7/31/1999	74055	FC	6.75	0.225	50050	Flow
OK0022861	466	700	001	8/31/1999	74055	FC	0.2	0.2	50050	Flow
OK0022861	200	400	001	9/30/1999	74055	FC	0.216	0.25	50050	Flow
OK0022861	400	500	001	5/31/2000	74055	FC	0.25	0.4	50050	Flow
OK0022861	400	500	001	6/30/2000	74055	FC	0.283	0.45	50050	Flow
OK0022861	300	400	001	7/31/2000	74055	FC	0.243	0.4	50050	Flow
OK0022861	400	500	001	8/31/2000	74055	FC	0.225	0.25	50050	Flow
OK0022861	100	200	001	9/30/2000	74055	FC	0.233	0.4	50050	Flow
OK0022861	500	600	001	5/31/2001	74055	FC	0.265	0.5	50050	Flow
OK0022861	300	400	001	6/30/2001	74055	FC	0.272	0.45	50050	Flow
OK0022861	100	200	001	7/31/2001	74055	FC	0.225	0.245	50050	Flow
OK0022861	200	300	001	8/31/2001	74055	FC	0.245	0.35	50050	Flow
OK0022861	300	400	001	9/30/2001	74055	FC	0.245	0.45	50050	Flow
OK0022861			001	5/31/2002	74055	FC	0.235	0.4	50050	Flow
OK0022861			001	6/30/2002	74055	FC	0.225	0.45	50050	Flow
OK0022861			001	7/31/2002	74055	FC	0.235	0.4	50050	Flow
OK0022861	100	200	001	8/31/2002	74055	FC	0.235	0.35	50050	Flow
OK0022861	100	200	001	9/30/2002	74055	FC	0.225	0.3	50050	Flow
OK0022861	1700	1800	001	5/31/2003	74055	FC	0.236	0.37	50050	Flow
OK0022861	2800	3300	001	6/30/2003	74055	FC	0.246	0.4	50050	Flow
OK0022861	200	300	001	7/31/2003	74055	FC	0.225	0.32	50050	Flow

NPDES	Monthly Average Concentration (cfu/100ml)	Monthly Maximum Concentration (cfu/100ml)	Outfall	Report Date	Parameter Code	Parameter	Monthly Average Flow (MGD)	Monthly Maximum Flow (MGD)	Parameter Code	Parameter
OK0022861	100	200	001	8/31/2003	74055	FC	0.242	0.375	50050	Flow
OK0022861	1500	2700	001	9/30/2003	74055	FC	0.249	0.475	50050	Flow
OK0022861	100	200	001	5/31/2004	74055	FC	0.108	0.25	50050	Flow
OK0022861	200	200	001	6/30/2004	74055	FC	0.133	0.35	50050	Flow
OK0022861	300	300	001	7/31/2004	74055	FC	0.156	0.4	50050	Flow
OK0022861	147	277	001	8/31/2004	74055	FC	0.139	0.27	50050	Flow
OK0022861	78	80	001	9/30/2004	74055	FC	0.117	0.168	50050	Flow
OK0022861	18	28	001	5/31/2005	74055	FC	0.114	0.154	50050	Flow
OK0022861	239	439	001	6/30/2005	74055	FC	0.11	0.138	50050	Flow
OK0022861	55	59	001	7/31/2005	74055	FC	0.095	0.169	50050	Flow
OK0022861	60	119	001	8/31/2005	74055	FC	0.102	0.158	50050	Flow
OK0022861	385	753	001	9/30/2005	74055	FC	0.095	0.153	50050	Flow
OK0022861	96	192	001	5/31/2006	74055	FC	0.173	0.399	50050	Flow
OK0022861	190	380	001	6/30/2006	74055	FC	0.106	0.246	50050	Flow
OK0022861	51	102	001	7/31/2006	74055	FC	0.095	0.18	50050	Flow
OK0022861	31	56	001	8/31/2006	74055	FC	0.097	0.119	50050	Flow
OK0022861	7	14	001	9/30/2006	74055	FC	0.098	0.163	50050	Flow
OK0028843	0	0	001	5/31/1998	74055	FC	0.102	0.113	50050	Flow
OK0028843	0	0	001	6/30/1998	74055	FC	0.115	0.2	50050	Flow
OK0028843	200	200	001	7/31/1998	74055	FC	0.065	0.093	50050	Flow
OK0028843	200	200	001	8/31/1998	74055	FC	0.065	0.091	50050	Flow
OK0028843	350	350	001	9/30/1998	74055	FC	0.169	0.52	50050	Flow
OK0028843	550	700	001	5/31/1999	74055	FC	0.395	0.799	50050	Flow
OK0028843	400	400	001	6/30/1999	74055	FC	0.368	0.705	50050	Flow
OK0028843	175	200	001	7/31/1999	74055	FC	0.25	0.674	50050	Flow
OK0028843	1200	1600	001	8/31/1999	74055	FC	0.343	0.84	50050	Flow
OK0028843	600	600	001	9/30/1999	74055	FC	370	830	50050	Flow
OK0028843	850	1100	001	5/31/2000	74055	FC	0.32	0.688	50050	Flow
OK0028843	2900	3900	001	6/30/2000	74055	FC	0.31	0.116	50050	Flow
OK0028843	4700	5200	001	7/31/2000	74055	FC	0.39	0.558	50050	Flow
OK0028843	900	1000	001	8/31/2000	74055	FC	0.576	0.911	50050	Flow

NPDES	Monthly Average Concentration (cfu/100ml)	Monthly Maximum Concentration (cfu/100ml)	Outfall	Report Date	Parameter Code	Parameter	Monthly Average Flow (MGD)	Monthly Maximum Flow (MGD)	Parameter Code	Parameter
OK0028843	700	900	001	9/30/2000	74055	FC	0.122	0.879	50050	Flow
OK0028843	100	100	001	5/31/2001	74055	FC	0.289	0.558	50050	Flow
OK0028843	200	200	001	6/30/2001	74055	FC	0.277	0.599	50050	Flow
OK0028843	100	200	001	7/31/2001	74055	FC	0.111	0.123	50050	Flow
OK0028843	100	200	001	8/31/2001	74055	FC	0.137	0.161	50050	Flow
OK0028843	200	200	001	9/30/2001	74055	FC	0.263	0.401	50050	Flow
OK0028843			001	5/31/2002	74055	FC	0.2	0.503	50050	Flow
OK0028843			001	6/30/2002	74055	FC	0.255	0.522	50050	Flow
OK0028843	200	200	001	7/31/2002	74055	FC	0.12	0.211	50050	Flow
OK0028843	100	100	001	8/31/2002	74055	FC	0.131	0.255	50050	Flow
OK0028843	200	200	001	9/30/2002	74055	FC	0.106	0.123	50050	Flow
OK0028843	100	100	001	5/31/2003	74055	FC	0.193	0.404	50050	Flow
OK0028843	0	0	001	6/30/2003	74055	FC	0.186	0.354	50050	Flow
OK0028843	100	200	001	7/31/2003	74055	FC	0.105	0.153	50050	Flow
OK0028843	200	400	001	8/31/2003	74055	FC	0.111	0.188	50050	Flow
OK0028843	0	0	001	9/30/2003	74055	FC	0.135	0.377	50050	Flow
OK0028843	58	106	001	5/31/2005	74055	FC	0.208	0.25	50050	Flow
OK0028843	2479	4914	001	6/30/2005	74055	FC	0.092	0.128	50050	Flow
OK0028843	506	753	001	7/31/2005	74055	FC	0.079	0.145	50050	Flow
OK0028843	98	182	001	8/31/2005	74055	FC	0.111	0.321	50050	Flow
OK0028843	50	97	001	9/30/2005	74055	FC	0.085	0.163	50050	Flow
OK0028843	99	181	001	10/31/2005	74055	FC	0.085	0.118	50050	Flow
OK0028843	166	328	001	11/30/2005	74055	FC	0.101	0.178	50050	Flow
OK0028843	198	307	001	5/31/2006	74055	FC	0.308	0.744	50050	Flow
OK0028843	5	9	001	6/30/2006	74055	FC	0.109	0.431	50050	Flow
OK0028843	955	1535	001	7/31/2006	74055	FC	0.07	0.092	50050	Flow
OK0028843	4	7	001	8/31/2006	74055	FC	0.06	0.08	50050	Flow
OK0028843	110	181	001	9/30/2006	74055	FC	0.065	0.077	50050	Flow
OK0028843	3	5	001	10/31/2006	74055	FC	0.095	0.37	50050	Flow

ODEQ Summary of Available Reports of Sansitary Sewer Overflows

Facility Name	Date	Facility ID	Location	Amount (gal)	Cause	Type of Source
Haileyville Sewage Plant	1/26/1998	S20634	Doyle St.		Overflow of ground water thru sewer system	
Haileyville Sewage Plant	1/26/1998	S20634	Football field, Doyle St. & Hailey St.		Floodwaters overflowed thru sewers	
Haileyville	2/17/1998	S20634	Doyle St.		Rain	
Haileyville Sewage Plant	2/26/1998	S20634	Football field		Rain flooded thru sewers	
Haileyville	3/7/1998	S20634	Manhole by football field			
Haileyville WWTP	3/16/1998	S20634	Football field, 2nd & Hailey, Doyle St.		Immense rain in sewer, lightening hit pump on lift station	
Haileyville WWTP	3/17/1998	S20634	Doyle St., football field		Rain still flooding through sewers	
Haileyville Sewage Plant	3/31/1998	S20634	Football field, Doyle St.		Immense amount of rain	
Haileyville	6/18/1998	S20634	2nd St. & Hwy 63 at football field		Rain	
Haileyville	8/23/1998	S20634	Manhole at football field		Lift station down	
Haileyville	9/14/1998	S20634	Doyle St. / football field		Rain	
Haileyville	9/21/1998	S20634	Football field	150	Lightning hit l.S.	
Haileyville	10/5/1998	S20634	Doyle St./2nd & 3rd St. & Haileyville/ football field			
Haileyville	11/1/1998	S20634	2nd & 3rd on Hailey			
Haileyville	11/1/1998	S20634	Football field			
Haileyville	12/4/1998	S20634	1st & Hailey/2nd & Hailey/Doyle St./McCloud			
Haileyville	12/4/1998	S20634	Doyle St.	28,000	Rain	
Haileyville	12/12/1998	S20634	Doyle St./Mccloud St.	18,000	Rain	
Haileyville	12/12/1998	S20634	2nd & Hailey	3,000	Rain	
Haileyville	3/5/1999	S20634	Football field	8,000	Rain	
Haileyville	3/8/1999	S20634	2nd & Doyle	4,000	Rains	
Haileyville	3/13/1999	S20634	2nd & Doyle	30,000	Rains	
Haileyville	3/27/1999	S20634	Doyle & Mccloud	53,000	Rains	
Haileyville	3/29/1999	S20634	Doyle & 2nd/McCloud	10,000	Rains	
Haileyville	5/29/1999	S20634	2nd & Doyle	35,000	Rain	
Haileyville	6/17/1999	S20634	Mccloud/football field	1,500	Pump failure	
Haileyville	6/28/1999	S20634	1st & Mccloud		Pump failure	
Haileyville	6/30/1999	S20634	2nd & Doyle		Rain	

Facility Name	Date	Facility ID	Location	Amount (gal)	Cause	Type of Source
Haileyville	6/30/1999	S20634	Mcloud	1,500		
Haileyville	4/27/2000	S20634	1st & Doyle		Rains	
Haileyville	4/27/2000	S20634	Mcloud		Rains	
Haileyville	5/1/2000	S20634	1st. & Doyle		Rains	
Haileyville	5/1/2000	S20634	Mcloud		Rains	
Haileyville	5/9/2000	S20634	2nd & Doyle		Rains	
Haileyville	5/9/2000	S20634	Mcloud		Rains	
Haileyville	6/19/2000	S20634	Mcloud		Rains	
Haileyville	6/19/2000	S20634	Doyle		Rains	
Haileyville	11/7/2000	S20634	Hwy 63 & 2nd		Rains	
Haileyville	11/7/2000	S20634	2nd & Doyle		Rains	
Haileyville	11/7/2000	S20634	3rd & Hailey		Rains	
Haileyville	11/7/2000	S20634	Craig		Rain	
Haileyville	1/12/2001	S20634	1st & Doyle		Heavy rains	
Haileyville City Hall	1/12/2001	S20634	1st & Doyle		Heavy rains	
Haileyville WW	2/15/2001	S20634	Main & Doyle	Unknown	Excessive rain. 2" in 24 hrs	
Haileyville WW	2/16/2001	S20634	600 blk of Craig St	Unknown	Heavy rain	
Haileyville WW	2/16/2001	S20634	Main & Doyle	Unknown	Heavy rain	
Haileyville WW	2/16/2001	S20634	1st & Doyle	Unknown	Heavy rain	
Haileyville WW	2/16/2001	S20634	2nd St & Hailey	Unknown	Heavy rain	
Haileyville WW	2/16/2001	S20634	Hwy 63 & 2nd St.	Unknown	Heavy rain	
Haileyville	3/4/2004	S20634	Doyle St.	8,000	I&I	Manhole
Haileyville		S20634	600 Gleason			
Hartshorne	1/7/1998	20633	Apachi St. manhole running over	10000	Heavy rain and pump broke down	
Hartshorne	8/6/1992	S20633	Apache & First St.	0	Heavy rains	
Hartshorne	11/26/1994	S20633	Lift station on Apache	3000	Electrical storm threw breaker	
Hartshorne	12/8/1994	S20633	N 11th St.	5000	Line blockage	
Hartshorne	12/8/1994	S20633	915 Apache	12000	Rain I/I	
Hartshorne	12/8/1994	S20633	N 9th and Quapaw	5000	Rain I/I	
Hartshorne	4/1/1996	S20633	Apache St. end (lift station)	1000	Power failure	
Hartshorne	4/15/1996	S20633	Apache St.	5000	Pump failure & valve busted	
Hartshorne	4/16/1996	S20633	Apache St.		Pump down & valve broke	
Hartshorne	11/1/1996	S20633	Apache St. manhole		Rain	
Hartshorne	1/7/1999	S20633	106 Apache		Pump malfunction	
Hartshorne	10/10/2004	S20633			Rain	

Facility Name	Date	Facility ID	Location	Amount (gal)	Cause	Type of Source
Hartshorne	11/1/2004	S20633	Headworks		Flooding	Head works
Hartshorne	11/23/2004	S20633			Rain	
Hartshorne	11/29/2004	S20633			Rain	
Hartshorne	12/7/2004	S20633	Plant		Rain	
Hartshorne	1/3/2005	S20633	Plant		Rain	Head works
Hartshorne	1/4/2005	S20633	Plant			
Hartshorne	1/4/2005	S20633	Plant		Rain	Head works
Hartshorne	1/13/2005	S20633	Plant		Rain	Head works
Hartshorne	2/6/2005	S20633	Plant		Rain	Lagoon/basin
Hartshorne	3/21/2005	S20633			Rain	Drying beds
Hartshorne	3/21/2005	S20633	Plant		Rain	Head works
Hartshorne	3/27/2005	S20633	Plant		Rain	Head works
Hartshorne	4/1/2005	S20633	Plant		Rain	Head works
Hartshorne	4/6/2005	S20633	Plant		I&I	Head works
Hartshorne	3/19/2006	S20633			Rain	
Hartshorne	4/29/2006	S20633			Rain	Drying beds
Hartshorne	5/4/2006	S20633			Rain	Drying beds
Hartshorne	10/15/2006	S20633			I&I	Head works
Hartshorne	11/29/2006	S20633			Rain	Manhole
Hartshorne	12/20/2006	S20633			Rain	Head works
Hartshorne	12/25/2006	S20633	Plant		Rain	Head works
Hartshorne	12/28/2006	S20633	Plant		Rain	Head works
Hartshorne	1/12/2007	S20633			Ice storm	Head works
Quinton	12/13/1992	S20202	5 different locations in town	0	I/I overload	
Quinton	3/17/2000	S20202	Lagoon	1,440	Rain	
Quinton	10/26/2000	S20202	Lagoons	2,125	Equipment failure	
Quinton	11/19/2002	S20202	Lagoon	2,200	Leaking line	
Red Oak	10/25/1991	S20106	Right behind the lift station - manhole overflow.	0	Stormwater runoff	
Red Oak	10/25/1991	S20106	Red Oak Creek		Heavy rainfall	
Red Oak	10/26/1991	S20106	North of resident - manhole overflow	0	Stormwater runoff	
Red Oak	10/26/1991	S20106	Red Oak Creek lift station		Heavy rainfall	
Red Oak	10/28/1991	S20106	Manhole behind the lift station	0	Too much rain	
Red Oak	10/28/1991	S20106	50 ft west of lift station on Red Oak Creek		Stormwater entered the system	

Facility Name	Date	Facility ID	Location	Amount (gal)	Cause	Type of Source
Red Oak	10/31/1991	S20106	West of the lift station	0	Stormwater	
Red Oak	10/31/1991	S20106	Behind the residence of Bill Rutledge	0	Stormwater	
Red Oak	10/31/1991	S20106	50 ft west of lift station		Stormwater entered system	
Red Oak	10/31/1991	S20106	100 ft N and west of Bill Rutledge residence		Stormwater entering system	
Red Oak	12/1/1991	S20106	Manhole 75 ft west of lift station		Heavy rainfall	
Red Oak	12/1/1991	S20106	Manhole 100 ft NW of Bill Rutledge residence		Excessive rain/smoke testing	
Red Oak	12/2/1991	S20106	Manhole 100 ft NW of Bill Rutledge residence		Heavy rainfall	
Red Oak	12/12/1991	S20106	Manhole 100 ft. NW of Rutledge residence		Infiltration/inflow	
Red Oak	12/12/1991	S20106	Manhole 75 ft. west of the lift station		Infiltration/inflow	
Red Oak	5/18/1992	S20106	100 ft. NW of Bill Rutledge	0	Stormwater infiltration caused manhole to overflow	
Red Oak	5/18/1992	S20106	100 ft. W of Lift Station	0	Stormwater infiltration caused manhole overflow	
Red Oak	5/19/1992	S20106	100 ft. W of Lift Station	0	Stormwater infiltration caused manhole to overflow	
Red Oak	5/19/1992	S20106	100 ft. NW of Bill Rutledge	0	Stormwater infiltration caused manhole overflow	
Red Oak	6/14/1992	S20106	Manhole 100 ft. NW of Bill Rutledge residence	0	Stormwater entering sewer system	
Red Oak	6/14/1992	S20106	Manhole 100 ft. west of the lift station	0	Stormwater	
Red Oak	9/10/1992	S20106	Manhole located 100 ft. west of the lift station		Stormwater	
Red Oak	9/10/1992	S20106	Manhole located 100 ft. NW of the Bill Rutledge residence	0	Stormwater	
Red Oak	9/19/1992	S20106	Manhole 100 ft west of lift station	0	Stormwater	
Red Oak	9/19/1992	S20106	100 ft NW of Bill Rutledge residence	0	Stormwater	
Red Oak	9/19/1992	S20106	100 ft NW of the Bill Rutledge residence		Stormwater	

Facility Name	Date	Facility ID	Location	Amount (gal)	Cause	Type of Source
Red Oak	2/15/1993	S20106	Manhole 100 ft NW of Bill Rutledge residence	0	I/I	
Red Oak	2/15/1993	S20106	Manhole 100 ft W of lift station	0	I/I	
Red Oak	4/14/1993	S20106	Manhole 100 ft W of lift station	0	Stormwater	
Red Oak	4/14/1993	S20106	Manhole 100 ft NW of Bill Rutledge residence	0	Stormwater	
Red Oak	5/11/1993	S20106	Manhole 100 W of lift station	0	Heavy rains	
Red Oak	11/16/1993	S20106	100 ft. west of lift station	0	Rain and I/I	
Red Oak	11/16/1993	S20106	100 ft. NW of Bill Rutledge	0	Rain and I/I	
Red Oak	12/8/1994	S20106	100 ft. west of lift station	0	Rain I/I	
Red Oak	12/8/1994	S20106	100 ft. NW of Bill Rutledge residence	0	Rain I/I	
Red Oak	5/8/1995	S20106	100 ft. west of l.S.	0	Rain I/I ppage	
Red Oak	5/8/1995	S20106	100 ft. NW of Bill Rutledge residence	0	Rain I/I ppage	
Red Oak	6/2/1995	S20106	Lift station manhole way south 1 1/4 miles	0	Rain I/I	
Red Oak	3/27/1996	S20106	Lift station/Bill Rutledge residence	0	Rain water	
Red Oak	10/31/1996	S20106	Manhole 100 ft. W. of l.S.		Stormwater entering system	
Red Oak	11/25/1996	S20106	Manhole located 100 ft. NW of Bill Rutledge residence		Stormwater	
Red Oak	11/25/1996	S20106	Manhole located 100 ft. West of l.S.		Stormwater	
Red Oak	11/30/1996	S20106	Manhole 100 ft. W. of l.S.		Stormwater	
Red Oak	2/3/1997	S20106	Manhole located 100 ft. NW of Bill Rutledge residence		Stormwater	
Red Oak	2/3/1997	S20106	Manhole located 100 ft. West of l.S.		Stormwater	
Red Oak	2/20/1997	S20106	100 ft. W. of l.S./100 ft. NW of Bill Rutledge residence		Stormwater	
Red Oak	7/18/1997	S20106	Manhole N of Bob Wilcox residence		Obstruction	
Red Oak	12/30/1997	S20106	Manhole west of Wilbur Henry residence			
Red Oak	10/27/1999	S20106	Janet Mauzey resident – SW 2nd & SW Oak	100	Pump failure	
Red Oak	5/6/2001	S20106	40 ft east of l.S.		Power outage at L.S.	Manhole

Facility Name	Date	Facility ID	Location	Amount (gal)	Cause	Type of Source
Red Oak	5/27/2001	S20106	Residence of Allen & Brenda Lyons		I&I	
Red Oak	5/28/2001	S20106	L.S.		I&I & power failure	Manhole
Red Oak	5/29/2001	S20106	Bill Rutledge residence		I&I	
Red Oak	10/15/2001	S20106	Manhole east of l.S.		Rain	Manhole
Red Oak	12/16/2001	S20106	Manhole front of l.S.		Rain	Manhole
Red Oak	3/18/2002	S20106	110 ft N of Brenda Lyons residence		I&I	Manhole
Red Oak	3/18/2002	S20106	N. of Bill Rutledge residence		I&I	Manhole
Red Oak	3/18/2002	S20106	East of lift station		I&I	Manhole
Red Oak	4/7/2002	S20106	100 ft N of Bill Rutledge residence		I&I	Manhole
Red Oak	4/7/2002	S20106	N. of Brenda Lyons residence		I&I	Manhole
Red Oak	4/7/2002	S20106	50 ft. E. of l.S.		I&I	Manhole
Red Oak	9/12/2004	S20106	Behind Rutledge residence		Blockage	Manhole
Red Oak	3/21/2005	S20106	Lift station		Electrical failure	Manhole
Red Oak	3/22/2005	S20106	E. of l.S.		Malfunction	Manhole
Red Oak	3/9/2006	S20106	E. of lift station		Power failure	Manhole
Red Oak PWA	5/27/2001	S20106	Manhole in front (east) of lift station	Unknown	I&I due to rain. 1 pump not working	Manhole
Red Oaks	10/31/1996	S20106	Manhole 100 ft. NW of Bill Rutledge residence		Rain	

APPENDIX C
ESTIMATED FLOW EXCEEDANCE PERCENTILES

Appendix C

Estimated Flow Exceedance Percentiles

WQ Station	OK220100040020-001AT	OK220200040010W	OK220200040050J	OK220600010070G	OK220600010100P	OK220600030010-001AT	OK220600030010T	OK220600030020-002SR	OK220600030050M	OK220600040030G
	Fourche Maline Creek	**Sans Bois Creek**	**Sans Bois Creek-Mountain Fork**	**Longtown Creek**	**Mill Creek**	**Brushy Creek**	**Brushy Creek**	**Blue Creek**	**Peaceable Creek**	**Beaver Creek**
WBID Segment	OK220100040020_00	OK220200040010_40	OK220200040050_00	OK220600010070_00	OK220600010100_20	OK220600030010_00	OK220600030010_10	OK220600030020_00	OK220600030050_00	OK220600040030_00
USGS Gage Reference	7247500[†]	07246000	07246000	07247500	07247500	07232000	07247500	07247500	7231990[†]	07247500
Watershed Area (sq. mile)	222.9	89.1	76.2	66.5	78.7	20.4	146.6	23.0	49.5	16.0
NRCS Curve Number	66.6	67.9	65.4	71.4	65.3	64.7	67.9	69.3	63.1	68.9
Average Annual Rainfall (inch)	50.7	47.7	50.0	47.0	45.2	47.0	47.6	47.9	46.0	48.3
Percentile	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
0	18,900	5,344	4,570	4,075	4,869	10,131	5,870	971	3,460	2,502
1	1,545	539	460	764	883	5,645	2,616	433	2,797	204
2	1,050	367	314	550	648	2,315	1,593	264	966	139
3	790	228	195	456	532	1,663	802	133	599	104
4	627	183	156	378	447	1,070	544	90	482	83
5	490	159	136	331	377	827	337	56	391	65
6	397	143	123	278	319	561	270	45	250	53
7	326	109	93	230	267	433	230	38	203	43
8	260	97	83	198	224	375	204	34	167	34
9	219	88	75	165	184	341	162	27	136	29
10	181	75	64	141	158	313	145	24	109	24
11	154	67	57	123	136	272	128	21	93	20
12	129	58	50	100	112	236	117	20	77	17
13	112	51	44	88	95	190	104	17	65	15
14	100	48	41	74	83	173	85	14	53	13
15	89	44	38	66	72	152	75	13	47	12
16	81	40	34	58	64	120	58	10	43	11
17	73	37	32	51	57	105	55	9.4	39	9.7
18	66	33	29	46	51	92	48	8.2	35	8.7
19	59	31	26	42	46	82	38	6.6	30	7.8
20	54	28	24	38	42	76	34	5.9	27	7.1
21	49	26	22	34	38	63	30	5.3	23	6.5
22	45	24	21	32	35	55	28	4.9	21	6.0
23	41	22	19	29	32	50	25	4.4	17	5.4
24	38	19	16	27	29	46	20	3.7	16	5.0
25	36	18	15	25	27	41	19	3.5	14	4.8
26	33	17	15	23	25	40	17	3.1	13	4.4
27	31	16	14	22	23	36	15	2.8	11	4.1
28	29	15	13	20	21	31	14	2.6	9.8	3.8
29	26	13	11	18	20	26	12	2.3	9.0	3.4
30	24	12	10	17	19	24	11	2.1	8.1	3.2
31	23	12	10	16	17	21	9.3	1.8	7.3	3.0
32	21	11	9.7	15	16	20	8.0	1.6	6.4	2.8
33	20	11	9.2	14	14	17	7.1	1.5	5.4	2.6

WQ Station	OK220100040020-001AT	OK220200040010W	OK220200040050J	OK220600010070G	OK220600010100P	OK220600030010-001AT	OK220600030010T	OK220600030020-002SR	OK220600030050M	OK220600040030G
	Fourche Maline Creek	**Sans Bois Creek**	**Sans Bois Creek-Mountain Fork**	**Longtown Creek**	**Mill Creek**	**Brushy Creek**	**Brushy Creek**	**Blue Creek**	**Peaceable Creek**	**Beaver Creek**
WBID Segment	OK220100040020_00	OK220200040010_40	OK220200040050_00	OK220600010070_00	OK220600010100_20	OK220600030010_00	OK220600030010_10	OK220600030020_00	OK220600030050_00	OK220600040030_00
USGS Gage Reference	7247500†	07246000	07246000	07247500	07247500	07232000	07247500	07247500	7231990†	07247500
Watershed Area (sq. mile)	222.9	89.1	76.2	66.5	78.7	20.4	146.6	23.0	49.5	16.0
NRCS Curve Number	66.6	67.9	65.4	71.4	65.3	64.7	67.9	69.3	63.1	68.9
Average Annual Rainfall (inch)	50.7	47.7	50.0	47.0	45.2	47.0	47.6	47.9	46.0	48.3
Percentile	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
34	18	10	8.9	13	13	14	6.0	1.3	4.7	2.4
35	17	10	8.4	11	12	13	5.7	1.3	4.2	2.3
36	16	9.7	8.2	10	11	12	5.6	1.2	4.0	2.1
37	15	9.4	8.0	9.8	10	11	5.2	1.2	3.7	2.0
38	14	8.9	7.5	9.3	9.8	9.3	4.7	1.1	3.3	1.9
39	13	8.4	7.1	8.2	9.1	8.7	4.5	1.1	3.0	1.7
40	12	8.4	7.1	7.6	8.5	8.0	4.2	1.0	2.6	1.6
41	11	7.8	6.6	7.1	7.8	7.5	3.7	0.93	2.5	1.5
42	11	7.7	6.5	6.5	7.2	7.1	3.6	0.91	2.2	1.5
43	10	7.1	6.0	6.5	6.5	6.3	3.4	0.87	2.0	1.3
44	9.3	6.8	5.8	6.0	6.2	5.8	3.0	0.81	1.8	1.2
45	8.7	6.5	5.5	5.4	5.7	5.1	2.7	0.76	1.7	1.2
46	8.3	6.3	5.3	5.1	5.4	4.7	2.6	0.74	1.5	1.1
47	7.7	5.8	4.9	4.7	5.1	4.4	2.4	0.70	1.4	1.0
48	7.2	5.6	4.7	4.5	4.8	4.2	2.1	0.65	1.3	0.95
49	6.8	5.5	4.6	4.2	4.5	3.8	2.0	0.64	1.2	0.90
50	6.4	5.3	4.4	4.0	4.2	3.5	1.8	0.61	1.1	0.85
51	6.1	5.2	4.4	3.8	4.0	3.2	1.6	0.58	1.0	0.81
52	5.8	5.0	4.2	3.5	3.8	3.1	1.6	0.57	1.0	0.77
53	5.5	4.7	4.0	3.4	3.6	2.8	1.5	0.56	0.90	0.73
54	5.1	4.5	3.8	3.2	3.4	2.6	1.3	0.53	0.89	0.68
55	4.9	4.2	3.5	3.1	3.3	2.5	1.2	0.51	0.83	0.65
56	4.6	4.0	3.3	2.8	3.1	2.3	1.0	0.47	0.75	0.61
57	4.4	4.0	3.3	2.7	2.9	2.1	0.83	0.45	0.68	0.58
58	4.2	4.0	3.3	2.6	2.8	2.0	0.77	0.44	0.64	0.54
59	4.0	3.7	3.1	2.5	2.7	1.9	0.61	0.41	0.63	0.53
60	3.8	3.4	2.9	2.4	2.5	1.7	0.49	0.39	0.57	0.49
61	3.5	3.3	2.8	2.3	2.5	1.5	0.45	0.38	0.52	0.46
62	3.3	3.2	2.7	2.2	2.3	1.4	0.37	0.37	0.49	0.44
63	3.1	2.9	2.4	2.1	2.2	1.1	0.30	0.36	0.47	0.41
64	2.9	2.7	2.2	2.0	2.1	1.0	0.21	0.34	0.43	0.38
65	2.7	2.4	2.0	1.9	2.0	0.87	0.18	0.34	0.42	0.36
66	2.5	2.4	2.0	1.8	1.8	0.77	0.14	0.33	0.40	0.33
67	2.4	2.1	1.8	1.7	1.8	0.71	0.11	0.33	0.36	0.32
68	2.2	2.0	1.7	1.6	1.7	0.64	0.10	0.33	0.32	0.29
69	2.0	1.9	1.5	1.5	1.6	0.56	0.07	0.32	0.29	0.26
70	1.9	1.8	1.4	1.5	1.5	0.51	0.05	0.32	0.27	0.25

WQ Station	OK220100040020-001AT	OK220200040010W	OK220200040050J	OK220600010070G	OK220600010100P	OK220600030010-001AT	OK220600030010T	OK220600030020-002SR	OK220600030050M	OK220600040030G
	Fourche Maline Creek	**Sans Bois Creek**	**Sans Bois Creek-Mountain Fork**	**Longtown Creek**	**Mill Creek**	**Brushy Creek**	**Brushy Creek**	**Blue Creek**	**Peaceable Creek**	**Beaver Creek**
WBID Segment	OK220100040020_00	OK220200040010_40	OK220200040050_00	OK220600010070_00	OK220600010100_20	OK220600030010_00	OK220600030010_10	OK220600030020_00	OK220600030050_00	OK220600040030_00
USGS Gage Reference	7247500†	07246000	07246000	07247500	07247500	07232000	07247500	07247500	7231990†	07247500
Watershed Area (sq. mile)	222.9	89.1	76.2	66.5	78.7	20.4	146.6	23.0	49.5	16.0
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Percentile	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
71	1.7	1.6	1.3	1.4	1.4	0.45	0.02	0.31	0.25	0.23
72	1.6	1.6	1.3	1.3	1.4	0.43	0.01	0.31	0.23	0.21
73	1.4	1.4	1.1	1.3	1.2	0.36	0.00	0.31	0.20	0.19
74	1.3	1.3	1.1	1.2	1.2	0.33	0.00	0.31	0.19	0.17
75	1.1	1.2	0.93	1.1	1.1	0.27	0.00	0.31	0.18	0.15
76	1.0	1.1	0.89	1.0	0.98	0.24	0.00	0.31	0.16	0.13
77	0.95	1.1	0.86	0.98	0.85	0.21	0.00	0.31	0.15	0.13
78	0.84	1.0	0.77	0.93	0.78	0.19	0.00	0.31	0.13	0.11
79	0.74	0.9	0.71	0.82	0.72	0.16	0.00	0.31	0.12	0.10
80	0.66	0.85	0.66	0.71	0.65	0.14	0.00	0.31	0.10	0.09
81	0.60	0.83	0.64	0.71	0.60	0.13	0.00	0.31	0.09	0.08
82	0.50	0.64	0.49	0.60	0.53	0.10	0.00	0.31	0.08	0.07
83	0.40	0.59	0.44	0.60	0.47	0.09	0.00	0.31	0.06	0.05
84	0.36	0.59	0.44	0.52	0.42	0.06	0.00	0.31	0.04	0.05
85	0.30	0.40	0.28	0.46	0.35	0.04	0.00	0.31	0.01	0.04
86	0.24	0.33	0.22	0.41	0.29	0.01	0.00	0.31	0.00	0.03
87	0.20	0.33	0.22	0.35	0.23	0.00	0.00	0.31	0.00	0.03
88	0.15	0.11	0.03	0.32	0.18	0.00	0.00	0.31	0.00	0.02
89	0.10	0.09	0.00	0.26	0.16	0.00	0.00	0.31	0.00	0.01
90	0.10	0.09	0.00	0.21	0.10	0.00	0.00	0.31	0.00	0.01
91	0.02	0.09	0.00	0.16	0.08	0.00	0.00	0.31	0.00	0.00
92	0.00	0.09	0.00	0.14	0.05	0.00	0.00	0.31	0.00	0.00
93	0.00	0.09	0.00	0.11	0.03	0.00	0.00	0.31	0.00	0.00
94	0.00	0.09	0.00	0.08	0.00	0.00	0.00	0.31	0.00	0.00
95	0.00	0.09	0.00	0.06	0.00	0.00	0.00	0.31	0.00	0.00
96	0.00	0.09	0.00	0.04	0.00	0.00	0.00	0.31	0.00	0.00
97	0.00	0.09	0.00	0.01	0.00	0.00	0.00	0.31	0.00	0.00
98	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00
99	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00
100	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

† incremental watershed area below other gages

Appendix C
General Methodology for Estimating Flow at WQM Stations

Flows duration curve will be developed using existing USGS measured flow where the data exist 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 will be derived for each Oklahoma stream segment in the following priority:

i) In cases where a USGS flow gage occurs on, or within one-half mile upstream or downstream of the Oklahoma stream segment.

a. If simultaneously-collected flow data matching the water quality sample collection date are available, these flow measurements will be used.

b. If flow measurements at the coincident gage are missing for some dates on which water quality samples were collected, the gaps in the flow record will be filled, or the record will be extended, by estimating flow based on measured streamflows at a nearby gage. First, the most appropriate nearby stream gage is identified. All flow data are first log-transformed to linearize the data because flow data are highly skewed. Linear regressions are then developed between 1) daily streamflow at the gage to be filled/extended, and 2) streamflow at all gages within 95 miles that have at least 300 daily flow measurements on matching dates. The station with the best flow relationship, as indicated by the highest r-squared value, is selected as the index gage. R-squared indicates the fraction of the variance in flow explained by the regression. The regression is then used to estimate flow at the gage to be filled/extended from flow at the index station. Flows will not be estimated based on regressions with r-squared values less than 0.25, even if that is the best regression. In some cases, it will be necessary to fill/extend flow records from two or more index gages. The flow record will be filled/extended to the extent possible based on the best index gage (highest r-squared value), and remaining gaps will be filled from the next best index gage (second highest r-squared value), and so forth.

c. Flow duration curves will be based on measured flows only, not on the filled or extended flow time series calculated from other gages using regression.

d. On a stream impounded by dams to form reservoirs of sufficient size to impact stream flow, only flows measured after the date of the most recent impoundment will be used to develop the flow duration curve. This also applies to reservoirs on major tributaries to the stream.

ii) In the case no coincident flow data are available for a stream segment, but flow gage(s) are present upstream and/or downstream without a major reservoir between, flows will be 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 National Resources Conservation Service (NRCS) runoff curve numbers and antecedent rainfall condition. Drainage subbasins will first be delineated for all impaired 303(d)-listed WQM stations, along with all USGS flow stations located in the 8-digit HUCs with impaired streams. Parsons will then identify all the USGS gage stations upstream and downstream of the subwatersheds with 303(d) listed WQM stations.

a. Watershed delineations are performed using ESRI Arc Hydro with a 30 m resolution National Elevation Dataset (NED) digital elevation model, and National Hydrography Dataset (NHD) streams. The area of each watershed will be calculated following watershed delineation.

b. The watershed average curve number is 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 is extracted from NRCS STATSGO soil data, and land use category from the 2001 National Land Cover Dataset (NLCD). Based on land use and the hydrologic soil group, SCS curve numbers are estimated at the 30-meter resolution of the NLCD grid as shown in Table 7. The average curve number is then calculated from all the grid cells within the delineated watershed.

c. The average rainfall is 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 20 Feb 2004).

Table C-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/Sansd/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

d. Flow at the ungaged site is calculated from the gaged site. The NRCS runoff curve number equation is:

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

where:

Q = runoff (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

$$I_a = 0.2*S \qquad (2)$$

Thus, the runoff curve number equation can be rewritten:

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

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

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

e. 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:

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

where M is 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, are then used to calculate the depth equivalent daily flow Q of the ungaged site. Finally, the volumetric flow rate at the ungaged site is calculated by multiplying by the area of the watershed of the ungaged site and converted to cubic ft..

f. If any flow measurements are available on the stream segment of interest, the projected flows will be compared to the measured flows on each date. If there is poor agreement, projections will be repeated with a simpler approach, using only the watershed area ratio and the gaged site (thereby eliminating the influence of differences in curve number and precipitation between the gaged and ungaged stream watersheds). If this simpler approach provides better agreement with existing data, the projected flows based on the simpler approach will be used.

iii) In the rare case where no coincident flow data are available for a WQM station and no gages are 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 above for upstream or downstream gages.

APPENDIX D
STATE OF OKLAHOMA ANTIDEGRADATION POLICY

Appendix D
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 E
RESPONSE TO COMMENTS

Appendix E

Response to Comments

A. Comments from Poteau Valley Improvement Authority (PVIA)

A1: In light of the long-standing, significant water quality issues in the Fourche Maline-Lake Wister watershed and the continuing decline in water quality in the area, we request a public meeting be held to review and discuss the proposed bacteria TMDL.

- ***Response #A1****: This was the only meeting request that was received. A single request does not constitute a significant degree of public interest, thus no meeting was held.*

A2: the primary weakness of the document is its lack of a true watershed perspective in both its organization and analysis.

- ***Response #A2****: The report addresses bacteria impairments for10 stream segments located relatively close to each other. Watersheds contributing to each stream segment were clearly shown in Figure 1-1. All assessments and sources were considered for the watershed contributing to each impaired segment. Unimpaired segments and their watersheds were not considered since no TMDL is required for them.*

A3: The title and organization of the document obscure the actual watersheds included make it difficult for interested parties to be aware of or to evaluate the document's analysis for any particular watershed. The title of the public notice, dated January 16, 2008, is "Availability of Draft Bacteria TMDL for the San Bois Creek *Watershed*" (our emphasis). We note that the "San Bois Creek Area Watershed" does not exist. The 10 creek segments lumped together in this document contribute to three watersheds – as recognized in the numeric codes included in the document title – all but two flow ultimately to two different reservoirs – Wister and Eufaula – that have both significant local importance and unique water quality issues.

- ***Response #A3****: The report contains 10 impaired stream segments. Each segment has its own drainage area or watershed (Figure 1-1). In addition, from the stream network on Figure 1-1, one could easily determine where a stream eventually flows.*

  We believe the title of the report, "Bacteria Total Maximum Daily Loads for OK220100, OK220200, OK220600 in the San Bois Creek Area, Oklahoma", is appropriate and descriptive of the study area. We recognize the concept of watershed and tried not to use it in the title to avoid confusion. "San Bois Creek Area" was used in the title because San Bois Creek is centrally located in the 10 stream segments grouped in this report.

A4: The document should therefore be re-titled using a better, more descriptive title, not one relying solely on a numeric code. The discussion and analysis in the document should be reorganized to reflect a true watershed basis.

- ***Response #A4**: Please refer to responses #A2 and #A3.*

A5: The lumping of non-related creek segments in the document has led to the production of meaningless summary statistics, as, for example, the statement that there were an estimate "157 sanitary sewer overflows… in the San Bois Creek Study Area"(pg.3-4). Since the area is not a watershed, the total number of sewer overflows in this artificially constructed study area provides no information to anyone who seeks to understand the potential impact of those sewer overflows on any particular watershed or water body. How many sewer overflows occurred, for example, in creeks contributory to Lake Eufaula? To understand the real cumulative analysis of any particular creek segment, the reader must continually extract information from discussions and tables that lump together unrelated and non-cumulative data.

The public notice includes a statement that there are an estimated "141 failing septic systems in the San Bois Creek *watershed* (our emphasis) (Public Notice pg. 4), a summary statement that actually never occurs in the document itself, and that demonstrates our point – the confusion clearly extends to ODEQ personnel. There are only 46 failing septic systems estimate for the San Bois Creek Segments; the larger number is for all 10 creek segments.

- ***Response #A5**: There were 157 sanitary sewer overflows (SSO) recorded between October 1991 and January 2007 in the study area of this report. Right below the paragraph of this description, Table 3-3 shows the details of the SSOs, including the name of the stream segment, facility name, number of occurrences, and so on. Using Table 3-3 and Figure 1-1, one could easily find out how many SSOs occurred in creeks contributory to Lake Eufaula, Lake Wister or other waterbodies in the study area.*

  Similarly, it was estimated that there were 141 failing septic tank systems in the entire study area. Table 3-10 provides specifics regarding the total number of septic tanks and the number of failing septic tanks within the sub-watershed of each stream segment.

A6: This lumping, obscuring, and ignoring of watershed connections is in direct contradiction to the US EPA's recommended "watershed approach" which recognizes that "a watershed approach is the most effective framework to address today's water resource challenges." (http://www.epa.gov/owow/watershed/approach.html)

- ***Response #A6**: Each stream segment has its own sub-watershed as shown in Figure 1-1. Please also see response #A2 and #A3.*

A7: We restrict the remainder of our comments to the Fourche Marline Creek segment (OK220100040020_00), which is the only one of the 10 segments discussed that is tributary to Lake Wister and thence to the Poteau River.

We recognized that the organizational structure of the TMDL is based on stream segments as identified in the Oklahoma Waterbody Identification System, nevertheless the restriction of analysis to these segments, without any recognition of the true watershed context, leads to serious omissions and questionable conclusions.

The bacteria pollutant identified as being of concern in the Fourche Maline Creek segment is enterococci. Of the several bacterial-type analyses used to identify potential problems, enterococci are the type most closely associated with humans, and the most likely to indicate pollution by human sewage. The document contains an extensive discussion of potential fecal coliform sources, but no discussion of potential enterococci sources.

- ***Response #A7**: The TMDL addresses all stream segments that are known to be impaired for bacteria and their watershed. It would be inappropriate and unnecessary to prepare a TMDL analysis for stream segments and watersheds which are not impaired.*

  Fecal coliform, E. coli, and enterococci are the three bacteria indicators used in Oklahoma to assess pathogen pollution. Fecal coliform sources and loadings were extensively discussed in the report because fecal coliform has been in use longer than the other indicators and has been more extensively studied. Fecal coliform has also been utilized in permit limits for NPDES permit for decades while E coli and enterococci are not. By comparison, the data available for E. coli and enterococci are much more limited. The sources of bacteria should not change with bacteria indicators. A bacteria source with a high level of fecal coliform is likely to have high levels for E. coli and enterococci.

A8: The TMDL analysis nevertheless suggests the primary source of bacterial problems in the stream segment is non-point source in origin (pg.5-2). However, graph on pg. 5-4 shows bacteria loads at near the water criterion levels even under low flow conditions (pg. 5-4), suggesting the situation is more complex. Neither these potential contradictions nor their possible explanations are discussed in the document.

- ***Response #A8**: Figure 5-1 on page 5-4 shows that all samples collected during high flows (top 20%) exceeded the water quality standard and all samples collected during low flows (lower 20%) met the water quality standard. Overall, non-point sources are the primary sources of bacteria. See also comment B-16 below.*

A9: Significant failure of septic systems in the vicinity of the sampling location could contribute to the high bacteria counts. The document calculates a hypothetical 41 failing septic systems in the Fourche Maline Creek segment, but this analysis has only a tenuous connection to the high bacterial count samples actually recorded, because:

The Fourche Maline Creek segment under consideration is approximately 36.9 miles long. The TMDL analysis is based upon a single sample point located approximately five miles from the upstream (western) boundary of the creek segment. Therefore, this sample site cannot be known to be representative of the 86% of the stream and contributing watershed that is located downstream.

On the other hand, the community of Wilburton is only some seven miles upstream from the western boundary of the study area. It is therefore significantly closer to the sampling location than much of the watershed supposedly being analyzed, and discharges from the Wilburton area, being upstream, definitely contribute to the water quality of the study area. Yet, this potential impact is ignored.

- ***Response #A9**: We agree that it would be beneficial to have more monitoring stations on Fourche Maline Creek. However, one station is all we have in this segment. The data from this station shows the stream segment is impaired. We are required to develop TMDLs for impaired streams.*

  The Wilburton discharge is located on a different upstream segment. We do not have evidence the upstream segment is impaired for bacteria. That is why the drainage area for the upstream segment was not included in this report.

A10: Similarly, the downstream (eastern) edge of the study area is only a few miles from Wister Lake, the primary water source for PVIA and most of LeFlore County. Yet because the single, upstream, data point utilized for analysis is more than 5 miles from a drinking water intake, any consideration of the downstream water quality impacts on the lake are excluded (pg.2-5).

- ***Response #A10**: The TMDL for the Fourche Maline Creek segment (OK220100040020_00) calls for 86% bacteria load reduction from the sub-watershed of the segment (Figure 1-1). When the bacteria loads from streams contributing to the lake are reduced, the water quality in the lake should improve. Wister Lake is not specifically included in the report because Wister Lake is not impaired for bacteria.*

A11: A wasteload allocation for the Red Oak Sewage System is included in the TMDL calculation (pg. 5-10 and 5-11). In an abstract theoretical sense this is understandable, but in a real practical sense, given that the actual physical location of the Red Oak facility is downstream of the Fourche Maline segment sample point, the Red Oak facility cannot be contributing to the high enterococci bacteria counts being recorded.

- ***Response #A11**: We agree that the sample data did not capture the bacteria from Red Oak PWA.*

  However, discharges from point sources are not believed to be the cause of the bacteria exceedances. Red Oak PWA operates a lagoon system. Due to the long detention time and open water surface receiving UV radiation from the sun, lagoon systems, when designed and operated properly, should have not be contributing to any bacteria problems. In order to assure future compliance, a bacteria limit will be added to the Red Oak permit when it is re-issued. See Section 5.2 of the report.

A12: Therefore, the actual sources of high numbers of bacterial pollutants, representing a long standing, significant human health hazard to the people of the Fourche Maline Creek watershed, remain unknown and unexamined in the document.

- ***Response #A12****: The source estimates in the report are intended to evaluate the relative contributions from various possible sources, not the absolute loading. We agree that there is uncertainty in any estimate but the source estimates are based on the best data available. We believe the report provides a reasonable assessment of the relative magnitude of bacteria sources within each sub-watershed so that remedial efforts may be efficiently directed at the most likely candidates.*

B. Comments from Oklahoma Department of Agriculture, Food, and Forestry and Oklahoma Conservation Commission

B1. The title of the report and several parts of the report referenced only to Sans Bois Creek is misleading, as the Sans Bois Creek area occupies less than 20% of the study areas. It would be more appropriate to name the title as well as to refer to the study areas as Parts of Oklahoma Planning Basin 2 of Lower Arkansas River.

- ***Response #B1****: Please refer to response #A3.*

B2. Page X, last paragraph before section E.3. We would like the last sentence of the paragraph to read: The data analysis and load duration curves (LDC) demonstrate that exceedances at the WQM stations are the result of a variety of nonpoint source loading occurring during high flow conditions although because of the number of low flow exceedances and historical sanitary sewer overflows, point sources cannot be ruled out as an additional source.

- ***Response #B2****:* The report text was changed as follows. "The data analysis and the load duration curves (LDC) demonstrate that exceedances at the WQM stations are the result of a variety of nonpoint source loading occurring during a range of flow conditions. Low flow exceedances are likely due to a combination of nonpoint sources, uncontrolled point sources, and permit noncompliance."

B3. Page 3-6 second paragraph, begins with "Bacteria associated with urban runoff..". The final sentence in the paragraph discusses the merits of BMPs. Might it be possible to also mention the elimination of illicit discharges and rehabilitation of dilapidated sewage collection systems as needed to reduce leakage and SSOs?

- ***Response #B3****: The suggested language was added.*

B4. Page 3-7, 1st bullet of 2nd paragraph: "poultry waste" should be added after "Processed livestock manure".

- ***Response #B4****: the language was change to "Processed commercially raised farm animal manure is often applied to fields as fertilizer, and can contribute to fecal bacteria loading to waterbodies if washed into streams by runoff".*

B5. Page 3-8, Daily Fecal Coliform Production Rates by Livestock Species:
The report used the Beef Cattle release approximately 1.04 E+11, and Dairy Cattle release 1.01 E+11. They are 3 - 5 times as high as the rates used by Gene Yagow, et al., Virginia Tech University in research paper: "TMDL Modeling of Fecal Coliform Bacteria with HSPF", 2001, presented at the ASAE Annual International Meeting 2001, of 2.07 E+10 and 3.11 E+10 respectively.

- ***Response #B5****: The bacteria production rates in the report were taken from the American Society of Agricultural Engineers standards. Many other production rates could be found in the literature. The chosen rates are valid and not significantly different from the proposed reference. No changes were made as a result of this comment.*

B6. Page 3-8 Second paragraph- refers to first sentence. The term "*land application*" in common usage only refers to fecal material that is collected and then intentionally applied to a field. Direct defecation of manure by pastured animals is not included under this definition. To make this report more understandable to readers with an agricultural background it would help to have this statement made more clearly so that the reader is aware that ODEQ is referring to both land applied poultry waste and cattle manure from pastured livestock.

- ***Response #B6****: The data on land application area is from the USDA agriculture census. It follows the common usage of the term and does not include manure from pastured livestock. The language was clarified as follows: "These estimates are also based on the county level reports from the 2002 USDA county agricultural census, and thus represent approximations of the land application area in each watershed. Because of the lack of specific data, land application of livestock manure is not quantified in Table 3-7 but is considered a potential source of bacteria loading to the waterbodies in the Study Area." The title of Table 3-6 was also modified.*

B7. Page 3-8 last paragraph, last sentence- perhaps more appropriately should read "Cattle appear to represent the largest potential source of fecal bacteria from livestock."

- ***Response #B7****: The sentence was changed to "Cattle appear to represent the largest potential source of fecal bacteria".*

B8. Page 3-9, Table 3-6 "Livestock and Manure Estimates by Watershed":
  - The title should be: "Livestock and Manure Application Area Estimates by Watershed", as no manure amount is included in the table;

- Number of cattle and calves should be divided in two groups: one as free roaming and the other in feedlots, as the amount of manure produced by each group is quite different;
- Number of chickens and turkeys estimated are 2 –5 times as high as the actual numbers, per 2007 ODAFF database for PFOs (Poultry Feeding Operations) in Fourche Maline Creek, Sans Bois Creek and Sans Bois Creek - Mountain Fork watersheds. The numbers are 387,200; 70,000 and 34,000 respectively.

- ***Response #B8**: the title of Table 3-6 was changed to "Commercially Raised Farm Animals and Manure Application Area Estimates by Watershed".*

  The information was not available to divide cattle and calves into two groups. No changes were made as a result of this comment.

  These numbers are presented for information only. They are not used for loading estimates but are not significantly different from the agriculture census numbers that are used. DEQ will work with ODAFF to update the poultry database for future reports. The date of the data in the table was added.

B9. Page 3-9, Table 3-7 Fecal Coliform Production Estimates for Selected Livestock: Since the Coliform Production Rates and Number of Livestock are over-estimated, the numbers of Coliform Production presented in the table are about 5 times as high as they should be.

- ***Response #B9**: See response #B5.*

B10. Page 3-10, Table 3-8: Estimated Poultry Numbers for Contract Growers Inventoried by OPDAFF: Per ODAFF's most updated inventory, the number of birds in the Fourche Maline Creek (LeFlore County), Sans Bois Creek (Haskell County) and Sans Bois Creek - Mountain Fork (Haskell County) watersheds are: 342,200, 0, and 34,000 respectively; instead of 430,000, 18,000 and 116,000 as presented in the report. It results in a reduction of 187,800 birds in the study area, about 1/3 of the number of birds estimated. Thus, the overall impact of land application of chicken waste on water quality of streams in the watersheds, if any, is much less than the estimates.

- ***Response #B10**: • Response: These numbers are presented for information only. They are not used for loading estimates but are not significantly different from the agriculture census numbers that are used. DEQ will work with ODAFF to update the poultry database for future reports. The date of the data in the table was added.*

B11. Pages 3-7 to 3-10, sub-section 3.2.2: Non-Permitted Agricultural Activities and Domesticated Animals; and pages 3-13 to 3-14, section 3.3: Summary of Bacteria Sources, and Executive Summary:

- As most of the poultry feeding operations (PFOs) are regulated by ODAFF, they are required to land apply chicken waste in accordance with their Animal Waste Management Plans (AWMP) or Comprehensive Nutrient Management Plans

(CNMP). If best management practices (storage shed, fencing…) and conservation measures (setbacks…) are properly implemented, the contribution of bacteria from this group of animals to the watersheds, if any, would be insignificant.

- For Bacteria Contribution to the Watersheds by Livestock (beef and dairies cattle): As the survival rates of coliform depends on how the manure is stored, when and how it is spread on land, setbacks distances and BMPs conducted by farmers/ranchers, and relative locations of the farms to the streams, numbers of coliform reaching water-bodies from this source should be minimal compared to the amount of bacteria produced on land.

- ***Response #B11**: The following text was added in section 3.2.2: "Most poultry feeding operations are regulated by ODAFF and are required to land apply poultry waste in accordance with their Animal Waste Management Plans or Comprehensive Nutrient Management Plans. While these plans are not designed to control bacteria loading, best management practices and conservation measures, if properly implemented, could reduce the contribution of bacteria from this group of animals to the watersheds."*

  The following text was also added in section 3.3: "and a number of other environmental conditions. Manure handling practices, use of BMPs, and relative location to streams can also affect stream loading. Also, the structural properties of some manures, such as cow patties, may limit their washoff into streams by runoff. Because litter is applied in a pulverized form, it could be a larger source during storm runoff events. The Shoal Creek report showed that poultry litter was about 71% of the high flow load and cow pats contributed only about 28% of it (Missouri Department of Natural Resources, 2003). The Shoal Creek report also showed that poultry litter was insignificant under low flow conditions up to 50% frequency."

B12. Page 3-13, section 3.3: 2nd paragraph, ""Livestock are estimated to be….to land surfaces". It is suggested that this sentence be replaced by: Land Application of livestock manure and chicken waste could be considered one of major contributors of coliform loading to land surfaces; however, its contribution of coliform to the streams in the watersheds may not be significant, if BMPs are properly implemented when land applying manure/ waste.

- ***Response #B12**: The following clarifying language was added to the paragraph following: "Manure handling practices, use of BMPs, and relative location to streams can also affect stream loading."*

B13. Page 4-10 second paragraph- shouldn't the nonpoint source load be estimated by subtracting point source loading from instream loads?

- ***Response #B13**: The comment is correct. However, some language in this section was inadvertently left in the document from a previous calculation method. The obsolete language was deleted and remaining language was clarified as suggested. The correct calculation of current loading is found in Section 5.1.*

B14. Page 4-11, third paragraph- how can high flows occur in dry weather absent a discharge or dam breach?

- ***Response #B14****: A clarification was added. High flows could occur in the absence of local runoff due, for example, to precipitation upstream in the watershed or releases from upstream dams.*

B15. Page 4-12 under Step 5- can this be justified given the number of SSOs that occurred in some of the watersheds? If so, perhaps that could be better explained in the text.

- ***Response #B15****: Yes because SSOs are not included in the wasteload allocation component of the TMDL. A description of oversight and enforcement procedures for SSOs was added to Section 3.1.2.*

B16. Page 5-2 discussions about exceedances during variable flow conditions on streams that have point source dischargers should be clarified.

- We suggest wording saying that "due to the preponderance of exceedances during high flow conditions the majority of the pollution is thought to be due to NP sources but that the exceedances found during dry weather conditions indicate that some level of pollution may be due to point sources.
- As a further comment- SSOs might also occur during highflow conditions; therefore, in streams with both point and NPS pollution where SSOs have been known to occur, it is questionable to claim NPS as the major source without some assurance that either the SSOs happened during baseflow or that the SSO loading would have been overshadowed by the NPS load.
- In streams without PS, some clarification should be offered as to how exceedances happen during both low and highflow conditions. Otherwise, people are likely to question the justification that baseflow exceedances are point source and high flow exceedances are NPS.

- ***Response #B16****: The following text was added to Sections E.3 and 4.1: "However, violations that occur during low flows may not be caused exclusively by point sources. Violations have been noted in some watersheds that contain no point sources. Research has shown that bacteria loading in streams during low flow conditions may be due to direct deposit of cattle manure into streams and faulty septic tank/lateral field systems."*

B17. Page 5-22 1st paragraph- OCC is not a regulatory agency. A more appropriate sentence would be: "The Oklahoma Conservation Commission (OCC) is the lead agency for Nonpoint Source Pollution in Oklahoma."

- ***Response #B17****: The suggested change was made.*

C. Comments from Natural Resources Conservation Services, USDA

C1. We feel additional study, to the extent the major source(s) of bacteria loading can be identified, is needed to better determine how to resolve said problem of the watershed.

- ***Response #C1**: Additional study or data will be always helpful. However, we believe that the data is adequate to derive a TMDL reduction goal for each watershed in the study area. No change was made.*

C2. Relative to agricultural animals contributing to the bacteria loading problem, we recommend that agricultural producers use practices such as riparian vegetation buffers, livestock exclusion and nutrient management to at least reduce or possibly eliminate this non-point source of pollution.

Incentives to create riparian buffers will need to be offered in terms of getting producers to readily accept this practice. To date, it has been our experience producers resist riparian vegetative buffers due to the fact they have to fence stream sides to exclude livestock. Due to the meandering of most streams, it is more costly to fence streams. In addition, it is more costly to maintain fences in riparian areas due to brush growing in and/or adjacent to the fences. Recent ice storms have damaged fences due to woody debris falling from trees on the fence. Consequently, chemical and mechanical brush control means would be an on going maintenance cost of these fences.

Another problem with fencing streams for some producers would be the exclusion of livestock from the only water source within a grazing unit. It would cost the producer to create another water source in the grazing unit.

Nutrient management consists of the amount, timing, and placement of various nutrient types. When spreading animal waste as a source of nutrients, to reduce bacteria loading and excessive nutrients form reaching most water bodies, NRCS recommends producers not apply the waste to areas within 100 feet of most water bodies. The 100 feet would be the buffer distance needed in most situations relative to keeping live animal deposition or mechanically applied manure from reaching water bodies.

Additionally, it costs the producer to exclude livestock from the buffer area by reducing the livestock carrying capacity of the operation. The total cost is dependent upon the area fenced and excluded from grazing for each livestock operation.

Nutrient management consists of the amount, source, placement, form, and timing of nutrients. When spreading animal waste as a form of nutrients, to reduce bacteria loading and excessive nutrients form entering surface water, NRCS recommends producers not apply the waster to areas within 100 feet of most water bodies. In most situations, the 100 feet would be the buffer distance needed relative to keeping live animal deposition or mechanically applied manure from entering most water bodies.

Currently, financial incentives are available to assist qualified applicants with construction of fences to create riparian buffers through the NRCS Environmental Quality Incentives Programs (DQIP) and the Wildlife Habitat Incentives Program (WHIP). Also, these programs can assist with construction of ponds, wells, livestock watering facilities and stream crossings which could aid in reducing bacteria loading in a watershed.

***Response #C2**: We agree with your recommendations. Best Management Practices such as riparian vegetation buffers, livestock exclusion and nutrient management plans could reduce bacteria loadings to the streams. These BMPs would also reduce nutrients and sediment loadings to the streams.*

Oklahoma Conservation Commission (OCC) is the lead state agency in managing non-point source pollution in Oklahoma. We will forward your comments to the OCC for their consideration. Also, the following language was added to the section 5.7 of the report: "In addition, financial incentives are currently available to assist qualified applicants with construction of fences to create riparian buffers, ponds, wells, livestock watering facilities and stream crossings through the USDA, Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Programs (EQIP) and the Wildlife Habitat Incentives Program (WHIP)."