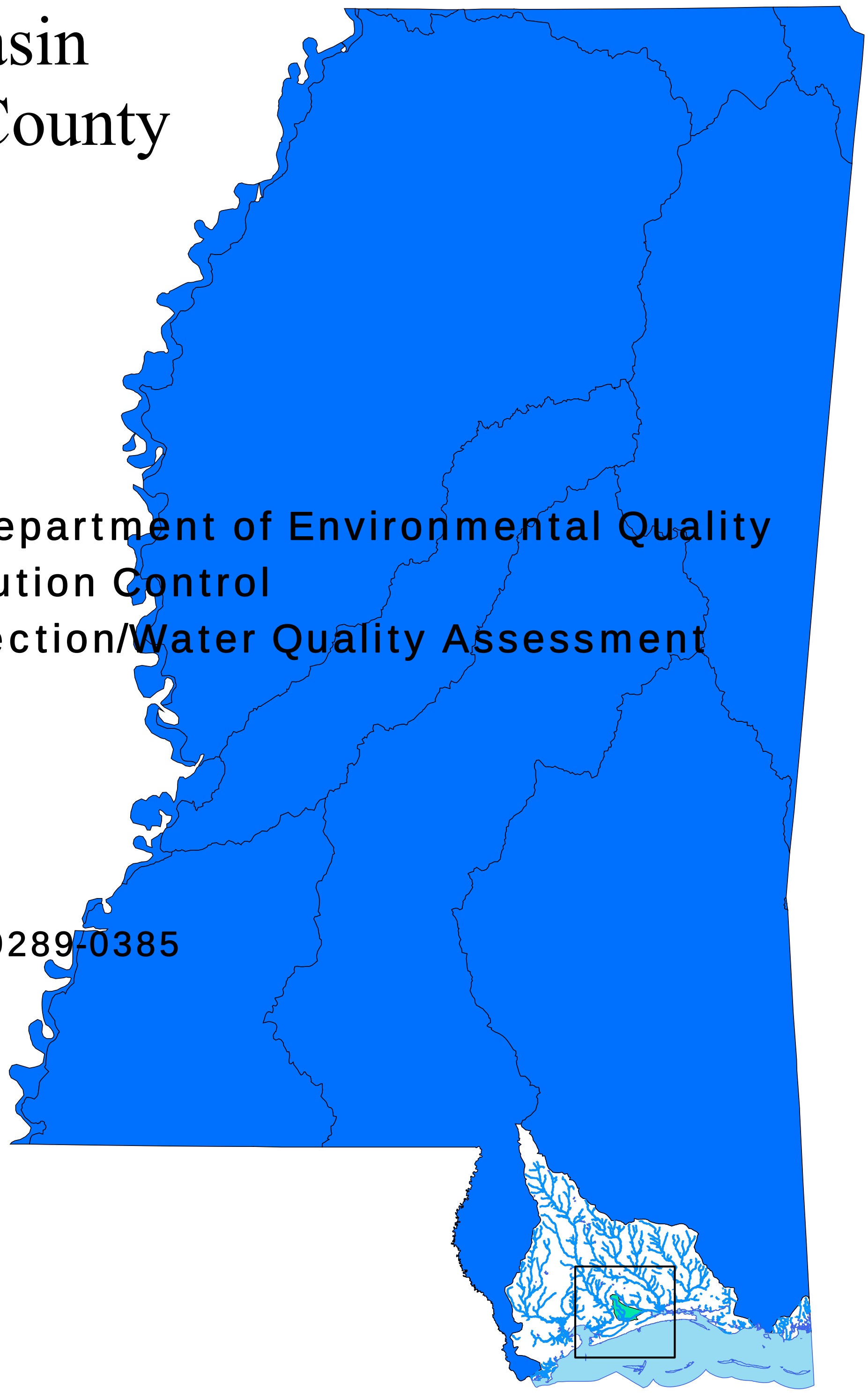
FINAL REPORT
July 2003
ID: 203072401

Fecal Coliform TMDL For **Turkey Creek** Coastal Basin Harrison County



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FOREWORD

This report contains one Total Maximum Daily Load (TMDL) for waterbody segments found on Mississippi's 1996 Section 303(d) List of Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	:	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	:g/l * cfs	Gm/day	2.45

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TMDL INFORMATION PAGE

Table i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Turkey Creek	MS118BBM1	Harrison	03170009	Pathogens	Monitored
Location– Near Gulfport: From confluence with Canal #2 to Highway 49					

Table ii. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Fecal Coliform	Secondary Contact	**May - October**: fecal coliform shall not exceed a geometric mean of 200 per 100 ml based on a minimum of five (5) samples taken over a 30-day period with no less than twelve (12) hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100 ml more than ten percent (10%) of the time. **November – April**: fecal coliform shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of five (5) samples taken over a 30-day period, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than ten percent (10%) of the time.

Table iii. NPDES Facilities

NPDES ID	Facility Name	Subwatershed	Receiving Water
MS0042897	Dolan's Trailer Park	03170009037	Turkey Creek
MS0052248	Ridgecrest Estates	03170009037	Turkey Creek

Table iv. Total Maximum Daily Load

Type	Number		Unit	MOS Type
	Summer	Winter		
WLA	1.55E+10	1.55E+10	counts/30 day critical period	
LA	3.61E+12	7.40E+12	counts/30 day critical period	
MOS	4.02E+11	8.24E+11	counts/30 day critical period	Explicit
TMDL	4.02E+12	8.24E+12	counts/30 day critical period	

EXECUTIVE SUMMARY

A segment of Turkey Creek was included on the Mississippi 1998 Section 303(d) List of Waterbodies as impaired due to fecal coliform bacteria. The standard states that from May through October the fecal coliform colony count shall not exceed a geometric mean of 200 per 100 ml, nor shall the samples examined during a 30-day period exceed 400 per 100 ml more than 10 percent of the time. Also from November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10 percent of the time. Local residents informed MDEQ of a swimming hole used by local children to swim in Turkey Creek. Additional physical problems have been identified by the public that could lead to impairment in the stream for this pollutant.

Turkey Creek flows in a southeasterly direction from its beginning until it meets Bernard Bayou in Harrison County. This TMDL has been developed for one listed section of Turkey Creek.

MDEQ assumed there is a 50% failure rate of septic tanks in the drainage area based on estimates from the State Department of Health for this area of the state. There are two NPDES Permitted treatment plants that discharge treated effluent that contains fecal coliform in the watershed.

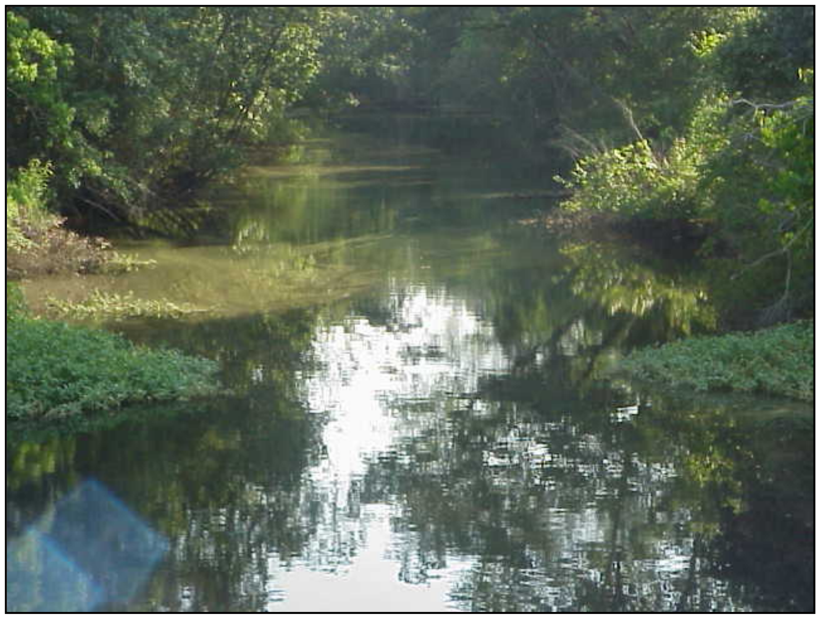


Photo 1. Turkey Creek

A mass balance approach was used to calculate the TMDL. This method of analysis was selected in accordance with guidance from EPA due to the small size of the watershed. After using this approach, summer and winter TMDLs were determined to be 4.02E+12 counts per 30 days and 8.24E+12 counts per 30 days, respectively.

Under existing conditions, calculations for Turkey Creek indicate violation of the summer geometric mean fecal coliform standards and the summer percent of time in exceedance. According to the mass balance method used to determine this TMDL, a 52% reduction is indicated for Turkey Creek to meet water quality standards. It is also necessary to evaluate the current septic tanks in the watershed to reduce the potential for pollution from failing septic tanks. Additionally, the City of Gulfport needs to reduce accidental spills from the sewage collection system that impair this stream during flood events.

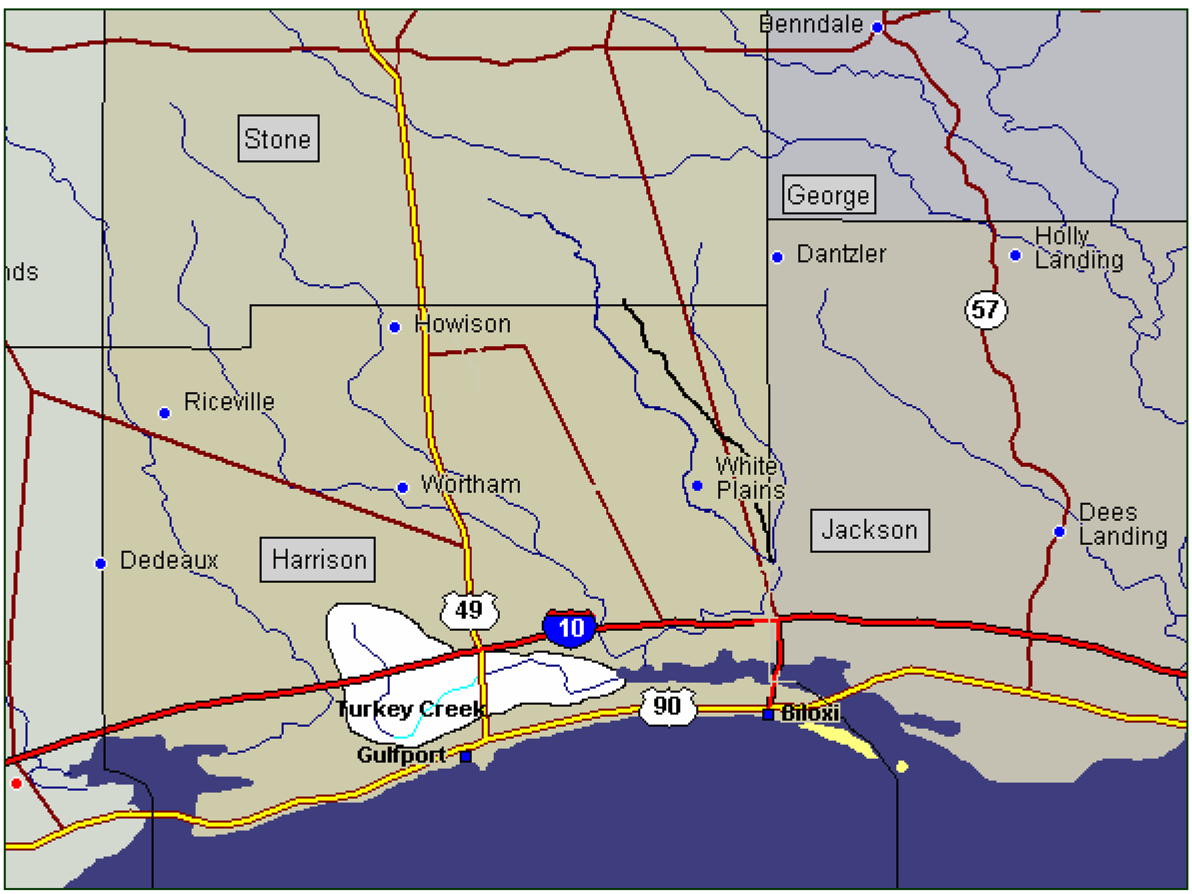
INTRODUCTION

1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is fecal coliform. Fecal coliform bacteria are used as indicator organisms. They are readily identifiable and indicate the possible presence of other pathogenic organisms in the water body. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of water resources.

The listed segment is near Gulfport, from the confluence with Canal #2 to Hwy 49. The 303d listed section is shown in Figure 1.

Figure 1 Turkey Creek Watershed 303d Listed Segment



The listed segment of Turkey Creek is in the Coastal Basin Hydrologic Unit Code (HUC) 03170009 in southeast Mississippi. The drainage area of the segment is approximately 11,100 acres; and lies within Harrison County as shown in Figure 2. The watershed is rural but includes the major urban area of Gulfport. Forest is the dominant landuse within the watershed. The land distribution is shown in Table 1.

Figure 2. Turkey Creek Watershed

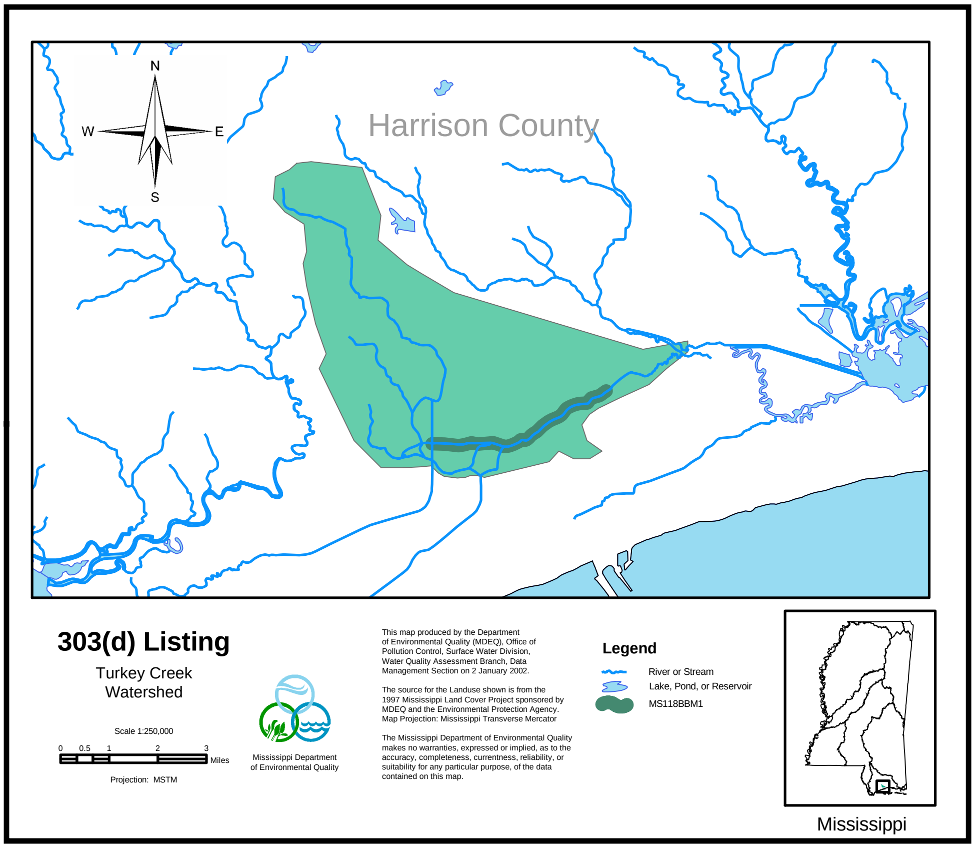


Table 1. Land Distribution in Acres for the Turkey Creek Watershed

	Urban**	Forest*	Cropland	Pasture	Total
Area (Acres)	1,392	5,134	3,270	1,328	11,124
% Area	12.5%	46.2%	29.4%	11.9%	100 %

*Includes Wetlands ** Includes Barren

1.2 Applicable Waterbody Segment Use

The water use classification for the listed segment of Turkey Creek, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulation, is Fish and Wildlife Support. The designated beneficial uses for Turkey Creek are Secondary Contact and Aquatic Life Support.

Photo 2. Swimming hole near railroad tracks above Highway 49

1.3 Applicable Waterbody Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (2002). The standard states that, for the months of May through October, the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100 ml more than 10 percent of the time. For the months of November through April, the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10 percent of the time. The water quality standard will be used to assess the data to determine impairment in the water body. The water quality standard will be used as the targeted endpoint to establish this TMDL.

TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. Recently, MDEQ established a revision to the fecal coliform standard that allows for a statistical review of any fecal coliform data set. There are two tests that the data set must pass to show non-impairment.

The first test states that for the summer the fecal coliform colony count shall not exceed a geometric mean of 200 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples and for the winter the fecal coliform colony count shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples. The second test states that for the summer the samples examined during a 30-day period shall not exceed a count of 400 per 100 ml more than 10 percent of the time and for the winter the samples examined during a 30-day period shall not exceed a count of 4000 per 100 ml more than 10 percent of the time.

2.1.1 Discussion of the Geometric Mean Test

The level of fecal coliform found in a natural water body varies greatly depending on several independent factors such as temperature, flow, or distance from the source. This variability is accentuated by the standard test used to measure fecal coliform levels in the water. The membrane filtration or MF method uses a direct count of bacteria colonies on a nutrient medium to estimate the fecal level. The fecal coliform colony count per 100 ml is determined using an equation that incorporates the dilution and volume to the sample filtered.

To account for this variability the dual test standard was established. The geometric mean test is used to dampen the impact of the large numbers when there are smaller numbers in the data set. The geometric mean is calculated by multiplying all of the data values together and taking the root of that number based on the number of samples in the data set.

$$G = \sqrt[n]{s1 * s2 * s3 * s4 * s5 * sn}$$

The standard requires a minimum of 5 samples be used to determine the geometric mean. MDEQ routinely gathers 6 samples within a 30-day period in case there is a problem with one of the samples. It is conceivable that there would be more samples available in an intensive survey, but typically each data set will contain 6 samples therefore, n would equal 6. For the data set to indicate no impairment, the result must be less than or equal to 200 in summer and 2000 in winter.

2.1.2 Discussion of the 10% Test

The other test looks at the data set as representing the 30 days for 100% of the time. The data points are sorted from the lowest to the highest and each value then represents a point on the curve from 0% to 100% or from day 1 to day 30. The lowest value becomes the 1st data point and the highest data point becomes the nth data point. The standard requires that 90% of the time, the counts of fecal coliform in the stream be less than or equal to 400 counts per 100 ml in summer and 4000 counts per 100 ml in winter.

By calculating a concentration of fecal coliform for every percentile point based on the data set, it is possible to determine a curve that represents the percentile ranking of the data set. Once the 90th percentile of the data set has been determined, it may be compared to the standard of 400 counts per 100 ml. If the 90th percentile of the data is greater than 400 then the stream will be considered impaired. This can be used not only to assess actual water quality data, but also computer generated model results. Actual water quality data will typically have 5 or 6 values in the data set, and computer generated model results would have 30 values.

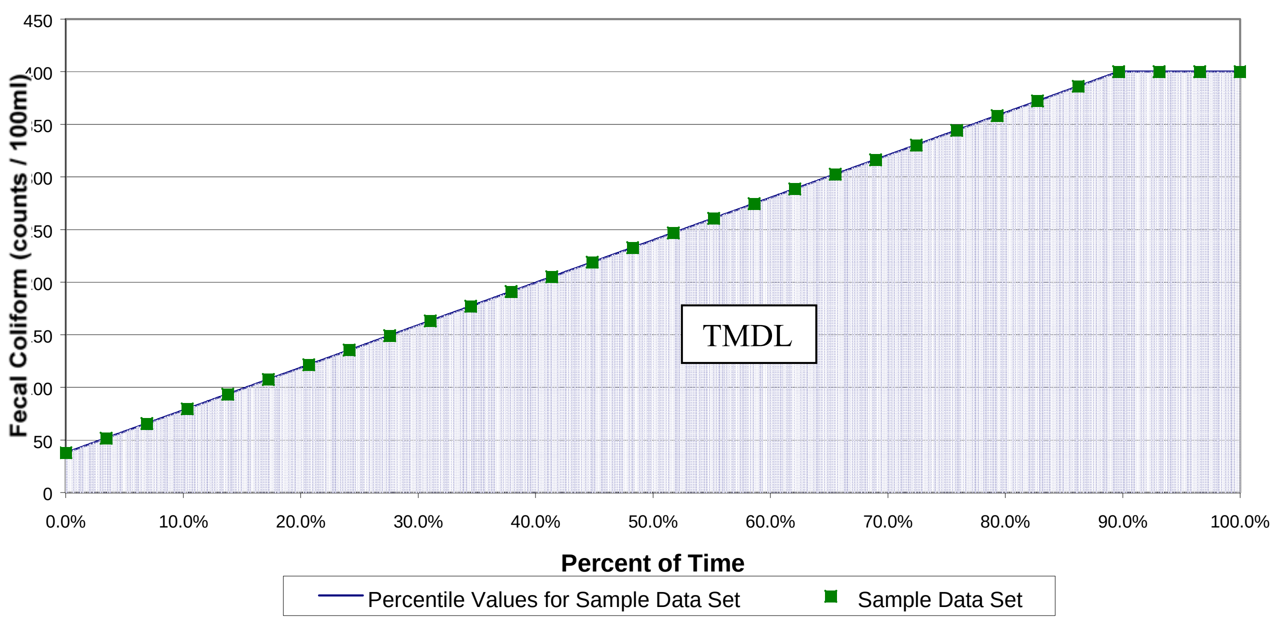
2.1.3 Discussion of Combining the Tests

MDEQ determined a curve that meets both portions of the standard and is indicative of possible water quality conditions. The integral of this curve represents the TMDL. That is, the maximum amount of fecal coliform in the water body either based on actual data sets or on computer generated values. By multiplying the integral of the 30-sample data set curve by the flow in the stream, the TMDL can be calculated.

Table 2. 30 point data set

Fecal Coliform (counts/100ml)	Percentile Ranking
37.82	0.0%
51.75	3.4%
65.68	6.9%
79.61	10.3%
93.54	13.8%
107.47	17.2%
121.4	20.7%
135.33	24.1%
149.26	27.6%
163.19	31.0%
177.12	34.5%
191.05	37.9%
204.98	41.4%
218.91	44.8%
232.84	48.3%
246.77	51.7%
260.7	55.2%
274.63	58.6%
288.56	62.1%
302.49	65.5%
316.42	69.0%
330.35	72.4%
344.28	75.9%
358.21	79.3%
372.14	82.8%
386.07	86.2%
400	89.7%
400	93.1%
400	96.6%
400	100.0%

Figure 3. 30 point data set curve



2.1.4 Discussion of the Targeted Endpoint

While the endpoint of a TMDL calculation is similar to a standard for a pollutant, the endpoint is not the standard. The endpoint selected for this TMDL is 200 counts per 100 ml for any given sample. If all of the data points are less than or equal to 200 then the water body will automatically pass both tests and not be considered impaired. Meeting the geometric mean test and applying the 10% test to the data sets apply both parts of the standard when applied to an actual data set or when considering a computer generated data set. It is therefore appropriate to select 200 as the targeted endpoint for the TMDL.

2.1.5 Discussion of the Critical Condition for Fecal Coliform

Critical conditions for waters impaired by nonpoint sources generally occur during periods of wet-weather and high surface runoff. But, critical conditions for point source dominated systems generally occur during periods of low-flow, low-dilution conditions. Therefore a careful examination of the data is needed to determine the critical 30-day period to be used for the TMDL.

2.2 Discussion of Instream Water Quality

There was one MDEQ ambient monitoring station located near Long Beach (02481240) on the listed segment. MDEQ monitoring for flow and fecal coliform was performed monthly at station 02481240 between June 1993 and April 1995. Data collected in this manner can not be used to calculate the geometric mean for the water body or the percent of time in exceedance of the instantaneous standard. Data was also collected at a special study station at Gulfport and Highway 49 at the Arkansas Street Bridge. The special study data were collected by MDEQ in 30 day groupings in November and December 2001, May 2002, and August 2002. Data collected in this manner can be used to calculate the geometric mean and the percent of time in exceedance for the water body. However, the results from the laboratory analysis of the May 2002 data indicated no bacteria in several samples. This indicates an error occurred with the sampling or analysis. The May 2002 results have been discarded, and the August 2002 data were collected to allow for a summer season to be analyzed.

2.2.1 Inventory of Available Water Quality Monitoring Data

Data collected at station 02481240 are listed in Table 3. Data collected for the special study in November and December 2001 are listed in Table 4. The August 2002 data are listed in Table 5.

Table 3. Fecal Coliform Data reported in Turkey Creek, MDEQ Station 02481240
June 1993 to April 1995

Date	Fecal Coliform (counts/100ml)	Flow (cfs)
06/09/93	90	5
07/13/93	50,000*	270
08/03/93	230	8
09/14/93	260	42
10/05/93	170	0.9
11/02/93	800	45
11/30/93	80	3
01/11/94	1,700	36
02/08/94	300	36
03/08/94	230	12
04/05/94	40	3
06/07/94	280	20
08/01/94	**740**	33
08/23/94	270	0.8
01/31/95	130	76
04/04/95	70	29

*Sample taken during out-of-bank flood and is not included in calculations

Table 4. Fecal Coliform Data reported in Turkey Creek, Special Study Station
November and December 2001

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
11/26/2001	10:57	110	110	No	165	No
12/03/2001	9:40	160				
12/05/2001	9:55	80ec				
12/07/2001	10:07	85ec				
12/11/2001	9:13	85ec				
12/19/2001	9:40	170				

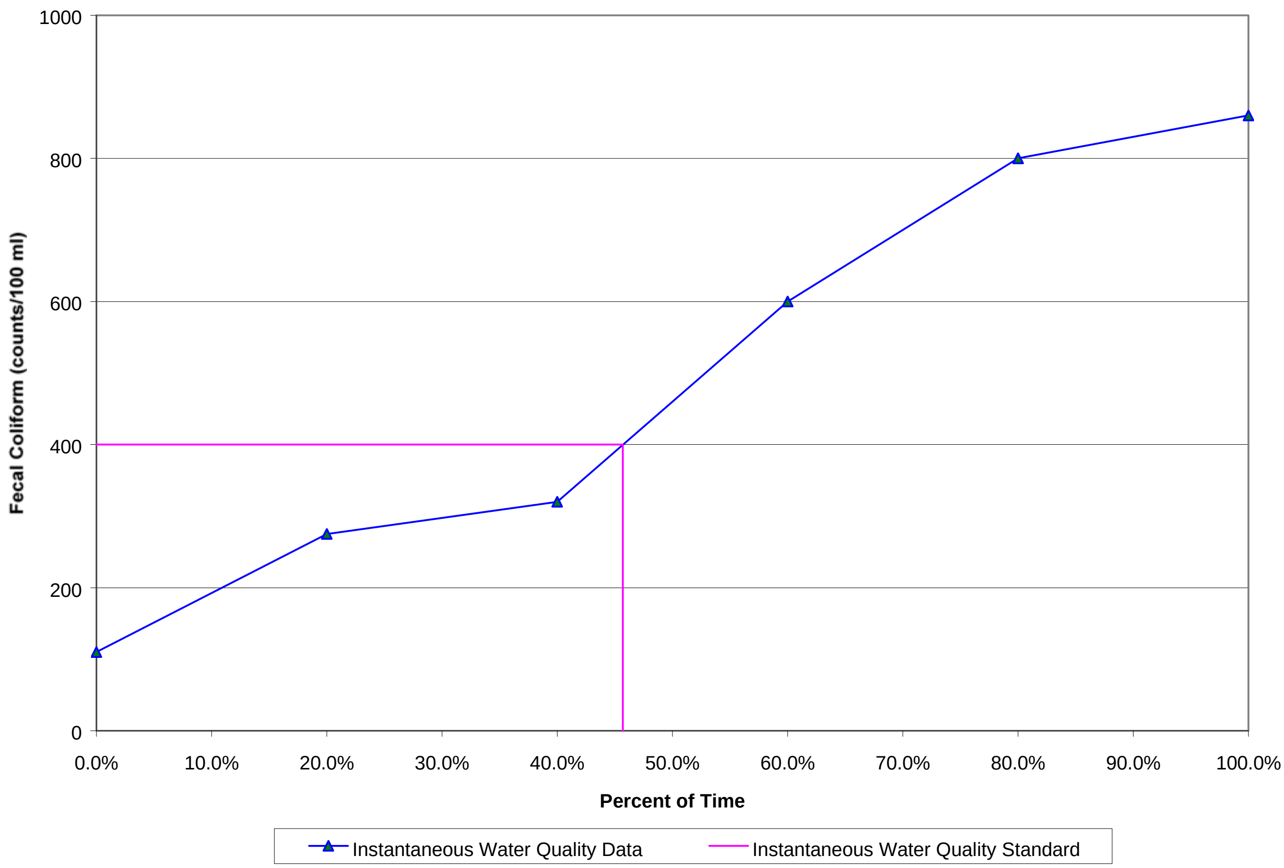
Table 5. Fecal Coliform Data reported in Turkey Creek, Special Study Station
August 2002

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
8/2/2002	13:35	110	398	Yes	830	Yes
8/13/2002	10:10	600ec				
8/15/2002	10:20	800				
8/19/2002	13:40	320ec				
8/28/2002	10:50	275				
8/30/2002	11:05	860				

2.2.2 Analysis of Instream Water Quality Monitoring Data

The data collected at the special study station during August 2002 indicated violation of the geometric mean portion of the standard and the percent of time in exceedence portion of the standard. The 90th percentile of the data set is 830, which is greater than the 400 necessary to meet the standard. A graphical representation can be seen in Figure 4 below. A line has been added to the graph representing 400 counts/100 ml and showing that this occurs less than 90% of the time, meaning that the counts of fecal coliform in the stream is greater than 400 more than 10% of the time. However, the data collected during November and December 2001 indicated no violations of either portion of the standard. Therefore, the summer season is considered the critical period for Turkey Creek.

Figure 4. Statistical Representation of Water Quality Data for Special Study Station, August 2002



SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Turkey Creek Watershed. This section documents the available information and interpretation for the analysis. The representation of the following sources in the model is discussed in Section 4.0, Mass Balance Procedure: Linking the Sources to the Endpoint.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during the low-flow, critical condition period. There were four point sources located in the watershed; however, two are now connected to the city sewer system. Therefore, only two are analyzed for this report. The two wastewater treatment plants analyzed in the Turkey Creek Watershed serve residential areas. Once the permitted dischargers were located, the effluent from each source was characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment types. Discharge monitoring reports (DMRs) were the best data source for characterizing effluent because they report measurements of flow and fecal coliform present in effluent samples. The DMRs for five years, 1993 through 1998, were analyzed. If evidence of insufficient treatment existed or when data were not available, professional judgement was used to estimate a fecal coliform loading rate for final calculations. The facilities included are listed in Table 6.

Table 6. Inventory of Point Source Dischargers

Facility Name	Subwatershed	NPDES Permit	Design Flow (MGD)	Permitted Concentration	Receiving Waterbody
Dolan's Trailer Park	03170009037	MS0042897	0.04	200	Turkey Creek
Ridgecrest Estates	03170009037	MS0052248	0.028	200	Turkey Creek
William Ladner Homes (aka Forest Heights)	03170009037	MS0023175	Connected to City Sewer System		
North Gulfport 7th and 8th Grade School	03170009037	MS0030916	Connected to City Sewer System		

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Turkey Creek, including:

- Failing septic systems
- Wildlife
- Other Direct Inputs
- Urban development

The approximately 11,100-acre drainage area of Turkey Creek contains many different landuse types, including forest, cropland, pasture, barren, and wetlands. The modeled landuse information for the watershed is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. The landuse categories were grouped into the landuses of urban, forest, cropland, pasture, barren, and wetlands. Figure 3.2 shows the landuse distribution for the watershed.

The MARIS landuse data for Mississippi was utilized by The Watershed Characterization System (WCS) to display, analyze, and compile data, such as MARIS landuse, population, and agriculture census data. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. The Natural Resources Conservation Service was also contacted for information about grazing animals in the watershed.

3.2.1 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek.

Photo 3. Turkey Creek Forested Area

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release. Due to these considerations, failing septic tanks are typically designated as both point and nonpoint sources of fecal coliform and the loads are split between the waste load allocation and the load allocation.

3.2.2 Wildlife

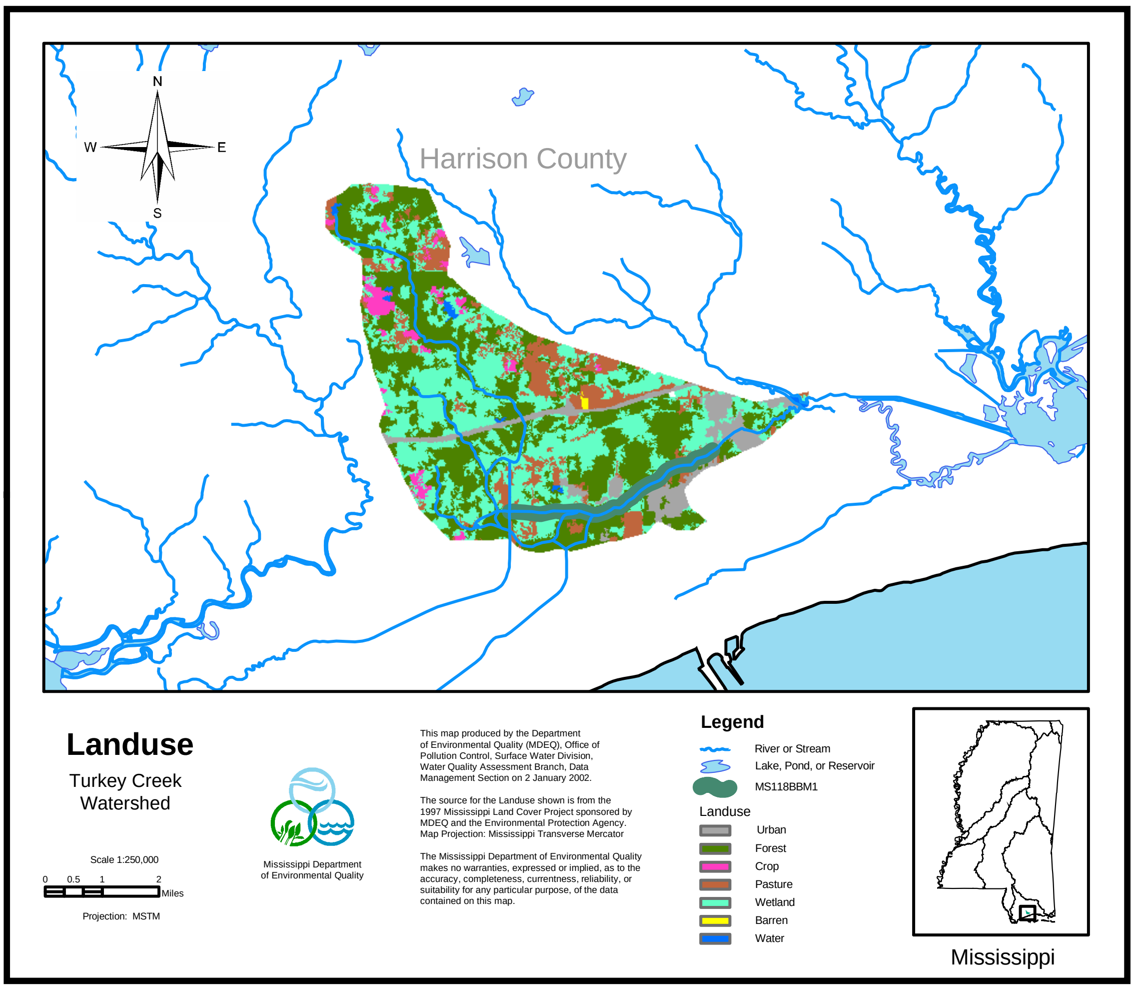
Wildlife present in the Turkey Creek Watershed contributes to fecal coliform bacteria on the land surface. It was assumed that the wildlife population remained constant throughout the year, and that wildlife were present on all land classified as pastureland, cropland, and forest. It was also assumed that the wildlife and the manure produced by the wildlife were evenly distributed throughout these land types.

Table 7. Landuse Distribution in Number of Acres

	Urban**	Forest*	Cropland	Pasture	Total
Area (Acres)	1392	5134	3270	1328	11,124
% Area	12.5%	46.2%	29.4%	11.9%	100 %

*Includes Wetlands ** Includes Barren

Figure 5. Landuse Distribution



3.2.3 Other Direct Inputs

The landuse report for the Turkey Creek Watershed indicates that pasture is 11.9% of the total land in the watershed. However in contacting the NRCS official for Harrison County, it was confirmed that there are no grazing animals in this watershed.

3.2.4 Urban Development

Urban areas include land classified as urban and barren. Fecal coliform contributions from urban areas may come from storm water runoff, runoff from construction sites, and runoff contribution from improper disposal of materials such as litter. It was reported at the public meeting that the sewer system serving this area is susceptible to overflows and failures. This raw sewage overflow would impair the water quality in Turkey Creek.

MASS BALANCE PROCEDURE

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

A mass balance approach was used to calculate this TMDL. This method of analysis was selected due to the size of the watershed and the lack of a USGS flow gage on the water body. It is not considered appropriate to use a standard one-dimensional hydrologic model or a load duration curve for a small watershed or in the absence of hydrologic data. The mass balance approach is suitable for this TMDL

4.2 Calculation of Load

The mass balance approach utilizes the conservation of mass principle. Loads can be calculated by multiplying the fecal coliform concentration in the water body for a 30-day period by the flow. The principle of the conservation of mass allows for the addition and subtraction of those loads to determine the appropriate numbers necessary for the TMDL. The loads can be calculated using the following relationship:

Load (counts/30days) = [**Concentration for 30 days** (30 days*counts/ 100 ml)] * [**Flow** (cfs)] * (Conversion Factor)

where (Conversion Factor) = [(28316.8 ml/1 ft^3)*(1 (100 ml)/100 (1 ml))*(60 s/1 min)*
(60 min/1 hour)*(24 hour/1 day)*(30 days/1 (30 days)/30 days]
= 2.45 E+07 ((100 ml * s)/(ft^3 *30 days*30days))

For the calculation of this TMDL, the concentration for 30 days used was the area under a curve that meets both portions of the standard with an assumed 30-sample data set. This value is 7129.425 (30days*counts/100 ml). The best stream with known flow to compare with Turkey Creek is Wolf Creek in the adjacent watershed. The average summer flow in Turkey Creek was estimated to be 23.04 cfs based on the average summer discharge of Wolf River at station 02481510 near Landon, Mississippi. (Telis)

Avg Summer Discharge (cfs)={[**02481510 Avg Summer Discharge** (cfs)]/[**02481510 Drainage Area** (square mile)]}*[**Turkey Creek Drainage Area** (square mile)]

Avg Summer Discharge (cfs) = {[**408.33** (cfs)]/[**308** (square mile)]}*[**17.38** (square mile)]

Avg Summer Discharge (cfs) = **23.04** cfs

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources, a load allocation for nonpoint sources, and a margin of safety.

5.1 Wasteload Allocations

Within this watershed, the contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. Table 8 lists the point source contributions, along with their existing load, allocated load, and percent reduction. The reduction is set at 0% because the treatment plants are operating well and currently disinfect the wastewater below the level permitted in their NPDES permits.

Table 8. Wasteload Allocations (Summer and Winter)

	Existing Load (counts/30 days)	Allocated Load (counts/30 days)	Percent Reduction
MS0042897	9.09E+09	9.09E+09	0%
MS0052248	6.36E+09	6.36E+09	0%
Total	**1.55E+10**	**1.55E+10**	**0%**

5.2 Load Allocations

The LA for Turkey Creek is calculated using the water quality criterion and the estimated critical flow. In calculating the LA component, the total TMDL for the water body is reduced by a 10 percent MOS. For this TMDL, the summer load is based on a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30 sample data set and the average summer flow of 23.04 cfs. The resulting summer LA is estimated to be 3.60E+12 counts/30 days. The resulting winter LA is estimated to be 7.39E+12 counts/30 days using the average winter flow. However, based on physical evidence brought to MDEQ's attention at the public meeting, the actual load in the stream needs to be lowered because of failing septic tanks and collection sewer failures that potentially pollute the waterbody.

Summer

LA = 0.9*(7129.425(30 days*counts/100ml)* 23.04(cfs) * 2.45E+07((100ml*s)/(ft^3 *30 days*30 days))) – 1.55E+10(counts for 30 days)

LA = 3.61E+12 counts for 30 days

Winter

LA = 0.9*(7129.425(30 days*counts/100ml)* 47.15(cfs) * 2.45E+07((100ml*s)/(ft^3 *30 days*30 days))) – 1.55E+10(counts for 30 days)

LA = 7.40E+12 counts for 30 days

5.3 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. For this study, reducing the TMDL by 10 percent explicitly specifies the MOS. Assuming the average summer flow, the resulting load attributed to the MOS for the summer is 4.02E+11 counts/30 days.

<u>Summer</u>

MOS = 0.1*(7129.425(30 days*counts/100ml)* 23.04(cfs) * 2.45E+07((100ml*s)/(ft^3*30 days*30 days)))
MOS = 4.02E+11 counts for 30 days

<u>Winter</u>

MOS = 0.1*(7129.425(30 days*counts/100ml)* 47.15(cfs) * 2.45E+07((100ml*s)/(ft^3*30 days*30 days)))
MOS = 8.24E+11 counts for 30 days

5.4 Calculation of the TMDL

This TMDL is calculated based on the following equation:

TMDL = WLA + LA + MOS

where WLA is the Waste Load Allocation, LA is the Load Allocation, and MOS is the Margin of Safety.

WLA = NPDES Permitted Facilities

LA = Surface Runoff + Other Direct Inputs

MOS = explicit

The summer TMDL was calculated based on the average summer flow of the watershed, and a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30-sample data set. The winter TMDL was calculated based on the average winter flow of the watershed, and a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30-sample data set.

<u>Summer</u>

TMDL = (7129.425(30 days*counts/100ml)* 23.04(cfs) * 2.45E+07((100ml*s)/(ft^3*30 days*30 days)))
TMDL = 4.02E+12 counts for 30 days

<u>Winter</u>

TMDL = (7129.425(30 days*counts/100ml)* 47.15(cfs) * 2.45E+07((100ml*s)/(ft^3*30 days*30 days)))
TMDL = 8.24E+12 counts for 30 days

Table 9. TMDL Summary for Listed Segment (counts/30 days) for Summer and Winter

	MS118BBM1	
	Summer	**Winter**
WLA	1.55E+10	1.55E+10
LA	3.61E+12	7.40E+12
MOS	4.02E+11	8.24E+11
TMDL = WLA + LA +MOS	**4.02E+12**	**8.24E+12**

5.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream is designated for the use of secondary contact. For this use, the pollutant standard is seasonal. MDEQ used the average summer flow for calculating the summer TMDL and the average winter flow for calculating the winter TMDL; therefore, the season differences are incorporated in the seasonal average flow values. Additionally, MDEQ selected the summer values as the target for the TMDL, which are more stringent

5.6 Reasonable Assurance

This component of TMDL development does not apply to this TMDL Report. There are no point sources (WLA) requesting a reduction based on promised Load Allocation components and reductions. The point sources are required to discharge effluent treated and disinfected that will be below the 200 colony counts per 100-ml. target at the end of the pipe.

CONCLUSION

The estimated reduction in the existing fecal coliform load is 52%. A reduction in sources of fecal coliform is a priority. Education projects that teach best management practices regarding urban bacteria loads and septic tank management should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants. Additional sewer rehabilitation projects are eligible for funding with CIAP funds. The TMDL will not impact existing or future NPDES Permits as long as the effluent is disinfected to meet water quality standards for pathogens. MDEQ will not approve any NPDES Permit application that does not plan to meet water quality standards for disinfection. MDEQ will continue to monitor the stream to check for future compliance with the state bacteria standard.

The data and calculations indicate that there is currently a bacteria problem in Turkey Creek and is supported by the physical evidence found during the tour of the stream. The City of Gulfport apparently has had sewer bypass problems in the past in this area. These sewer problems must be corrected. Additionally, this area of the state is considered a poor area to install septic tanks. However, there are several septic tanks currently operating in the watershed. These septic tanks should be tied into the current sewer system when it becomes available. Additionally, when the sewer system expands to the two current NPDES Permitted facilities, these facilities should also tie into the city sewer system.

6.1 Future Monitoring

MDEQ adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Turkey Creek Basin, Turkey Creek will receive additional monitoring to identify any change in water quality. MDEQ produced guidance for future Section 319 project funding will encourage NPS restoration projects that attempt to address TMDL related issues within Section 303(d)/TMDL watersheds in Mississippi.

6.2 Public Participation

On August 20, 2002 MDEQ staff met with local residents to tour the Turkey Creek watershed to obtain additional information regarding the physical problems with the stream. At that time, the swimming hole was identified as well as failing septic tanks. Additional flood control issues were shown to MDEQ staff, but are not included within this TMDL report.

The previous versions of this TMDL were published for a 30-day public notice. During this time, the public was notified by publication in the statewide newspaper and a newspaper in the area of the watershed. The public was given an opportunity to review the TMDL and submit comments. At the end of the 30-day period, MDEQ determined the level of interest in the TMDL was sufficient to hold a public meeting regarding this TMDL. On April 16, 2002 MDEQ held the public meeting in the watershed to discuss this TMDL and other issues in the watershed. Comments from that meeting were used to modify this TMDL. Additional data were collected in the watershed that now show there is an impairment in the stream during the summer season. The TMDL has been modified based on the new data.

This TMDL will be published for another 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper and newspapers in the area of the watershed. The public will be given an opportunity to review the TMDL and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list.

TMDL mailing list members may request to receive the TMDL reports through either, email or the postal service. Anyone wishing to be included on the TMDL mailing list should contact Greg Jackson at (601) 961-5098 or Greg_Jackson@deq.state.ms.us. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public meeting.

All written comments received during the public notice period and at any public meeting become a part of the record of this TMDL. All comments will be considered in the ultimate completion of this TMDL for submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered waterbody may be based upon a similar, unaltered or least impaired, waterbody or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving waterbody.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: use specified in water quality standards for each waterbody or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Fecal coliform bacteria: a group of bacteria that normally live within the intestines of mammals, including humans. Fecal coliform bacteria are used as an indicator of the presence of pathogenic organisms in natural water.

Geometric mean: the *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30^{th} root of the product of 30 numbers.

Impaired Waterbody: any waterbody that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all direct sources and land applied fecal coliform that enter a receiving waterbody. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a public body or a privately owned treatment works that accepts discharges that would otherwise be subject to Federal Pretreatment Requirements.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^4$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d_l}$, $\mathbf{d_2}$, $\mathbf{d_3}$) respectively could be shown as:

$$\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24 + 123 + 16 = 163$$

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant. It also contains a portion of the contribution from septic tanks.

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10.......................... Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BASINS ....Better Assessment Science Integrating Point and Nonpoint Sources

BMP ....Best Management Practice

CWA ....Clean Water Act

DMR .... Discharge Monitoring Report

EPA ....Environmental Protection Agency

GIS ....Geographic Information System

HUC ....Hydrologic Unit Code

LA .... Load Allocation

MARIS .... State of Mississippi Automated Resource Information System

MDEQ... Mississippi Department of Environmental Quality

MOS ....Margin of Safety

NRCS .... National Resource Conservation Service

NPDES .... National Pollution Discharge Elimination System

NPSM...Nonpoint Source Model

RF3.. Reach File 3

USGS .... United States Geological Survey

WLA .... Waste Load Allocation

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