TOTAL MAXIMUM DAILY LOAD (TMDL) DEVELOPMENT

For FECAL COLIFORM in the

LONG BRANCH WATERSHED

(HUC 03160109)

Cullman County, Alabama

United States Environmental Protection Agency

Region 4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et.seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S Environmental Protection Agency is hereby establishing a Total Maximum Daily Load (TMDL) for fecal coliform bacteria in Long Branch. Subsequent actions must be consistent with this TMDL.

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Date

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1.0 EXECUTIVE SUMMARY: LONG BRANCH

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify waterbodies which are not meeting water quality standards and to determine the Total Maximum Daily Load (TMDL) for pollutants causing the impairment. TMDLs are the sum of individual waste load allocations for point sources (WLAs), load allocations (LAs) for nonpoint sources including, natural background levels, and a margin of safety (MOS).

On the 1996, 1998, and 2000 303(d) list, the Alabama Department of Management (ADEM) identified Long Branch from its headwaters to the confluence with Wolf Creek as not supporting its designated use of Fish and Wildlife for ammonia, nutrients, organic enrichment/dissolved oxygen (OE/DO), and pathogens. In 1998, it was delisted for nutrients. The Fish and Wildlife classification includes other usage of the waterbody, which may be used for incidental water contact and recreation during June through September.

Long Branch is located in Cullman County and lies within the Mulberry Fork of the Black Warrior River basin, hydrologic unit 03160109. Long Branch is a tributary to Wolf Creek. The watershed is predominantly agricultural followed by forest with little urban or developed area. The drainage area of the watershed upstream of the monitoring station is approximately 644 acres (1.0 sq. mi.). Currently, there are no permitted point source dischargers of fecal coliform bacteria in the watershed.

Fecal coliform is used as the indicator for this pathogen TMDL in Alabama. A geometric mean of 200 colonies/100mL was established as the target for this TMDL as this is the most stringent water quality standards for the given designated use classifications. ADEM was contacted for fecal coliform data used to list the stream on the 1996 303(d) list, but the data were not provided to EPA. As a result, fecal coliform data collected in 1997 and 2001 were used to develop the TMDL.

This TMDL requires a 58 percent reduction in fecal coliform bacteria loading to the stream from nonpoint sources. All future point or nonpoint source of fecal coliform loading introduced in the watershed shall not exceed this TMDL.

2.0 TMDL: LONG BRANCH

2.1 Introduction

2.1.1 The TMDL Process

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify waterbodies which are not meeting water quality standards and to determine the Total Maximum Daily Load (TMDL) for pollutants causing the impairment. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between the pollution sources and instream water quality conditions, so that states can establish water quality based controls to reduce pollution and to restore and maintain the quality of their water resources (USEPA 1991).

TMDLs are the sum of individual waste load allocations for point sources (WLAs), load allocations (LAs) for nonpoint sources, including natural background levels, and a margin of safety (MOS). The margin of safety can be included either explicitly or implicitly and accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. A TMDL is denoted by the equation:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. For bacteria, TMDLs are expressed in terms of organism counts (or resulting concentration), in accordance with 40 CFR Part 130.2(i). For this TMDL, the load is expressed in units of counts per 30 days as this reflects the geometric mean standard.

2.1.2 Watershed Description

The State of Alabama identified Long Branch on the 1996 303(d) list as not supporting its designated use of Fish and Wildlife for OE/DO, nutrients, and pathogens. The Long Branch watershed is located in Cullman County, AL in the Black Warrior Basin (hydrologic unit code 03160109). The drainage area of the watershed measured upstream of the monitoring station is approximately 644 acres (see Figure 1). Water quality data collected at station DCK-5 was used for the 303(d) listing.

The distribution of land cover in the watershed is based on the Multi-Resolution Land Characteristic (MRLC) database derived from Landsat digital images from the period 1990-1993. The land cover distribution is presented in Table 1 and shown spatially in Figure 2. Agriculture, including pastureland and cropland, is the predominate land use (73 %) in the watershed followed by forest land (26 %). There is little urban or developed area in the watershed.

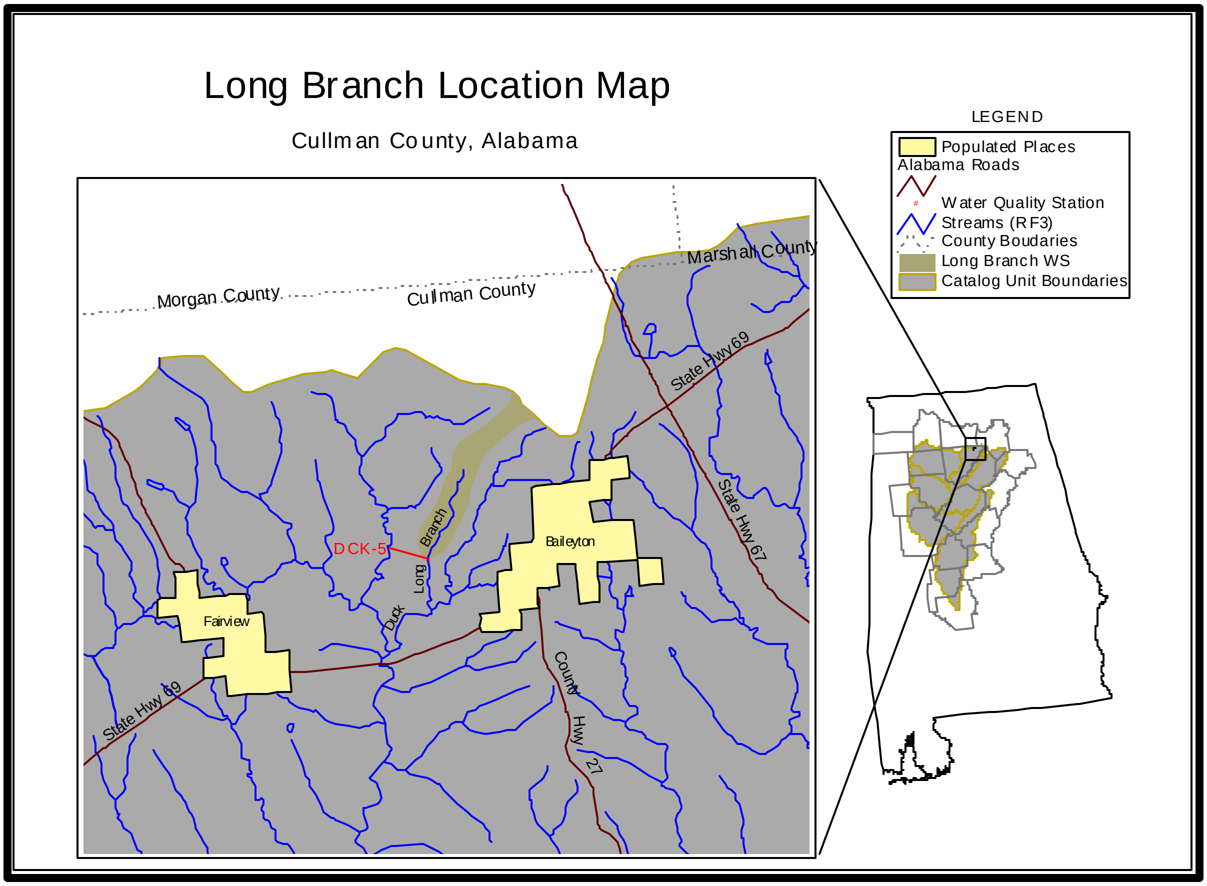

Figure 1. Location Map

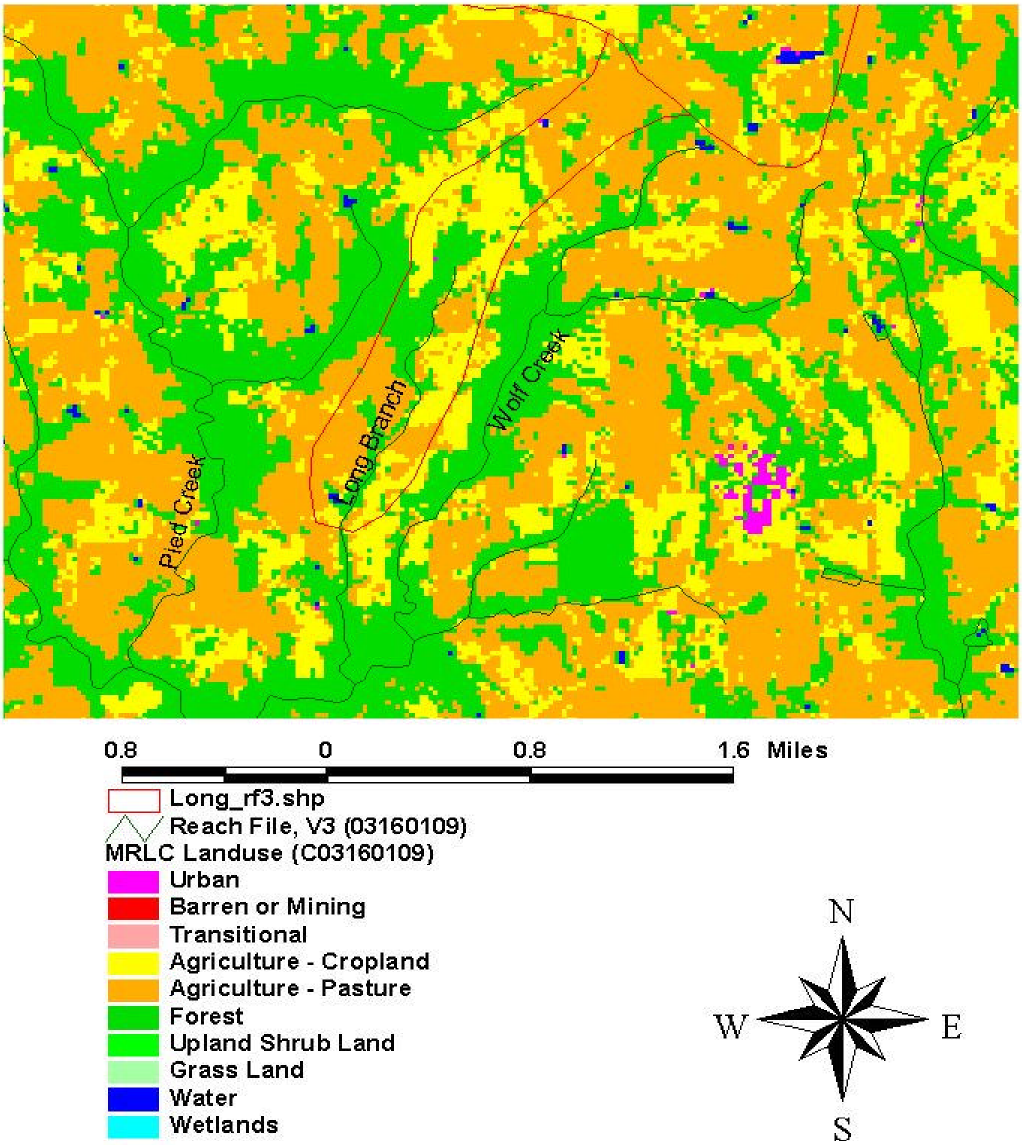

Figure 2. Land Use Distribution

Table 1. Long Branch Watershed Land Use Distribution[1]

Land Use	**Area** (acres)	**%-age of Total Watershed**
Deciduous Forest	49	7.6
Evergreen Forest	64	10
Mixed Forest	56	8.7
Commercial/Industrial/Transport.	1	0.1
Open Water	2	0.3
Pasture/Hay	293	45.6
Row Crops	179	27.7
Total	**645**	**100**

[1] Land use distribution above monitoring station DCK-5.

2.1.3 Designated Use of the Impaired Segments

The use classification for Long Branch is Fish and Wildlife and is described in ADEM Admin. Code R. 335-6-10-.09(5)(a), (b), (c), and (d).

(a). Best usage of waters:
Fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming and water-contact sports or as a source of water supply for drinking or food processing purposes.

(b). Conditions related to best usage:
The waters will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs.

(c). Other usage of waters:
It is recognized that the waters may be used for incidental water contact and recreation during June through September, except that water contact is strongly discouraged in the vicinity of discharges or other conditions beyond the control of the Department or the Alabama Department of Public Health.

(d). Conditions related to other usage:
The waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports.

2.2 TMDL Indicators and Numeric Targets

In Alabama, fecal coliform bacteria is used as an indicator of the presence of pathogens in a stream. Criteria for acceptable bacteria levels for the Fish and Wildlife use classification are presented in ADEM Admin. Code R. 335-6-10-.09(5)(e)7.(i) and (ii).

i. Bacteria of the fecal coliform group shall not exceed a geometric mean of 1,000 colonies/100mL; nor exceed a maximum of 2,000 colonies/100mL in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours.

ii. For incidental water contact and recreation during June through September, the bacterial quality of water is acceptable when a sanitary survey by the controlling health authorities reveals no source of dangerous pollution and when the geometric mean fecal coliform organism density does not exceed 100 colonies/100mL in coastal waters and 200 colonies/100mL in other waters. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours. When the geometric mean fecal coliform organism density exceeds these levels, the bacterial water quality shall be considered acceptable only if a second detailed sanitary survey and evaluation discloses no significant public health risk in the use of the waters. Waters in the immediate vicinity of discharges of sewage or other wastes likely to contain bacteria harmful to humans, regardless of the degree of treatment afforded these wastes, are not acceptable of swimming or other whole body water-contact sports.

Incidental water contact and recreation is the most stringent of the use classifications. The geometric mean standard of 200 counts/100mL was used as the target level for TMDL development. The TMDL for Long Branch represents the total load the stream can assimilate over a 30-day period and meet the target geometric mean concentration of 200 counts/100mL.

2.3 Water Quality Assessment

Water quality data collected at water quality station DCK-5 on Long Branch in 1997 and 2001 are shown in Table 2. Only data collected during 2001 were suitable to calculate the 30-day geometric mean concentration. In July 2001, the geometric mean concentration was calculated as 474 and results in a violation of the incidental water contact and recreation standard (See Appendix A). The instantaneous maximum criterion was not violated during any time period samples were collected.

Table 2 . Water quality sampling data collected at DCK-5 for Long Branch.

Sample Date	**Fecal Coliform Bacteria Concentration (counts/100mL)**	Sample Date	**Fecal Coliform Bacteria Concentration (counts/100mL)**
5/28/97	1680	7/18/2001	196
6/26/97	620	7/19/2001	330
8/28/97	1200	7/24/2001	930
10/8/97	112	7/25/2001	620
10/9/97	280	7/26/2001	640
		Geometric Mean Concentration	**474**

2.4 Source Assessment

2.4.1 Point Source Assessment

A point source is defined as any discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater, treated sanitary wastewater, storm water associated with industrial activity, or storm water from municipal storm sewer systems that serve over 100,000 people must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities are the only contributions to the wasteload allocation (WLA) component of the TMDL. There are no NPDES permitted facilities discharging fecal coliform bacteria located within the Long Branch watershed. All future NPDES facilities will be required to meet end-of-pipe criteria equivalent to the water quality standard for fecal coliform bacteria of 200 counts/100mL.

ADEM requires a general NPDES permit for all concentrated animal feeding operations (CAFOs) in excess of 1000 animal units and for poultry operations in excess of 125,000 birds. The general permit for CAFOs is a no discharge permit except during the 25-year, 24-hour storm event, and then the CAFO facility can discharge only process overflow wastewater to the stream. Based on the number of poultry in the watershed (see Table 3), it is possible that CAFOs could be causing or contributing to the impairment of Long Branch. This TMDL requires CAFO facilities to comply with their permits and to not cause or contribute to water quality impairment. If future water quality data indicate CAFOs are causing water quality impairment, individual permits may be required for these facilities.

2.4.2 Nonpoint Source Assessment

Nonpoint sources of fecal coliform bacteria are diffuse sources that cannot be identified as entering the waterbody at a single location. These sources generally involve land activities that contribute fecal coliform bacteria to streams during rainfall runoff events. Agricultural land is a suspected source of fecal coliform bacteria. Runoff from pastures and croplands, animal feeding operations, improper storage and land application of animal waste, and animals with access to streams are potential sources that can discharge fecal coliform bacteria into Long Branch. All sources considered to be nonpoint sources contribute to the load allocation (LA) portion of the TMDL. Typical nonpoint sources of fecal coliform bacteria include:

- Septic systems and urban runoff
- Grazing livestock
- Wildlife and animals with access to streams

The Watershed Characterization System (WCS), a geographic information system (GIS) interface, was used to display, analyze and compile spatial and attribute data. Available data sources included land use category, point source discharges, soil type and characteristics, population data (human and livestock), digital elevation data, stream characteristics, precipitation and flow data. Results from these analyses and literature values for fecal coliform concentrations provided loading rates from the various sources.

Septic Systems and Urban Runoff

Failing septic systems can contribute fecal coliform bacteria into the waterbody. The number of people in the watershed on septic systems is based on U.S. Census Bureau population estimates for 1997 and sewer practices in Cullman County. Based on 1990 U.S. census data, 66 people in the watershed were estimated to use septic systems. Using best professional judgment it was assumed that 10 percent of the total septic systems in the watershed would leak or fail. Each household was assumed to house 2.5 people.

Literature values were used to estimate the loadings from failing septic systems in the watershed using a representative effluent flow and concentration. Horsley and Witten (1996) estimate septic systems to have an average daily discharge of 70 gallons/person-day with effluent concentrations ranging from 10^4 to 10^7 counts/100mL. Assuming an effluent concentration of 10^4 counts/100mL, the load from failing septic systems was estimated to be 1.75×10^8 counts/day. Over any 30-day period, this daily load is equivalent to 5.25×10^9 counts/30 days. This load is conservative as it assumes septic systems discharge directly into the stream rather than through the soil layer. This assumption of the worst case scenario is used to develop the implicit margin of safety for this TMDL. Stormwater from urban areas can contribute to fecal coliform loads by delivering litter and the waste of domestic pets and wildlife to the stream.

Grazing Livestock

Animal population in the watershed are based on 1997 Agricultural Census data (USDA 1997) and are shown in Table 3. Poultry is the predominate livestock operation in the watershed.

Table 3. Livestock Distribution in Long Branch Watershed

Livestock	Number of Animals
Cattle	146
Beef Cow	82
Milk Cow	4
Hogs	0
Sheep	0
Poultry	275,171

Poultry operations dominate agricultural practices in the watershed. Without knowledge of the precise management practices of poultry litter in the watershed, it is assumed that poultry litter is stockpiled before applied to agricultural lands, or used as a feed material for cattle, composted, or sold. If the poultry litter is not spread at agronomical rates, then a large portion of the fecal coliform bacteria present in the litter could wash off to the stream during a storm event. With pasture encompassing the largest percentage of agricultural land, it is assumed that poultry litter is predominately spread on pastureland. The instream concentration from poultry litter is included in the pasture runoff load. Literature values for runoff from grazed pastureland vary from 1.2×10^2 to 1.3×10^6 counts/100mL (EPA 2001).

Wildlife and Animals with Access to Streams

Wildlife deposit waste containing fecal coliform bacteria onto the land where it can be transported during a rainfall runoff event to nearby streams. Fecal coliform contributions from wildlife were represented in the model based on deer population. It was assumed that deer are uniformly distributed to forest land, pasture land, cropland and wetland areas at a density based on local information. Fecal coliform loading rates due to deer were estimated (refer to Section 2.4.1 for discussion) to be 5.0×10^8 counts/animal/day with an assumed population of 45 deer/sq. mile. Using this rate and the assumption of equally distributed population of deer between forest and agricultural land uses, the fecal coliform load to the land surface (the background load) was estimated as 2.47×10^6 counts/acre/day.

Wildlife and other animals in the watershed may have access to streams that pass through pastures, forests, and croplands. The fecal coliform load from wildlife is considered background. Due to the limited number of cattle in the watershed and the fact that Long Branch often flows dry, it is reasonable to assume that the cattle operations in the watershed do not use the stream as a sole source of water supply for the cattle. Grazing animals may use the stream for shade and drinking water and at times may deposit feces in the stream. Fecal coliform loading to the stream from grazing animals using the stream for shade is included in the load attributed to wildlife.

2.5 Linking the Sources to the Indicators and Targets

Establishing the relationship between instream water quality and sources of fecal coliform, the pathogen indicator, is an important component of the TMDL. It provides the relative contribution of the sources, as well as a predictive examination of water quality resulting from changes in these source contributions.

2.5.1 Model Selection

A mass balance approach was used to calculate the TMDL. This method of analysis is appropriate for small watersheds with limited water quality data. Utilizing the conservation of mass principle, loads can be calculated using the following relationship:

Load (counts/d) = (**Concentration**, counts/100 mL) × (**Flow**, cfs) × (Conversion Factor)

Where the conversion factor = 7.34×10^8 to obtain units of counts/30-days

2.5.2 Model Setup

Long Branch was delineated into a single watershed based on a Reach File 3 (RF3) stream coverage and a Digital Elevation Model (DEM) of the area (see Figure 1). The farthest downstream point of the delineation was the confluence with Wolf Creek. The delineated watershed was used in conjunction with the WCS to quantify potential pollutant sources.

River flow influences the instream fecal coliform concentration. The critical flow in Long Branch of 1.65 cfs represents the average annual flow. This flow was estimated using the average streamflow per square mile relationship developed by Nelson (1984).

Avg. Annual Flow, cfs = (**Avg. Streamflow** per sq. mile) × (**Drainage Area**, sq. mile)

= (1.65 cfs/sq. mile) × (1.0 sq. mile)

= 1.65 cfs

The average annual flow was used to calculate the TMDL rather than the seven-day, ten year ($7Q_{10}$) or the seven-day, two-year ($7Q_2$) low flows since ADEM calculated these values to be zero based on USGS methodology (Bingham 1982).

2.5.3 Fecal Coliform Loading Rates

The existing load of fecal coliform bacteria in Long Branch is the sum of the point and nonpoint sources in the watershed. There are no point sources in the watershed contributing fecal coliform bacteria to Long Branch; therefore, the cause of impairment in Long Branch is due to nonpoint source loads. The existing load of fecal bacteria in the stream is based on the geometric concentration of 474 counts/100mL calculated in July 2001, and the average annual flow rate of 1.65 cfs. Using the equation for conservation of mass presented in Section 3.5.1, the existing load of fecal coliform bacteria in the stream is 5.74×10^{11} counts/30days (see Appendix A).

2.6 Total Maximum Daily Load (TMDL)

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while achieving water quality standards. The components of the TMDL are the Wasteload Allocation (WLA) and the Load Allocation (LA) and taking into consideration a margin of safety and seasonality. The WLA is the pollutant allocation to point sources while the LA is the pollutant allocation to natural background and nonpoint sources.

2.6.1 Waste Load Allocation (WLA)

There are no NPDES permitted discharges of fecal coliform bacteria in the Long Branch watershed. Therefore, the WLA component is zero. Any future permitted dischargers of fecal coliform bacteria in the watershed shall meet end-of-pipe standards of 200 counts/100mL.

2.6.2 Load Allocation (LA)

The load allocation (LA) for Long Branch is calculated using the water quality criterion and the average annual flow. In calculating the LA component, the water quality standard of 200 counts/100mL is reduced by the margin of safety. For the Long Branch TMDL, the LA is based on a fecal coliform concentration of 180 counts/100mL and an average annual flow rate of 1.65 cfs. The resulting LA is estimated to be 2.18×10^{11} counts/30days (see Appendix A).

3.6.3 Margin of Safety

The margin of safety (MOS) is part of the TMDL development process. There are two basic methods for incorporating the MOS (USEPA 1991):

- Implicitly incorporating the MOS using conservative model assumptions to develop allocations, or
- Explicitly specifying a portion of the total TMDL as the MOS; using the remainder for allocations.

The MOS is incorporated explicitly into this modeling process by selecting the instream target concentration at 180 counts/100mL (i.e., 20 counts/100mL less than the water quality standard of 200 counts/100mL). Assuming the average annual flow, the resulting load attributed to the MOS is 2.42×10^{10} counts/30days. An implicit MOS is also incorporated into the TMDL by using conservative assumptions in the calculation of the LA component. For existing conditions, the LA is based on the instream geometric mean concentration, which includes decay processes. The total load that can wash off the watershed could be higher if instream decay was not considered.

2.6.4. Seasonal Variation

In developing TMDLs for listed waterbodies, seasonality is typically addressed by assuming low flow (i.e., 7Q10) or wet weather conditions. For Long Branch, the 7Q10 flow is zero. By assuming the average annual flow is the critical flow in calculating the allowable load, seasonality is considered, as this flow is representative of wet weather conditions.

2.6.6 TMDL Calculation

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure (emphasis added). For Long Branch, the TMDL is expressed in terms of counts/30days and is shown in Table 4. The TMDL represents the total load the stream can assimilate over a 30-day period and meet the target geometric mean concentration of 200 counts/100mL. The TMDL analysis is included in Appendix A.

Table 4. TMDL Calculation

TMDL (counts/30days)	**WLA (counts/30days)**	**LA (counts/30days)**	**MOS (counts/30days)**	**Percent Reduction[1]**
2.422×10^{11}	0	2.18×10^{11}	2.42×10^{10}	58 %

1. The percent reduction is based on the instream load of 5.74×10^{11} counts/30days and the TMDL load of 2.422×10^{11} counts/30days.

This TMDL requires a 58 percent reduction of instream fecal coliform bacteria loadings to achieve water quality standards. With no point source discharge facilities of fecal coliform bacteria in the watershed, reductions are required from nonpoint sources. Runoff from grazed pasturelands is the probable source of impairment and could be due to not applying poultry litter on pastureland at agronomical rates or runoff from stacked poultry litter. Leaking or failing septic systems could also contribute to the impairment of Long Branch. Incorporation of best management practices (BMPs) to poultry litter operations to reduce runoff to the stream and identification and repair of failing septic systems could improve water quality conditions in Long Branch.

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APPENDIX A

TMDL ANALYSIS

Long Branch - TMDL Analysis

Date	Fecal coliform concentration (counts/100 ml)
7/18/01	196
7/19/01	330
7/24/01	930
7/25/01	620
7/26/01	640
geomean (7/2001):	**473.77**

Date	Fecal coliform concentration (counts/100 ml)
5/28/97	1680
6/26/97	620
8/28/97	1200
10/8/97	112
10/9/97	280

geomean: cannot calculate based on requirements of standard
instantaneous std: no violations in 1997 or 2001

Standard: 1000 counts/100 ml (geomean for fish and wildlife - primary standard)
200 counts/100 ml (geomean for incidental water contact and recreation during June through Sept)
both geomean standards require a minimum of 5 samples
instantaneous standard: 2000 counts/100 ml in any sample (fish and wildlife std - recreation has no instantaneous std)

Estimated flow: 1.65 (based on average annual flow since 7Q10 and 7Q2 are zero)

fecal coliform load (counts/30day): **flow (cfs) X geomean concentration (counts/100ml) X conversion factor**
conversion factor = 733939950 (to obtain units of counts/30day)

existing load (counts/30day) = 5.74E+11

TMDL = WLA + LA + MOS

Waste load allocation (counts/30day) = 0
Load allocation (counts/30day) = 2.18E+11 (based on a geometric mean concentration of 180 counts/100 ml)
MOS (counts/30day) = 2.42E+10 (based on a geometric mean concentration of 20 counts/100 ml)
TMDL = 2.42E+11 cnts/30days

% Reduction = (existing load - TMDL load)/existing load * 100

% Reduction = 57.79