Total Maximum Daily Load
For
Fecal Coliform
In
Broad Mouth Creek
(Hydrologic Unit Code: 03050109-090
& Stations S-010, S-289, & S-304)

May 2005

SCDHEC Technical Report Number: 016-05

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 for Broad Mouth Creek in the Saluda River Basin. Subsequent actions must be consistent with this TMDL.

James D. Giattina, Director Water Management Division	Date

Abstract

Total Maximum Daily Loads (TMDLs) have been developed for Broad Mouth Creek, which is a tributary of the Saluda River in Anderson and Abbeville Counties, SC. This creek has been on South Carolina's 303(d) list since 1998 at the upstream location and since 2000 at the lower two stations. These locations are Broad Mouth Creek at water quality monitoring station S-289 (at Blake Dairy Road S-04-267), Broad Mouth Creek at S-010 (at US-76), and Broad Mouth Creek at S-304 (at S-01-111). During the assessment period for the 2004 303(d) list (1998-2002), 41 % of samples at S-289, 40 % at S-010, and 29 % at S-304 exceeded the water quality standard. The watershed of Broad Mouth Creek is mostly forest, pasture, and cropland but has some urban land in and around the towns of Belton and Honea Path. There is one point source in the watershed. The Town of Belton and adjacent developed areas have been designated as a Municipal Separate Storm Sewer System (MS4). The probable sources of fecal coliform bacteria in Broad Mouth Creek are runoff from agricultural land, cattle-in-streams, failing septic systems, urban runoff, sewer overflows, and sewer leaks.

The load-duration curve methodology was used to calculate the existing loads and the TMDL loads for the creek. Existing loads and TMDL loads are presented in Table Ab-1. In order to reach the target loads for Broad Mouth Creek, reductions in the existing loads to the creek of 49 % to 75 % will be necessary. Resources and several TMDL implementation strategies to bring about these reductions are suggested.

Table Ab-1. Total Maximum Daily Loads for Broad Mouth Creek at impaired stations.

Station ID	Existing Waste Load	TMDL WLA		Existing Load	TMDL LA	MOS	TMDL	Percent Reduction[3]
	Continuous (cfu/day)	Continuous[1] (cfu/day)	MS4[2]	(cfu/day)	(cfu/day)	(cfu/day)	(cfu/day)	
S-289	NA	NA	75	1.8E+11	4.46E+10	2.35E+09	4.69E+10	75%
S-010	2.21E+07	2.21E+07	69	7.8E+11	2.44E+11	1.29E+10	2.57E+11	69%
S-304	2.21E+07	2.21E+07	NA	5.7E+11	2.89E+11	1.52E+10	8.05E+11	49%

Table Notes:
1. WLA is expressed as total monthly average.
2. MS4 expressed as percent reduction equal to LA reduction.
3. Percent reduction applies to LA and MS4 components when an MS4 is in the watershed.

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1.0 INTRODUCTION

1.1 Background

Fecal coliform bacteria is widely used as an indicator of pathogens in surface waters and wastewater. Acute gastrointestinal illnesses affect millions of people in the United States and cause billions of dollars of costs each year (Gaffield et al, 2003). Of these illnesses many are caused by contaminated drinking water. Untreated storm runoff has been associated with a number of disease outbreaks, most notably the outbreak in Milwaukee that caused many deaths.

Though occurring at low levels from natural sources, the concentration of fecal coliform bacteria can be elevated in water bodies as the result of pollution. Sources of fecal coliform bacteria are usually diffuse or nonpoint source, such as stormwater runoff, failing septic systems, and leaking sewers. Occasionally, the source of the pollutant is a point source. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water bodies that are not meeting designated uses under technology-based pollution controls. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in stream water quality conditions so that states can establish water quality-based controls to reduce pollution and restore and maintain the quality of water resources (USEPA 1991).

1.2 Watershed Description

The watershed of Broad Mouth Creek in Anderson and Abbeville Counties is in the Piedmont of western South Carolina (Figure 1). Broad Mouth Creek is a tributary of the Saluda River upstream of Lake Greenwood. Approximately half of the towns of Belton and Honea Path are in the watershed. Approximately 5000 people live in the Broad Mouth Creek watershed (2000 US Census). These TMDLs include those parts of the watersheds upstream of the water quality stations. Information about the watersheds is given in Table 1.

Table 1. Broad Mouth Creek water quality monitoring site descriptions.

Watershed	Station ID	Sampling Station Description	Drainage Area km^2	Drainage Area mi^2	Population
Broad Mouth Creek	S-289	Broad Mouth Creek at S-4-267	13.1	5.1	958
Broad Mouth Creek	S-010	Broad Mouth Creek at US-76	71.7	27.7	4730
Broad Mouth Creek	S-304	Broad Mouth Creek at S-01-111	84.9	32.8	5000

Forest is the principal land use in the Broad Mouth Creek watersheds; 46 % of the watershed above station S-289 was forest in 1992 (Table 2 and Figure2). Cropland made up 26 % and pasture 19 % of this watershed. The middle part of the watershed between S-289 and S-010 was 53 % forest,

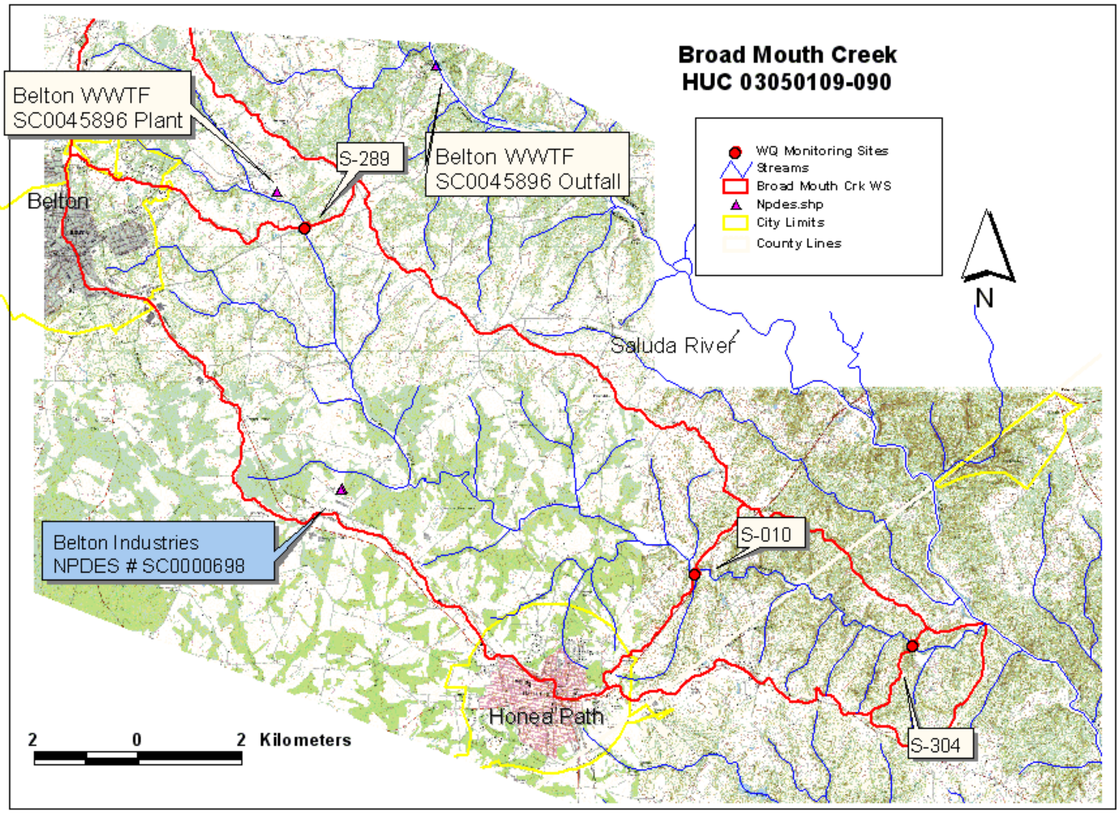

Figure 1. Map of Broad Mouth Creek watershed, Saluda Basin.

16% pasture and 16 % cropland. The lower part of the watershed between S-010 and S-304 was 78 % forest and 12 % each for pasture land and cropland. Developed land was highest upstream of S-289, but still less than 10 %. These land use data are from the National Land Cover Data 1992 (NLCD 1992) (Figure 2; Table 2).

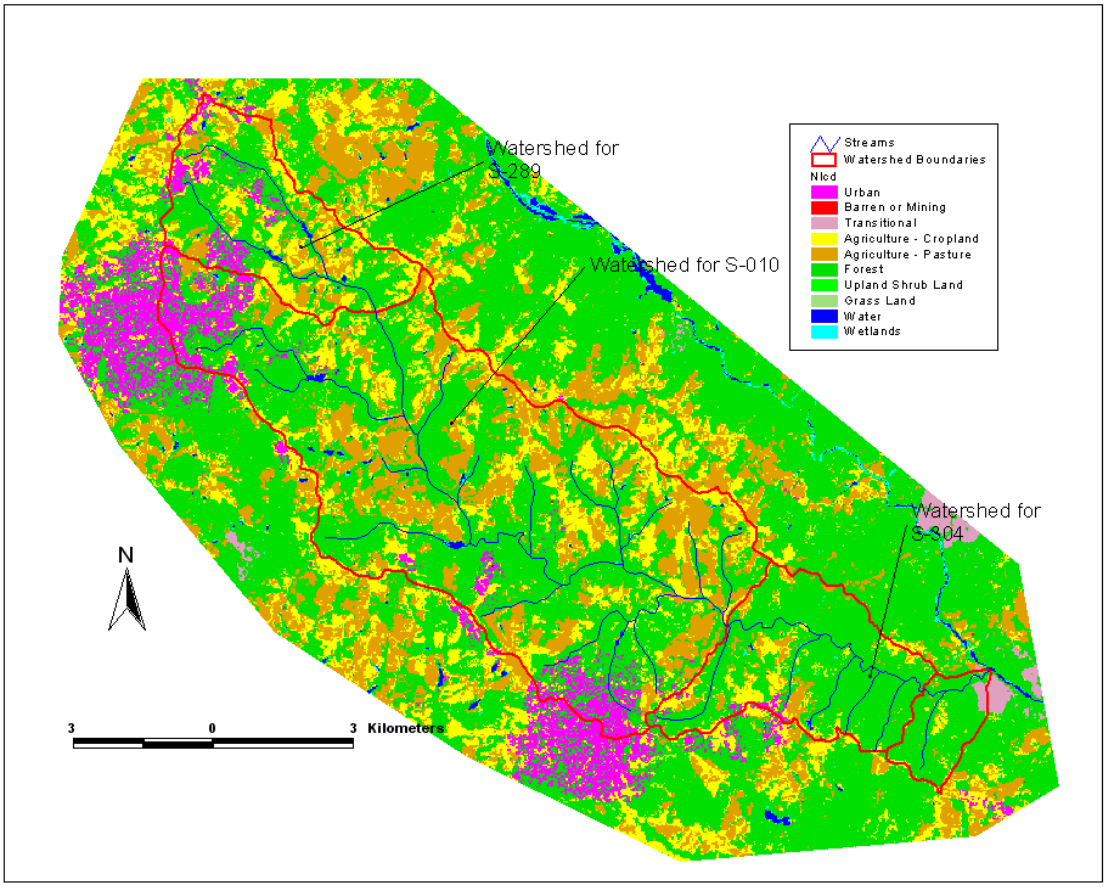

Figure 2. Map showing land uses in the Broad Mouth Creek watershed

1.3 Water Quality Standard

The impaired stream segments of Broad Mouth Creek are designated as Class Freshwater. Waters of this class are described as follows:

> "Freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses." (R.61-68)

South Carolina's standard for fecal coliform in Freshwater is:

> "Not to exceed a geometric mean of 200/100 ml, based on five consecutive samples during any 30 day period; nor shall more than 10% of the total samples during any 30 day period exceed 400/100 ml."(R.61-68).

Primary contact recreation is not limited to large streams and lakes. Even streams that are too small to swim in, will allow small children the opportunity to play and immerse their hands and faces. Essentially all perennial streams should therefore be protected from pathogen impairment.

Table 2. Land uses in Broad Mouth Creek watershed by water quality monitoring stations.

Land Use Class	**Land Use**	**Area (hectares)**			**Percentages**		
		S-289	**S-010**	**S-304**	**S-289**	**S-010**	**S-304**
	Water	9.0	24.1	1.5			
Developed	Residential Low Density	71.4	255.2	16.5			
	Residential High Density	9.4	19.4	0.0			
	Commercial, Industrial, & Transportation	27.0	101.9	5.0			
		107.7	376.5	21.4	8.2%	6.4%	1.6%
	Barren	1.2	2.4	0.5			
Forest	Forest Deciduous	355.4	1640.4	396.8			
	Forest Evergreen	116.4	801.0	385.0			
	Forest Mixed	136.0	674.2	243.7			
	Forest	**607.8**	**3115.6**	**1025.6**	**46.4%**	**53.1%**	**77.5%**
Pasture	**Pasture**	**243.7**	**1401.6**	**115.7**	**18.6%**	**23.9%**	**8.7%**
Cropland	Cropland	302.6	892.4	133.5			
		32.5	33.8	21.3			
		335.1	**926.3**	**154.8**	**25.6%**	**15.8%**	**11.7%**
Wetlands	Woody Wetlands	4.1	15.2	4.3			
	Emergent Herbaceous Wetlands	0.1	0.5	0.1			
		4.2	15.7	4.4	0.3%	0.3%	0.3%
	Wetlands						
Total for Watershed		**1308.7**	**5862.2**	**1323.9**	99.2%	99.5%	99.9%

Note: Land use areas are not cumulative: the watershed for S-289 is not included in the figures for S-010 and neither are included in the figures for S-304.

2.0 WATER QUALITY ASSESSMENT

Broad Mouth Creek has three water quality monitoring stations (Table 1 and Figure 1). An assessment of water quality data collected from 1998 through 2002 for the 2004 303(d) list at these stations indicated that all were impaired for recreational use. Broad Mouth Creek at S-289 has been placed on the 303(d) list of impaired waters since 1998; Broad Mouth Creek at S-010 and S-304 since 2000. However, 89 % of samples during the 1992-1996 assessment period at S-010 exceeded the standard. Waters in which no more than 10% of the samples collected over a five year period are greater than 400 fecal coliform counts or cfu / 100 ml are considered to comply with the South Carolina water quality standard for fecal coliform bacteria. Waters with more than 10 percent of samples greater than 400 cfu/ 100 ml are considered impaired for fecal coliform bacteria and placed on South Carolina's 303(d) list. During the most recent assessment period (1998-2002), 41 % of samples did not meet the fecal coliform criterion at S-010, 40 % at S-289 and 22 % at S-304. Descriptive statistics for data collected since 1990 at these locations is provided in Appendix A Table A-4. All of the data is provided in Appendix A Tables A-1 through A-3.

Water quality has definitely improved in Broad Mouth Creek at location S-010 since the 1998 assessment. The percentage of samples exceeding the standard of 400 cfu/100ml has declined from 89 % during the 1992-1996 period to 40 % during the 1998-2002 period (Table 3). It is unclear if fecal coliform pollution at locations S-289 and S-304 is improving. The watershed downstream of S-010, which drains directly to S-304, is small and is more wooded than the areas upstream of this section of the watershed. Most of the loading to S-304 is probably from upstream of S-010.

Table 3. Changes in percentage of standard violations by 303(d) list and site.

			Percent of Standard Violations		
303(d) List	**Period**		**S-289**	**S-010**	**S-304**
1998	1992-1996		25%	89%	NC *
2000	1994-1998		44%	81%	NC *
2002	1996-2000		50%	59%	29%
2004	1998-2002		41%	40%	26%

* Note: Not Calculated, fewer than 10 samples at S-304 for these periods.

Fecal coliform was directly related to turbidity in Broad Mouth Creek at S-010 and S-304, but not at S-289 (Figures 5-7). The association with turbidity indicates that fecal coliform is being washed into the creek with runoff. At S-289, however, the major sources of fecal coliform appear to be continuous, such as livestock in the stream, failing septic systems, illicit discharges, or leaking sewers.

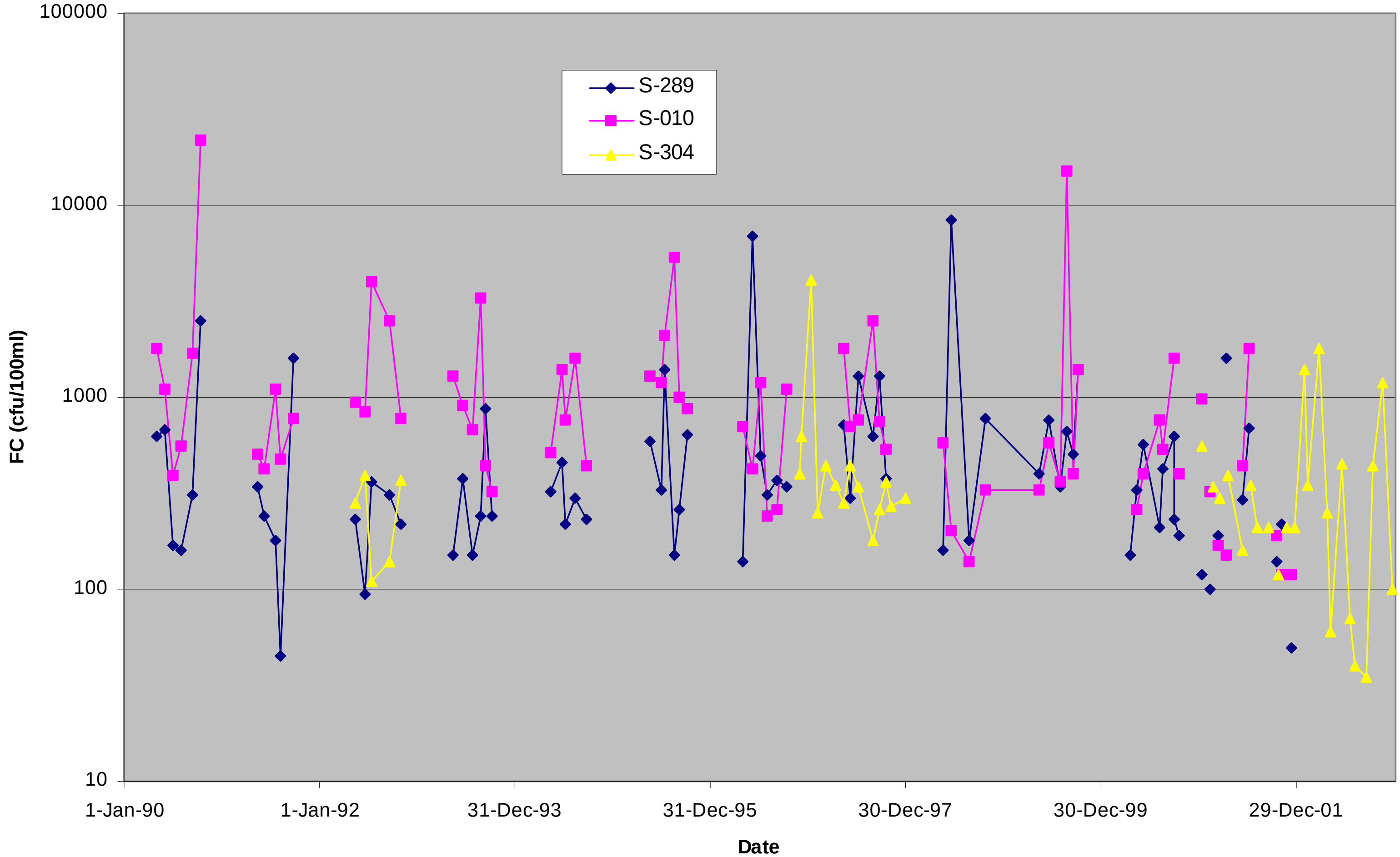

Figure 3. Fecal coliform concentrations in Broad Mouth Creek at three locations over time.

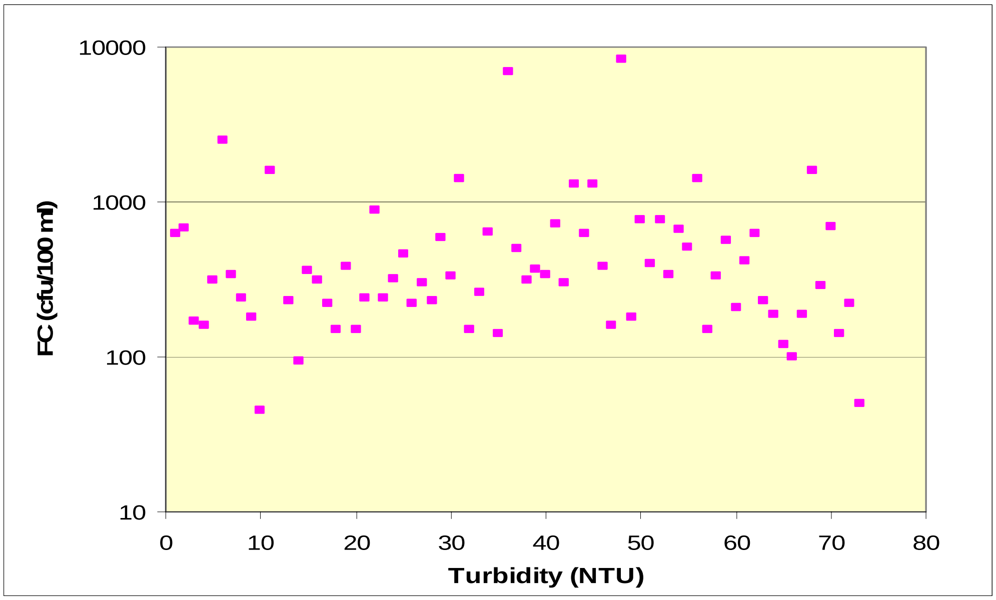

Figure 4. Comparison of turbidity and fecal coliform concentrations in Broad Mouth Creek at S-289.

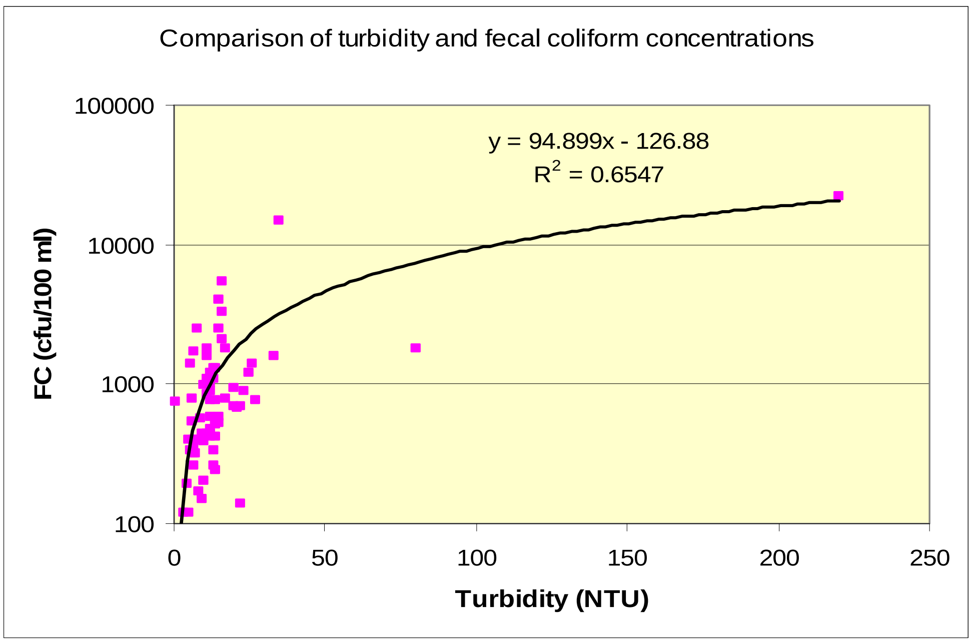

Figure 5. Comparison of turbidity and fecal coliform concentrations in Broad Mouth Creek at S-010.

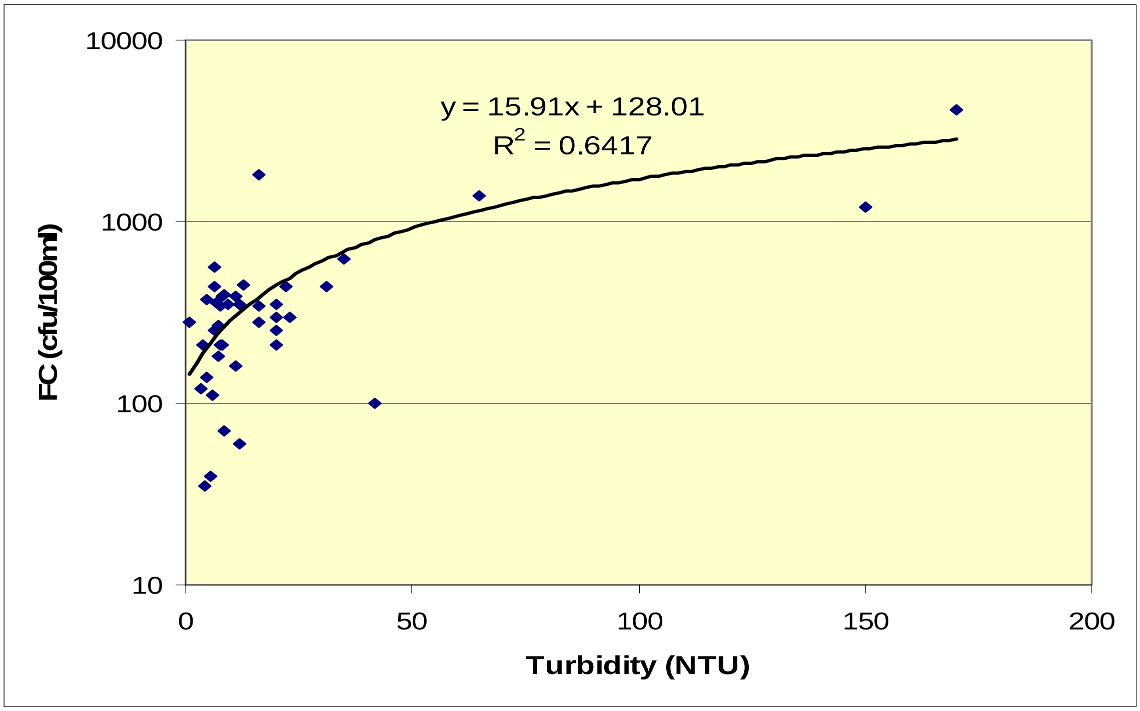

Figure 6. Comparison of turbidity and fecal coliform concentrations in Broad Mouth Creek at S-304.

3.0 SOURCE ASSESSMENT AND LOAD ALLOCATION

Fecal coliform bacteria are used by the State of South Carolina as the indicator for pathogens in surface waters. Pathogens, which are usually difficult to detect, cause disease and make full body contact recreation in lakes and streams risky. Indicators such as fecal coliform bacteria, enteroccoci, or E. *Coli* are easier to measure, have similar sources as pathogens, and persist a similar or longer length of time in surface waters. These bacteria are not in themselves usually disease causing.

There are many sources of pathogen pollution in surface waters. In general these sources may be classified as point and nonpoint sources. With the implementation of technology-based controls, pollution from point sources, such as factories and wastewater treatment facilities, has been greatly reduced. These point sources are required by the Clean Water Act to obtain a NPDES permit. In South Carolina NPDES permits require that dischargers of sanitary wastewater must meet the state standard for fecal coliform at the point of discharge. Municipal and private sanitary wastewater treatment facilities may occasionally be sources of pathogen or fecal coliform bacteria pollution. However, if these facilities are discharging wastewater that meets their permit limits, they are not causing the impairment. If one of these facilities is not meeting its permit limits, enforcement of the permit limit is required. A TMDL is not necessary for this purpose. Pathogen or fecal coliform

TMDLs are therefore essentially nonpoint source TMDLs even though the TMDL may include a wasteload allocation for a point source.

3.1 Point Sources in the Broad Mouth Creek Watershed

3.1.1 Continuous Point Sources

Currently there is one NPDES discharger or point source in the Broad Mouth Creek watershed that has a permit to discharge wastewater containing fecal coliform bacteria. Belton Industries (SC0000698) has discharged wastewater into a tributary of Broad Mouth Creek upstream of S-010. This facility has not reported a discharge since June 1998, however it maintains an active NPDES permit so that it may discharge into the creek in the future. Effluent data reported by Belton (Appendix B) indicates that this discharger is not contributing to the impairment of Broad Mouth Creek. A second facility, Belton's Leo Fisher WWTF (SC0045896) is located near the Broad Mouth Creek (Figure 1). However, its discharge is transported out of the watershed and discharged into the Saluda River.

The towns of Belton and Honea Path have sewage collection systems that are partly in the Broad Mouth Creek watershed. Sewage collection systems typically are placed adjacent to waterways. At these locations, there is a potential for collection system leaks which could result in elevated instream concentrations of fecal coliform bacteria. Sanitary sewer overflows (SSOs) are also a potential source, particularly after periods of intense rainfall. This source is associated with infrequent events, limited in duration and likely to have an insignificant long-term impact instream on recreational use. Identified collection system and/or SSO problems are addressed by SCDHEC through compliance and enforcement mechanisms.

3.1.2 Intermittent Point Sources

The Town of Belton and adjacent developed areas have been designated as a Municipal Separate Storm Sewer System or MS4 under NPDES Phase II Stormwater rules. Parts of the MS4s are in the Broad Mouth Creek watershed (Figure 7). A small area of the MS4 area drains into the S-289 watershed and a larger area drains directly into the S-010 watershed. These permitted sewer systems will be treated as point sources in the TMDL calculations below. Runoff from developed land that is collected by storm sewers and discharged untreated into streams is potentially a major source of fecal coliform bacteria to Broad Mouth Creek.

3.2 Nonpoint Sources in the Broad Mouth Creek Watershed

3.2.1 Wildlife

In these rural and suburban watersheds wildlife (mammals and birds), which is a source of fecal coliform bacteria, is possibly a significant though not major contributor. Wildlife in this area includes deer and other mammals as well as a variety of birds. Wildlife wastes are carried into nearby streams by runoff following rainfall or deposited directly in streams. Waterfowl also may be significant contributors of fecal coliform bacteria, particularly in urban and suburban ponds, which often provide a desirable habitat for geese and ducks. Forest lands, which typically have only low

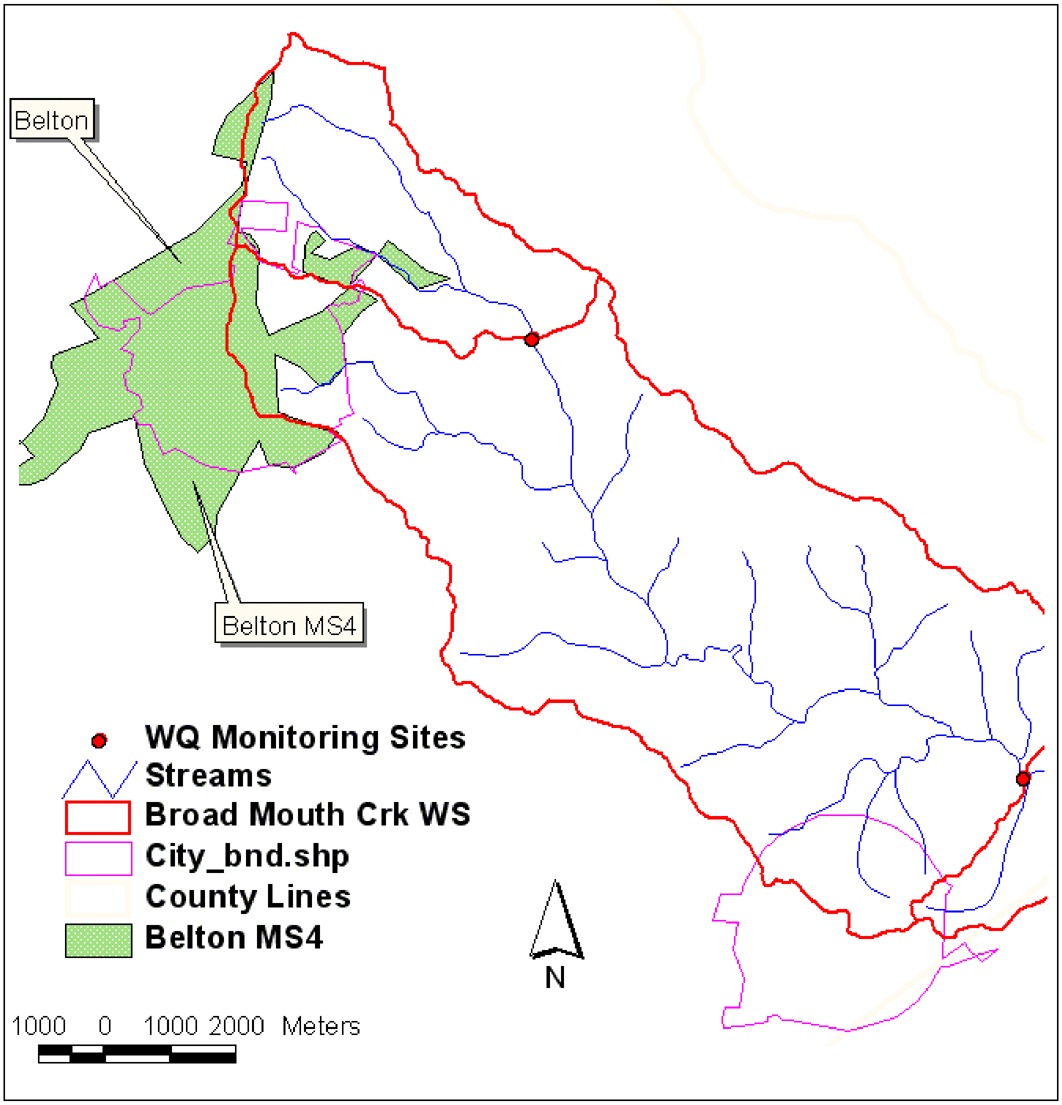

Figure 7. Map of the Broad Mouth Creek watershed showing the area designated as a MS4.

concentrations of wildlife as sources of fecal coliform bacteria, usually have low loading rates for fecal coliform bacteria.

3.2.2 Land Applied Manure

Livestock litter that is not properly stored or applied to land is a potential source of fecal coliform bacteria. Application of excessive amounts of litter, that is adding more nitrogen or phosphorus than the crop can use, and applying the litter too close to streams are the principal methods by which litter can pollute streams. One active permitted livestock operation is located in the Broad Mouth Creek watershed. This facility has 4 fields permitted fields for the land application of litter. This operation and its fields are located near Belton in the upper drainage area for S-010.

3.2.3 Grazing Animals

Livestock, especially cattle, are frequently major contributors of fecal coliform bacteria to streams. Grazing cattle and other livestock may contaminate streams with fecal coliform bacteria in two ways. Runoff from pastures may carry the bacteria into streams following rain events. Cattle that are allowed access to streams deposit manure directly into the streams. Manure deposited in streams can be a significant source of fecal coliform bacteria. Loading of fecal coliform bacteria to both of these creeks by this route is likely to be a major source of loading of fecal coliform. The 1997 Agricultural Atlas reported 16,794 cattle and calves in Abbeville County and 39,254 cattle and calves in Anderson County. Using the ratio of pastureland in the each watershed to that of the appropriate county, 222 cattle and calves were estimated to be in the S-289 drainage area, 1529 in the S-010 drainage area (includes 3-289), and 1647 in the S-304 watershed (includes both S-289 and S-010). An example of a worn down bank that cattle have developed in walking down to the creek is shown in Figure 7, which is 1.6 km upstream of S-289. Cattle in the creek are likely to be a major source of fecal coliform at S-289, where standard exceedences did not correlate with turbidity. Runoff from pastures seems to be a more significant part of loading to S-010.

Figure 8. Broad Mouth Creek showing trail
that cattle have used to cross or drink from the creek.

3.2.4 Failing Septic Systems

Septic systems that do not function properly may leak sewage unto the land surface where it can reach nearby streams. Failing septic systems may be improperly designed or constructed or they maybe systems that no longer function. The number of households that have septic systems was estimated using a GIS. The 2000 census database layer was compared to the town boundaries of Belton and Honea Path and the boundaries of the Broad Mouth Creek watershed. In 2000 there were an estimated 1940 people in some 740 households without sewer service in the Broad Mouth Creek watershed. The distribution of population among the three sampling stations is shown in Table 4. The number of rural households should correlate with the number of septic systems. Based on the evidence of continuous sources in the S-289 part of the watershed, failing septic systems could be a major source of fecal coliform bacteria going into the stream. However failing septic systems are likely to be a less important source of fecal coliform loading to Broad Mouth Creek than agricultural sources at the two downstream stations.

3.2.5 Urban Nonpoint Sources

The towns of Belton and Honea Path are both partly in the Broad Mouth Creek watershed. Most of Belton has been designated as a MS4. However, Honea Path has not. Honea Path is in the drainage area for S-010. The high percentage of impervious surfaces in built-up areas tends to increase runoff and reduce infiltration. The additional runoff compared to undeveloped land increases the amount of pollutants that are carried into streams. Dogs, cats, and other pets are the primary source of fecal coliform deposited on the urban landscape. There are also ‘urban’ wildlife, such as squirrels, raccoons, pigeons, and other birds, all of which contribute to the fecal coliform load.

Table 4. Populations in the Broad Mouth Creek watershed by water quality monitoring station (numbers are cumulative).

Station	Total Population	Rural Population	Rural Households
S-289	976	562	192
S-010	4846	1729	650
S-304	5091	1941	738

4.0 LOAD-DURATION CURVE METHOD

Load-duration curves were developed as a method of developing TMDLs that applies to all hydrologic conditions. The load-duration curve method uses the cumulative frequency distribution of stream flow and pollutant concentration data to estimate the existing and the TMDL loads for a water body. Development of the load-duration curve is described in this chapter.

The load-duration curve method requires an adequate period of record for flow data. Generally a longer record is better, though after a record of 20 to 30 years, additional data would affect mostly the extreme values, which are usually not included in the load-duration curve. Broad Mouth Creek, like many small streams in South Carolina is not gauged. South Rabon Creek, which is some 20 to 32 km east of Broad Mouth Creek, is a comparable, gauged stream with similar land uses and topography. Data from the gauge (USGS 02165200) on the South Rabon Creek near Laurens, South Carolina for the period of record (Jan.25, 1967 to Sept. 30, 1981 and May 3, 1990 through Dec. 31, 2002) was used to generate the flow-duration curve. The South Rabon Creek watershed is similar in area, 76.4 km^2 compared to 84.9 km^2 for Broad Mouth Creek watershed at S-304 and 71.7 km^2 for S-010. The drainage area for S-289 is substantially smaller (13.1 km^2). Blue Hill Creek at USGS gauging station #2192830, which has a similar sized drainage area, was evaluated as a reference, gauged stream, however, it has a limited period of record (Oct 1, 1998 to present) therefore it was not used. The mean of the difference between estimated daily flows for S-289 from the two reference stations for the common period of record was less than 10 % of the estimate from the South Rabon Creek.

The flows for Broad Mouth Creek at the different water quality monitoring sites were estimated by multiplying the daily flow rates from South Rabon Creek by the ratio of the Broad Mouth Creek drainage area to that of South Rabon Creek (0.1715, 0.9385 and 1.1113, respectively). The flows were ranked from low to high and the values that exceed certain selected percentiles determined. A flow-duration curve for Broad Mouth Creek at S-010 is provided in Appendix D (Figure D-1). The load-duration curve was generated by calculating the load from the observed fecal coliform concentrations, the flow rate that corresponds to the date of sampling, and a conversion factor. The load was plotted against the appropriate flow recurrence interval to generate the curve (Figures 7, 8 and 9). The target line was created by calculating the allowable load from the flow and the appropriate fecal coliform standard concentration in the same manner. Sample loads above this line are violations of the standard, while loads below the line are in compliance.

The water quality target was set at 380 cfu/100ml for the instantaneous criterion, which is five percent lower than the water quality criteria of 400 cfu/100ml. A five percent explicit Margin of Safety (MOS) was reserved from the water quality criteria in developing the load-duration curves. The instantaneous criterion was targeted as a conservative approach and should be protective of both the instantaneous and 30-day geometric mean fecal coliform bacteria standards.

Trend lines were determined for sample loads for each station that exceeded the standard. Trend lines for all three locations were power functions (Figures 7, 8, and 9). The r^2 (coefficient of determination or a measure of variance explained by the regression equation) for S-289 is 0.5519. The coefficient for the trend line for S-010 was 0.5179 and the r^2 for S-304 was 0.8423. The existing loads to Broad Mouth Creek at the monitoring stations were calculated from the means of all loads that were between the 10 % and 90 % flow recurrence intervals for each location. This excludes flows that occur infrequently. These trend lines matched their respective target lines better than the alternatives and have acceptable coefficients.

The TMDL load is calculated from the target line. Load values at 5 % occurrence intervals along the target line from 10 to 90 % were averaged. The Load Allocation (LA) values are derived from the 380 cfu/100ml water quality target, which includes the explicit Margin of Safety. Calculations for both existing and TMDL loads are provided in Appendix B.

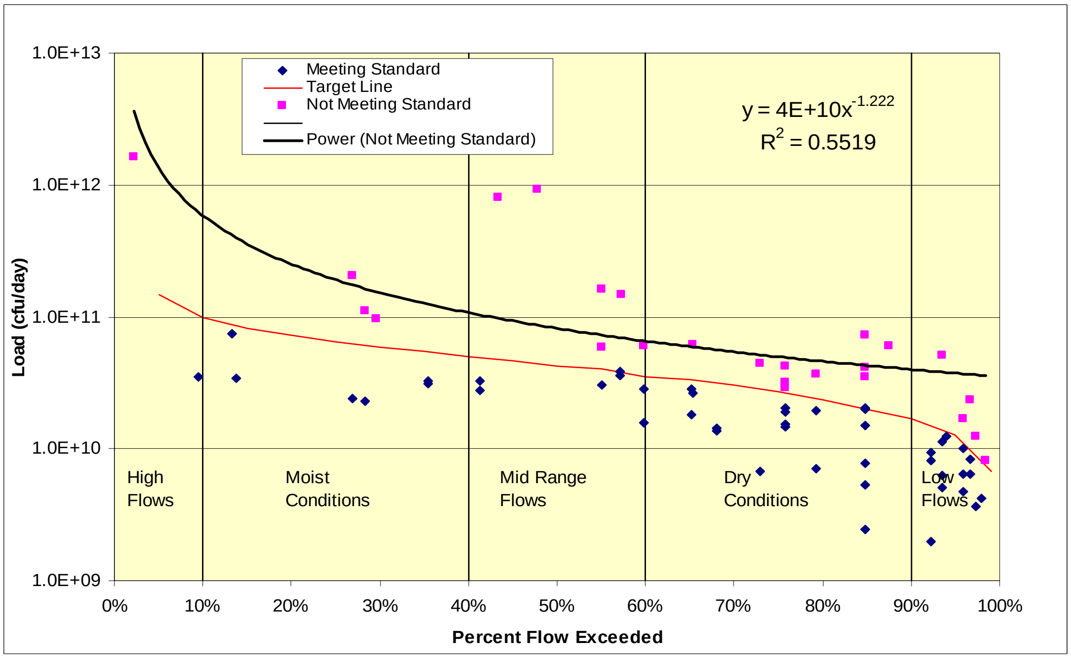

Figure 9. Load-Duration Curve for Broad Mouth Creek at S-289.

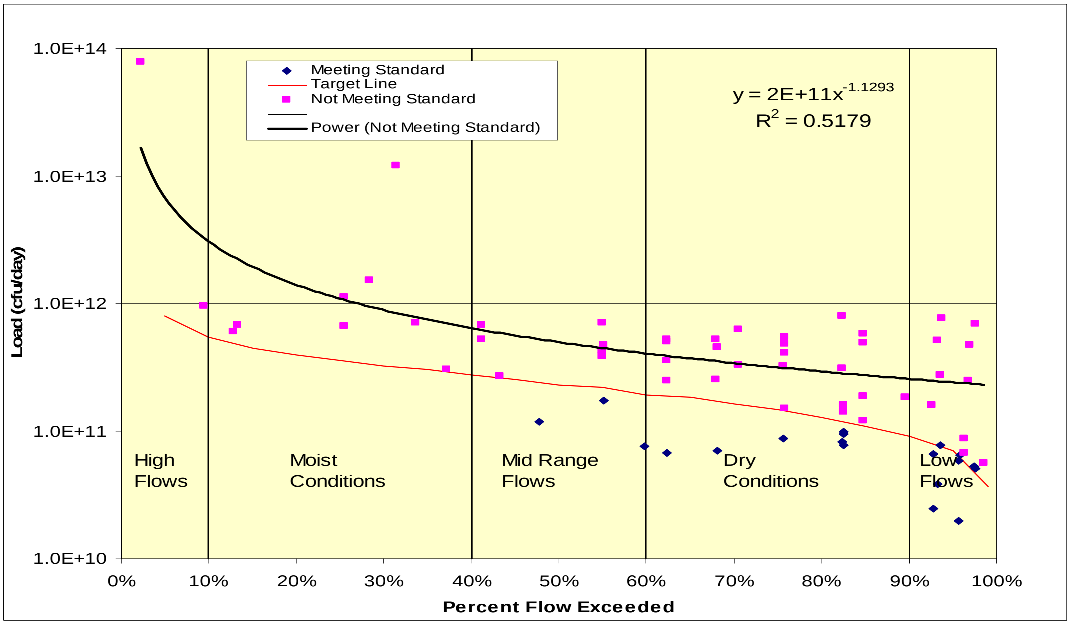

Figure 10. Load-Duration Curve for Broad Mouth Creek at S-010

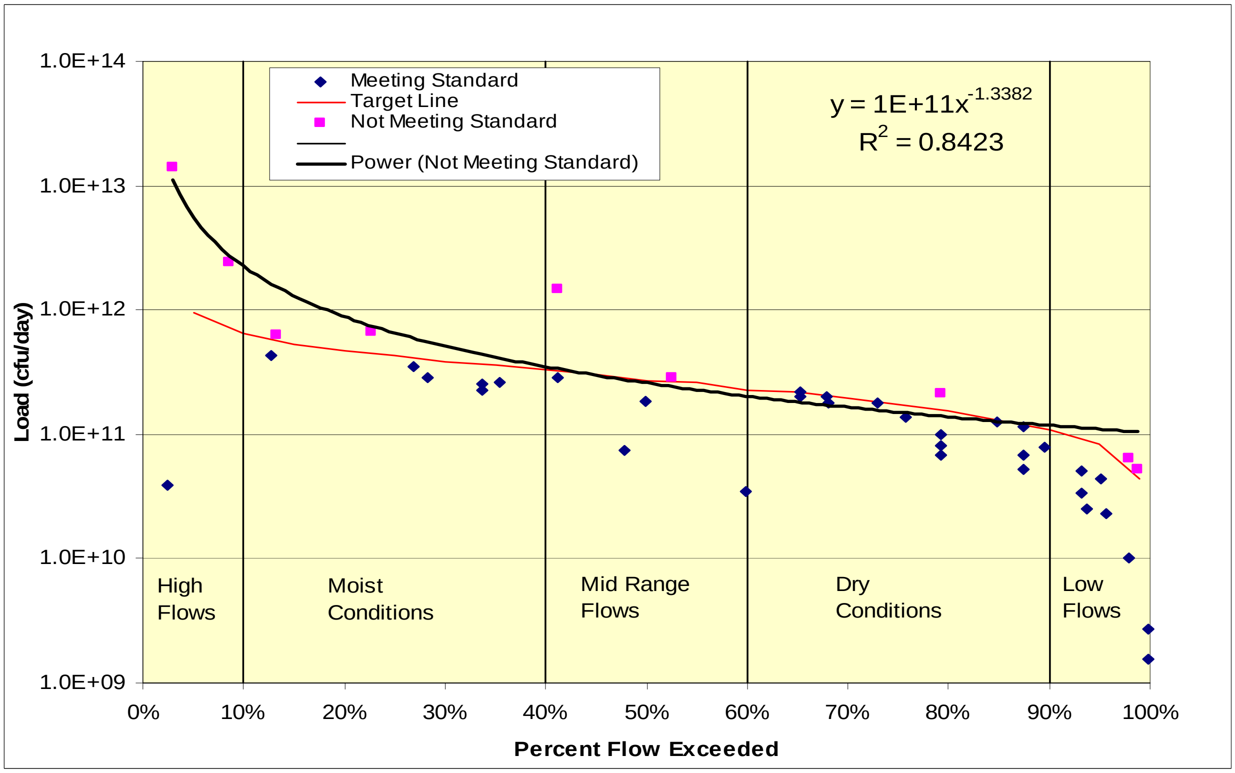

Figure 11. Load-Duration Curve for Broad Mouth Creek at S-304.

5.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

A total maximum daily load (TMDL) for a given pollutant and water body is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is represented by the equation:

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while still achieving water quality standards. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis to establish water quality-based controls.

For most pollutants, TMDLs are expressed as a mass load (e.g., kilograms per day). For bacteria, however, TMDLs are expressed in terms of number (#), cfu, or organism counts (or resulting concentration), in accordance with 40 CFR 130.2(l).

5.1 Critical Conditions

These TMDLs are based on the flow recurrence interval between 10 % and 90 %. This encompasses 80 % of flows in Broad Mouth Creek. Only flows that are characterized as ‘High’ or ‘Low’ flows in Figures 9, 8, and 10 are not included in the analysis. For these TMDLs critical conditions are this range of the flow recurrence interval.

5.2 Existing Load

The existing loads were calculated from the trend lines of observed values that exceeded the water quality standard and were between and including 10 and 90 % recurrence limits. Loadings from all sources are included in this value: runoff, cattle-in-streams, and failing septic systems. Existing loads for all stations on Broad Mouth Creek are provided in Table 5.

5.3 Margin of Safety

The margin of safety (MOS) may be explicit and/or implicit. The explicit margin of safety is 5 % of the TMDL or 20 counts/ 100ml of the instantaneous criterion of 400 cfu/100 ml. Values of the MOS for each location are given in Table 5.

5.4 TMDL

For most pollutants, TMDLs are expressed as a mass load (e.g., kilograms per day). For bacteria, however, TMDLs are expressed in terms of cfu or organism counts (or resulting concentration), in accordance with 40 CFR 130.2(l). The resulting TMDL should be protective of both the instantaneous, per day, and geometric mean, per 30-day, criteria.

The target loading value is the load to the creek that it can receive and meet the water quality standard. It is simply the TMDL minus the MOS. Values for each component of the TMDLs for the three locations on Broad Mouth Creek are provided in Table 5. The required reduction in load, expressed as a percentage is also provided in Table 5.

The town of Belton and adjacent urbanized areas are designated as MS4s. The reduction percentages in this TMDL apply also to the fecal coliform waste load attributable to those areas of the watershed which are covered or will be covered under NPDES MS4 (Municipal Separate Storm Sewer System) permits. Compliance by Belton or another entity with responsibility for the MS4, with the terms of its individual MS4 permit will fulfill any obligations it has towards implementing this TMDL.

Table 5. TMDL components for Broad Mouth Creek.

Impaired Station	Existing Load cfu/day	WLA cfu/day	MS4 WLA %	LA cfu/day	MOS cfu/day	TMDL cfu/day	% Reduction
S-289	1.8E+11	NA	75	4.46E+10	2.35E+09	4.96E+10	75
S-010	7.8E+11	2.21E+07	69	2.44E+11	1.29E+10	2.57E+11	69
S-304	5.7E+11	2.21E+07	NA	2.89E+11	1.52E+10	3.05E+11	49

6.0 IMPLEMENTATION

As discussed in the *Implementation Plan for Achieving Total Maximum Daily Load Reductions From Nonpoint Sources for the State of South Carolina* (SCDHEC,1998), South Carolina has several tools available for implementing this nonpoint source TMDL. Specifically, SCDHEC's animal agriculture permitting program addresses animal operations and land application of animal wastes. In addition, SCDHEC will work with the existing agencies in the area to provide nonpoint source education in the Broad Mouth Creek watershed. Local sources of nonpoint source education and assistance include Clemson Extension Service, the Natural Resource Conservation Service (NRCS), the Anderson and Abbeville County Soil and Water Conservation Services, and the South Carolina Department of Natural Resources. Clemson Extension Service offers a 'Farm-A-Syst' package to farmers. Farm-A-Syst allows the farmer to evaluate practices on their property and determine the nonpoint source impact they may be having. It recommends best management practices (BMPs) to correct nonpoint source problems on the farm. NRCS can provide cost share money to land owners installing BMPs.

SCDHEC is empowered under the State Pollution Control Act to perform investigations of and pursue enforcement for activities and conditions, which threaten the quality of waters of the state.
In addition, other interested parties (universities, local watershed groups, etc.) may apply for section 319 grants to install BMPs that will reduce fecal coliform loading to Broad Mouth Creek. TMDL implementation projects are given highest priority for 319 funding.

The iterative BMP approach as defined in the general storm water NPDES MS4 permit is expected to provide significant implementation of this TMDL. Discovery and removal of illicit storm drain cross connection is one important element of the storm water NPDES permit. Public nonpoint source pollution education is another.

In addition to the resources cited above for the implementation of this TMDL in the Broad Mouth Creek watershed, Clemson Extension has developed a Home-A-Syst handbook that can help rural homeowners reduce sources of NPS pollution on their property. This document guides homeowners through a self-assessment, including information on proper maintenance practices for septic tanks. SCDHEC also employs a nonpoint source educator who can assist with distribution of these tools as well as provide additional BMP information.

Using existing authorities and mechanisms, these measures will be implemented in these two watersheds in order to bring about the required reductions in fecal coliform bacteria loading to Broad Mouth Creek. DHEC will continue to monitor, according to the basin monitoring schedule, the effectiveness of implementation measures and evaluate stream water quality as the implementation strategy progresses.

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APPENDIX A Fecal Coliform Data

Table A-1 Fecal coliform data for Broad Mouth Creek at S-289.

Date	Time	FC (cfu/ 100ml)
1-May-90	1125	620
4-Jun-90	1150	680
5-Jul-90	1155	170
2-Aug-90	1115	160
12-Sep-90	1150	310
12-Oct-90	1235	2500
17-May-91	1210	340
6-Jun-91	1030	240
22-Jul-91	1150	180
8-Aug-91	1120	45
26-Sep-91	1130	1600
11-May-92	1335	230
18-Jun-92	1220	95
13-Jul-92	1325	360
17-Sep-92	1230	310
28-Oct-92	1115	220
14-May-93	1115	150
17-Jun-93	1225	380
28-Jul-93	1315	150
27-Aug-93	1250	240
14-Sep-93	1045	880
6-Oct-93	1245	240
12-May-94	1135	320
22-Jun-94	1025	460
5-Jul-94	1035	220
11-Aug-94	1035	300
22-Sep-94	1035	230
17-May-95	1010	590
29-Jun-95	1030	330
14-Jul-95	1035	1400
18-Aug-95	1055	150
8-Sep-95	1025	260
3-Oct-95	1045	640
1-May-96	1205	140
4-Jun-96	1240	6900
2-Jul-96	1305	500
1-Aug-96	1145	310
3-Sep-96	1010	370
10-Oct-96	955	340
9-May-97	1115	720
6-Jun-97	1055	300
2-Jul-97	1000	1300
28-Aug-97	840	620
19-Sep-97	1000	1300
17-Oct-97	920	380
14-May-98	1040	160
18-Jun-98	1200	8400
20-Aug-98	1130	180
19-Oct-98	1040	770
11-May-99		400
17-Jun-99		760
29-Jul-99		340
25-Aug-99		660
13-Sep-99		510
4-Oct-99		1400
17-Apr-00		150
9-May-00		330
1-Jun-00		570
31-Jul-00		210
15-Aug-00		420
26-Sep-00		630
27-Sep-00		230
12-Oct-00		190
9-Jan-01		120
5-Feb-01		100
12-Mar-01		190
9-Apr-01		1600
8-Jun-01		290
5-Jul-01		690
17-Oct-01		140
1-Nov-01		220
6-Dec-01		50

Table A-2 Fecal coliform data for Broad Mouth Creek at S-010.

Date	Time	FC (cfu/ 100ml)
1-May-90	1150	1800
4-Jun-90	1215	1100
5-Jul-90	1215	390
2-Aug-90	1130	560
12-Sep-90	1210	1700
12-Oct-90	1215	22000
17-May-91	1230	510
6-Jun-91	1055	420
22-Jul-91	1225	1100
8-Aug-91	1145	480
26-Sep-91	1200	780
11-May-92	1430	940
18-Jun-92	1245	840
13-Jul-92	1415	4000
17-Sep-92	1255	2500
28-Oct-92	1045	780
13-May-93	1140	1300
17-Jun-93	1205	900
28-Jul-93	1250	680
27-Aug-93	1235	3300
14-Sep-93	1110	440
6-Oct-93	1220	320
12-May-94	1115	520
22-Jun-94	1100	1400
5-Jul-94	1100	760
11-Aug-94	1100	1600
22-Sep-94	1055	440
17-May-95	1035	1300
28-Jun-95	1050	1200
14-Jul-95	1055	2100
18-Aug-95	1115	5400
8-Sep-95	1045	1000
3-Oct-95	1110	880
1-May-96	1145	700
4-Jun-96	1205	420
2-Jul-96	1245	1200
1-Aug-96	1125	240
3-Sep-96	1055	260
10-Oct-96	1020	1100
9-May-97	1400	1800
Date	**Time**	**FC (cfu/ 100ml)**
6-Jun-97	1220	700
2-Jul-97	1200	760
28-Aug-97	1100	2500
19-Sep-97	840	740
17-Oct-97	1200	540
14-May-98	1310	580
18-Jun-98	1140	200
20-Aug-98	1200	140
19-Oct-98	1010	330
11-May-99		330
17-Jun-99		580
29-Jul-99		360
25-Aug-99		15000
13-Sep-99		400
4-Oct-99		1400
9-May-00		260
1-Jun-00		400
31-Jul-00		760
15-Aug-00		540
26-Sep-00		1600
12-Oct-00		400
9-Jan-01		980
5-Feb-01		320
12-Mar-01		170
9-Apr-01		150
8-Jun-01		440
5-Jul-01		1800
17-Oct-01		190
1-Nov-01		120
6-Dec-01		120

Table A-3 Fecal coliform data for Broad Mouth Creek at S-304.

Date	Time	FC (cfu/ 100ml)
11-May-92	1455	280
18-Jun-92	1305	390
13-Jul-92	1355	110
17-Sep-92	1320	140
28-Oct-92	1010	370
25-Nov-96	1015	400
4-Dec-96	1025	620
10-Jan-97	1035	4100
3-Feb-97	1055	250
7-Mar-97	1215	440
10-Apr-97	1130	350
9-May-97	1425	280
6-Jun-97	1300	440
2-Jul-97	1220	340
28-Aug-97	1120	180
19-Sep-97	1145	260
17-Oct-97	1230	360
6-Nov-97	1145	270
30-Dec-97	1210	300
10-Jan-01		560
21-Feb-01		340
14-Mar-01		300
12-Apr-01		390
8-Jun-01		160
6-Jul-01		350
3-Aug-01		210
14-Sep-01		210
23-Oct-01		120
20-Nov-01		210
20-Dec-01		210
23-Jan-02		1400
5-Feb-02		350
21-Mar-02		1800
23-Apr-02		250
2-May-02		60
13-Jun-02		450
15-Jul-02		70
1-Aug-02		40
12-Sep-02		35
Date	**Time**	**FC (cfu/ 100ml)**
10-Oct-02		440
12-Nov-02		> 1200
19-Dec-02		100

Table A-4 Statistics for fecal coliform data 1990-2002 in Broad Mouth Creek (cfu/100ml).

S-289

Statistic	Value
Minimum	45
Geometric Mean	366
Median	325
Maximum	8400
% Violations	36%

S-010

Statistic	Value
Minimum	120
Geometric Mean	740
Median	720
Maximum	22000
% Violations	73%

S-304

Statistic	Value
Minimum	35
Geometric Mean	275
Median	300
Maximum	4100
% Violations	24%

APPENDIX B DMR Data

Table B-1. DMR Data for Belton Industries SC0000698.

Date	Flow (mgd)			Fecal Coliform (cfu/100ml)	
	Monthly			Monthly	
	Mean	Max		Mean	Max
1/31/1989		0.0167		6	40
2/28/1989		0.0167		70	70
3/31/1989		0.046		2	2
4/30/1989		0.0167		10	10
5/31/1989		0.0167		< 100	< 100
6/30/1989		0.046		< 10	< 10
7/31/1989		0.0029		< 10	< 10
8/31/1989		0.0111		30	30
9/30/1989		0.0081		50	50
10/31/1989		0.0081		20	20
11/30/1989		0.0081		< 10	< 10
12/31/1989		0.0167		120	120
1/31/1990		0.0188		< 10	< 10
2/28/1990		0.0167		< 10	< 10
3/31/1990		0.026		500	500
4/30/1990		0.0029		< 10	< 10
6/30/1990		0.0167		30	30
10/31/1990		0.00432		< 10	< 10
11/30/1990				60	60
12/31/1990				< 10	< 10
1/31/1991				< 10	< 10
2/28/1991		0.0167		20	20
3/31/1991		0.0047		< 10	< 10
5/31/1991		0.0167		20	20
6/30/1991		0.0029		800	800
7/31/1991	0.0208	0.0387		170	340
8/31/1991	0.0167	0.0583		55	100
9/30/1991		0.0167		35	60
10/31/1991		0.0081		35	40
11/30/1991		0.0006		9	80
12/31/1991	0.0167	0.0167		10	10
1/31/1992	0.0111	0.0111		40	40
7/31/1992	0.0081	0.0081		< 10	< 10
8/31/1992	0.0047	0.0047		100	100
9/30/1992		0.0029		40	40
10/31/1992		0.0081		30	30
11/30/1992		0.46		130	130

12/31/1992		0.0167		11	130
Date	**Flow (mgd)**			**Fecal Coliform (cfu/100ml0**	
	Monthly			**Monthly**	
	Mean	**Max**		**Mean**	**Max**
1/31/1993		0.0167		150	150
2/28/1993		0.0047		30	30
3/31/1993	0.0676	0.0676		50	100
4/30/1993	0.0422	0.0422		< 10	< 10
5/31/1993	0.0128	0.0128		< 10	< 10
6/30/1993	0.0081	0.0081		5	30
7/31/1993					
8/31/1993	0.0029	0.0029		< 1	< 1
9/30/1993	0.0037	0.0037			
10/31/1993	0.0167	0.0167			
11/30/1993	0.0081	0.0081			
12/31/1993	0.0081	0.0081			
1/31/1994	0.0167	0.0167		< 1	< 1
2/28/1994	0.0128	0.0128		< 1	< 1
3/31/1994	0.0167	0.0167		< 1	< 1
4/30/1994	0.0081	0.0081		4	4
5/31/1994	0.0029	0.0029		< 1	< 1
6/30/1994	0.0029	0.0029		< 1	< 1
7/31/1994	0.0029	0.0029		< 1	< 1
8/31/1994	0.0291	0.0291		< 1	< 1
9/30/1994	0.0047	0.0047		< 1	< 1
10/31/1994	0.0081	0.0081		< 1	< 1
11/30/1994	0.0081	0.0081		< 10	< 10
12/31/1994	0.0047	0.0047		< 2	< 2
1/31/1995	0.0081	0.0081		4	4
2/28/1995	0.0081	0.0081		2	2
3/31/1995	0.0147	0.0147		10	10
4/30/1995	0.0017	0.0017		< 1.11	< 1.11
5/31/1995	0.0029	0.0029		86	86
6/30/1995	0.0029	0.0029		< 1	< 1
8/31/1995	0.029	0.029		< 1	< 1
10/31/1995	0.46	0.46		< 2	< 2
11/30/1995	0.0291	0.0291		< 2	< 2
12/31/1995	0.0037	0.0037		< 1	< 1
1/31/1996	0.0057	0.0057		< 2	< 2
2/29/1996	0.0128	0.0128		< 2	< 2
3/31/1996	0.0029	0.0029		22	22
4/30/1996	0.0081	0.0081		< 1	< 1
5/31/1996	0.0029	0.0029		< 1.0	< 1.0

7/31/1996	0.0025	0.0029		< 1	< 1
8/31/1996	0.0005	0.0005		< 1.0	< 1.0
Date	**Flow (mgd)**			**Fecal Coliform (cfu/100ml)**	
	Monthly			**Monthly**	
	Mean	**Max**		**Mean**	**Max**
9/30/1996	0.0029	0.0029		10	10
10/31/1996	0.0068	0.0068		< 1.0	< 1.0
11/30/1996	0.0029	0.0029		< 1.0	< 1.0
12/31/1996	0.0128	0.0128		< 2.0	< 2.0
1/31/1997	0.0068	0.0068		< 1.0	< 1.0
2/28/1997	0.011	0.011		< 2.0	< 2.0
3/31/1997	0.0028	0.0047		< 1.5	< 2.0
4/30/1997	0.0029	0.0029		< 2.0	< 2.0
6/30/1997	0.00113	0.001128		45	> 2000
7/31/1997	0.00117	0.012367		< 10.0	< 10.0
12/31/1997	0.00208	0.021561		91	91
1/31/1998	0.00547	0.020497		6	6
2/28/1998	0.00961	0.059009		19	19
3/31/1998	0.0062	0.046848		< 3.0	< 3.0
4/30/1998	0.01553	0.111723		< 3.0	< 3.0
5/31/1998	0.00612	0.03528		2	2
6/30/1998	0.00357	0.012246		1	1

The flow value for outfall #001 of Belton Industries (SC0000698), which has permit limits for fecal coliform, that was used to determine the WLA is 0.002918 mgd or 11,046 liters/day. WLA = 2.21E+07 cfu/day.

APPENDIX C Calculation of Existing and TMDL Loads

Table C-1 Calculation of existing loads.

Broad Mouth Creek at S-289
From equation of Trend Line:
y = 4E+10 x ^ -1.222

Percen-tile	Load	
0.10	6.67E+11	
0.15	4.06E+11	
0.10	6.67E+11	
0.20	2.86E+11	
0.25	2.18E+11	
0.30	1.74E+11	
0.35	1.44E+11	
0.40	1.23E+11	
0.45	1.06E+11	
0.50	9.33E+10	
0.55	8.30E+10	
0.60	7.47E+10	
0.65	6.77E+10	
0.70	6.19E+10	
0.75	5.69E+10	
0.80	5.25E+10	
0.85	4.88E+10	
0.90	4.55E+10	
0.95	4.26E+10	
Mean Load	**1.80E+11 cfu/day**	

Broad Mouth Creek at S-010
From equation of Trend Line:
y = 2E+11 x ^ -1.1293

Percen-tile	Load	
0.10	2.69E+12	
0.15	1.70E+12	
0.10	2.69E+12	
0.20	1.23E+12	
0.25	9.57E+11	
0.30	7.79E+11	
0.35	6.55E+11	
0.40	5.63E+11	
0.45	4.93E+11	
0.50	4.38E+11	
0.55	3.93E+11	
0.60	3.56E+11	
0.65	3.25E+11	
0.70	2.99E+11	
0.75	2.77E+11	
0.80	2.57E+11	
0.85	2.40E+11	
0.90	2.25E+11	
0.95	2.12E+11	
Mean Load	**7.78E+11**	**cfu/day**

Broad Mouth Creek at S-304
From equation of Trend Line:
y = 1E+11 x ^ -1.3382

Percen-tile	Load	
0.10	2.18E+12	
0.15	1.27E+12	
0.10	2.18E+12	
0.20	8.62E+11	
0.25	6.39E+11	
0.30	5.01E+11	
0.35	4.08E+11	
0.40	3.41E+11	
0.45	2.91E+11	
0.50	2.53E+11	
0.55	2.23E+11	
0.60	1.98E+11	
0.65	1.78E+11	
0.70	1.61E+11	
0.75	1.47E+11	
0.80	1.35E+11	
0.85	1.24E+11	
0.90	1.15E+11	
Mean Load	**5.67E+11**	**cfu/day**

Table C-2. Calculations of TMDL loads.

Broad Mouth Creek at S-289

Target Conc: 380 cfu/100ml
From Target Line

% Exceeded	Load (cfu/day)	Flow (cfs)
0.10	9.39E+10	10.10
0.15	7.80E+10	8.39
0.20	6.84E+10	7.36
0.25	6.21E+10	6.68
0.30	5.57E+10	5.99
0.35	5.25E+10	5.65
0.40	4.77E+10	5.13
0.45	4.46E+10	4.79
0.50	3.98E+10	4.28
0.55	3.82E+10	4.11
0.60	3.34E+10	3.59
0.65	3.18E+10	3.42
0.70	2.86E+10	3.08
0.75	2.55E+10	2.74
0.80	2.23E+10	2.40
0.85	1.91E+10	2.05
0.90	1.59E+10	1.71
Mean Load	**4.46E+10**	**cfu/day**

Broad Mouth Creek at S-010

% Exceeded	Load (cfu/day)	Flow (cfs)
0.10	5.15E+11	55.36
0.15	4.27E+11	45.98
0.20	3.75E+11	40.35
0.25	3.40E+11	36.59
0.30	3.05E+11	32.84
0.35	2.88E+11	30.96
0.40	2.62E+11	28.15
0.45	2.44E+11	26.27
0.50	2.18E+11	23.46
0.55	2.09E+11	22.52
0.60	1.83E+11	19.70
0.65	1.74E+11	18.77
0.70	1.57E+11	16.89
0.75	1.40E+11	15.01
0.80	1.22E+11	13.14
0.85	1.05E+11	11.26
0.90	8.72E+10	9.38
Mean Load	**2.44E+11**	**cfu/day**

Broad Mouth Creek at S-304

% Exceeded	Load (cfu/day)	Flow (cfs)
0.10	6.10E+11	65.59
0.15	5.06E+11	54.48
0.20	4.44E+11	47.81
0.25	4.03E+11	43.36
0.30	3.62E+11	38.91
0.35	3.41E+11	36.69
0.40	3.10E+11	33.35
0.45	2.89E+11	31.13
0.50	2.58E+11	27.79
0.55	2.48E+11	26.68
0.60	2.17E+11	23.35
0.65	2.07E+11	22.24
0.70	1.86E+11	20.01
0.75	1.65E+11	17.79
0.80	1.45E+11	15.56
0.85	1.24E+11	13.34
0.90	1.03E+11	11.12
Mean Load	**2.89E+11**	**cfu/day**

Table C-3 Calculation of percent reductions.

Broad Mouth Creek at S-289:	
=(Existing Load - TMDL Load) / Existing Load	
% Reduction:	**75%**

Broad Mouth Creek at S-010:	
=(Existing Load - TMDL Load) / Existing Load	
% Reduction:	**69%**

Broad Mouth Creek at S-304:	
=(Existing Load - TMDL Load) / Existing Load	
% Reduction:	**49%**

APPENDIX D Flow-duration Curves

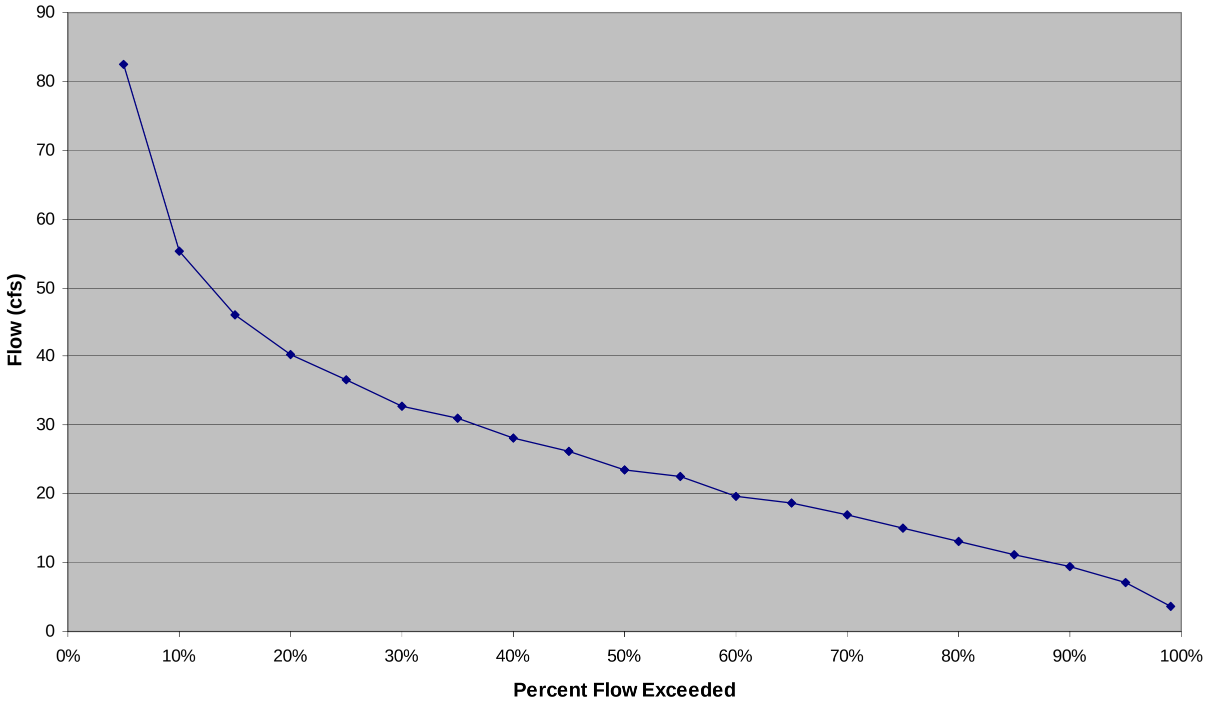

Figure D-1 Flow-duration curve for Broad Mouth Creek at S-010.

APPENDIX E Public Notification