Watershed Characterization Document
Hollow Creek (Hydrologic Unit Codes: 03060106070-010, -020, -030) Station SV-350
Fecal Coliform Bacteria

June 2005

SCDHEC Technical Report Number: 020-05

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 Hollow Creek in the Savannah River Basin. Subsequent actions must be consistent with this TMDL.

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Abstract

A fecal coliform (FC) bacteria Total Maximum Daily Load (TMDL) has been developed for Hollow Creek, which is a tributary of the Savannah River in Aiken County, SC. This creek has been on South Carolina's 303(d) list for FC since 2002. During the assessment period for the 2004 303(d) list (1998-2002), 11 % of samples at SV-350 exceeded the water quality standard. Land uses in the watershed of Hollow Creek are mostly forest, cropland and non-urban transitional. There are two point sources in the watershed. Two minor domestic wastewater facilities are permitted for land application of treated wastes. These facilities are not permitted for a direct discharge to waters of the State. The City of Aiken, Aiken County and adjacent developed areas have been designated as a Municipal Separate Storm Sewer System (MS4). The probable sources of fecal coliform bacteria in Hollow Creek are predominantly cattle-in-streams, grazing horses, runoff from pasture lands, failing septic systems, urban runoff and potential sewer leaks.

Load-duration curve methodology was used to calculate the existing load and the TMDL load for the creek. The existing load and TMDL load are presented in Table Ab-1. In order to reach the target load for Hollow Creek, reduction in the existing load to the creek of 39 % will be necessary. Resources and several TMDL implementation strategies to bring about these reductions are suggested.

Table Ab-1. Total Maximum Daily Loads for Hollow 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)	
SV-350	NA	NA	39 %	1.54E+12	9.33E+11	4.91+E10	9.82E+11	39 %

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 are 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 stormwater 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 can be diffuse or nonpoint sources, such as runoff, failing septic systems, and leaking sewers. The source of the pollutant can also be 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 Hollow Creek watershed in Aiken County is located in the Southeastern Plains Ecoregion of South Carolina (Figure 1). The headwaters of the creek rise in the City of Aiken. Hollow Creek then flows southwest and into the Savannah River.

The watershed is primarily rural except along the northern portion of the watershed, which is in the City of Aiken. Approximately 18,447 people live in the Hollow Creek Watershed (2000 US Census). This TMDL includes the part of the watershed upstream of the water quality station SV-350. The location description of the water quality monitoring station and area of the watershed is given in Table 1.

Table 1. Hollow Creek water quality monitoring site description

Watershed	Station ID	Sampling Station Description	Drainage Area Km^2	Drainage Area mi^2	Population (2000 Census)
Hollow Creek	SV-350	Hollow Creek at S-02-05	229.5	88.6	18,447

The predominant land use in the Hollow Creek watershed, according to the 1992 NLCD, was forest, consisting of 55 % of the land area (Table 2 and Figure 2). Agricultural land uses made up

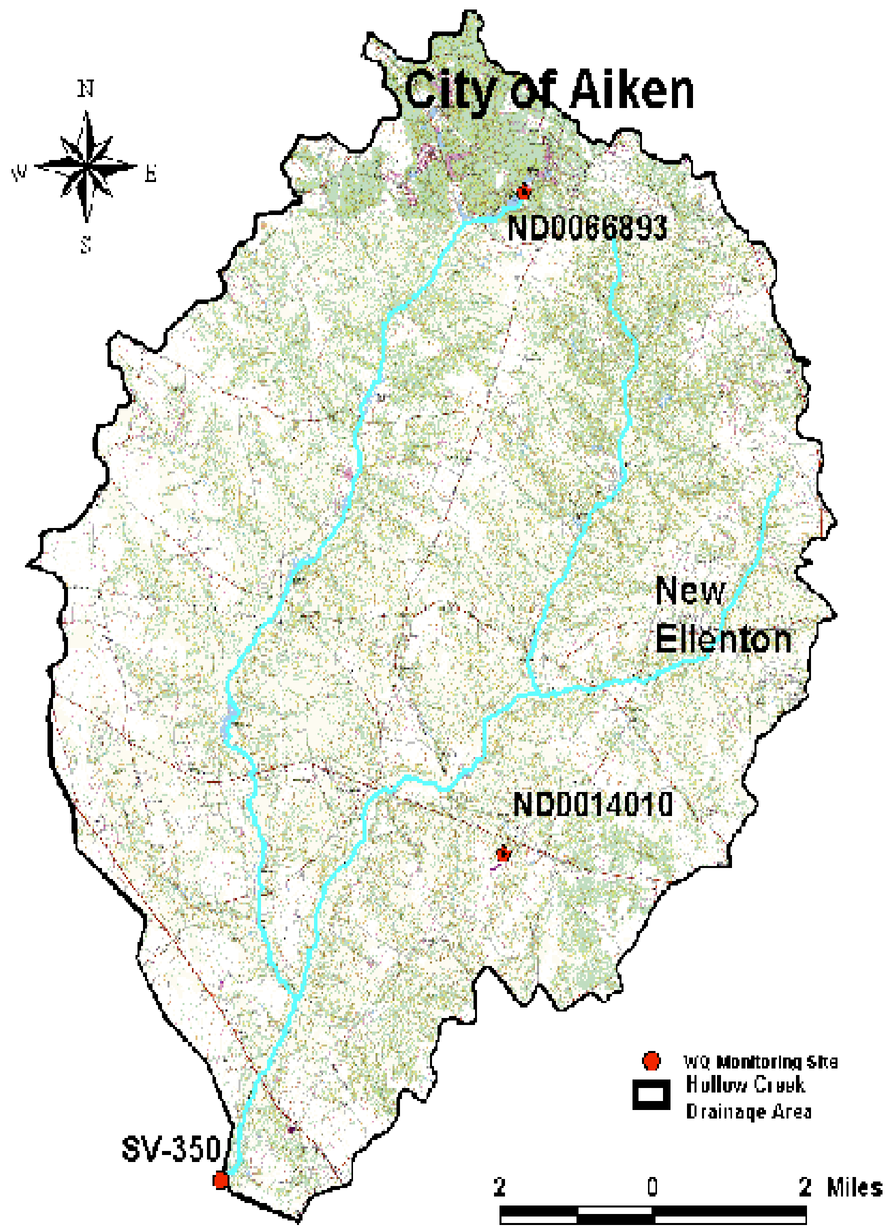

Figure 1. Map of the Hollow Creek watershed to SV-350, Savannah Basin.

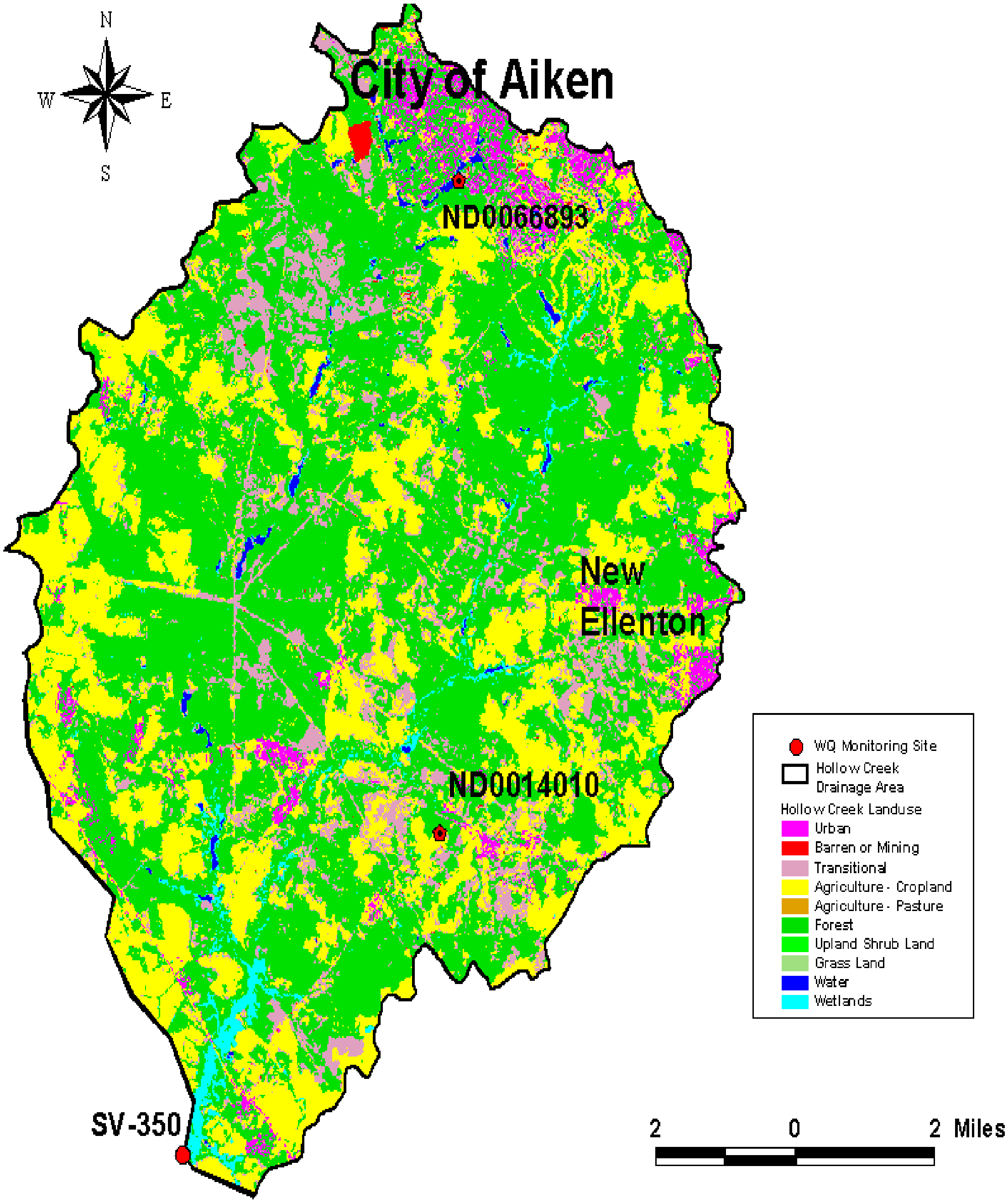

Figure 2. Map showing land uses in the Hollow Creek watershed.

28 % of the watershed. Non-urban transitional land use comprised 11% of the watershed. Findings from a November 23, 2004 windshield survey were generally consistent with the summary although a significantly larger proportion of pasture land to standing row crops was observed.

Table 2. Land uses in Hollow Creek watershed upstream of S-02-05.

Land Use Groups	Land Use	Area (hectares)	Area Sub-totals (hectares)	% Land Use	Sub-totals %
Water	Water	127.7	**127.7**		**0.6%**
	Residential Low Density	539.0		2.3%	
	Residential High Density	99.5		0.4%	
	Commercial, Industrial, & Transportation	117.1		0.5%	
Developed			**755.6**		**3.2%**
	Barren	83.3	**83.3**		**0.3%**
	Forest Deciduous	2349.2		10.2%	
	Forest Evergreen	7723.3		33.7%	
	Forest Mixed	2441.8		10.6%	
Forest			**12514.3**		**54.5%**
	Pasture/Hay	709.1		3.1%	
	Cropland	5651.7		24.6%	
	Urban Grasses	104.9		0.5%	
Agricultural			**6465.7**		**28.2%**
	Wetlands Woody	446.6		1.9%	
	Wetlands Herbaceous	2.8		0.0%	
Wetlands			**449.4**		**2.0%**
Transitional	Agricultural/Shrub	2554.6	**2554.6**		**11.1%**
Total for Watershed		**22950.4**			**100.0%**

1.3 Water Quality Standard

The impaired stream segment of Hollow Creek is 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.

2.0 WATER QUALITY ASSESSMENT

Hollow Creek has one water quality monitoring station, SV-350 (Table 1 and Figure 1). An assessment of water quality data for the 2004 303(d) list using data collected from 1998 through 2002 at this station, indicates that it is impaired for recreational use. Hollow Creek at SV-350 has been on the 303(d) list of impaired waters since 2002. 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), 11% of samples did not meet the fecal coliform criterion at SV-350. All of the data collected since 1995 is provided in Appendix A Table A-1. There was no data collected at this location prior to 1995.

Fecal coliform bacteria concentrations have remained about the same at location SV-350 in Hollow Creek since 1995 (Figure 3). The percentage of samples exceeding the standard of 400 cfu/100ml was 13 % 1996-2000 period compared to 11 % during the most recent period. The watershed for SV-350 is becoming more urbanized upstream, which increases the percentage of impervious surface. The higher percentage of impervious surface has the potential to degrade water quality in the receiving streams.

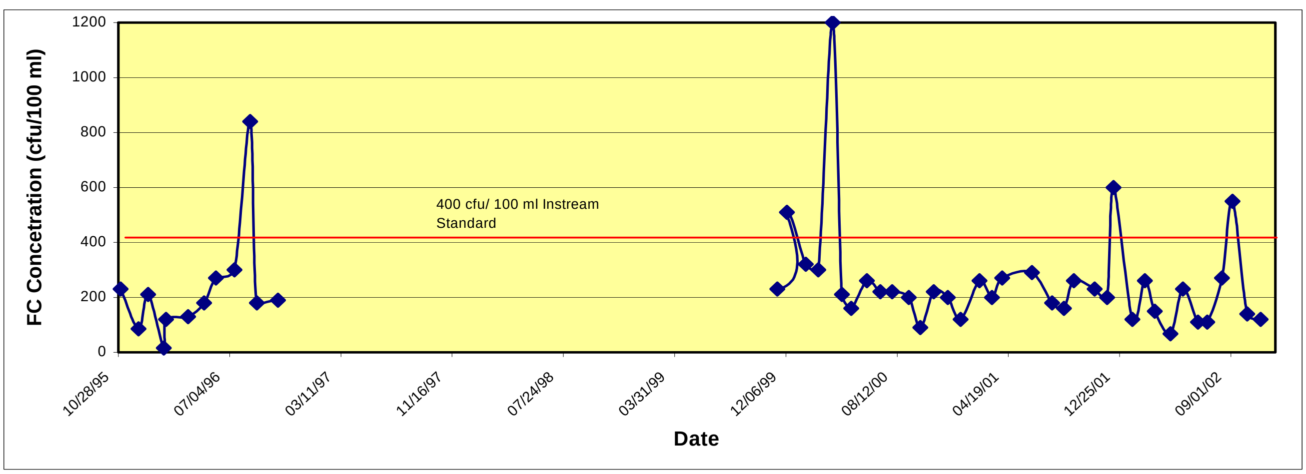

Figure 3. Fecal coliform concentration in Hollow Creek at SV-350 over time

There is not a simple relationship between precipitation and fecal coliform concentrations in Hollow Creek (Appendix C; Figure C-1). Fecal coliform concentrations show some increase with rainfall, as measured in nearby Aiken 4 NE (cooperative monitoring station); but the relationship is not clear. This pattern suggests that there are both continuous sources of fecal coliform bacteria, such as cattle in the creeks and rainfall associated sources, such as runoff from pasture land or land application of waste.

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 the same sources as pathogens, and persist a similar or longer length of time in surface waters. These indicator 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. All 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.

3.1 Point Sources

3.1.1 Continuous Point Sources

Currently there are two minor dischargers (point sources) in the Hollow Creek watershed that have permits to discharge effluent containing fecal coliform bacteria; however, both facilities are permitted for land application of treated wastewater only. The facilities do not discharge directly to waters of the State (i.e. Hollow Creek).

The City of Aiken has sewage collection systems that are in the northern portion of the Hollow 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 City of Aiken and Aiken County 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 Hollow Creek watershed. A small area of the MS4 area drains into the SV-350 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 Hollow Creek.

3.2 Nonpoint Sources

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. The SC Department of Natural Resources (Charles Ruth, DNR Deer Project Supervisor, personal communication, 2000) has estimated a density of 15-30 deer/mi^2 for this area. 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 concentrations of wildlife as sources of fecal coliform bacteria, usually have low loading rates for fecal coliform bacteria.

3.2.2 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 can be a significant source of fecal coliform bacteria. Loading of fecal coliform bacteria to Hollow Creek via this route is likely to be significant. The 2002 Agricultural Atlas (AA) reported 10,634 cattle and calves in Aiken County. Using the ratio of pastureland in the watershed to that of the County, 1542 cattle and calves were estimated to be in the SV-350 drainage area. Cattle in the creek are likely to be a source of fecal coliform at this station, accounting for some of the samples at lower flows. A windshield survey was conducted on November 23, 2004. In addition to grazing cattle, observations revealed a significant number of horse ranches, stables and grazing horses in the watershed. Using the 2002 AA, 400 horses and ponies were estimated to be in the watershed. Runoff from these pastures is also likely to be a major source of loading to SV-350.

3.2.3 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 Aiken and the boundaries of the Hollow Creek watershed. In 2000, there were an estimated 10,675 people in some 4343 households without sewer service in the Hollow Creek watershed. The number of rural households should correlate with the number of septic systems. Based on the evidence of dry weather sources in the SV-350 part of the watershed, failing septic systems could be a source of fecal coliform bacteria going into the stream.

3.2.4 Urban Nonpoint Sources

The headwaters of Hollow Creek are in the City of Aiken. At the time of data collection for the NLCD (about 1992), urban land made up 3.2 % of the watershed. As the percentage of impervious surface in a watershed increases with development, more rainfall runs off the land and less infiltrates into the soil. The additional runoff compared to undeveloped land increases the amount of pollutants that are carried into receiving streams. Dogs 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 3. Total and rural populations in Hollow Creek watershed.

Station	Total Population	Rural Population	Rural Households
SV-350	18,744	10,675	4,343

4.0 LOAD-DURATION CURVE METHOD

A Load-duration curve was developed as a method of completing a TMDL that applies to all hydrologic conditions (Cleland, 2003). 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 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 flow data, which typically is not available for the site or stream. Hollow Creek, like many small streams in South Carolina is not gauged. Upper Three Runs, which is some 16 km south and east of Hollow Creek, is a comparable, gauged stream with similar land uses and topography (USGS 02197300). The period of record (January 2, 1992 through November 30, 2002) was used to generate the load-duration and flow-duration curves. The Upper Three Runs watershed is similar in area, 225.3 km^2 compared to 229.5 km^2 for Hollow Creek watershed at SV-350.

Flows for Hollow Creek at the water quality monitoring site were estimated by multiplying the daily flow rates from Upper Three Runs by the ratio of the Hollow Creek drainage area to that of Upper Three Runs (1.02:1). The flows were ranked from low to high and the values that exceed certain selected percentiles determined. A flow-duration curve for Hollow Creek at SV-350 is provided in (Appendix C; Figure C-2). 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 (Figure 4). 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 criterion 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.

A trend line was determined for sample loads that exceeded the standard for each station. The trend line for Hollow Creek was a exponential function (Figure 4). The correlation coefficient (r^2) for this curve was 0.9785. The existing load to Hollow Creek was calculated from the means of all loads

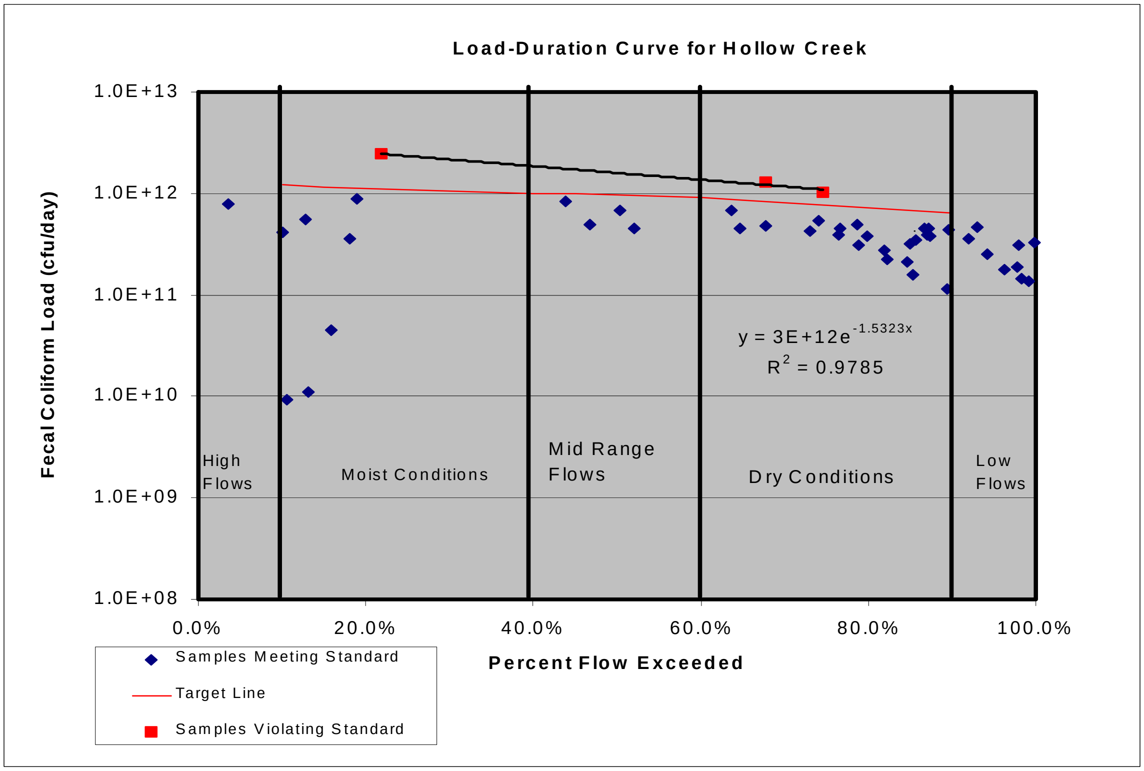

Figure 4. Load-duration Curve for Hollow Creek at SV-350.

that were between the 10 % and 90 % flow recurrence intervals. This excludes some flows that occur infrequently. 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.

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:

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

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

This TMDL is based on the flow recurrence interval between 10 % and 90 %. This encompasses 80 % of flows in Hollow Creek. Only flows that are characterized as 'Low' or 'High' flows in Figure 4 are not included in the analysis. For this TMDL critical conditions are this range of the flow recurrence interval.

5.2 Existing Load

The existing load was calculated from the trend line 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, grazing horses, and failing septic systems. The existing wasteload allocation and load allocation for Hollow Creek are provided in Table 4.

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 4.

5.4 Wasteload Allocation

There are no NPDES dischargers in the Hollow Creek watershed. Two minor domestic wastewater facilities are permitted for land application of treated wastes. These facilities are not permitted for a direct discharge to waters of the State. A portion of the watershed is a designated Municipal Separate Storm Sewer System (MS4).

5.5 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 TMDL for

this location on Hollow Creek are provided in Table 4. The required reduction in load, expressed as a percentage is also provided in Table 4.

Table 4. TMDL components for Hollow Creek.

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)	
SV-350	NA	NA	39 %	1.54E+12	9.33E+11	4.91+E10	9.82E+11	39 %

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

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. There are also a number of *voluntary* measures available to interested parties. SCDHEC will work with the existing agencies in the area to provide nonpoint source education in the Hollow Creek Watershed. Local sources of nonpoint source education and assistance include Clemson Extension Service, the Natural Resource Conservation Service (NRCS), the Aiken 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 agricultural nonpoint source problems. 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 Hollow 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 Hollow Creek watershed, Clemson Extension has developed a Home-A-Syst handbook that can help urban or 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 *voluntary* mechanisms, these measures will be implemented in the Hollow Creek watershed in order to bring about a 39 % reduction in fecal coliform bacteria loading to Hollow 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 Observed Data Summary for Hollow Creek.

Site	Date	Instream Flow (cfs)*	FC (cfu/100 ml) @ SV-350	Prec.(in) @ Aiken NE COOP
SV-350	02-Nov-95	126.3	230	0.01
SV-350	12-Dec-95	129.3	85	0
SV-350	03-Jan-96	153.8	210	0.1
SV-350	07-Feb-96	123.2	15	0
SV-350	12-Mar-96	121.2	120	0
SV-350	02-Apr-96	130.4	130	0
SV-350	08-May-96	126.3	180	0.35
SV-350	03-Jun-96	102.9	270	0
SV-350	15-Jul-96	120.2	300	0.13
SV-350	19-Aug-96	118.1	840	0.34
SV-350	03-Sep-96	101.8	180	0
SV-350	21-Oct-96	104.9	190	0
SV-350	17-Nov-99	80.5	230	0
SV-350	08-Dec-99	82.5	510	0
SV-350	20-Jan-00	105.9	320	0.77
SV-350	17-Feb-00	92.7	300	0
SV-350	20-Mar-00	171.1	1200	1.85
SV-350	10-Apr-00	83.5	210	0
SV-350	01-May-00	78.4	160	0
SV-350	05-Jun-00	71.3	260	0
SV-350	05-Jul-00	67.2	220	0
SV-350	01-Aug-00	88.6	220	0.71
SV-350	07-Sep-00	80.5	200	0.2
SV-350	03-Oct-00	72.3	90	0
SV-350	02-Nov-00	70.3	220	0
SV-350	04-Dec-00	77.4	200	0.07
SV-350	02-Jan-01	75.4	120	0
SV-350	13-Feb-01	78.4	260	0.25
SV-350	13-Mar-01	91.7	200	1.06
SV-350	05-Apr-01	82.5	270	0
SV-350	11-Jun-01	66.2	290	0
SV-350	26-Jul-01	72.3	180	0.7
SV-350	22-Aug-01	64.2	160	0
SV-350	13-Sep-01	70.3	260	0
SV-350	30-Oct-01	70.3	230	0
SV-350	27-Nov-01	71.3	200	0
SV-350	11-Dec-01	88.6	600	0.68
SV-350	23-Jan-02	72.3	120	0.1
SV-350	20-Feb-02	68.2	260	0
SV-350	14-Mar-02	75.4	150	0
SV-350	18-Apr-02	68.2	68	0
SV-350	16-May-02	55.0	230	0
SV-350	19-Jun-02	54.0	110	0
SV-350	10-Jul-02	50.9	110	0
SV-350	12-Aug-02	48.9	270	0
SV-350	05-Sep-02	56.0	550	0
SV-350	08-Oct-02	55.0	140	0
SV-350	07-Nov-02	60.3	120	0

*Based on USGS 02197300 and a 88.6 mi^2 Drainage Area

APPENDIX B Calculation of Existing and TMDL Loads

Table B-1. Calculation of existing loads

Using Equation, Calculation of
Existing Load for SV-350:
Equation: y = 3E+12e ^ -1.5323x

%Exceeded	**Load**
10%	2.57E+12
15%	2.38E+12
20%	2.21E+12
25%	2.05E+12
30%	1.89E+12
35%	1.75E+12
40%	1.63E+12
45%	1.51E+12
50%	1.39E+12
55%	1.29E+12
60%	1.20E+12
65%	1.11E+12
70%	1.03E+12
75%	9.51E+11
80%	8.81E+11
90%	7.55E+11
	1.54E+12

Table B-2. Calculation of TMDL loads

TMDL Load

Target FC Conc: 380

% Exceeded	**Flow (cfs)**	
10%	130.35	1.21E+12
15%	124.24	1.16E+12
20%	120.17	1.12E+12
25%	116.10	1.08E+12
30%	113.04	1.05E+12
35%	109.99	1.02E+12
40%	107.95	1.00E+12
45%	105.91	9.85E+11
50%	102.86	9.56E+11
55%	99.80	9.28E+11
60%	96.75	8.99E+11
65%	91.66	8.52E+11
70%	86.56	8.05E+11
75%	82.49	7.67E+11
80%	77.40	7.20E+11
85%	72.31	6.72E+11
90%	68.23	6.34E+11
	Average	9.33E+11

TMDL = WLA + LA + MOS

Table B-3 Calculation of percent reduction.

Percent Reduction Required:		
Existing Load:	1.54E+12	cfu/day
TMDL Load:	9.33+E11	cfu/day
Load Reduction:	6.07E+11	cfu/day
Percent reduction:	39.4%	

APPENDIX C

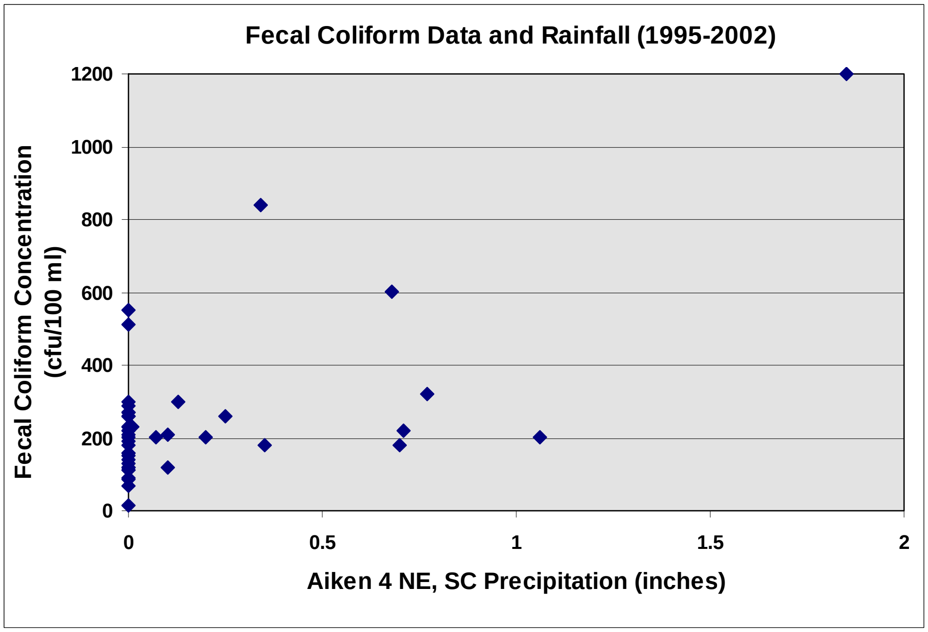

Figure C-1 Comparison between precipitation and fecal coliform concentration in Hollow Creek.

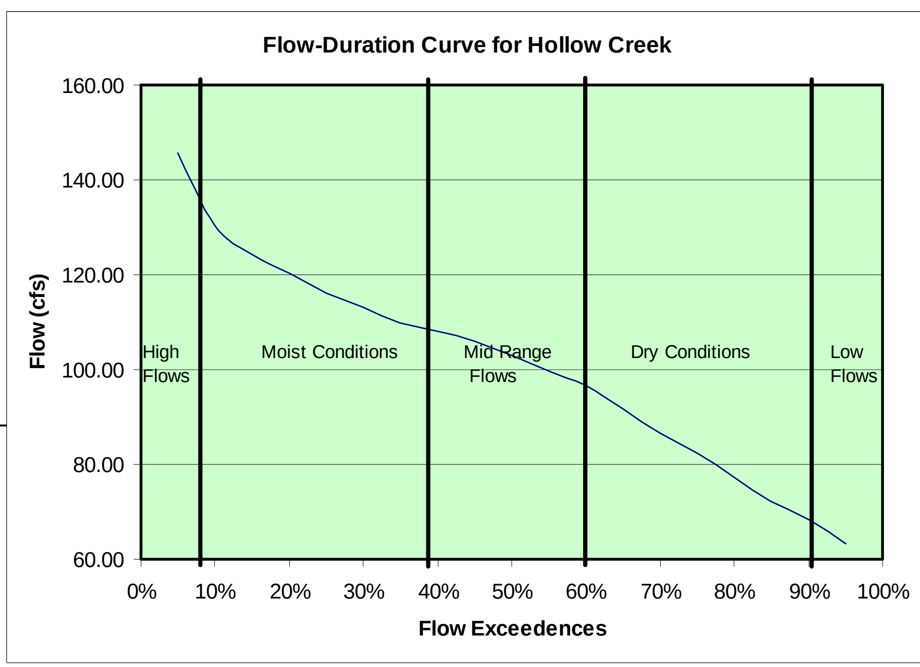

Figure C-2 Flow-duration curve for Hollow Creek at SV-350.

APPENDIX D Public Notification