Total Maximum Daily Load Document
Indian Field Swamp (Hydrologic Unit Codes: 030502060201, -02, -04 & Station E-032)
Fecal Coliform Bacteria, Indicator for Pathogens

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DHEC
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Abstract

A Total Maximum Daily Load (TMDL) have been developed for the Indian Field Swamp, which is a tributary of the Edisto River in Orangeburg and Dorchester Counties, SC. Indian Field Swamp at E-032 was listed on South Carolina's 303(d) list in 2004. During the assessment period for the 2004 303(d) list (1998-2002), 21 % of samples at E-032 exceeded the water quality standard. The watershed of Indian Field Swamp is mostly forest, wetland, and cropland. There is one small point source of fecal coliform bacteria in the watershed. The towns of Harleyville and St George are partly in the watershed; but there are no MS4s. The probable sources of fecal coliform bacteria in this creek are agricultural runoff, failing septic tanks, and cattle in creek.

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 Indian Field Swamp, a reduction in the existing load to the creek of 60 % will be necessary. Resources and several TMDL implementation strategies to bring about these reductions are suggested.

Table Ab-1. Total Maximum Daily Load for Indian Field Swamp.

Station ID	TMDL (cfu/day)	MOS (cfu/day)	WLA		LA (cfu/day)	Existing Load (cfu/day)	% Reduction to Meet Load Allocation[3]
			Continuous Sources[1] (cfu/day)	Intermittent Sources[2] (% Reduction)			
E-032	6.23E+11	3.10 E+10	1.14E+09	60 %	5.92 E+11	1.46 E+12	60%

Table Notes:

1 - WLA is expressed as total monthly average.

2 - Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4, construction and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for pollutant of concern, whichever is less restrictive.

3 - Percent reduction applies to existing load; Where Percentage Reduction = (Existing Load-Load Allocation) / Existing Load

Table of Contents

Tables

Figures

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 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

Indian Field Swamp is a blackwater tributary of the Edisto River in the Middle Atlantic Coastal Plain Eco-region of South Carolina (Figure 1) (HUC 030502060204). The creek is typically slow moving, has a braided channel in places, and has a broad floodplain that is flooded for parts of the year. Polk Swamp is the largest tributary of Indian Field Swamp, but its confluence is downstream of the impaired reach. Gum Branch is a large tributary that enters Indian Field Swamp 3.2 km (2 miles) upstream of station E-032. Most of the Indian Field Swamp watershed is in Dorchester County; however, the upper end is in Orangeburg County. Parts of the Towns of Harleyville and St George are in the watershed. Over 5,000 people live in the Indian Field Swamp watershed (2000 US Census) (Table 1). This TMDL includes that part of the watershed, upstream of the water quality station at S-18-19. Additional information about the watershed is given in Table 1.

Table 1. Indian Field Swamp water quality monitoring site description.

Watershed	Station ID	Sampling Station Description	Drainage Area		Population
			km^2	mi^2	
Indian Field Swamp	E-032	Indian Field Swamp at S-18-19	25.2	9.7	5237

The latest available land use data is from the National Land Cover Data (NLCD), which represents land uses in the early 1990s. Forest was the predominant land use in the Indian Field Swamp watershed; accounting for 52 % of the watershed (Table 2 and Figure 2). Wetlands were the second

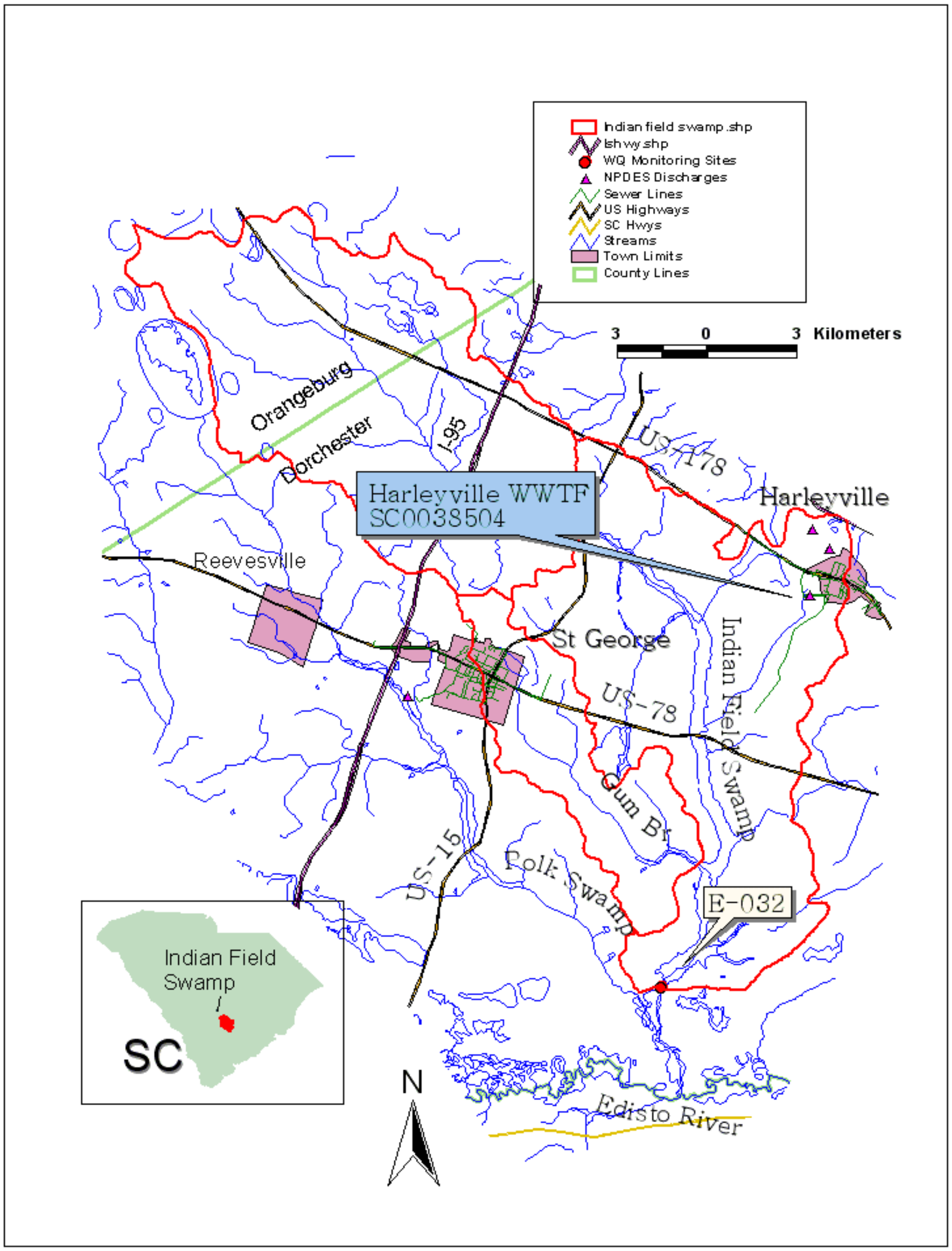

Figure 1. Map of Indian Field and Polk Swamp watersheds, in the Edisto Basin.

largest land use at 21 %. Croplands make up most of the remaining land use 20 %. Pasture land and land in transition made up together 6 % of total land use. Urban or developed land was only 1

% of the land in the Indian Field Swamp watershed. Agriculture is a major activity in this largely rural watershed.

1.3 Water Quality Standard

The impaired stream segment of Indian Field Swamp 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.

Table 2. Land uses in Indian Field Swamp watershed in the early 1990's.

Land Uses	**Area (hectares)**	**Area (acres)**	**Percen-tages**
Water	34.6	85.4	0.1%
Urban	283.8	701.2	1.0%
Barren or Mining	74.3	183.5	0.3%
Transitional	762.7	1,884.5	2.7%
Forest	**14,911.6**	**36,846.5**	**51.9%**
Agricultural Pasture	983.1	2,429.2	3.4%
Agricultural Cropland	**5,729.9**	**14,158.7**	**19.9%**
Wetlands	**5,947.7**	**14,696.9**	**20.7%**
Totals	**28,727.6**	**70,985.8**	**100.0%**

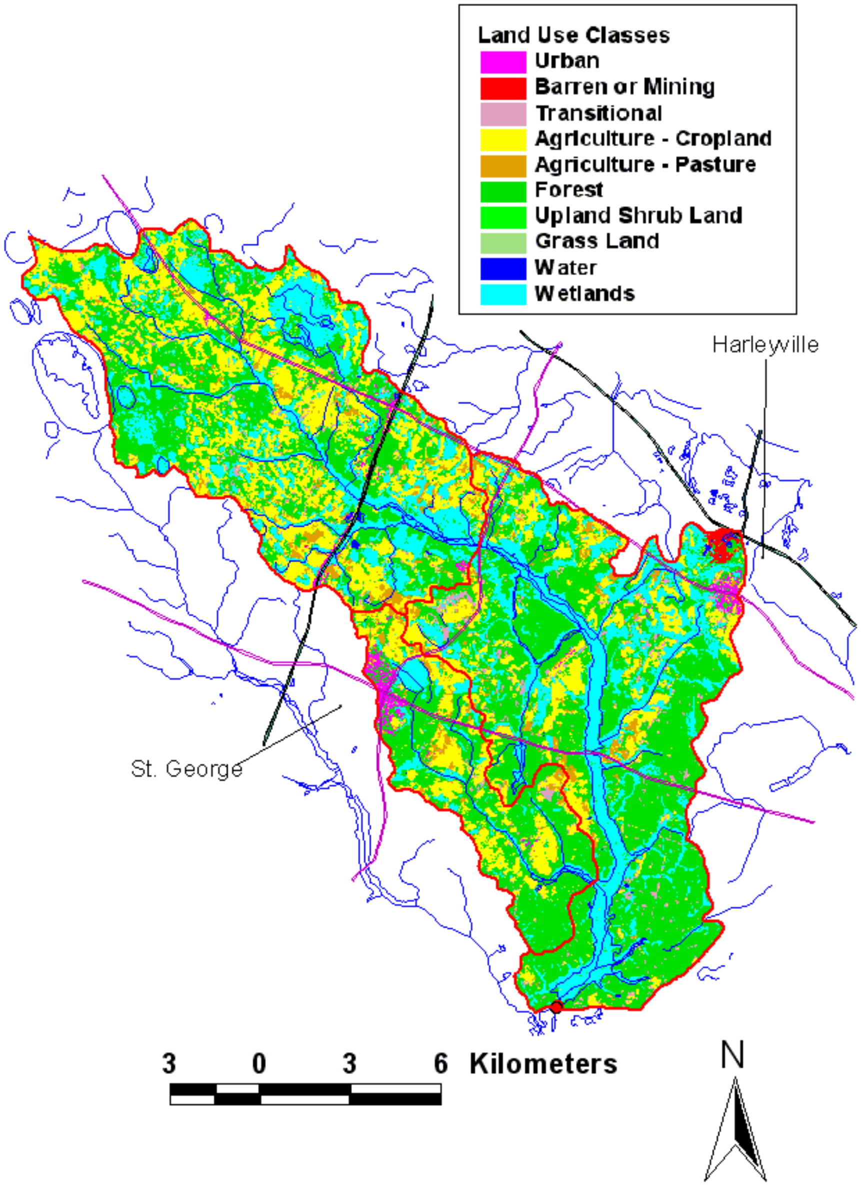

Figure 2. Map showing land uses in the Indian Field Swamp watershed in the early 1990s.

2.0 WATER QUALITY ASSESSMENT

DHEC has one water quality monitoring station on Indian Field Swamp (Table 1 and Figure 1). An assessment of water quality data collected from 1998 through 2002 for the 2004 303(d) list at this station indicated that it was impaired for recreational use. Indian Field Swamp has not been listed before. During the 1998-2002 monitoring period 21 % of samples at E-032 exceeded the standard for fecal coliform bacteria. 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. Descriptive statistics for data collected since 1996 at these locations is provided in Appendix A Table A-2. All of the data is provided in Appendix A Table A-1.

Indian Field Swamp was sampled in 1992, 1996-1998 and 2001-2004. No samples exceeded the standard in 1992. Only one sample exceeded the standard of 400 cfu/100ml during the 1996-1998 period. Sampling from 2001 through 2004 found eleven samples of 45 that exceeded the standard or 24 % (Figure 3). These findings indicate that the stream has an increasing fecal coliform load.

There is little correlation between fecal coliform bacteria concentrations and turbidity in these waters (Figure 4).

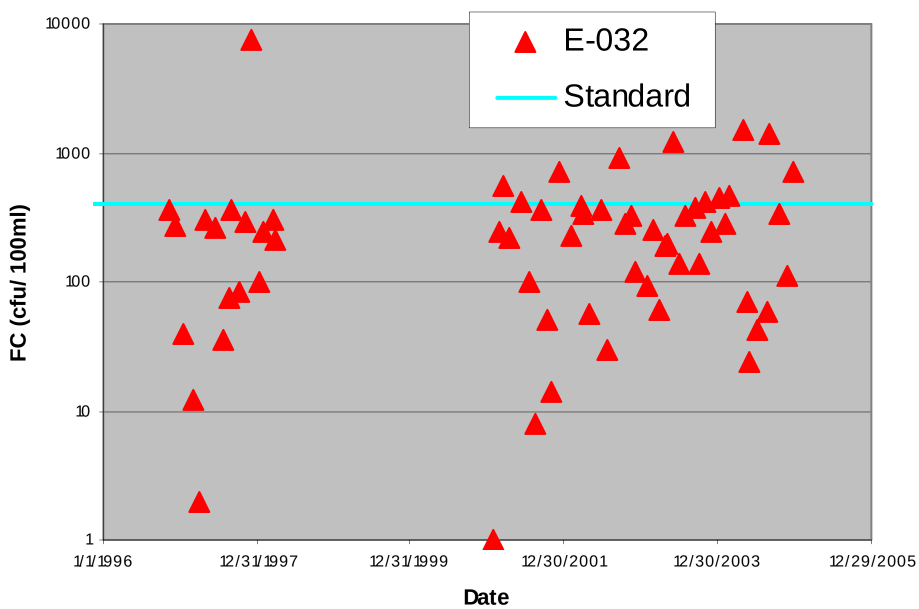

Figure 3. Fecal coliform concentrations in Indian Field Swamp at E-032 from 1996 through 2004.

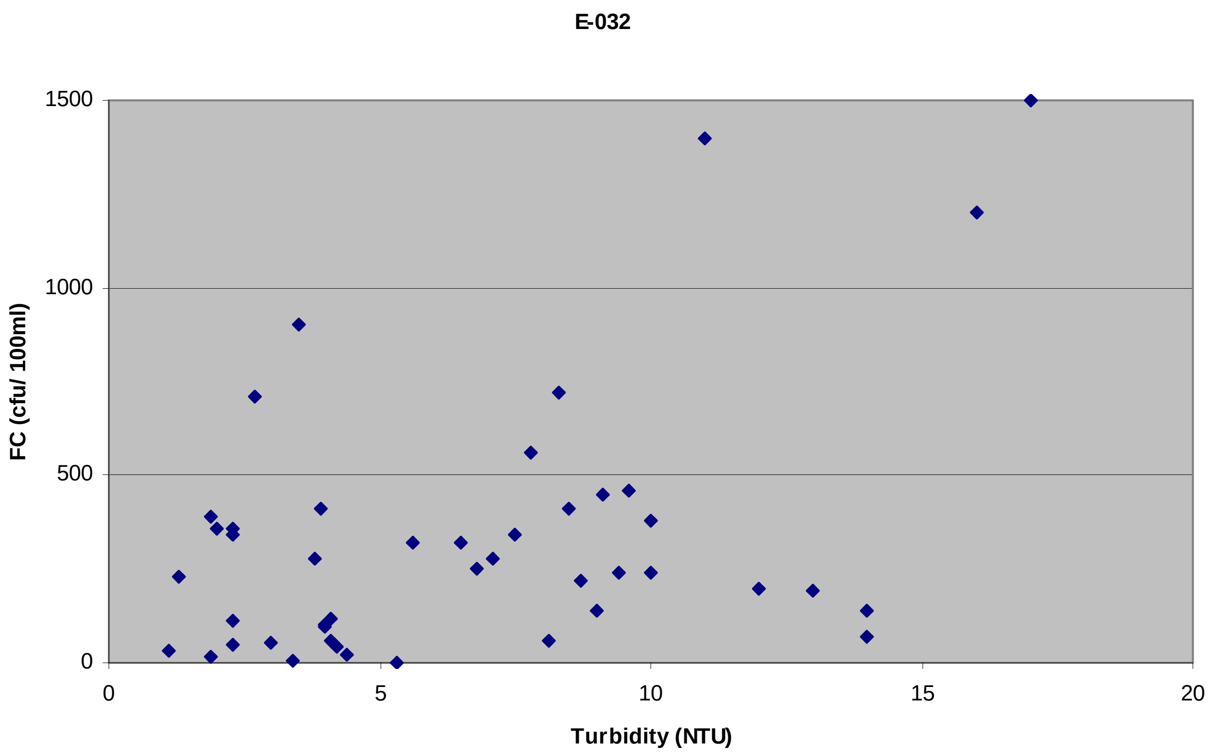

Figure 4. Comparison of turbidity and fecal coliform concentrations in Indian Field Swamp at E-032.

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 Indian Field Swamp Watershed

3.1.1 Continuous Point Sources

Currently there is one NPDES discharger in the Indian Field Swamp watershed that has a permit to discharge wastewater containing fecal coliform bacteria. The Town of Harleyville (SC0038504) discharges wastewater into Tom and Kate Branch, a tributary of Indian Field Swamp, some 16 km (10 miles) upstream of E-032. This facility has a permit to discharge 0.15 mgd of wastewater. At this flow rate the facility could discharge 1.14 E+09 cfu/day of fecal coliform bacteria. This facility reported no permit violations between 1990 and 2005 fecal coliform. Indeed only a few samples exceeded the detection limit, which was never more than 50 cfu/100 ml.

The Town of Harleyville's sewage collection system is not extensive. Sewer lines do not cross Indian Field Swamp or Tom and Kate Branch; but cross another tributary of Indian Field Swamp at US 178. The sewage collection system in this case is unlikely to be a major contributor to the impairment of Indian Field Swamp, because of the minimal proximity to the streams and the distance upstream from the sampling station. Identified collection system and/or SSO problems are addressed by SCDHEC through compliance and enforcement mechanisms.

3.1.2 Intermittent Point Sources

This primarily rural watershed has no designated Municipal Separate Storm Sewer System (MS4). However, there maybe industrial or construction activities going on at any time that could produce stormwater runoff. Industrial facilities that have the potential to cause or contribute to a violation of a water quality standard are covered by the Storm Water Industrial General Permit (SCR000000). Construction activities are covered by the Storm Water Construction General Permit (SCR100000). Where the construction has the potential to affect water quality of a water body with a TMDL, the Storm Water Pollution Prevention Plan (SWPPP) for the site must address any pollutants of concern and adhere to any wasteload allocations in the TMDL.

3.2 Nonpoint Sources in the Indian Field Swamp 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 concentrations of wildlife as sources of fecal coliform bacteria, usually have low loading rates for fecal coliform bacteria.

3.2.2 Agricultural Activities

Agricultural activities that involve livestock or animal wastes are potential sources of fecal coliform contamination of surface waters. Fecal matter can enter the waterway by rainfall runoff from the land or by direct deposition into the stream.

3.2.2.1 Agricultural Animal Facilities

Owners/operators of most commercial animal growing operations are required by R. 61-43, Standards for the Permitting of Agricultural Animal Facilities, to obtain permits for the handling, storage, treatment (if necessary) and disposal of the manure, litter and dead animals generated at their facilities (SC DHEC 2002). The requirements of R. 61-43 are designed to protect water quality; therefore, we have a reasonable assurance that facilities operating in compliance with this regulation should not contribute to downstream water quality impairments.

While there are currently no confined animal feeding operations (CAFOs) in South Carolina, there are three active permitted swine operations and two poultry operations in the Indian Field Swamp watershed. The upper part of Indian Field Swamp has 147 permitted fields and another 7 in Gum Branch. More than 120 of the fields are west of I-95 so that they are far upstream of the impaired sampling station. The fields in the Gum Branch watershed are near St. George in the upper part of this watershed. These facilities are routinely inspected for compliance with their permits. Permitted agricultural facilities that operate in compliance with their permit are not considered to be sources of impairment.

3.2.2.2 Grazing Animals

Livestock, especially cattle, are frequently major contributors of fecal coliform bacteria to streams. Cattle on average produce some 1 E+11 cfu/day per animal of fecal coliform bacteria (ASAE, 1998). Grazing cattle and other livestock may contaminate streams with fecal coliform bacteria indirectly by runoff from pastures or directly by defecating into streams and ponds. The grazing of unconfined livestock (in pastures) is not regulated by SC DHEC. The 2002 Agricultural Atlas reported 16,735 cattle and calves in Orangeburg County and 4310 cattle and calves in Dorchester County. Using the ratio of pastureland in the each part of the watershed to that of the appropriate county, 1173 cattle and calves were estimated to be in the E-032 drainage area. Most of the pasture land in this watershed appears to be in the middle part of the watershed (Figure 2). Direct loading by cattle or other livestock to the creeks is likely to be a significant source of fecal coliform bacteria to the Indian Field Swamp.

3.2.3 Failing Septic Systems

Failing septic systems can contribute to bacterial contamination of downstream waterbodies (US EPA, 2001). Loading to streams from failing septic systems is likely to be continual rather than precipitation related. The population and number of households that use septic systems were estimated by comparing the 2000 census GIS layer to the sewer line GIS layer and the Indian Field Swamp watershed. In 2000 there were an estimated 3500 people in some 1500 households without sewer service (Indicated as ‘Unincorporated’ in Table 3) in the Indian Field Swamp watershed draining to E-032. This number is almost three times the population that has sewer service. The evidence from the load-duration curve, that some of bacterial load is due to continual sources, suggests that failing septic systems could be a major source of fecal coliform bacteria going into the stream.

3.2.4 Urban Nonpoint Sources

Urban and suburban stormwater runoff from streets, parking lots and lawns can contribute a large bacterial load to receiving waters (Gaffield, 2003). However, there is very little urban development within the watershed. The Towns of Harleyville and St George are both small, low density communities that are not presently covered by a MS4 and seem unlikely to be significant sources of fecal coliform bacteria given their distance upstream of the impaired station. However without monitoring data upstream of E-032, it is impossible to rule out this source.

Table 3. Populations and households in Indian Field Swamp watersheds by town or unincorporated area.

Type	Population	Households
Unincorporated	3519	1513
Town	1386	657

4.0 LOAD-DURATION CURVE METHOD

The load-duration curve method was developed as a means of incorporating natural variability, uncertainty, and risk assessment into TMDL development (Bonta and Cleland, 2003). The analysis is based on the range of hydrologic conditions for which there is appropriate water quality data. 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 for Indian Field Swamp is described in this chapter.

The load-duration curve method requires an adequate period of record for flow data. Usually small streams are not gauged and one must estimate the flow from a similar nearby stream. Indian Field Swamp, like many small streams in South Carolina is not gauged. Cow Castle Creek is the adjacent watershed on the north edge of Indian Field Swamp; its gauging station (USGS 02174250) some 24 km (15 miles) north-northwest of Harleyville. The Cow Castle Creek watershed is a smaller (6417 hectares compared to 14532 hectares for Indian Field Swamp) gauged stream with similar land uses and topography. Mean daily flow data from the gauge on the Cow Castle Creek (http://sc.water.usgs.gov/) near Bowman, South Carolina for the period of record (Oct.1, 1995 to Dec. 31, 2004) was used to generate the flow-duration curve (Appendix D Figure D-1).

The flows for Indian Field Swamp at the different water quality monitoring sites were estimated by multiplying the daily flow rates from Cow Castle Creek by the ratio of the Indian Field Swamp drainage area to that of Cow Cattle Creek (2.2646). The flows were ranked from low to high and the values that exceed certain selected percentiles determined. 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. Fecal coliform data from 1998 through 2004 was used in the load-duration curve analysis. The load was plotted against the appropriate flow recurrence interval to generate the curve (Figure 5). 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 allows a Margin of Safety of 20 cfu/100ml (5 % of 400 cfu/100ml). This explicit Margin of Safety (MOS) was reserved from the water quality criteria rather than an implicit MOS. 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 that best fit the data was determined for all samples that exceeded the standard. The best fitting trend line for Indian Field Swamp was a polynomial function (Figure 5). The r^2 (coefficient of determination or a measure of variance explained by the regression equation) for this line is 0.8777. The polynomial function fit the data better than the other functions offered in Excel, but above the 75 % exceeded value the load becomes negative. The other functions matched the data even less and had much smaller r^2s. The existing load to Indian Field Swamp at the monitoring stations was calculated from the means of all loads that were between the 5 % and 75 % flow recurrence intervals for each location. This excludes flows that occur infrequently.

The TMDL load is calculated from the target line. Load values at 5 % occurrence intervals along the target line from 5 to 75 % were averaged. The Load Allocation (LA) values are derived from the 380 cfu/100ml water quality target, which excludes the explicit Margin of Safety. Calculations for both existing and TMDL loads are provided in Appendix B.

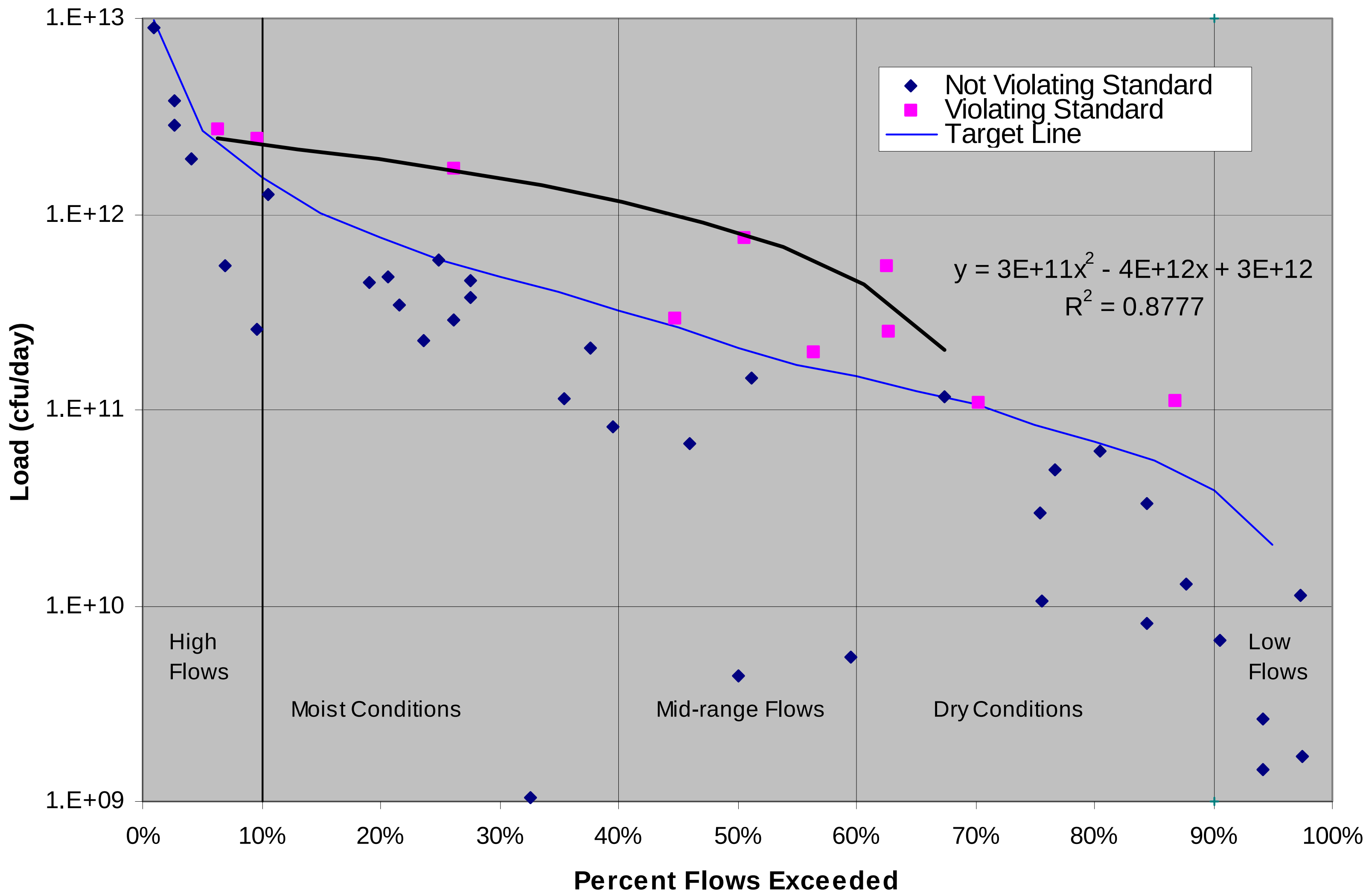

Figure 5. Load-Duration Curve for Indian Field Swamp at E-032.

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

This TMDL is based on the flow recurrence interval between 5 % and 75 %. This interval was used because it encompassed most of the samples that exceeded the standard and above 75 % the load values from the trend line were negative. The 5 to 75 % range encompasses 70 % of flows in Indian Field Swamp. All flows that are characterized as ‘Low’ and half characterized as ‘Dry Conditions’ or ‘High’ in Figure 5 were not included in the analysis. For these TMDLs critical conditions are this range of the flow recurrence interval.

5.2 Wasteload Allocation

The wasteload allocation (WLA) is the portion of the TMDL allocated to point sources (US EPA, 1999).

5.2.1 Continuous Point Sources

The one continuous point source, Harleyville WWTF, has a WLA of 1.14E+09 cfu/day.

5.2.2 Intermittent Point Sources

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future MS4, construction and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction instead of a numeric loading due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern, whichever is less restrictive. The percent reduction applied is the same as that applied to the existing load, 60%. This watershed has no MS4s at the time that this TMDL is being completed.

5.3 Load Allocation

The Load Allocation applies to the nonpoint sources of fecal coliform bacteria and is expressed both as a load and as a percent reduction.

5.4 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 5 and 75 % recurrence limits. Loadings from all sources are included in this value: runoff, cattle-in-streams, and failing septic systems. The existing load for the station on Indian Field Swamp is provided in Table 4.

5.5 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. The calculated value of the Margin of Safety is given in Table 4.

5.6 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 the three locations on Indian Field Swamp are provided in Table 4. The required reduction in load, expressed as a percentage is also provided.

Table 4. TMDL components for Indian Field Swamp.

Station ID	TMDL (cfu/day)	MOS (cfu/day)	WLA		LA (cfu/day)	Existing Load (cfu/day)	% Reduction to Meet Load Allocation[3]
			Continuous Sources[1] (cfu/day)	Intermittent Sources[2] (% Reduction)			
E-032	6.23E+11	3.10 E+10	1.14E+09	60 %	5.92 E+11	1.46 E+12	60%

Table Notes:

1 - WLA is expressed as total monthly average.

2 - Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4, construction and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for pollutant of concern, whichever is less restrictive.

3 - Percent reduction applies to existing load; Where Percentage Reduction = (Existing Load-Load Allocation) / Existing Load

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 Indian Field Swamp watershed. Local sources of nonpoint source education and assistance include Clemson Extension Service, the Natural Resource Conservation Service (NRCS), the Orangeburg and Dorchester 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 Indian Field Swamp. 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 Indian Field Swamp 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 Indian Field Swamp. 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 Indian Field Swamp at E-032.

Date	Turb (NTU)	FC (cfu/ 100ml)
5/22/1992		320
6/1/1992		130
7/24/1992		170
8/12/1992		160
9/1/1992		140
10/21/1992		152
11/14/1996		360
12/4/1996		270
1/16/1997		40
3/6/1997		12
4/3/1997		2
5/1/1997		300
6/19/1997		260
7/22/1997		36
8/19/1997		76
9/2/1997		360
10/7/1997		84
11/3/1997		290
12/1/1997		7600
1/12/1998		100
2/3/1998		240
3/19/1998		300
4/2/1998		210
1/30/2001	5.3	1
2/22/2001	9.4	240
3/13/2001	7.8	560
4/17/2001	8.7	220
6/7/2001	3.9	410
7/23/2001	4	100
8/15/2001	3.4	8
9/13/2001	2.3	360
10/16/2001	2.3	50
11/1/2001	1.9	14
12/10/2001	2.7	710
1/31/2002	1.3	230
3/20/2002	1.9	390
4/1/2002	2.3	340
5/1/2002	3	56
Date	Turb (NTU)	FC (cfu/ 100ml)
6/26/2002	2	360
7/24/2002	1.1	30
9/17/2002	3.5	900
10/21/2002	3.8	280
11/18/2002	5.6	320
12/3/2002	4.1	120
1/29/2003	4	94
2/26/2003	6.8	250
3/27/2003	8.1	60
4/24/2003	13	190
5/6/2003	12	200
6/4/2003	16	1200
7/1/2003	9	140
8/5/2003	6.5	320
9/15/2003	10	380
10/2/2003	14	140
11/3/2003	8.5	410
12/1/2003	10	240
1/8/2004	9.1	450
2/2/2004	7.1	280
3/1/2004	9.6	460
4/28/2004	17	1500
5/18/2004	14	70
6/2/2004	4.4	24
7/7/2004	4.2	43
8/26/2004	4.1	58
9/7/2004	11	1400
10/18/2004	7.5	340
11/23/2004	2.3	110
12/28/2004	8.3	720

Table A-2 Statistics for fecal coliform data 1998-2002 in Indian Field Swamp (cfu/100ml).

E-032

Statistic	Value
Minimum	1
Mean	262
Geometric Mean	140
Median	240
Maximum	900
% Violations	16.0%

APPENDIX B DMR Data

Table B-1. DMR Data for Harleyville WWTF SC0038504.

Date	FC (cfu/ 100ml)
1/31/1990	12
2/28/1990	62
3/31/1990	22
4/30/1990	<4
5/31/1990	1
6/30/1990	<2
7/31/1990	<4
8/31/1990	6
9/30/1990	2
10/31/1990	17
11/30/1990	7
12/31/1990	5
1/31/1991	3
2/28/1991	8
3/31/1991	6
4/30/1991	<3
5/31/1991	28
6/30/1991	<2
7/31/1991	7
8/31/1991	<12
9/30/1991	3
10/31/1991	12
11/30/1991	25
2/29/1992	8
3/31/1992	2
4/30/1992	3
5/31/1992	<4
6/30/1992	3
7/31/1992	7
8/31/1992	6
9/30/1992	10
10/31/1992	6
11/30/1992	9
12/31/1992	2
1/31/1993	16
2/28/1993	9
3/31/1993	<2
4/30/1993	8
5/31/1993	<2
6/30/1993	<2
7/31/1993	3
8/31/1993	3
9/30/1993	<14
10/31/1993	<2
11/30/1993	<2
12/31/1993	<2
1/31/1994	<2
2/28/1994	<2
3/31/1994	<8
4/30/1994	2
5/31/1994	<4
6/30/1994	<6
7/31/1994	<4
8/31/1994	<6
10/31/1994	<4
11/30/1994	4
12/31/1994	4
1/31/1995	4
2/28/1995	<14
3/31/1995	<50
4/30/1995	<50
5/31/1995	<50
6/30/1995	<50
7/31/1995	<50
8/31/1995	<50
9/30/1995	<50
10/31/1995	<50
11/30/1995	<50
12/31/1995	<50
1/31/1996	<50
2/29/1996	<50
3/31/1996	<50
4/30/1996	<50
5/31/1996	<50
6/30/1996	<50
7/31/1996	<50
8/31/1996	<50
9/30/1996	<50
10/31/1996	<50
11/30/1996	<50
12/31/1996	<50
1/31/1997	<50
2/28/1997	<50
3/31/1997	<50
4/30/1997	<50
5/31/1997	<50
6/30/1997	<50
7/31/1997	<50
8/31/1997	<50
9/30/1997	<50
10/31/1997	<50
11/30/1997	<50
12/31/1997	<50
2/28/1998	<50
3/31/1998	<50
4/30/1998	<10
5/31/1998	<10
6/30/1998	<10
7/31/1998	<10
8/31/1998	<10
9/30/1998	<10
10/31/1998	<10
11/30/1998	<10
12/31/1998	<10
1/31/1999	<10
2/28/1999	<10
3/31/1999	13
4/30/1999	<10
5/31/1999	17.3
6/30/1999	<10
7/31/1999	<10
8/31/1999	14
9/30/1999	<10
10/31/1999	<10
11/30/1999	<10
12/31/1999	10
1/31/2000	<10
2/29/2000	<2
3/31/2000	<2
4/30/2000	<2
5/31/2000	<2
6/30/2000	<2
7/31/2000	<2

8/31/2000	2
9/30/2000	<2
10/31/2000	<2
11/30/2000	<2
12/31/2000	<2
1/31/2001	<2
2/28/2001	<2
3/31/2001	<2
4/30/2001	<2
5/31/2001	<2
6/30/2001	1
7/31/2001	<2
8/31/2001	<1
9/30/2001	<1
10/31/2001	<1
11/30/2001	<1
12/31/2001	<1
1/31/2002	<1
2/28/2002	1
3/31/2002	<1
4/30/2002	<1
5/31/2002	<1
6/30/2002	<1
7/31/2002	<1
8/31/2002	<1
9/30/2002	<1
10/31/2002	<1
11/30/2002	<1
12/31/2002	<1
1/31/2003	<1
2/28/2003	<1
3/31/2003	<1
4/30/2003	<1
5/31/2003	<1
6/30/2003	<1
7/31/2003	<1
8/31/2003	<1
9/30/2003	148
10/31/2003	40
11/30/2003	<1
12/31/2003	<1
1/31/2004	<1
2/29/2004	<1
Date	**FC (cfu/ 100ml)**
3/31/2004	<1
4/30/2004	<1
5/31/2004	<1
6/30/2004	<1
7/31/2004	<1
8/31/2004	<1
9/30/2004	<2.3
10/31/2004	<1
11/30/2004	<1
12/31/2004	<1
1/31/2005	<1
2/28/2005	<1
3/31/2005	<1
4/30/2005	<1
5/31/2005	<1
6/30/2005	<1
7/31/2005	<1
8/31/2005	<1
9/30/2005	<1
10/31/2005	<1
11/30/2005	<1
12/31/2005	<1

APPENDIX C Calculation of Existing and TMDL Loads

Table C-1 Calculation of existing load.

Calculation of Existing Load

Equation: $y = 3E{+}11 X^2 - 4E{+}12X + 3E{+}12$

% Exceeded	Load (cfu/day)	
0.05	2.80E+12	
0.10	2.60E+12	
0.15	2.41E+12	
0.20	2.21E+12	
0.25	2.02E+12	
0.30	1.83E+12	
0.35	1.64E+12	
0.40	1.45E+12	
0.45	1.26E+12	
0.50	1.08E+12	
0.55	8.91E+11	
0.60	7.08E+11	
0.65	5.27E+11	
0.70	3.47E+11	
0.75	1.69E+11	
0.80	-8.00E+09	Not included in Mean.
0.85	-1.83E+11	Not included in Mean.
0.90	-3.57E+11	Not included in Mean.
0.95	-5.29E+11	Not included in Mean.
Mean Load	1.46E+12	

Table C-2. Calculations of TMDL load (Load Allocation).

Calculation of TMDL Load

Target Conc 380 cfu/100ml

From Target Line

% Exceeded	Load (cfu/day)		Flow (cfs)	
			Flow (l/day)	
0.05	2.66E+12		7.00E+08	
0.10	1.55E+12		4.07E+08	
0.15	1.02E+12		2.69E+08	
0.20	7.66E+11		2.01E+08	
0.25	5.83E+11		1.54E+08	
0.30	4.74E+11		1.25E+08	
0.35	4.01E+11		1.06E+08	
0.40	3.24E+11		8.54E+07	
0.45	2.66E+11		7.00E+07	
0.50	2.08E+11		5.47E+07	
0.55	1.71E+11		4.51E+07	
0.60	1.49E+11		3.93E+07	
0.65	1.24E+11		3.26E+07	
0.70	1.06E+11		2.78E+07	
0.75	8.39E+10		2.21E+07	
0.80	6.93E+10		1.82E+07	Not included in Mean.
0.85	5.47E+10		1.44E+07	Not included in Mean.
0.90	3.87E+10		1.02E+07	Not included in Mean.
0.95	2.04E+10		5.37E+06	Not included in Mean.
Mean Load	**5.92E+11**			

Table C-3 Calculation of percent reductions.

Percent Reduction Required:		
Existing Load:	1.46E+12	cfu/day
Load Allocation:	5.92E+11	cfu/day
Load Reduction:	8.70E+11	cfu/day
Percent reduction:	59.5%	

APPENDIX D Flow-duration Curve

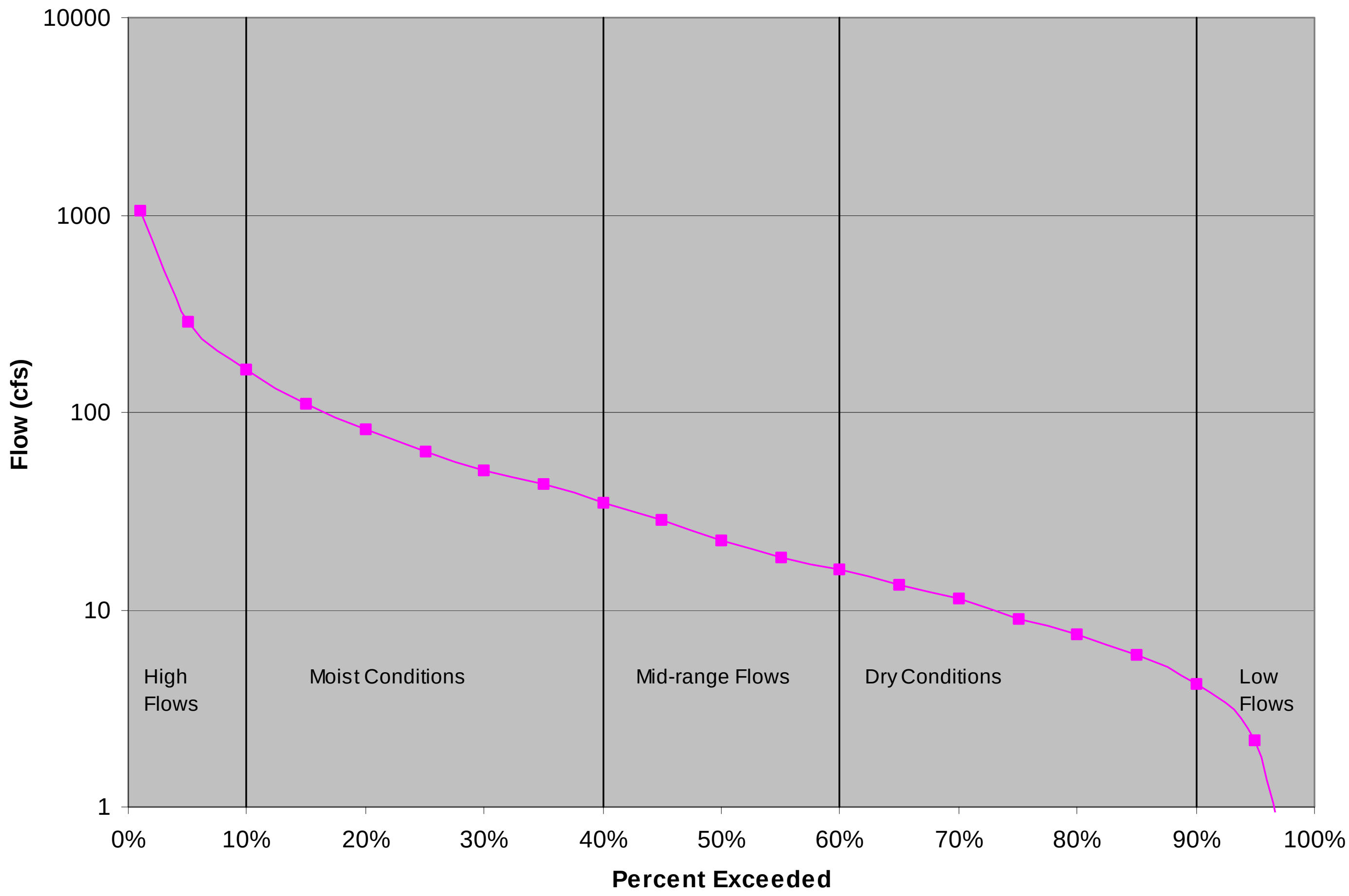

Figure D-1 Flow-duration curve for Indian Field Swamp at E-032.

APPENDIX E Public Participation

NOTICE OF AVAILABILITY OF INITIAL DRAFT TMDLs

INDIAN FIELD SWAMP
DORCHESTER AND ORANGEBURG COUNTIES

Pollutant of Concern: Fecal Coliform Bacteria. Indian Field Swamp Watershed: Hydrologic unit 030502060204. A Map of this watershed is available on the Internet at: www.scdhec.gov/water/shed/ed_main.html.
Persons wishing to submit views and information on this draft total maximum daily load are invited to make these submissions in writing no later than 5:00pm October 23, 2006, to: S.C. Dept. of Health and Environmental Control, Bureau of Water, 2600 Bull St, Columbia, S.C. 29201, Attn: Matt Carswell, or via e-mail to carsweme@dhec.sc.gov. Persons may also contact Mr. Wayne Harden at Hardencw@dhec.sc.gov. The purpose of TMDLs is to calculate the amount of pollutant reduction necessary for an impaired waterbody to achieve and maintain water quality standards. Comments will be considered in development of the final draft TMDL and addressed in a responsiveness summary to be provided to all commenters. Copies of individual TMDLs can be obtained from the Bureau of Water web site: http://www.scdhec.gov/water or by calling, writing, or e-mailing at the address above. Section 303(d)(1) of the Clean Water Act (CWA), 33 U.S.C. §1313(d)(1)(C), and the implementing regulation of the US Environmental Protection Agency (EPA, 40 C.F.R. § 130.7(c) (1), require the establishment of TMDL for waters identified as impaired.