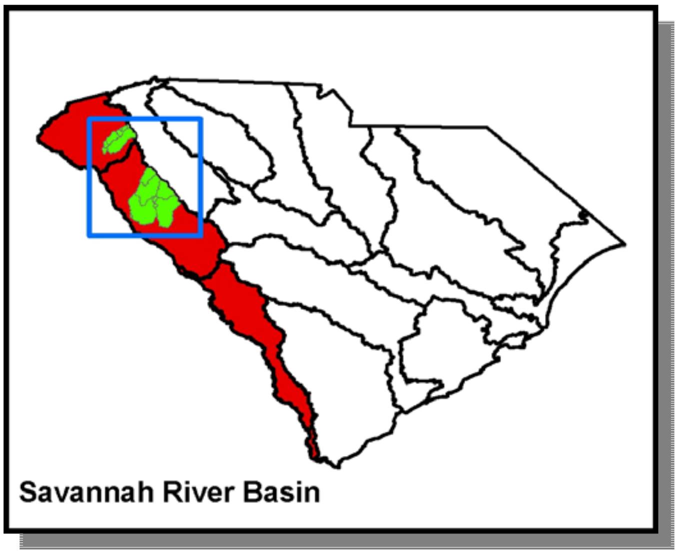
TOTAL MAXIMUM DAILY LOADS

FOR FECAL COLIFORM FOR EIGHTEEN MILE CREEK, THREE AND TWENTY CREEK, LITTLE RIVER AND LONG CANE CREEK WATERSHEDS IN THE SAVANNAH RIVER BASIN, SOUTH CAROLINA

HYDROLOGIC UNIT CODES: 03060101 AND 03060103 (STATIONS SV-017, SV-245, SV-135, SV-233, SV-268, SV-241, SV-111, SV-052, SV-164, SV-348, SV-192, RS-01049, SV-053B, SV-349, SV-318)



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Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 4, ATLANTA, GEORGIA

AND

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL, BUREAU OF WATER

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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 Loads (TMDLs) for Fecal Coliform for Eighteen Mile Creek, Three and Twenty Creek, Little River, and Long Cane Creek in the Savannah River Basin. Subsequent actions must be consistent with this TMDL.

______________________________ ______________________________

James D. Giattina, Director Date

Water Management Division

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ACRONYMS AND ABBREVIATIONS

AFO	Animal feeding operations
BMP	Best management practice
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
cfu	Colony forming units
CNPCP	Coastal Nonpoint Pollution Control Program
CWA	Clean Water Act
DMR	Discharge monitoring report
GIS	Geographic information system
HUC	Hydrologic unit code
LA	Load allocation
LDC	Load duration curve
ml	Milliliter
mgd	Million gallons per day
MOS	Margin of safety
MRLC	Multi-resolution land characteristic
MS4	Municipal separate storm sewer system
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
PRG	Percent reduction goal
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SSO	Sanitary sewer overflow
TMDL	Total maximum daily load
USEPA	U.S. Environmental Protection Agency
USC	United States Code
USGS	U.S. Geological Survey
WLA	Wasteload allocation
WQM	Water quality monitoring
WQS	Water quality standard
WWTP	Wastewater Treatment Plant

SECTION 1 INTRODUCTION

1.1 Background

Section 303(d) of the Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDL) for water bodies not meeting designated uses where technology-based controls are in place. TMDLs establish 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 states can implement water quality-based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of its water resources (USEPA 1991).

This report documents the data and assessment utilized to establish TMDLs for fecal coliform bacteria for certain water bodies in the Savannah River Basin in accordance with the requirements of Section 303(d) of the CWA, Water Quality Planning and Management Regulations (40 CFR Part 130), USEPA guidance, and South Carolina (SC) Department of Health and Environmental Control (SCDHEC) guidance and procedures. States are required to submit all TMDLs to USEPA for review and approval. Once USEPA approves a TMDL, then the water body may be moved to Category 4a, where it remains until compliance with water quality standards (WQS) is achieved (USEPA 2003).

The purpose of this TMDL Report is to assist SCDHEC with establishing pollutant load allocations for impaired water bodies. TMDLs determine the pollutant loading a water body can assimilate without exceeding the WQS for that pollutant. TMDLs also establish the pollutant load allocation necessary to meet the WQS established for a water body based on the relationship between pollutant sources and in-stream water quality conditions. A TMDL consists of a wasteload allocation (WLA), a load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES) as point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with model assumptions and data limitations.

SCDHEC included 15 water quality monitoring (WQM) stations from four Hydrologic Unit Codes (HUC) within the Savannah River Basin on the 2004 South Carolina 303(d) list for exceedances of the fecal coliform bacteria WQS. Figures 1-1 and 1-2 are orientation maps showing the following 11-digit HUCs of the Savannah River Basin where the 303(d)-listed WQM stations are located:

- Eighteen Mile Creek (HUC 03060101090),
- Three and Twenty Creek (HUC 03060101100),
- Little River (HUC 03060103140), and
- Long Cane Creek (HUC 03060103150).

Figure 1-1 Eighteen Mile Creek and Three and Twenty Creek Watersheds

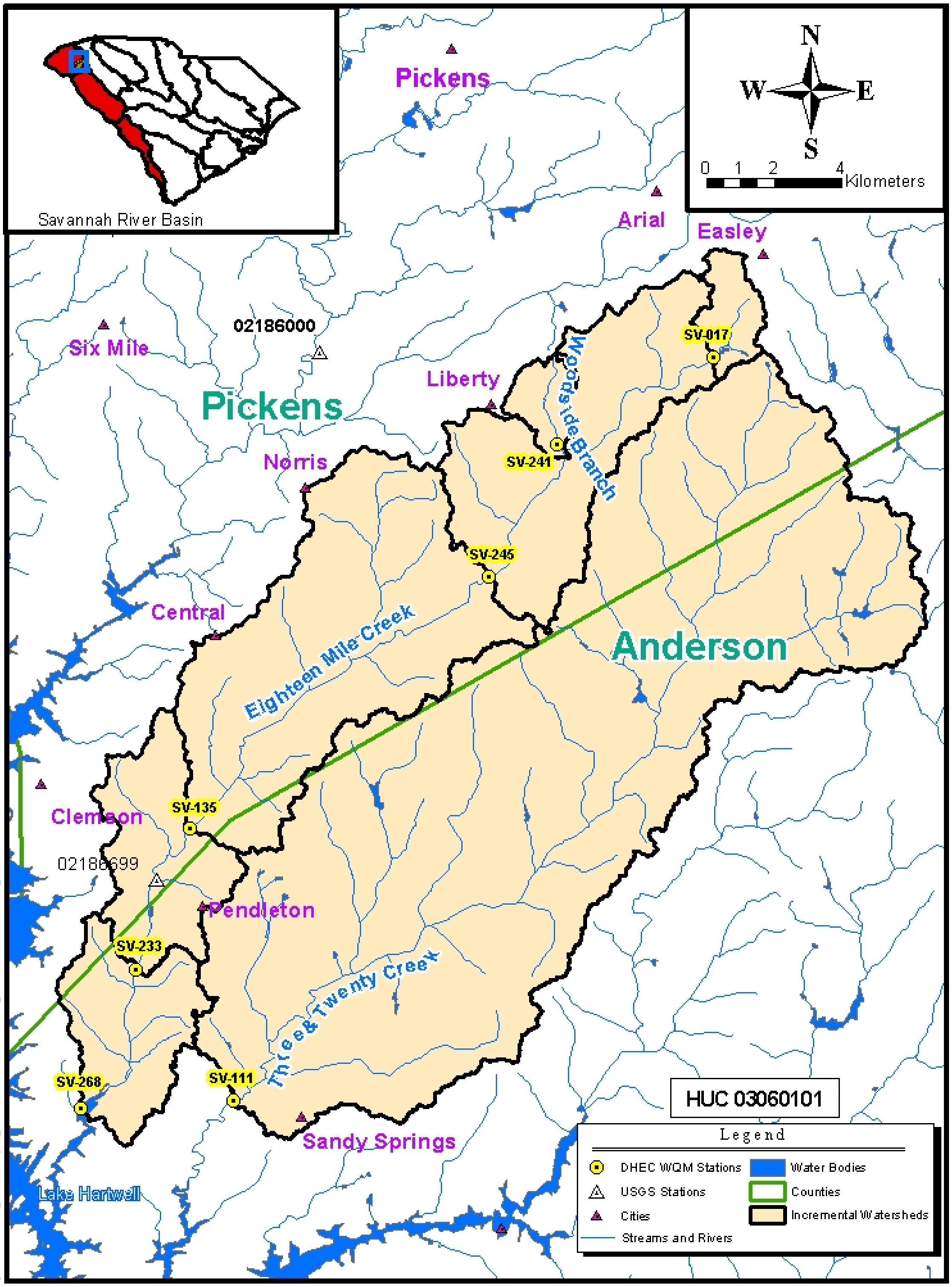
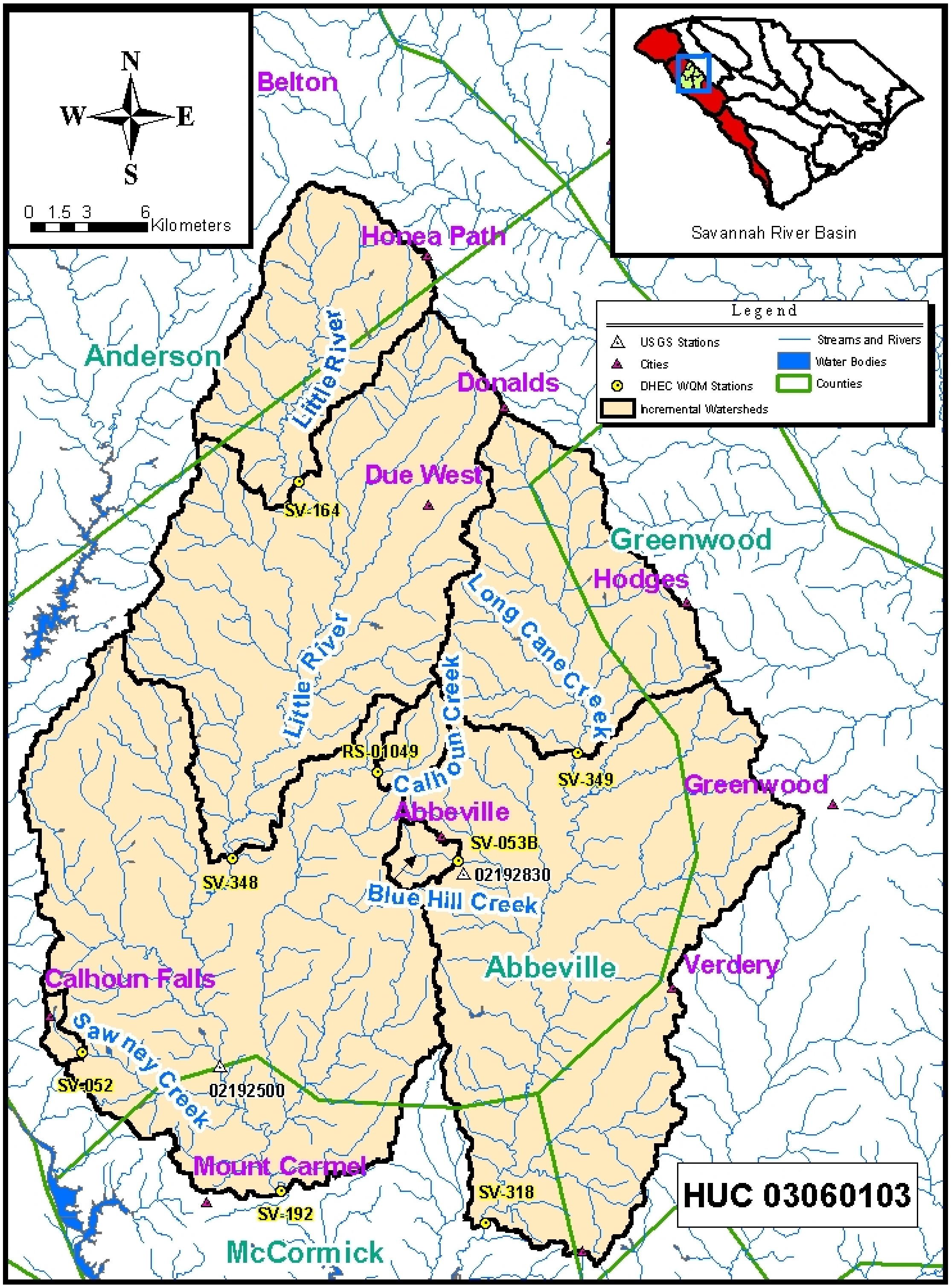


Figure 1-2 Little River and Long Cane Creek Watersheds



The 303(d)-listed WQM stations associated with these water bodies are shown in Table 1-1 below and are generally listed upstream to downstream. The presence of fecal coliform bacteria in aquatic environments indicates the receiving water has been contaminated with human or animal fecal material. Fecal coliform bacteria contamination is an indication that a potential health risk exists for individuals exposed to the water. Implementation of fecal coliform bacteria loading controls will be necessary to restore the primary contact recreation use designated for each of the water bodies listed in Table 1-1.

Table 1-1 Water Quality Monitoring Stations on 2004 303(d) List for Fecal Coliform in the Upper Savannah River Basin

Water Body Name	SCDHEC WQM Station	WQM Station Locations
Eighteen Mile Creek/Lake Hartwell (HUC 03060101090)		
Eighteen Mile Creek	SV-017	Eighteen Mile Creek at unnumbered County Rd 2.25 mi. SSW of Easley
Eighteen Mile Creek	SV-245	Eighteen Mile Creek at S-39-27 3.3 mi. South of Liberty
Eighteen Mile Creek	SV-135	Eighteen Mile Creek at S-39-93 SW of Central
Eighteen Mile Creek	SV-233	Eighteen Mile Creek at 2-04-279
Eighteen Mile Creek	SV-268	Lake Hartwell Eighteen Mile Creek BR at 2-04-1098
Woodside Branch	SV-241	Woodside Branch at US 123 1.5 mi. East of Liberty
Three and Twenty Creek/Lake Hartwell (HUC 03060101100)		
Three and Twenty Creek	SV-111	Three and Twenty Creek at S-04-280
Little River/Lake Thurmond (HUC 03060103140)		
Sawney Creek	SV-052	Sawney Creek at CO Rd 1.5 mi. SE of Calhoun Falls
Little River	SV-164	Little River at S-01-24
Little River	SV-348	Little River at S-01-32
Little River	SV-192	Little River at S-33-19
Calhoun Creek	RS01049	Calhoun Creek at SC-28, 1.5 mi. NW of Abbeville
Long Cane Creek (HUC 03060103150)		
Blue Hill Creek	SV-053B	Blue Hill Creek on S. Main St. Abbeville
Long Cane Creek	SV-349	Long Cane Creek at S-01-159
Long Cane Creek	SV-318	Long Cane Creek at S-33-117

1.2 Watershed Description

General. The Savannah River Basin overlays portions of eastern Georgia, western South Carolina, and southwestern North Carolina. Headwaters of the Savannah River originate in the mountains of North Carolina, South Carolina, and Georgia near Ellicott Rock, the point where the borders of those three states meet (Savannah Riverkeeper 2004). From the confluence of the Seneca and Tugaloo Rivers in Lake Hartwell, the Savannah River flows for more than 300 miles to the Atlantic Ocean through forests, agricultural lands, large artificial impoundments, and swamps, encompassing more than 10,577 square miles. Approximately 43 percent of the river basin lies within South Carolina. Ecosystems within the basin include agricultural systems, upland forests, bottomland hardwoods, pine plantations, free flowing streams, water impoundments, swamps, and freshwater and marine marshes (Savannah Riverkeeper 2004).

The Upper Savannah River Basin encompasses 7 watersheds and 1,164 square miles. The Upper Savannah River Basin, predominately within the Piedmont geographical region, is an area of gently rolling to hilly slopes with narrow stream valleys dominated by forests, farms, and orchards; elevations range from 375 to 1,000 feet. There are approximately 1,341 stream miles and 43,677 acres of lake waters in the upper basin (SCDHEC 2003). Four of the seven watersheds within the Upper Savannah River Basin are addressed in this TMDL report.

The Eighteen Mile Creek watershed (HUC 03060101090) lies almost entirely within Pickens County, South Carolina with a small portion located in Anderson County. Most of the Three and Twenty Creek watershed (HUC 03060101100) is located in Anderson County, with a small portion falling within Pickens County. Both Eighteen Mile and Three and Twenty Creeks are tributaries to separate arms of Lake Hartwell. Eighteen Mile Creek watershed has the greatest potential for future growth and development given the existing transportation, water and wastewater infrastructure in and around the watershed (SCDHEC 2003). Three and Twenty Creek has moderate potential for population growth and future development (SCDHEC 2003). Most of the Little River (HUC 03060103140) and Long Cane Creek (HUC 03060103150) watersheds are located in Abbeville County; however, small portions of the contributing watersheds also lie in Anderson, McCormick, and Greenwood Counties. A significant portion of the Long Cane Creek watershed and a small portion of the Little River watershed fall within the boundary of Sumter National Forest. Both of these watersheds have moderate potential for growth; however, development potential is limited in each watershed by the Sumter National Forest (SCDHEC 2003). All four of the HUCs are located in the Piedmont Region of South Carolina. The predominant soil type in all four HUCs is an association of the Cecil-Hiwassee series.

Rainfall. Normal yearly rainfall in the Upper Savannah River area during the period of 1971 to 2000 was 48.01 inches, according to South Carolina's 30-year climatological record (SCDHEC 2003). Data from National Weather Service stations in Anderson, Anderson County Airport, West Pelzer, Calhoun Falls, Greenwood, Edgefield, McCormick, Belton, Antreville, and Johnston were compiled to determine general climatic information for the Upper Savannah River area. The highest seasonal rainfall occurred in the winter with 13.14 inches; 12.15, 11.96, and 10.76 inches of rain fell in the spring, summer, and fall, respectively (SCDHEC 2003).

Land Use. Tables 1-2 and 1-3 summarize the general land use categories and the associated percentages for the contributing watershed upstream of each WQM station. The land use/land cover data were derived from 1996 U.S. Geological Survey (USGS) Multi-Resolution Land Characteristic (MRLC) land use data. Figures 1-3 and 1-4 depict the land use categories occurring within the watersheds of Eighteen Mile Creek and Three and Twenty Creek, Little River, and Long Cane Creek, respectively. Land uses are

Table 1-2 Land Use Summary Table for Incremental Watersheds of Eighteen Mile Creek and Three and Twenty Creek

Description	Code	SV-017	SV-245	SV-135	SV-233	SV-268	SV-241	SV-111
Water	0	8	13	73	11	18	4	59
Water Percent	0	0.60	0.14	0.12	0.22	0.41	0.41	0.11
Open Water	11	1	27	27	3	53	0	189
Open Water Percent	11	0.06	0.30	0.04	0.07	1.20	0.04	0.36
Low Intensity Residential	21	408	918	3,421	1,149	26	65	1,452
Low Intensity Residential Percent	21	32.15	10.14	5.72	24.05	0.59	6.29	2.77
High Intensity Residential	22	131	97	156	123	2	3	79
High Intensity Residential Percent	22	10.29	1.07	0.26	2.57	0.05	0.27	0.15
High Intensity Commercial/Industrial/Transportation	23	114	245	1,050	282	38	20	419
High Intensity Commercial/Industrial/Transportation Percent	23	8.98	2.70	1.76	5.89	0.87	1.95	0.80
Bare Rock/Sand/Clay	31	1	14	55	10	6	1	64
Bare Rock/Sand/Clay Percent	31	0.10	0.16	0.09	0.21	0.13	0.08	0.12
Quarries/Strip Mines/Gravel Pits	32		56	12				96
Quarries/Strip Mines/Gravel Pits Percent	32		0.62	0.02				0.18
Transitional	33			336		41		140
Transitional Percent	33			0.56		0.93		0.27
Deciduous Forest	41	149	2,336	19,719	1,121	1,150	327	13,072
Deciduous Forest Percent	41	11.76	25.80	33.00	23.46	26.09	31.51	24.97
Evergreen Forest	42	215	2,309	17,313	1,116	1,957	364	8,773
Evergreen Forest Percent	42	16.92	25.50	28.97	23.36	44.39	35.07	16.76
Mixed Forest	43	71	946	7,155	411	383	157	5,281
Mixed Forest Percent	43	5.56	10.45	11.97	8.60	8.70	15.15	10.09
Pasture/Hay	81	45	966	5,185	207	406	18	14,490
Pasture/Hay Percent	81	3.56	10.67	8.68	4.33	9.22	1.74	27.68
Row Crops	82	51	841	4,006	174	226	55	7,358
Row Crops Percent	82	4.05	9.29	6.70	3.64	5.14	5.32	14.05
Other Grasses (Urban/recreational)	85	73	199	730	146	18	8	535
Other Grasses (Urban/recreational) Percent	85	5.73	2.19	1.22	3.06	0.41	0.76	1.02
Woody Wetlands	91	3	86	520	26	79	15	343
Woody Wetlands Percent	91	0.25	0.95	0.87	0.53	1.78	1.43	0.66
Emergent Herbaceous Wetlands	92		1	3		4		8
Emergent Herbaceous Wetlands Percent	92		0.01	0.01		0.09		0.02
TOTAL ACRES		1,281	9,058	59,759	4,777	4,497	1,043	52,359

Table 1-3 Land Use Summary Table for Incremental Watersheds of Little River and Long Cane Creek

Description	Code	SV-052	SV-164	SV-348	SV-192	RS-1049	SV-053B	SV-349	SV-318
Water	0	7	34	26	70			29	72
Water Percent	0	0.60	0.13	0.04	0.07			0.08	0.08
Open Water	11	7	97	119	121	29	1	79	187
Open Water Percent	11	0.61	0.37	0.17	0.12	0.89	0.03	0.22	0.21
Low Intensity Residential	21	260	484	366	212	34	583	151	2,102
Low Intensity Residential Percent	21	23.80	1.84	0.53	0.22	1.02	26.94	0.41	2.38
High Intensity Residential	22	47	63	18	21		75	3	208
High Intensity Residential Percent	22	4.28	0.24	0.03	0.02		3.47	0.01	0.24
High Intensity Commercial/Industrial/Transportation	23	107	136	67	111	7	250	96	404
High Intensity Commercial/Industrial/Transportation Percent	23	9.79	0.52	0.10	0.11	0.21	11.54	0.26	0.46
Bare Rock/Sand/Clay	31	2	19	41	43	5	6	22	60
Bare Rock/Sand/Clay Percent	31	0.16	0.07	0.06	0.04	0.15	0.27	0.06	0.07
Quarries/Strip Mines/Gravel Pits	32				33				
Quarries/Strip Mines/Gravel Pits Percent	32				0.03				
Transitional	33		39	382	3,393			733	5,590
Transitional Percent	33		0.15	0.56	3.46			2.01	6.34
Deciduous Forest	41	169	6,562	17,860	23,812	664	471	9,210	19,329
Deciduous Forest Percent	41	15.45	25.03	25.98	24.29	20.22	21.77	25.31	21.92
Evergreen Forest	42	203	3,381	18,569	33,335	677	312	8,297	37,513
Evergreen Forest Percent	42	18.57	12.90	27.01	34.00	20.62	14.40	22.80	42.54
Mixed Forest	43	141	2,533	11,873	15,310	431	234	5,442	13,829
Mixed Forest Percent	43	12.94	9.66	17.27	15.62	13.14	10.81	14.96	15.68
Pasture/Hay	81	21	6,890	11,944	10,631	1,058	32	7,917	3,804
Pasture/Hay Percent	81	1.96	26.28	17.37	10.84	32.24	1.46	21.76	4.31
Row Crops	82	71	5,787	7,162	10,658	317	140	4,227	4,545
Row Crops Percent	82	6.50	22.07	10.42	10.87	9.66	6.46	11.62	5.15
Other Grasses (Urban/recreational)	85	56	104	143	71	43	56	74	278
Other Grasses (Urban/recreational) Percent	85	5.15	0.40	0.21	0.07	1.32	2.59	0.20	0.32
Woody Wetlands	91	2	87	175	217	16	6	101	255
Woody Wetlands Percent	91	0.19	0.33	0.25	0.22	0.50	0.27	0.28	0.29
Emergent Herbaceous Wetlands	92		4	7	5	0	0	4	11
Emergent Herbaceous Wetlands Percent	92		0.02	0.01	0.01	0.01	0.01	0.01	0.01
TOTAL ACRES		1,092	26,219	68,752	98,040	3,282	2,165	36,385	88,232

Figure 1-3 Land Use Map: Eighteen Mile and Three and Twenty Mile Creeks

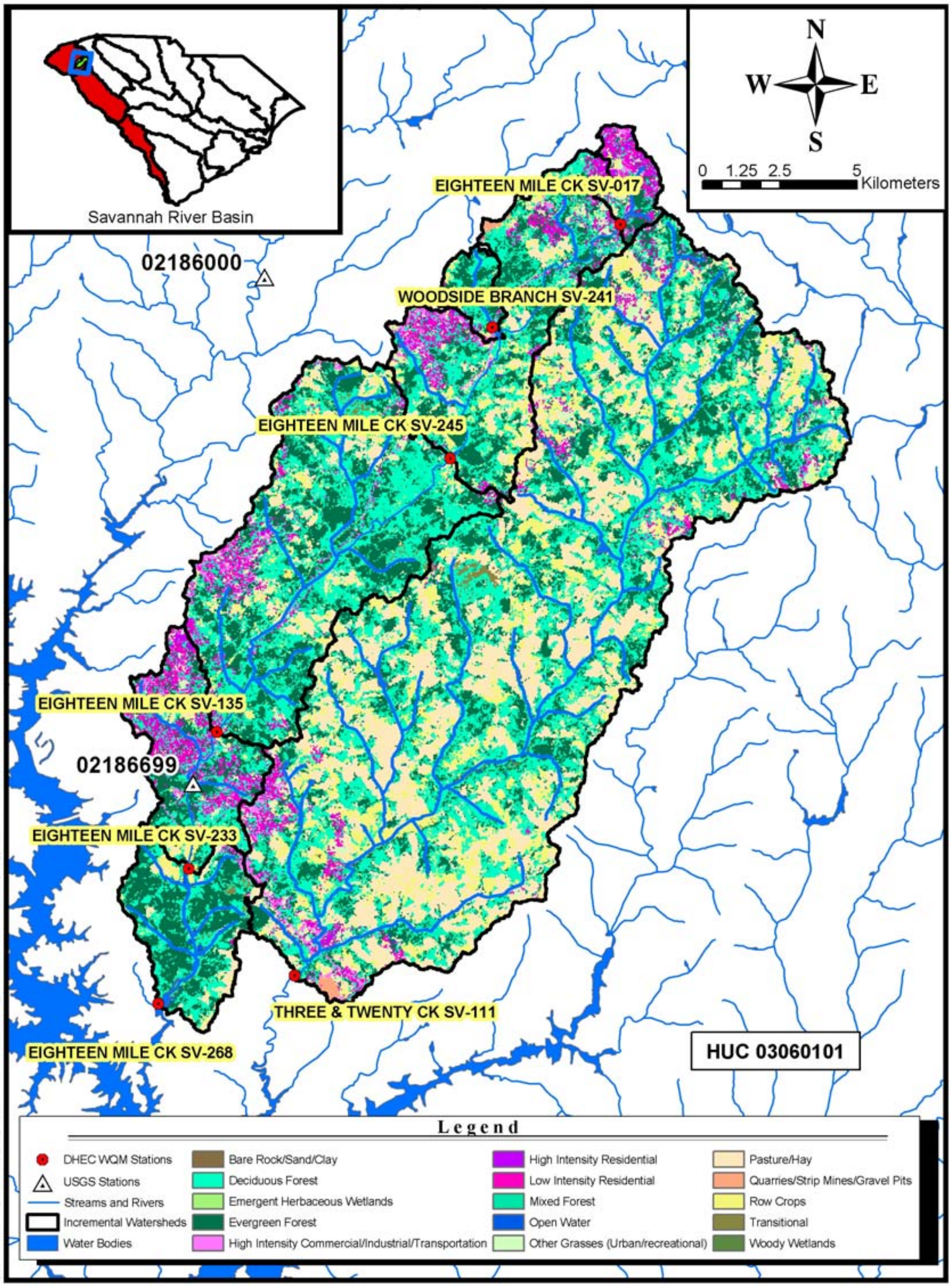
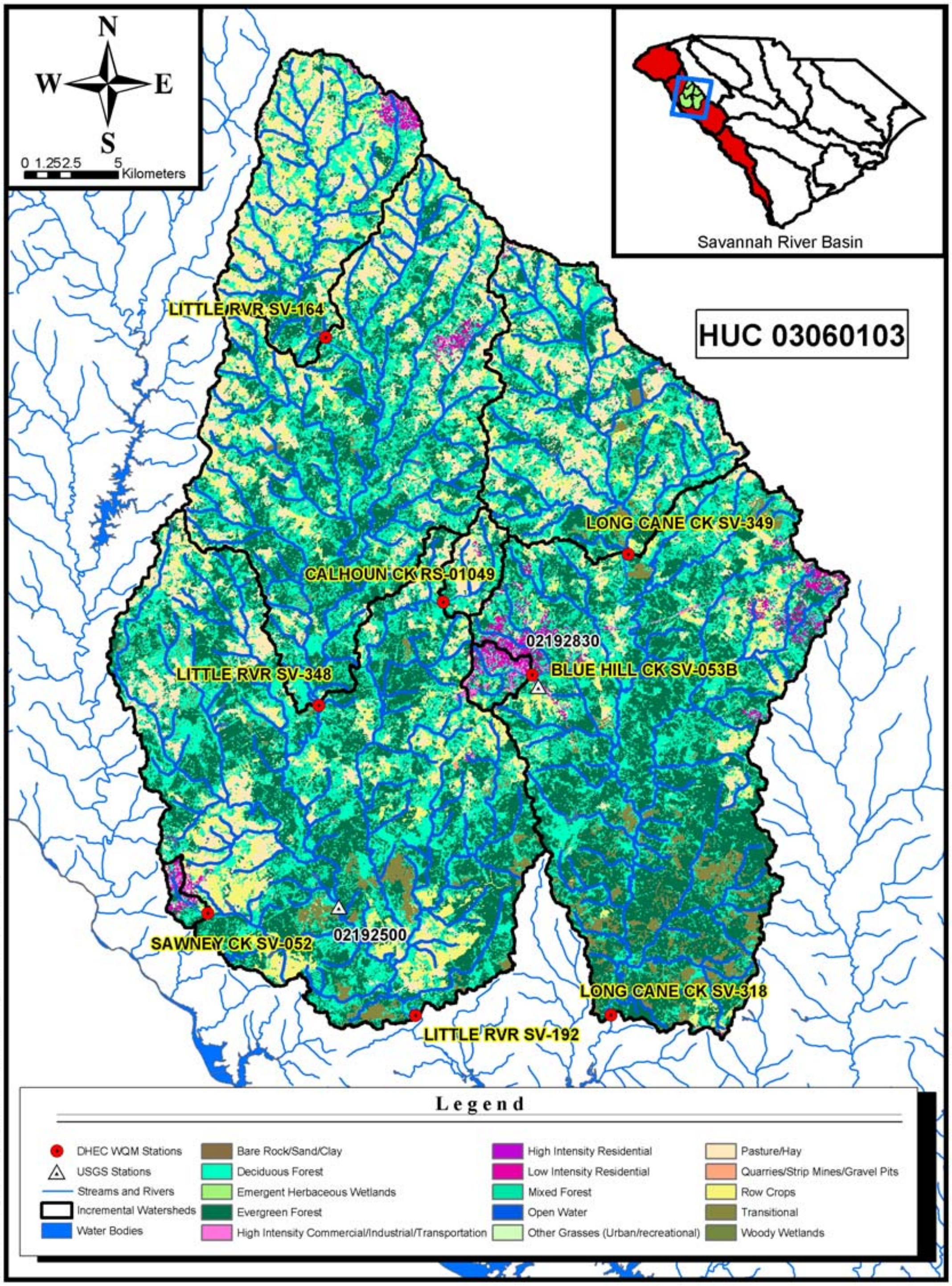


Figure 1-4 Land Use Map: Little River and Long Cane Creek



similar in these watersheds, with slightly more than half of the area forested and about 25 percent agricultural. Urban areas are slightly higher in HUC 03060101090 compared to the other three HUCs, and are concentrated mostly on the northwestern side of the Eighteen Mile Creek watershed which is bordered by a number of towns and cities, including Pendleton, Clemson, Central, Norris, and Liberty. A summary of the land use characteristics for the watershed associated with each WQM station is provided below.

SV-017 - Eighteen Mile Creek at County Road 2.25 Miles South by Southwest of the City of Easley

The contributing watershed of SV-017 contains approximately 1,281 acres. The upper half of this watershed is urbanized with low density residential (32.15 percent) and high density residential (10.29 percent) land uses. The majority of houses in this watershed are connected to a sewage collection system. There are no domestic wastewater treatment plants in this watershed. The sewage is conveyed to a wastewater treatment plant east (Greenville area) of this watershed. The upper watershed also contains row crop farmland (4 percent). The lower half of this watershed is primarily wooded (approximately 24 percent) with scattered residential subdivisions and farm land.

SV-241 - Woodside Branch at US 123

The SV-241 watershed contains approximately 1,043 acres and is primarily forested at approximately 82 percent. Low intensity residential development occupies 6.29 percent of the watershed. Row crop lands occupies 5.32 percent

SV-245 - Eighteen Mile Creek at S-39-27

The SV-245 watershed contains approximately 9,058 acres. Forests, which are primarily in the lower two-thirds of the watershed, occupy approximately 61 percent of the total watershed area. Pastures and row crops occupy approximately 20 percent. The upper third contains mostly low density residential areas, which is the southern portion of the City of Liberty, a small municipal separate storm sewer system (MS4), and occupies approximately 10 percent of the total watershed area. High density residential areas occupy only 1 percent of the area, or approximately 100 acres.

SV-135 - Eighteen Mile Creek at S-39-93

The SV-135 watershed encompasses approximately 59,759 acres. This watershed is mostly forested, 74 percent. Together, pastures and row crops account for approximately 15 percent. A small part of the City of Norris and more than half of the City of Central are located within this watershed. Low and high density residential areas occupy approximately 6 percent of the watershed.

SV-233 - Eighteen Mile Creek at S-2-04-279

The SV-233 watershed encompasses approximately 4,778 acres. Approximately 55 percent of this watershed is classified as forested. This watershed contains the southeastern part of the City of Clemson and surrounding unincorporated subdivisions. The urban area (residential, commercial, industrial, and transportation) in this watershed is approximately 32 percent of the total area.

SV-268 - Lake Howell at S-2-04-1098

There are approximately 4,497 acres in the SV-268 watershed. Approximately 79 percent of this watershed is classified as forested. The upper portion of the watershed, approximately 14 percent, is used for agriculture, , including pastures and row crops.

SV-111 - Three and Twenty Creek at S-04-280

The contributing watershed of Three and Twenty Creek at SV-111 is approximately 52,358 acres. The majority of the land use within SV-111 is deciduous, evergreen, and mixed forests at 52 percent. The remainder is largely composed of pasture/hay land and row crops, 28 percent and 14 percent, respectively. The large percentage of pasture/hay land use is indicative of the large numbers of livestock kept in the pastures and hay produced for winter feeding of the livestock. The watershed is sparsely populated with only 3 percent combined low and high density residential land use. The largest concentration of residences surrounds the towns of Pendleton and Sandy Springs on the southern edge of the watershed. The large percentage of pasture/hay land indicates that the area is likely being used to feed livestock.

SV-052 - Sawney Creek at CO Rd 1.5 mi. SE of Calhoun Falls

There are approximately 1,092 acres within the SV-052 watershed, the second smallest watershed in the study. The Town of Calhoun Falls comprises the majority of land use in the Sawney Creek watershed. The watershed is approximately 24 percent low density residential, 4 percent high density residential, and 10 percent high density commercial/industrial/transportation land use. Deciduous, mixed, and evergreen forests make up 15 percent, 19 percent and 13 percent, respectively. Pasture/hay and row crops make up less than 9 percent of the watershed land use.

SV-164 - Little River at S-01-24

The SV-164 watershed, the northernmost watershed in HUC 3060103140, is split between Anderson and Abbeville Counties and contains much of the Town of Honea Path. Even though much of the town is within the watershed, the watershed is sparsely populated with over 95 percent of the land used for pasture, row crops, and forested areas. There are approximately 26,219 acres in the watershed. Pasture/hay and row crops comprise approximately 26 percent and 22 percent, respectively, of the land use in the watershed which indicates much of the land is used for livestock. Low and high density residential use combines for a total of just over 2 percent of the land use. Deciduous, evergreen, and mixed forests constitute 25 percent, 13 percent, and 10 percent of the watersheds land use.

SV-348 - Little River at S-01-32

SV-348 contains approximately 68,752 acres of watershed. The 2000 census reported 1,209 persons living in the watershed’s population center of Due West, located in the northwest portion of the watershed (U.S. Census 2000). Major land uses are: deciduous forest, 26 percent; evergreen forest, 27 percent; mixed forest, 17 percent;

pasture, 17 percent; and row crops, 10 percent. The small population base comprises less than 1 percent of the watershed land use.

SV-192 - Little River at S-33-19

The SV-192 watershed includes approximately 98,040 acres of land. The only residential area located within SV-192 is the eastern portion of the Town of Calhoun Falls, with a population of 2,303 in 2000. Combined low and high density residential areas make up less than 0.5 percent of the watershed. Deciduous, evergreen, and mixed forest areas constitute over 73 percent of the watershed land use. Pasture/hay and row crops make up the majority of the remaining land uses with approximately 22 percent.

RS-01049 - Calhoun Creek at SC-28, 1.5 mi. NW of Abbeville

RS-01049 is located in the center of HUC 3060103140 just downstream of the Town of Cold Spring and northwest of Abbeville. The watershed is predominantly pasture/hay land with over 32 percent of the area used for that purpose. Forest makes up the bulk of the remaining land in the watershed with 20 percent deciduous forest, 21 percent evergreen forest and 13 percent mixed forest. Row crops contribute nearly 10 percent to the land use of the watershed.

SV-053B - Blue Hill Creek on S. Main St. Abbeville

The Blue Hill Creek watershed (SV-053B) encircles much of the residential area of the City of Abbeville, the county seat, population 5,840. The predominant land use in the watershed is low intensity residential areas at 27 percent; high intensity residential land use adds another 3 percent. Deciduous, evergreen, and mixed forest land uses are 22 percent, 14 percent and 11 percent, respectively. Row crops and pasture/hay account for 8 of the land use.

SV-349 - Long Cane Creek at S-01-159

The Long Cane Creek watershed above SV-349 drains approximately 36,385 acres. The watershed is split between Greenwood and Abbeville Counties. Major urban areas include the Towns of Donalds and Hodges, both with populations of less than 500. Residential density in the watershed is low with low intensity and high intensity residential land use combined for a total of less than 1 percent. Forested areas compose the greatest percentage of land use with deciduous, evergreen, and mixed forests covering 25 percent, 23 percent and 15 percent, respectively. Pasture/hay land use covers 22 percent, and row crops are the remaining major land use in the watershed at nearly 12 percent. The large percentage of pasture/hay land use indicates large numbers of livestock are kept in the pastures, and that hay is produced for winter feeding of the livestock.

SV-318 Long Cane Creek at S-33-117

SV-318 is located in the Long Cane Creek watershed, which is split between Abbeville, Greenwood, and McCormick Counties. The watershed contains approximately 88,232 acres. Major urban centers within the watershed include portions of Abbeville, Greenwood, Verdery, and Troy. Low and high intensity residential land use occupies less than 3 percent of the watershed. Forested areas comprise nearly 80 percent of the watershed's land use, with pasture/hay and row crop land uses covering a combined 9.5 percent and transitional land use making up more than 6 percent. The entire watershed lies within the boundary of Sumter National Forest.

SECTION 2
WATER QUALITY ASSESSMENT

2.1 Water Quality Standards

Water quality standards for the State of South Carolina were promulgated in the South Carolina Pollution Control Act, Section 48-1-10 *et seq*. Chapter 61, R61-68 (SCDHEC 2001). All water bodies in the Savannah River Basin are designated as freshwater. Waters of this class are defined in Regulation 61-68, §610, *Water Classifications and Standards*, and designated uses are described as follows:

> *Freshwater 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. These waters are suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. This class is also suitable for industrial and agricultural uses.* (SCDHEC 2001)

South Carolina's numeric criteria for fecal coliform bacteria to protect for primary contact recreation use in freshwater are:

> *Not to exceed a geometric mean of 200 cfu/100ml, based on five consecutive samples during any 30 day period; nor shall more than 10 percent of the total samples during any 30 day period exceed 400 cfu/100ml*. (SCDHEC 2001)

The State of South Carolina Integrated Report for 2004 identified the WQM stations requiring fecal coliform TMDLs (SCDHEC 2004a). Fecal coliform bacteria monitoring data collected primarily by the SCDHEC Bureau of Water from 1998 through 2002 were used in the 2004 303(d) listing procedure. While South Carolina WQSs stipulate two separate water quality criteria for assessing primary contact recreation, there are insufficient data available to calculate the 30-day geometric mean since most water quality samples are collected once a month. As a result, monitoring stations with greater than 10 percent of the samples exceeding 400 colony-forming units (cfu) per 100 milliliters (ml) were considered impaired and were placed on the list for TMDL development. Targeting the instantaneous criterion of 400 cfu/100 m/L as the water quality goal corresponds to the basis for 303(d) listing and will be protective of the geometric mean criterion.

2.2 Assessment of Existing Water Quality Data

Table 2-1 summarizes the data supporting the decision to place the WQM stations targeted in this report on the SCDHEC 2004 303(d) list. Additional ambient fecal coliform data for each WQM station from 1990 to 2002 (if available) are provided in Appendix A. Ambient fecal coliform data were provided by SCDHEC and obtained from USEPA Storage and Retrieval Database (USEPA 2005).

Some of the fecal coliform data for WQM stations represents only spring and summer months (SV-017, SV-245, SV-241, and SV-053B), while other stations have been sampled throughout the year (SV-052, SV135, SV-111, SV-192, SV-318, SV-348, SV-349, SV-268, SV-233, and SV-164). Station RS-01049 on Calhoun Creek was sampled monthly only in 2001. However, because land practices and bacteria load delivery mechanisms are considered relatively consistent over the course of the year, it is assumed that winter loading should be consistent with that of periods for which data do exist (SCDHEC 2003a). Between 10 and 25 percent of the samples collected between 1998 and 2002 exceed the WQS at six of the 15 WQM stations. Eight of the remaining nine WQM stations are not supporting primary contact recreation use with the percentage of samples exceeding the numeric criterion ranging from 25 to 58 percent. All 14 samples collected at WQM station SV-053B between July 1998 and October 2000 exceeded the numeric criterion.

Blue Hill Creek upstream of station SV-053B and Eighteen Mile Creek upstream of station SV-135 demonstrate chronic fecal coliform problems with 100 percent and 58 percent of the samples exceeding the WQS, respectively. Eighteen Mile Creek upstream of SV-017, Three and Twenty Creek (SV-111), and Long Cane Creek upstream of SV-349 also indicate frequent high fecal coliform concentrations that exceed the WQS at 50, 43, and 50 percent, respectively. Potential sources of fecal coliform are discussed later in this report.

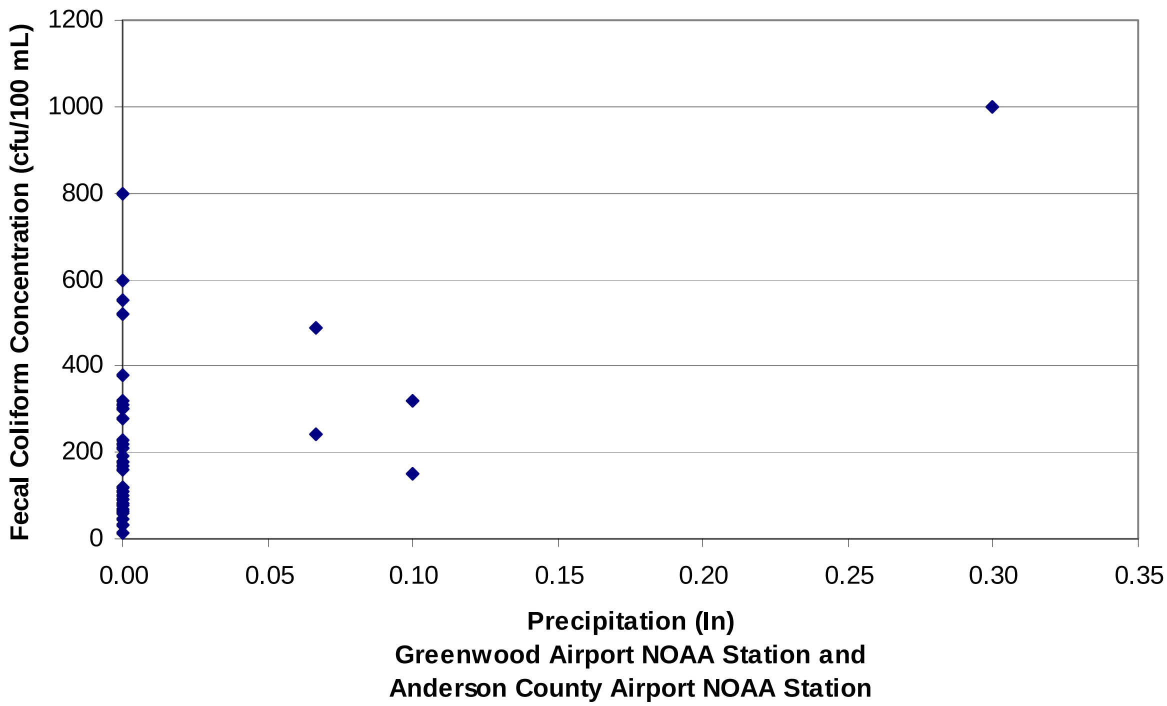
Table 2-1 Fecal Coliform Bacteria Observed from 1998 through 2002

Station	Total Number of Samples	Maximum Concentration cfu/100 m/L	Total Number of Samples > 400 cfu/ 100 m/L	Percent of Samples > 400 cfu/100 m/L
SV-017	16	2,900	8	50%
SV-245	16	1,500	5	31%
SV-135	31	1,500	18	58%
SV-233	21	1,700	7	33%
SV-268	41	1,700	7	17%
SV-241	16	1,100	4	25%
SV-111	47	2,500	20	43%
SV-052	30	3,400	6	20%
SV-164	14	980	3	21%
SV-348	14	920	4	29%
SV-192	36	1,000	7	19%
RS-01049	12	880	2	17%
SV-053B	14	30,000	14	100%
SV-349	14	1,100	7	50%
SV-318	57	600	7	12%

Different analyses were performed to develop a better understanding of the conditions under which bacteria loads are entering streams in each watershed. Precipitation data from local National Oceanic and Atmospheric Administration (NOAA) weather stations were plotted against ambient fecal coliform data from Appendix A at each WQM station to discern whether there is a correlation between rainfall rates and instream fecal coliform concentrations. While most of the fecal coliform samples were collected during drier months, some inferences about fecal coliform transport can be derived from this type of comparison.

Fecal coliform data and rainfall data from the period 1994 through 2002 were used to generate the plots. Rainfall data for a 3-day period (2 days prior to and the day of each fecal coliform sample) selected from weather stations proximal to each WQM station were averaged. This comparison of fecal coliform concentration with the 3-day average rainfall was conducted for all but four WQM stations (SV-348, SV-349, RS01049 and SV-053B) because no rainfall occurred on the dates of the fecal coliform samples from these stations. Fecal coliform sampling for two stations was conducted when little rainfall occurred (SV-233 and SV-164); therefore, the relationship of rainfall and fecal coliform concentrations for these stations is uninformative. For other monitoring stations, including SV-017, SV-245, SV-268, SV-241, SV-111, SV-192, and SV-318, it is unclear whether the days on which measured rainfall occurred coincided with elevated fecal coliform concentrations. This is primarily a function of small data sets, but this lack of a relationship could also suggest that fecal coliform may be associated with continuous sources (point or nonpoint) that are not significantly affected by rainfall. Figure 2-1 is an example plot of station SV-192 showing a marginal relationship between fecal coliform concentrations and precipitation. Plots for the other eight stations showing no significant relationship are provided in Appendix B.

Figure 2-1 Comparison of Precipitation and Fecal Coliform Concentrations in Little River at S-33-19 (SV-192)



Two monitoring stations (SV-052 and SV-135) appeared to have a relationship between fecal coliform concentrations and precipitation. Figures 2-2 and 2-3 are plots depicting these relationships for SV-052 (Sawney Creek) and SV-135 (Eighteen Mile Creek), respectively. Fecal coliform concentrations from these two stations appear to be directly proportional to precipitation, indicating that fecal coliform loading is associated with surface runoff related to rainfall.

Precipitation data used to develop all plots were derived from NOAA weather monitoring stations. The names of the weather monitoring stations are provided under each plot. The NOAA stations include Anderson County Airport, Clemson-Oconee County Airport, Greenville Downtown, and Greenwood Airport.

Figure 2-2 Comparison of Precipitation and Fecal Coliform Concentrations in Sawney Creek at CO Rd 1.5 mi SE of Calhoun Falls (SV-052)

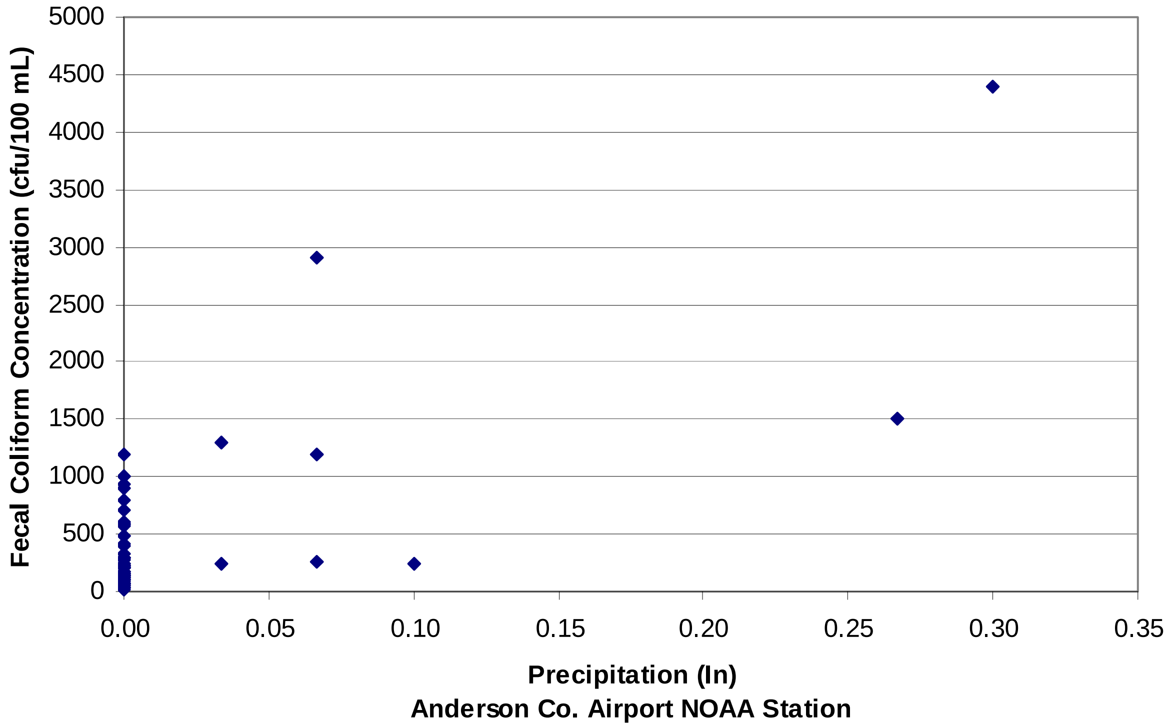
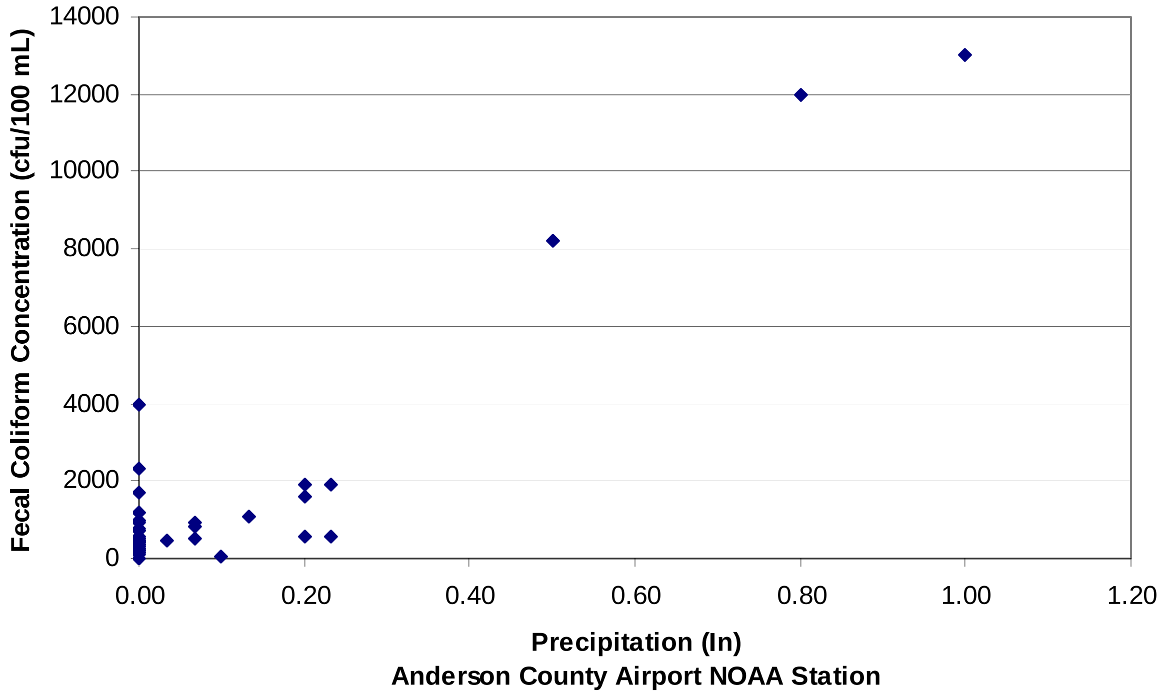


Figure 2-3 Comparison of Precipitation and Fecal Coliform Concentrations in Eighteen Mile Creek at S-39-93 SW of Central (SV-135)



2.3 Establishing the Water Quality Target

40 CFR §130.7(c)(1) states that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards." For the WQM stations requiring TMDLs in this report, defining the water quality target is straightforward and dictated by the fecal coliform numeric criteria established for the protection and maintenance of the primary contact recreation use as defined in the South Carolina WQSs (See Subsection 2.1). However, because available fecal coliform data were collected on an approximate monthly basis (See Appendix A) instead of five samples over 30 days, data for these TMDLs are analyzed and presented in relation to the instantaneous criterion of 400 cfu/100 m/L, which requires that no more than 10 percent of the samples can exceed this numeric criterion. Therefore, the water quality target for each impaired WQM station will be expressed as:

> *The water quality target is 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.*

This water quality target will be used to determine the allowable bacteria load which is derived by using the actual or estimated flow record multiplied by the instream fecal coliform criteria minus a 5 percent MOS. The line drawn through the allowable load data points is the water quality target which represents the maximum load for any given flow that still satisfies the WQS (SCDHEC 2003a).

SECTION 3
POLLUTANT SOURCE ASSESSMENT

A source assessment characterizes known and suspected sources of pollutant loading to impaired waterbodies. Sources within a watershed are categorized and quantified to the extent that information is available. Fecal coliform bacteria originate from warm-blooded animals and some plant life. Although fecal coliform are not harmful, they are present in mammal waste that also contains harmful bacteria and viruses.

Sources of fecal coliform bacteria may be point or nonpoint in nature. Point sources are permitted through the NPDES program. NPDES facilities that discharge treated wastewater effluent are required to monitor fecal coliform bacteria concentrations in accordance with their permit.

Nonpoint sources are diffuse sources that typically cannot be identified as entering a water body at a single location. These sources may involve land activities that contribute fecal coliform bacteria to surface water as a result of stormwater runoff. The following discussion describes what is known regarding point and nonpoint sources of fecal coliform bacteria in the impaired watersheds.

3.1 Point Source Discharges

There are two types of point sources discharging fecal coliform bacteria into the streams addressed in this report; they are continuous point sources and Municipal Separate Storm Sewer Systems. Continuous point source discharges such as wastewater treatment plants (WWTP), could result in discharge of elevated concentrations of fecal coliform bacteria if the disinfection unit is not properly maintained, is of poor design, or if flow rates are above the disinfection capacity. Stormwater runoff from MS4 areas can also contain high fecal coliform bacteria concentrations and is discussed in Subsection 3.1.2. The following is a brief discussion of each type of point source discharge.

3.1.1 Continuous Point Sources

Table 3.1 lists 12 active NPDES point sources continuously discharging upstream of nine of the 15 WQM stations. The locations of the active NPDES facilities upstream of each WQM station are shown in Figures 3-1 and 3-2.

Discharge Monitoring Reports (DMR) were used to determine the number of fecal coliform analysis performed from 1998 through 2003, the maximum concentration during this period, the number of violations occurring when the monthly geometric mean concentration exceeded 200 cfu/100 m/L, and the number of violations when a daily concentration exceeded 400 cfu/100 m/L. For the most part, the data indicate only occasional fecal coliform permit violations occurring at some of the facilities located in the watersheds listed in Table 3-1. While Liberty Denim LLC (SC0000264), which discharged into Woodside Branch (SV-241) may have been a source of fecal coliform loading, the facility discontinued reporting fecal coliform concentration at the end of October 2000 after the company rerouted its domestic wastewater to another treatment

Figure 3-1 Locations of NPDES Dischargers, Small MS4s, and Animal Feeding Operations in Eighteen Mile Creek and Three and Twenty Creek Watersheds

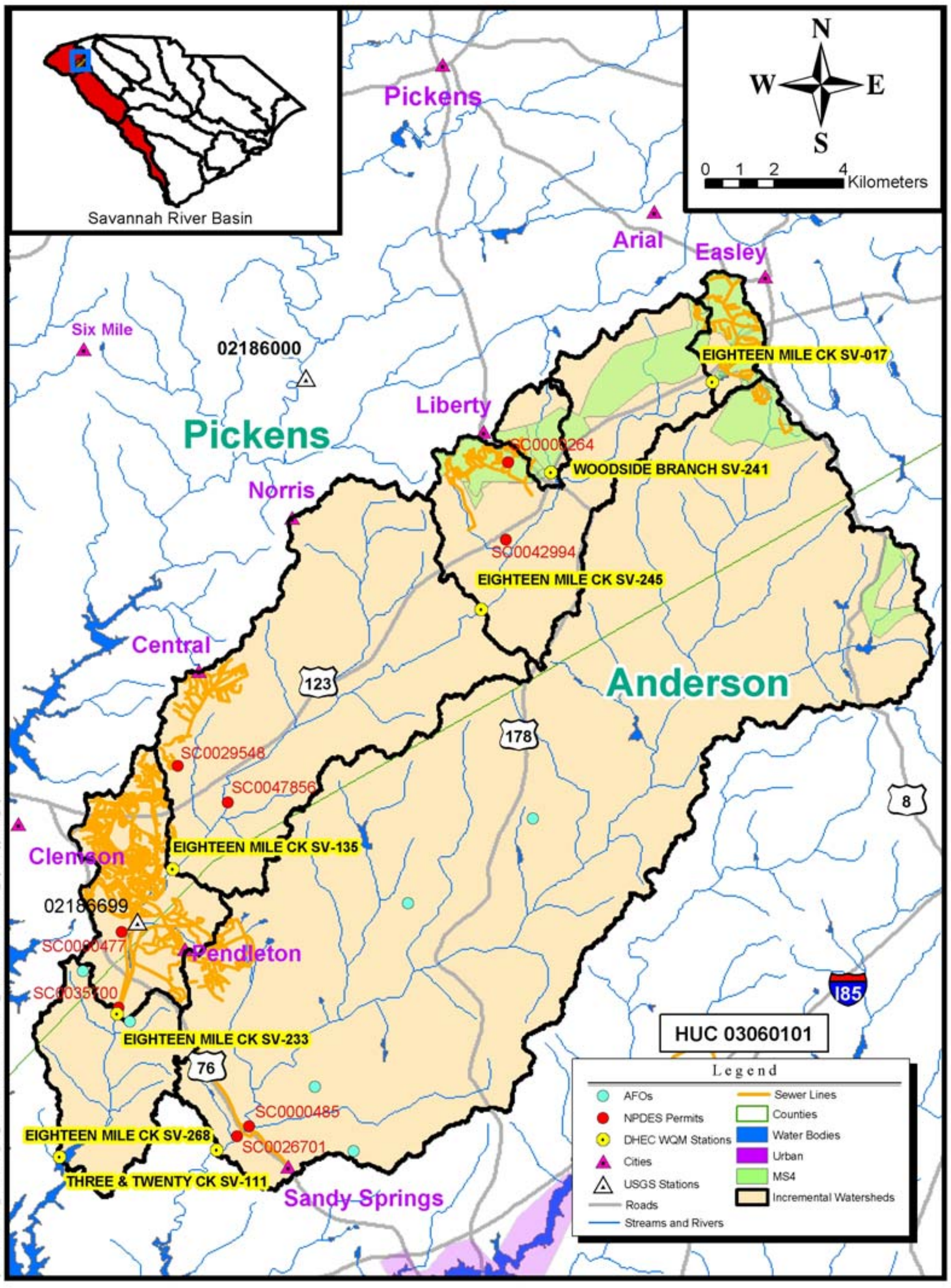
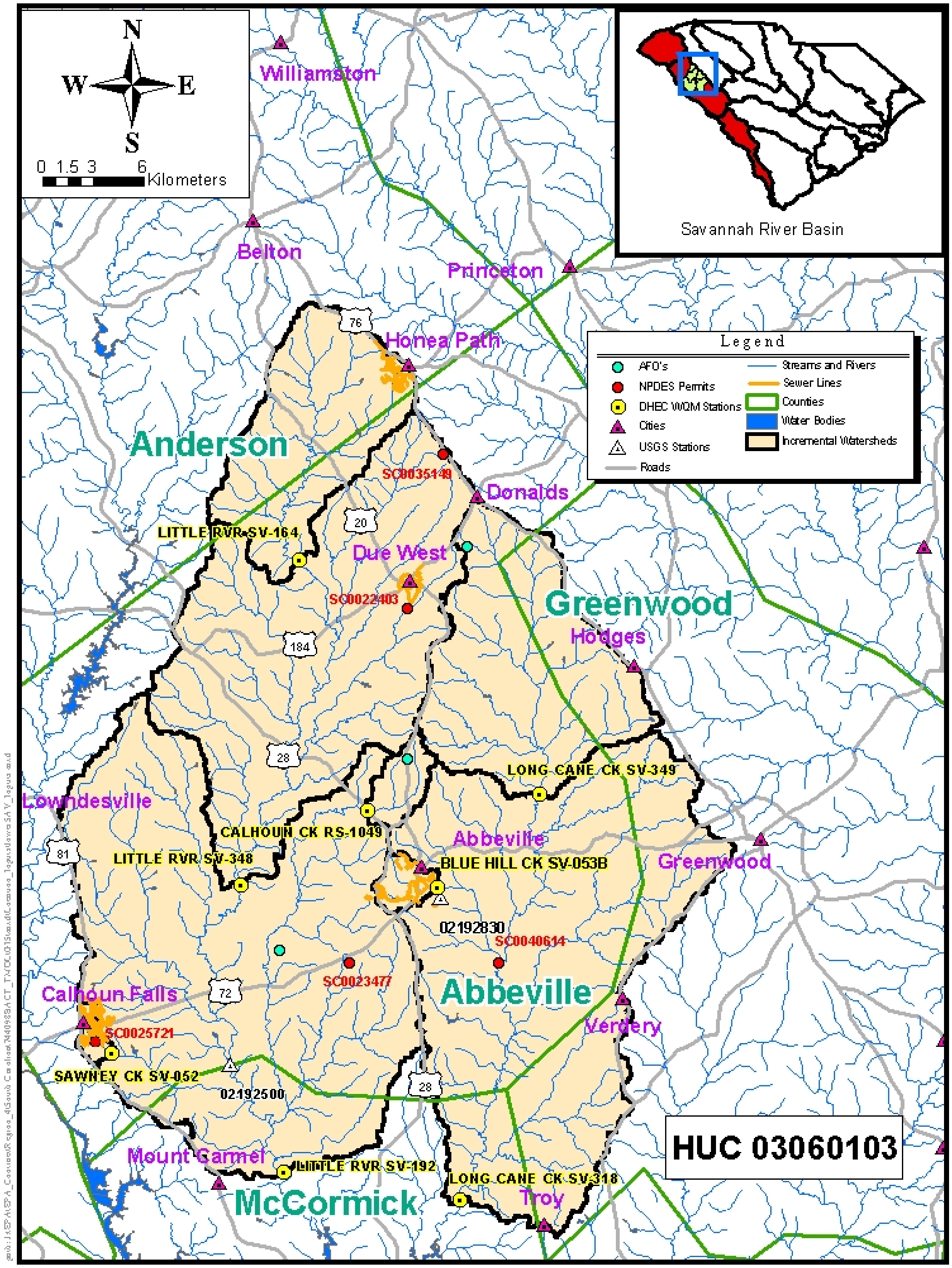


Figure 3-2 Locations of NPDES Dischargers, Small MS4s, and Animal Feeding Operations in Little River and Long Cane Creek Watersheds



plant outside the watershed. The Town of Calhoun Falls (SC0025721) which discharges into Sawney Creek (SV-052), has had both monthly and daily fecal coliform violations every year during the 5-year study period. The Town of Calhoun Falls' WWTP discharge may have contributed to the water quality exceedances at Station SV-052 between 1998 and 2002. However, the town recently upgraded its WWTP and did not have fecal coliform violations from March through November 2004.

The remaining data show there are more daily maximum violations than monthly average violations. This is indicative of stormwater entering sanitary sewers and overwhelming the disinfection unit of the WWTP. Nevertheless, the small number of exceedances spread over a 5-year period suggests that continuous point sources are not a primary source of the measured fecal coliform concentration at WQM stations SV-241 (Woodside Branch), SV-245, SV-135, SV-233 (Eighteen Mile Creek), SV-111 (Three and Twenty Creek), SV-052, SV-348, SV-192 (Little River), and SV-318 (Long Cane Creek).

Some NPDES permits only require monitoring and reporting. For those permits, USEPA's permit compliance system database was used to determine the maximum monthly average flow rate for each WWTP from 2002 through 2004. Where permit Fact Sheets were available, the design flow of the WWTP was used.

Inactive permits or industrial dischargers are not included in Table 3-1. Upstream of SV-245, NPDES permits SC0026174 and SC0026182 ceased discharging to Eighteen Mile Creek in June 2000. Between January 1998 and June 2000, data in the DMR indicate that 10 percent and 6 percent, respectively, of the daily maximum concentrations exceeded the permit limit. However, given the small flow of these two facilities and because the exceedances only occurred once each year, those facilities did not contribute significant fecal coliform loading to have a bearing on the 303(d) listing determination. Upstream of SV-135, NPDES permit SC0025003 ceased discharging to Eighteen Mile Creek in April 2000. In 1999, that facility may have contributed to the excessive fecal coliform loads that influenced 303(d) listing because 25 percent of its daily maximum concentrations exceeded the permit limit between January 1998 and April 2000.

Table 3-2 summarizes the existing load estimates for each NPDES facility. Existing point source loads were estimated by multiplying monthly average flow rates by the monthly geometric mean of fecal coliform discharged and using a unit conversion factor. The fecal coliform values were extracted from each point source's DMR. The 90^{th} percentile value was used to express the estimated existing load in counts per day.

Table 3-1 Permitted Facilities Discharging Fecal Coliform Bacteria

Water Quality Monitoring Station / Permittee	NPDES Permit Number	Receiving Water	Flow (mgd)	# Fecal Coliform Analysis	Maximum Concentration cfu/100 ml	Monthly Average >200 cfu/100 ml	Maximum Daily Concentration >400 cfu/100 ml	Percent of Samples Exceeding Permit Limit
HUC 03060101090								
SV-017 Eighteenmile Creek at Co. Rd. 2.25 mi. SSW of Easley								
No Active NPDES Permit Discharges with fecal coliform limits			NA					
SV-245 Eighteenmile Creek at S-39-27								
Pickens County/ 18 Mile Ck Upper Reg. WWTP	**SC0042994**	Eighteenmile Creek	1.0	43	300	0	0	0%
SV-135 Eighteenmile Creek at S-39-93								
Heatherwood SD/Madera Util.	**SC0029548**	Eighteenmile Creek Tributary	0.072	70	23000	3	3	9%
Pickens County/ 18 Mile Ck Middle Reg. WWTP	**SC0047856**	Eighteenmile Creek	1.0	44	1600	0	1	2%
SV-233 Eighteenmile Creek at S-2-04-279								
Milliken & Co./Pendleton Finishing **(no fc limit)**	**SC0000477**	Eighteenmile Creek	0.171*	36	3500	2	4	17%
Town of Pendleton-Clemson Reg. WWTP	**SC0035700**	Eighteenmile Creek	2.0	72	>600	0	1	1%
SV-268 Lake Hartwell 2-04-1098								
No Active NPDES Permit Discharges with fecal coliform limits			NA					
SV-241 Woodside Branch at US 123								
Liberty Denim LLC	**SC0000264**	Woodside Branch	0.397*	67	1600	0	11	16%
HUC 03060101100								
SV-111 Three and Twenty Creek At S-04-280								
Mt Vernon Mills/Lafrance	**SC0000485**	Three and Twenty Creek	0.10**	72	667	0	1	1%
Michelin N America/Sandy Springs	**SC0026701**	Three and Twenty Creek	.325*	72	1600	0	2	3%
HUC 03060103140								
SV-052 Sawney Creek at Co. Rd. 1.5 mi. SE of Calhoun Falls								
Town of Calhoun Falls	**SC0025721**	Sawney Creek	3.0	72	<13,831	21	31	72%
SV-164 Little River at S-01-24								
No Active NPDES Permit Discharges with fecal coliform limits			NA					
SV-348 Little River at S-01-32								
Town of Due West WWTP	**SC0022403**	Park Creek	0.30	72	510	0	2	3%
SV-192 Little River at S-33-19								
Milliken & Co./Sharon Plant	**SC0023477**	Unnamed Branch / Hillbern Cree	0.04*	74	4	0	0	0%
RS-01049 Calhoun Creek at SC-28								
No Active NPDES Permit Discharges with fecal coliform limits			NA					
HUC 03060103150								
SV-053B Blue Hill Creek on S. Main, Abbeville								
No Active NPDES Permit Discharges with fecal coliform limits			NA					
SV-349 Long Cane Creek at S-01-159								
No Active NPDES Permit Discharges with fecal coliform limits			NA					
SV-318 Long Cane Creek at S-33-117								
City of Abbeville	**SC0040614**	Long Cane Creek at S-1-314	1.7	82	600	0	3	4%
* Maximum Monthly Average Flow (2002 - 2004)								
** Average flow rate from permit Fact Sheet (Maximum Day is 0.371 mgd).								

Table 3-2 Estimated Existing Fecal Coliform Loading from NPDES Facilities (1998-2003)

Water Quality Monitoring Station / Permittee	NPDES Permit Number	Receiving Water	90th percentile load (cfu/day)
HUC 03060101090			
SV-017 Eighteenmile Creek at Co. Rd. 2.25 mi. SSW of Easley			
No Active NPDES Permit Discharges			
SV-245 Eighteenmile Creek at S-39-27			
Pickens County/ 18 Mile Ck Upper Reg. WWTP	**SC0042994**	Eighteenmile Creek	8.3037E+07
SV-135 Eighteenmile Creek at S-39-93			
Heatherwood SD/Madera Util.	**SC0029548**	Eighteenmile Creek Tributary	2.3598E+07
Pickens County/ 18 Mile Ck Middle Reg. WWTP	**SC0047856**	Eighteenmile Creek	5.8015E+07
SV-233 Eighteenmile Creek at S-2-04-279			
Town of Pendleton-Clemson Reg. WWTP	**SC0035700**	Eighteenmile Creek	4.3593E+08
SV-268 Lake Hartwell 2-04-1098			
No Active NPDES Permit Discharges			
SV-241 Woodside Branch at US 123			
Liberty Denim LLC	**SC0000264**	Woodside Branch	3.6181E+08
HUC 03060101100			
SV-111 Three and Twenty Creek At S-04-280			
Mt Vernon Mills/Lafrance	**SC0000485**	Three and Twenty Creek	1.7042E+08
Michelin N America/Sandy Springs	**SC0026701**	Three and Twenty Creek	7.5731E+07
HUC 03060103140			
SV-052 Sawney Creek at Co. Rd. 1.5 mi. SE of Calhoun Falls			
Town of Calhoun Falls	**SC0025721**	Sawney Creek	1.8665E+10
SV-164 Little River at S-01-24			
No Active NPDES Permit Discharges			
SV-348 Little River at S-01-32			
Town of Due West WWTP	**SC0022403**	Park Creek	1.1872E+08
SV-192 Little River at S-33-19			
Milliken & Co./Sharon Plant	**SC0023477**	Unnamed Branch / Hillbern Creek	1.1810E+06
RS-01049 Calhoun Creek at SC-28			
No Active NPDES Permit Discharges			
HUC 03060103150			
SV-053B Blue Hill Creek on S. Main, Abbeville			
No Active NPDES Permit Discharges			
SV-349 Long Cane Creek at S-01-159			
No Active NPDES Permit Discharges			
SV-318 Long Cane Creek at S-33-117			
City of Abbeville	**SC0040614**	Long Cane Creek at S-1-314	5.2815E+08

3.1.2 Municipal Separate Storm Sewer Systems

In 1990, the USEPA developed rules establishing Phase I of the NPDES Stormwater Program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4) and then discharged into local waterbodies (SCDHEC 2002). Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges.

Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality-related issues, including roadway runoff management, municipal-owned operations, and hazardous waste treatment. There are no large or medium MS4s within the watersheds of the WQM stations addressed in this report.

Phase II of the rule extends coverage of the NPDES stormwater program to certain small MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES Stormwater Program. Phase II requires operators of regulated small MS4s to obtain NPDES permits and develop a stormwater management program. Programs are to be designed to reduce discharges of pollutants to the "maximum extent practicable," protect water quality, and satisfy appropriate water quality requirements of the CWA.

There are four regulated small MS4s within the watersheds of the WQM stations addressed in this report: the Cities of Easley (SV-017), Liberty (SV-241 and SV-245), and Clemson (SV-233); and Pickens County. All the MS4s occur in the Eighteen Mile Creek Watershed (HUC 03060101090).

Small MS4 stormwater programs must address the following minimum control measures:

- Public Education and Outreach;
- Public Participation/Involvement;
- Illicit Discharge Detection and Elimination;
- Construction Site Runoff Control;
- Post- Construction Runoff Control; and
- Pollution Prevention/Good Housekeeping.

At this time there have been no Phase II MS4 permits issued due to challenges to the SCDHEC Phase II general permit. Small MS4s that submitted the required Notice of Intent and Stormwater Management Plan in March 2003 were not required by federal regulations (40 CFR 122.26) to monitor for fecal coliform or implement best management plans (BMP) for fecal coliform reduction. Therefore, no MS4-specific fecal coliform stormwater data were available.

A study by The National Urban Runoff Program indicated that the group mean fecal coliform concentration of 14 watersheds in different areas within the United States was approximately 15,000 cfu/100 m/L in stormwater runoff (USEPA 1983). Runoff from urban areas not permitted under the MS4 program may be a significant source of fecal coliform bacteria. Water quality data collected from streams draining many of the un-permitted communities show existing loads of fecal coliform bacteria at levels greater than the State's instantaneous standards. BMPs such as buffer strips and proper disposal of domestic animal waste reduce fecal coliform bacteria loading to water bodies.

Sanitary sewer overflows (SSO) are also a potential source of fecal coliform loading to streams. The paragraphs below summarize available information on the stormwater management programs for the different MS4 areas and general information on potential SSO contributions.

Pickens County: The county is committed to reducing water pollution through implementation of its Stormwater Management Plan, which is funded from the county's General Fund (Pickens County 2004). There have been 37 reported SSOs in Pickens County since 1998; however, specific locations of these SSOs were not available. Most of Pickens County is outside the Eighteen Mile Creek watershed. Cities designated within the Eighteen Mile Creek watershed are discussed below.

- City of Easley was listed by the USEPA as a Phase II entity in December 1999. The City of Easley was required to submit an application for an NPDES Permit for stormwater discharges to receiving waters. In June 2003, in anticipation of this permit being issued and recognizing that the permit was an unfunded mandate, the City of Easley established a stormwater utility fee. Since that time, the City has been implementing its stormwater management plan. Some of the key components of the City's stormwater management program currently include formulation of a stormwater utility fee; adoption of an erosion control ordinance; a draft ordinance for illicit dischargers, including enforcement actions; and a public education program about stormwater and improving water quality. The City of Easely continues to build the capacity to manage and expand components of its stormwater management program to address water quality management issues such as fecal coliform loading (City of Easley 2005).
- Clemson is in the process of designing a stormwater management program. Currently the City Engineering Department does not have specific programs designed or funded to address each of the NPDES MS4 minimum control measures. However, the City's regional approach to stormwater management and sediment and erosion control requirements for construction are two components that will be integrated into its future stormwater management program (Clemson City Engineering Department 2005).
- No information was available on the MS4 stormwater management program for Liberty, SC.

Abbeville County: While there are no MS4s designated in the Little River or Long Cane Creek watersheds, there are SSOs within Abbeville County which are a source of fecal coliform loading. Since 2000 there have been 14 SSOs reported in Abbeville County. Of the 14 SSOs reported, seven were 5,000 gallons or greater. The Town of Calhoun Falls had one SSO of 250,000-300,000 gallons at its WWTP in 2003. Calhoun Falls WWTP discharges into Sawney Creek. In 2004, the Town of Abbeville had two SSOs of 10,000 gallons or more. One of the SSOs was from a broken sewer line within a creek that flows to Long Cane Creek (SCDHEC 2005).

3.2 Nonpoint Sources

Nonpoint sources include those that cannot be identified as entering the water body at a specific location. Because fecal coliform is associated with warm-blooded animals, nonpoint sources of fecal coliform may originate from both rural and urbanized areas.

The following discussion highlights some of the major nonpoint sources identified in the watershed. These sources include urban runoff, failing septic systems, domesticated animals, wildlife, animal feeding operations (AFO), and agricultural runoff. Since there are no continuous point source dischargers upstream from WQMs SV-017, SV-268 (Eighteen Mile Creek), SV-164 (Little River), RS-01049 (Calhoun Creek), SV-053 (Blue Hill Creek), and SV-349 (Long Cane Creek), the sources of fecal coliform emanate from stormwater runoff and one or more of the following nonpoint source categories.

3.2.1 Wildlife

Fecal coliform bacteria are produced by warm-blooded animals such as deer, wild turkey, raccoons, other small mammals, and waterfowl. The Department of Natural Resources in South Carolina conducted a study in 2000 to estimate whitetail deer density based on suitable habitat (SCDNR 2000). This study assumed that deer habitat includes forests, croplands, and pastures.

The deer population density in the Eighteen Mile Creek and Three and Twenty Creek watersheds (HUC 03060101) varies from 15 to 30 deer per square mile except for a small area within the SV-233 watershed. The deer density along Pendleton Road northwest of the Pickens – Anderson County line and southeast of Clemson is more than 45 deer per square mile. The area is a forested urban area.

The deer population density in the Little River, Sawney Creek, and Long Cane Creek watersheds (HUC 03060103) is more than 45 deer per square mile except within the Little River watershed above WQM station SV-164 and the northeastern part (approximately 50%) of the Long Cane Creek watershed above WQM station SV-349. The density in these two areas varies between 30 and 45 deer per square mile.

Approximately 70,000 ducks, mostly wood ducks, green-winged teal, mallards, and ringnecks, wintered in South Carolina in January 2003 (Strange 2003). This is substantially lower than the long term average of 200,000 (Strange 2003). In an effort to increase the wintering duck population, numerous waterfowl impoundments were created, one of which is within the Eighteen Mile Creek watershed. The 17-acre Clemson Waterfowl Impoundment is located southwest of U.S. Highway 76 along Eighteen Mile Creek, approximately 2 miles from Pendleton. The fecal coliform load above SV-268 attributed to wintering migratory waterfowl is unknown, but could be considerable during winter months.

Given these representative statistics and the large amount of rural area (forest, cropland, and pasture) in the Eighteen Mile Creek, Three and Twenty Creek, Little River, and Long Cane Creek watersheds, wildlife can contribute a significant portion of the overall fecal coliform load.

3.2.2 Agricultural Activities and Grazing Animals

Domesticated animals produce significant amounts of waste and are recognized as a source of fecal coliform loading. Manure generated at AFOs is typically used as fertilizer on crop lands, forests, and pastures. The CWA does not regulate nonpoint source runoff from agriculture lands receiving agronomic applications of manure (CWA §502(14)). Stormwater leaving a concentrated animal feeding operation (CAFO) is regulated under the NPDES program; however, there are currently no NPDES CAFOs permitted in South

Carolina. SCDHEC currently maintains a list of AFOs throughout the state categorized by the type of facility (cattle, swine, poultry) and size which is defined by a specific number of animal units (large, medium, small). No data are available to estimate fecal coliform levels in stormwater runoff from the AFO lagoons or land application fields associated with these facilities. The following describes the estimated manure production of various domesticated animals within the watersheds of this report.

Cattle: In 2002, Anderson County contained the largest population of cattle in the state at 40,505 (USDA 2002). Anderson County contains 924 cattle farms, of which only 32 are dairies. Abbeville and Pickens Counties contained 19,123 and 9,090 cattle and 375 and 320 cattle farms, respectively. A 1,000-pound beef or dairy cow produces approximately 11 tons and 15 tons of manure per year, respectively (OSU 1992). Assuming the average cow weighs 750 pounds, the manure production in Anderson County would be approximately 911 tons per day. Table 3-3 provides the estimated manure production for each watershed. The number of cattle within each WQM station watershed was estimated by dividing the number of cattle in each county by the total acres of pasture land in each county. This cattle density value was then multiplied by the number of acres of pasture land in each watershed. Table 3-4 is a list of the AFOs which have been assigned NPDES permit numbers by SCDHEC for tracking purposes.

Table 3-3 Estimated Tons of Manure by WQM Station

WQM Station	Number of Cattle and Calves in Watershed	Tons of Manure Deposited Daily in Watershed
SV-111	5,761	130
SV-135	662	15
SV-164	2,820	68
SV-192	5,523	125
SV-233	91	2
SV-268	164	4
SV-318	1,760	40
SV-348	5,923	139
SV-349	3,685	83
SV-017	22	0.5
SV-241	9	0.2
SV-245	472	11
SV-052	11	0.2
SV-053B	16	0.4
RS-01049	532	12

According to SCDHEC's Appalachia I District Office, cattle in creeks may be the largest source of dry weather fecal coliform loading in Three and Twenty Creek, Little River, and Long Cane Creek. For many farmers the creeks are the only water source for their cattle.

Table 3-4 lists the AFO facilities located in each HUC. Most are considered small operations, with one medium dairy and one large chicken egg laying operation. The facilities in the table below located in HUC 03060101 do not have land application fields based on the SCDHEC geographic information system (GIS) database. Based on the SCDHEC data files, the two dairy facilities in HUC 03060103 have approximately 250 acres of pasture or crop land which is used for land application of manure.

Table 3-4 Animal Feeding Operations

NPDES	TYPE	DESIGN COUNT	AFO SIZE	COUNTY NAME	HUC CODE14
HUC 03060101					
ND0014681	SWINE	60	small	Anderson	03060101090020
ND0067431	STOCKYARD	400	NA	Anderson	03060101090020
ND0013684	DAIRY	125	small	Anderson	03060101100020
ND0014117	DAIRY	80	small	Anderson	03060101100020
ND0070955	BROILERS	23000	small	Anderson	03060101100020
ND0081884	DAIRY	300	medium	Anderson	03060101100010
HUC 03060103					
ND0062065	DAIRY	50	small	Abbeville	03060103140110
ND0077526	LAYERS	95000	large	Abbeville	03060103140120
ND0008010	DAIRY	115	small	Abbeville	03060103150010

Horses: In 2002, there were 3,014 horses in Anderson County (USDA 2002). A single horse produces 350 pounds of manure per week (Card 2004). The 2002 horse manure production in Anderson County was approximately 75 tons per day. Abbeville and Pickens Counties had 1,423 and 645 horses in 2002, producing 36 and 16 tons per day, respectively (USDA 2002).

Poultry: Broilers produce approximately 0.14 pounds of manure per day (MWPS 1993). Ten farms in Anderson County contained approximately 1 million broilers in 2002 (USDA 2002) producing approximately 72 tons of manure per day. Egg layers produce approximately 0.21 pounds of manure per day (USDA 2002). The number of egg layers and pullets in Anderson County in 2002 is unknown; however, the poultry population was 165,773 in 1997, a 25 percent decrease from 220,473 in 1992. The estimated poultry population in 2002 is approximately 124,000 chickens producing 13 tons of manure per day. Chicken census data were not available for Abbeville, McCormick, and Pickens Counties, but land application of chicken manure in these counties is believed to be minimal. Based on the SCDHEC data files, the poultry facility in HUC 03060103 has approximately 476 acres of pasture or crop land used for land application of chicken manure.

3.2.3 Failing Onsite Wastewater Disposal Systems and Illicit Discharges

According to 1990 U.S. census information, 32,270, 5,500, 1,840, and 18,770 households used septic systems in Anderson, Abbeville, McCormick, and Pickens Counties, respectively (U.S. Census Bureau 1990). Table 3.5 provides an estimation, based on U.S. Census data, of the number of septic tanks in each watershed. As expected, the larger but less densely populated watersheds, such as SV-135, SV-111, SV-192, and SV-318, have the most septic systems. Nevertheless, the density of septic systems shown in Table 3.5, is more relevant. The density of septic systems within each watershed was estimated by dividing the number of septic systems in each census tract by the number of acres in each census tract. This density was then applied to the number of acres of each census tract within a WQM station watershed. Most census tracts are fully within a watershed. Census tracts crossing a watershed boundary required an additional calculation to estimate the number of septic systems based on the proportion of the census tracking falling within each watershed. This step involved adding up all the septic systems for each whole or partial census tract. Since subdivisions are built on large land tracts (hundreds of acres) the number of septic systems per 100 acres is easier to visualize; therefore, the following equation was used to estimate the number of septic tanks in Table 3-5:

Septic tanks per 100 acres = (number of septic tanks / number of acres in the watershed) x 100

Given enough time, most if not all septic systems operating at full capacity fail. Septic system failures are also proportional to the adequacy of a state's minimum design criteria (Hall 2002). Failures include surface ponding or runoff or failure of treatment prior to the effluent mixing with groundwater. Fecal coliform contaminated groundwater can and does discharge to creeks through springs and seeps. Most of the studies estimated that the minimum lot size necessary to ensure against contamination is roughly one-half to one acre (Hall 2002). Some studies, however, found that lot sizes in this range or even larger would cause contamination of ground or surface water (University Of Florida 1987). It has been estimated that areas with more than 40 septic systems per square mile (6.25 septic systems per 100 acres) can be considered to have potential contamination problems (Canter and Knox 1986). The 1995 American Housing Survey conducted by the U.S. Census Bureau estimates that, 10 percent of occupied homes with on-lot septic systems experienced malfunctions during the year nationwide.

Department Of Health And Environmental Control, Regulations 61-56 of the State of South Carolina Code of Regulations do not require a minimum lot size, but requires minimum setbacks, such as property lines, that dictate the required size of each individual lot. The minimum setback distance to a surface water body is 50 linear feet. There is no single family residence requirement to reserve a backup area should the original system fail.

According to the National Small Flows Clearinghouse, the State of South Carolina does not require an inspection of the septic systems prior to the sale of the property (NSFC 1996). A pilot onsite septic system inspector training program has been undertaken for eight coastal counties, in part, for the purpose of meeting conditions placed on South Carolina's conditionally approved Coastal Nonpoint Pollution Control Program (CNPCP). Current state regulations do not require post-operational inspections once a newly installed system has passed final installation inspection. The federally mandated CNPCP allows states to develop strong voluntary programs (in lieu of passing new regulations) aimed at reducing specific sources of nonpoint source pollution (SCDHEC 2002). Currently, there are no plans to create an inspection program for non-coastal counties.

Failing septic tanks may be contributing to fecal coliform WQS exceedances. Fecal coliform loading from failing septic tanks can be transported to streams in a variety of ways, including runoff from surface ponding or through groundwater.

Table 3-5 Septic Tank Summary

WQM Station	Estimated Number of Septic Tanks in WQM Station Watershed	Average Number of Septic Tanks per 100-Acres in WQM Station Watershed
SV-017	140	11
SV-245	854	9
SV-135	1190	2
SV-233	288	6
SV-268	111	2
SV-241	39	4
SV-111	2514	5
SV-052	5	0
SV-164	773	3
SV-348	1359	2
SV-192	1098	1
RS-01049	96	3
SV-053B	41	2
SV-349	931	3
SV-318	2178	2

3.2.4 Domestic Pets

Pets can be a major contributor of fecal coliform to streams. On average nationally, there are 0.58 dogs per household, and 0.66 cats per household (American Veterinary Medical Association 2004). Using the U.S. census data (U.S. Census Bureau 2000), dog and cat populations can be estimated for the counties as shown in Table 3-6.

Table 3-6 Estimated Number of Household Pets

County	Number of Households	Number of Dogs	Number of Cats
Abbeville	10,131	5,876	6,686
Anderson	65,649	38,076	43,328
Pickens	41,306	23,957	27,262

A study in a Washington D.C. suburb found that dogs produce approximately 0.42 pounds of fecal waste per day (Thorpe 2003). Based on this assumption, it is estimated that dogs are producing around 1 ton, 8 tons, and 5 tons of waste per day, in Abbeville, Anderson, and Pickens Counties, respectively. The large estimated population of domestic animals in Anderson and Pickens Counties is expected given the more urbanized areas of the counties. Consequently, fecal coliform from domestic animals transported by runoff from urban and suburban areas in the Eighteen Mile Creek watersheds can be a significant source of loading.

3.3 Summary of Fecal Coliform Sources by WQM Station

The following data and information were used to describe point and nonpoint sources of fecal coliform and to estimate existing fecal coliform loading at each WQM station.

- Watershed land use and land cover;
- Watershed soil characteristics;
- Agricultural census data, including livestock populations;
- Households served by septic tanks and septic tank failure rate;
- Animal feeding operations;
- Domestic pet census data;
- NPDES permitted point sources and discharge monitoring reports; and
- MS4 regulations.

Based on the information and data presented and analyzed in Section 1 through Section 3 of this report, the following inferences can be made regarding the sources and magnitude of fecal coliform contributions to the watersheds of 303(d)-listed WQM Stations in Eighteen Mile Creek, Three and Twenty Creek, Little River, and Long Cane Creek. Residential areas not classified as MS4s are categorized as nonpoint sources.

3.3.1 Eighteen Mile Creek

Forests dominate the Eighteen Mile Creek drainage area, with the second most prevalent land use being pastures. Direct contributions from wildlife, avian species, and livestock are contributing factors. The entire northwestern border of the watershed is experiencing urban/suburban growth which contributes fecal coliform loading from failing septic systems and rainfall runoff (urban runoff) transporting a consistent source of fecal coliform from domestic pets and urban wildlife. The following paragraphs summarize the most probable sources of fecal coliform within the watersheds of each of the 303(d)-listed WQM stations. Stations along Eighteen Mile Creek are discussed below.

WQM Station SV-017

The contributing watershed of SV-017 contains approximately 1,281 acres. The upper half of this watershed is primarily low density residential (32.15 percent) and high density residential (10.29 percent) land uses. The lower half of this watershed is primarily wooded (approximately 24 percent) with scattered residential subdivisions and farm land. Most of the residences are serviced by sewer, but there are approximately 477 septic tanks in this watershed. The Town of Easley sends its sewered wastewater east to a WWTP in another watershed. Fecal coliform data from WQM Station SV-017 indicated the WQS was exceeded in eight out of 16 samples, or 50 percent of the samples collected from May 1998 through October 2000. Likely dry weather sources of fecal coliform are domesticated animals watering in the creeks, wildlife, failing septic tanks, or leaking sewers.

WQM Station SV-241

The contributing watershed of WQM Station SV-241 contains approximately 1,043 acres and is primarily forested at approximately 82 percent. Low intensity residential development occupies 6.29 percent of the watershed. Row crop land occupies 5.32 percent. Fecal coliform data from WQM Station SV-241 (Woodside Branch) indicated the WQS was exceeded in four out of 16 samples (25 percent) collected from May 1998 through October 2000. The exceedances occurred in June and July of 1998 and 2000.

Liberty Denim, LLC is the only NPDES permitted discharger in this watershed. There were maximum daily discharge violations in June (500 cfu/100 m/L) and July (1,600 cfu/100 m/L) 1998. However since 2000 this discharger has rerouted wastewater to another WWTP outside the watershed and this discharger is no longer a source of fecal coliform loading. The SV-241 watershed is mostly forest, so wildlife is considered a major contributor.

WQM Station SV-245

The contributing watershed of WQM Station SV-245 (Eighteen Mile Creek) contains approximately 9,058 acres. Approximately 61 percent of the total watershed area, primarily in the lower two-thirds of the watershed is forested. Pastures and row crops occupy approximately 20 percent. The upper third contains the City of Liberty, a small MS4 which occupies approximately 10 percent of the total watershed area. U.S. Census data for 1990 indicates there is a density of 26 septic systems per 100 acres. Septic system failures may be contributing to fecal coliform loading upstream of SV-245.

Fecal coliform data from WQM Station SV-245 indicated the WQS was exceeded in five of 16 samples, or 31 percent of the samples collected from May 1998 through October 2000. Dry weather nonpoint sources may originate from domesticated farm animals and wildlife watering in the creek.

WQM Station SV-135

The SV-135 watershed encompasses approximately 59,759 acres. This watershed is mostly forested, 74 percent. Together, pastures and row crops account for approximately 15 percent. Low and high density residential areas occupy approximately 6 percent of the watershed. A small part of the City of Norris and more than half of the City of Central are located within this watershed. Additionally, the immediate area around the WQM station is residential. The density of septic systems is very low, but may be misleading. Failing septic systems may be located in the relatively small residential areas. Water samples collected during the months of March 1998 through December 2000 from WQM Station SV-135 (Eighteen Mile Creek) indicated fecal coliform counts above the WQS in 58 percent of the 31 samples.

The two permitted NPDES dischargers, had very few violations (four out of 114 samples), and are not a significant source of fecal coliform loading. Only 6 percent of the watershed is urbanized. The chronic nature of exceedances at this WQM station under all flow conditions suggests continual sources of fecal coliform loading from nonpoint sources. Although only 15 percent of the watershed is in pastures or row crops, cattle watered in the creek may be a significant source of loading. Wildlife may also be a major contributor.

WQM Station SV-233

The SV-233 watershed encompasses approximately 4,778 acres. Approximately 55 percent of this watershed is classified as forested. This watershed contains the southeastern part of the City of Clemson and surrounding unincorporated subdivisions. The urban area (MS4) in this watershed is approximately 32 percent of the total area. Deer density is more than 45 per 100 acres along Pendleton Road between Clemson and Pendleton. Fecal coliform data from WQM Station SV-233 (Eighteen Mile Creek) exceeded the 400 cfu/100 m/L WQS by 33 percent of the 21 samples collected from January 2001 through December 2002. Samples were collected with the stream flow under moist and mid-range flows. No samples were collected during extended dry-weather.

The two permitted NPDES WWTPs located in this watershed are not fecal coliform loading. Milliken & Company/Pendleton Finishing (SC0000477) had two monthly geometric mean (July – August 1999) and four maximum daily fecal coliform permit violations. The permittee quit sampling for fecal coliform at the end of October 2000 and moved its domestic wastewater to a different WWTP. The other NPDES facility had only one maximum daily permit violation out of 44 samples. Stormwater runoff from low density residential areas is a likely source of fecal coliform loading. The density of septic systems is extremely high with an average of 61 septic tanks per 100 acres. Wildlife and pets within residential areas may also be contributing to the fecal coliform exceedances.

WQM Station SV-268

There are approximately 4,497 acres in the SV-268 watershed. Approximately 79 percent of this watershed is classified as forested. Approximately 14 percent of the watershed is composed of agriculture land use, such as pastures and row crops. Fecal coliform contribution from wildlife, such as ducks, could be significant.

Analysis of water samples collected at WQM Station SV-268 (Eighteen Mile Creek) indicated the fecal coliform count exceeded the 400 cfu/100 m/L WQS 17 percent of the time for samples collected from March 1998 through November 2002.

This watershed does not contain any significant residential development and there is no NPDES permitted WWTP in this watershed. Therefore, sources of fecal coliform are likely to be domesticated animals and wildlife.

WQM Station SV-111

The contributing watershed of Three and Twenty Creek at WQM SV--111 is approximately 52,358 acres. The land use mix is forests at 52 percent, pasture/hay lands at 28 percent, row crops at 14 percent, and residential areas at 3 percent. Fecal coliform data for WQM Station SV-111 (Three and Twenty Creek) exceed the 400 cfu/100 m/L WQS in 43 percent of the 47 samples collected from 1998 through 2002.

The two NPDES permitted WWTPs located in this watershed are not considered significant sources of fecal coliform loading. There were only three daily maximum permit violations for these WWTPs from 1998 through 2003. This watershed has the most septic systems (4,019), but a low density of eight septic systems per 100 acres. Nevertheless, the watershed has several concentrated residential areas which use septic systems. Sources of fecal coliform are likely to be cattle watering in the creek, failing septic systems, and wildlife.

3.3.2 Sawney Creek, Little River, and Long Cane Creek

WQM Station SV-052

There are approximately 1,092 acres within the SV-052 watershed (Sawney Creek). The combined land use mix of residential, commercial, industrial, and transportation is approximately 38 percent; forests at 47 percent; and pasture/hay/ row crops at 9 percent. Water samples collected during the months of 1998 through 2000 indicated fecal coliform counts above the 400 cfu/100 m/L WQS occurred 20 percent of the time.

The WWTP for the Town of Calhoun Falls discharges to this watershed. While the Town of Calhoun Falls may have contributed to fecal coliform loading between 1998 and 2002, the town recently upgraded its WWTP and is no longer considered a significant source of fecal coliform loading. The population density of deer in this watershed exceeds 45 per square-mile. The sources of fecal coliform most probably come from residential stormwater runoff, domesticated animals, and wildlife.

WQM Station SV-164

There are approximately 26,219 acres in this part of the Little River watershed. The land use mix is approximately 48 percent pasture/hay/row crops, 47 percent forest, and 2 percent residential. Much of the land is used for livestock.

Twenty-one percent of the 14 samples collected from November 1999 through December 2000 exceeded the 400 cfu/100 m/L WQS. With no point source discharges and primarily rural land use, the most probable sources of fecal coliform are wildlife and domesticated animals watering in the river.

WQM Station SV-348

SV-348 is an entirely rural watershed of approximately 68,752 acres. Major land uses are: deciduous forest, 26 percent; evergreen forest, 27 percent; mixed forest, 17 percent; pasture, 17 percent; and row crops, 10 percent. Rural land use, small population base, few septic tanks, and only one small point source discharger, clearly indicate that fecal coliform loading is entirely nonpoint source related. Likely sources are wildlife and domesticated animals.

WQM Station SV-192

The contributing watershed to WQM Station SV-192 includes approximately 98,040 acres of land. The land use mix is 0.5 percent residential, 73 percent forest, and 22 percent pasture/hay/row crops indicating that nonpoint sources are the primary origin of fecal coliform loading. Domesticated animals and wildlife are the likely sources of fecal coliform. No fecal coliform permit violations were reported for the one NPDES point source discharge.

WQM Station RS-01049

The contributing watershed to WQM Station RS-01049 contains 3,282 acres. The land use mix includes: pasture/hay/row crops at 42 percent, residential at less than 2 percent, and forest at 54 percent. Seventeen percent of the 12 samples collected from January 2001 through December 2001 exceeded the 400 cfu/100 m/L WQS. Rural land use, small population base, few septic tanks, and no point source dischargers clearly indicate that fecal coliform loading is entirely nonpoint source related. Cattle watering in creeks and wildlife may be a source of dry and wet weather fecal coliform loading.

WQM Station SV-053B

The contributing watershed to WQM Station SV-053B contains 2,165 acres (Blue Hill Creek) which are primarily forested at 47 percent, 30 percent being residential (City of Abbeville), and row crops and pasture/hay accounting for 8 percent. The density of septic system (21 per 100 acres) is high. Failing septic systems may be a source of fecal coliform. One-hundred percent of the fecal coliform data collected from July 1998 through October 2000 at WQM Station SV-053B exceeded the 400 cfu/100 m/L WQS. The highest value recorded was 30,000 cfu/100 m/L.

There are two NPDES dischargers upstream of this station: the City of Abbeville WWTP and a textile mill. Fecal coliform is not believed to be present in either discharged effluent. The WWTP discharges from a large pond that collects filter backwash water. It is unknown whether fecal coliform filtered from the raw water could survive in the pond. The textile mill has since 1996 sent its domestic wastewater to the city's WWTP. The watershed contains both sewered and non-sewered homes and open spaces. A close examination of Figure 3-2 shows sewers adjacent and/or within some of the creeks. As mentioned earlier, the Town of Abbeville recently had a sewer line break within a tributary to Long Cane Creek. Leaking sewers are the most probable source of fecal coliform in this watershed.

WQM Station SV-349

The Long Cane Creek watershed above WQM SV-349 drains approximately 36,385 acres. Residential density is insignificant at less than 1 percent, forested areas comprise the greatest percentage of land at 63 percent. Pasture/hay/row crops make up 34 percent of the land use. The large percentage of pasture/hay land use indicates large numbers of livestock are kept in the pastures, and that hay is produced for winter feeding of the livestock. Fifty percent of the 14 samples collected from November 1999 through December 2000 exceeded the 400 cfu/100 m/L WQS. Domesticated animals and wildlife are the primary sources of fecal coliform loading causing consistent exceedances of the WQS.

WQM Station SV-318

This lower part of the Long Cane Creek watershed contains approximately 88,232 acres. Small towns within the watershed include portions of Abbeville, Verdery, and Troy. Residential land use occupies less than 3 percent of the watershed. Forested areas comprise nearly 80 percent of the watershed's land use, with pasture/hay and row crop land uses covering a combined 9.5 percent, and transitional land use making up more than 6 percent. The entire watershed lies within the boundary of Sumter National Forest. Although this watershed has one of the lowest septic system densities, residential areas in the upper watershed are not sewered. Twelve percent of the 57 fecal coliform samples collected from January 1998 through December 2002 exceeded the 400 cfu/100 m/L WQS. Likely sources are failing septic tanks, wildlife, and domesticated animals.

SECTION 4
TECHNICAL APPROACH AND METHODOLOGY

A TMDL is defined as the total quantity of a pollutant that can be assimilated by a receiving water body while achieving the WQS. A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for uncertainty concerning the relationship between effluent limitations and water quality.

This definition can be expressed by the following equation:

TMDL = Σ WLA + Σ LA + MOS

The objective of the TMDL is to estimate allowable pollutant loads and to allocate these loads to the known pollutant sources in the watershed so the appropriate control measures can be implemented and the WQS achieved. 40 CFR §130.2 (1) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For fecal coliform, TMDLs are expressed as cfu per day where possible or as percent reductions, and represent the maximum one-day load the stream can assimilate while still attaining the WQS.

4.1 Using Load Duration Curves to Develop TMDLs

Load duration curves (LDCs) are graphical analytical tools that illustrate the relationships between stream flow and water quality and assist in decision making regarding this relationship. Flow is an important factor affecting the loading and concentration of fecal coliform. Both point and nonpoint source loads of pollutants to streams may be affected by changes in flow regime. Given an understanding of the potential loading mechanisms of fecal coliform, and how those mechanisms are related to flow condition, it is possible to infer and quantify the major contributing sources of pollutants to a stream by examining the relationship between flow and pollutant concentration or load. The fecal coliform TMDLs presented in this report are designed to be protective of typical flow conditions. The following discussion provides an overview of the approach used to develop LDCs and TMDL calculations. Results and calculations are presented in Section 5.

4.2 Stepwise Explanation of How TMDL Calculations were Performed

The following discussion provides a summary of the steps involved in the calculation of the key components of the fecal coliform TMDLs presented in Section 5 of this report.

Step 1: Develop Flow Percentiles for each WQM Station. Direct flow measurements are not available for all of the WQM stations addressed in this report. This information, however, is vitally important to understanding the relationship between water quality and stream flow. Therefore, in order to characterize flow, in some cases flow data were derived from a flow estimation model for each relevant watershed. Flow data to support development of flow duration curves will be derived for each SCDHEC WQM station in the following priority:

i) In cases where a USGS flow gage coincides with, or occurs within one-half mile upstream or downstream of a SCDHEC WQM station and simultaneous daily flow data matching the water quality sample date are available, these flow measurements will be used.

ii) If flow measurements at the coincident gage are missing for some dates on which water quality samples were collected, gaps in the flow record will be filled, or the record extended, by estimating flow based on measured streamflows at a nearby gage. First, the most appropriate nearby stream gage is identified. All flow data are first log-transformed to linearize the data because flow data are highly skewed. Linear regressions are then developed between 1) daily streamflow at the gage to be filled/extended; and 2) streamflow at all gages within 95 miles that have at least 300 daily flow measurements on matching dates. The station with the strongest flow relationship, as indicated by the highest correlation coefficient (r-squared value), is selected as the index gage. R-squared indicates the fraction of the variance in flow explained by the regression. The regression is then used to estimate flow at the gage to be filled/extended from flow at the index station. Flows will not be estimated based on regressions with r-squared values less than 0.25, even if that is the best regression. This value was selected based on familiarity with using regression analysis in estimating flows. In some cases, it will be necessary to fill/extend flow records from two or more index gages. The flow record will be filled/extended to the extent possible based on the strongest index gage (highest r-squared value), and remaining gaps will be filled from successively weaker index gages (next highest r-squared value), and so forth.

iii) In the event no coincident flow data are available for a WQM station, but flow gage(s) are present upstream and/or downstream, flows will be estimated for the WQM station from an upstream or downstream gage using a watershed area ratio method derived by delineating subwatersheds, and relying on the Natural Resources Conservation Service runoff curve numbers and antecedent rainfall condition. Drainage subbasins will first be delineated for all impaired 303(d)-listed WQM stations, along with all USGS flow stations located in the 8-digit HUCs with impaired streams. All USGS gage stations upstream and downstream of the subwatersheds with 303(d)-listed WQM stations will be identified.

Step 2: Develop Flow Duration Curves. Flow duration curves serve as the foundation of LDC TMDLs. Flow duration curves are graphical representations of the flow regime of a stream at a given site. The flow duration curve is an important tool of hydrologists, utilizing the historical hydrologic record from stream gages to forecast future recurrence frequencies.

Flow duration curves are a type of cumulative distribution function. The flow duration curve represents the fraction of flow observations that exceed a given flow at the site of interest. The observed flow values are first ranked from highest to lowest, then, for each observation, the percentage of observations exceeding that flow is calculated. The flow rates for each 5^{th} percentile for each WQM station are provided in Appendix D. The flow value is read from the ordinate (y-axis), which is typically on a logarithmic scale since the high flows would otherwise overwhelm the low flows. The flow exceedance frequency is read from the abscissa, which is numbered from 0 to 100 percent, and may or may not be logarithmic. The lowest measured flow occurs at an exceedance frequency of 100 percent, indicating that flow has equaled or exceeded this value 100 percent of the time, while the highest measured flow is found at an exceedance frequency of 0 percent. The median flow occurs at a flow exceedance frequency of 50 percent.

While the number of observations required to develop a flow duration curve is not rigorously specified, a flow duration curve is usually based on more than 1 year of observations, and encompasses inter-annual and seasonal variations. Ideally, the drought and flood of record are included in the observations. For this purpose, the long term flow gaging stations operated by the USGS are ideal.

A typical semi-log flow duration curve exhibits a sigmoidal shape, bending upward near a flow duration of 0 percent and downward at a frequency near 100 percent, often with a relatively constant slope in between. However, at extreme low and high flow values, flow duration curves may exhibit a “stair step” effect due to the USGS flow data rounding conventions near the limits of quantitation. The extreme high flow conditions (<10th percentile) and low flow conditions (>95 percentile) are not considered in development of these TMDLs. The overall slope of the flow duration curve is an indication of the flow variability of the stream.

Flow duration curves can be subjectively divided into several hydrologic condition classes. These hydrologic classes facilitate the diagnostic and analytical uses of flow and LDCs. The hydrologic classification scheme utilized in the development of these TMDLs is presented in Table 4-1.

Table 4-1 Hydrologic Condition Classes

Flow Duration Interval	Hydrologic Condition Class*
0-10%	High flows
10-40%	Moist Conditions
40-60%	Mid-Range Conditions
60-90%	Dry Conditions
90-100%	Low Flows

Source: Cleland 2003.

Step 3: Estimate Current Point Source Loading. In South Carolina, NPDES permittees that discharge treated sanitary wastewater must meet the state WQS for fecal coliform bacteria at the point of discharge (see discussion in Section 2). However, for TMDL analysis it is necessary to understand the relative contribution of WWTPs to the overall pollutant loading and their general compliance with required effluent limits. The fecal coliform load for continuous point source dischargers was estimated by multiplying the monthly average flow rates by the monthly geometric mean and a conversion factor. The data were extracted from each point source’s DMR from 1998 through 2003. The 90th percentile value of the monthly loads was used to express the estimated existing load in counts/day. The current pollutant loading from each permitted point source discharge as summarized in Section 3 was calculated using the equation below.

Point Source Loading = monthly average flow rates (mgd) * geometric mean of corresponding fecal coliform concentration * unit conversion factor (#/day)

Where:

unit conversion factor = 37,854,120 100m/L/day

Step 4: Estimate Current Loading and Identify Critical Conditions. It is difficult to estimate current nonpoint loading due to lack of specific water quality and flow information that would assist in estimating the relative proportion of non-specific sources within the watershed. Therefore, existing instream loads were used as a conservative surrogate for nonpoint loading. It was calculated by multiplying the concentration by the flow matched to the specific sampling date. Then using the hydrologic flow intervals shown in Table 4-1, the 90th percentile nonpoint loading within each of the intervals would then represent the nonpoint loading estimate for that interval. Existing loads have been estimated using a regression-based relationship developed between observed fecal coliform loads and flow or flow exceedance percentile

In many cases, inspection of the LDC will reveal a critical condition related to exceedances of WQSs. For example, criteria exceedances may occur more frequently in wet weather, low flow conditions, or after large rainfall events. The critical conditions are such that if WQSs were met under those conditions, WQSs would likely be met overall. Given that the instantaneous fecal coliform criterion indicates that no more than 10 percent of samples should exceed 400 cfy/100 m/L, it is appropriate to evaluate existing loading as the 90th percentile of observed fecal coliform concentrations. Together with the MOS, the reduction calculated in this way should ensure that no more than 10 percent of samples will exceed the criterion.

Existing loading is calculated as the 90th percentile of measured fecal coliform concentrations under each hydrologic condition class multiplied by the flow at the middle of the flow exceedance percentile. For example, in calculating the existing loading under dry conditions (flow exceedance percentile = 60-90%), the 75th percentile exceedance flow is multiplied by the 90th percentile of fecal coliform concentrations measured under the 60-90th percentile flows. The "high flow" or "low flow" hydrologic conditions will not be selected as critical conditions because these extreme flows are not representative of typical conditions, and few observations are typically available to reliably estimate loads under these conditions. This methodology results in multiple estimates of existing loading. However, TMDLs are typically expressed as a load or concentration under a single scenario. Therefore, these TMDLs will assume that if the highest percent reduction associated with the difference between the existing loading and the LDC (TMDL) is achieved, the WQS will be attained under all other flow conditions.

Step 5: Develop Fecal Coliform Load Duration Curves (TMDL). Load duration curves are based on flow duration curves, with the additional display of historical pollutant load observations at the same location, and the associated water quality criterion or criteria. In lieu of flow, the ordinate is expressed in terms of a fecal coliform load (cfus/day). The curve represents the single sample water quality criterion for fecal coliform (400 cfu/100 m/L) expressed in terms of a load through multiplication by the continuum of flows historically observed at the site. The points represent individual paired historical observations of fecal coliform concentration and flow. The fecal coliform concentration data used for each WQM station are provided in Appendix A. The fecal coliform load (or the y-value of each point) is calculated by multiplying the fecal coliform WQS by the instantaneous flow (cubic feet per second) from the same site and time, with appropriate volumetric and time unit conversions.

TMDL (cfu/day) = WQS * flow (cfs) * unit conversion factor

Where: WQS = 400 cfu/100mL

*unit conversion factor = 24,465,525 mL*s /* ft^3**day*

The flow exceedance frequency (x-value of each point) is obtained by looking up the historical exceedance frequency of the measured flow, in other words, the percent of historical observations that equal or exceed the measured flow. It should be noted that the site daily average stream flow is often used if an instantaneous flow measurement is not available. Fecal coliform loads representing exceedance of water quality criteria fall above the water quality criterion line.

Step 6: Develop LDCs with MOS. An LDC depicting slightly lower estimates than the TMDL is developed to represent the TMDL with MOS. An explicit MOS is defined for each TMDL by establishing an LDC using 95 percent of the TMDL value (5 percent of the 400 cfu/100 m/L instantaneous water quality criterion) to slightly reduce assimilative capacity in the watershed, thus providing a 5 percent MOS. The MOS at any given percent flow exceedance, therefore, is defined as the difference in loading between the TMDL and the TMDL with MOS.

Step 7: Calculate WLA. As previously stated, the pollutant allocation for point sources is defined by the WLA. A point source can be either a wastewater (continuous) or stormwater (MS4) discharge. Stormwater point sources are typically associated with urban and industrialized areas, and recent USEPA guidance includes permitted stormwater discharges as point source discharges and, therefore, part of the WLA.

The LDC approach recognizes that the assimilative capacity of a water body depends on the flow, and that maximum allowable loading will vary with flow condition. TMDLs can be expressed in terms of maximum allowable concentrations, or as different maximum loads allowable under different flow conditions, rather than single maximum load values. This concentration-based approach meets the requirements of 40 CFR, 130.2(i) for expressing TMDLs "in terms of mass per time, toxicity, or other appropriate measures" and is consistent with USEPA's *Protocol for Developing Pathogen TMDLs* (USEPA 2001).

WLA for WWTP. Wasteload allocations may be set to zero in cases of watersheds with no existing or planned continuous permitted point sources. For watersheds with permitted point sources, wasteloads may be derived from NPDES permit limits. A WLA may be calculated for each active NPDES wastewater discharger using a mass balance approach as shown in the equation below. The permitted average flow rate used for each point source discharge and the water quality criterion concentration are used to estimate the WLA for each wastewater facility. All WLA values for each subwatershed are then summed to represent the total WLA for the watershed.

WLA (cfu/day) = WQS * flow * unit conversion factor

Where: WQS = 400 cfu /100mL

flow (cfs) = permitted flow or design flow (if unavailable)

*unit conversion factor = 24,465,525 mL*s / ft^3*day*

WLA for MS4s. Because a WLA for each MS4 cannot be calculated as an individual value, WLAs for MS4s are expressed as a percent reduction goal (PRG) derived from the LDC for nonpoint sources. The method for estimating the percent reduction of fecal coliform loading is described in Step 8.

Step 8: Calculate LA. Load allocations can be calculated under different flow conditions as the water quality target load minus the WLA. The LA is represented by the area under the LDC but above the WLA. The LA at any particular flow exceedance is calculated as shown in the equation below.

LA = TMDL – MOS - ∑WLA

However, to express the LA as an individual value, the LA is derived using the equation above but at the median point of the hydrologic condition class requiring the largest percent reduction as displayed in the LDCs provided in Appendix E. Thus, an alternate method for expressing the LA is to calculate a PRG for fecal coliform. Load allocations are calculated as percent reductions from current estimated loading levels required to meet water quality criteria.

Step 9: Estimate WLA Load Reduction. The WLA load reduction was not calculated because it was assumed that the continuous dischargers (NPDES permitted WWTPs) are adequately regulated under existing permits and, therefore, no WLA reduction would be required. For the MS4 permittees, the percent reduction was assumed to be the same as the nonpoint load reduction.

Step 10: Estimate LA Load Reduction. After existing loading estimates are computed for the three different hydrologic condition classes described in Step 2, nonpoint load reduction estimates for each WQM station are calculated by using the difference between estimated existing loading (Step 5) and the LDC (TMDL). This difference is expressed as a percent reduction, and the hydrologic condition class with the largest percent reduction is selected as the critical condition and the overall PRG for the LA. Results of all these calculations are discussed in Section 5

SECTION 5
TMDL CALCULATIONS

5.1 TMDLs

A TMDL is defined as the total quantity of a pollutant that can be assimilated by a receiving water body while achieving WQSs. A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for uncertainty concerning the relationship between effluent limitations and water quality.

This definition can be expressed by the following equation:

$$TMDL = \Sigma\ WLA + \Sigma\ LA + MOS$$

The objective of the TMDL is to estimate allowable pollutant loads and to allocate those loads to the known pollutant sources in the watershed so the appropriate control measures can be implemented and the WQS achieved. 40 CFR § 130.2 (1) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For fecal coliform, TMDLs are expressed as cfus per day, where possible, or as percent reductions, and represent the maximum 1-day load the stream can assimilate and still maintain the WQS.

5.2 Critical Conditions and Estimated Loading

USEPA regulations at 40 CFR 130.7(c) (1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Available instream WQM data were evaluated with respect to flows and magnitude of water quality criteria exceedance using LDCs. Load duration curve analysis involves using measured or estimated flow data, instream criteria, and fecal coliform concentration data to assess flow conditions in which water quality exceedances are occurring (SCDHEC 2003a). The goal of flow weighted concentration analysis is to compare instream observations with flow values to evaluate whether exceedances generally occur during low or high flow periods (SCDHEC 2003a).

To calculate the fecal coliform load at the WQS, the instantaneous fecal coliform criterion of 400 cfu/100 m/L is multiplied by the flow rate at each flow exceedance percentile, and a unit conversion factor (2.4466×10^{7} $s \cdot m/L \cdot day^{-1} \cdot ft^{-3}$). This calculation produces the maximum fecal coliform load in the stream without exceeding the instantaneous standard over the range of flow conditions.

The allowable fecal coliform loads at the WQS establish the TMDL and are plotted versus flow exceedance percentile as an LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a fecal coliform load.

To estimate existing loading, the loads associated with individual fecal coliform observations are paired with the actual or estimated flow at the same site on the same date. Fecal coliform loads are then calculated by multiplying the measured fecal coliform concentration by the flow rate and a unit conversion factor of 2.4466×10^{7} $s \cdot mL \cdot day^{-1} \cdot ft^{-3}$. The associated flow exceedance percentile is then matched with the measured flow from the tables provided in Appendix D. The observed fecal coliform loads are then added to the LDC plot as points. These points represent individual ambient water quality samples of fecal coliform. Points above the LDC indicate the fecal coliform instantaneous standard was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample met the WQS.

The LDC approach recognizes that the assimilative capacity of a water body depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading, and load reductions required to meet the TMDL water quality target, can also be calculated under different flow conditions. The difference between existing loading and the water quality target is used to calculate the loading reductions required. Given that the instantaneous fecal coliform criterion indicates that no more than 10 percent of samples should exceed 400 cfu/100 m/L, it is appropriate to evaluate existing loading as the 90th percentile of observed fecal coliform concentrations. Together with the MOS, the reduction calculated in this way should ensure that no more than 10 percent of samples will exceed the criterion.

Existing loading is calculated as the 90th percentile of measured fecal coliform concentrations under each hydrologic condition class multiplied by the flow at the middle of the flow exceedance percentile. For example, in calculating the existing loading under dry conditions (flow exceedance percentile = 60-90 percent), the 75th percentile exceedance flow is multiplied by the 90th percentile of fecal coliform concentrations measured under 60-90th percentile flows.

After existing loading and percent reductions are calculated under each hydrologic condition class, the critical condition for each TMDL is identified as the flow condition requiring the largest percent reduction. However, the "high flow" (<10th percentile flow exceedance) or "low flow" (> 90th percentile flow exceedance) hydrologic conditions will not be selected as critical conditions because these extreme flows are not representative of typical conditions, and few observations are available to reliably estimate loads under these conditions. In the example shown below in Table 5-1 for WQM Station SV-017, while similar load reductions are required under all the hydrologic condition classes, the critical condition occurs under "Dry Conditions," when a 76 percent loading reduction is required to meet the WQS.

The LDC for WQM Station SV-017 shown in Figure 5-1 indicates actual fecal coliform loads are exceeding the instantaneous load of the WQS during all flow conditions. A closer look at the LDCs prepared for all the WQM stations (See Appendix E) addressed in this report indicate that fecal coliform loads are exceeding the instantaneous load of the WQS during most flow conditions. The LDCs were developed for the time period from January 1990 through December 2002.

The existing instream fecal coliform load (actual or estimated flow multiplied by observed fecal coliform concentration) is compared to the allowable load for that flow. Any existing loads above the allowable LDCs represent an exceedance of the WQS. For a low flow loading situation, there are typically observations in excess of criteria at the low flow side of the chart. For a high flow loading situation, observations in excess of criteria at the high flow side of the chart are typical. For water bodies impacted by both point and nonpoint sources, the "nonpoint source critical condition" would typically occur during high flows, when rainfall runoff would contribute the bulk of the pollutant load, while the "point source critical condition" would typically occur during low flows, when treatment plant effluents would dominate the base flow of the impaired water.

Table 5-1 Estimated Existing Fecal Coliform Loading for Station SV-017, with Critical Condition Highlighted

Hydrologic Condition Class*	Estimated Existing Loading (cfu/100ml)	% Reduction Required
High Flows	3.56E+11	NA
Moist Conditions	8.76E+10	64%
Mid-Range Conditions	5.12E+10	69%
Dry Conditions	4.25E+10	76%
Low Flows	2.02E+10	NA

* Hydrologic Condition Classes are derived from Cleland 2003.

Figure 5-1 Estimated Fecal Coliform Load and Critical Conditions, Station SV-017

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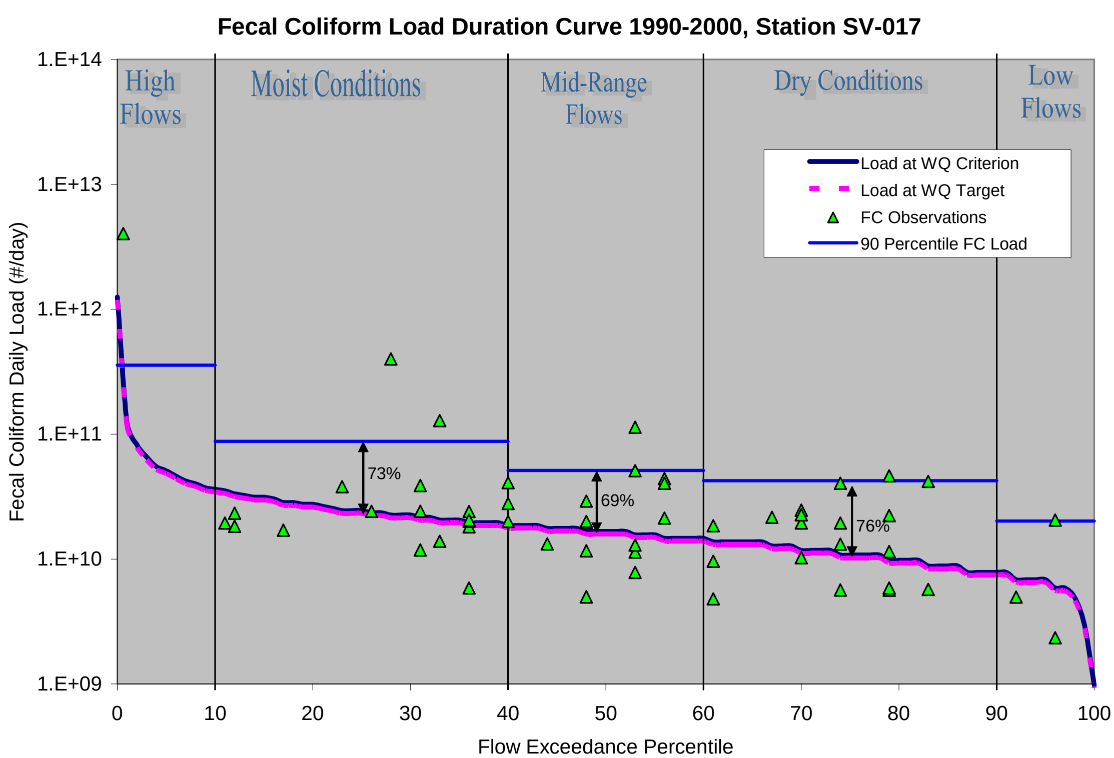


Based on these characteristics, critical conditions for each WQM station are summarized in Table 5-2.

Table 5-2 Summary of Critical Conditions for each WQM Station as derived from Load Duration Curves

SCDHEC WQM Station	Moist Conditions	Mid-Range Conditions	Dry Conditions
SV-017			✱
SV-245	✱		
SV-135	✱		
SV-233		✱	
SV-268	✱		
SV-241	✱		
SV-111		✱	
SV-052	✱		
SV-164			✱
SV-348	✱		
SV-192		✱	
RS01049			✱
SV-053B	✱		
SV-349	✱		
SV-318	✱		

The existing load for each WQM station was derived from the critical condition line depicted on the LDCs described above and provided in Appendix E. Estimated existing loading is derived from the 90th percentile of observed fecal coliform loads corresponding to the critical condition identified at each WQM station identified in Table 5-2. This estimated loading is indicative of loading from all sources including continuous point source dischargers, MS4s, SSOs, failing septic systems, wildlife, domestic pets, and livestock. The total estimated existing load for each station is provided in Table 5-3.

Table 5-3 Estimated Existing Loading at each WQM Station

SCDHEC WQM Station	90th Percentile Load Estimation (counts/day)	Flow Exceedance Percentile
SV-017	4.25E+10	75
SV-245	6.54E+11	25
SV-135	2.08E+12	25
SV-233	1.40E+12	50
SV-268	4.07E+12	25
SV-241	8.61E+11	25
SV-111	2.13E+12	50
SV-052	1.94E+11	25
SV-164	1.77E+11	75
SV-348	1.79E+12	25
SV-192	8.76E+11	50
RS01049	5.53E+09	75
SV-053B	2.09E+12	25
SV-349	7.74E+11	25
SV-318	6.06E+12	25

5.3 Waste Load Allocation

Table 5-4 summarizes the WLA of the permitted NPDES facilities within the watershed of each WQM station. The WLA for each facility is derived from the following equation:

WLA = WQS * flow * unit conversion factor (#/day)

Where: WQS = 400 cfu /100mL

flow (cfs) = permitted flow

*unit conversion factor = 24,465,525 mL*s / ft^3*day*

Table 5-4 Wasteload Allocations (WLA) for NPDES Permitted Facilities

Water Quality Monitoring Station / Permittee	NPDES Permit Number	Flow (mgd)	Load (counts/day)
HUC 03060101090			
SV-245 Eighteen Mile Creek at S-39-27			
Pickens County/ 18 Mile Ck Upper Reg. WWTP	**SC0042994**	1.0	1.51E+10
SV-135 Eighteen Mile Creek at S-39-93			
Heatherwood SD/Madera Util.	**SC0029548**	0.072	1.09E+09
Pickens County/ 18 Mile Ck Middle Reg. WWTP	**SC0047856**	1.0	1.51E+10
SV-233 Eighteen Mile Creek at S-2-04-279			
Milliken & Co./Pendleton Finishing **(no fc limit)**	**SC0000477**	0.171*	2.59E+09
Town of Pendleton-Clemson Reg. WWTP	**SC0035700**	2.0	3.03E+10
SV-241 Woodside Branch at US 123			
Liberty Denim LLC	**SC0000264**	0.397*	6.01E+09
HUC 03060101100			
SV-111 Three and Twenty Creek At S-04-280			
Mt Vernon Mills/Lafrance	**SC0000485**	0.10**	1.51E+09
Michelin N America/Sandy Springs	**SC0026701**	.325*	4.92E+09
HUC 03060103140			
SV-052 Sawney Creek at Co. Rd. 1.5 mi. SE of Calhoun Falls			
Town of Calhoun Falls	**SC0025721**	3.0	4.54E+10
SV-348 Little River at S-01-32			
Town of Due West WWTP	**SC0022403**	0.30	4.54E+09
SV-192 Little River at S-33-19			
Milliken & Co./Sharon Plant	**SC0023477**	0.04*	6.06E+08
HUC 03060103150			
SV-318 Long Cane Creek at S-33-117			
City of Abbeville	**SC0040614**	1.7	2.57E+10
* Maximum Monthly Average Flow (2002 - 2004)			
** Average flow rate from permit Fact Sheet (Maximum Day is 0.371 mgd).			

When multiple NPDES facilities occur within a watershed, individual WLAs are summed and the total WLA for continuous point sources is included in the TMDL calculation for the corresponding WQM station. When there are no NPDES WWTPs discharging into the contributing watershed of a WQM station, then the WLA is zero.

Some portion of four different MS4s fall within the Eighteen Mile Creek watershed (HUC 03060101090). There are no MS4s in Three and Twenty Creek watershed (HUC 0306010110), Little River watershed (HUC 03060103140) or Long Cane Creek watershed (HUC 03060103150). Because of insufficient data, it is not possible to express a WLA for MS4s as a load or concentration; therefore, the WLA is expressed as a PRG. Each MS4 was assigned a PRG equal to the PRG identified in the LA for each WQM station. The PRGs that will serve as a component of the WLA are provided in Table 5-5. When multiple WQM stations fall under one MS4 jurisdiction, multiple PRGs can occur. In these cases the highest PRG is selected as the overall reduction requirement incorporated into the TMDL of each station. For example, by reviewing the LDCs in Appendix E, Stations SV-241 and SV-245 have PRGs of 89 percent and 69 percent, respectively. Therefore, using a conservative approach, the highest reduction goal of 89 percent is selected and incorporated into the TMDLs (see Table 5-5) for both WQM stations SV-241 and SV-245.

Table 5-5 WLA for MS4 Entities in Eighteen Mile Creek Watershed (HUC 03060101090)

MS4 Entity	WQM Stations	Percent Reduction
City of Easely	SV-017	76
Liberty	SV-241, SV-245	89
Clemson	SV-233	57
Pickens County	SV-268, SV-233, SV-135	77

5.4 Load Allocation

As discussed in Section 3, nonpoint source fecal coliform loading to the receiving streams of each WQM station emanate from a number of different sources. As discussed in Section 4, nonpoint source loading was estimated and depicted under all flow conditions using LDCs. Figure 5-1, the LDC for SV-017, displays the relationships between the TMDL water quality target, the MOS, and the PRG that will serve as an alternative for expressing the LA. The data analysis and the LDCs demonstrate that exceedances at most of the WQM stations are the result of continuous nonpoint source loading such as failing septic systems, cattle in streams, and fecal loading from wildlife and domestic pets transported by runoff events. The LAs, calculated as the difference between the TMDL, MOS, and WLA, for each WQM station are presented in Table 5-6. Where MS4s are present then the LA is not calculated and is expressed as a PRG.

5.5 Seasonal Variability

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Seasonal variation was accounted for in these TMDLs by using more than 5 years of water quality data (1990-2002) whenever possible and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

5.6 Margin of Safety

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs include an MOS. The MOS is a conservative measure incorporated into the TMDL equation that accounts for the uncertainty associated with calculating the allowable fecal coliform pollutant loading to ensure WQSs are attained. USEPA guidance allows for use of implicit or explicit expressions of the MOS, or both. When conservative assumptions are used in development of the TMDL, or conservative factors are used in the calculations, the MOS is implicit. When a specific percentage of the TMDL is set aside to account for uncertainty, then the MOS is considered explicit.

For the explicit MOS the water quality target was set at 380 cfu/100 m/L for the instantaneous criterion, which is 5 percent lower than the water quality criterion of 400 cfu/100 m/L. The net effect of the TMDL with MOS is that the assimilative capacity of the watershed is slightly reduced. These TMDLs incorporates an explicit MOS by using a curve representing 95 percent of the TMDL as the average MOS. The MOS at any given percent flow exceedance, therefore, can be defined as the difference in loading between the TMDL and the TMDL with MOS. For consistency, the explicit MOS at each WQM station will be expressed as a numerical value derived from the same critical condition as the largest load reduction goal at the respective 25th, 50th, or 75th flow exceedance percentile (see Table 5-5).

There are other conservative elements utilized in these TMDLs that can be recognized as an implicit MOS such as:

- The use of instream fecal coliform concentrations to estimate existing loading; and
- The highest PRG for nonpoint sources, based on the LDC used.

This conservative approach to establishing the MOS will ensure that both the 30-day geometric mean and instantaneous fecal coliform bacteria standards can be achieved and maintained.

5.7 TMDL Calculations

The fecal coliform TMDLs for the 303(d)-listed WQM stations covered in this report were derived using LDCs. A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for uncertainty concerning the relationship between effluent limitations and water quality.

This definition can be expressed by the following equation:

$$TMDL = \Sigma\, WLA + \Sigma\, LA + MOS$$

For each WQM station the TMDLs presented in this report are expressed in cfus per day or as a percent reduction. The TMDLs are presented in fecal coliform counts to be protective of both the instantaneous, per day, and geometric mean, per 30-day, criteria. To express a TMDL as an individual value, the LDC is used to derive the LA, the MOS, and the TMDL based on the median percentile of the critical condition (*i.e.*, the median percentile of the hydrologic condition class requiring the greatest percent reduction to meet the instantaneous criterion which is the water quality target). The WLA component of each TMDL is the sum of all WLAs within the contributing watershed of each WQM station which is derived from each NPDES facilities' maximum design flow and the permitted 1-day maximum concentration of 400 cfu/100 m/L. When MS4s do not exist in the contributing watershed,the LDC and the simple equation of:

$$Average\ LA = average\ TMDL - MOS - \sum WLA$$

can provide an individual value for the LA in counts per day which represents the area under the TMDL target line and above the WLA line. Percent reductions necessary to achieve the water quality target are also provided for all WQM stations as another acceptable representation of the TMDL. Like the LA, the percent reduction is derived from the median percentile of the critical condition (*i.e.*, the median percentile of the hydrologic condition class requiring the greatest percent reduction to meet the instantaneous criterion which is the water quality target). Table 5-6 summarizes the TMDLs for each WQM station, and Figures 5-2 through 5-16 present the LDCs for each station depicting the TMDL, MOS, and WLA.

Table 5-6 TMDL Summary for WQM Stations in Eighteen Mile Creek, Three and Twenty Creek, Little River and Long Cane Creek Watersheds

SCDHEC WQM Station	WLAs (cfu/day)	MS4 WLA (% reduction)	LA (cfu/day or % reduction)	MOS	TMDL (cfu/day or % reduction)	Percent reduction
Eighteen Mile Creek and Three and Twenty Creek HUCs 03060101090 and -110						
SV-017	0	76	76	5.38E+08	1.08E+10	76
SV-245	1.51E+10	89	89	1.08E+10	2.16E+11	89
SV-135	1.62E+10	77	77	2.54E+10	5.08E+11	77
SV-233	2.59E+9	57	57	3.14E+10	6.28E+11	57
SV-268	0	77	77	5.43E+10	1.09E+12	77
SV-241	6.01E+09	NA	9.16E+10	5.14E+09	1.03E+11	89
SV-111	6.44E+09	NA	9.60E+11	5.08E+10	1.02E+12	55
Little River and Long Cane Creek HUCs 03060103140 and -150						
SV-052	4.54E+10	NA	1.41E+10	3.13E+09	6.26E+10	69
SV-164	0	NA	1.08E+11	5.68E+09	1.14E+11	39
SV-348	4.54E+09	NA	1.25E+12	6.61E+10	1.32E+12	30
SV-192	6.06E+08	NA	5.40E+11	2.84E+10	5.69E+11	38
RS01049	0	NA	2.79E+09	1.47E+08	2.94E+09	50
SV-053B	0	NA	1.67E+10	8.81E+08	1.76E+10	99
SV-349	0	NA	2.86E+11	1.51E+10	3.01E+11	63
SV-318	2.57E+10	NA	4.72E+12	2.50E+11	4.99E+12	22

There are several municipalities in the watershed that have or will have NPDES MS4 permits. These communities will eventually be covered under one or more NPDES Phase II stormwater permits. The reduction percentages in this TMDL apply also to the fecal coliform WLA attributable to those areas of the watershed which are covered or will be covered under NPDES MS4 permits. Compliance by those municipalities within the terms of their individual MS4 permits will fulfill any obligations they have toward implementing this TMDL.

Figure 5-2 TMDL for SV-017 Eighteen Mile Creek

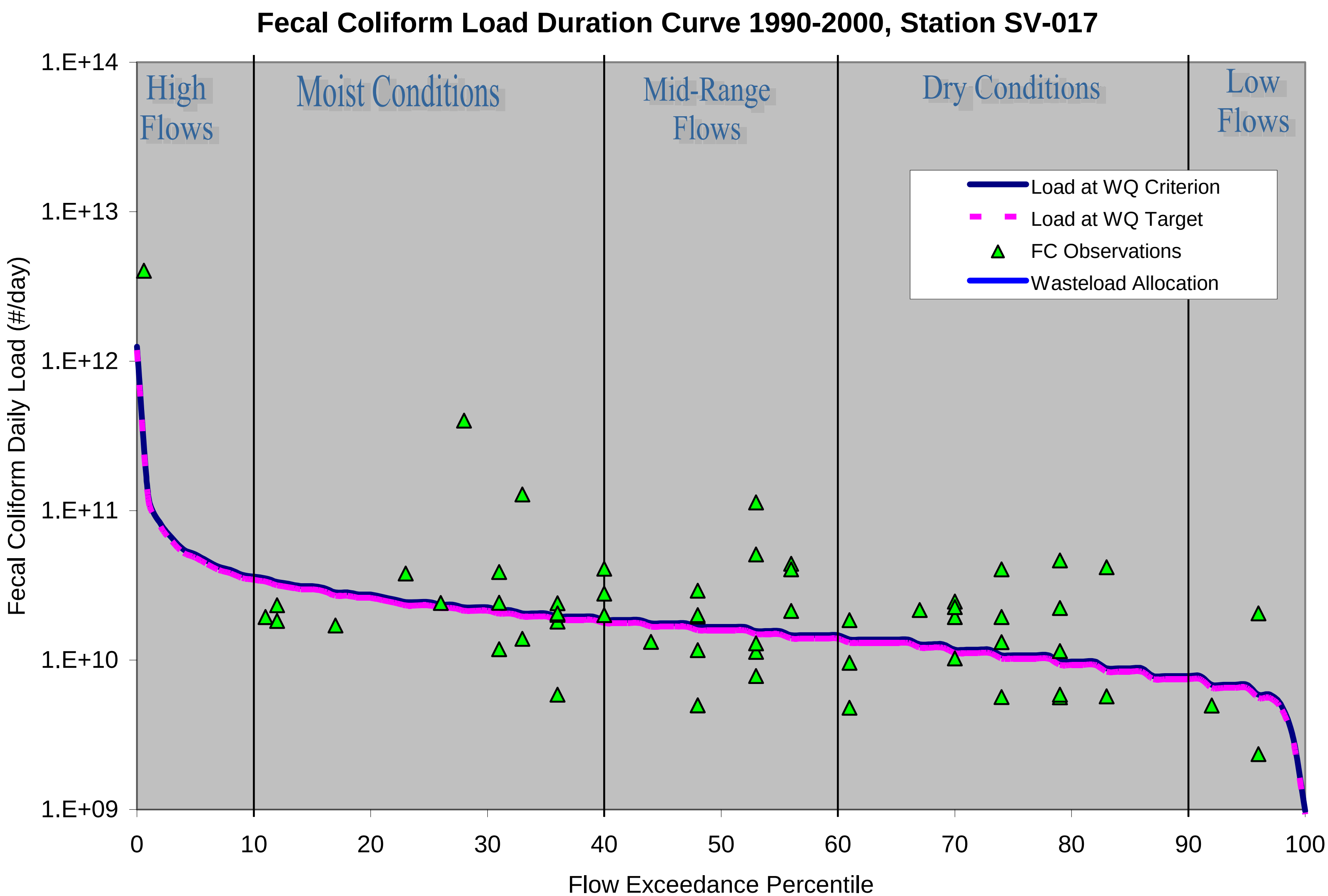


Figure 5-3 TMDL for SV-245 Eighteen Mile Creek

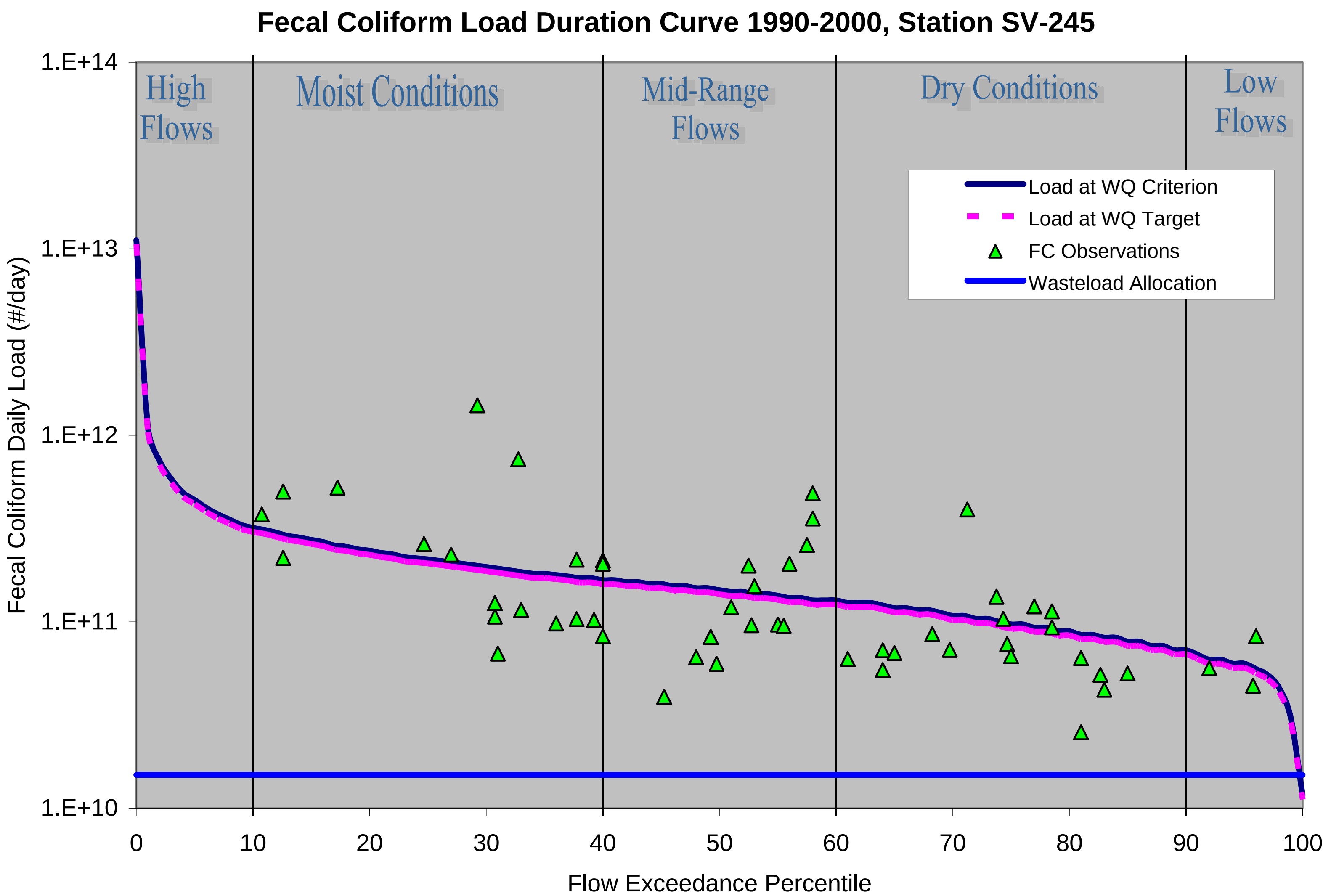


Figure 5-4 TMDL for SV-135 Eighteen Mile Creek

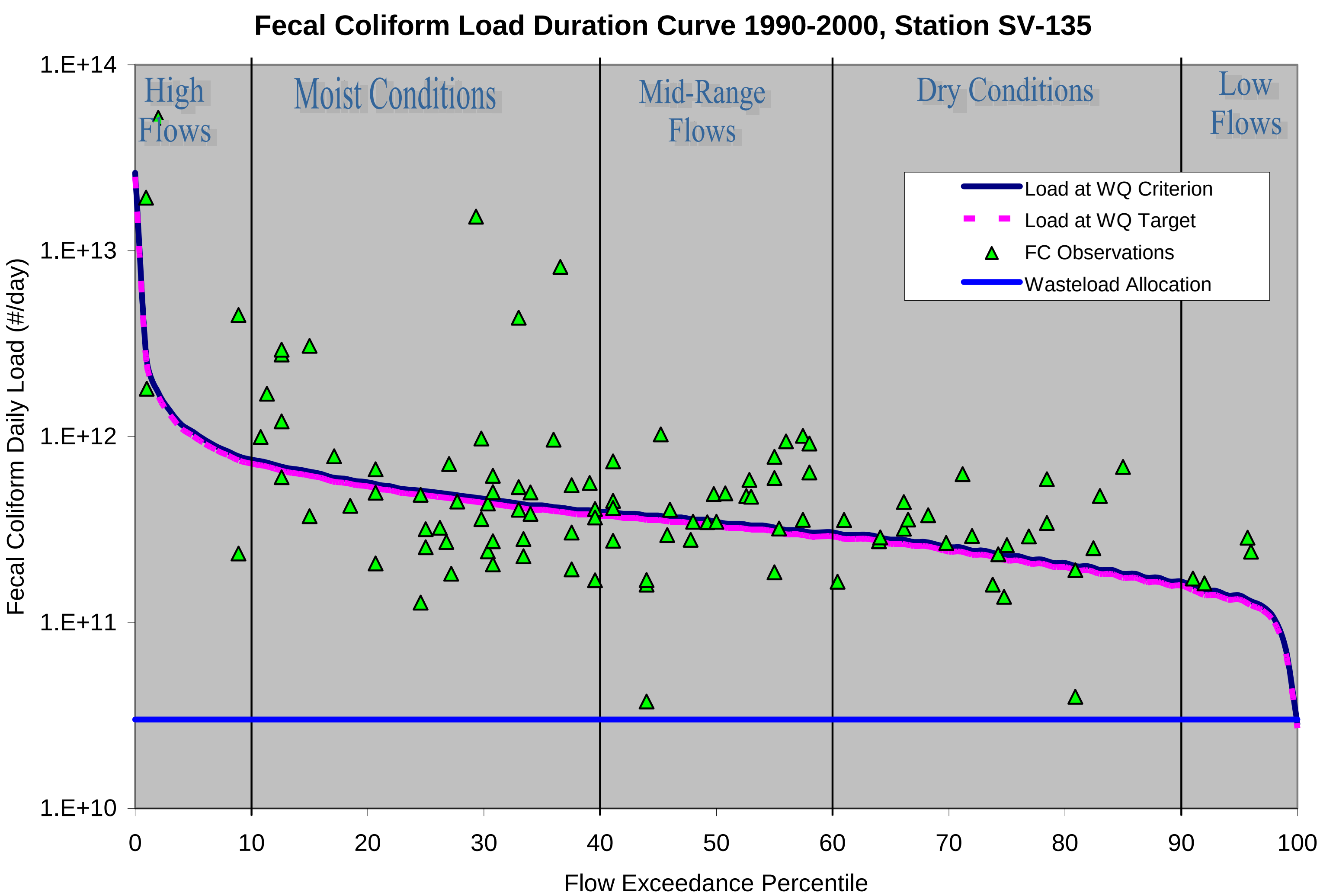


Figure 5-5 TMDL for SV-233 Eighteen Mile Creek

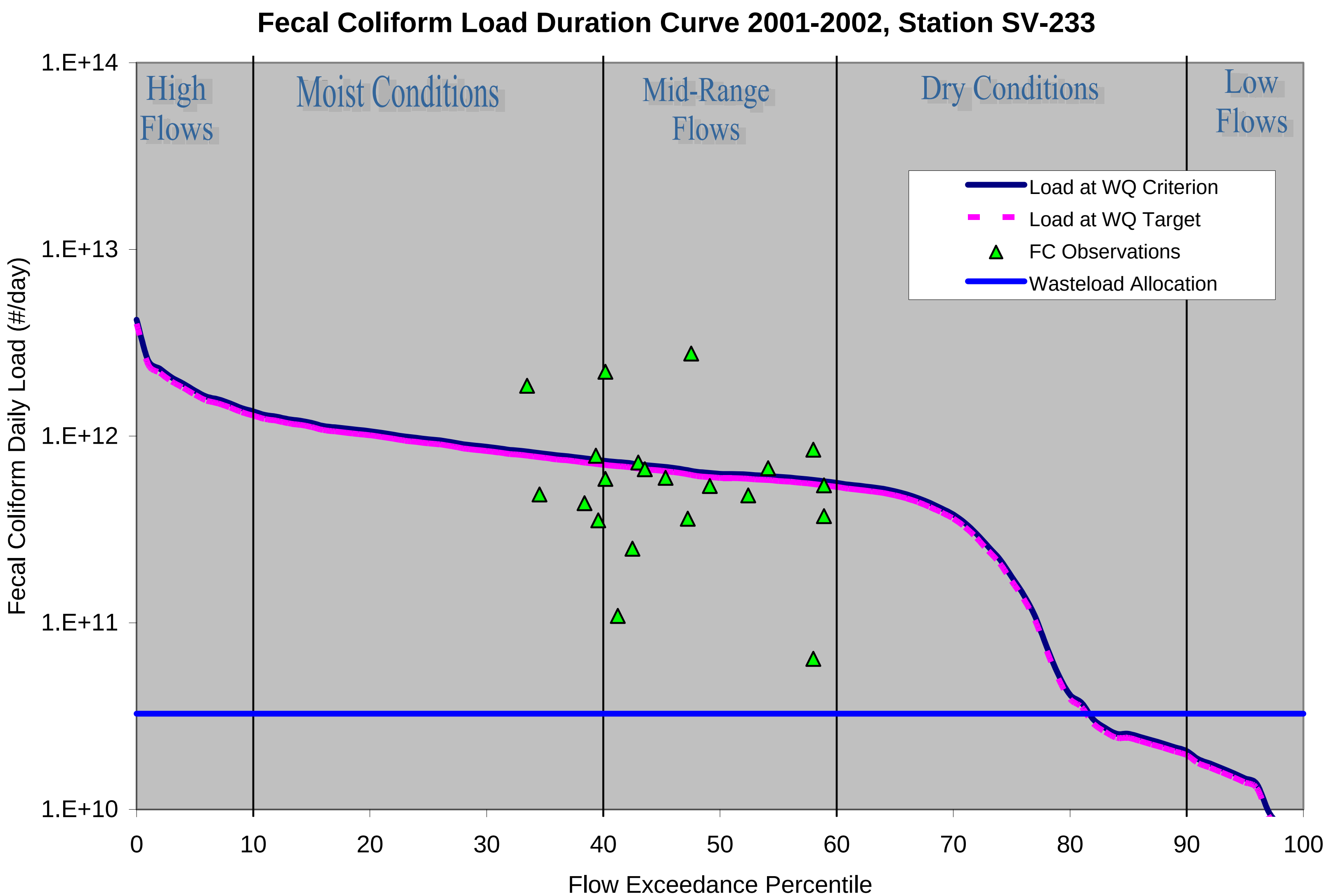


Figure 5-6 TMDL for SV-268 Eighteen Mile Creek

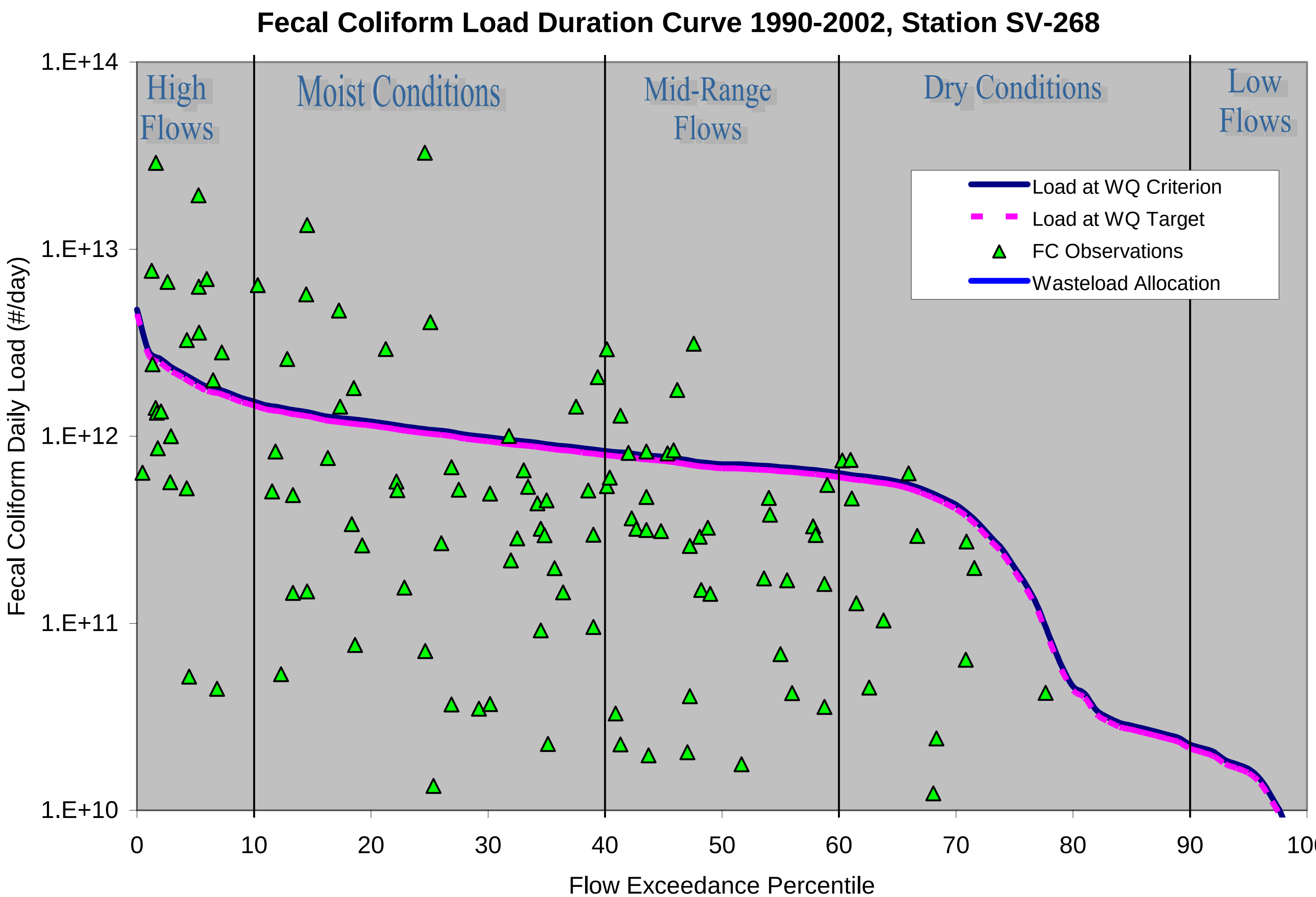


Figure 5-7 TMDL for SV-241 Woodside Branch

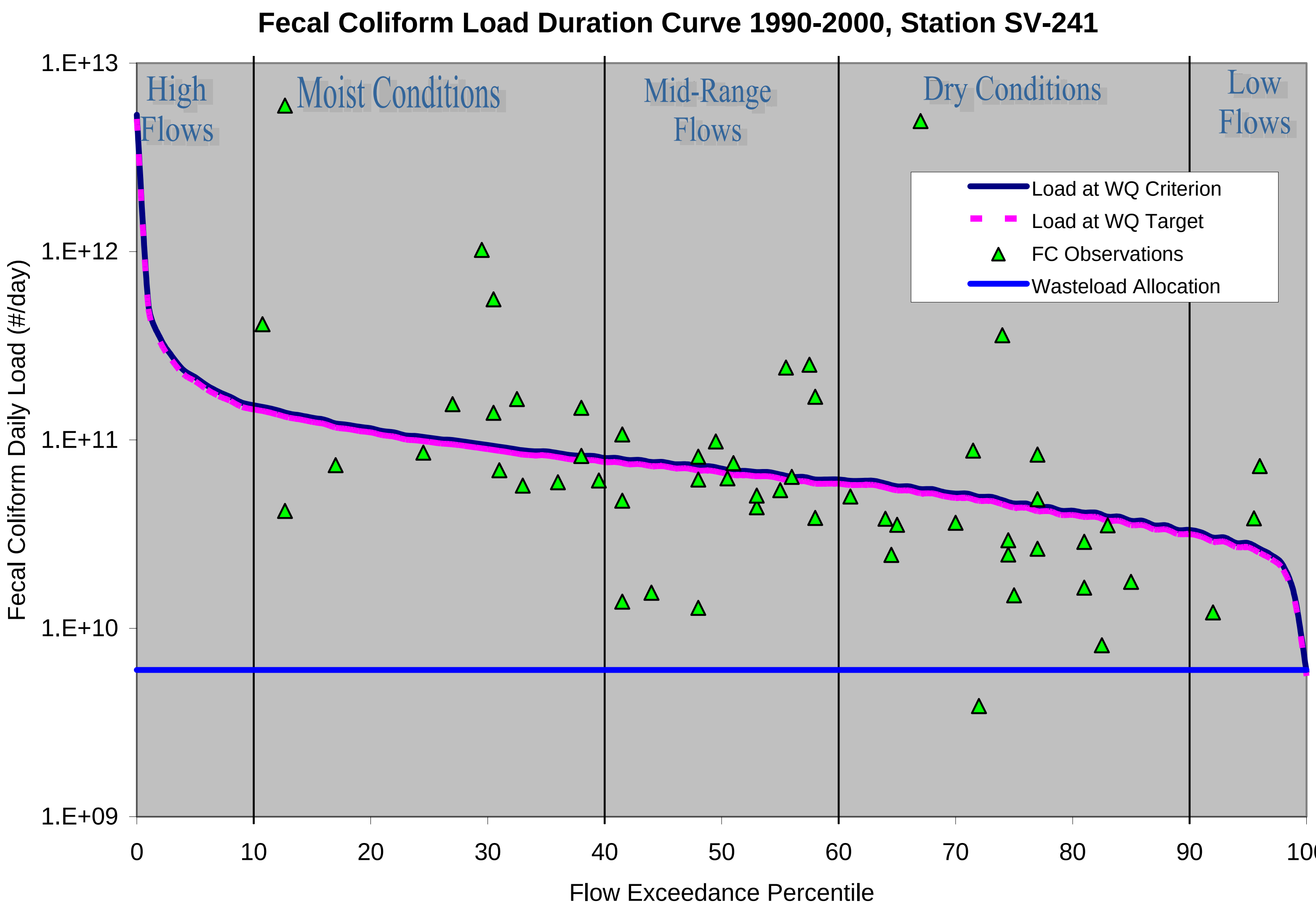


Figure 5-8 TMDL for SV-111 Three and Twenty Creek

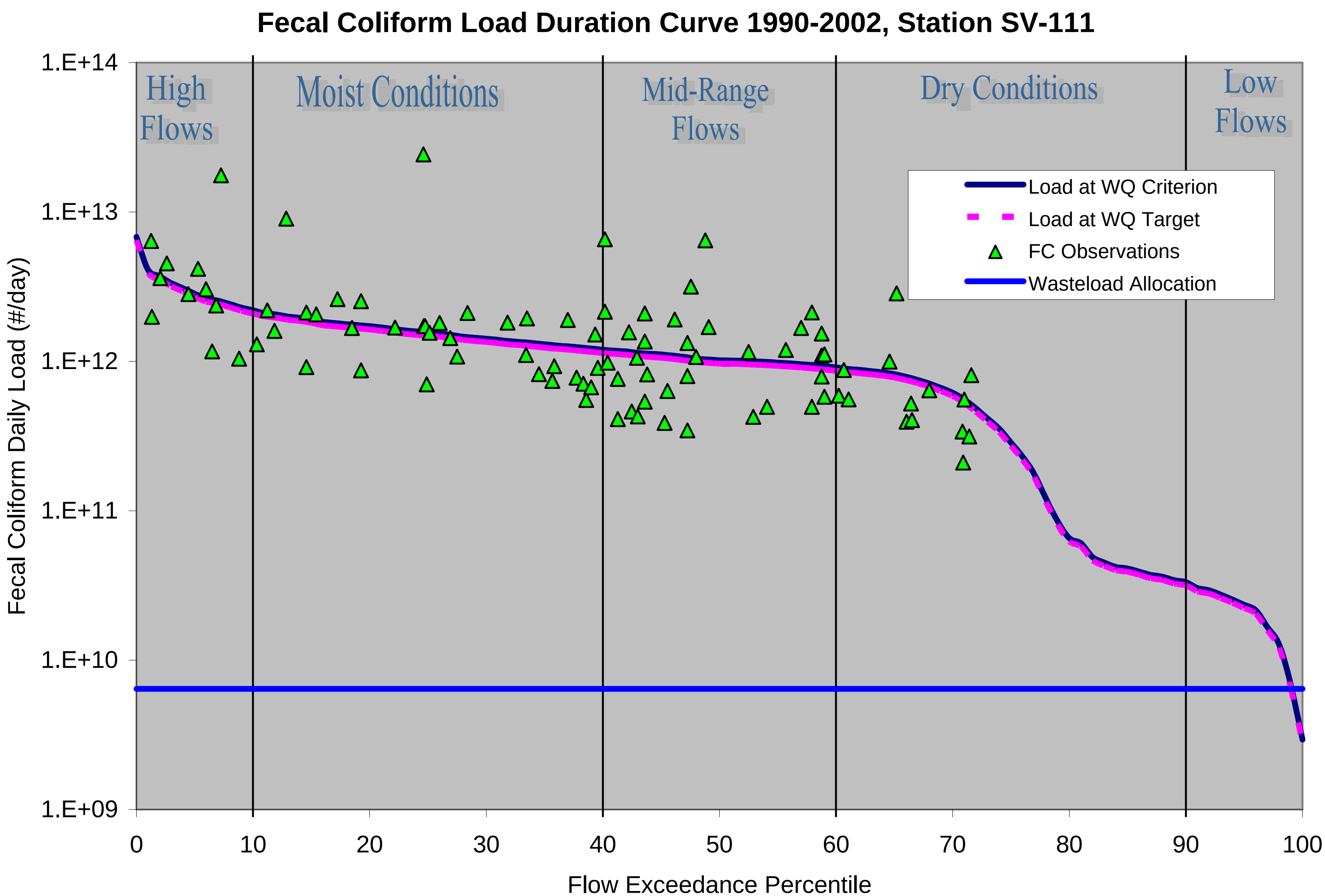


Figure 5-9 TMDL for SV-052 Sawney Creek

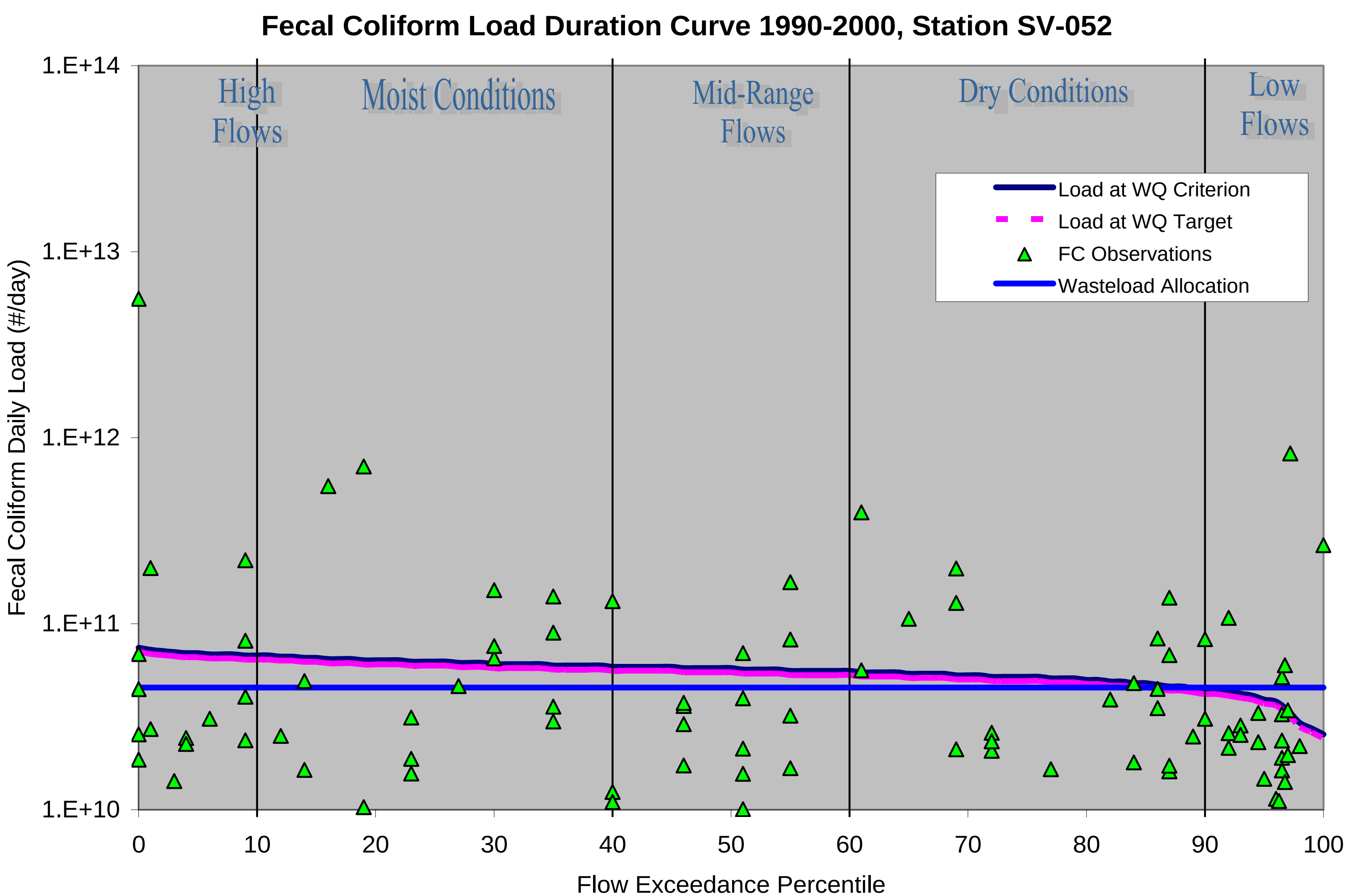


Figure 5-10 TMDL for SV-164 Little River

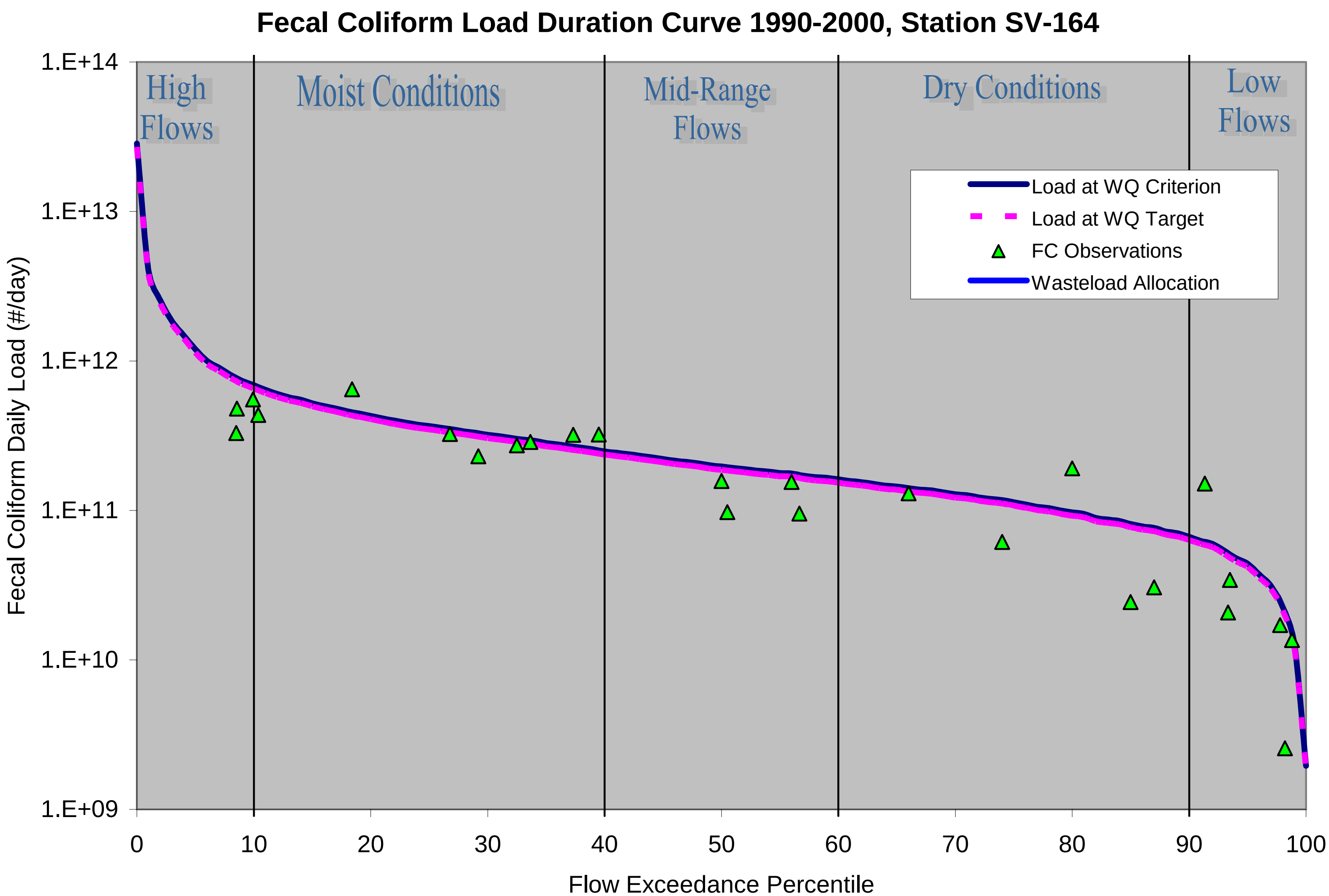


Figure 5-11 TMDL for SV-348 Little River

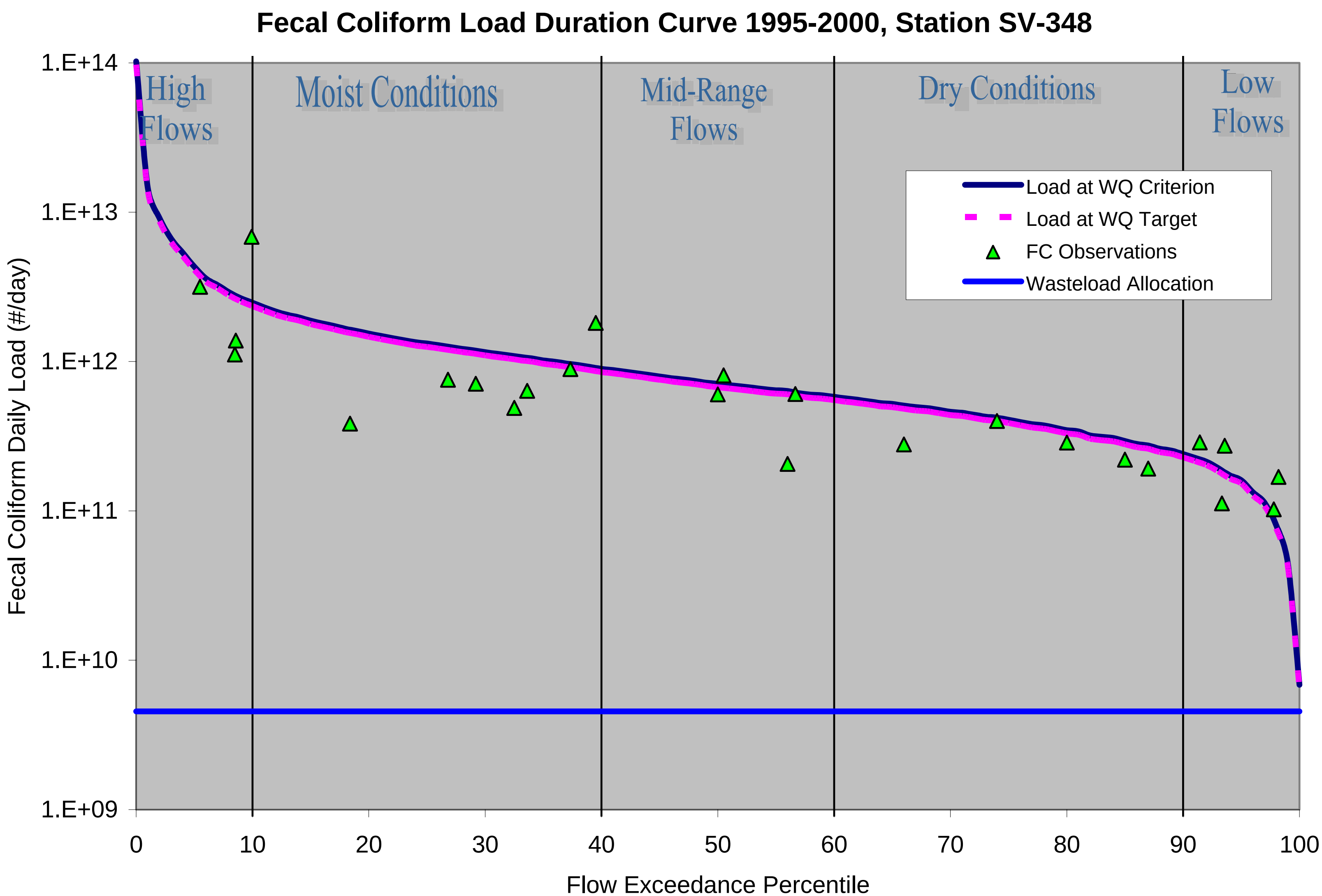


Figure 5-12 TMDL for SV-192 Little River

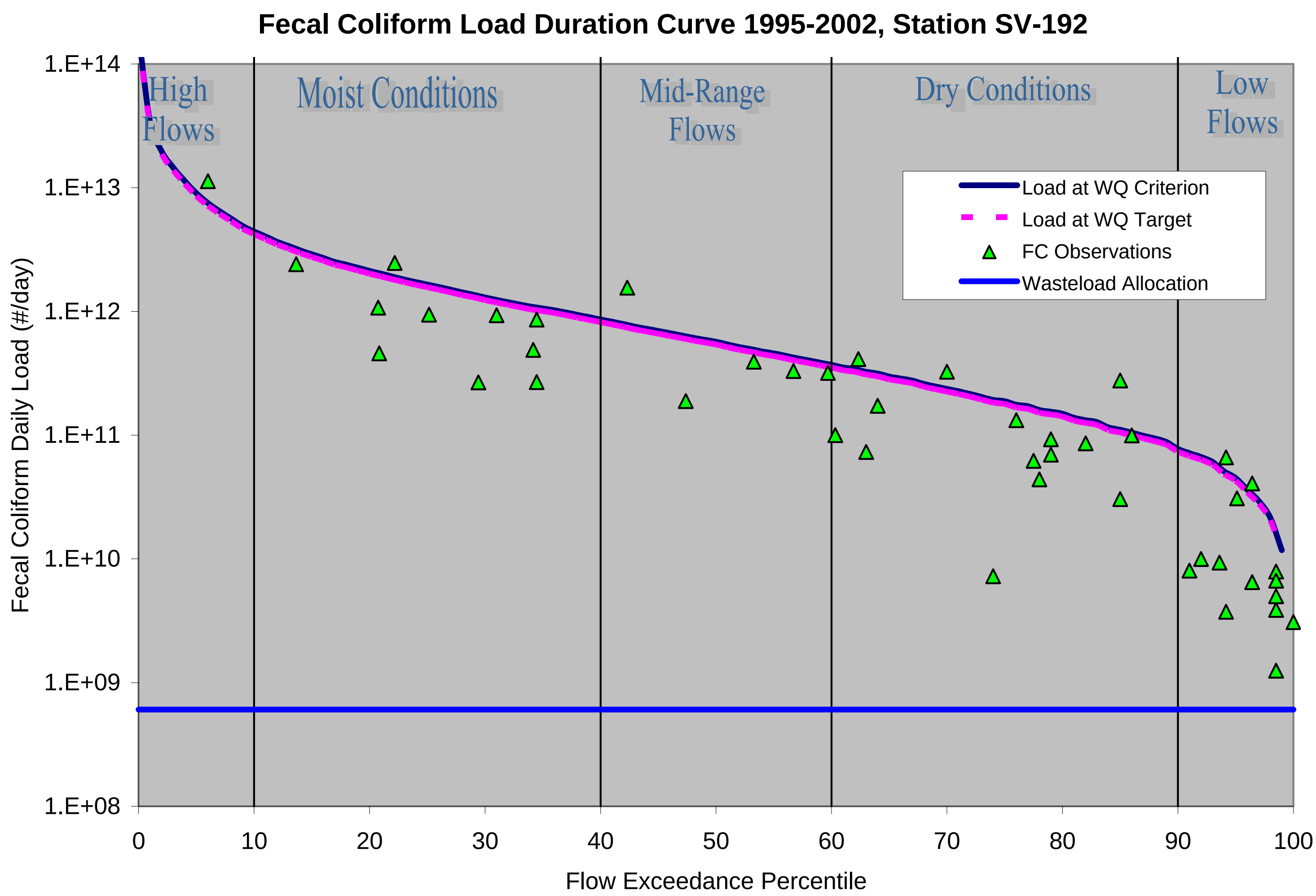
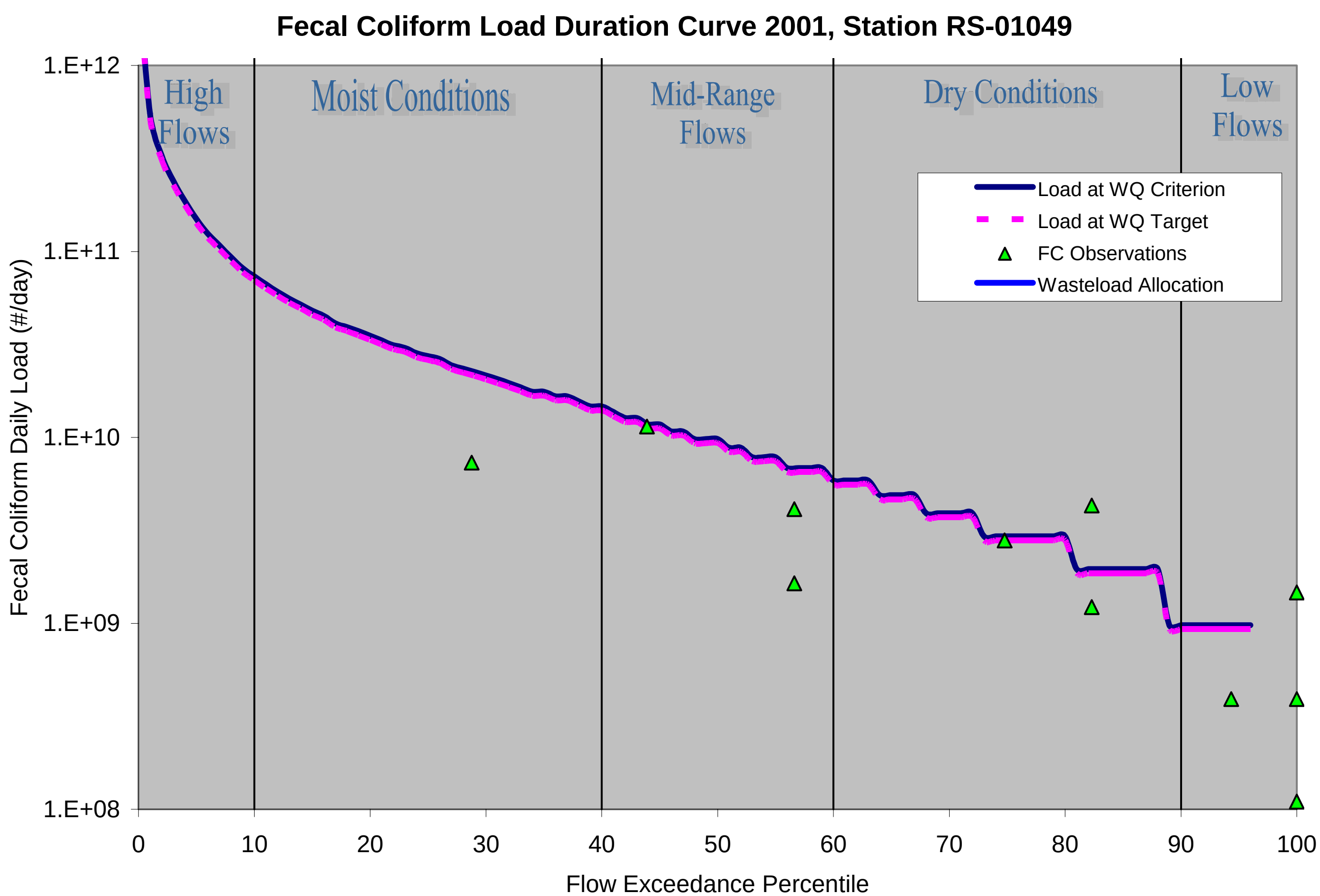
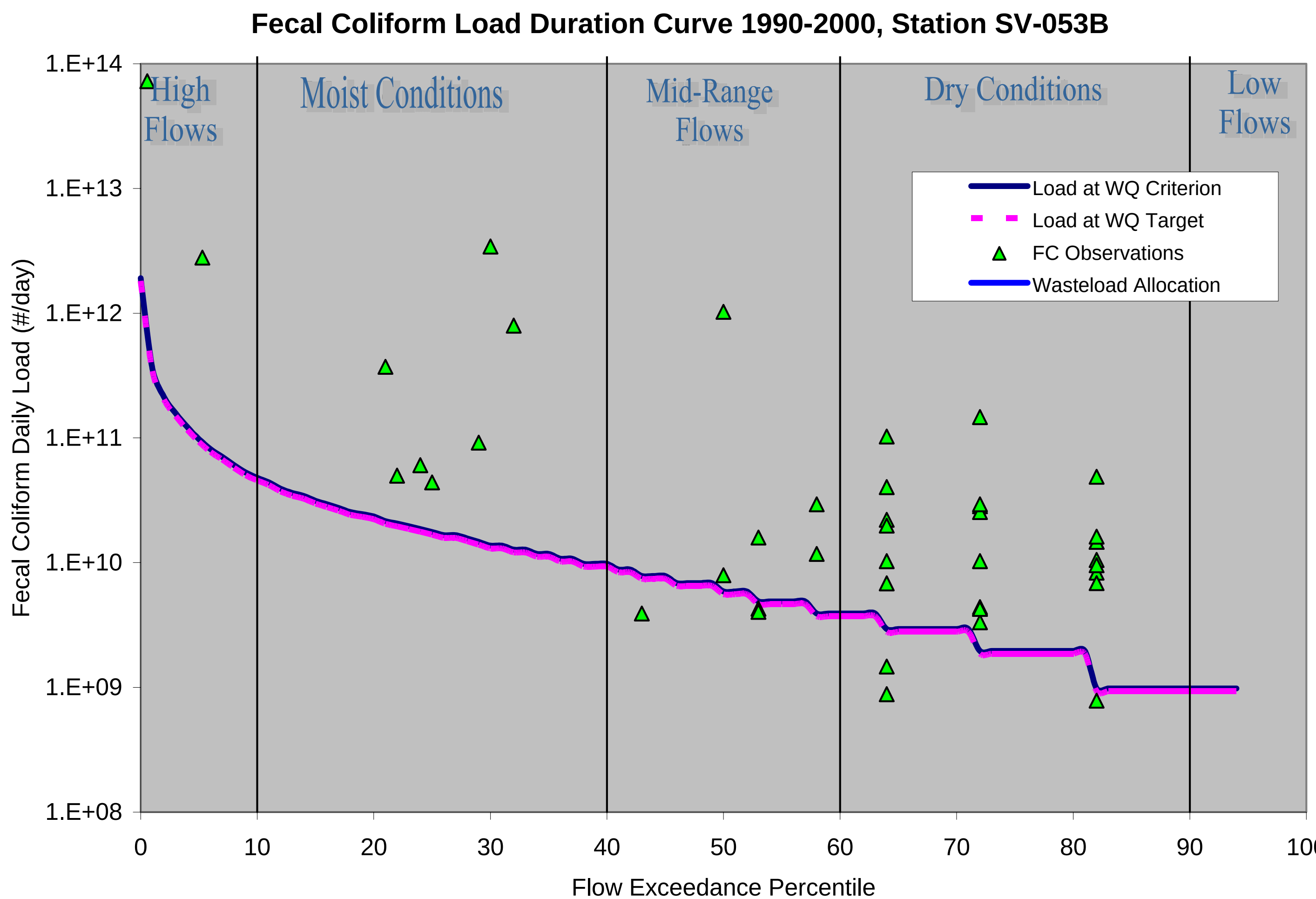


Figure 5-13 TMDL for RS-01049 Calhoun Creek



The stepped characteristic of the load duration curve at SV-053B is caused by the extremely low flow conditions typical of this stream. This effect is related to the estimated flow values provided in Appendix D for SV-053B, which starting from the 51st flow exceedance percentile up to the 96th percentile, are less than 1. The plotting of the curve using flow values with single digit integers does not have sufficient resolution to display the line as a smooth curve.

Figure 5-14 TMDL for SV-053B Blue Hill Creek



The stepped characteristic of the load duration curve at SV-053B is caused by the extremely low flow conditions typical of this stream. This effect is related to the estimated flow values provided in Appendix D for SV-053B, which starting from the 41st flow exceedance percentile up to the 94th percentile, are less than 1. The plotting of the curve using flow values with single digit integers does not have sufficient resolution to display the line as a smooth curve.

Figure 5-15 TMDL for SV-349 Long Cane Creek

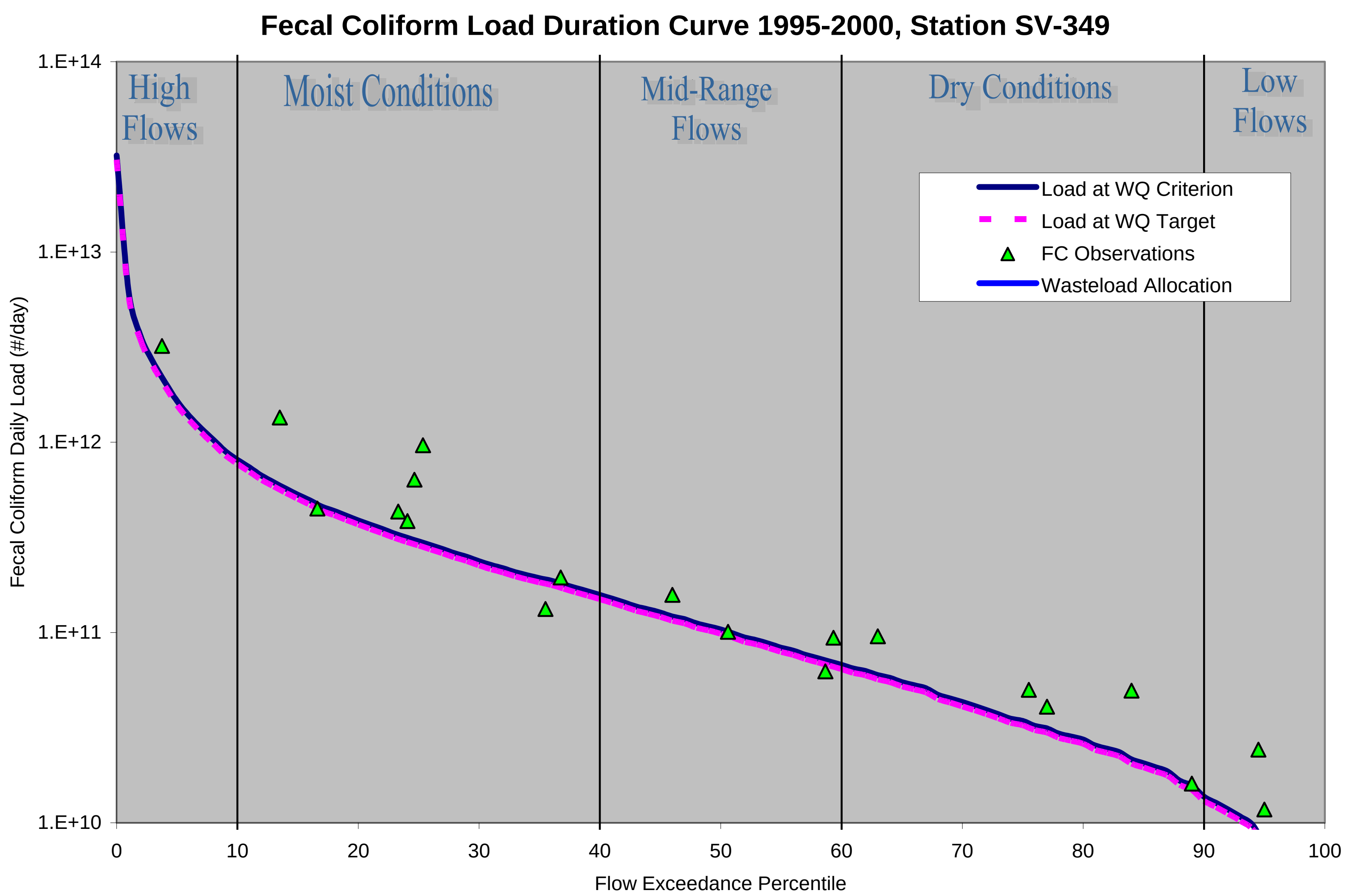
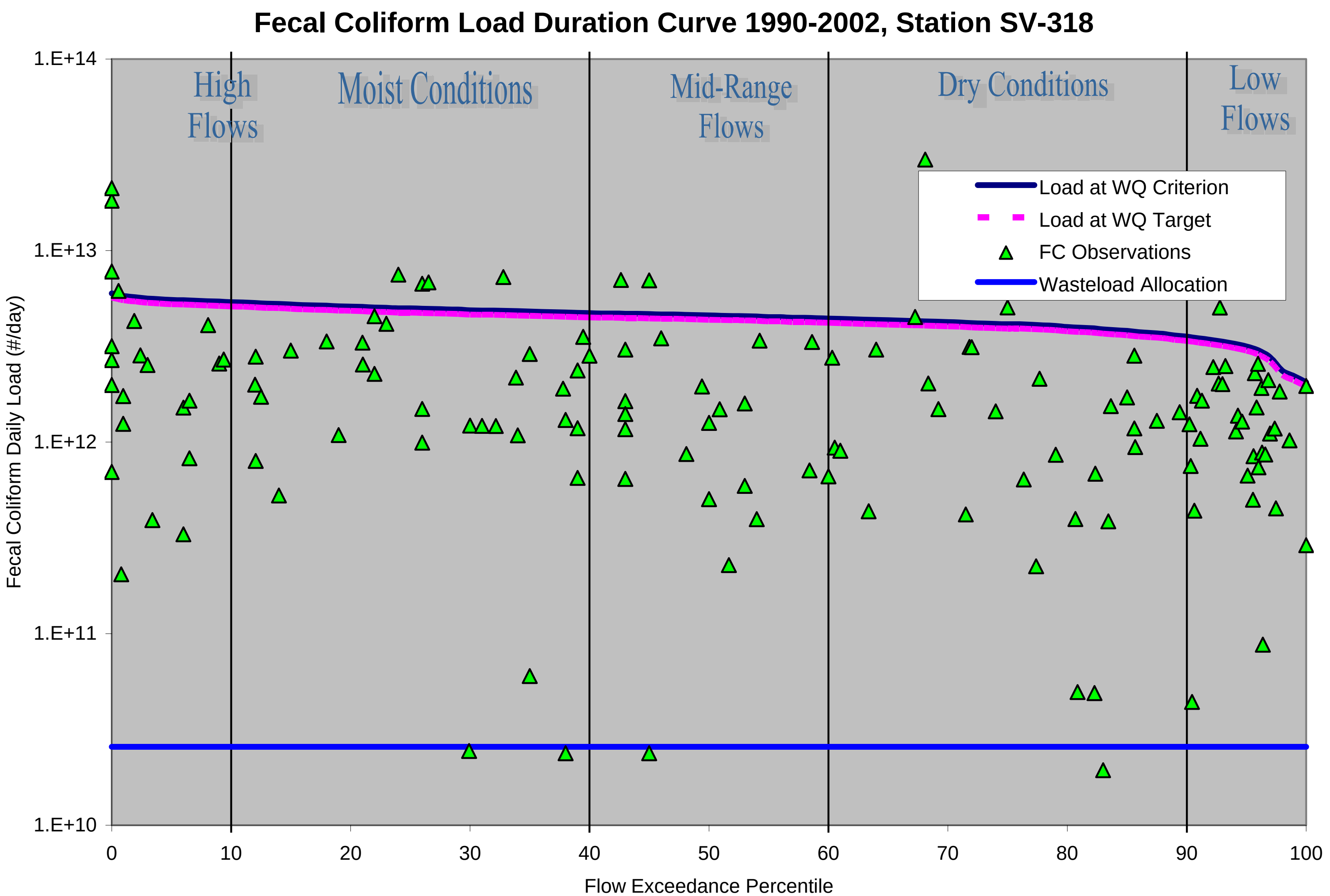


Figure 5-16 TMDL for SV-318 Long Cane Creek



SECTION 6
PUBLIC PARTICIPATION

Section 303(d)(1) of the Clean Water Act (CWA), 33 United States Code [USC] §1313(d)(1)(C), and the implementing regulation of the U.S. Environmental Protection Agency (40 CFR §130.7(c)(1), require the establishment of TMDLs for waters identified by states as not meeting water quality standards (WQS) under authority of §303(d)(1)(A) of the CWA. These TMDLs are established at levels necessary to implement applicable WQSs with seasonal variations and a margin of safety, accounting for lack of knowledge concerning the relationship between pollutant loading and water quality. When USEPA establishes a TMDL, 40 CFR §130.7(d)(2) requires USEPA to publish a Public Notice and seek comments concerning a TMDL.

The USEPA developed fecal coliform bacteria TMDLs for the identified §303(d)(1)(A) waters listed in the table below on the 2004 §303(d) List for the State of South Carolina.

Water Body Name	SCDHEC WQM Station	WQM Station Locations
Eighteen Mile Creek/Lake Hartwell (HUC 03060101090)		
Eighteen Mile Creek	SV-017	Eighteen Mile Creek at unnumbered County Rd 2.25 mi. SSW of Easley
Eighteen Mile Creek	SV-245	Eighteen Mile Creek at S-39-27 3.3 mi. South of Liberty
Eighteen Mile Creek	SV-135	Eighteen Mile Creek at S-39-93 SW of Central
Eighteen Mile Creek	SV-233	Eighteen Mile Creek at 2-04-279
Eighteen Mile Creek	SV-268	Lake Hartwell Eighteen Mile Creek BR at 2-04-1098
Woodside Branch	SV-241	Woodside Branch at US 123 1.5 mi. East of Liberty
Three and Twenty Creek/Lake Hartwell (HUC 03060101100)		
Three & Twenty Creek	SV-111	Three and Twenty Creek at S-04-280
Little River/Lake Thurmond (HUC 03060103140)		
Sawney Creek	SV-052	Sawney Creek at CO Rd 1.5 mi. SE of Calhoun Falls
Little River	SV-164	Little River at S-01-24
Little River	SV-348	Little River at S-01-32
Little River	SV-192	Little River at S-33-19
Calhoun Creek	RS01049	Calhoun Creek at SC-28, 1.5 mi. NW of Abbeville
Long Cane Creek (HUC 03060103150)		
Blue Hill Creek	SV-053B	Blue Hill Creek on S. Main St. Abbeville
Long Cane Creek	SV-349	Long Cane Creek at S-01-159
Long Cane Creek	SV-318	Long Cane Creek at S-33-117

SECTION 7
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APPENDIX A
FECAL COLIFORM DATA – 1990 - 2002

APPENDIX B
PLOTS COMPARING PRECIPITATION AND FECAL COLIFORM CONCENTRATIONS

APPENDIX C
NPDES PERMIT DISCHARGE MONITORING REPORT DATA

APPENDIX D
ESTIMATED FLOW EXCEEDANCE PERCENTILES

APPENDIX E
LOAD DURATION CURVES – ESTIMATED LOADING AND CRITICAL CONDITIONS