TOTAL MAXIMUM DAILY LOAD (TMDL)

for

Pathogens

in the

Little River Subwatershed

of the

Ft. Loudoun Lake Watershed (HUC 06010201)

Blount, Knox, and Sevier Counties, Tennessee

FINAL

Prepared by:

Tennessee Department of Environment and Conservation
Division of Water Pollution Control
6th Floor L & C Tower
401 Church Street
Nashville, TN 37243-1534

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LIST OF ABBREVIATIONS

ADB	Assessment Database
AFO	Animal Feeding Operation
BMP	Best Management Practices
BST	Bacteria Source Tracking
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DWPC	Division of Water Pollution Control
E. coli	Escherichia coli
EPA	Environmental Protection Agency
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - Fortran
HUC	Hydrologic Unit Code
IPSI	Integrated Pollutant Source Identification
LA	Load Allocation
LDC	Load Duration Curve
LSPC	Loading Simulation Program in C^{++}
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NHD	National Hydrography Dataset
NMP	Nutrient Management Plan
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCR	Polymerase Chain Reaction
PDFE	Percent of Days Flow Exceeded
PFGE	Pulsed Field Gel Electrophoresis
Rf3	Reach File v.3
RM	River Mile
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
SWMP	Storm Water Management Program
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TWRA	Tennessee Wildlife Resources Agency
USGS	United States Geological Survey
UCF	Unit Conversion Factor
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

Total Maximum Daily Load for Pathogens in Ft. Loudoun Lake Watershed (HUC 06010201)

Impaired Waterbody Information

State: Tennessee
Counties: Blount, Knox, and Sevier
Watershed: Little River Subwatershed of Ft. Loudoun Lake (HUC 06010201)
Constituents of Concern: Pathogens

Impaired Waterbodies Addressed in This Document:

Waterbody ID*	Waterbody	Miles Impaired
TN06010201026 – 0100	RODDY BRANCH	6.4
TN06010201026 – 0400	PISTOL CREEK	7.66
TN06010201026 – 0430	LAUREL BANK BRANCH	22.72
TN06010201028 – 1000	CROOKED CREEK	13.91
TN06010201032 – 0800	SHORT CREEK	10.7
TN06010201033 – 0100	LITTLE ELLEJOY CREEK	14.7
TN06010201033 – 0200	PITNER CREEK	13.5
TN06010201033 – 1000	ELLEJOY CREEK	14.78
TN06010201033 – 2000	ELLEJOY CREEK	5.37
TN06010201034 – 0200	WILDWOOD BRANCH	6.26
TN06010201034 – 1000	NAILS CREEK	24.5
TN06010201066 – 0300	GRANDVIEW BRANCH	1.7
TN06010201066 – 0600	HIGH BLUFF BRANCH	1.25
TN06010201066 – 1000	STOCK CREEK	3.77
TN06010201066 – 1200	GUN HOLLOW BRANCH	1.36
TN06010201066 – 2000	STOCK CREEK	1.98

*Waterbody ID based on Final 2004 303(d) List

Designated Uses:

The designated use classifications for these tributaries to the Little River include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation.

Water Quality Goal:

Derived from *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January, 2004* for recreation use classification (most stringent):

The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

Additionally, consistent with current TMDL methodology, standards from *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, October 1999* for recreation use classification:

> The concentration of a fecal coliform group shall not exceed 200 per 100 mL nor shall the concentration of the *E. coli* group exceed 126 per 100 mL, as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having a fecal coliform group or *E. coli* concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 mL.

TMDL Scope:

Waterbodies identified on the Final 2004 303(d) list as impaired due to E. coli and/or fecal coliform. TMDLs are generally developed for impaired waterbodies on a HUC-12 basis.

Analysis/Methodology:

The TMDLs for impaired tributaries to the Little River were developed using the load duration curve methodology to assure compliance with the E. Coli 126 counts/100 mL geometric mean and 941 counts/100 mL maximum standards while also incorporating the fecal coliform 200 counts/100 mL geometric mean and 1,000 counts/100 mL maximum concentration as surrogates. A duration curve is a cumulative frequency graph that represents the percentage of time during which the value of a given parameter is equaled or exceeded. Load duration curves are developed from flow duration curves and can illustrate existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow regime represented by these existing loads. Load duration curves were used to determine the load reductions required to meet the target maximum concentrations for E. coli and fecal coliform (standard - MOS). When sufficient data were available, load reductions were also determined based on geometric mean criteria.

Critical Conditions:

Water quality data collected over a period of 10 years for load duration curve analysis were used to assess the water quality standards representing a range of hydrologic and meteorological conditions.

Seasonal Variation:

The 10-year period used for LSPC model simulation period and for load duration curve analysis included all seasons and a full range of flow and meteorological conditions.

Margin of Safety (MOS):

Explicit – 10% of the water quality standard for each impaired subwatershed.

Summary of TMDLs, WLAs, & LAs for Impaired Waterbodies

HUC-12 Subwatershed (06010201__) or Drainage Area	Impaired Waterbody	Impaired Waterbody ID	TMDL	WLAs		LAs	
				Leaking Collection Systems[a]	MS4s[b]	Precipitation Induced Nonpoint Sources	Other Direct Sources[c]
			[% Red.]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0103	Short Creek	TN06010201032 – 0800	***79.3***	**NA**	**79.3**	**79.3**	**0**
0104	Little Ellejoy Creek	TN06010201033 – 0100	***88.9***	**NA**	**88.9**	**88.9**	**0**
	Pitner Creek	TN06010201033 – 0200					
	Ellejoy Creek	TN06010201033 – 1000 & 2000					
0105	Crooked Creek	TN06010201028 – 1000	***96.5***	**NA**	**96.5**	**96.5**	**0**
	Wildwood Branch	TN06010201034 – 0200					
	Nails Creek	TN06010201034 – 1000					
0106	Roddy Branch	TN06010201026 – 0100	***87.6***	**NA**	**87.6**	**87.6**	**0**
0107	Pistol Creek	TN06010201026 – 0400	***71.6***	**NA**	**71.6**	**71.6**	**0**
0108	Grandview Branch	TN06010201066 – 0300	***88.0***	**NA**	**88.0**	**88.0**	**0**
	High Bluff Branch	TN06010201066 – 0600					
	Stock Creek	TN06010201066 – 1000 & 2000					
	Gun Hollow Branch	TN06010201066 – 1200					

a. *The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

b. *Applies to any MS4 discharge loading in the subwatershed.*

c. *The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

PATHOGEN TOTAL MAXIMUM DAILY LOAD (TMDL)
LITTLE RIVER SUBWATERSHED (HUC 06010201)

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those waterbodies that are not attaining water quality standards. State water quality standards consist of designated uses for individual waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses, and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and nonpoint sources in order to restore and maintain the quality of water resources (USEPA, 1991).

2.0 SCOPE OF DOCUMENT

This document presents details of TMDL development for waterbodies in the Little River subwatershed, part of the Ft. Loudoun Lake watershed, identified on the Final 2004 303(d) list as not supporting designated uses due to E. coli and/or fecal coliform. TMDL analyses are performed primarily on a 12-digit hydrologic unit area (HUC-12) basis. In some cases, where appropriate, TMDLs are developed for an impaired waterbody drainage area only.

3.0 WATERSHED DESCRIPTION

The Ft. Loudoun Lake watershed (HUC 06010201) is located in East Tennessee (Figure 1), primarily in Blount, Knox, Loudoun, and Sevier Counties. The Little River subwatershed lies within two Level III ecoregions (Blue Ridge Mountains, Ridge and Valley) and contains seven Level IV ecoregions as shown in Figure 2 (USEPA, 1997):

- **The Southern Sedimentary Ridges (66e)** in Tennessee include some of the westernmost foothill areas of the Blue Ridges Mountains ecoregion, such as the Bean, Starr, Chilhowee, English, Stone, Bald, and Iron Mountain areas. Slopes are steep, and elevations are generally 1000-4500 feet. The rocks are primarily Cambrian-age sedimentary (shale, sandstone, siltstone, quartzite, conglomerate), although some lower stream reachs occur on limestone. Soils are predominantly friable loams and fine sandy loams with variable amounts of sandstone rock fragments, and support mostly mixed oak and oak-pine forests.

- **Limestone Valleys and Coves (66f)** are small but distinct lowland areas of the Blue Ridge, with elevations mostly between 1500 and 2500 feet. About 450 million years ago, older Blue Ridge rocks to the east were forced up and over younger rocks to the west. In places, the Precambrian rocks have eroded through to Cambrian or Ordovician-age limestones, as seen especially in isolated, deep cove areas that are surrounded by steep mountains. The main areas of limestone include the Mountain City lowland area and Shady Valley in the north; and Wear Cove, Tuckaleechee Cove, and Cades Cove of the Great Smoky Mountains in the south. Hay and pasture, with some tobacco patches on small farms, are typical land uses.

- **The Southern Metasedimentary Mountains (66g)** are steep, dissected, biologically-diverse mountains that include Clingmans Dome (6643 feet), the highest point in Tennessee. The Precambrian-age metamorphic and sedimentary geologic materials are generally older and more metamorphosed than the Southern Sedimentary Ridges (66e) to the west and north. The Appalachian oak forests and, at higher elevations, the northern hardwoods forests include a variety of oaks and pines, as well as silverbell, hemlock, yellow poplar, basswood, buckeye, yellow birch, and beech. Spruce-fir forests, found generally above 5500 feet, have been affected greatly over the past twenty-five years by the balsam woolly aphid. The Copper Basin, in the southeast corner of Tennessee, was the site of copper mining and smelting from the 1850's to 1987, and once left more than fifty square miles of eroded earth.

- **The Southern Limestone/Dolomite Valleys and Low Rolling Hills (67f)** form a heterogeneous region composed predominantly of limestone and cherty dolomite. Landforms are mostly low rolling ridges and valleys, and the solids vary in their productivity. Landcover includes intensive agriculture, urban and industrial, or areas of thick forest. White oak forests, bottomland oak forests, and sycamore-ash-elm riparian forests are the common forest types, and grassland barrens intermixed with cedar-pine glades also occur here.

- **The Southern Shale Valleys (67g)** consist of lowlands, rolling valleys, and slopes and hilly areas that are dominated by shale materials. The northern areas are associated with Ordovician-age calcareous shale, and the well-drained soils are often slightly acid to neutral. In the south, the shale valleys are associated with Cambrian-age shales that contain some narrow bands of limestone, but the soils tend to be strongly acid. Small farms and rural residences subdivide the land. The steeper slopes are used for pasture or have reverted to brush and forested land, while small fields of hay, corn , tobacco, and garden crops are grown on the foot slopes and bottomland.

- **The Southern Sandstone Ridges (67h)** ecoregion encompasses the major sandstone ridges, but these ridges also have areas of shale and siltstone. The steep, forested chemistry of streams flowing down the ridges can vary greatly depending on the geologic material. The higher elevation ridges are in the north, including Wallen Ridge, Powell Mountain, Clinch Mountain, and Bays Mountain. White Oak Mountain in the south has some sandstone on the west side, but abundant shale and limestone as well. Grindstone Mountain, capped by the Gizzard Group sandstone, is the only remnant of Pennsylvanian-age strata in the Ridge and Valley of Tennessee.

- **The Southern Dissected Ridges and Knobs (67i)** contain more crenulated, broken, or hummocky ridges, compared to smoother, more sharply pointed sandstone ridges. Although shale is common, there is a mixture and interbedding of geologic materials. The ridges on the east side of Tennessee's Ridge and Valley tend to be associated with the Ordovician-age Sevier shale, Athens shale, and Holston and Lenoir limestones. These can include calcareous shale, limestone, siltstone, sandstone, and conglomerate. In the central and western part of the ecoregion, the shale ridges are associated with the Cambrian-age Rome Formation: shale and siltstone with beds of sandstone. Chestnut oak forests and pine forests are typical for the higher elevations of the ridges, with areas of white oak, mixed mesophytic forest, and tulip poplar on the lower slopes, knobs, and draws.

The Little River subwatershed, located in Blount, Knox, and Sevier Counties, Tennessee, has a drainage area of approximately 379 square miles (mi^2). Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Although changes in the land use of the Little River subwatershed have occurred since 1993 as a result of development, this is the most current land use data available. Land use for the Little River subwatershed is summarized in Table 1 and shown in Figure 3. Predominant land use in the Little River watershed is forest (74.5%) followed by agriculture (18.7%). Urban areas represent approximately 4.1% of the total drainage area of the watershed. Details of land use distribution of impaired subwatersheds in the Little River subwatershed are presented in Appendix A.

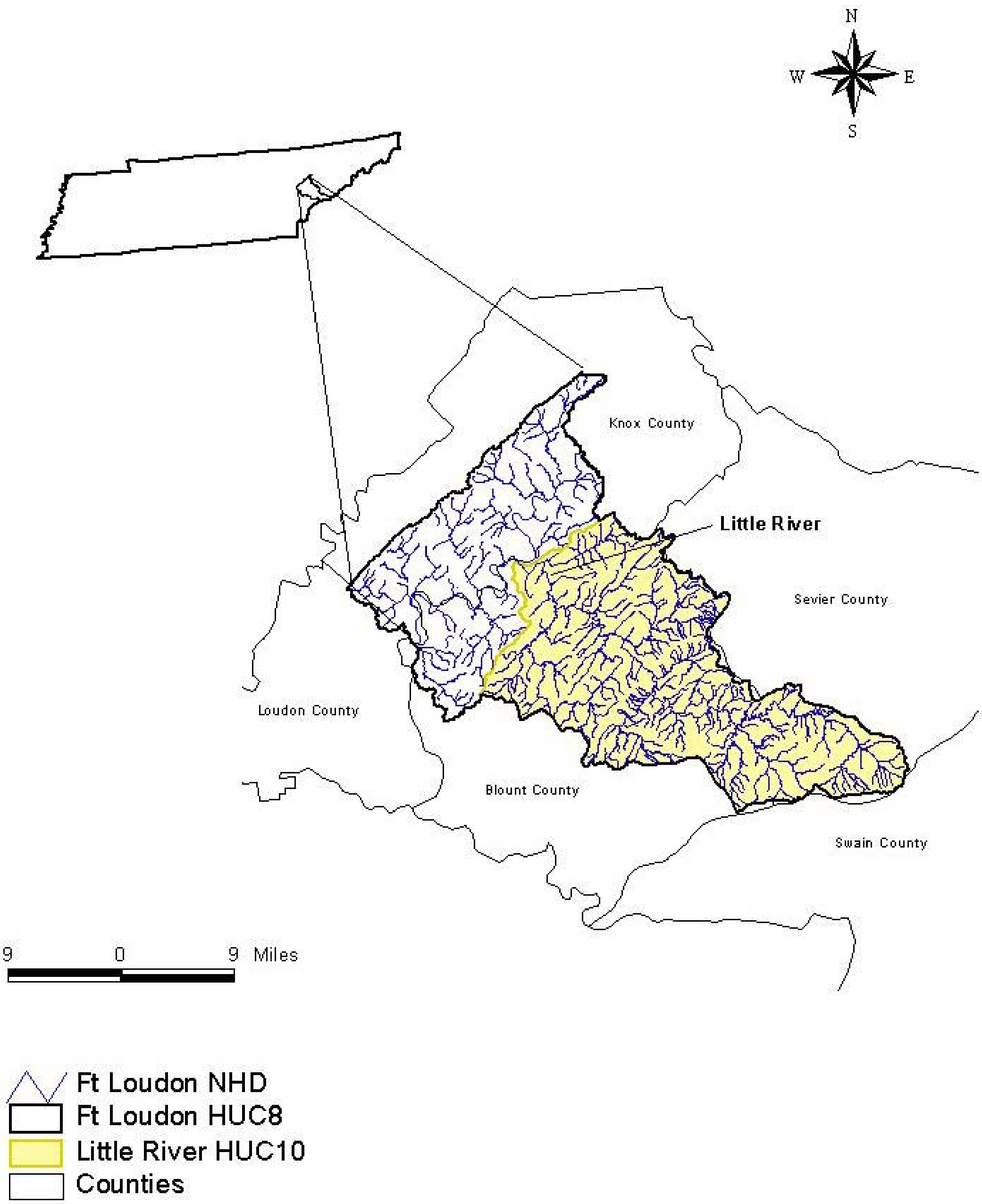

Figure 1. Location of the Ft. Loudoun Lake Watershed and the Little River Subwatershed.

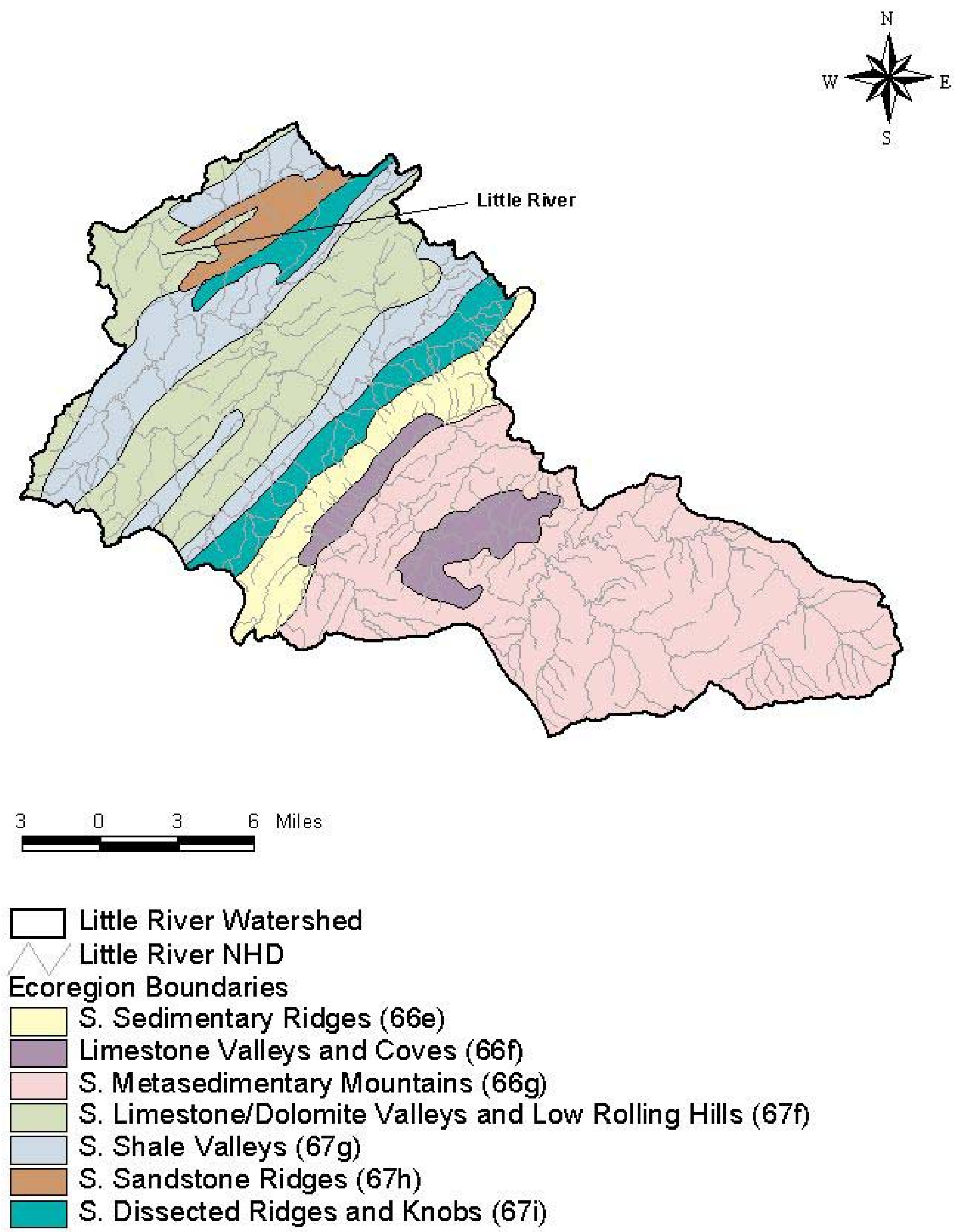

Figure 2. Level IV Ecoregions in the Little River Subwatershed.

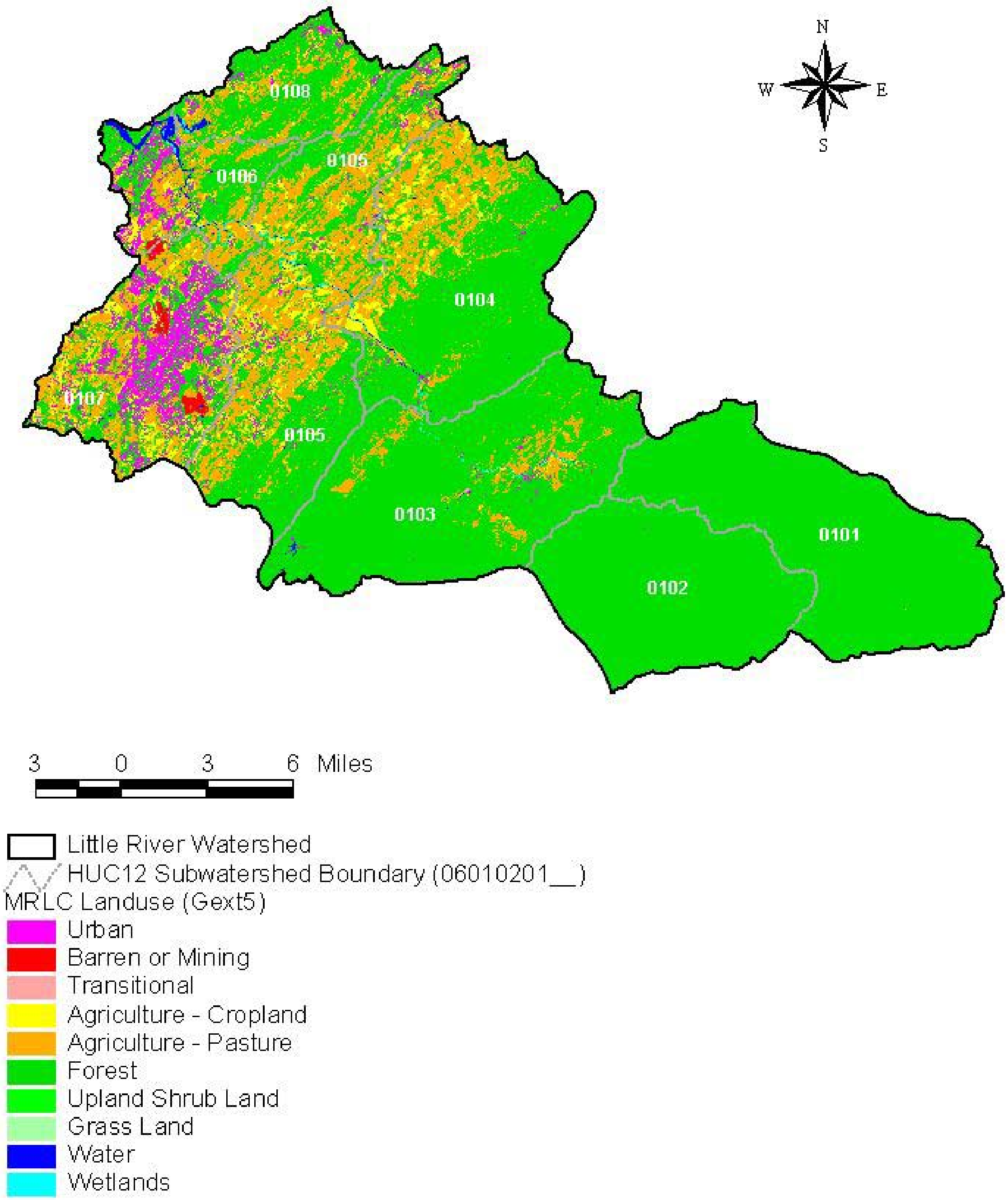

Figure 3. Land Use Characteristics of the Little River Subwatershed.

Table 1. MRLC Land Use Distribution – Little River Subwatershed

Land Use	Area	
	[acres]	[%]
Bare Rock/Sand/Clay	1	0.0
Deciduous Forest	69,933	28.9
Emergent Herbaceous Wetlands	35	0.0
Evergreen Forest	59,263	24.5
High Intensity Commercial/Industrial/ Transportation	3,015	1.2
High Intensity Residential	1,047	0.4
Low Intensity Residential	6,058	2.5
Mixed Forest	50,905	21.0
Open Water	972	0.4
Other Grasses (Urban/recreational)	4,614	1.9
Pasture/Hay	37,522	15.5
Quarries/Strip Mines/ Gravel Pits	759	0.3
Row Crops	7,758	3.2
Transitional	37	0.0
Woody Wetlands	409	0.2
Total	**242,327**	**100.0**

4.0 PROBLEM DEFINITION

The State of Tennessee's final 2004 303(d) list (TDEC, 2004a) was approved by the U.S. Environmental Protection Agency (EPA), Region IV in August of 2005. This list identified portions of fourteen waterbodies in the Little River Subwatershed as not supporting designated use classifications due, in part, to E. coli (see Table 2). The designated use classifications for these waterbodies include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation.

When used in the context of waterbody assessments, the term pathogens is defined as disease-causing organisms such as bacteria or viruses that can pose an immediate and serious health threat if ingested or introduced into the body. The primary sources for pathogens are untreated or inadequately treated human or animal fecal matter. The fecal coliform and E. coli groups are indicators of the presence of pathogens in a stream.

The waterbody segments listed in Table 2 were assessed as impaired based on sampling data and/or biological surveys. The results of these assessment surveys are summarized in Table 3 and shown in Figure 4. The assessment information presented is excerpted from the EPA/TDEC Assessment Database (ADB) and is referenced to the waterbody ID in Table 2. ADB information may be accessed at:

http://gwidc.memphis.edu/website/wpc_arcmap

5.0 WATER QUALITY GOAL

As previously stated, the designated use classifications for the Little River waterbodies include fish & aquatic life, recreation, irrigation, and livestock watering & wildlife. Of the use classifications with numeric criteria for E. coli, the recreation use classification is the most stringent and will be used to establish target levels for TMDL development. The coliform water quality criteria, for protection of the recreation use classification, is established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January 2004* (TDEC, 2004b). Section 1200-4-3-.03 (4) (f) states:

> The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL.
>
> Additionally, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

None of the impaired waterbodies in the Little River Subwatershed have been classified as either Tier II or Tier III streams.

Prior to January 2004, the coliform water quality criteria, for protection of the recreation use classification, established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, October 1999* (TDEC, 1999), Section 1200-4-3-.03 (4) (f) states:

> The concentration of a fecal coliform group shall not exceed 200 per 100 mL, nor shall the concentration of the *E. coli* group exceed 126 per 100 mL, as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having a fecal coliform group or *E. coli* concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 mL.

In addition to utilizing the E. coli water quality standards (with MOS) as the target, this TMDL utilizes a fecal coliform target as a surrogate for determining the attainment of the E. coli standard because of the demonstrated high correlation between E. coli and fecal coliform in this watershed. In the state of Tennessee, E. coli and fecal coliform are well correlated (R = 0.902) when evaluating all available ecoregion data (623 observations).

Therefore, this TMDL employs both the E. coli water quality standard and the surrogate fecal coliform by determining the amount of load reduction required to comply with each of four criteria: 1) the geometric mean standard for E. coli of 126 counts/100mL, 2) the E. coli sample maximum of 941 counts/100 mL, 3) the geometric mean for fecal coliform of 200 counts/100 mL, and 4) the fecal coliform sample maximum of 1,000 counts/100 mL. The fecal coliform surrogate is most frequently used when insufficient monitoring data is available for E. coli or when analysis of E. coli monitoring data suggests that a listed segment is not impaired. The most protective (or highest percent of load reduction) of the four criteria will determine the percent reduction(s) required for impaired waterbodies. The analysis of fecal coliform data is only part of the methodology and is not included to comply with current water quality standards.

Note: In this document, the water quality standards are the instream goals. The term “target concentration” reflects the application of an explicit Margin of Safety (MOS) to the water quality standard. See Section 8.4 for an explanation of MOS.

Table 2. Final 2004 303(d) List for E. coli Impaired Waterbodies – Little River Subwatershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN06010201026-0100	RODDY BRANCH	6.4	Alterations in stream-side or littoral vegetative cover Physical Substrate Habitat Alteration Escherichia coli	Pasture Grazing Channelization Removal of Riparian Habitat
TN06010201026-0400	PISTOL CREEK	7.66	Siltation Escherichia coli	Discharges from MS4 area
TN06010201026-0430	LAUREL BANK BRANCH	22.72	Siltation Escherichia coli	Discharges from MS4 area
TN06010201028-1000	CROOKED CREEK	13.91	Siltation Escherichia coli	Pasture Grazing Livestock in Stream
TN06010201032-0800	SHORT CREEK	10.7	Escherichia coli	Undetermined Source
TN06010201033-0100	LITTLE ELLEJOY CREEK	14.7	Nitrate Escherichia coli	Pasture Grazing Animal Feeding Operations
TN06010201033-0200	PITNER CREEK	13.5	Escherichia coli	Pasture Grazing
TN06010201033-1000	ELLEJOY CREEK	14.78	Escherichia coli	Pasture Grazing

Table 2 (cont'd). Final 2004 303(d) List for E. coli Impaired Waterbodies – Little River Subwatershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN06010201033-2000	ELLEJOY CREEK	5.37	Nitrates Siltation Escherichia coli	Pasture Grazing
TN06010201034-0200	WILDWOOD BRANCH	6.26	Alterations in stream-side or littoral vegetative cover Escherichia coli	Pasture Grazing
TN06010201034-1000	NAILS CREEK	24.5	Escherichia coli	Pasture Grazing
TN06010201066-0300	GRANDVIEW BRANCH	1.7	Escherichia coli	Discharges from MS4 area
TN06010201066-0600	HIGH BLUFF BRANCH	1.25	Escherichia coli	Discharges from MS4 area
TN06010201066-1000	STOCK CREEK	3.77	Physical Substrate Habitat Alterations Siltation Escherichia coli	Pasture Grazing Channelization
TN06010201066-1200	GUN HOLLOW BRANCH	1.36	Escherichia coli	Pasture Grazing
TN06010201066-2000	STOCK CREEK	1.98	Escherichia coli	Pasture Grazing

Table 3. Water Quality Assessment of Waterbodies Impaired Due to E. coli - Little River Subwatershed

Waterbody ID	Segment Name	Comments
TN06010201026 – 0100	RODDY BRANCH	2003 TDEC chemical station at RM0.6; 1 E.coli observation out of 10 over 1000; G.M. = 282. 2000 LAB biorecon at RM0.6; 9 EPT, 1 intolerant, 29 total genera. BR score = 7. Habitat score = 89. 1998 TDEC biological survey at mile 0.6. 12 EPT genera. FAL assessment based on NCBI = 4.95. Habitat score = 119. G.M. 387 E.coli.
TN06010201026 – 0400	PISTOL CREEK	2000 LAB RBPIII at RM0.2; 4 EPT, 32 total genera. Index score = 28. Failed biocriteria. Habitat score = 121. 1998 TDEC biological survey at mile 1.9. 2 EPT genera, 13 total taxa, NCBI 6.33. Habitat assessment = 99. G.M. 299 E.coli. TVA survey at mile 1.9. 36 IBI.
TN06010201026 – 0430	LAUREL BANK BRANCH	2000 LAB biorecon at RM1.0; 6 EPT, 3 intolerant, 26 total genera. BR score = 5. Habitat score = 92. 1999 TDEC station at Highway 334. Fecal coliform elevated.
TN06010201028 – 1000	CROOKED CREEK	2000 LAB RBPIII at RM1.1; 6 EPT, 38 total genera. Index score = 32. Habitat score = 76. 2000 LAB biorecon at RM5.3; 3 EPT, 2 intolerant, 17 total genera. BR score = 5. Habitat score = 92. 2003 TDEC RBPIII at RM7.2 ; 7 EPT, 20 total genera. Index score = 30. Failed biocriteria. Habitat score = 129. 2000 LAB biorecon at RM7.2; 7 EPT, 3 intolernat, 20 total genera. BR score = 9. Habitat score = 87.
TN06010201032 – 0500	SHORT CREEK	2002 LAB RBPIII at RM0.1; 12 EPT, 25 total genera. Index score = 36. Passed biocriteria. Habitat score = 112. 1998 TDEC biological survey at mile 0.05. 19 EPT genera. G.M. 290 E.coli. 1996 TVA station at mile 0.2. IBI 40 (fair). 10 EPT families, 21 total families.
TN06010201033-0100	LITTLE ELLEJOY CREEK	2003 TDEC RBPIII & chemical station at RM0.2; 1 out of 12 E.coli observations over 1000; G.M. = 375; 4 EPT, 19 total genera. Index score = 32. Habitat score = 121. 2000 LAB biorecon at RM0.2; 4 EPT, 1 intolerant, 15 total genera. BR score = 9. 1999 TDEC station @RM0.8. Fish IBI = 44. Nitrate/nitrite elevated
TN06010201033-0200	PITNER CREEK	2003 TDEC RBPIII & chemical station at RM0.8; 2 out of 12 E.coli observations over 1000; G.M. = 552; 9 EPT, 8 intolerant, 24 total genera. BR score = 15. Habitat score = 127. 2000 LAB biorecon at RM0.8 ; 9 EPT, 8 intolerant, 24 total genera. BR score = 15. Habitat score = 127.
TN06010201033 – 1000	ELLEJOY CREEK	2003 TDEC RBPIII & chemical station at RM0.1; 2 out of 12 E.coli observations over 1000; G.M. = 333; 6 EPT, 29 total genera. Index score = 34. Passed biocriteria. Habitat score = 154. 2000 LAB RBPIII at RM0.1; 7 EPT, 26 total genera. BR score = 38. Habitat score = 127. 2003 TDEC chemical station at RM3.2; 3 out of 12 E.coli observations over 1000; G.M. = 443. 2003 TDEC chemical station at RM5.5; 9 out of 12 E.coli observations over 1000.

Table 3 (cont'd). Water Quality Assessment of Waterbodies Impaired Due to E. coli - Little River Subwatershed

Waterbody ID	Segment Name	Comments
TN06010201033 – 2000	ELLEJOY CREEK	2003 TDEC RBPIII & chemical station at RM8.0; 3 out of 12 E.coli observations over 1000; G.M. = 421; 4 EPT, 20 total genera. Index score = 28. Failed biocriteria. Habitat score = 94. 2003 TDEC chemical station at Rm10.1; 3 out of 12 E.coli observations over 1000; G.M. = 283.
TN06010201034 – 0200	WILDWOOD BRANCH	2003 TDEC chemical station at RM0.1; 2 out of 13 E.coli observations over 1000; G.M. = 448. 2000 LAB biorecon at RM0.1; 7 EPT, 2 intolerant, 22 total genera. BR score = 5. Habitat score = 148.
TN06010201034 – 1000	NAILS CREEK	2003 TDEC RBPIII & chemical station at RM0.7; 4 out of 13 E.coli observations over 1000; G.M. = 679; 9 EPT, 31 total genera. Index score = 36. Passed biocriteria. Habitat score = 132. 2000 Lab biorecon at RM0.7; 8 EPT, 3 intolerant, 22 total genera. BR score = 7. Habitat score = 115. 2003 TDEC RBPIII & chemical station at RM4.5; 4 out of 13 E.coli observations over 1000; G.M. = 564; 5 EPT, 28 total genera. Index score = 32. Passed biocriteria. Habitat score = 106. 2003 TDEC RBPIII & chemical station at RM8.3; 2 out of 13 E.coli observations over 1000; G.M. = 490; 7 EPT, 22 total genera. Index score = 36. Passed biocriteria. Habitat score = 90.
TN06010201066 – 0300	GRANDVIEW BRANCH	2003 TDEC pathogen station at RM0.6; 2 samples out of 12 E.coli observations were over 1000; G.M. of samples was 346. DNA testing of bacteria indicates pathogens not of bovine origin.
Tn06010201066 – 0600	HIGH BLUFF BRANCH	2003 TDEC pathogen station at RM0.1; 2 samples out of 12 E.coli observations were over 1000, G.M. of samples was 414. DNA analysis of bacteria suggests source is not bovine.
TN06010201066 – 1000	STOCK CREEK	2003 TDEC chemical station at RM2.0; 2 out of 12 E.coli observations over 1000; G.M. = 245. 2003 TDEC RBPIII & chemical station at RM3.2; 2 out of 12 E.coli observations over 1000; G.M. = 348; 7 EPT, 20 total genera. Index score = 30. Failed biocriteria. Habitat score = 111. 2003 TDEC chemical station at RM4.6; 2 out of 12 E.coli observations over 1000; G.M. = 388.
TN06010201066 – 1200	GUN HOLLOW BRANCH	2003 TDEC pathogen station at RM0.6; 1 samples out of 12 E.coli observations was over 1000; G.M. of samples was 455. DNA analysis of bacteria indicated bovine sources.
TN06010201066 – 2000	STOCK CREEK	2003 TDEC RBPIII & chemical station at RM 5.3; 4 out of 12 E.coli observations over 1000; G.M. = 462; 9 EPT, 27 total genera. Index score = 36. Passed biocriteraia. Habitat score = 123. 2003 TDEC chemical station at RM6.5; 4 out of 12 E.coli observations over 1000; G.M. = 516.

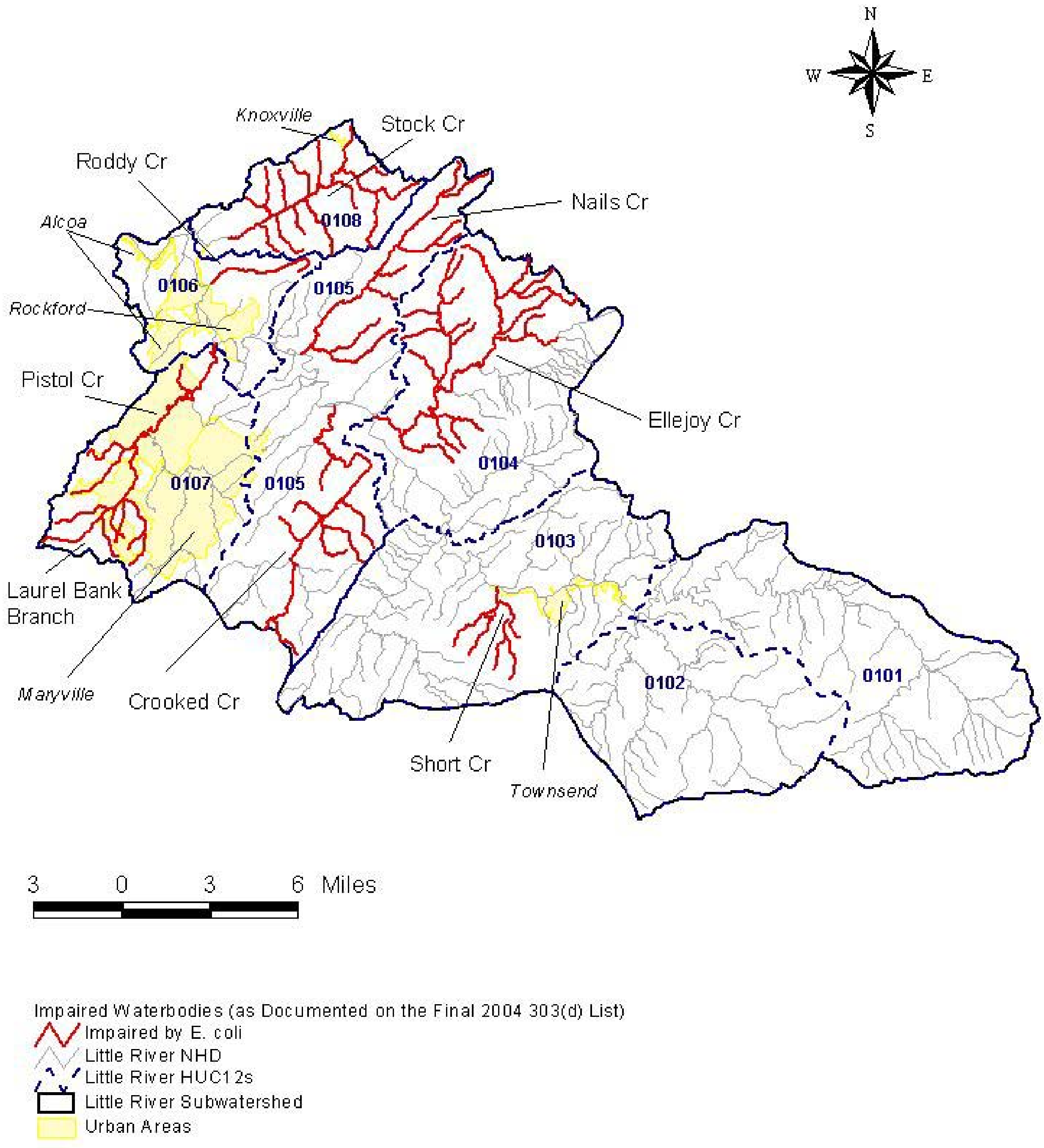

Figure 4. Waterbodies Impaired by E. Coli (as Documented on the Final 2004 303(d) List).

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM GOAL

There are numerous water quality monitoring stations that provide data for waterbodies identified as impaired for E. coli in the Little River subwatershed:

- Roddy Branch Subwatershed:
  - RODDY000.6BT – Roddy Branch, 100 m. upstream of unnamed road off Roddy Branch Rd.
- Pistol Creek Subwatershed:
  - PISTO001.9BT – Pistol Creek at Highway 335 bridge
- Laurel Bank Branch Subwatershed:
  - No monitoring stations in Laurel Bank Branch Subwatershed
- Crooked Creek Subwatershed:
  - CROOK001.1BT – Crooked Creek, 200 m. upstream of Davis Ford Rd.
  - CROOK007.2BT – Crooked Creek at 1st private driveway off Friendship Way
  - FLAG000.1BT – Flag Branch 45 yds upstream of Centennial Rd.
  - MOOK000.3BT – Mook Branch 40 yds upstream of Butler Mill Rd.
  - NFCRO000.3BT – North Fork Crooked Creek 80 yds upstream of Blockhouse Rd.
  - SFCRO000.1BT – South Fork Crooked Creek 50 yds upstream of Wilkinson Pike
- Short Creek Subwatershed:
  - LAURE1T0.1BT – 1st unnamed trib to Laurel Lake, 150 yds upstream of Laurel Lake Rd. (Slate Quarry Hollow)
  - LAURE2T0.1BT – 2nd unnamed trib to Laurel Lake, 100 yds downstream of Laurel Valley Rd. (Cooper Hollow)
  - LICK000.1BT – Lick Branch 50 yds upstream of Laurel Valley Rd.
  - SHORT000.1BT – Short Creek 120 m. upstream of restaurant parking lot on Laurel Valley Rd. @ Highway 321 (≈ RM 0.1)
  - SHORT000.5BT – Short Creek upstream of Laurel Valley Rd. bridge (≈ RM 0.5)
  - SHORT000.7BT – Short Creek at Lawson Rd. bridge, upstream of confluence with Tipton Branch (≈ RM 0.7)
  - SHORT001.4BT – Short Creek on TU property, off Indian Creek Trail Rd. (≈ RM 1.4)
  - SHORT001.9BT – Short Creek at private driveway crossing, off Old Cades Cove Rd. (≈ RM 1.9)
  - TIPTO000.4BT – Tipton Branch 200 yds downstream of Laurel Lake Dam
- Ellejoy Creek Subwatershed:
  - ELLEJ000.1BT – Ellejoy Creek at Ellejoy Creek Rd. crossing (≈ RM 0.1)
  - ELLEJ003.2BT – Ellejoy Creek at Cold Springs Rd. crossing (≈ RM 3.2)
  - ELLEJ005.5BT – Ellejoy Creek at McHenry Rd. crossing (≈ RM 5.5)
  - ELLEJ008.0BT – Ellejoy Creek downstream of A R Davis Rd. (≈ RM 8.0)
  - ELLEJ010.1SV – Ellejoy Creek at Tipton Hollow Rd. bridge (≈ RM 10.1)
  - LELLE000.21BT – Little Ellejoy Creek 100 yds upstream of Bethlehem Rd.
  - MILLS001.0BT – Millstone Branch 150 upstream of culvert under A R Davis Rd.
  - PITNE000.8BT – Pitner Branch 200 yds downstream of Ellejoy Rd.

- Nails Creek Subwatershed:
  - NAILS000.7BT – Nails Creek at Andy Harris Rd. bridge (≈ RM 0.7)
  - NAILS003.5BT – Nails Creek upstream of Cedar Grove (≈ RM 3.5)
  - NAILS004.5BT – Nails Creek at Conley Farm Rd. (≈ RM 4.5)
  - NAILS008.3BT – Nails Creek at Bakers St. (≈ RM 8.3)
  - WILDW000.1BT – Wildwood Branch, 80 yds upstream of Andy Harris Rd.

- Stock Creek Subwatershed:
  - GHOLL000.6KN – Gun Hollow Branch downstream of Stock Creek Rd at Van Gilder farm
  - GRAND000.5KN – Grandview Branch at Haws Rd. bridge
  - HBLUF000.1KN – High Bluff Branch at Pickens Gap Rd. bridge
  - MCCAL000.2KN – McCall Branch upstream of Tipton Station Rd.
  - MMILL000.1KN – Martin Mill Branch at Martin Mill Pike bridge, at confluence with Stock Creek
  - NSPRI000.3KN – Neubert Springs Branch at Neubert Springs Rd. and driveway crossing
  - SHOME000.3KN – Sevier Home Branch at Neubert Springs Rd., 1st driveway crossing from bridge over Stock Creek
  - SPANG000.2KN – Spangler Branch at tarwater Rd. bridge
  - STOCK002.0KN – Stock Creek, 100 m. upstream of Hall Rd. (≈ RM 2.0)
  - STOCK003.2KN – Stock Creek at Martin Mill Pike bridge (≈ RM 3.2)
  - STOCK004.6KN – Stock Creek at Neubert Spring Rd. (≈ RM 4.6)
  - STOCK005.3KN – Stock Creek at Haws Rd. bridge (≈ RM 5.3)
  - STOCK006.5KN – Stock Creek upstream of Tipton Station Rd. bridge, immediately upstream of confluence with McCall Branch (≈ RM 6.5)
  - STOCK007.3KN – Stock Creek at Pickens Gap Rd., upstream of confluence with High Bluff Trib. (≈ RM 7.3)
  - STOCK008.4KN – Stock Creek at Pickens gap Rd., upstream of confluence with Nichols Mountain Branch (≈ RM 8.4)

The location of these monitoring stations is shown in Figure 5. Water quality monitoring results for these stations are tabulated in Appendix B. Examination of the data shows violations of the 941 counts/100 mL maximum E. coli standard and the 1,000 counts/100 mL maximum fecal coliform criterion at many monitoring stations. Water quality monitoring results for those stations with 10% or more of samples in violation of water quality maximum criteria are summarized in Table 4.

There were not enough data to calculate the geometric mean at each monitoring station. Whenever a minimum of 5 samples was collected at a given monitoring station over a period of not more than 30 consecutive days, the geometric mean was calculated. All calculated geometric means were in violation of their respective geometric mean standard.

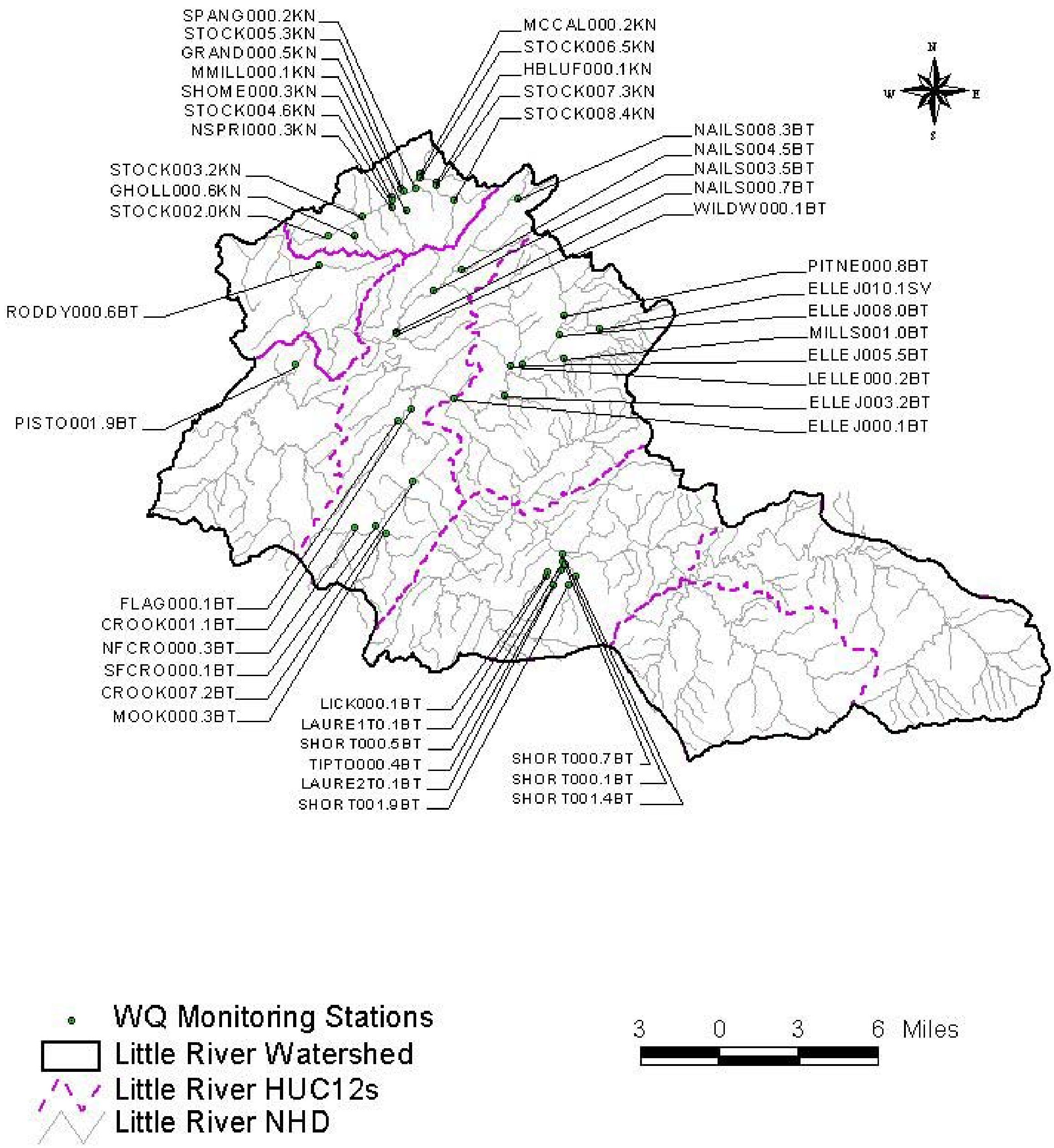

Figure 5. Water Quality Monitoring Stations in the Little River Subwatershed

Table 4. Summary of Water Quality Monitoring Data

Monitoring Station	Monitoring Dates	E. Coli						Fecal Coliform					
		Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.	Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.
			Min.	Avg.	Max.				Min.	Avg.	Max.		
CROOK001.1BT	1998 - 2004	20	130	>2393	>2419	15	75.0%	20	250	6,955	56,000	12	60.0%
CROOK007.2BT	2004	2	131	773	1,414	1	50.0%	2	190	1,064	1,938	1	50.0%
ELLEJ000.1BT	1998 - 2004	21	59	>1001	>2419	4	19.0%	21	100	1,265	1,490	4	19.0%
ELLEJ003.2BT	2003 - 2004	12	83	696	>2419	3	25.0%	12	80	1,006	2,600	5	41.7%
ELLEJ005.5BT	2003 - 2004	12	84	>1624	>2419	8	66.7%	12	130	2,730	9,700	8	66.7%
ELLEJ008.0BT	2003 - 2004	12	161	617	2,419	3	25.0%	12	140	688	2,000	3	25.0%
ELLEJ010.1SV	2003 - 2004	12	17	561	1,414	3	25.0%	12	42	645	2,500	2	16.7%
FLAG000.1BT	4/04 -- 8/04	4	104	765	1,203	2	50.0%	4	320	884	1,600	1	25.0%
GHOLL000.6KN	2003 - 2004	11	173	572	1,553	1	9.1%	11	160	518	1,200	1	9.1%
GRAND000.5KN	1998 - 2004	10	99	659	2,419	2	20.0%	10	80	613	2,100	1	10.0%
HBLUF000.1KN	1998 - 2004	10	152	548	1,414	2	20.0%	10	240	608	2,000	1	10.0%
LELLE000.2BT	2003 - 2004	12	105	531	1,986	1	8.3%	12	100	683	3,000	3	25.0%
MCCAL000.2KN	1998 - 2004	10	89	322	1,203	1	10.0%	10	80	333	1,200	1	10.0%
MILLS001.0BT	2003 - 2004	12	11	429	1,414	1	8.3%	12	30	610	1,600	3	25.0%
NAILS000.7BT	1998 - 2004	29	179	>1168	>2419	12	41.4%	29	200	1,566	15,600	11	37.9%
NAILS003.5BT	2003	1	980	980	980	1	100.0%	1	1,240	1,240	1,240	1	100.0%
NAILS004.5BT	2003 - 2004	10	86	>1098	>2419	4	40.0%	10	90	1,140	3,400	4	40.0%
NAILS008.3BT	2003 - 2004	12	155	687	2,419	2	16.7%	12	60	657	2,100	3	25.0%
NFCR000.3BT	4/04 -- 8/04	1	1,300	1,300	1,300	1	100.0%	2	430	708	986	0	0.0%
NSPRI000.3KN	2003 - 2004	10	79	451	1,300	2	20.0%	10	120	504	1,600	2	20.0%
PISTO001.9BT	1998	17	93	601	2,419	3	17.6%	17	80	993	7,900	3	17.6%

Table 4 (cont'd). Summary of Water Quality Monitoring Data

Monitoring Station	Monitoring Dates	E. Coli						Fecal Coliform					
		Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.	Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.
			Min.	Avg.	Max.				Min.	Avg.	Max.		
PITNE000.8BT	2003 - 2004	12	261	>819	>2419	2	16.7%	12	168	849	2,800	3	25.0%
RODDY000.6BT	1998 - 2003	27	62	768	3,448	6	22.2%	27	50	875	4,100	6	22.2%
SFCR000.1BT	2004	4	299	841	2419	1	25.0%	4	200	758	2,000	1	25.0%
SHORT000.1BT	1998 - 2004	20	13	>587	>2419	3	15.0%	20	14	447	2,700	2	10.0%
STOCK002.0KN	2003 - 2004	12	<1	422	1,414	2	16.7%	12	<1	387	1,500	1	8.3%
STOCK003.2KN	1998 - 2004	28	50	842	4,661	6	21.4%	28	120	855	3,600	5	17.9%
STOCK004.6KN	2003 - 2004	12	59	576	1,300	2	16.7%	12	120	644	1,800	2	16.7%
STOCK005.3KN	2003 - 2004	12	135	>778	>2419	4	33.3%	12	100	850	3,500	3	25.0%
STOCK006.5KN	2003 - 2004	12	117	>790	>2419	4	33.3%	12	90	552	2,200	2	16.7%
STOCK007.3KN	2003 - 2004	12	4	397	1,553	1	8.3%	12	100	504	2,600	1	8.3%
STOCK008.4KN	2003 - 2004	18	24	298	1,120	2	11.1%	18	10	265	800	0	0.0%
WILDW000.1BT	2003 - 2004	12	102	>730	>2419	2	16.7%	12	54	874	2,700	5	41.7%

7.0 SOURCE ASSESSMENT

An important part of TMDL analysis is the identification of individual sources, or source categories of pollutants in the watershed that affect pathogen loading and the amount of loading contributed by each of these sources.

Under the Clean Water Act, sources are classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by three broad categories: 1) NPDES regulated municipal and industrial wastewater treatment facilities (WWTFs); 2) NPDES regulated industrial and municipal storm water discharges; and 3) NPDES regulated Concentrated Animal Feeding Operations (CAFOs). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES regulated point sources. Nonpoint sources are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For the purposes of this TMDL, all sources of pollutant loading not regulated by NPDES permits are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

7.1 Point Sources

7.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

Both treated and untreated sanitary wastewater contain coliform bacteria. There are no NPDES permitted WWTFs discharging to the impaired subwatersheds of the Little River subwatershed.

7.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

Municipal Separate Storm Sewer Systems (MS4s) are considered to be point sources of pathogens. Discharges from MS4s occur in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. Large and medium MS4s serving populations greater than 100,000 people are required to obtain NPDES storm water permits. At present, there are no MS4s of this size in the Little River subwatershed. As of March 2003, small MS4s serving urbanized areas, or having the potential to exceed instream water quality standards, are required to obtain a permit under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002). An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. Under the General Permit, an annual report must be submitted to the Director of TDEC Water Pollution Control Division.

Five permittees are covered under Phase II of the NPDES Storm Water Program (Figure 6). The five permitted MS4s in the Little River subwatershed are as follows:

NPDES Permit Number	Phase	Permittee Name	Issuance Date	Effective Date	Expiration Date
TNS075116	II	Blount County	10/17/03	10/20/03	2/26/08
TNS075132	II	City of Alcoa	9/19/03	9/19/03	2/26/08
TNS075434	II	City of Maryville	9/30/03	9/30/03	2/26/08
TNS075582	II	Knox County	10/2/03	10/2/03	2/26/08
TNS075655	II	Sevier County	3/8/04	9/30/03	2/26/08

The Tennessee Department of Transportation (TDOT) is also being issued MS4 permits for State roads in urban areas. Information regarding storm water permitting in Tennessee may be obtained from the TDEC website at http://www.state.tn.us/environment/wpc/stormh2o/.

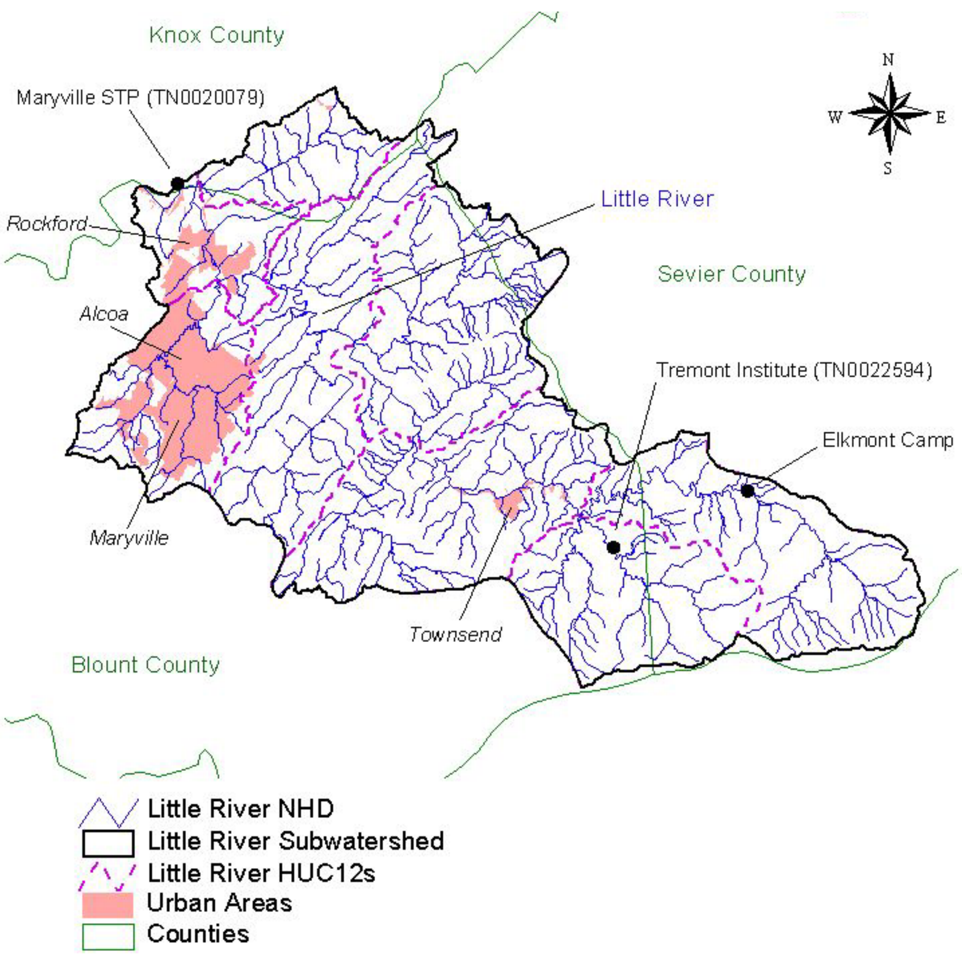

Figure 6. NPDES Regulated Point Sources in and near the Little River Subwatershed.

7.1.3 NPDES Concentrated Animal Feeding Operations (CAFOs)

Animal feeding operations (AFOs) are agricultural enterprises where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland (USEPA, 2002a). Concentrated Animal Feeding Operations (CAFOs) are AFOs that meet certain criteria with respect to animal type, number of animals, and type of manure management system. CAFOs are considered to be potential point sources of pathogen loading and are required to obtain an NPDES permit. Most CAFOs in Tennessee obtain coverage under TNA000000, *Class II Concentrated Animal Feeding Operation General Permit*, while larger, Class I CAFOs are required to obtain an individual NPDES permit.

As of May 11, 2005, there are no Class II CAFOs in the Little River subwatershed with coverage under the general NPDES permit. There are also no Class I CAFOs with individual permits located in the watershed.

7.2 Nonpoint Sources

Nonpoint sources of coliform bacteria are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of coliform bacteria on land surfaces and wash off as a result of storm events. Nonpoint sources of pathogen loading are primarily associated with agricultural and urban land uses. The vast majority of waterbodies identified on the approved 2002 303(d) list and on the Final 2004 303(d) list as impaired due to E. coli are attributed to nonpoint agricultural or urban sources.

7.2.1 Wildlife

Wildlife deposit coliform bacteria, with their feces, onto land surfaces where it can be transported during storm events to nearby streams. The overall deer density for Tennessee was estimated by the Tennessee Wildlife Resources Agency (TWRA) to be 23 animals per square mile. Fecal coliform loads due to deer are estimated by EPA to be 5.0×10^8 counts/animal/day.

7.2.2 Agricultural Animals

Agricultural activities can be a significant source of coliform bacteria loading to surface waters. The activities of greatest concern are typically those associated with livestock operations:

- Agricultural livestock grazing in pastures deposit manure containing coliform bacteria onto land surfaces. This material accumulates during periods of dry weather and is available for washoff and transport to surface waters during storm events. The number of animals in pasture and the time spent grazing are important factors in determining the loading contribution.
- Processed agricultural manure from confined feeding operations is often applied to land surfaces and can provide a significant source of coliform bacteria loading. Guidance for issues relating to manure application is available through the University of Tennessee Agricultural Extension Service and the Natural

Resources Conservation Service (NRCS).

- Agricultural livestock and other unconfined animals often have direct access to waterbodies and can provide a concentrated source of coliform bacteria loading directly to a stream.

Table 5. Livestock Distribution in the Little River Subwatershed

Subwatershed	Livestock Population (TVA)		
	Beef Cow	Milk Cow	Horse
Stock Creek	1,275	0	80
Roddy Branch	125	0	5
Pistol Creek	1,925	0	110
Crooked Creek	2,575	0	170
Short Creek	600	0	20
Ellejoy Creek	3,325	150	140
Nails Creek	1,650	150	80

Potential data sources related to livestock operations include the 2002 Census of Agriculture utilizing the Watershed Characterization System (WCS). WCS is an Arcview geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. Livestock information provided in WCS is based on the ratio of watershed pasture area to county pasture area applied to the livestock population within the county. Another potential data source was the Integrated Pollutant Source Identification (IPSI) in Blount County and the Little River watershed conducted by the Tennessee Valley Authority (TVA) (TVA, 2003). The IPSI provided information on livestock operations classified by relative size, accurate to the nearest 25 cows and 5 horses. Data from the IPSI, when available, are considered to be more accurate because they are based on actual location and size rather than an area ratio. Livestock data for pathogen-impaired watershed is summarized in Table 5.

7.2.3 Failing Septic Systems

Some coliform loading in the Little River subwatershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from 1997 county census data of people in the Little River subwatershed utilizing septic systems were compiled using the WCS and are summarized in Table 6. In east Tennessee, it is estimated that there are approximately 2.37 people per household on septic systems, some of which can be reasonably assumed to be failing. A survey conducted by TVA identified septic systems that were suspect and may be contributing contaminants to the surface water through overland flow, particularly when saturated soil conditions exist (TVA, 2003). Suspect systems were defined as systems exhibiting a visible plume or drain field, or at locations that are questionable for on-site septic systems. As with livestock in streams, discharges of raw sewage provide a concentrated source of coliform bacteria directly to waterbodies.

Table 6. Population on Septic Systems in the Little River Subwatershed

Subwatershed	Population on Septic Systems	No. of Suspect Systems
Stock Creek	7,740	69
Roddy Branch	505	12
Pistol Creek	3,419	581
Crooked Creek	2,818	176
Short Creek	827	115
Ellejoy Creek	3,353	176
Nails Creek	2,031	201

7.2.4 Urban Development

Nonpoint source loading of coliform bacteria from urban land use areas is attributable to multiple sources. These include: stormwater runoff, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Impervious surfaces in urban areas allow runoff to be conveyed to streams quickly, without interaction with soils and groundwater. Pistol Creek has the highest percentage of urban land area for impaired waterbodies in the Little River subwatershed, with 24.9%. Land use for the Little River impaired drainage areas is summarized in Figures 7 and 8 and tabulated in Appendix A.

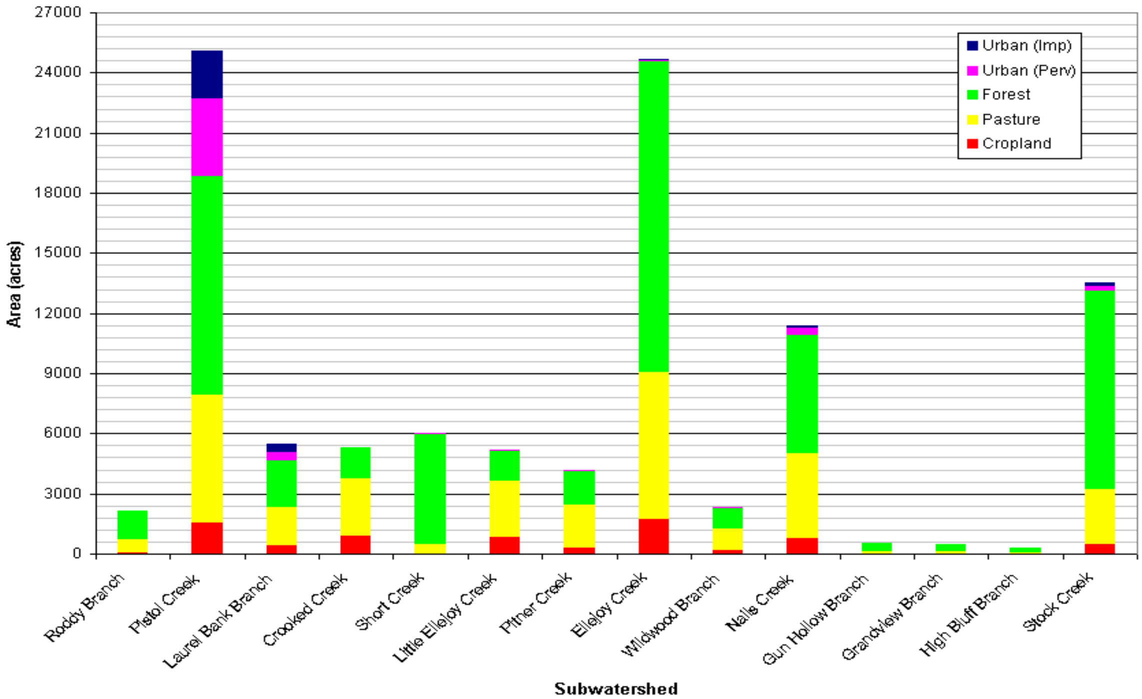

Figure 7. Land Use Area of Little River Pathogen-Impaired Subwatersheds.

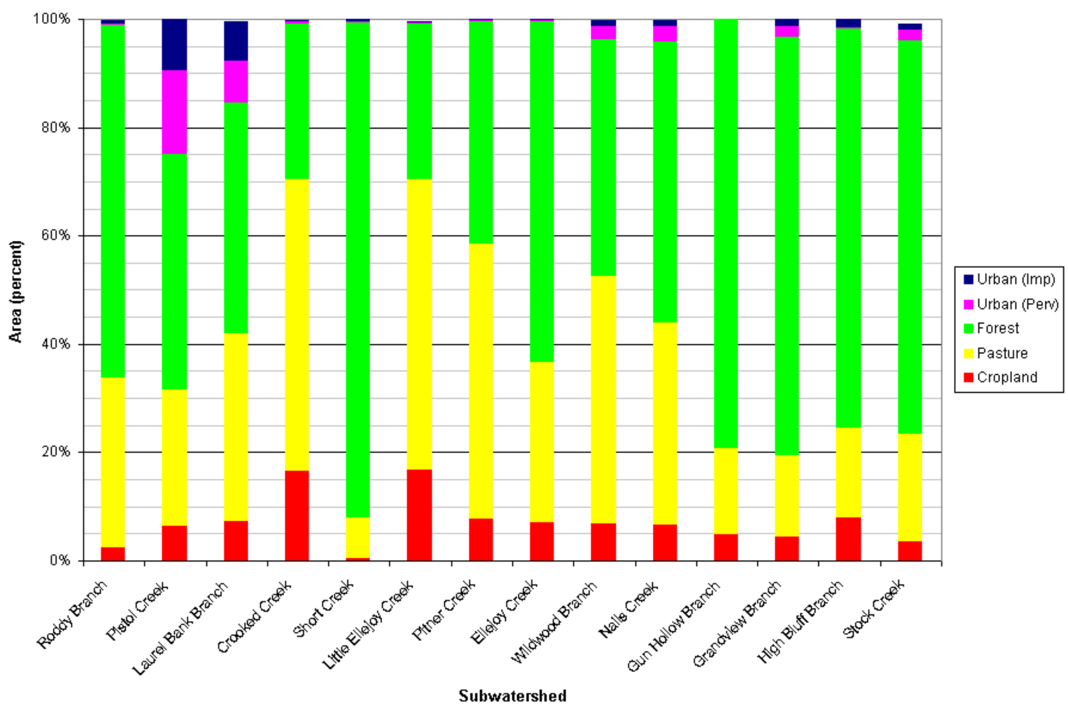

Figure 8. Land Use Percent of the Little River Pathogen-Impaired Subwatersheds.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

The Total Maximum Daily Load (TMDL) process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or <u>other appropriate measure</u>.

This document describes pathogen TMDL, Waste Load Allocation (WLA), and Load Allocation (LA) development for waterbodies identified as impaired due to E. coli on the Final 2002 303(d) list or the Final 2004 303(d) list. TMDL analyses are performed primarily on a 12-digit hydrologic unit area (HUC-12) basis for subwatersheds containing waterbodies identified as impaired due to E. coli.

8.1 Expression of TMDLs, WLAs, & LAs

In this document, the pathogen TMDL is expressed as the percent reduction in instream loading required to decrease existing E. coli or fecal coliform concentrations to desired target levels. Target concentrations are equal to the desired water quality goals (see Section 5.0) minus the appropriate MOS. WLAs & LAs for precipitation-induced loading sources are also expressed as required percent reductions in pathogen loading. Allocations for loading that is independent of precipitation (WLAs for WWTFs and LAs for “other direct sources”) are expressed as counts/day.

8.2 TMDL Analysis Methodology

Establishing the relationship between in-stream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling.

TMDLs for the Little River subwatershed were developed using load duration curves for analysis of impaired waterbodies. A load duration curve (LDC) is a cumulative frequency graph that illustrates existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow regime represented by these existing loads. Load duration curves were considered to be well suited for analysis of periodic monitoring data collected by grab sample. LDCs were developed at monitoring site locations in impaired waterbodies and an overall load reduction calculated to meet E. coli and fecal coliform targets according to the methods described in Appendix C.

8.3 Critical Conditions and Seasonal Variation

The critical condition for non-point source fecal coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, fecal coliform bacteria builds up on the land surface, and is washed off by rainfall. The critical condition for point source loading occurs during periods of low streamflow when dilution is minimized. Both conditions are represented in the TMDL analysis.

The ten-year period from October 1, 1994 to September 30, 2004 was used to simulate flow. This 10-year period contained a range of hydrologic conditions that included both low and high streamflows. Critical conditions are accounted for in the load duration curve analysis by using the entire period of flow and water quality data available for the impaired waterbodies. In all subwatersheds, water quality data have been collected during most flow ranges. Based on the location of the water quality exceedances on the load duration curves, no one delivery mode for pathogens appears to be dominant (see Section 9.3 and Table 10).

Seasonal variation was incorporated in the load duration curves by using the entire simulation period and all water quality data collected at the monitoring stations. The water quality data were not collected during all seasons.

8.4 Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations

An explicit MOS, equal to 10% of the E. coli and fecal coliform water quality goals (ref. Section 5.0), was utilized for TMDL analysis. Explicit MOS and the resulting target concentrations are shown in Table 7.

Table 7. Explicit MOS and Target Concentrations

Pollutant	WQ Goal Type	WQ Goal [cts./100mL]	Explicit MOS [cts./100mL]	Target [cts./100mL]
E. coli	Maximum	941	94	847
	30-Day Geometric Mean	126	13	113
Fecal Coliform	Maximum	1,000	100	900
	30-Day Geometric Mean	200	20	180

8.5 Determination of TMDLs

E. coli and fecal coliform load reductions were calculated for impaired segments in the Little River subwatershed using Load Duration Curves to evaluate compliance with the maximum target concentrations (Appendix C). When sufficient data were available, load reductions were also developed to achieve compliance with the 30-day geometric mean target concentrations (Appendix C). All of the instream load reductions for a particular waterbody were compared and the largest required load reduction was selected as the TMDL. These TMDL load reductions for the impaired segments are shown in Table 8 and are applied to the entire HUC-12 subwatershed in which the impaired waterbodies are located. In cases where the geometric mean could not be developed, it is assumed that achieving the load reduction based on the maximum target concentrations should result in attainment of the geometric mean criteria.

For Gun Hollow Branch, insufficient data were available to calculate the 30-day geometric mean and analysis of available data using maximum target concentrations indicated no load reduction would be required. However, the geometric mean of all monitoring data (E.coli=465, fecal=463, excluding highest and lowest values) indicated impairment. In this case, load reductions were developed using comparison of the geometric mean of all monitoring data, excluding highest and lowest values, to the 30-day geometric mean target concentrations (see Section 8.2).

8.6 Determination of WLAs & LAs

WLAs & LAs are developed in Appendix E for point sources and nonpoint sources respectively. TMDLs, WLAs, & LAs for Little River watershed impaired waterbodies are summarized in Table 9.

Table 8. Determination of TMDLs for Impaired Waterbodies, Little River Subwatershed

HUC-12 Subwatershed (06010201__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	Required Load Reduction [%]				
			Based on Target Maximum Concentration		Based on 30-day Geometric Mean Concentration		TMDL
			Fecal Coliform	E. Coli	Fecal Coliform	E. Coli	
0103	Short Creek	TN06010201032 – 0800	52.9	58.3	62.5	79.3	**79.3**
0104	Little Ellejoy Creek	TN06010201033 – 0100	17.4	NR			**88.9**
	Pitner Creek	TN06010201033 – 0200	57.4	>54.8			
	Ellejoy Creek	TN06010201033 – 1000 & 2000	35.7	19.0	82.1	88.9	
0105	Crooked Creek	TN06010201028 – 1000	94.6	>65.0	96.5	95.4	**96.5**
	Wildwood Branch	TN06010201034 – 0200	48.9	>54.6			
	Nails Creek	TN06010201034 – 1000	65.9	>65.0	83.5	90.4	
0106	Roddy Branch	TN06010201026 – 0100	67.4	>65.0	83.5	87.6	**87.6**
0107	Pistol Creek	TN06010201026 – 0400	57.9	46.2	55.3	71.6	**71.6**
0108	Grandview Branch	TN06010201066 – 0300	16.2	40.0			**88.0**
	High Bluff Branch	TN06010201066 – 0600	3.1	17.2			
	Stock Creek	TN06010201066 – 1000 & 2000	63.4	81.5	60.0	88.0	
	Gun Hollow Branch[d]	TN06010201066 – 1200	61.1	75.7			

[a] Waterbody ID based on Final 2004 303(d) List
[b] *Load reductions were determined based on comparison of the geometric mean of all monitoring data to the 30-day geometric mean target concentrations. Additional monitoring is recommended.*

Table 9. WLAs & LAs for Little River Subwatershed, Tennessee

HUC-12 Subwatershed (06010201__) or Drainage Area	Impaired Waterbody	Impaired Waterbody ID	TMDL	WLAs		LAs	
				Leaking Collection Systems[a]	MS4s[b]	Precipitation Induced Nonpoint Sources	Other Direct Sources[c]
			[% Red.]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0103	Short Creek	TN06010201032 – 0800	***79.3***	**NA**	**79.3**	**79.3**	**0**
0104	Little Ellejoy Creek	TN06010201033 – 0100	***88.9***	**NA**	**88.9**	**88.9**	**0**
	Pitner Creek	TN06010201033 – 0200					
	Ellejoy Creek	TN06010201033 – 1000 & 2000					
0105	Crooked Creek	TN06010201028 – 1000	***96.5***	**NA**	**96.5**	**96.5**	**0**
	Wildwood Branch	TN06010201034 – 0200					
	Nails Creek	TN06010201034 – 1000					
0106	Roddy Branch	TN06010201026 – 0100	***87.6***	**NA**	**87.6**	**87.6**	**0**
0107	Pistol Creek	TN06010201026 – 0400	***71.6***	**NA**	**71.6**	**71.6**	**0**
0108	Grandview Branch	TN06010201066 – 0300	***88.0***	**NA**	**88.0**	**88.0**	**0**
	High Bluff Branch	TN06010201066 – 0600					
	Stock Creek	TN06010201066 – 1000 & 2000					
	Gun Hollow Branch	TN06010201066 – 1200					

a. The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.
b. Applies to any MS4 discharge loading in the subwatershed.
c. The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

9.0 IMPLEMENTATION PLAN

The TMDLs, WLAs, and LAs developed in Section 8 are intended to be the first phase of a long-term effort to restore the water quality of impaired waterbodies in the Little River subwatershed through reduction of excessive pathogen loading. Adaptive management methods, within the context of the State's rotating watershed management approach, will be used to modify TMDLs, WLAs, and LAs as required to meet water quality goals.

9.1 Point Sources

9.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

All present and future discharges from industrial and municipal wastewater treatment facilities are required to be in compliance with the conditions of their NPDES permits at all times. In Tennessee, permit limits for treated sanitary wastewater require compliance with coliform water quality standards (ref: Section 5.0) prior to discharge. No additional reduction is required. WLAs for WWTFs are expressed as average loads in counts per day. WLAs are derived from facility design flows and permitted E. coli limits.

9.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For regulated discharges from municipal separate storm sewer systems, WLAs will be implemented through Phase I & II MS4 permits. These permits will require the development and implementation of a Storm Water Management Program (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. The *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002) was issued on February 27, 2003 and requires SWMPs to include six minimum control measures:

- Public education and outreach on storm water impacts
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site storm water runoff control
- Post-construction storm water management in new development and re-development
- Pollution prevention/good housekeeping for municipal operations

For discharges into impaired waters, the proposed Small MS4 General Permit (ref: http://www.state.tn.us/environment/wpc/stormh2o/MS4II.php) requires that SWMPs include a section describing how discharges of pollutants of concern will be controlled to ensure that they do not cause or contribute to instream exceedances of water quality standards. Specific measures and BMPs to control pollutants of concern must also be identified. In addition, MS4s must implement the WLA provisions of an applicable TMDL and describe methods to evaluate whether storm water controls are adequate to meet the WLA.

Implementation of the coliform WLAs for MS4s in this TMDL document will require effluent or instream monitoring to evaluate SWMP effectiveness with respect to reduction of pathogen loading.

9.1.3 NPDES Regulated Concentrated Animal Feeding Operations (CAFOs)

WLAs provided to CAFOs will be implemented through NPDES Permit No. TNA000000, General NPDES Permit for *Class II Concentrated Animal Feeding Operation* or the facility's individual permit. Among the provisions of the general permit are:

- Development and implementation of a site-specific Nutrient Management Plan (NMP) that:
    - Includes best management practices (BMPs) and procedures necessary to implement applicable limitations and standards;
    - Ensures adequate storage of manure, litter, and process wastewater including provisions to ensure proper operation and maintenance of the storage facilities.
    - Ensures proper management of mortalities (dead animals);
    - Ensures diversion of clean water, where appropriate, from production areas;
    - Identifies protocols for manure, litter, wastewater and soil testing;
    - Establishes protocols for land application of manure, litter, and wastewater;
    - Identifies required records and record maintenance procedures.

  The NMP must submitted to the State for approval and a copy kept on-site.

- Requirements regarding manure, litter, and wastewater land application BMPs.

- Requirements for the design, construction, operation, and maintenance of CAFO liquid waste management systems that are constructed, modified, repaired, or placed into operation after April 13, 2006. The final design plans and specifications for these systems must meet or exceed standards in the NRCS Field Office Technical Guide and other guidelines as accepted by the Departments of Environment and Conservation, or Agriculture.

Provisions of individual CAFO permits are similar. NPDES Permit No. TNA000000, *Class II Concentrated Animal Feeding Operation General Permit* is available on the TDEC website at http://www.state.tn.us/environment/wpc/programs/cafo/ .

9.2 Nonpoint Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most nonpoint source discharges. Reductions of pathogen loading from nonpoint sources (NPS) will be achieved using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired waters. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. There are links to a number of publications and information resources on EPA's

Nonpoint Source Pollution web page (http://www.epa.gov/owow/nps/pubs.html) relating to the implementation and evaluation of nonpoint source pollution control measures.

TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach (ref: http://www.state.tn.us/environment/wpc/watershed/). The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance. It relies on participation at the federal, state, local and nongovernmental levels to be successful.

BMPs have been utilized in the Little River subwatershed to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. These BMPs (e.g., animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment, livestock exclusion, etc.) may have contributed to reductions in in-stream concentrations of coliform bacteria in the Little River subwatershed during the TMDL evaluation period. The TDA keeps a database of BMPs implemented in Tennessee. Those listed in the Little River subwatershed are shown in Figure 9. It is recommended that additional information (e.g., livestock access to streams, manure application practices, etc.) be provided and evaluated to better identify and quantify agricultural sources of coliform bacteria loading in order to minimize uncertainty in future modeling efforts.

It is further recommended that BMPs be utilized to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. Demonstration sites for various types of BMPs should be established, maintained, and evaluated (performance in source reduction) over a period of at least two years prior to recommendations for utilization for subsequent implementation. E. coli sampling and monitoring are recommended during low-flow (baseflow) and storm periods at sites with and without BMPs and/or before and after implementation of BMPs.

In addition, the Tennessee Valley Authority (TVA) has conducted an Integrated Pollutant Source Identification (IPSI) (TVA, 2003) in Blount County and the Little River watershed. The IPSI provided detailed source information on a watershed scale, including the location of geographic features that are known or suspected to contribute nonpoint source pollution within the watershed. The survey of animal operations identified beef cattle, milk cows, and horse operations and classified the sites by relative size and proximity to a stream. Analysis of geographic data also identified septic systems that were suspect. Suspect systems were defined as systems exhibiting a visible plume or drain field, or at locations that are questionable for on-site septic systems. Use of information included in the IPSI can aid in identification of pollution sources that should be targeted for pollution reduction programs.

Within the Little River watershed, a project was recently completed by a group of organizations, including the University of Tennessee Community Partnership Center, the Tennessee Valley Authority, the University of Tennessee Dept. of Urban and Regional Planning, and the Little River Watershed Association. The objective of the project was to test the effectiveness of participatory methods and tools in watershed planning, to develop new methods and tools, and to become a model for stakeholder-driven environmental planning for the nation. The project was also intended to build capacity for future watershed restoration and protection efforts. Another project is currently being funded by TDEC. The Blount County Extension is the lead organization for a project located in Pistol Creek, a tributary of the Little River. The objective of the project is to organize a sources, and making recommendations for solutions. Additional information about these two projects is included in Appendix H.

9.3 Application of Load Duration Curves for Implementation Planning

The Load Duration Curve methodology (Appendix D) is a form of water quality analysis and presentation of data that aids in guiding implementation by targeting strategies to appropriate flow conditions. One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of pathogens by differentiating between point and non-point problems. The E. coli load duration analysis was utilized for implementation planning. The E. coli load duration curve for each pathogen-impaired subwatershed (Figures 10 thru 22) was analyzed to determine the frequency with which water quality monitoring data exceed the E. coli target maximum concentration of 847 counts/100 mL (standard – MOS) under five flow conditions (low, dry, mid-range, moist, and high).

Table 10 presents Load Duration analysis statistics for E. coli in the Little River Subwatershed and Table 11 presents targeted implementation strategies for each source category covering the entire range of flow (Stiles, 2003). Each implementation strategy addresses a range of flow conditions and targets point sources, non-point sources, or a combination of each. Results indicate the Pistol Creek implementation strategy will require BMPs targeting primarily non-point sources (dominant under high flow/runoff conditions) while the implementation strategy for Stock Creek and Ellejoy Creek will require BMPs targeting sources dominant under low flow/dry conditions. The implementation strategies listed in Table 11 are a subset of the categories of BMPs and implementation strategies available for application to the pathogen-impaired Little River subwatersheds for reduction of pathogen loading and mitigation of water quality impairment.

See Appendix C for a detailed discussion of the Load Duration Curve Methodology applied to the Little River Subwatershed.

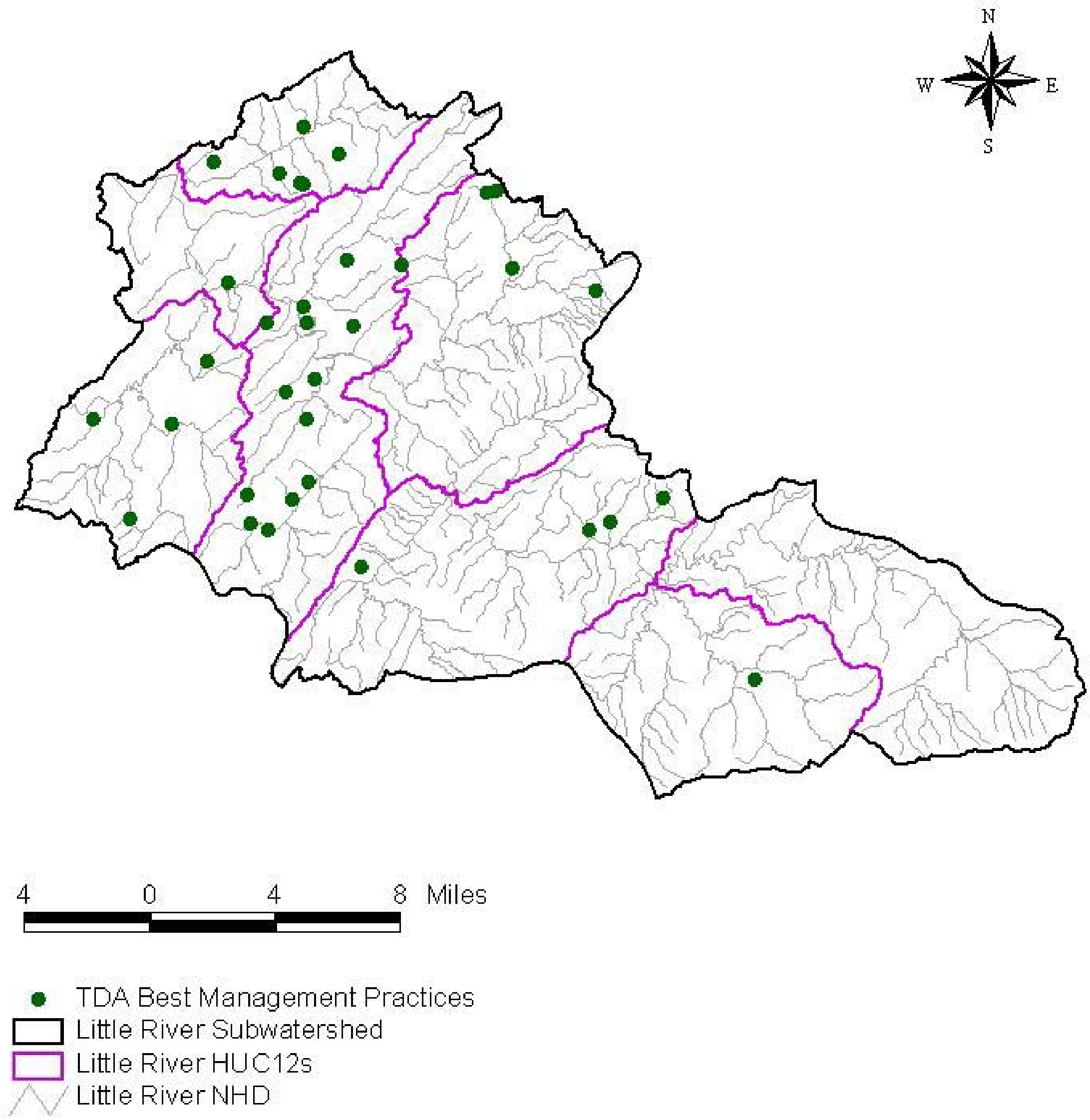

Figure 9. Tennessee Department of Agriculture Best Management Practices located in the Little River Subwatershed.

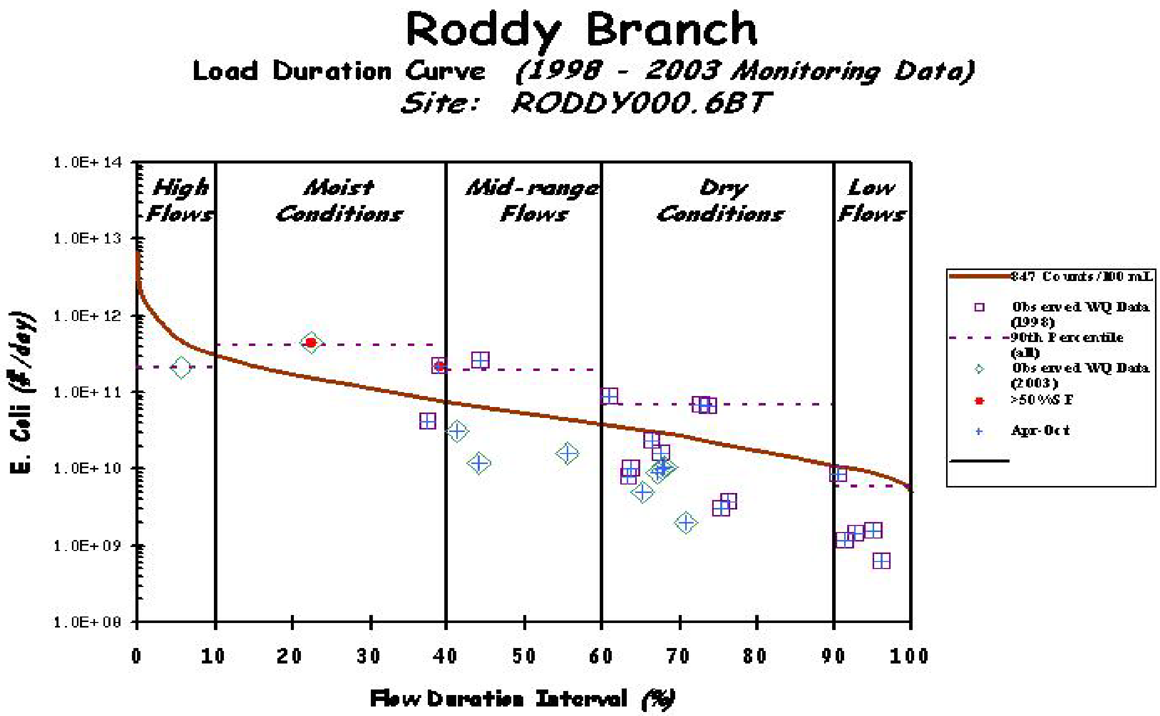

Figure 10. Load Duration Curve for Roddy Branch

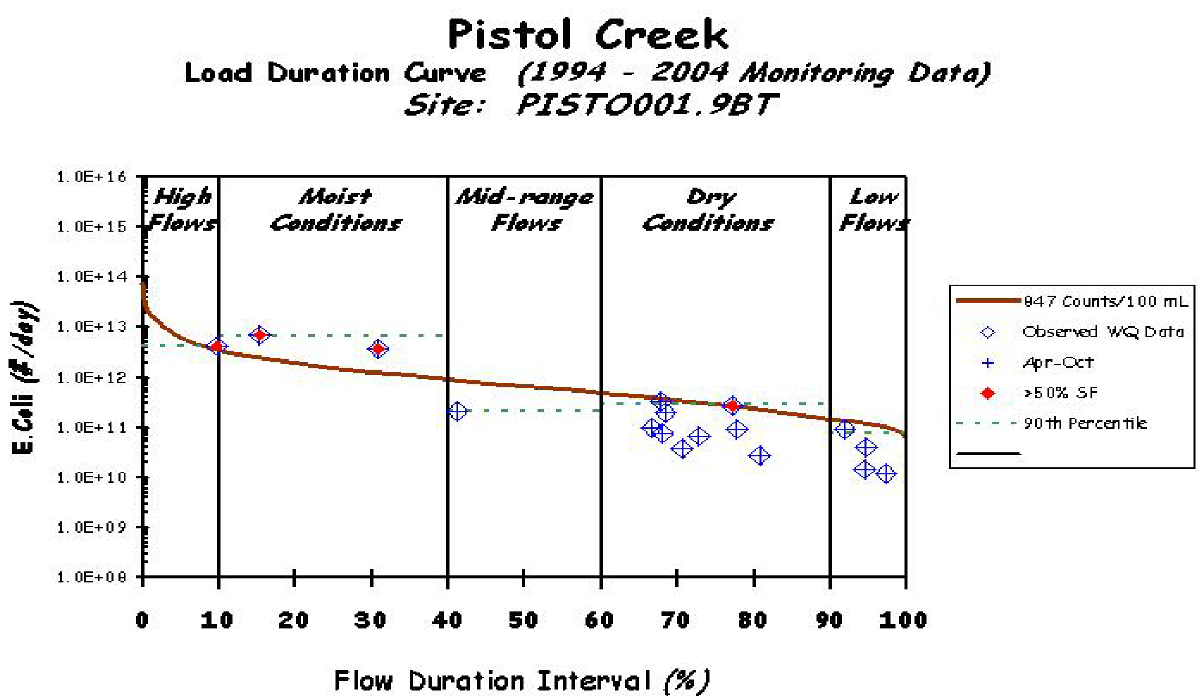

Figure 11. Load Duration Curve for Pistol Creek

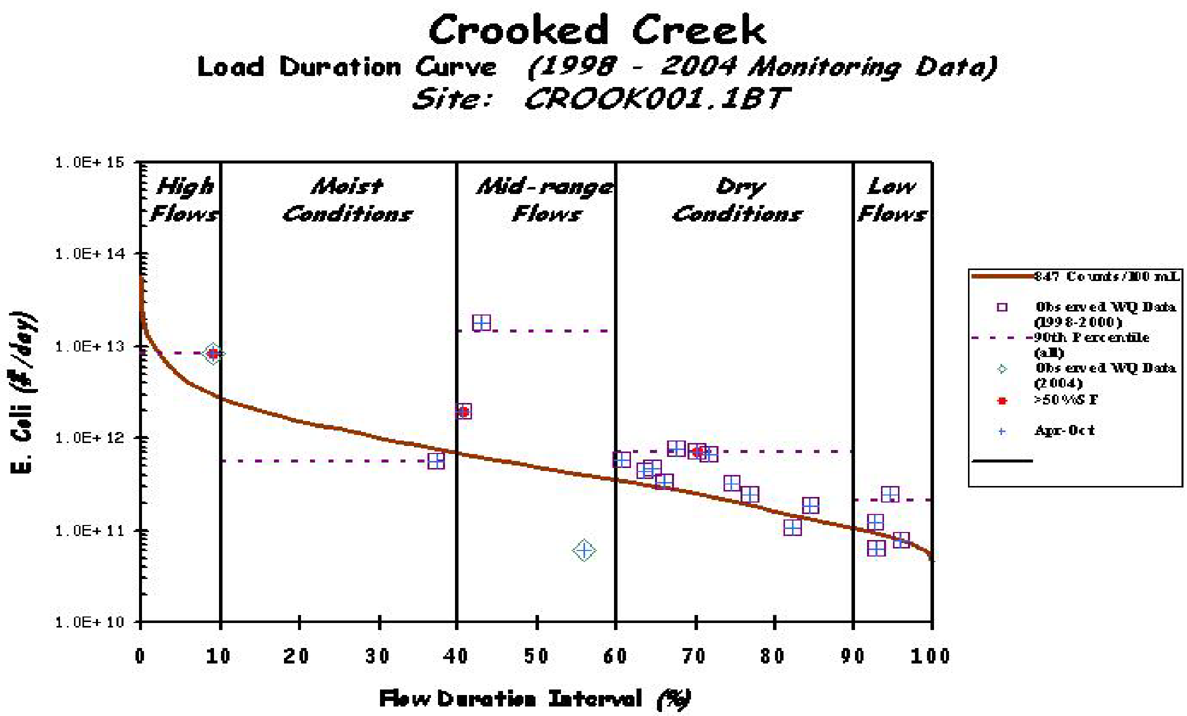

Figure 12. Load Duration Curve for Crooked Creek

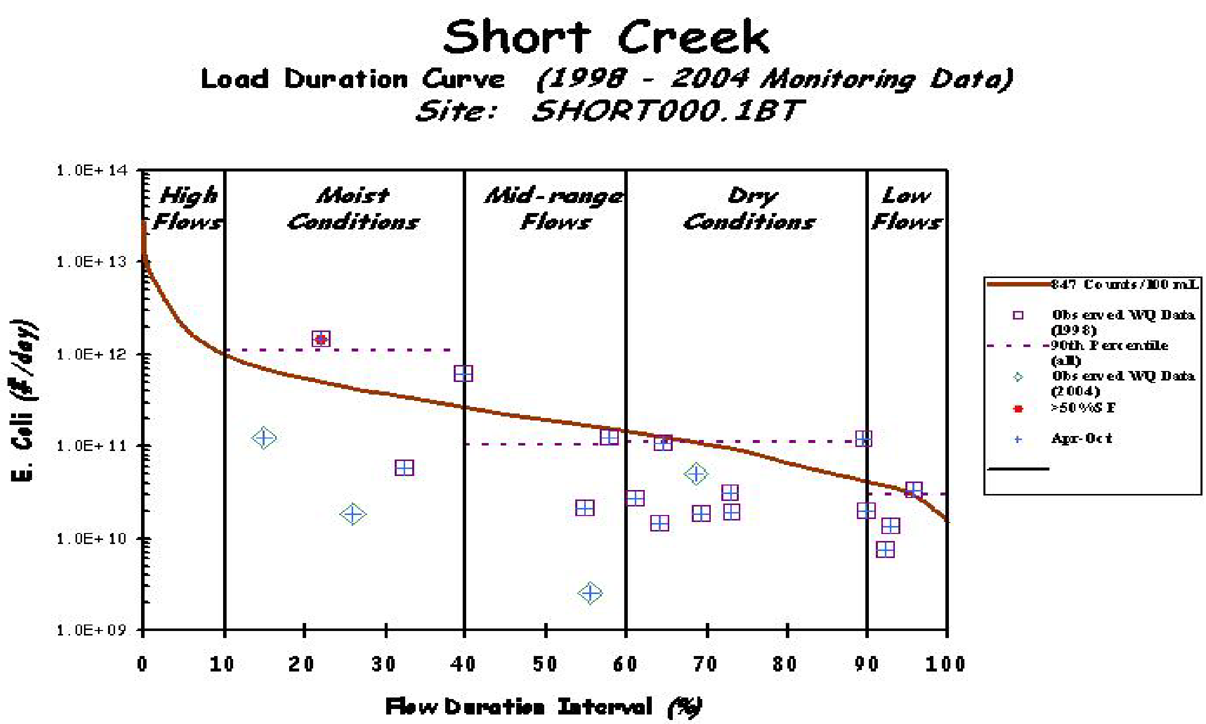

Figure 13. Load Duration Curve for Short Creek

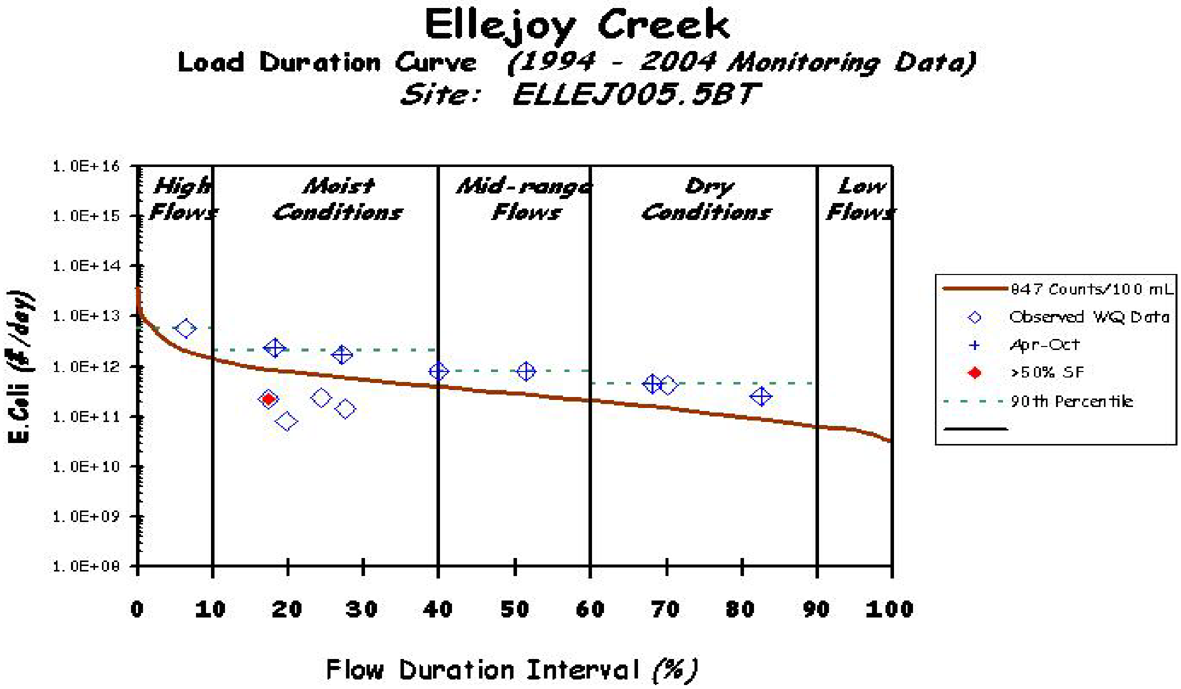

Figure 14. Load Duration Curve for Ellejoy Creek

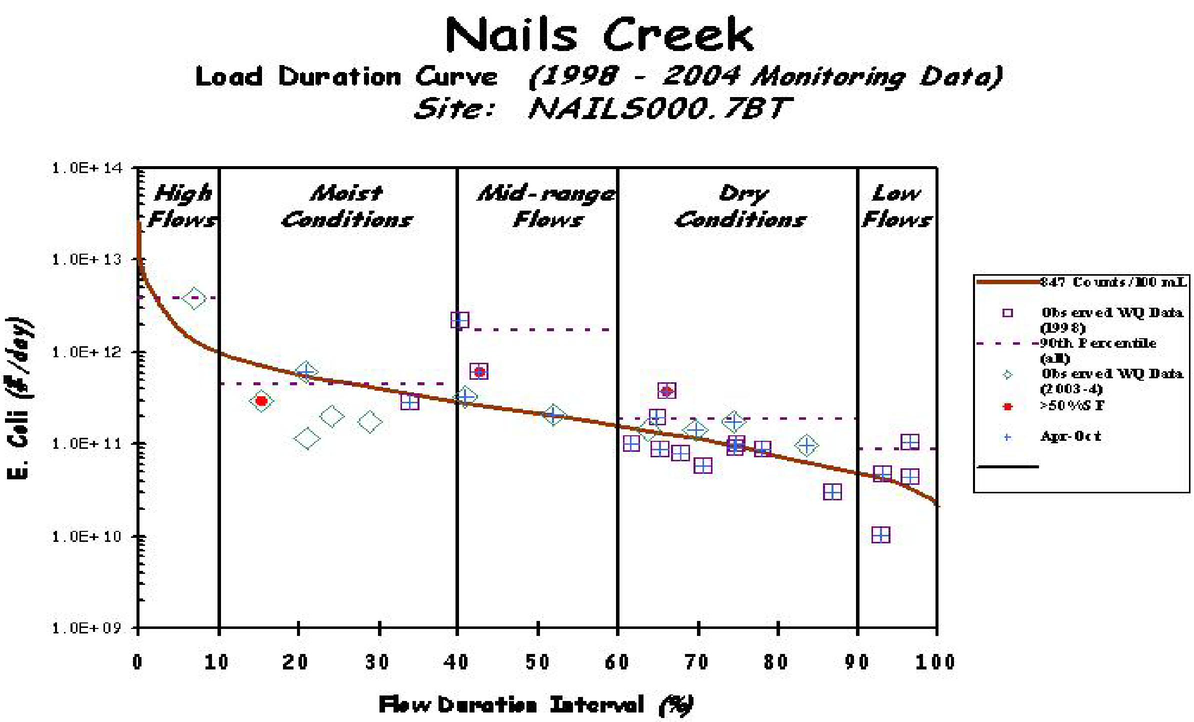

Figure 15. Load Duration Curve for Nails Creek

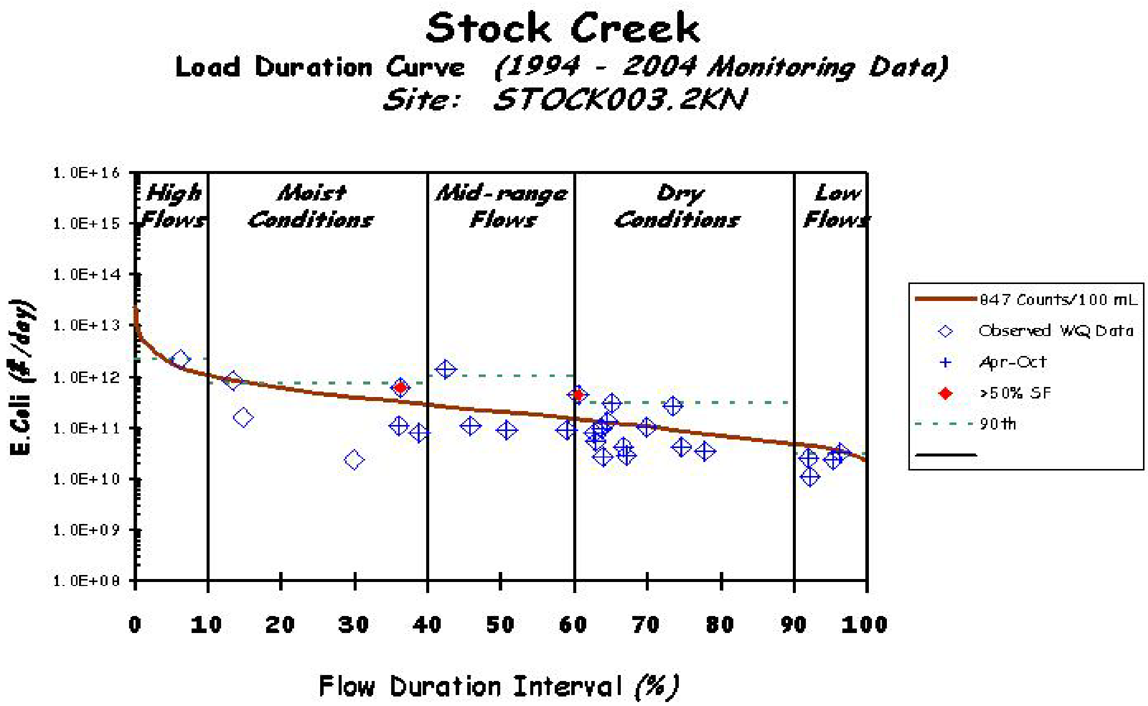

Figure 16. Load Duration Curve for Stock Creek

9.4 Additional Monitoring

Documenting progress in reducing the quantity of pathogens entering the Little River subwatershed is an essential element of the TMDL Implementation Plan. Additional monitoring and assessment activities are recommended to determine whether implementation of TMDLs, WLAs, & LAs in tributaries and upstream reaches will result in achievement of instream water quality targets for fecal coliform and/or E. coli. Future monitoring activities should be representative of all seasons and a full range of flow and meteorological conditions. Monitoring activities should also be adequate to assess water quality using the 30-day geometric mean standard.

Tennessee's watershed management approach specifies a five-year cycle for planning and assessment. Each watershed will be examined (or re-examined) on a rotating basis. Generally, in years two and three of the five-year cycle, water quality data are collected in support of water quality assessment (including TMDL development) and planning activities. Therefore, a watershed TMDL is developed one to two years prior to commencement of the next cycle's monitoring period.

Additional sampling for both fecal coliform and E. coli is recommended to aid in a better understanding of the relationship between fecal coliform concentration and E. coli concentration.

Table 10. Load Duration Curve Summary for E.Coli and/or Fecal Coliform Impaired Segments

Flow Condition		High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Roddy Branch at Mile 0.6	% Samples > 941 Counts/100 mL[1]	0.0	66.7	25.0	21.4	0.0
	Reduction[2]	0.0%	65.0%	66.4%	63.0%	0.0%
Pistol Creek at Mile 1.9	% Samples > 941 Counts/100 mL[1]	100.0	100.0	0.0	11.1	0.0
	Reduction[2]	16.2%	65.0%	0.0%	0.0%	0.0%
Crooked Creek at Mile 1.1	% Samples > 941 Counts/100 mL[1]	NA	66.7	83.3	75.0	66.7
	Reduction[2]	NA	97.3%	65.0%	65.0%	60.8%
Short Creek at Mile 0.1	% Samples > 941 Counts/100 mL[1]	NA	40.0	0.0	11.1	0.0
	Reduction[2]	NA	62.3%	0.0%	20.5%	0.0%
Ellejoy Creek at Mile 5.5	% Samples > 941 Counts/100 mL[1]	100.0	33.3	100.0	100.0	NA
	Reduction[2]	67.9%	65.0%	64.0%	65.0%	NA
Nails Creek at Mile 0.7	% Samples > 941 Counts/100 mL[1]	100.0	28.6	66.7	66.7	66.7
	Reduction[2]	65.0%	73.1%	46.9%	44.6%	60.5%
Stock Creek at Mile 3.2	% Samples > 941 Counts/100 mL[1]	100.0	16.7	25.0	23.1	0.0
	Reduction[2]	24.4%	30.0%	75.2%	63.7%	0.0%

1 Tennessee maximum daily water quality standard for E.coli (941 Counts/100 mL).
2 Reductions based on analyses of observed values in each range (see Appendix D).

Table 11. Load Duration Curve Summary for Example Implementation Strategies

Flow Condition	High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded	0-10	10-40	40-60	60-90	90-100
Example Implementation Strategies					
Municipal NPDES		L	M	H	H
Stormwater Management		H	H	H	
SSO Mitigation	H	H	M	L	
Collection System Repair		L	M	H	H
Septic System Repair		L	M	H	M
Livestock Exclusion[1]			M	H	H
Pasture Management/Land Application of Manure[1]	H	H	M	L	
Riparian Buffers[1]		H	H	H	
	Potential for source area contribution under given hydrologic condition (H: High; M: Medium; L: Low)				

[1] Example Best Management Practices (BMPs) for Agricultural Source reduction. Actual BMPs applied may vary.

Additional monitoring and assessment activities are recommended for the Laurel Bank Branch subwatershed to verify the assessment status of the stream reach identified on the Final 2004 303(d) list as impaired due to pathogens. If it is determined that this stream reach is still not fully supporting designated uses, then sufficient data to enable development of a TMDL must be acquired.

Additional monitoring and assessment activities are also recommended for the Short Creek subwatershed. Recent monitoring data suggests improvement in water quality in Short Creek. If additional monitoring representing all seasons and a full range of flow and meteorological conditions confirms that Short Creek is no longer impaired, then Short Creek should be removed from the 303(d) list.

Additional monitoring and assessment activities are also recommended for the Gun Hollow Branch subwatershed. Analysis of monitoring data using Load Duration Curve methodology suggests Gun Hollow Branch is not impaired. However, the geometric mean of all monitoring data (E.coli=465, fecal=463) suggests impairment of the stream. Additional monitoring representing all seasons and a full range of flow and meteorological conditions is recommended to determine the degree of impairment of attainment of pathogen water quality standards within Gun Hollow Branch subwatershed.

9.5 Source Identification

An important aspect of pathogen load reduction activities is the accurate identification of the actual sources of pollution. In cases where the sources of pathogen impairment are not readily apparent, Microbial Source Tracking (MST) is one approach to determining the sources of fecal pollution and pathogens affecting a waterbody. Those methods that use bacteria as target organisms are also known as Bacterial Source Tracking (BST) methods. This technology is recommended for source identification in E. coli impaired waterbodies.

Bacterial Source Tracking is a collective term used for various emerging biochemical, chemical, and molecular methods that have been developed to distinguish sources of human and non-human fecal pollution in environmental samples (Shah, 2004). In general, these methods rely on genotypic (also known as "genetic fingerprinting"), or phenotypic (relating to the physical characteristics of an organism) distinctions between the bacteria of different sources. Three primary genotypic techniques are available for BST: ribotyping, pulsed field gel electrophoresis (PFGE), and polymerase chain reaction (PCR). Phenotypic techniques generally involve an antibiotic resistance analysis (Hyer, 2004).

The USEPA has published a fact sheet that discusses BST methods and presents examples of BST application to TMDL development and implementation (USEPA, 2002b). Various BST projects and descriptions of the application of BST techniques used to guide implementation of effective BMPs to remove or reduce fecal contamination are presented. The fact sheet can be found on the following EPA website: http://www.epa.gov/owm/mtb/bacsortk.pdf.

A multi-disciplinary group of researchers is developing and testing a series of different microbial assay methods based on real-time PCR to detect fecal bacterial concentrations and host sources in water samples (McKay, 2005). The assays have been used in a study of fecal contamination and have proven useful in identification of areas where cattle represent a significant fecal input and in development of BMPs. It is expected that these types of assays could have broad applications in monitoring fecal impacts from Animal Feeding Operations, as well as from wildlife and human sources. Other BST projects have been conducted or are currently in progress throughout the state of Tennessee, as presented in sessions of the Thirteenth Tennessee Water Resources Symposium (Lawrence, 2003) and the Fifteenth Tennessee Water Resources Symposium (Bailey, 2005; Baldwin, 2005; Farmer, 2005).

BST technology was utilized in a study conducted in Stock Creek (Layton, 2004). Microbial source tracking using real-time PCR assays to quantify *Bacteroides* 16S rRNA genes was used to determine the percent of fecal contamination attributable to cattle. E. coli loads attributable to cattle were calculated for each of nine sampling sites in the Stock Creek subwatershed on twelve sampling dates. At the site on High Bluff Branch (tributary to Stock Creek), none of the sample dates had E. coli loads attributable to cattle above the threshold. This suggests that at this site removal of E. coli attributable to cattle would have little impact on the total E. coli loads. The E. coli load attributable to cattle made a large contribution to the total E. coli load at each of the eight remaining sampling sites. At two of the sites (STOCK005.3KN and GHOLL000.6KN), 50–75% of the E. coli attributable to cattle loads alone was above the 126 CFU/100mL threshhold. This suggests that removal of the E. coli attributable to cattle at these sites would reduce the total E. coli load to acceptable limits. (See Appendix F.)

9.6 Evaluation of TMDL Effectiveness

The effectiveness of the TMDL will be assessed within the context of the State's rotating watershed management approach. Watershed monitoring and assessment activities will provide information by which the effectiveness of pathogen loading reduction measures can be evaluated. Additional monitoring data, ground-truthing activities, and bacterial source identification actions are recommended to enable implementation of particular types of BMPs to be directed to specific areas in impaired subwatersheds. This will optimize utilization of resources to achieve maximum reductions in pathogen loading. These TMDLs will be re-evaluated during subsequent watershed cycles and revised as required to assure attainment of applicable water quality standards.

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed pathogen TMDLs for the Little River subwatershed was placed on Public Notice for a 35-day period and comments solicited. Steps that were taken in this regard include:

1) Notice of the proposed TMDLs was posted on the Tennessee Department of Environment and Conservation website. The announcement invited public and stakeholder comment and provided a link to a downloadable version of the TMDL document.

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings which was sent to approximately 90 interested persons or groups who have requested this information.

3) A draft copy of the proposed TMDL was sent to those MS4s that are wholly or partially located in pathogen-impaired subwatersheds. A draft copy was be sent to the following entities:

   Blount County, Tennessee (TNS075116)
   City of Alcoa (TNS075132)
   City of Maryville (TNS075434)
   Knox County, Tennessee (TNS075582)
   Sevier County, Tennessee (TNS075655)
   Tennessee Dept. of Transportation (TNS077585)

4) Notice of the availability of the proposed TMDL was sent to the Little River Watershed Association in Maryville, Tennessee. The Little River Watershed Association (LRWA) is a community organization that works to protect, preserve, and enhance resources located within and near the Little River watershed.

11.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, P.E., Watershed Management Section
e-mail: Vicki.Steed@state.tn.us

Sherry H. Wang, Ph.D., Watershed Management Section
e-mail: Sherry.Wang@state.tn.us

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APPENDIX A

Land Use Distribution in the Little River Subwatershed

Table A-1. MRLC Land Use Distribution of Little River Subwatersheds

Land Use	Little River Subwatersheds					
	Roddy Branch		Pistol Creek		Laurel Bank Branch[1]	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0
Deciduous Forest	569	26.3	1,652	6.6	389	7.1
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0
Evergreen Forest	415	19.2	2,751	10.9	780	14.2
High Intensity Commercial/Industrial/Transp.	13	0.6	1,652	6.6	379	6.9
High Intensity Residential	0	0.0	794	3.2	58	1.1
Low Intensity Residential	2	0.1	3,809	15.1	392	7.1
Mixed Forest	419	19.4	3,559	14.2	802	14.6
Open Water	6	0.3	51	0.2	18	0.3
Other Grasses (Urban/recreation; e.g. parks)	8	0.3	2,246	8.9	342	6.2
Pasture/Hay	677	31.3	6,356	25.3	1,903	34.7
Quarries/Strip Mines/Gravel Pits	0	0.0	678	2.7	0	0.0
Row Crops	55	2.5	1,573	6.3	402	7.3
Transitional	0	0.0	21	0.1	20	0.4
Woody Wetlands	0	0.0	0	0.0	0	0.0
Total	2,164	100.0	25,141	100.0	5,483	100.0

Table A-1 (Cont.). MRLC Land Use Distribution of Little River Subwatersheds

Land Use	Little River Subwatersheds					
	Crooked Creek		Short Creek		Little Ellejoy Creek[2]	
	[acres]	[%]	[acres]	[acres]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0	0	0
Deciduous Forest	399	7.5	2,496	41.4	394	7.6
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0
Evergreen Forest	485	9.1	1,390	23.1	475	9.2
High Intensity Commercial/Industrial/Transp.	16	0.3	26	0.4	15	0.3
High Intensity Residential	0	0.0	1	0.0	0	0.0
Low Intensity Residential	14	0.3	12	0.2	13	0.2
Mixed Forest	640	12.0	1,583	26.3	627	12.1
Open Water	11	0.2	7	0.1	11	0.2
Other Grasses (Urban/recreation; e.g. parks)	4	0.1	21	0.4	4	0.1
Pasture/Hay	2,873	54.0	449	7.5	2,784	53.7
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0
Row Crops	877	16.5	25	0.4	864	16.7
Transitional	0	0.0	14	0.2	0	0.0
Woody Wetlands	0	0.0	0	0.0	0	0.0
Total	5,319	100.0	6,024	100.0	5,188	100.0

Table A-1 (Cont.). MRLC Land Use Distribution of Little River Subwatersheds

Land Use	Little River Subwatersheds					
	Pitner Creek[2]		Ellejoy Creek		Wildwood Branch[3]	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0	0	0	0	0.0
Deciduous Forest	686	16.5	6,717	27.2	254	10.9
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0
Evergreen Forest	324	7.8	4,085	16.6	272	11.7
High Intensity Commercial/Industrial/Transp.	6	0.1	34	0.1	24	1.0
High Intensity Residential	1	0.0	2	0.0	1	0.0
Low Intensity Residential	14	0.3	56	0.2	57	2.5
Mixed Forest	689	16.6	4,719	19.1	414	17.8
Open Water	3	0.1	17	0.1	1	0.0
Other Grasses (Urban/recreation; e.g. parks)	2	0.1	7	0.0	78	3.3
Pasture/Hay	2,106	50.7	7,321	29.7	1,062	45.7
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0
Row Crops	323	7.8	1,719	7.0	161	6.9
Transitional	0	0.0	0	0.0	0	0.0
Woody Wetlands	1	0.0	1	0.0	0	0.0
Total	4,153	100.0	24,677	100.0	2,324	100.0

Table A-1 (Cont.). MRLC Land Use Distribution of Little River Subwatersheds

Land Use	Little River Subwatersheds					
	Nails Creek		Grandview Branch[4]		High Bluff Branch[4]	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0	0	0.0
Deciduous Forest	1,495	13.1	108	22.5	74	24.9
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0
Evergreen Forest	1,731	15.2	110	23.0	55	18.4
High Intensity Commercial/Industrial/Transp.	96	0.8	5	1.0	5	1.6
High Intensity Residential	14	0.1	1	0.2	0	0.0
Low Intensity Residential	361	3.2	10	2.2	0	0.1
Mixed Forest	2,409	21.1	148	30.9	91	30.5
Open Water	5	0.0	0	0.0	0	0.0
Other Grasses (Urban/recreation; e.g. parks)	266	2.3	3	0.7	0	0.0
Pasture/Hay	4,258	37.3	72	15.1	49	16.4
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0
Row Crops	767	6.7	21	4.4	24	8.0
Transitional	0	0.0	0	0.0	0	0.0
Woody Wetlands	0	0.0	0	0.0	0	0.0
Total	11,403	100.0	478	100.0	298	100.0

Table A-1 (Cont.). MRLC Land Use Distribution of Little River Subwatersheds

Land Use	Little River Subwatersheds			
	Stock Creek		Gun Hollow Branch[4]	
	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0
Deciduous Forest	3,055	22.4	164	32.0
Emergent Herbaceous Wetlands	17	0.1	0	0.0
Evergreen Forest	3,114	22.8	113	22.0
High Intensity Commercial/Industrial/Transp.	141	1.0	0	0.0
High Intensity Residential	19	0.1	0	0.0
Low Intensity Residential	291	2.1	0	0.0
Mixed Forest	3,471	25.4	130	25.3
Open Water	115	0.8	0	0.0
Other Grasses (Urban/recreation; e.g. parks)	215	1.6	0	0.0
Pasture/Hay	2,725	20.0	81	15.8
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0
Row Crops	473	3.5	25	4.9
Transitional	0	0.0	0	0.0
Woody Wetlands	25	0.2	0	0.0
Total	13,661	100.0	514	100.0

1 Laurel Bank Branch is a tributary to Pistol Creek
2 Little Ellejoy Creek and Pitner Creek are tributaries to Ellejoy Creek
3 Wildwood Branch is a tributary to Nails Creek
4 Grandview Branch, High Bluff Branch, and Gun Hollow Branch are tributaries to Stock Creek

APPENDIX B

Water Quality Monitoring Data

There are a number of water quality monitoring stations that provide data for waterbodies identified as impaired for pathogens in the Little River subwatershed. The location of these monitoring stations is shown in Figure 5. Monitoring data recorded at these stations for Fecal Coliform and Escherichia Coli (E. Coli) are tabulated in Table B-1.

Table B-1. Water Quality Monitoring Data – Little River Subwatersheds

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
CROOK001.1BT	6/17/98	420	613
	6/23/98	40500	24192
	7/6/98	14066	1203
	7/8/98	950	980
	7/14/98	3200	2419
	7/21/98	2000	1300
	7/28/98	2500	2419
	8/6/98	1450	1414
	8/12/98	2600	2419
	8/18/98	2200	1300
	8/25/98	640	1120
	9/17/98	730	579
	9/22/98	720	1203
	9/30/98	3500	2419
	10/8/98	56000	2419
	10/14/98	1550	1120
	10/27/98	570	816
	10/5/00	550	613
	4/12/04	250	130
	5/3/04	4700	>2419
CROOK007.2BT	4/12/04	190	131
	5/3/04	1938	1414
	7/26/04	3900	1986
	8/18/04	430	378
ELLEJ000.1BT	6/17/98	560	461
	6/23/98	14900	9804
	7/6/98	378	613
	7/8/98	440	613
	7/14/98	740	613
	7/21/98	500	488
	8/25/98	330	461
	9/22/98	460	613
	10/27/98	230	131
	6/30/03	520	387

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
ELLEJ000.1BT (continued)	7/14/03	900	579
	8/6/03	1200	980
	8/18/03	1400	1046
	10/1/03	220	308
	10/22/03	300	328
	11/5/03	100	126
	12/5/03	360	345
	1/6/04	2300	>2419
	1/20/04	360	411
	2/5/04	250	228
	2/19/04	110	59
ELLEJ003.2BT	6/30/03	2500	1986
	7/14/03	1200	921
	8/6/03	1800	1414
	8/18/03	1800	770
	10/1/03	640	649
	10/22/03	570	548
	11/5/03	330	435
	12/5/03	116	161
	1/6/04	2600	>2419
	1/20/04	250	219
	2/5/04	180	142
	2/19/04	80	83
ELLEJ005.5BT	6/30/03	4000	>2419
	7/14/03	2400	2419
	8/6/03	1900	2419
	8/18/03	2600	>2419
	10/1/03	2200	1733
	10/22/03	6400	>2419
	11/5/03	9700	>2419
	12/5/03	132	219
	1/6/04	2800	>2419
	1/20/04	340	308
	2/5/04	130	84
	2/19/04	160	210
ELLEJ008.0BT	6/30/03	350	308
	7/14/03	800	1046
	8/6/03	1000	770
	8/18/03	600	326

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
ELLEJ008.0BT (continued)	10/1/03	270	192
	10/22/03	300	345
	11/5/03	2000	1120
	12/5/03	280	291
	1/6/04	1900	2419
	1/20/04	320	222
	2/5/04	140	161
	2/19/04	290	205
ELLEJ010.1SV	6/30/03	2500	1300
	7/14/03	900	579
	8/6/03	900	649
	8/18/03	1300	1414
	10/1/03	510	517
	10/22/03	400	727
	11/5/03	660	1120
	12/5/03	42	31
	1/6/04	290	173
	1/20/04	70	17
	2/5/04	50	88
	2/19/04	120	114
FLAG000.1BT	4/12/04	320	104
	5/3/04	996	1203
	7/26/04	1600	1203
	8/18/04	620	548
GHOLL000.6KN	6/4/03	600	579
	7/7/03	1200	921
	8/13/03	320	225
	8/26/03	420	345
	9/16/03	590	579
	10/9/03	830	1553
	10/30/03	240	261
	11/20/03	560	613
	12/11/03	230	461
	1/17/04	160	173
	2/19/04	550	579
GRAND000.5KN	6/4/03	960	921
	8/13/03	370	260
	8/26/03	2100	2419
	9/16/03	290	228

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
GRAND000.5KN (continued)	10/9/03	116	167
	10/30/03	700	308
	11/20/03	700	727
	12/11/03	620	1300
	1/27/04	190	157
	2/19/04	80	99
HBLUF000.1KN	6/4/03	2000	1414
	8/13/03	810	980
	8/26/03	540	397
	9/16/03	400	461
	10/9/03	460	344
	10/30/03	240	152
	11/20/03	600	921
	12/11/03	400	291
	1/27/04	320	326
	2/19/04	310	194
LAURE1T0.1BT	4/6/04	<2	6
	5/19/04	20	8
	6/16/04	4	2
	7/20/04	10	4
	8/11/04	100	51
	8/17/04	200	119
	8/31/04	24	58
LAURE2T0.1BT	4/6/04	14	23
	4/28/04	4	6
	5/19/04	10	33
	6/16/04	150	133
	7/20/04	<2	4
	8/11/04	220	190
	8/17/04	40	59
	8/31/04	270	345
LELLE000.2BT	6/30/03	800	816
	7/14/03	1100	345
	8/6/03	360	411
	8/18/03	1000	649
	10/1/03	280	249
	10/22/03	300	272
	11/5/03	550	770
	12/5/03	146	121

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
LELLE000.2BT (continued)	1/6/04	3000	1986
	1/20/04	310	488
	2/5/04	250	162
	2/19/04	100	105
LICK000.1BT	4/6/04	18	3
	4/28/04	52	47
	4/28/04	144	133
	5/19/04	36	17
	6/16/04	30	37
	7/20/04	30	12
	8/11/04	54	36
	8/17/04	28	18
	8/31/04	108	108
MCCAL000.2KN	6/4/03	1200	1203
	8/13/03	200	89
	8/26/03	210	115
	9/16/03	330	199
	10/9/03	200	192
	10/30/03	230	205
	11/20/03	400	649
	12/11/03	340	308
	1/27/04	140	115
	2/19/04	80	144
MILLS001.0BT	6/30/03	1600	1414
	7/14/03	900	649
	8/6/03	1200	921
	8/18/03	1200	816
	10/1/03	850	238
	10/22/03	360	285
	11/5/03	430	411
	12/5/03	68	83
	1/6/04	300	110
	1/20/04	320	179
	2/5/04	30	11
	2/19/04	60	28
MMILL000.1KN	6/4/03	320	308
	7/9/03	670	1120
	8/13/03	2200	250
	8/26/03	540	201

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
MMILL000.1KN (continued)	9/16/03	360	291
	10/9/03	176	153
	10/30/03	49	66
	11/20/03	540	727
	12/11/03	390	488
	1/27/04	120	104
	2/19/04	280	276
MOOK000.3BT	4/12/04	760	272
	5/3/04	444	168
	7/26/04	2600	2419
	8/18/04	900	1230
NAILS000.7BT	6/17/98	440	687
	6/23/98	15600	6488
	7/6/98	440	579
	7/8/98	720	1203
	7/14/98	510	548
	7/21/98	620	921
	7/28/98	2600	1986
	8/6/98	490	548
	8/12/98	2400	816
	8/18/98	420	435
	8/25/98	500	921
	9/17/98	530	980
	9/22/98	410	461
	9/30/98	2800	2419
	10/8/98	3400	2419
	10/14/98	302	211
	10/27/98	590	1046
	6/16/03	1530	1553
	6/30/03	1500	1300
	8/6/03	1300	921
	8/18/03	1300	866
	10/1/03	900	986
	10/22/03	580	1046
	11/5/03	1900	866
	12/5/03	350	345
	1/6/04	2500	>2419
	1/20/04	310	345

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
NAILS000.7BT (continued)	2/5/04	260	179
	2/19/04	200	365
NAILS003.5BT	6/16/03	1240	980
NAILS004.5BT	6/30/03	850	1300
	8/6/03	1600	921
	8/18/03	1600	2419
	10/1/03	630	613
	10/22/03	770	921
	11/5/03	3400	>2419
	12/5/03	106	179
	1/6/04	3100	>2419
	1/20/04	230	688
	2/5/04	160	111
	2/19/04	90	86
NAILS008.3BT	6/16/03	850	649
	6/30/03	2100	2419
	8/6/03	1000	816
	8/18/03	1100	980
	10/1/03	430	488
	10/22/03	220	272
	11/5/03	620	687
	12/5/03	192	214
	1/6/04	900	1120
	1/20/04	200	276
	2/5/04	210	162
	2/19/04	60	155
NFCR000.3BT	4/12/04	430	
	5/3/04	986	1300
	7/26/04	2500	2419
	7/26/04	2700	2419
	8/18/04	800	687
	8/18/04	770	921
NSPRI000.3KN	6/4/03	280	201
	7/9/03	280	219
	8/13/03	120	79
	8/26/03	528	326
	9/16/03	152	157
	10/9/03	166	158
	10/30/03	1300	1300

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
NSPRI000.3KN (continued)	11/20/03	1600	1046
	12/11/03	430	921
	1/27/04	180	101
PISTO001.9BT	6/17/98	150	206
	6/23/98	3100	2419
	7/6/98	354	435
	7/8/98	240	173
	7/14/98	240	179
	7/21/98	160	308
	7/28/98	1500	1011
	8/6/98	770	727
	8/12/98	146	210
	8/18/98	120	93
	8/25/98	106	102
	9/17/98	390	291
	9/22/98	740	866
	9/30/98	740	579
	10/8/98	7900	2419
	10/14/98	150	105
	10/27/98	80	99
PITNE000.8BT	6/30/03	1300	866
	7/14/03	2200	1986
	8/6/03	600	866
	8/18/03	470	387
	10/1/03	800	866
	10/22/03	490	548
	11/5/03	168	276
	12/5/03	310	387
	1/6/04	2800	>2419
	1/20/04	530	687
	2/5/04	240	261
	2/19/04	280	276
RODDY000.6BT	6/17/98	360	435
	6/23/98	4100	3448
	7/6/98	208	260
	7/8/98	540	649
	7/14/98	490	461
	7/21/98	130	119
	7/28/98	2600	2419

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
RODDY000.6BT (continued)	8/6/98	2500	1986
	8/12/98	3700	2419
	8/18/98	150	194
	8/25/98	68	153
	9/17/98	110	124
	9/22/98	800	687
	9/30/98	110	147
	10/8/98	3000	2419
	10/14/98	94	96
	10/27/98	50	62
	7/30/03	280	308
	8/13/03	210	365
	8/19/03	202	308
	8/28/03	280	260
	9/8/03	200	155
	10/9/03	162	135
	10/13/03	330	291
	10/20/03	72	65
	11/20/03	370	365
	11/24/03	2500	2419
SFCR000.1BT	4/12/04	300	328
	5/3/04	532	317
	7/26/04	2000	2419
	8/18/04	200	299
SHOME000.3KN	6/4/03	740	770
	8/13/03	360	219
	8/26/03	250	276
	9/16/03	520	517
	10/9/03	430	291
	10/30/03	62	102
	11/20/03	440	411
	12/11/03	300	387
	1/27/04	140	111
	2/19/04	100	93
SHORT000.1BT	6/17/98	90	144
	6/23/98	2000	1986
	7/6/98	106	159
	7/8/98	138	96
	7/14/98	500	727

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
SHORT000.1BT (continued)	7/21/98	220	276
	7/28/98	2700	>2419
	8/6/98	410	687
	8/12/98	210	146
	8/18/98	58	104
	8/25/98	116	173
	9/17/98	380	411
	9/22/98	1900	2419
	9/29/98	370	326
	10/6/98	800	921
	10/13/98	210	172
	4/6/04	14	13
	4/28/04	26	36
	5/19/04	210	387
	6/16/04	200	147
SHORT000.5BT	4/6/04	6	13
	4/28/04	26	47
	5/19/04	240	261
	6/16/04	340	88
SHORT000.7BT	4/6/04	18	20
	4/28/04	42	47
	5/19/04	200	435
	6/16/04	120	129
SHORT001.4BT	4/6/04	200	155
	4/28/04	46	50
	5/19/04	106	115
	6/16/04	90	104
SHORT001.9BT	4/6/04	26	14
	4/28/04	16	25
	5/19/04	196	118
	6/16/04	350	345
SPANG000.2KN	6/4/03	210	129
	8/13/03	170	131
	8/26/03	340	196
	9/16/03	100	73
	10/9/03	64	67
	10/30/03	20	32
	11/20/03	240	125
	12/11/03	90	85

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
SPANG000.2KN (continued)	1/27/04	60	58
	2/19/04	90	9
STOCK002.0KN	6/4/03	500	461
	7/9/03	50	44
	8/13/03	290	517
	8/26/03	200	105
	9/16/03	200	194
	10/9/03	200	148
	10/30/03	106	99
	11/20/03	1500	1300
	11/20/03	<1	<1
	12/11/03	870	1414
	1/27/04	200	225
	2/19/04	300	214
STOCK003.2KN	6/17/98	286	276
	6/23/98	3600	4661
	7/6/98	270	488
	7/8/98	380	866
	7/14/98	360	291
	7/21/98	300	387
	7/28/98	1900	1553
	8/6/98	630	613
	8/12/98	3600	2419
	8/18/98	640	816
	8/25/98	320	387
	9/22/98	280	219
	9/30/98	430	548
	10/8/98	3500	2419
	10/14/98	370	488
	10/27/98	580	770
	4/30/03	410	388
	6/4/03	580	488
	7/9/03	700	365
	8/13/03	290	231
	8/26/03	710	1986
	9/16/03	142	173

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
STOCK003.2KN (continued)	10/9/03	340	326
	10/30/03	280	206
	11/20/03	2000	1120
	12/11/03	690	866
	1/27/04	230	179
	2/19/04	120	50
STOCK004.6KN	4/30/03	270	178
	6/4/03	540	613
	7/9/03	380	435
	8/13/03	350	276
	8/26/03	630	649
	9/16/03	122	192
	10/9/03	880	816
	10/30/03	1600	1230
	11/20/03	1800	980
	12/11/03	830	1300
	1/27/04	210	185
	2/19/04	120	59
STOCK005.3KN	4/30/03	210	205
	6/4/03	680	649
	7/9/03	300	308
	8/13/03	290	272
	8/26/03	200	184
	9/16/03	142	199
	10/9/03	2100	1733
	10/30/03	3500	>2419
	11/20/03	1700	1986
	12/11/03	830	1046
	1/27/04	150	197
	2/19/04	100	135
STOCK006.5KN	4/30/03	560	313
	6/4/03	1140	1041
	7/9/03	320	488
	8/13/03	400	548
	8/26/03	460	345
	9/16/03	126	117
	10/9/03	230	185
	10/30/03	300	>2419

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
STOCK006.5KN (continued)	11/20/03	2200	1986
	12/11/03	650	1414
	1/27/04	150	435
	2/19/04	90	184
STOCK007.3KN	4/30/03	300	166
	6/4/03	320	248
	7/9/03	460	770
	8/13/03	102	129
	8/26/03	390	291
	9/16/03	290	344
	10/9/03	360	4
	10/30/03	250	211
	11/20/03	2600	1553
	12/11/03	630	687
	1/27/04	240	222
	2/19/04	100	138
STOCK008.4KN	4/30/03	82	91
	6/4/03	94	44
	7/9/03	210	144
	8/13/03	156	84
	8/26/03	240	326
	9/16/03	114	91
	10/9/03	114	137
	10/9/03	110	131
	10/30/03	64	28
	10/30/03	10	24
	11/20/03	760	1120
	11/20/03	700	980
	12/11/03	800	921
	12/11/03	700	816
	1/27/04	290	153
	1/27/04	220	146
	2/19/04	60	91
	2/19/04	50	28
TIPTO000.4BT	4/6/04	2	3
	4/28/04	4	10
	5/19/04	84	19
	6/16/04	20	35

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
TIPTO000.4BT	7/20/04	20	19
	8/11/04	74	126
	8/17/04	100	59
	8/31/04	20	50
WILDW000.1BT	6/16/03	620	770
	6/30/03	1100	579
	8/6/03	1400	548
	8/18/03	1100	579
	10/1/03	500	613
	10/22/03	430	517
	11/5/03	1800	1986
	12/5/03	54	102
	1/6/04	2700	>2419
	1/20/04	350	291
	2/5/04	280	190
	2/19/04	150	167

APPENDIX C

Load Duration Curve Development
and
Determination of Required Load Reductions

A flow duration curve is a cumulative frequency graph, constructed from historic flow data at a particular location, that represents the percentage of time a particular flow rate is equaled or exceeded. When a water quality target (or criteria) concentration is applied to the flow duration curve, the resulting load duration curve (LDC) represents the allowable pollutant loading in a waterbody over the entire range of flow. Pollutant monitoring data, plotted on the LDC, provides a visual depiction of stream water quality as well as the frequency and magnitude of any exceedances. Load duration curve intervals can be grouped into several broad categories or zones, in order to provide additional insight about conditions and patterns associated with the impairment. For example, the duration curve could be divided into five zones: one representing high flows, another for moist conditions, one covering median or mid-range flows, another for dry conditions, and one representing low flows. Impairments observed in the low flow zone typically indicate the influence of point sources, while those further left generally reflect potential nonpoint source contrigutions (Cleland, 2003).

C.1 Development of Flow Duration Curves

Flow duration curves are developed for a waterbody from daily discharges of flow over a period of record. In general, there is a higher level of confidence that curves derived from data over a long period of record correctly represent the entire range of flow. The preferred method of flow duration curve computation uses daily mean data from USGS continuous-record stations located on the waterbody of interest. For ungaged streams, alternative methods must be used to estimate daily mean flow. These include: 1) regression equations (using drainage area as the independent variable) developed from continuous record stations in the same ecoregion; 2) drainage area extrapolation of data from a nearby continuous-record station of similar size and topography; and 3) calculation of daily mean flow using a dynamic computer model, such as the Loading Simulation Program C++ (LSPC).

Flow duration curves for impaired waterbodies in the Little River subwatershed were derived from LSPC hydrologic simulations based on parameters derived from calibration at USGS Station No. 03535000, located on Bullrun Creek near Halls Crossroads, Tennessee, in the Lower Clinch watershed (see Appendix D for details of calibration). For example, a flow-duration curve for Stock Creek at RM 3.2 was constructed using simulated daily mean flow for the period from 10/1/94 through 9/31/04 (RM 3.2 corresponds to the location of monitoring station STOCK003.2KN). This flow duration curve is shown in Figure C-13 and represents the cumulative distribution of daily discharges arranged to show percentage of time specific flows were exceeded during the period of record (the largest daily mean flow during this period is exceeded 0% of the time and the smallest daily mean flow is exceeded ~100% of the time). Flow duration curves for other impaired waterbodies were derived using a similar procedure and are shown in Figures C-1 thru C-13.

C.2 Development of Load Duration Curves and Determination of Required Load Reductions

E. coli and fecal coliform load duration curves for impaired waterbodies in the Little River Subwatershed were developed from the flow duration curves developed in Section C.1 and available water quality monitoring data. Load duration curves were developed using the following procedure (Stock Creek is shown as an example):

1. A target load-duration curve was generated for Stock Creek by applying the fecal coliform target concentration of 900 cts./100 mL (1,000 cts./100mL - MOS) to each of the ranked flows used to generate the flow duration curve (ref.: Section D.1) and plotting the results. The fecal coliform target maximum load corresponding to each ranked daily mean flow is:

   $(\text{Target Load})_{\text{Stock Creek}}$ = (900 cts./100 mL) x (Q) x (UCF)

   where: Q = daily mean flow
   UCF = the required unit conversion factor

   For E. coli, the target concentration of 847 cts./100 mL was applied to generate load duration curves corresponding to the E. coli water quality standard (see Section 5.0).

2. Daily loads were calculated for each of the water quality samples collected at monitoring station STOCK003.2KN (ref.: Table B-1) by multiplying the sample concentration by the daily mean flow for the sampling date and the required unit conversion factor. TOWN000.9JO was selected for LDC analysis because it was the monitoring station on Town Creek with the most exceedances of the target concentration.

   Note: In order to be consistent for all analyses, the derived daily mean flow was used to compute sampling data loads, even if measured ("instantaneous") flow data was available for some sampling dates.

3. Using the flow duration curves developed in C.1, the "percent of days the flow was exceeded" (PDFE) was determined for each sampling event. Each sample load was then plotted on the load duration curves developed in Step 1 according to the PDFE. The resulting fecal coliform and E. coli load duration curves for are shown in Figures C-38 and C-39.

4. For cases where the existing load exceeded the target maximum load at a particular PDFE, the reduction required to reduce the sample load to the target load was calculated.

5. The 90th percentile value for all of the fecal coliform sampling data at STOCK003.2KN monitoring site was determined. If the 90th percentile value exceeded the target maximum fecal coliform concentration, the reduction required to reduce the 90th percentile value to the target maximum concentration was calculated.

6. Step 5 was repeated for E. coli data at STOCK003.2KN.

7. For cases where five or more samples were collected over a period of not more than 30 consecutive days, the geometric mean fecal coliform concentration was determined and compared to the target geometric mean fecal coliform concentration of 180 cts/100 mL (200 cts/100mL – MOS). If the sample geometric mean exceeded the target geometric mean concentration, the reduction required to reduce the sample geometric mean value to the target geometric mean concentration was calculated.

8. Step 7 was repeated for the E. coli data at STOCK003.2KN.

9. The load reductions required to meet the target maximum and target 30-day geometric mean concentrations of both fecal coliform and E. coli were compared and the load

reduction of the greatest magnitude selected as the TMDL for Stock Creek. The determination of required load reductions for Stock Creek is shown in Tables C-27 and C-28.

Load reduction curves and required load reductions of other impaired waterbodies were derived in a similar manner and are shown in Figures C-14 through C-39 and Tables C-1 through C-30.

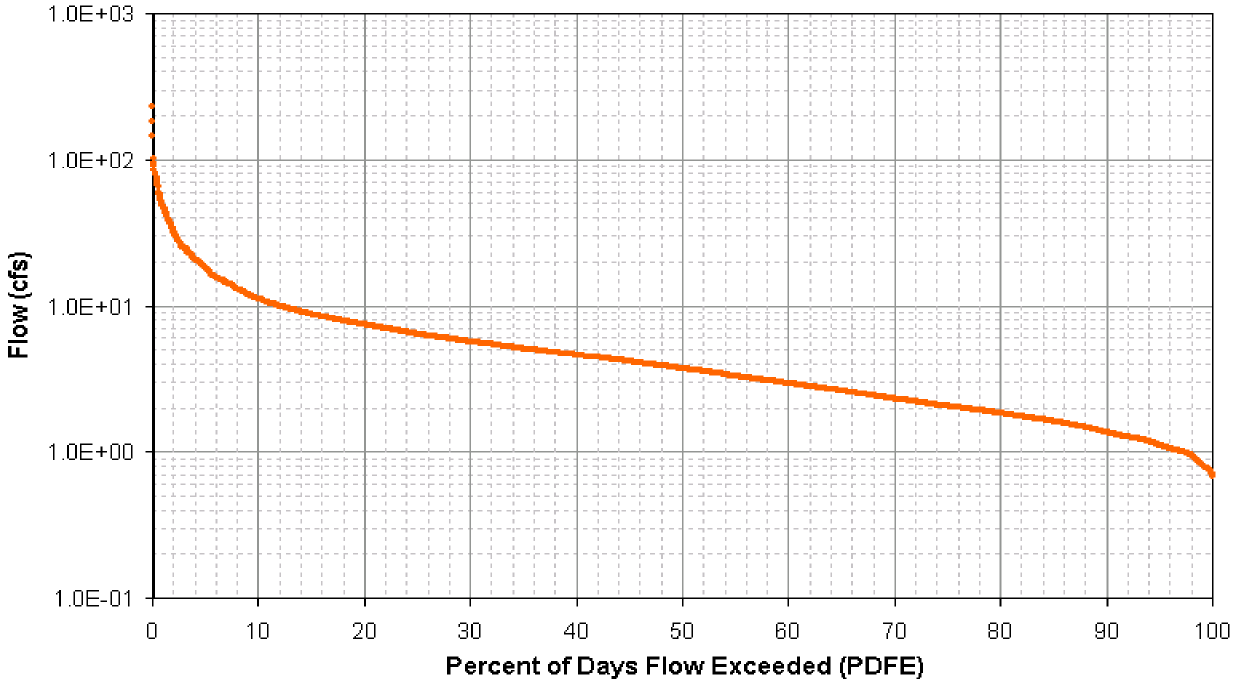


Figure C-1. Flow Duration Curve for Roddy Branch at Mile 0.6

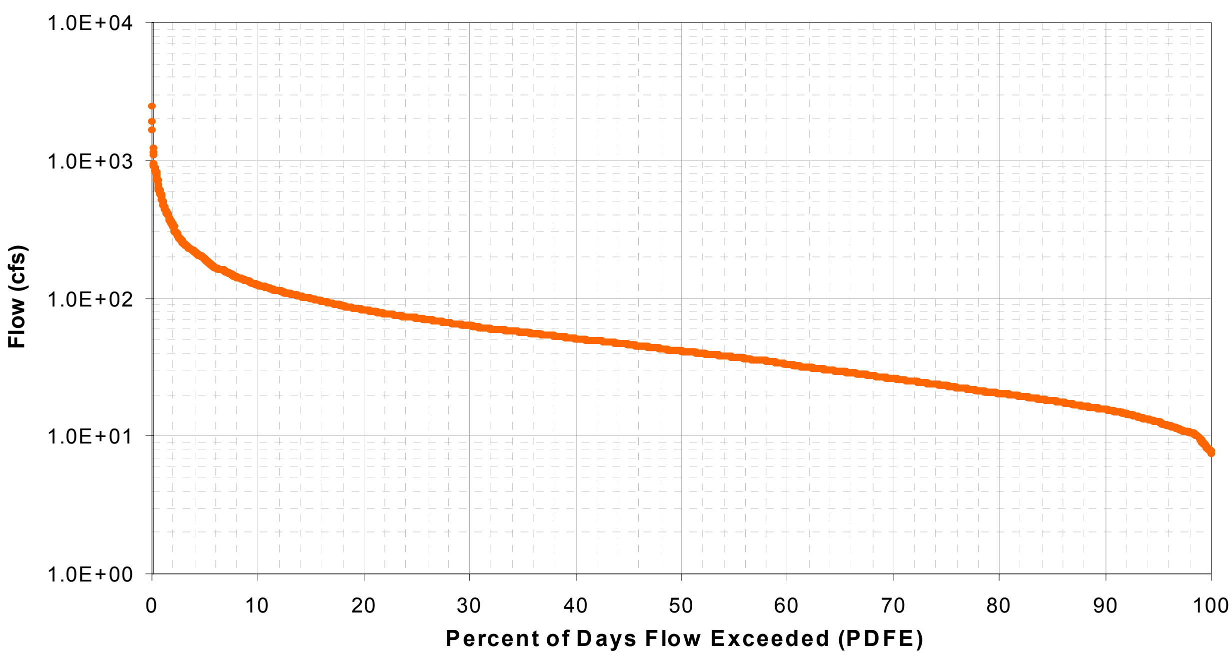


Figure C-2. Flow Duration Curve for Pistol Creek at Mile 1.9

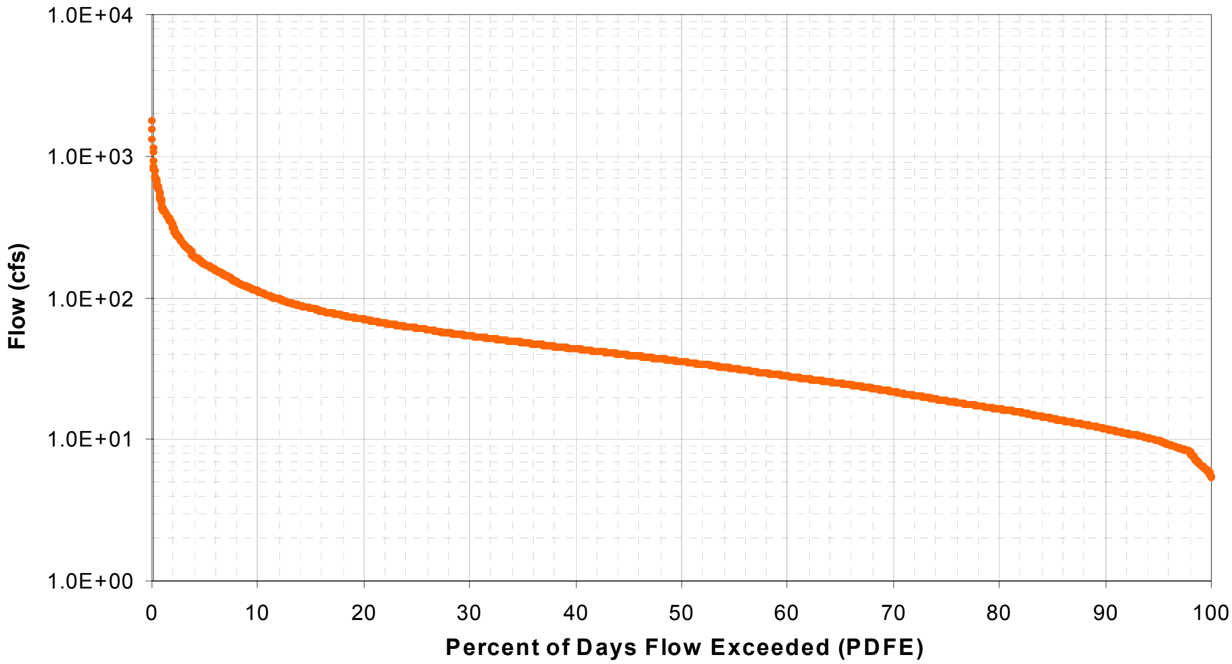


Figure C-3. Flow Duration Curve for Crooked Creek at Mile 1.1

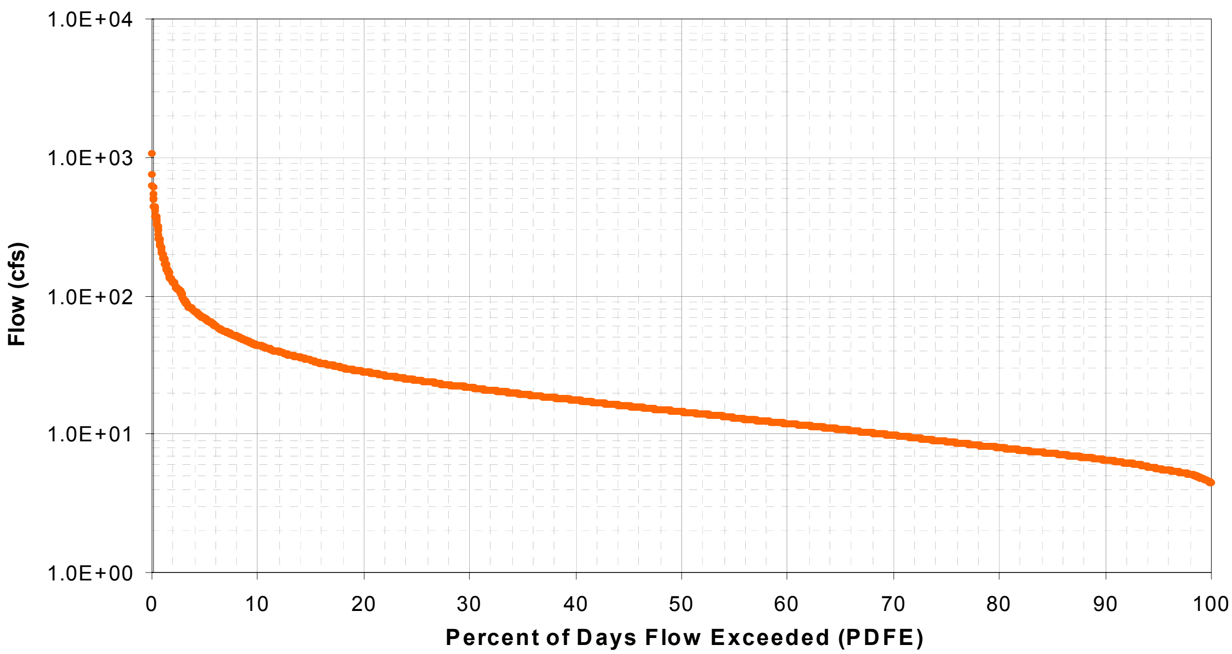


Figure C-4. Flow Duration Curve for Short Creek at Mile 0.1

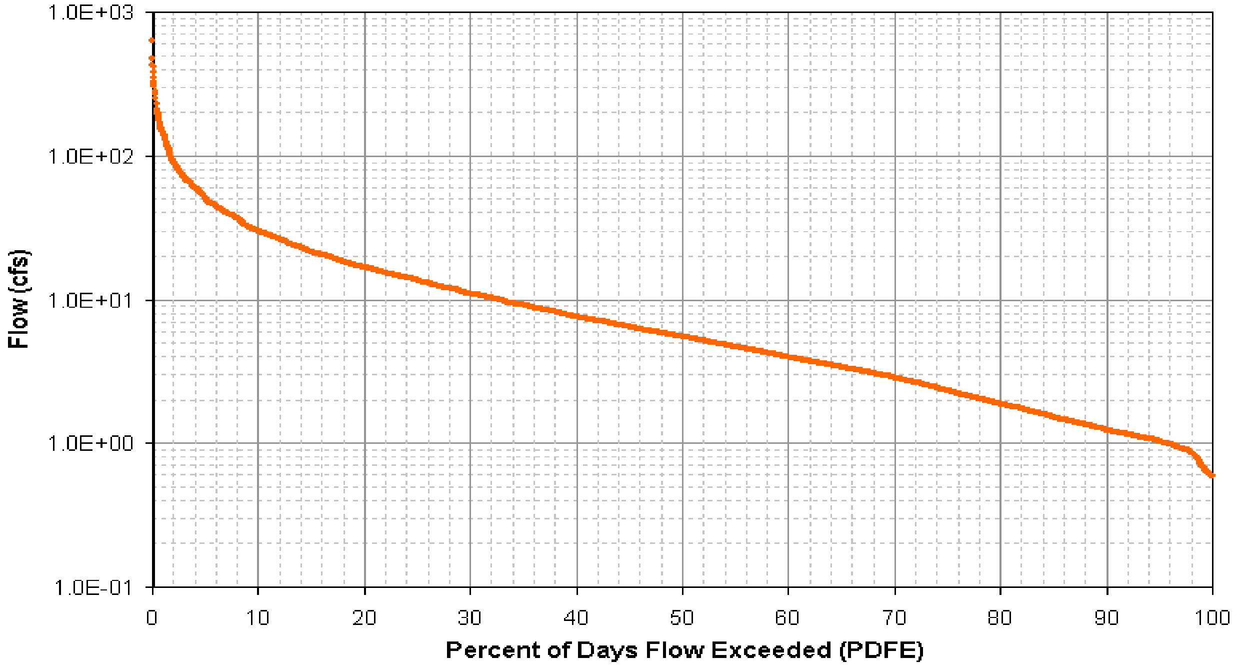


Figure C-5. Flow Duration Curve for Little Ellejoy Creek at Mile 0.2

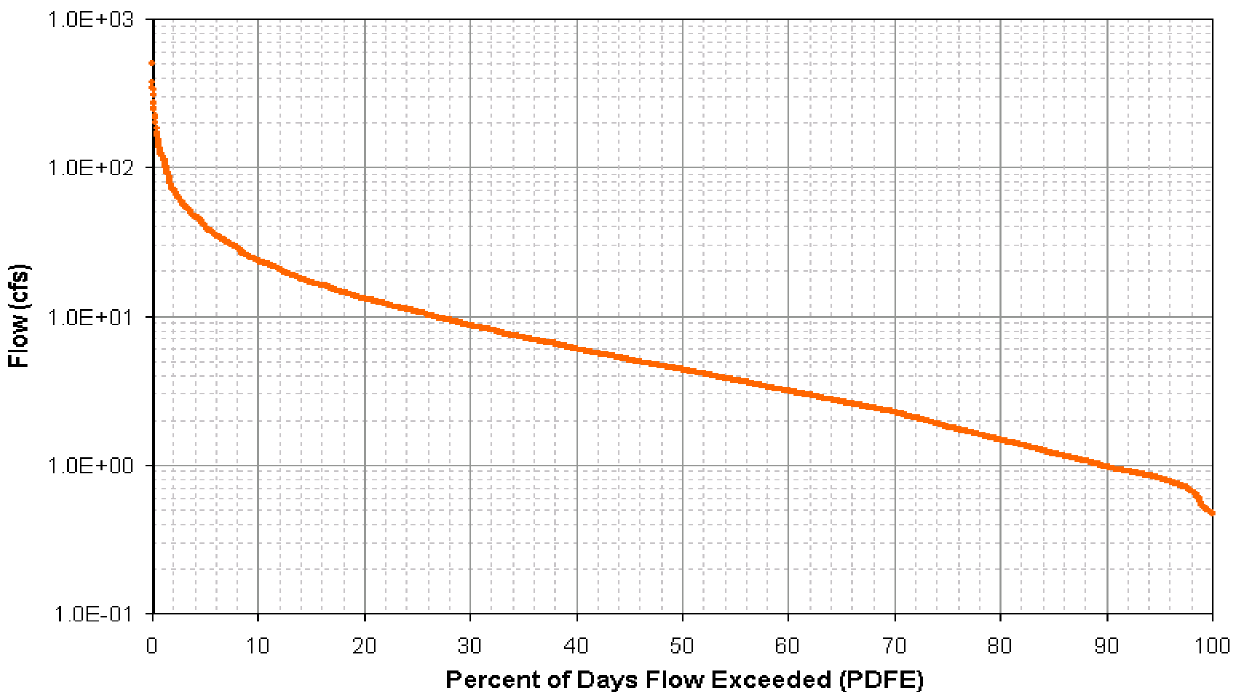


Figure C-6. Flow Duration Curve for Pitner Creek at Mile 0.8

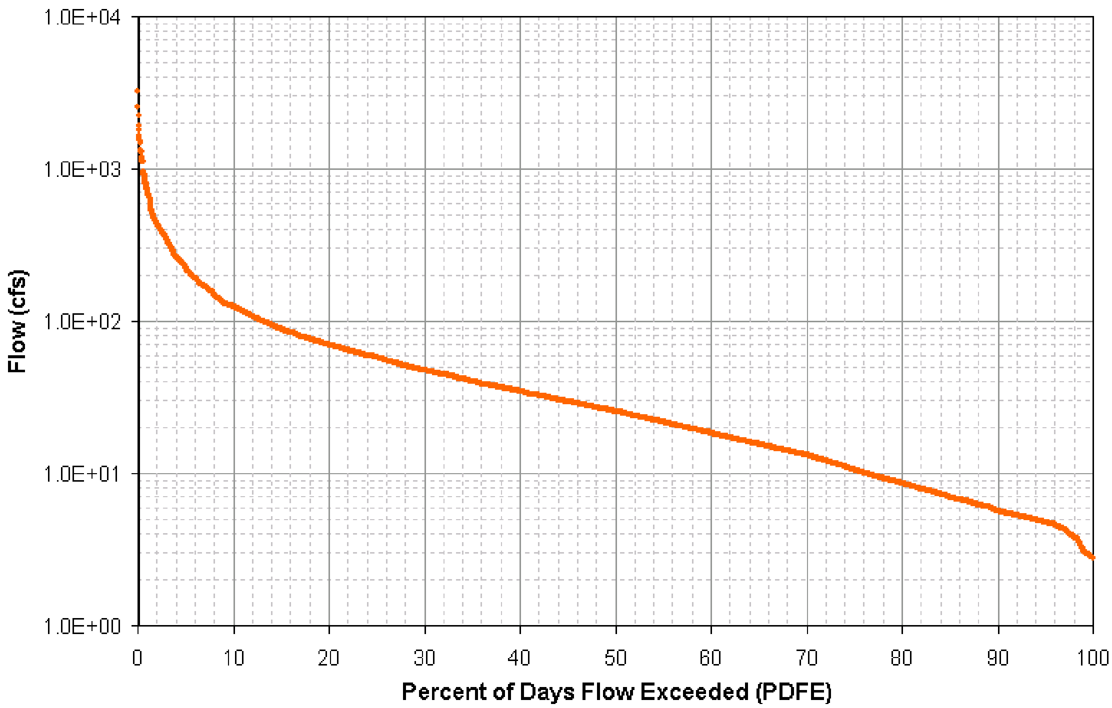


Figure C-7. Flow Duration Curve for Ellejoy Creek at Mile 0.1

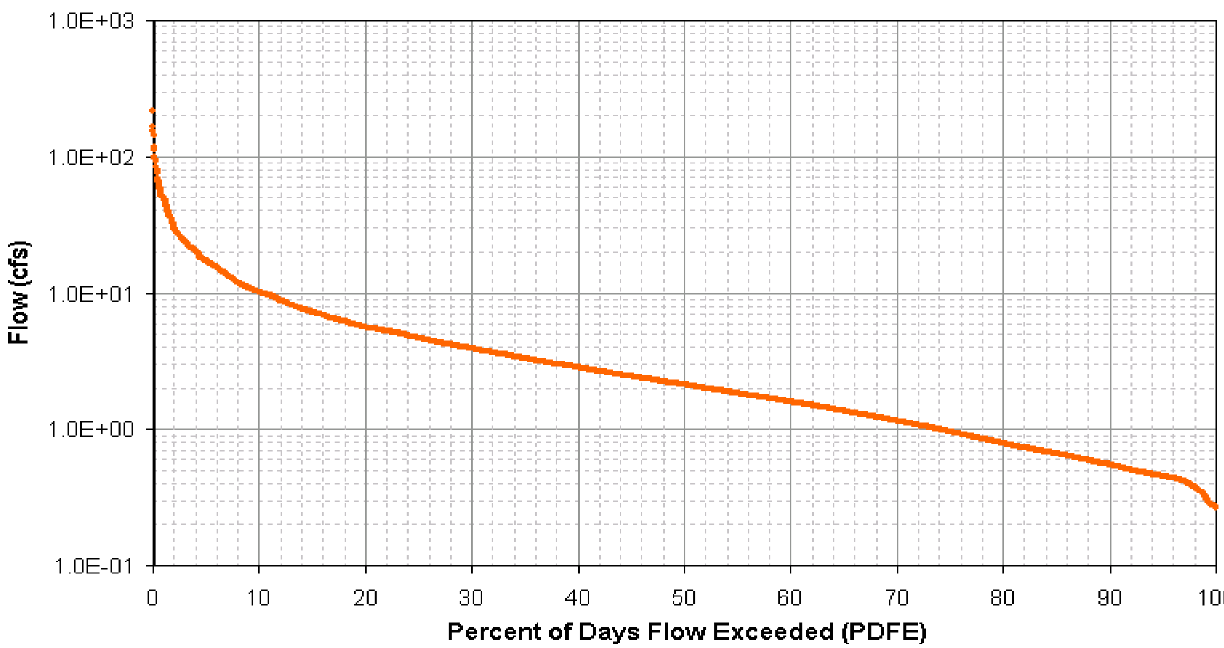


Figure C-8. Flow Duration Curve for Wildwood Branch at Mile 0.1

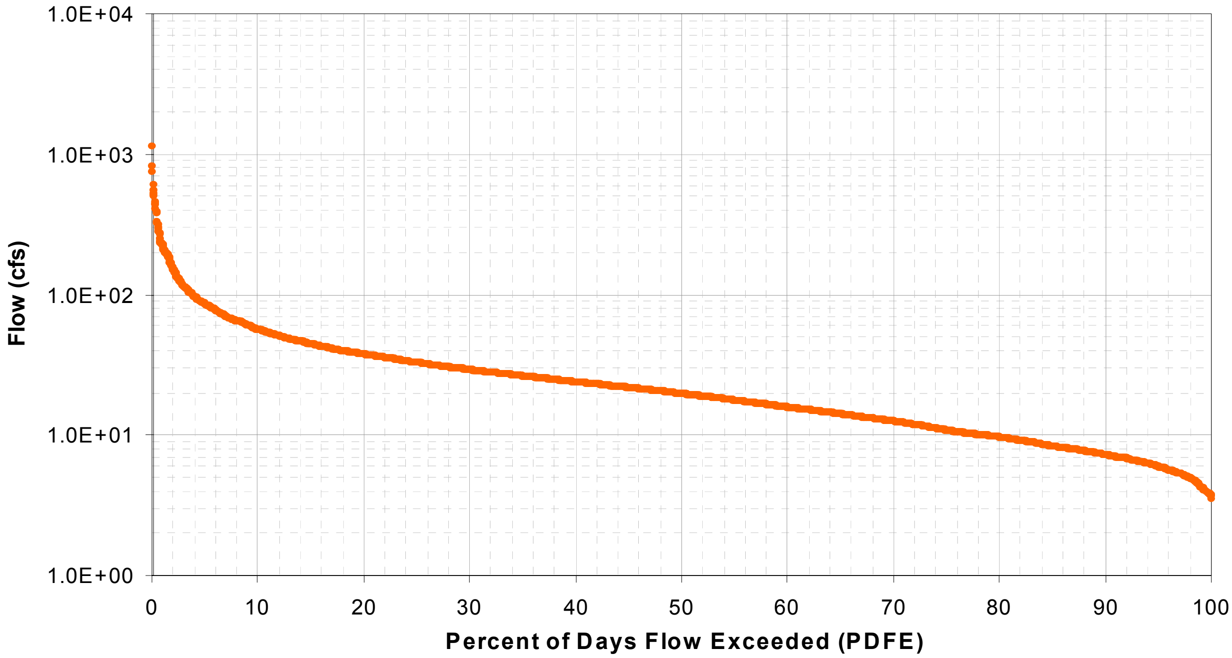


Figure C-9. Flow Duration Curve for Nails Creek at Mile 0.7

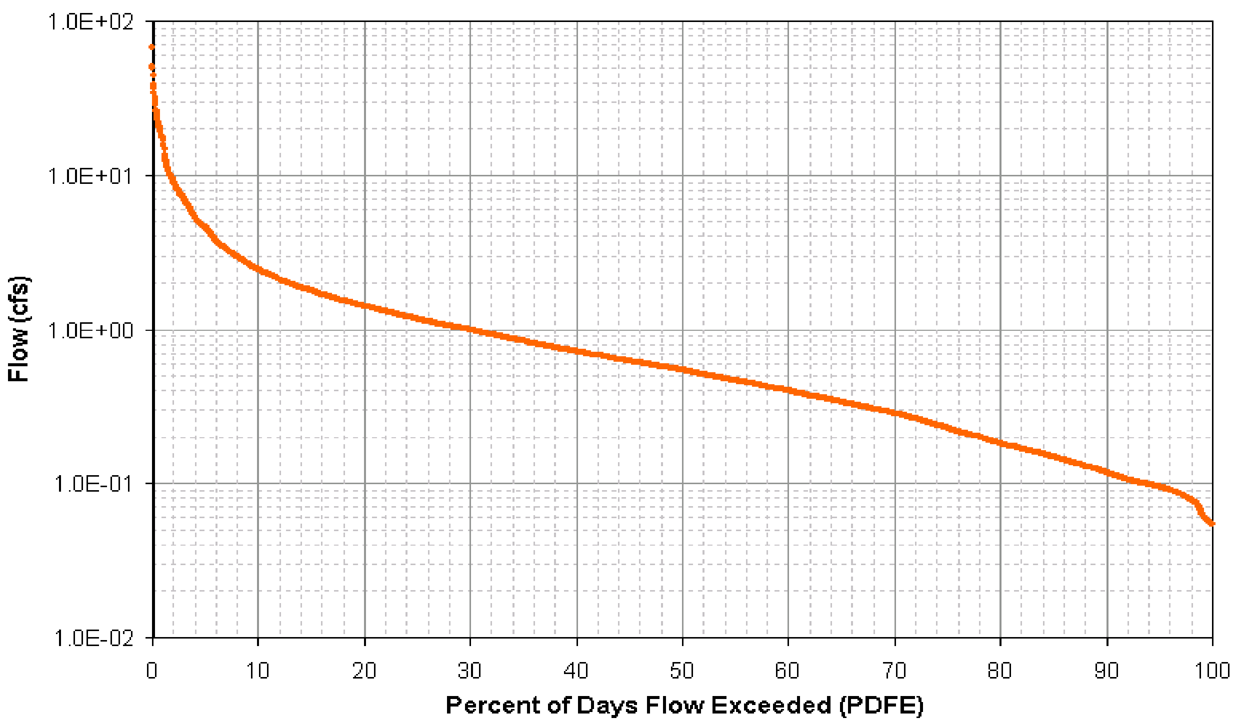


Figure C-10. Flow Duration Curve for Grandview Branch at Mile 0.5

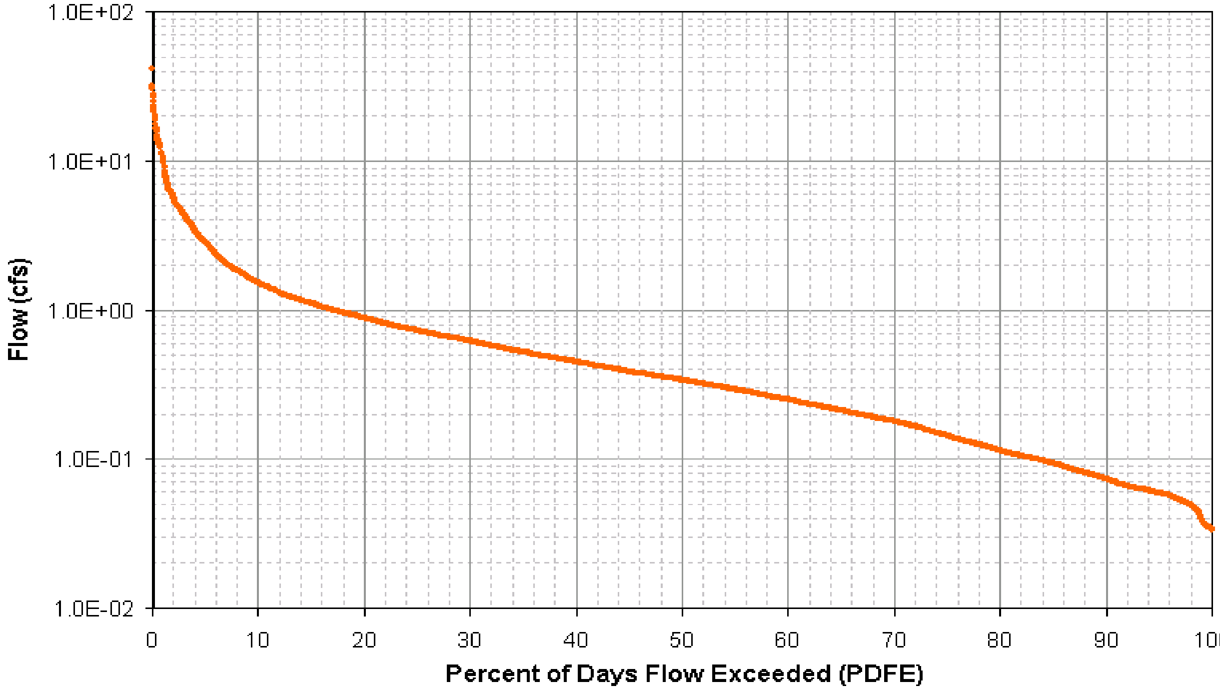


Figure C-11. Flow Duration Curve for High Bluff Branch at Mile 0.1

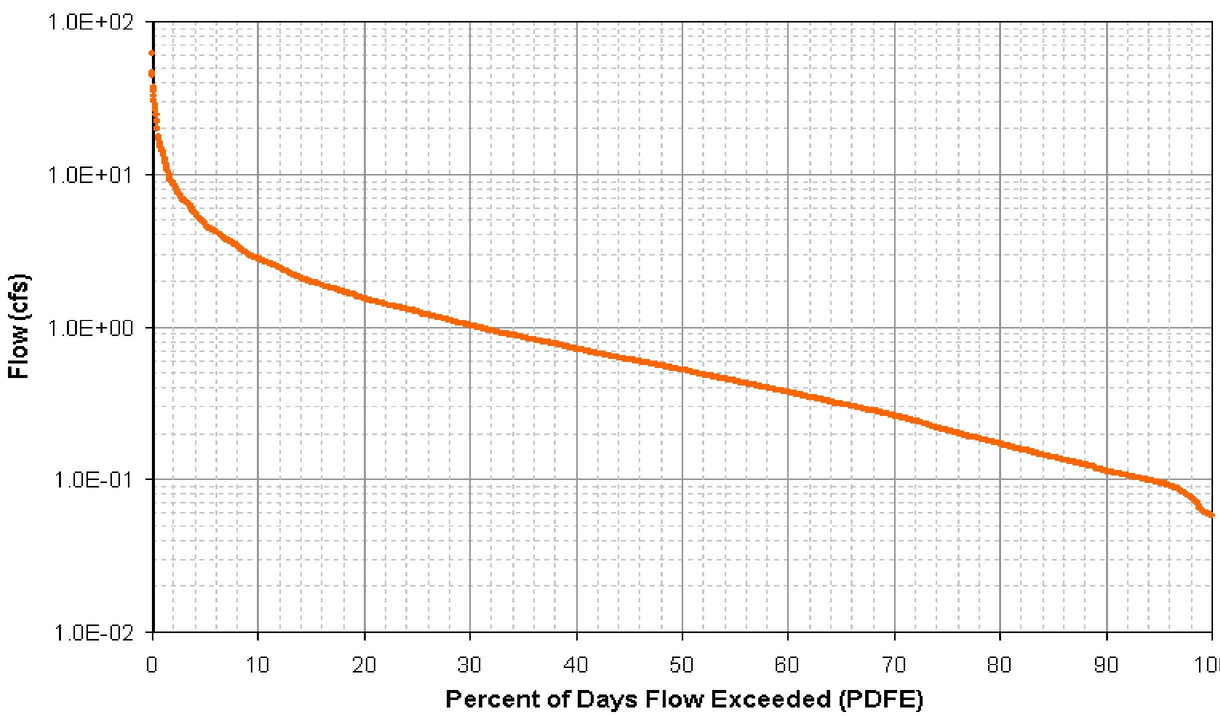


Figure C-12. Flow Duration Curve for Gun Hollow Branch at Mile 0.6

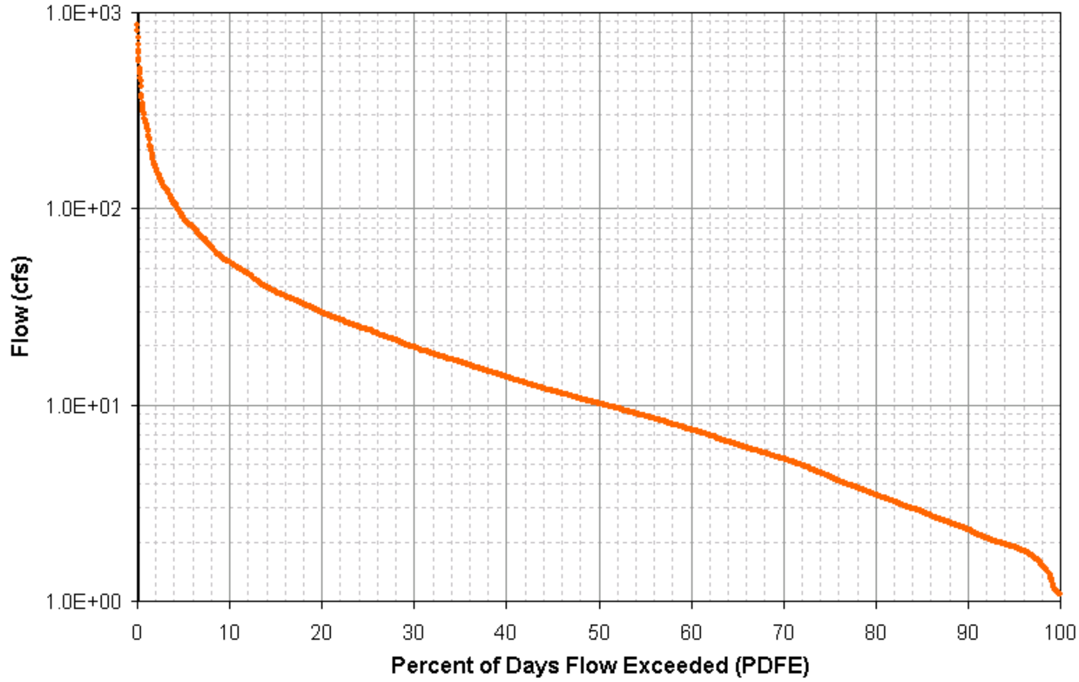


Figure C-13. Flow Duration Curve for Stock Creek at Mile 3.2

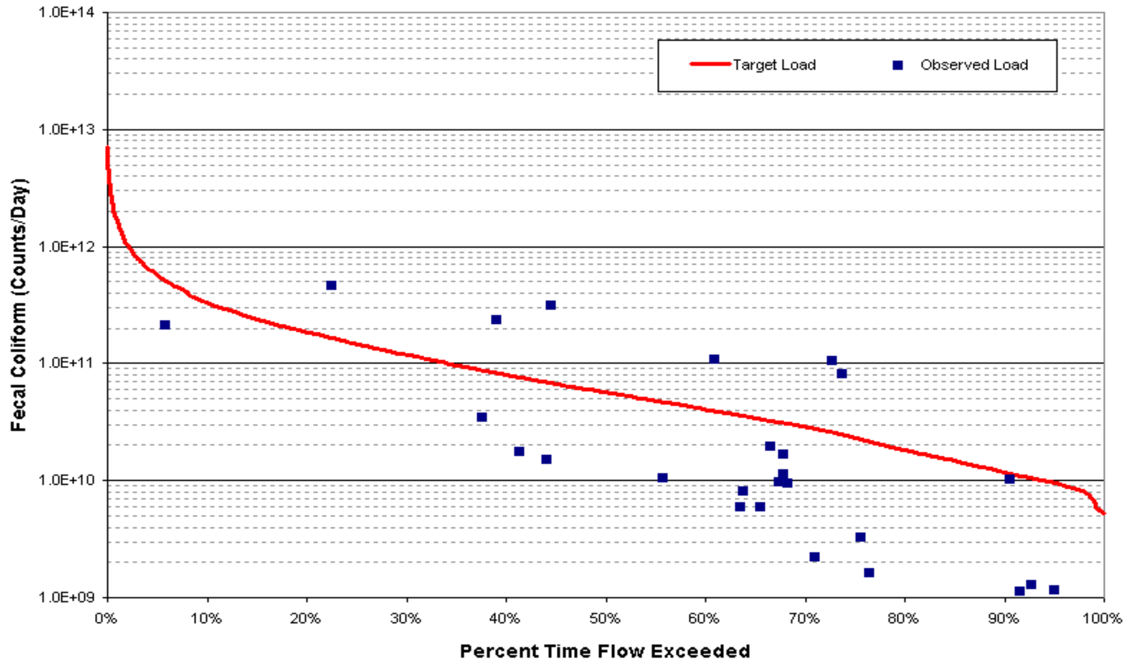


Figure C-14. Fecal Coliform Load Duration Curve for Roddy Branch at Mile 0.6

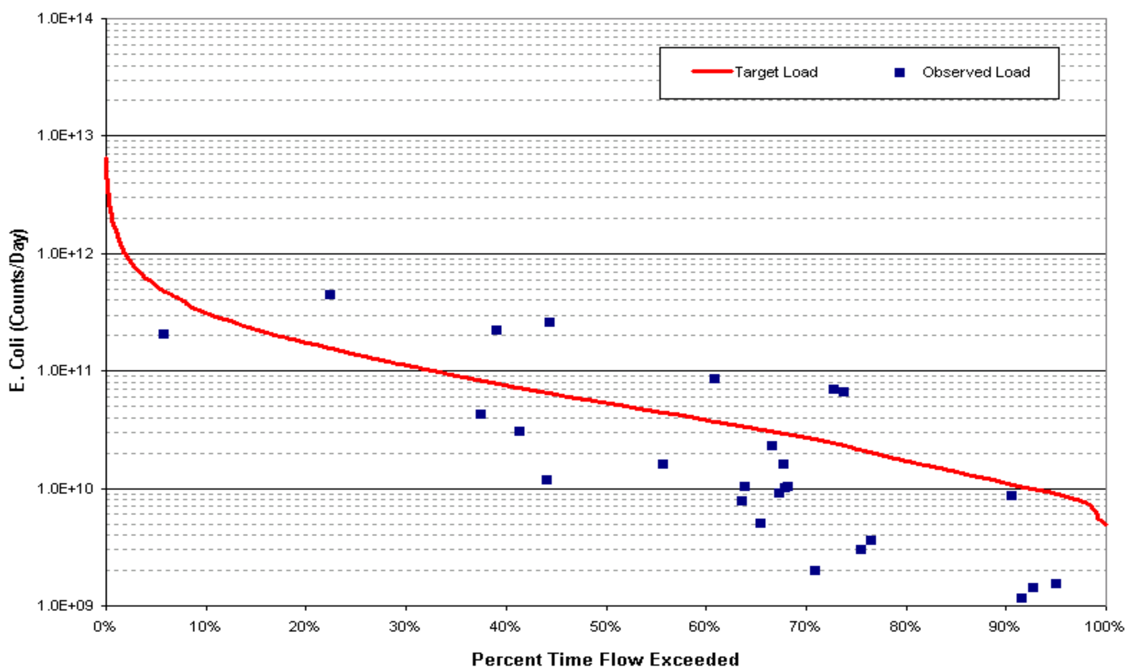


Figure C-15. E. Coli Load Duration Curve for Roddy Branch at Mile 0.6

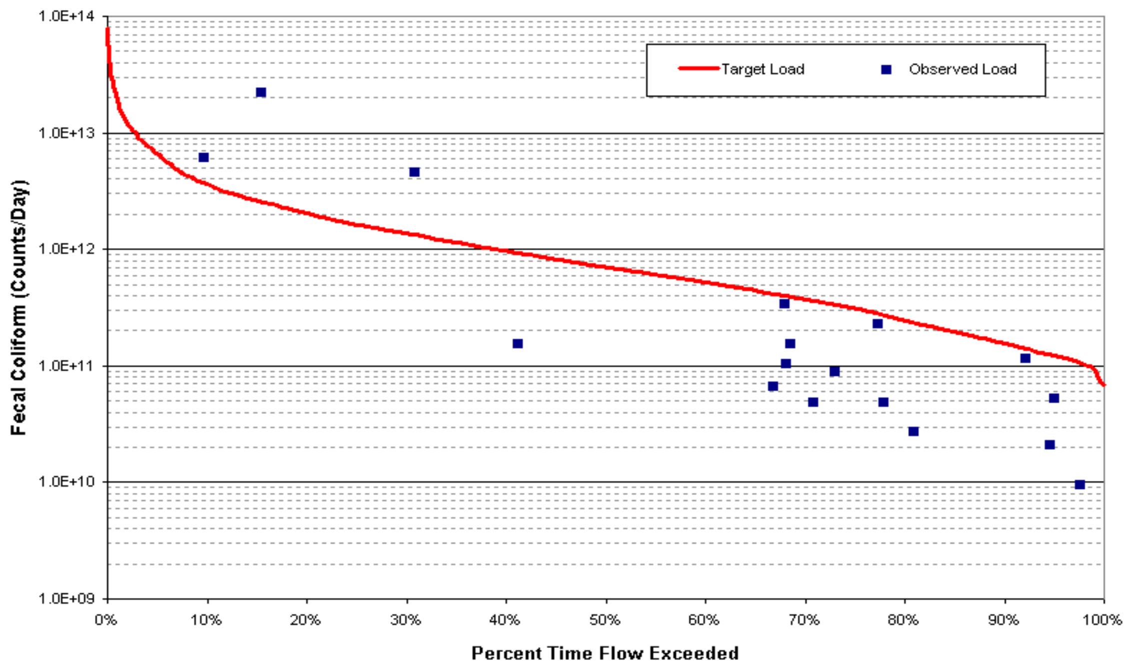


Figure C-16. Fecal Coliform Load Duration Curve for Pistol Creek at Mile 1.9

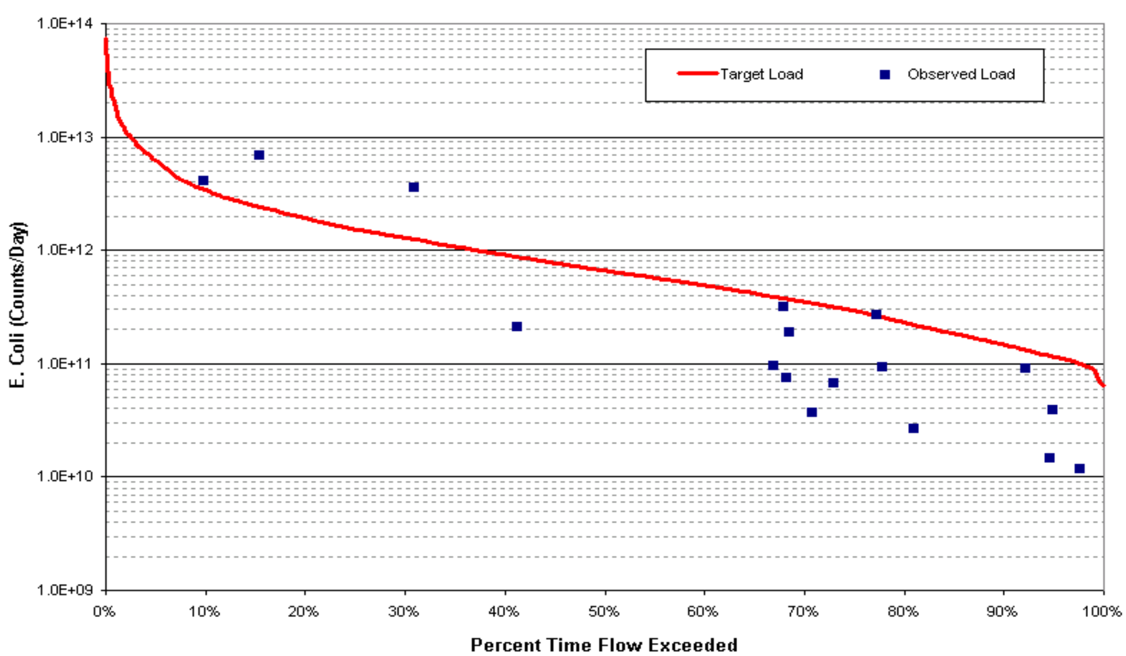


Figure C-17. E. Coli Load Duration Curve for Pistol Creek at Mile 1.9

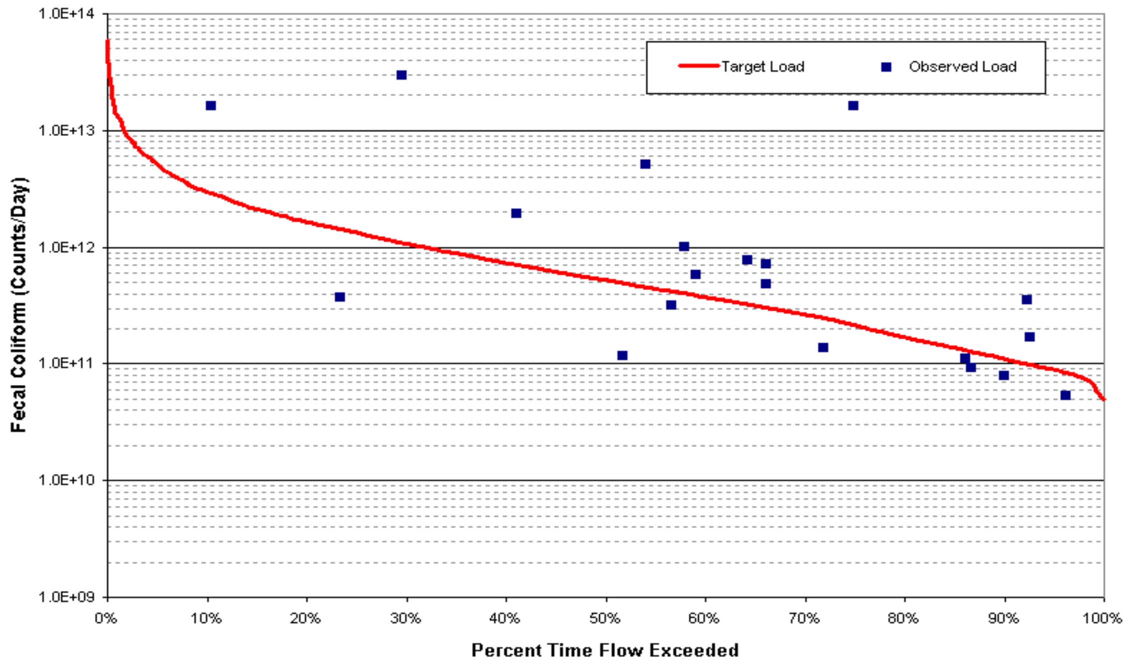


Figure C-18. Fecal Coliform Load Duration Curve for Crooked Creek at Mile 1.1

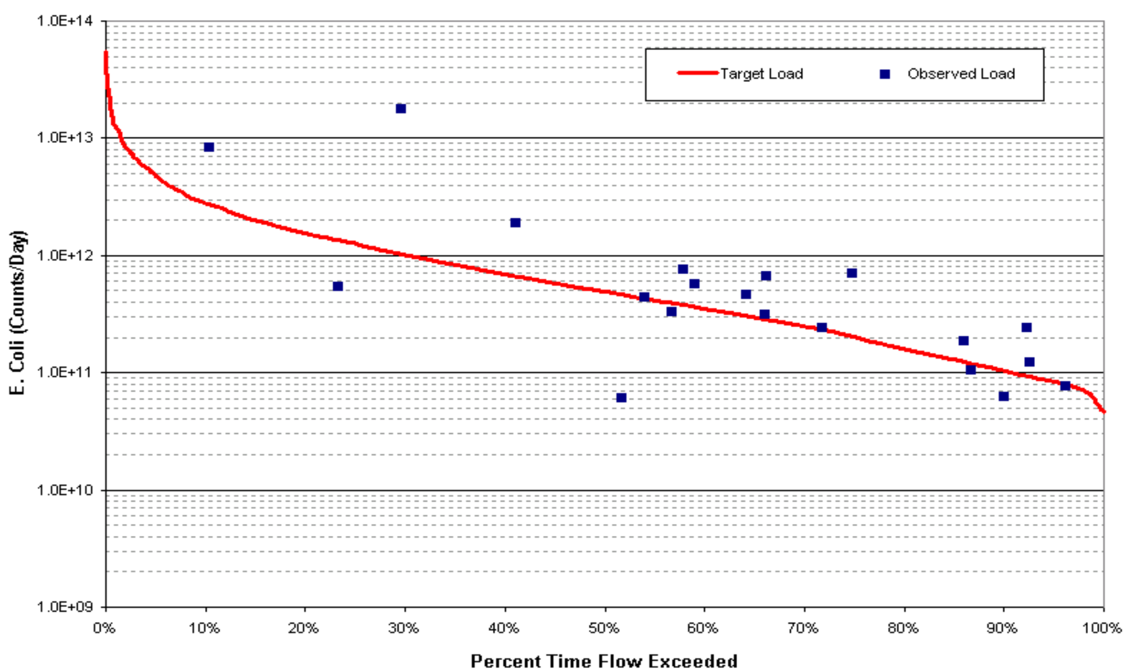


Figure C-19. E. Coli Load Duration Curve for Crooked Creek at Mile 1.1

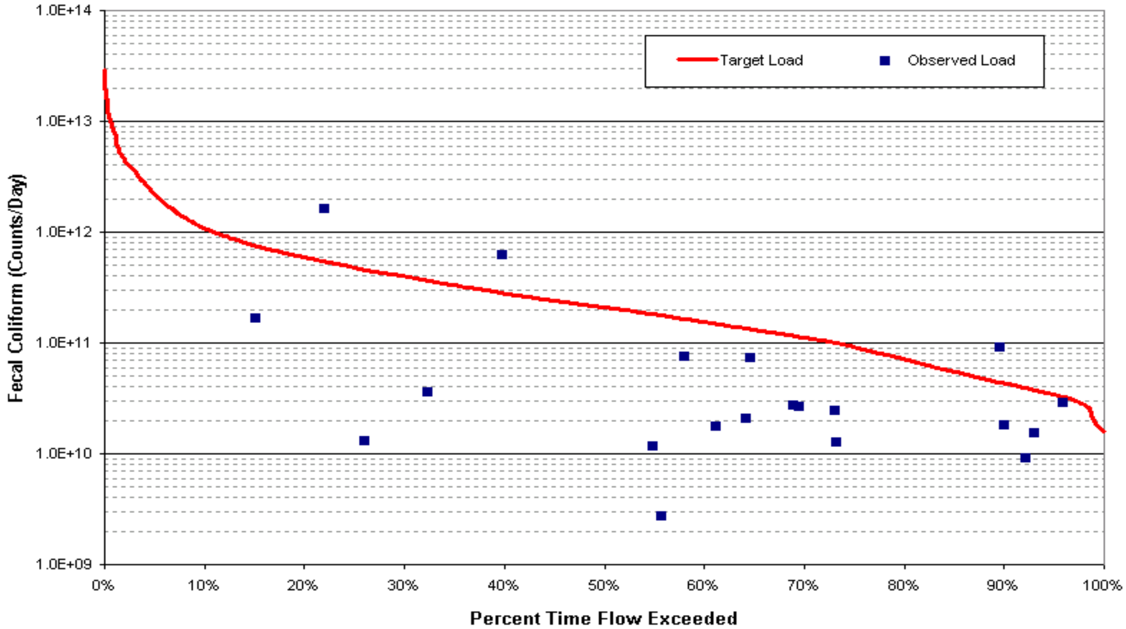


Figure C-20. Fecal Coliform Load Duration Curve for Short Creek at Mile 0.1

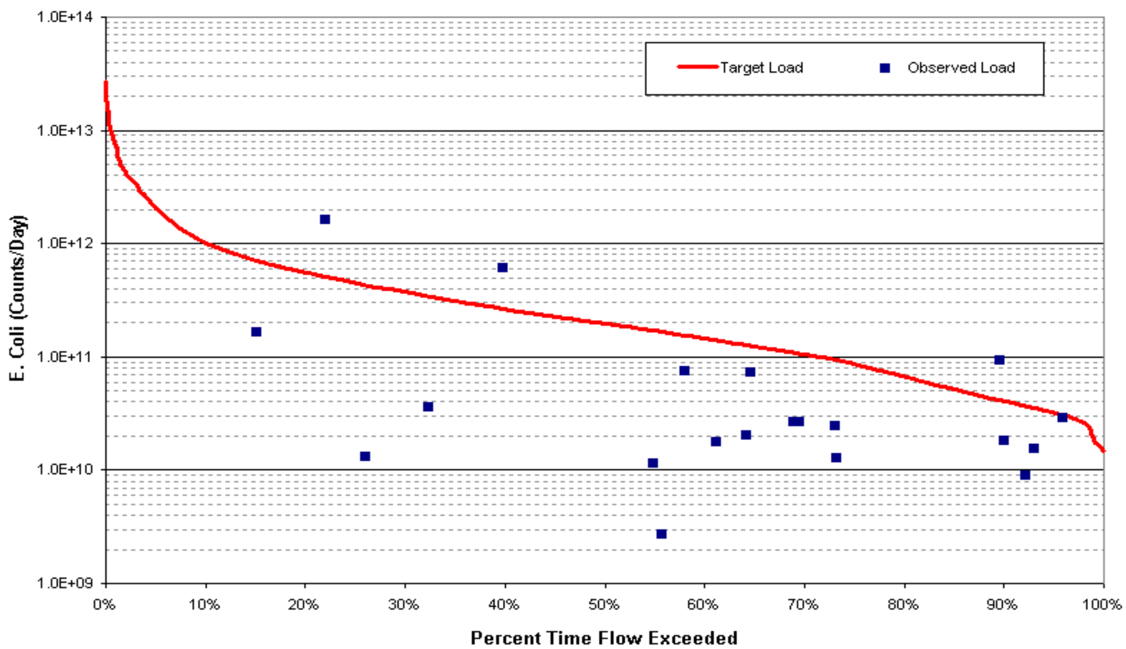


Figure C-21. E. Coli Load Duration Curve for Short Creek at Mile 0.1

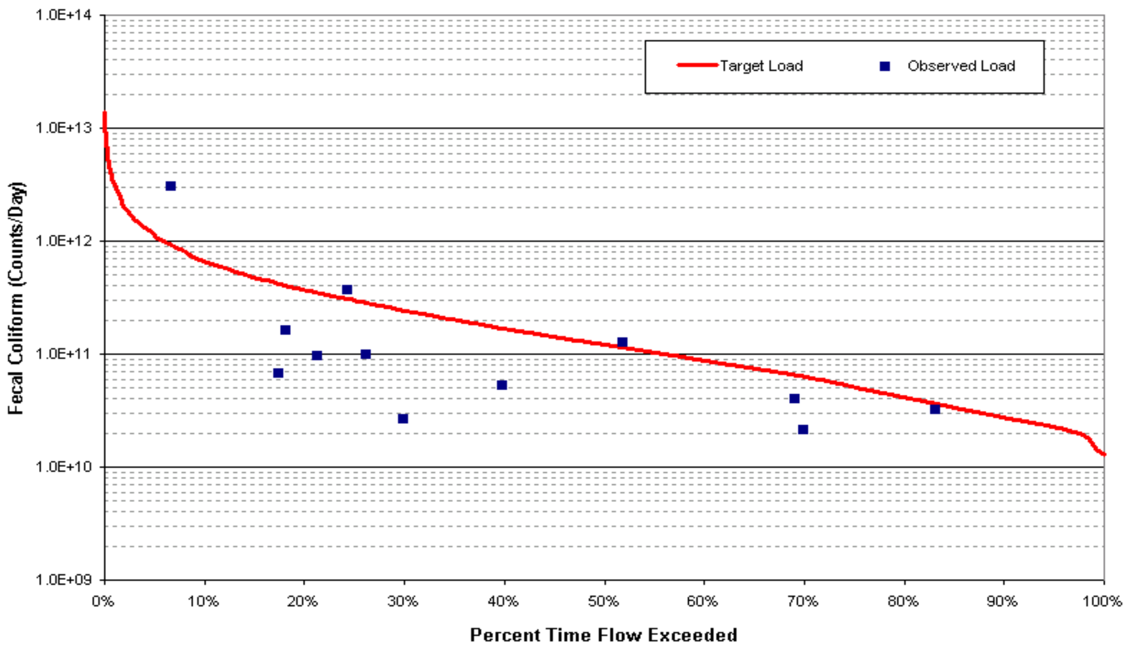


Figure C-22. Fecal Coliform Load Duration Curve for Little Ellejoy Creek at Mile 0.2

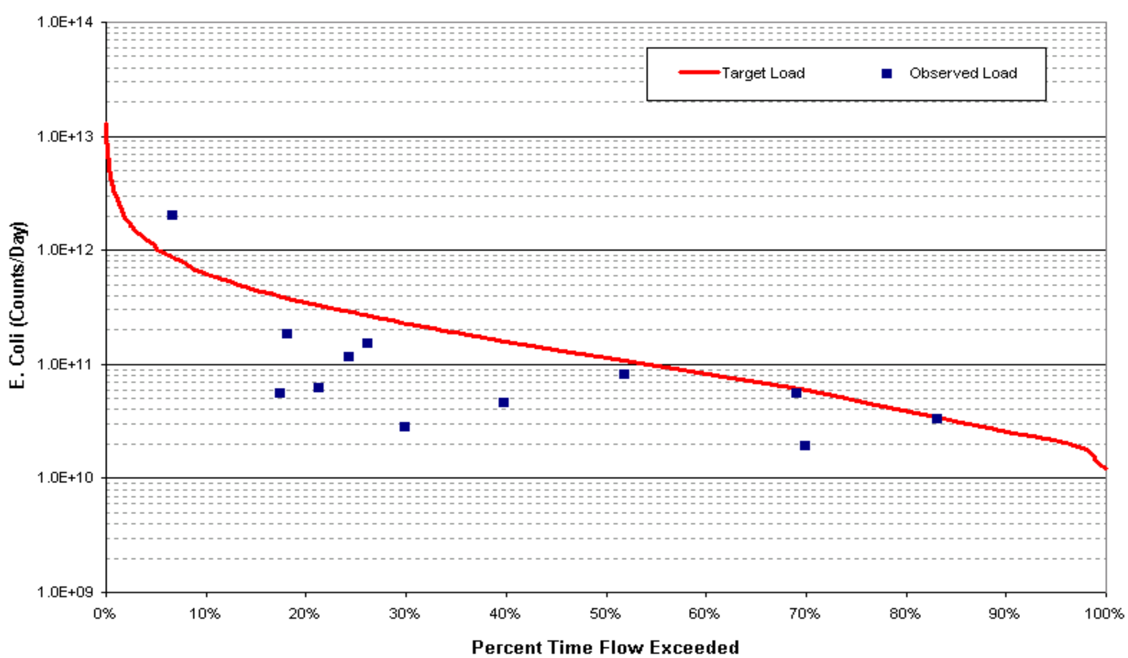


Figure C-23. E. Coli Load Duration Curve for Little Ellejoy Creek at Mile 0.2

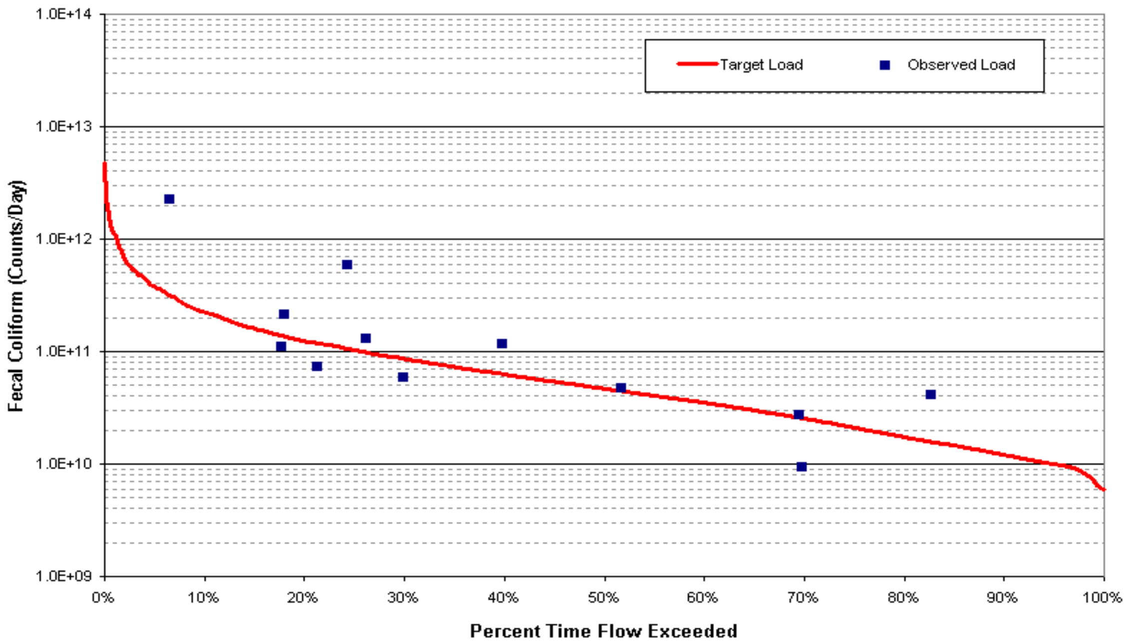


Figure C-24. Fecal Coliform Load Duration Curve for Pitner Creek at Mile 0.8

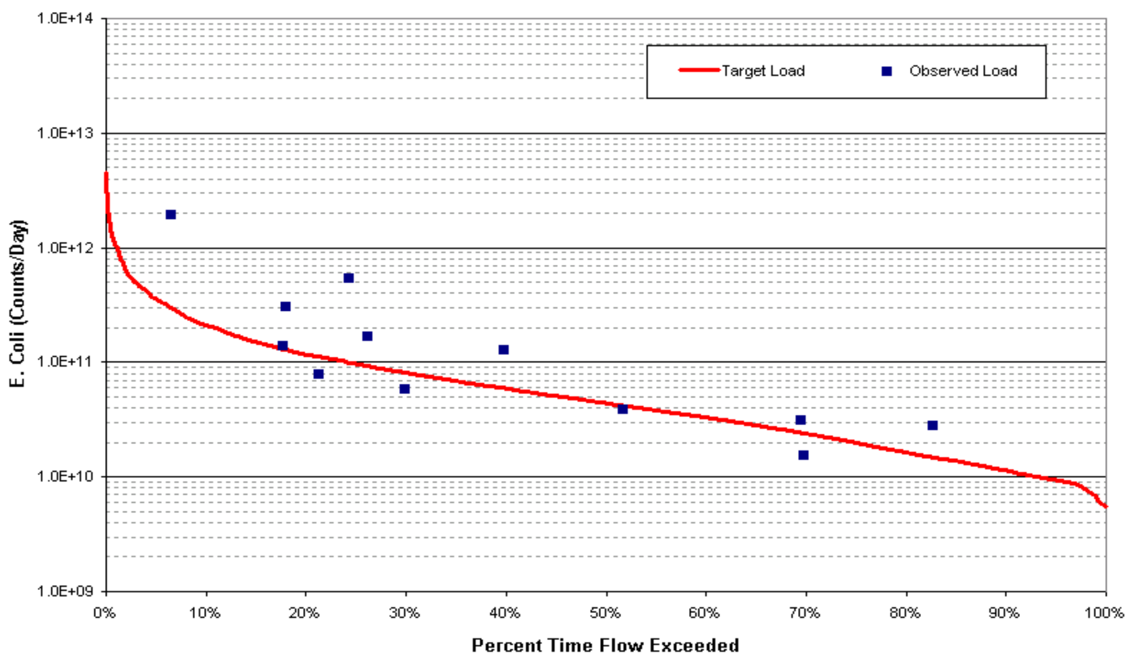


Figure C-25. E. Coli Load Duration Curve for Pitner Creek at Mile 0.8

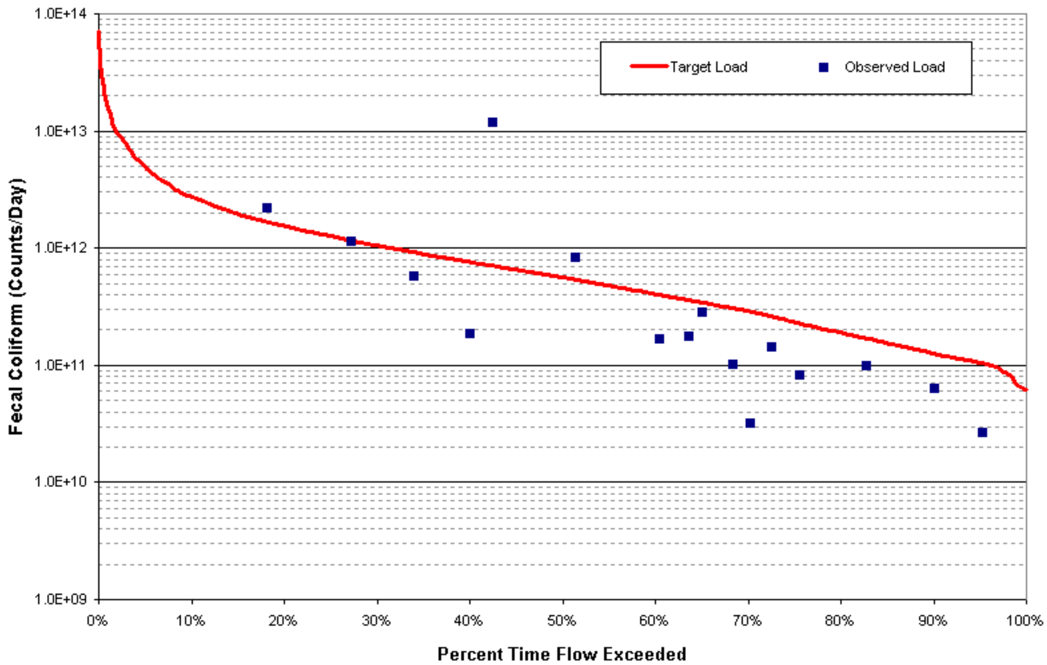


Figure C-26. Fecal Coliform Load Duration Curve for Ellejoy Creek at Mile 0.1

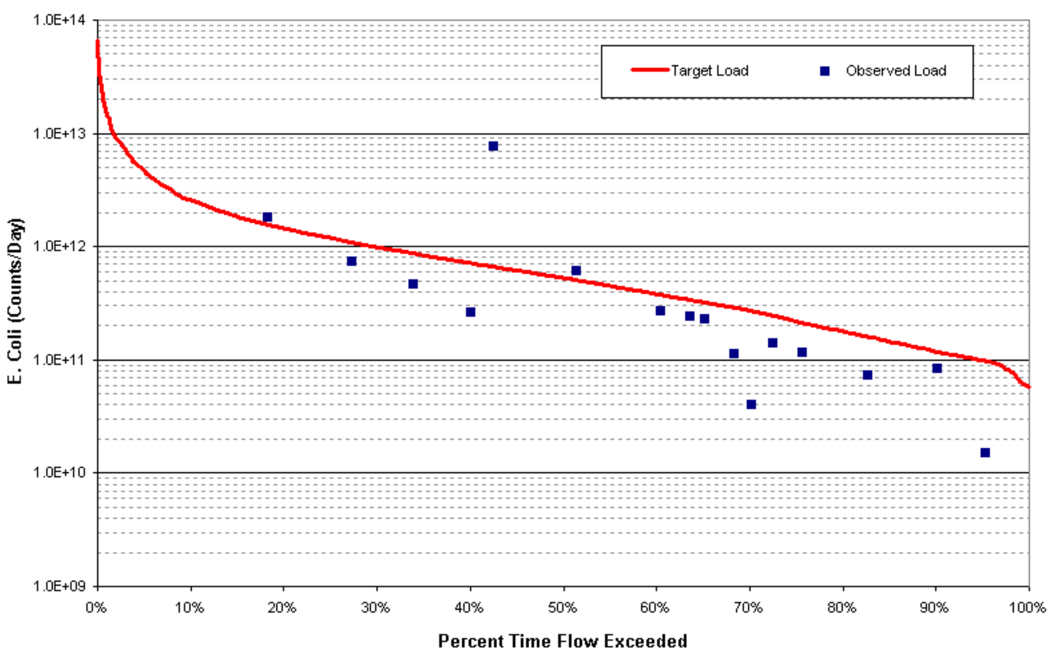


Figure C-27. E. Coli Load Duration Curve for Ellejoy Creek at Mile 0.1

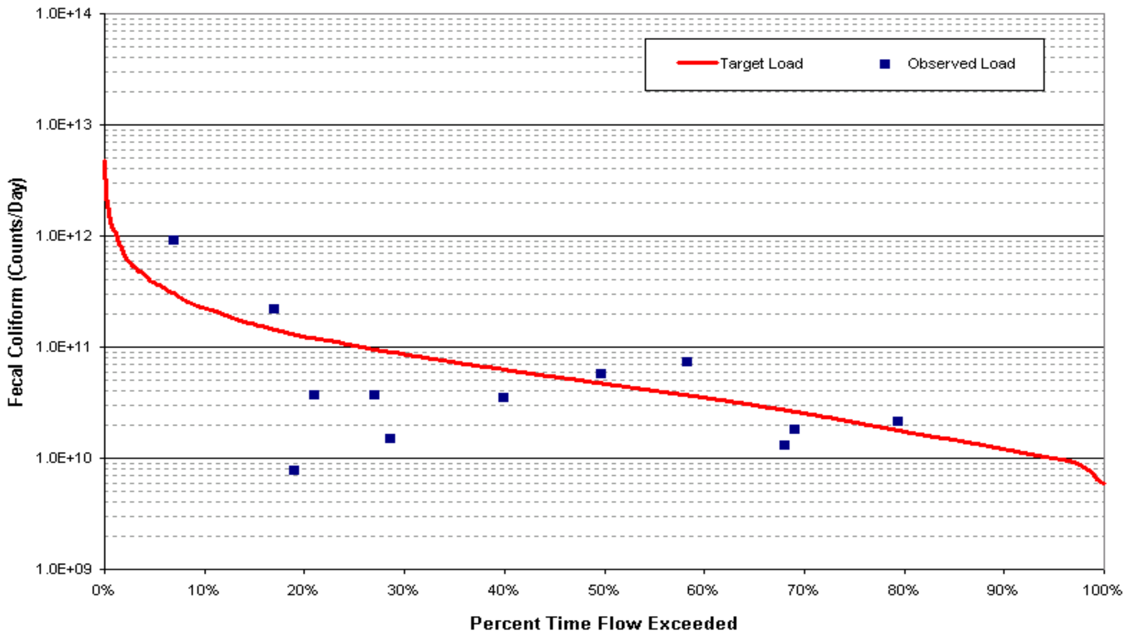


Figure C-28. Fecal Coliform Load Duration Curve for Wildwood Branch at Mile 0.1

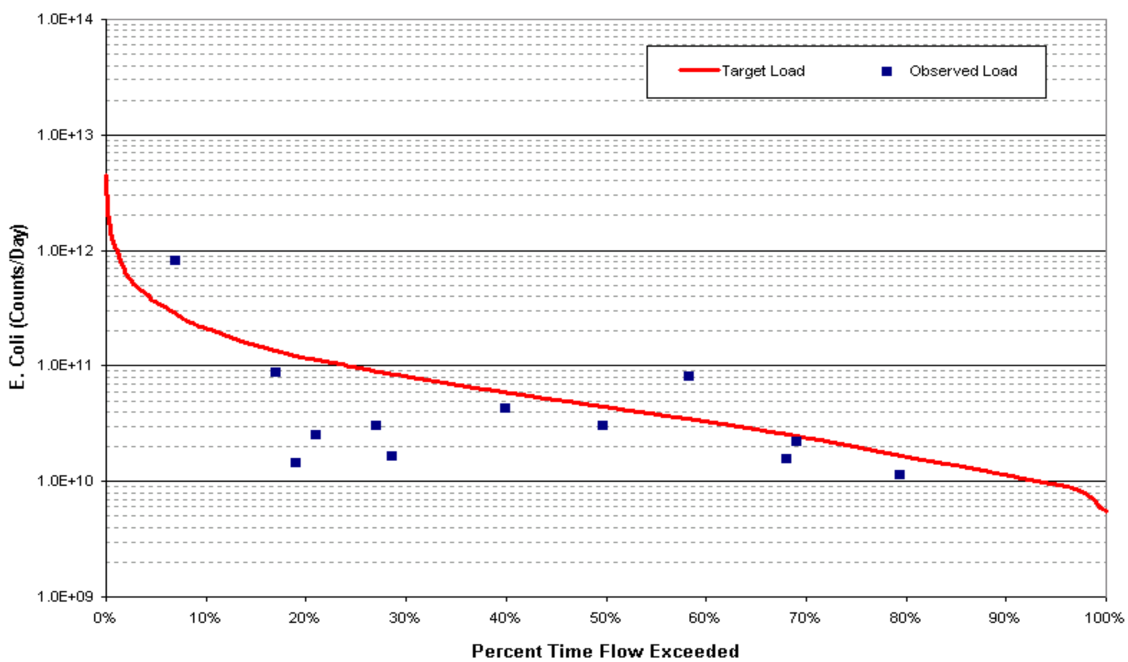


Figure C-29. E. Coli Load Duration Curve for Wildwood Branch at Mile 0.1

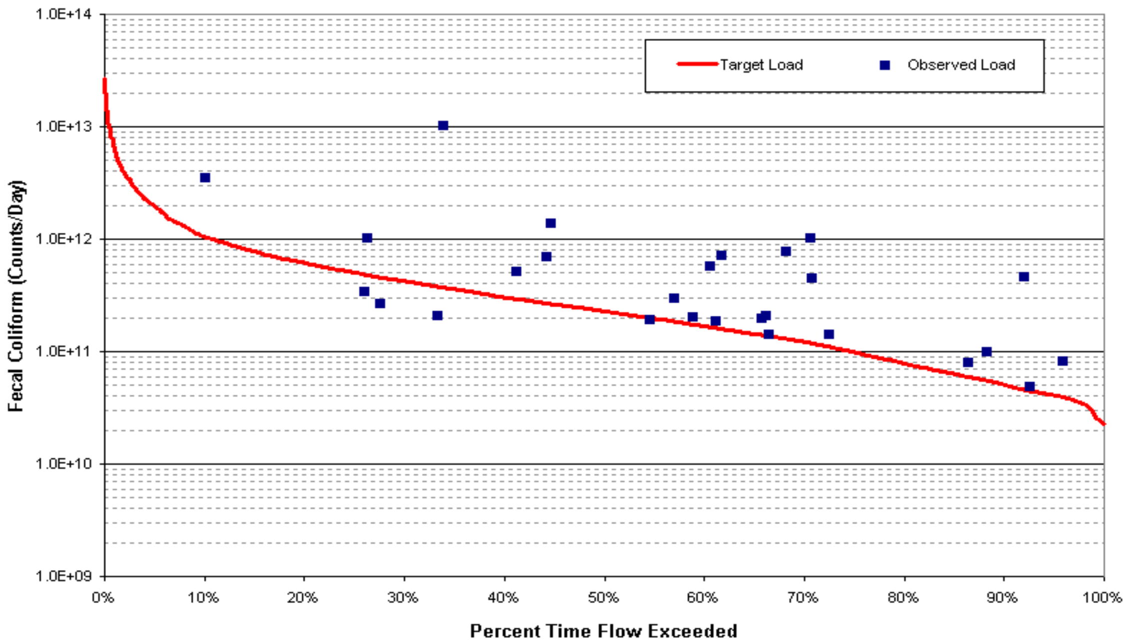


Figure C-30. Fecal Coliform Load Duration Curve for Nails Creek at Mile 0.7

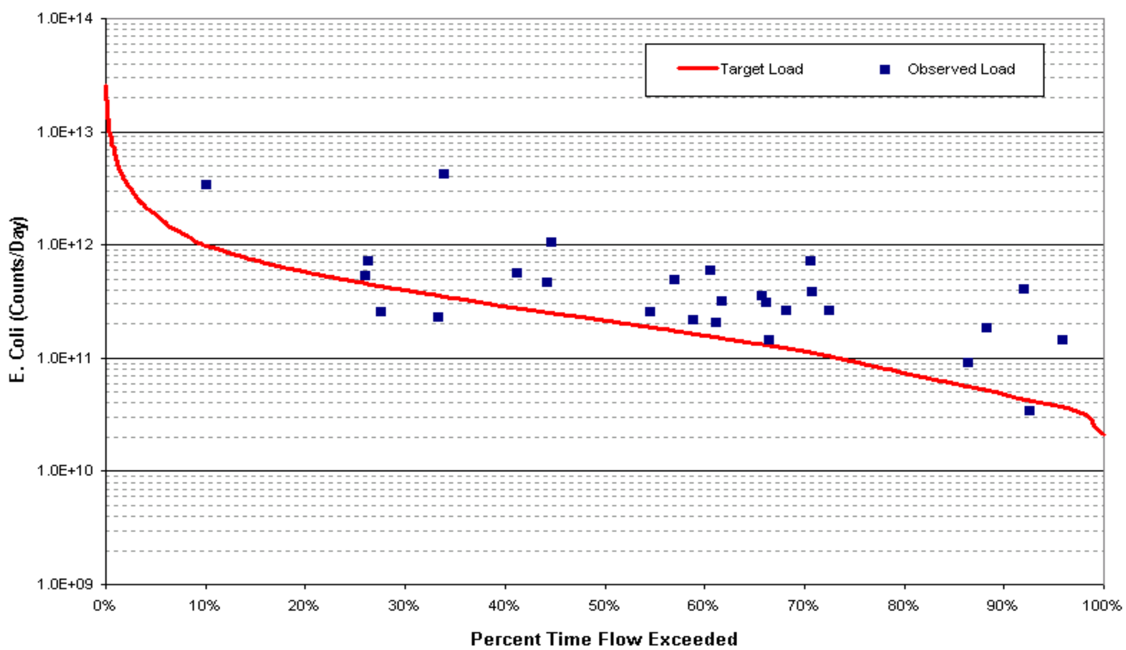


Figure C-31. E. Coli Load Duration Curve for Nails Creek at Mile 0.7

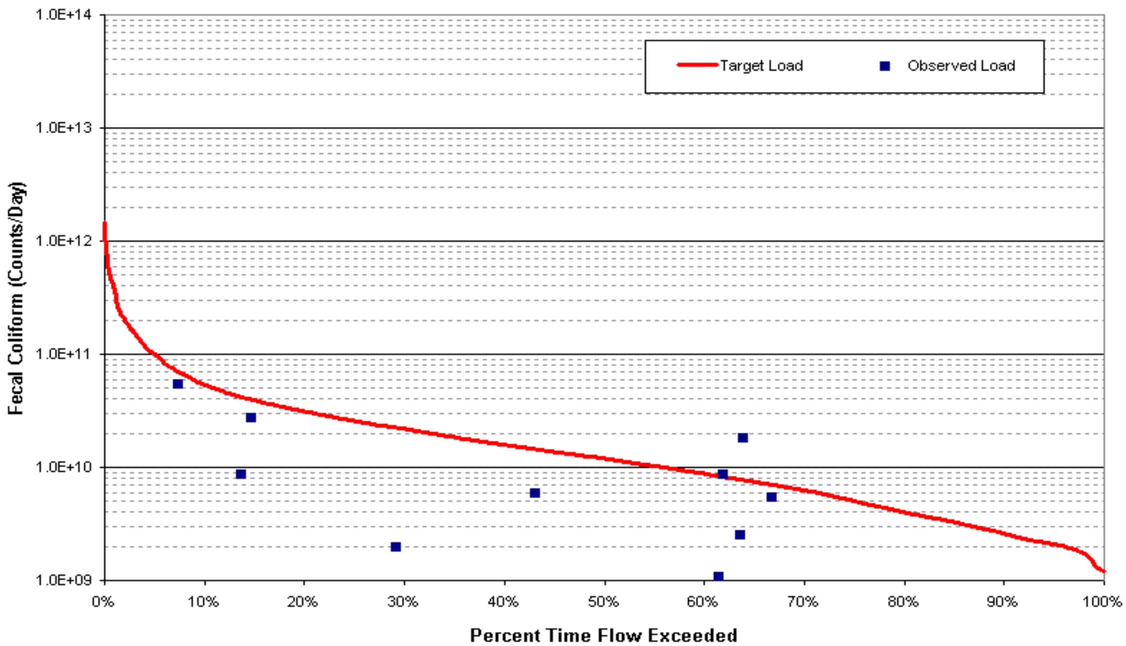


Figure C-32. Fecal Coliform Load Duration Curve for Grandview Branch at Mile 0.5

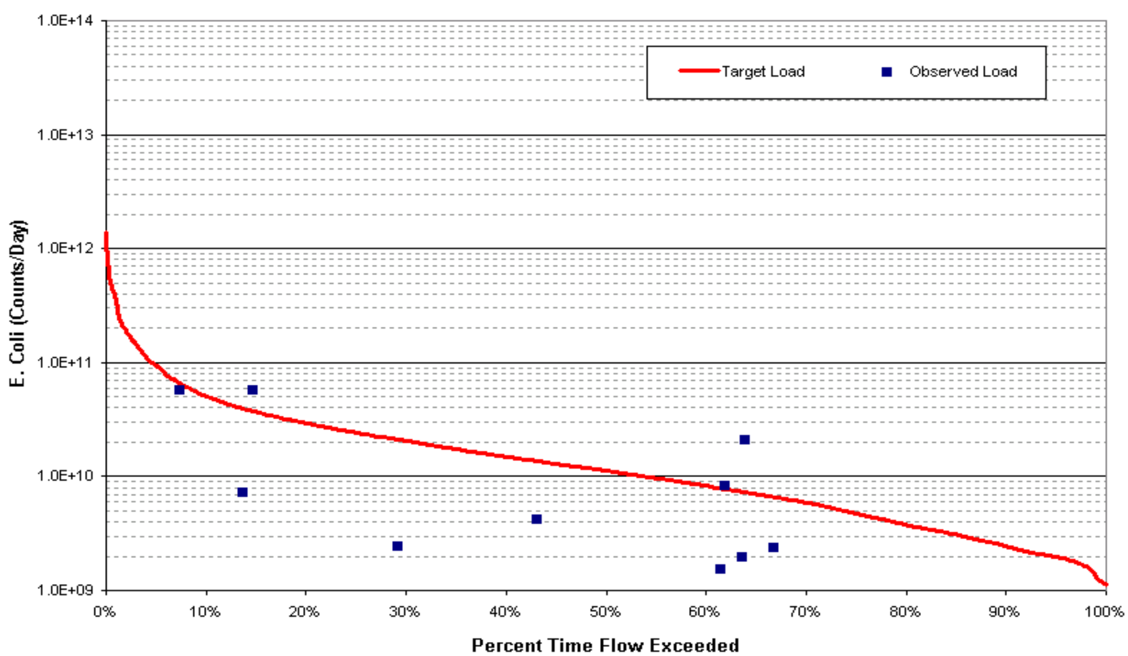


Figure C-33. E. Coli Load Duration Curve for Grandview Branch at Mile 0.5

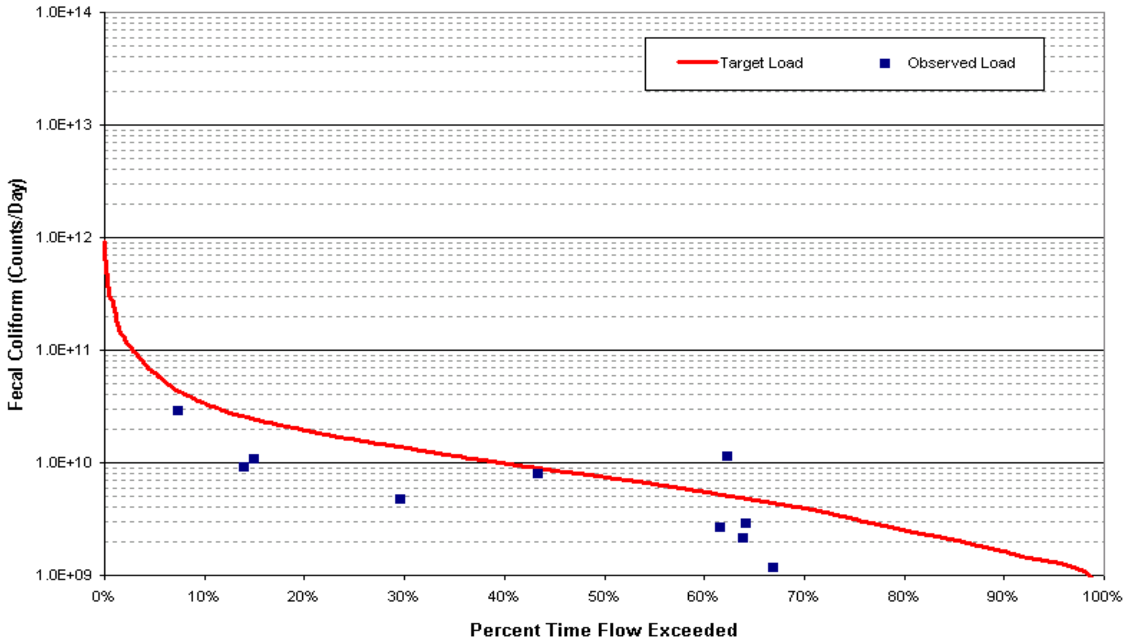


Figure C-34. Fecal Coliform Load Duration Curve for High Bluff Branch at Mile 0.1

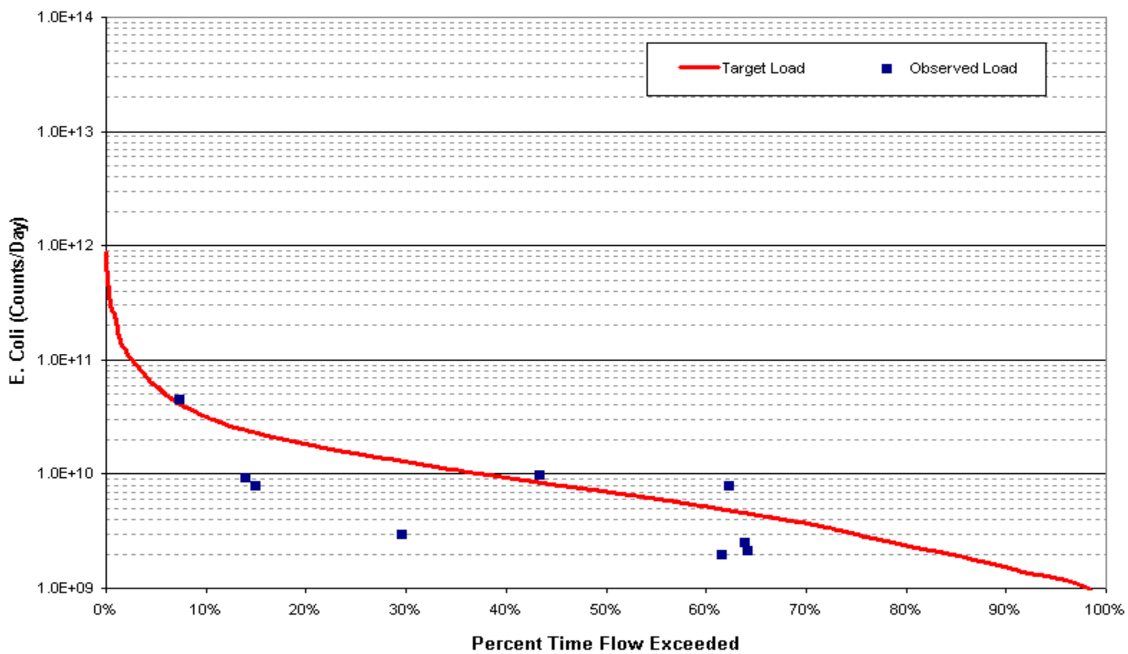


Figure C-35. E. Coli Load Duration Curve for High Bluff Branch at Mile 0.1

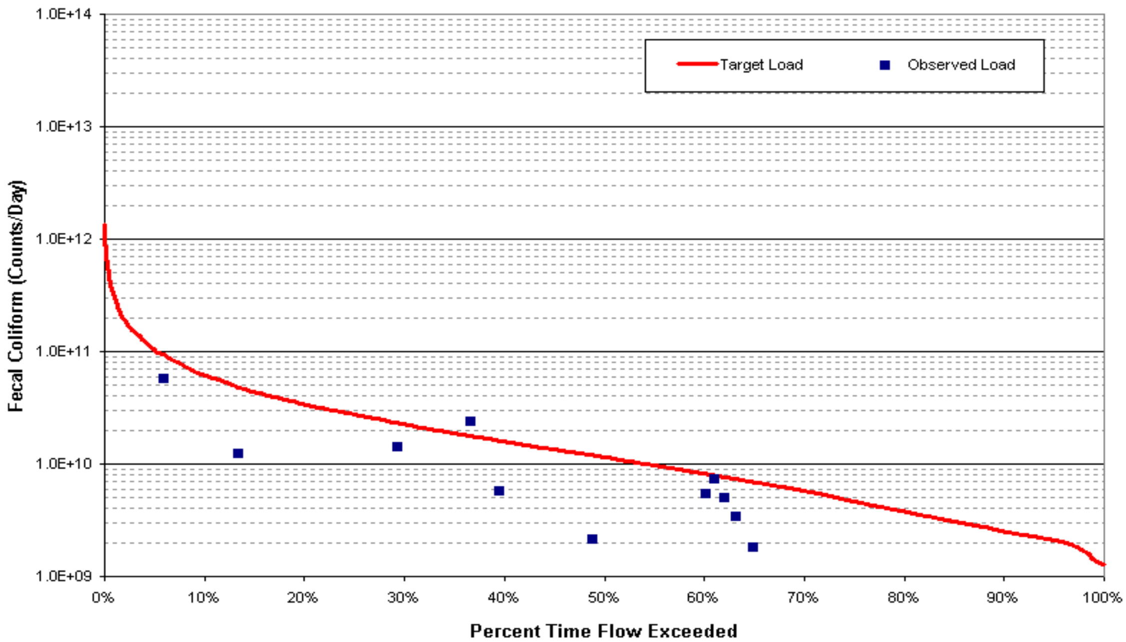


Figure C-36. Fecal Coliform Load Duration Curve for Gun Hollow Branch at Mile 0.6

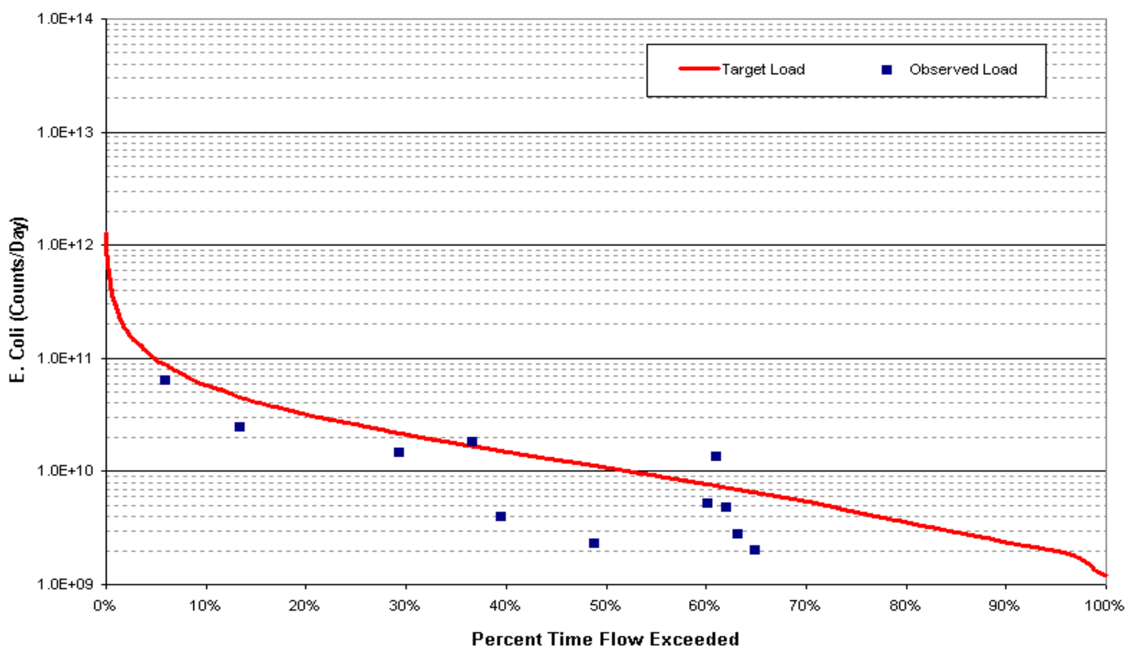


Figure C-37. E. Coli Load Duration Curve for Gun Hollow Branch at Mile 0.6

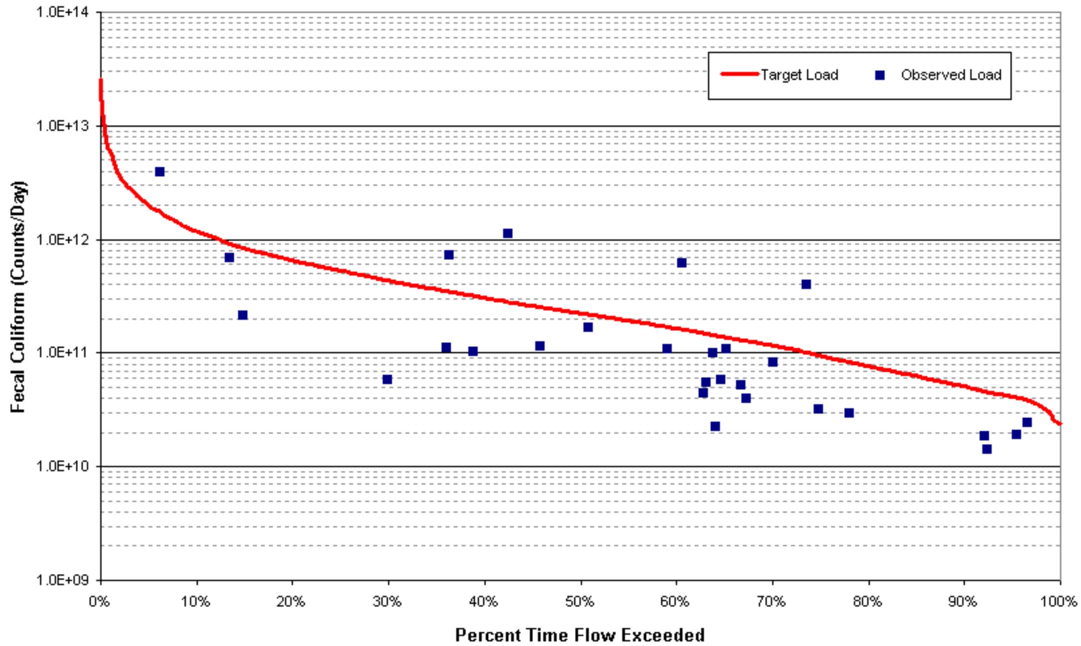


Figure C-38. Fecal Coliform Load Duration Curve for Stock Creek at Mile 3.2

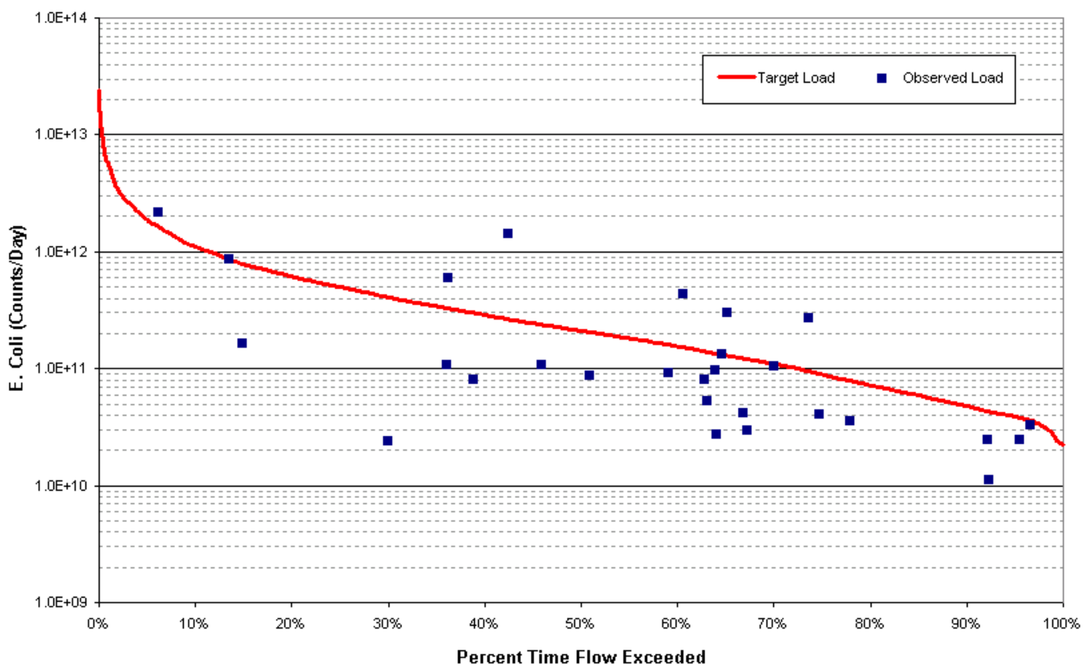


Figure C-39. E. Coli Load Duration Curve for Stock Creek at Mile 3.2

Table C-1. Required Reduction for Roddy Branch at Mile 0.6 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	3.99	37.50%	360	**NR**		
6/23/98	3.79	39.00%	**4100**	78.1		
7/6/98	1.78	60.90%	208	**NR**		
7/8/98	1.62	63.80%	540	**NR**		
7/14/98	1.42	67.80%	490	**NR**	605.27	70.3
7/21/98	1.18	72.70%	130	**NR**	493.71	63.5
7/28/98	3.12	44.40%	**2600**	65.4	450.73	60.1
8/6/98	1.40	68.20%	**2500**	64.0	741.12	75.7
8/12/98	1.13	73.70%	**3700**	75.7	1089.06	**83.5**
8/18/98	1.27	70.90%	150	**NR**	859.47	79.1
8/25/98	1.03	75.50%	68	**NR**	754.99	76.2
9/17/98	0.50	91.50%	110	**NR**		
9/22/98	0.52	90.50%	800	**NR**		
9/30/98	0.44	95.00%	110	**NR**		
10/8/98	0.98	76.40%	**3000**	70.0		
10/14/98	0.48	92.70%	94	**NR**		
10/27/98	0.41	96.10%	50	**NR**		
7/30/03	1.43	67.30%	280	**NR**		
8/13/03	3.46	41.30%	210	**NR**		
8/19/03	3.15	44.10%	202	**NR**		
8/28/03	1.47	66.50%	280	**NR**		
9/8/03	2.13	55.70%	200	**NR**		
10/9/03	1.64	63.50%	162	**NR**		
10/13/03	1.53	65.40%	330	**NR**		
10/20/03	1.42	67.70%	72	**NR**		
11/20/03	23.45	5.80%	370	**NR**		
11/24/03	7.59	22.40%	**2500**	64.0		
		90th Percentile	**2760**	**67.4**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-2. Required Reduction for Roddy Branch at Mile 0.6 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	3.99	37.50%	435	**NR**		
6/23/98	3.79	39.00%	**3448**	75.4		
7/6/98	1.78	60.90%	260	**NR**		
7/8/98	1.62	63.80%	649	**NR**		
7/14/98	1.42	67.80%	461	**NR**	650.72	82.6
7/21/98	1.18	72.70%	119	**NR**	502.12	77.5
7/28/98	3.12	44.40%	**2419**	65.0	467.76	75.8
8/6/98	1.40	68.20%	**1986**	57.4	702.46	83.9
8/12/98	1.13	73.70%	**2419**	65.0	913.90	**87.6**
8/18/98	1.27	70.90%	194	**NR**	768.63	85.3
8/25/98	1.03	75.50%	153	**NR**	808.26	86.0
9/17/98	0.50	91.50%	124	**NR**		
9/22/98	0.52	90.50%	687	**NR**		
9/30/98	0.44	95.00%	147	**NR**		
10/8/98	0.98	76.40%	**2419**	65.0		
10/14/98	0.48	92.70%	96	**NR**		
10/27/98	0.41	96.10%	62	**NR**		
7/30/03	1.43	67.30%	308	**NR**		
8/13/03	3.46	41.30%	365	**NR**		
8/19/03	3.15	44.10%	308	**NR**		
8/28/03	1.47	66.50%	260	**NR**		
9/8/03	2.13	55.70%	155	**NR**		
10/9/03	1.64	63.50%	135	**NR**		
10/13/03	1.53	65.40%	291	**NR**		
10/20/03	1.42	67.70%	65	**NR**		
11/20/03	23.45	5.80%	365	**NR**		
11/24/03	7.59	22.40%	**>2419**	>65.0		
		90th Percentile	**>2419**	**>65.0**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-3. Required Load Reduction for Pistol Creek at Mile 1.9 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	42.07	41.20%	150	**NR**		
6/23/98	60.91	30.80%	**3100**	71.0		
7/6/98	18.22	67.90%	354	**NR**		
7/8/98	18.80	66.80%	240	**NR**		
7/14/98	18.08	68.10%	240	**NR**	394	54.3
7/21/98	12.90	77.20%	160	**NR**	399	54.9
7/28/98	168.59	9.70%	**1500**	40.0	345	47.8
8/6/98	16.53	70.80%	770	**NR**	403	**55.3**
8/12/98	17.92	68.50%	146	**NR**	365	50.7
8/18/98	15.34	72.90%	120	**NR**	318	43.4
8/25/98	12.43	77.80%	106	**NR**	293	38.6
9/17/98	6.45	92.10%	390	**NR**		
9/22/98	10.70	80.90%	740	**NR**		
9/30/98	5.69	94.60%	740	**NR**		
10/8/98	116.30	15.40%	**7900**	88.6		
10/14/98	5.58	94.90%	150	**NR**		
		90th Percentile	**2140**	**57.9**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-4. Required Load Reduction for Pistol Creek at Mile 1.9 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	42.07	41.20%	206	**NR**		
6/23/98	60.91	30.80%	**2419**	62.8		
7/6/98	18.22	67.90%	435	**NR**		
7/8/98	18.80	66.80%	173	**NR**		
7/14/98	18.08	68.10%	179	**NR**	368	69.3
7/21/98	12.90	77.20%	308	**NR**	398	**71.6**
7/28/98	168.59	9.70%	**1011**	11.0	335	66.3
8/6/98	16.53	70.80%	727	**NR**	371	69.5
8/12/98	17.92	68.50%	210	**NR**	385	70.6
8/18/98	15.34	72.90%	93	**NR**	338	66.6
8/25/98	12.43	77.80%	102	**NR**	271	58.3
9/17/98	6.45	92.10%	291	**NR**		
9/22/98	10.70	80.90%	866	**NR**		
9/30/98	5.69	94.60%	579	**NR**		
10/8/98	116.30	15.40%	**2419**	62.8		
10/14/98	5.58	94.90%	105	**NR**		
		90th Percentile	**1574**	**46.2**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-5. Required Load Reduction for Crooked Creek at Mile 1.1 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	36.82	23.30%	420	**NR**		
6/23/98	30.17	29.50%	**40,500**	97.8		
7/6/98	15.07	54.00%	**14,066**	93.6		
7/8/98	13.79	56.60%	950	**NR**		
7/14/98	13.04	57.80%	**3200**	71.9	3735.5	95.2
7/21/98	10.00	66.00%	**2000**	55.0	5103.9	**96.5**
7/28/98	32.41	41.00%	**2500**	64.0	2924.2	93.8
8/6/98	16.53	59.00%	**1450**	37.9	1856.3	90.3
8/12/98	11.27	66.10%	**2600**	65.4	2270.3	92.1
8/18/98	14.52	64.20%	**2200**	59.1	2106.4	91.5
8/25/98	8.84	71.80%	640	**NR**	1677.2	89.3
9/17/98	4.41	89.90%	730	**NR**		
9/22/98	6.36	86.00%	720	**NR**		
9/30/98	4.13	92.20%	**3500**	74.3		
10/8/98	11.89	74.80%	**56,000**	98.4		
10/14/98	4.50	92.50%	**1550**	41.9		
10/27/98	3.86	96.10%	570	**NR**		
10/5/00	7.00	86.60%	550	**NR**		
4/12/04	19.35	51.60%	250	**NR**		
5/3/04	143.36	10.40%	**4700**	80.9		
		90th Percentile	**16,709**	**94.6**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-6. Required Load Reduction for Crooked Creek at Mile 1.1 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	36.82	23.30%	613	**NR**		
6/23/98	30.17	29.50%	**24192**	96.5		
7/6/98	15.07	54.00%	**1203**	29.6		
7/8/98	13.79	56.60%	**980**	13.6		
7/14/98	13.04	57.80%	**2419**	65.0	2114.7	94.7
7/21/98	10.00	66.00%	**1300**	34.9	2457.8	**95.4**
7/28/98	32.41	41.00%	**2419**	65.0	1550.7	92.7
8/6/98	16.53	59.00%	**1414**	40.1	1601.7	92.9
8/12/98	11.27	66.10%	**2419**	65.0	1918.9	94.1
8/18/98	14.52	64.20%	**1300**	34.9	1694.8	93.3
8/25/98	8.84	71.80%	**1120**	24.4	1645.0	93.1
9/17/98	4.41	89.90%	579	**NR**		
9/22/98	6.36	86.00%	**1203**	29.6		
9/30/98	4.13	92.20%	**2419**	65.0		
10/8/98	11.89	74.80%	**2419**	65.0		
10/14/98	4.50	92.50%	**1120**	24.4		
10/27/98	3.86	96.10%	816	**NR**		
10/5/00	7.00	86.60%	613	**NR**		
4/12/04	19.35	51.60%	130	**NR**		
5/3/04	143.36	10.40%	**>2419**	>65.0		
		90th Percentile	**>2419**	**>65.0**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-7. Required Load Reduction for Short Creek at Mile 0.1 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	16.56	32.30%	90	**NR**		
6/23/98	12.76	39.80%	**2000**	55.0		
7/6/98	6.81	61.10%	106	**NR**		
7/8/98	6.16	64.10%	138	**NR**		
7/14/98	6.09	64.50%	500	**NR**	265.39	32.2
7/21/98	4.58	73.00%	220	**NR**	317.34	43.3
7/28/98	24.69	22.00%	**2700**	66.7	336.97	46.6
8/6/98	7.48	57.90%	410	**NR**	441.66	59.2
8/12/98	5.20	69.40%	210	**NR**	480.34	**62.5**
8/18/98	8.27	54.80%	58	**NR**	312.21	42.3
8/25/98	4.57	73.10%	116	**NR**	274.69	34.5
9/17/98	1.98	89.90%	380	**NR**		
9/22/98	2.01	89.50%	**1900**	52.6		
9/29/98	1.72	92.90%	370	**NR**		
10/6/98	1.49	95.80%	800	**NR**		
10/13/98	1.78	92.10%	210	**NR**		
4/6/04	8.07	55.70%	14	**NR**		
4/28/04	20.67	26.00%	26	**NR**		
5/19/04	5.31	68.80%	210	**NR**		
6/16/04	34.14	15.10%	200	**NR**		
		90th Percentile	**1910**	**52.9**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-8. Required Load Reduction for Short Creek at Mile 0.1 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	16.56	32.30%	144	**NR**		
6/23/98	12.76	39.80%	**1986**	57.4		
7/6/98	6.81	61.10%	159	**NR**		
7/8/98	6.16	64.10%	96	**NR**		
7/14/98	6.09	64.50%	727	**NR**	316.45	64.3
7/21/98	4.58	73.00%	276	**NR**	360.43	68.6
7/28/98	24.69	22.00%	**2419**	65.0	374.93	69.9
8/6/98	7.48	57.90%	687	**NR**	502.41	77.5
8/12/98	5.20	69.40%	146	**NR**	546.36	**79.3**
8/18/98	8.27	54.80%	104	**NR**	370.32	69.5
8/25/98	4.57	73.10%	173	**NR**	337.29	66.5
9/17/98	1.98	89.90%	411	**NR**		
9/22/98	2.01	89.50%	**2419**	65.0		
9/29/98	1.72	92.90%	326	**NR**		
10/6/98	1.49	95.80%	921	**NR**		
10/13/98	1.78	92.10%	172	**NR**		
4/6/04	8.07	55.70%	13	**NR**		
4/28/04	20.67	26.00%	36	**NR**		
5/19/04	5.31	68.80%	387	**NR**		
6/16/04	34.14	15.10%	147	**NR**		
		90th Percentile	**2029**	**58.3**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-9. Required Reduction for Little Ellejoy Creek at Mile 0.2 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/30/03	1.67	83.00%	800	**NR**
7/14/03	14.03	24.30%	1100	18.2
8/6/03	18.36	18.10%	360	**NR**
8/18/03	5.23	51.80%	1000	10.0
10/1/03	7.69	39.70%	280	**NR**
10/22/03	2.90	69.80%	300	**NR**
11/5/03	2.97	69.00%	550	**NR**
12/5/03	19.01	17.40%	146	**NR**
1/6/04	42.47	6.60%	3000	70.0
1/20/04	13.02	26.10%	310	**NR**
2/5/04	15.88	21.20%	250	**NR**
2/19/04	11.00	29.80%	100	**NR**
		90th Percentile	**1090**	**17.4**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-10. Required Reduction for Little Ellejoy Creek at Mile 0.2 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/30/03	1.67	83.00%	816	**NR**
7/14/03	14.03	24.30%	345	**NR**
8/6/03	18.36	18.10%	411	**NR**
8/18/03	5.23	51.80%	649	**NR**
10/1/03	7.69	39.70%	249	**NR**
10/22/03	2.90	69.80%	272	**NR**
11/5/03	2.97	69.00%	770	**NR**
12/5/03	19.01	17.40%	121	**NR**
1/6/04	42.47	6.60%	1986	57.4
1/20/04	13.02	26.10%	488	**NR**
2/5/04	15.88	21.20%	162	**NR**
2/19/04	11.00	29.80%	105	**NR**
		90th Percentile	811	**0.0**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-11. Required Reduction for Pitner Creek at Mile 0.8 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/30/03	1.32	82.70%	1300	30.8
7/14/03	11.09	24.20%	**2200**	59.1
8/6/03	14.55	18.00%	600	**NR**
8/18/03	4.15	51.70%	470	**NR**
10/1/03	6.09	39.80%	800	**NR**
10/22/03	2.32	69.40%	490	**NR**
11/5/03	2.30	69.70%	168	**NR**
12/5/03	14.75	17.70%	310	**NR**
1/6/04	33.37	6.50%	**2800**	67.9
1/20/04	10.18	26.10%	530	**NR**
2/5/04	12.51	21.20%	240	**NR**
2/19/04	8.74	29.80%	280	**NR**
		90th Percentile	**2110**	**57.4**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-12. Required Reduction for Pitner Creek at Mile 0.8 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/30/03	1.32	82.70%	866	**NR**
7/14/03	11.09	24.20%	**1986**	57.4
8/6/03	14.55	18.00%	866	**NR**
8/18/03	4.15	51.70%	387	**NR**
10/1/03	6.09	39.80%	866	**NR**
10/22/03	2.32	69.40%	548	**NR**
11/5/03	2.30	69.70%	276	**NR**
12/5/03	14.75	17.70%	387	**NR**
1/6/04	33.37	6.50%	**>2419**	>65.0
1/20/04	10.18	26.10%	687	**NR**
2/5/04	12.51	21.20%	261	**NR**
2/19/04	8.74	29.80%	276	**NR**
		90th Percentile	**>1874**	**>54.8**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-13. Required Load Reduction for Ellejoy Creek at Mile 0.1 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	42.13	33.90%	560	**NR**		
6/23/98	32.24	42.50%	**14900**	94.0		
7/6/98	18.14	60.40%	378	**NR**		
7/8/98	16.38	63.60%	440	**NR**		
7/14/98	15.58	65.10%	740	**NR**	1005.3	**82.1**
7/21/98	11.88	72.50%	500	**NR**	982.8	81.7
8/25/98	10.32	75.60%	330	**NR**		
9/22/98	5.70	90.10%	460	**NR**		
10/27/98	4.76	95.30%	230	**NR**		
6/30/03	7.73	82.70%	520	**NR**		
7/14/03	52.62	27.20%	900	**NR**		
8/6/03	75.79	18.20%	**1200**	25.0		
8/18/03	24.39	51.40%	**1400**	35.7		
10/1/03	34.72	40.00%	220	**NR**		
10/22/03	14.06	68.30%	300	**NR**		
11/5/03	13.15	70.20%	100	**NR**		
12/5/03	79.10	17.30%	360	**NR**		
1/6/04	184.19	6.30%	**2300**	60.9		
1/20/04	59.31	24.30%	360	**NR**		
2/5/04	71.00	19.80%	250	**NR**		
2/19/04	51.97	27.50%	110	**NR**		
		90th Percentile	**1400**	**35.7**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-14. Required Load Reduction for Ellejoy Creek at Mile 0.1 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	42.13	33.90%	461	**NR**		
6/23/98	32.24	42.50%	**9804**	91.4		
7/6/98	18.14	60.40%	613	**NR**		
7/8/98	16.38	63.60%	613	**NR**		
7/14/98	15.58	65.10%	613	**NR**	1008.1	88.8
7/21/98	11.88	72.50%	488	**NR**	1019.6	**88.9**
8/25/98	10.32	75.60%	461	**NR**		
9/22/98	5.70	90.10%	613	**NR**		
10/27/98	4.76	95.30%	131	**NR**		
6/30/03	7.73	82.70%	387	**NR**		
7/14/03	52.62	27.20%	579	**NR**		
8/6/03	75.79	18.20%	**980**	13.6		
8/18/03	24.39	51.40%	**1046**	19.0		
10/1/03	34.72	40.00%	308	**NR**		
10/22/03	14.06	68.30%	328	**NR**		
11/5/03	13.15	70.20%	126	**NR**		
12/5/03	79.10	17.30%	345	**NR**		
1/6/04	184.19	6.30%	**2419**	65.0		
1/20/04	59.31	24.30%	411	**NR**		
2/5/04	71.00	19.80%	228	**NR**		
2/19/04	51.97	27.50%	59	**NR**		
		90th Percentile	**1046**	**19.0**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-15. Required Reduction for Ellejoy Creek at Mile 5.5 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/30/03	4.18	82.70%	**4000**	77.5
7/14/03	28.48	27.20%	132	**NR**
8/6/03	41.02	18.20%	130	**NR**
8/18/03	13.20	51.40%	**2600**	65.4
10/1/03	18.79	40.00%	**2200**	59.1
10/22/03	7.61	68.30%	**6400**	85.9
11/5/03	7.12	70.20%	**9700**	90.7
12/5/03	42.81	17.30%	**2400**	62.5
1/6/04	99.69	6.30%	**2800**	67.9
1/20/04	32.10	24.30%	**1900**	52.6
2/5/04	38.43	19.80%	160	**NR**
2/19/04	28.13	27.50%	340	**NR**
		90th Percentile	**6160**	**85.4**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-16. Required Reduction for Ellejoy Creek at Mile 5.5 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/30/03	4.18	82.70%	**>2419**	>65.0
7/14/03	28.48	27.20%	219	**NR**
8/6/03	41.02	18.20%	84	**NR**
8/18/03	13.20	51.40%	**>2419**	>65.0
10/1/03	18.79	40.00%	**1733**	51.1
10/22/03	7.61	68.30%	**>2419**	>65.0
11/5/03	7.12	70.20%	**>2419**	>65.0
12/5/03	42.81	17.30%	**2419**	65.0
1/6/04	99.69	6.30%	**>2419**	>65.0
1/20/04	32.10	24.30%	**2419**	65.0
2/5/04	38.43	19.80%	210	**NR**
2/19/04	28.13	27.50%	308	**NR**
		90th Percentile	**>2419**	**>65.0**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-17. Required Load Reduction for Wildwood Branch at Mile 0.1 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/16/03	1.19	69.00%	620	**NR**
6/30/03	0.81	79.30%	**1100**	18.2
8/6/03	6.53	17.00%	**1400**	35.7
8/18/03	2.14	49.70%	**1100**	18.2
10/1/03	2.88	39.90%	500	**NR**
10/22/03	1.24	68.00%	430	**NR**
11/5/03	1.68	58.30%	**1800**	50.0
12/5/03	5.89	19.00%	54	**NR**
1/6/04	13.92	6.90%	**2700**	66.7
1/20/04	4.31	27.00%	350	**NR**
2/5/04	5.47	21.00%	280	**NR**
2/19/04	4.10	28.50%	150	**NR**
		90th Percentile	**1760**	**48.9**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-18. Required Load Reduction for Wildwood Branch at Mile 0.1 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/16/03	1.19	69.00%	770	**NR**
6/30/03	0.81	79.30%	579	**NR**
8/6/03	6.53	17.00%	548	**NR**
8/18/03	2.14	49.70%	579	**NR**
10/1/03	2.88	39.90%	613	**NR**
10/22/03	1.24	68.00%	517	**NR**
11/5/03	1.68	58.30%	1986	57.4
12/5/03	5.89	19.00%	102	**NR**
1/6/04	13.92	6.90%	2419	>65.0
1/20/04	4.31	27.00%	291	**NR**
2/5/04	5.47	21.00%	190	**NR**
2/19/04	4.10	28.50%	167	**NR**
		90th Percentile	**1864**	**>54.6**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-19. Required Load Reduction for Nails Creek at Mile 0.7 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	32.13	26.00%	440	**NR**		
6/23/98	27.06	33.90%	**15,600**	94.2		
7/6/98	17.98	54.50%	440	**NR**		
7/8/98	17.00	57.00%	720	**NR**		
7/14/98	16.28	58.80%	510	**NR**	1020.91	82.4
7/21/98	13.81	66.20%	620	**NR**	1093.39	**83.5**
7/28/98	22.06	44.60%	**2600**	65.4	764.09	76.4
8/6/98	15.48	61.10%	490	**NR**	780.72	76.9
8/12/98	13.16	68.20%	**2400**	62.5	993.27	81.9
8/18/98	13.77	66.40%	420	**NR**	955.44	81.2
8/25/98	11.75	72.50%	500	**NR**	915.21	80.3
9/17/98	7.66	88.30%	530	**NR**		
9/22/98	8.08	86.40%	410	**NR**		
9/30/98	6.85	92.00%	**2800**	67.9		
10/8/98	12.39	70.60%	**3400**	73.5		
10/14/98	6.67	92.50%	302	**NR**		
10/27/98	5.70	95.90%	590	**NR**		
6/16/03	15.62	60.60%	**1530**	41.2		
6/30/03	12.33	70.80%	**1500**	40		
8/6/03	31.92	26.30%	**1300**	30.8		
8/18/03	22.16	44.20%	**1300**	30.8		
10/1/03	23.49	41.20%	900	**NR**		
10/22/03	13.96	65.70%	580	**NR**		
11/5/03	15.27	61.70%	**1900**	52.6		
12/5/03	30.95	27.50%	350	**NR**		
1/6/04	57.06	10.00%	**2500**	64.0		
1/20/04	27.33	33.30%	310	**NR**		
2/5/04	33.53	24.30%	260	**NR**		
2/19/04	32.18	25.90%	200	**NR**		
		90th Percentile	**2640**	**65.9**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-20. Required Load Reduction for Nails Creek at Mile 0.7 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	32.13	26.00%	687	**NR**		
6/23/98	27.06	33.90%	**6488**	87.0		
7/6/98	17.98	54.50%	579	**NR**		
7/8/98	17.00	57.00%	**1203**	29.6		
7/14/98	16.28	58.80%	548	**NR**	1112.14	89.8
7/21/98	13.81	66.20%	**921**	8.0	1179.29	**90.4**
7/28/98	22.06	44.60%	**1986**	57.4	930.66	87.9
8/6/98	15.48	61.10%	548	**NR**	920.48	87.7
8/12/98	13.16	68.20%	816	**NR**	851.72	86.7
8/18/98	13.77	66.40%	435	**NR**	813.28	86.1
8/25/98	11.75	72.50%	**921**	8.0	813.28	86.1
9/17/98	7.66	88.30%	**980**	13.6		
9/22/98	8.08	86.40%	461	**NR**		
9/30/98	6.85	92.00%	**2419**	65.0		
10/8/98	12.39	70.60%	**2419**	65.0		
10/14/98	6.67	92.50%	211	**NR**		
10/27/98	5.70	95.90%	**1046**	19.0		
6/16/03	15.62	60.60%	**1553**	45.5		
6/30/03	12.33	70.80%	**1300**	30.8		
8/6/03	31.92	26.30%	**921**	8.0		
8/18/03	22.16	44.20%	**866**	2.2		
10/1/03	23.49	41.20%	**986**	14.1		
10/22/03	13.96	65.70%	**1046**	19.0		
11/5/03	15.27	61.70%	**866**	2.2		
12/5/03	30.95	27.50%	345	**NR**		
1/6/04	57.06	10.00%	**>2419**	>65.0		
1/20/04	27.33	33.30%	345	**NR**		
2/5/04	33.53	24.30%	179	**NR**		
2/19/04	32.18	25.90%	365	**NR**		
		90th Percentile	**>2419**	**>65.0**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-21. Required Reduction for Grandview Branch at Mile 0.5 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/4/03	0.37	61.90%	960	**NR**
8/13/03	0.66	43.10%	370	**NR**
8/26/03	0.35	63.80%	**2100**	57.1
9/16/03	0.36	63.50%	290	**NR**
10/9/03	0.38	61.40%	116	**NR**
10/30/03	0.32	66.70%	700	**NR**
11/20/03	3.21	7.30%	700	**NR**
12/11/03	1.81	14.60%	620	**NR**
1/27/04	1.89	13.70%	190	**NR**
2/19/04	1.03	29.10%	80	**NR**
		90th Percentile	**1074**	16.2

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table S-22. Required Reduction for Grandview Branch at Mile 0.5 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/4/03	0.37	61.90%	921	**NR**
8/13/03	0.66	43.10%	260	**NR**
8/26/03	0.35	63.80%	**2419**	65.0
9/16/03	0.36	63.50%	228	**NR**
10/9/03	0.38	61.40%	167	**NR**
10/30/03	0.32	66.70%	308	**NR**
11/20/03	3.21	7.30%	727	**NR**
12/11/03	1.81	14.60%	**1300**	34.9
1/27/04	1.89	13.70%	157	**NR**
2/19/04	1.03	29.10%	99	**NR**
		90th Percentile	**1412**	40.0

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-23. Required Reduction for High Bluff Branch at Mile 0.1 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/4/03	0.23	62.30%	**2000**	55.0
8/13/03	0.41	43.30%	810	**NR**
8/26/03	0.22	64.20%	540	**NR**
9/16/03	0.22	63.90%	400	**NR**
10/9/03	0.24	61.60%	460	**NR**
10/30/03	0.20	66.80%	240	**NR**
11/20/03	1.99	7.30%	600	**NR**
12/11/03	1.12	14.90%	400	**NR**
1/27/04	1.17	13.90%	320	**NR**
2/19/04	0.63	29.50%	310	**NR**
		90th Percentile	**929**	3.1

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-24. Required Reduction for High Bluff Branch at Mile 0.1 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/4/03	0.23	62.30%	**1414**	40.0
8/13/03	0.41	43.30%	**980**	13.6
8/26/03	0.22	64.20%	397	**NR**
9/16/03	0.22	63.90%	461	**NR**
10/9/03	0.24	61.60%	344	**NR**
10/30/03	0.20	66.80%	152	**NR**
11/20/03	1.99	7.30%	921	**NR**
12/11/03	1.12	14.90%	291	**NR**
1/27/04	1.17	13.90%	326	**NR**
2/19/04	0.63	29.50%	194	**NR**
		90th Percentile	**1023**	17.2

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-25. Required Reduction for Gun Hollow Branch at Mile 0.6 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/4/03	0.37	60.10%	600	**NR**
7/7/03	0.81	36.60%	**1200**	25.0
8/13/03	0.73	39.50%	320	**NR**
8/26/03	0.34	63.10%	420	**NR**
9/16/03	0.35	62.00%	590	**NR**
10/9/03	0.36	61.00%	830	**NR**
10/30/03	0.31	64.90%	240	**NR**
11/20/03	4.26	5.90%	560	**NR**
12/11/03	2.19	13.30%	230	**NR**
1/17/04	0.55	48.80%	160	**NR**
2/19/04	1.05	29.30%	550	**NR**
90th Percentile			830	0.0
Geometric Mean of All Sampling Data			463	61.1

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-26. Required Reduction for Gun Hollow Branch at Mile 0.6 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/4/03	0.37	60.10%	579	**NR**
7/7/03	0.81	36.60%	921	**NR**
8/13/03	0.73	39.50%	225	**NR**
8/26/03	0.34	63.10%	345	**NR**
9/16/03	0.35	62.00%	579	**NR**
10/9/03	0.36	61.00%	**1553**	45.5
10/30/03	0.31	64.90%	261	**NR**
11/20/03	4.26	5.90%	613	**NR**
12/11/03	2.19	13.30%	461	**NR**
1/17/04	0.55	48.80%	173	**NR**
2/19/04	1.05	29.30%	579	**NR**
90th Percentile			921	0.0
Geometric Mean of All Sampling Data			465	75.7

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-27. Required Load Reduction for Stock Creek at Mile 3.2 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	15.97	36.00%	286	**NR**		
6/23/98	12.78	42.40%	**3600**	75.0		
7/6/98	6.78	62.80%	270	**NR**		
7/8/98	6.38	64.60%	380	**NR**		
7/14/98	5.93	66.70%	360	**NR**	520.02	65.4
7/21/98	4.37	74.70%	300	**NR**	525.02	65.7
7/28/98	15.82	36.20%	**1900**	52.6	462.02	61.0
8/6/98	6.52	63.80%	630	**NR**	547.34	67.1
8/12/98	4.63	73.50%	**3600**	75.0	858.15	79.0
8/18/98	5.34	70.00%	640	**NR**	962.81	81.3
8/25/98	3.81	77.90%	320	**NR**	975.32	**81.5**
9/22/98	2.08	92.30%	280	**NR**		
9/30/98	1.85	95.4%	430	**NR**		
10/8/98	7.38	60.5%	**3500**	74.3		
10/14/98	2.09	92.1%	370	**NR**		
10/27/98	1.76	96.5%	580	**NR**		
4/30/03	11.55	45.8%	410	**NR**		
6/4/03	7.76	59.0%	580	**NR**		
7/9/03	9.96	50.8%	700	**NR**		
8/13/03	14.56	38.8%	290	**NR**		
8/26/03	6.27	65.1%	710	**NR**		
9/16/03	6.46	64.0%	142	**NR**		
10/9/03	6.71	63.0%	340	**NR**		
10/30/03	5.86	67.2%	280	**NR**		
11/20/03	80.82	6.1%	**2000**	55.0		
12/11/03	41.45	13.4%	690	**NR**		
1/27/04	38.17	14.8%	230	**NR**		
2/19/04	19.77	29.9%	120	**NR**		
		90th Percentile	**2450**	**63.4**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-28. Required Load Reduction for Stock Creek at Mile 3.2 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/17/98	15.97	36.00%	276	**NR**		
6/23/98	12.78	42.40%	**4661**	81.8		
7/6/98	6.78	62.80%	488	**NR**		
7/8/98	6.38	64.60%	866	**NR**		
7/14/98	5.93	66.70%	291	**NR**	691.58	83.7
7/21/98	4.37	74.70%	387	**NR**	739.95	84.7
7/28/98	15.82	36.20%	**1553**	45.5	593.94	81.0
8/6/98	6.52	63.80%	613	**NR**	621.66	81.8
8/12/98	4.63	73.50%	**2419**	65.0	763.44	85.2
8/18/98	5.34	70.00%	816	**NR**	938.28	**88.0**
8/25/98	3.81	77.90%	387	**NR**	938.28	**88.0**
9/22/98	2.08	92.30%	219	**NR**		
9/30/98	1.85	95.4%	548	**NR**		
10/8/98	7.38	60.5%	**2419**	65.0		
10/14/98	2.09	92.1%	488	**NR**		
10/27/98	1.76	96.5%	770	**NR**		
4/30/03	11.55	45.8%	388	**NR**		
6/4/03	7.76	59.0%	488	**NR**		
7/9/03	9.96	50.8%	365	**NR**		
8/13/03	14.56	38.8%	231	**NR**		
8/26/03	6.27	65.1%	**1986**	57.4		
9/16/03	6.46	64.0%	173	**NR**		
10/9/03	6.71	63.0%	326	**NR**		
10/30/03	5.86	67.2%	206	**NR**		
11/20/03	80.82	6.1%	**1120**	24.4		
12/11/03	41.45	13.4%	866	**NR**		
1/27/04	38.17	14.8%	179	**NR**		
2/19/04	19.77	29.9%	50	**NR**		
		90th Percentile	**2116**	**60.0**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-29. Required Reduction for Stock Creek at Mile 5.3 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
4/30/03	7.21	38.80%	210	**NR**
6/4/03	4.93	50.80%	680	**NR**
7/9/03	3.85	59.00%	300	**NR**
8/13/03	5.72	45.80%	290	**NR**
8/26/03	3.33	63.00%	200	**NR**
9/16/03	3.10	65.10%	142	**NR**
10/9/03	3.20	64.00%	**2100**	57.1
10/30/03	2.90	67.20%	**3500**	74.3
11/20/03	40.03	6.10%	**1700**	47.1
12/11/03	20.53	13.40%	830	**NR**
1/27/04	18.91	14.80%	150	**NR**
2/19/04	9.79	29.90%	100	**NR**
		90th Percentile	**2060**	56.3

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-30. Required Reduction for Stock Creek at Mile 5.3 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
4/30/03	7.21	38.80%	205	**NR**
6/4/03	4.93	50.80%	649	**NR**
7/9/03	3.85	59.00%	308	**NR**
8/13/03	5.72	45.80%	272	**NR**
8/26/03	3.33	63.00%	184	**NR**
9/16/03	3.10	65.10%	199	**NR**
10/9/03	3.20	64.00%	**1733**	51.1
10/30/03	2.90	67.20%	**>2419**	>65.0
11/20/03	40.03	6.10%	**1986**	57.4
12/11/03	20.53	13.40%	**1046**	19
1/27/04	18.91	14.80%	197	**NR**
2/19/04	9.79	29.90%	135	**NR**
		90th Percentile	**>1961**	>56.8

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

APPENDIX D

Hydrodynamic Modeling Methodology

HYDRODYNAMIC MODELING METHODOLOGY

D.1 Model Selection

The Loading Simulation Program C++ (LSPC) was selected for flow simulation of pathogen-impaired waters in the subwatersheds of the Little River subwatershed. LSPC is a watershed model capable of performing flow routing through stream reaches. LSPC is a dynamic watershed model based on the Hydrologic Simulation Program - Fortran (HSPF)

D.2 Model Set Up

The Little River subwatershed was delineated into subwatersheds in order to facilitate model hydrologic calibration. Boundaries were constructed so that subwatershed "pour points" coincided with HUC-12 delineations, impaired waterbodies, and water quality monitoring stations. Watershed delineation was based on the NHD stream coverage and Digital Elevation Model (DEM) data. This discretization facilitates simulation of daily flows at water quality monitoring stations.

Several computer-based tools were utilized to generate input data for the LSPC model. The Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to support hydrology model simulations for selected subwatersheds. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

An important factor influencing model results is the precipitation data contained in the meteorological data files used in these simulations. Weather data from multiple meteorological stations were available for the time period from January 1970 through August 2004. Meteorological data for a selected 11-year period were used for all simulations. The first year of this period was used for model stabilization with simulation data from the subsequent 10-year period (10/1/94 – 9/30/04) used for TMDL analysis.

D.3 Model Calibration

Hydrologic calibration of the watershed model involves comparison of simulated streamflow to historic streamflow data from U. S. Geological Survey (USGS) stream gaging stations for the same period of time. A USGS continuous record station located near the Little River subwatershed with a sufficiently long and recent historical record was selected as the basis of the hydrology calibration. The USGS station was selected based on similarity of drainage area, Level IV ecoregion, land use, and topography. The calibration involved comparison of simulated and observed hydrographs until statistical stream volumes and flows were within acceptable ranges as reported in the literature (Lumb, et al., 1994).

Initial values for hydrologic variables were taken from an EPA developed default data set. During the calibration process, model parameters were adjusted within reasonable constraints until acceptable agreement was achieved between simulated and observed streamflow. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge.

The results of the hydrologic calibration for Bullrun Creek near Halls Crossroads, USGS Station 03535000, are shown in Table D-1 and Figures D-1 and D-2.

Table D-1. Hydrologic Calibration Summary: Bullrun Creek (USGS 03535000)

Simulation Name:	USGS03535000	**Simulation Period:**	
		Watershed Area (ac):	43607.17
Period for Flow Analysis			
Begin Date:	**10/01/80**	**Baseflow PERCENTILE:**	2.5
End Date:	**09/30/86**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**82.36**	Total Observed In-stream Flow:	**91.27**
Total of highest 10% flows:	**42.83**	Total of Observed highest 10% flows:	**47.36**
Total of lowest 50% flows:	**9.68**	Total of Observed Lowest 50% flows:	**10.06**
Simulated Summer Flow Volume (months 7-9):	**9.30**	Observed Summer Flow Volume (7-9):	**7.91**
Simulated Fall Flow Volume (months 10-12):	**14.00**	Observed Fall Flow Volume (10-12):	**15.95**
Simulated Winter Flow Volume (months 1-3):	**31.45**	Observed Winter Flow Volume (1-3):	**35.49**
Simulated Spring Flow Volume (months 4-6):	**27.61**	Observed Spring Flow Volume (4-6):	**31.92**
Total Simulated Storm Volume:	**76.18**	Total Observed Storm Volume:	**83.16**
Simulated Summer Storm Volume (7-9):	**7.76**	Observed Summer Storm Volume (7-9):	**5.88**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-9.76**	10	
Error in 50% lowest flows:	**-3.75**	10	
Error in 10% highest flows:	**-9.57**	15	
Seasonal volume error - Summer:	**17.59**	30	
Seasonal volume error - Fall:	**-12.22**	30	
Seasonal volume error - Winter:	**-11.39**	30	
Seasonal volume error - Spring:	**-13.50**	30	
Error in storm volumes:	**-8.39**	20	
Error in summer storm volumes:	**31.99**	50	

Criteria for Median Monthly Flow Comparisons	
Lower Bound (Percentile):	25
Upper Bound (Percentile):	75

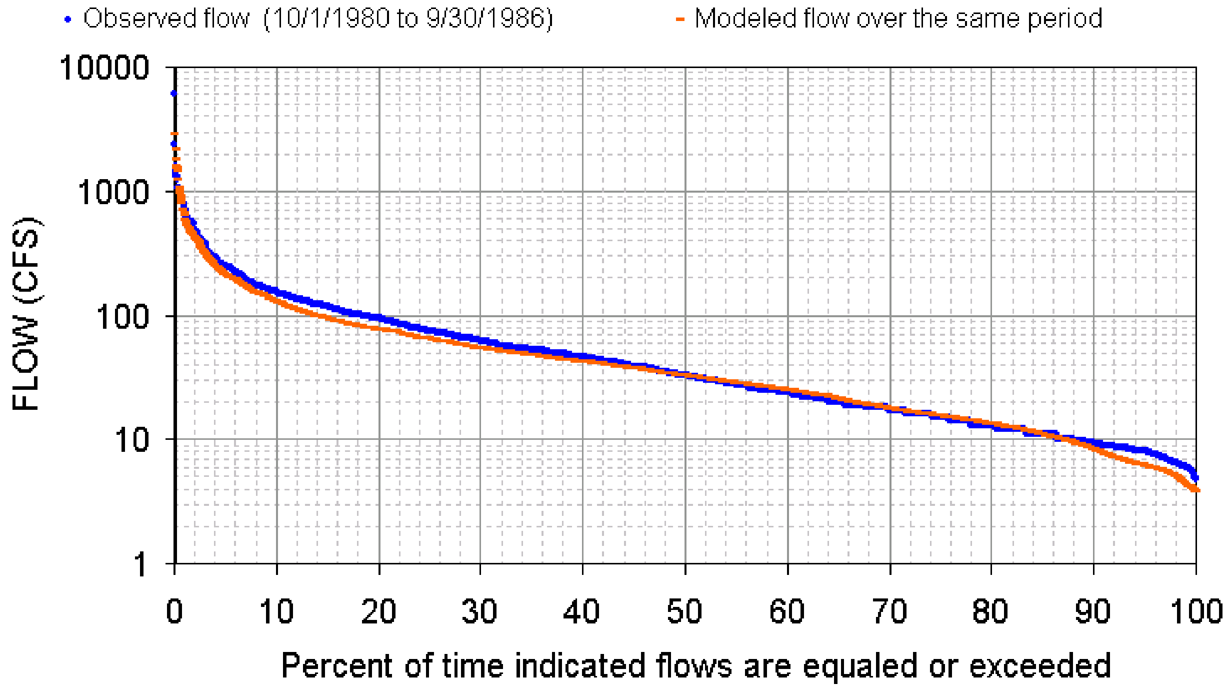


Figure D-1. Hydrologic Calibration: Bullrun Creek, USGS 03535000 (WYs1981-86)

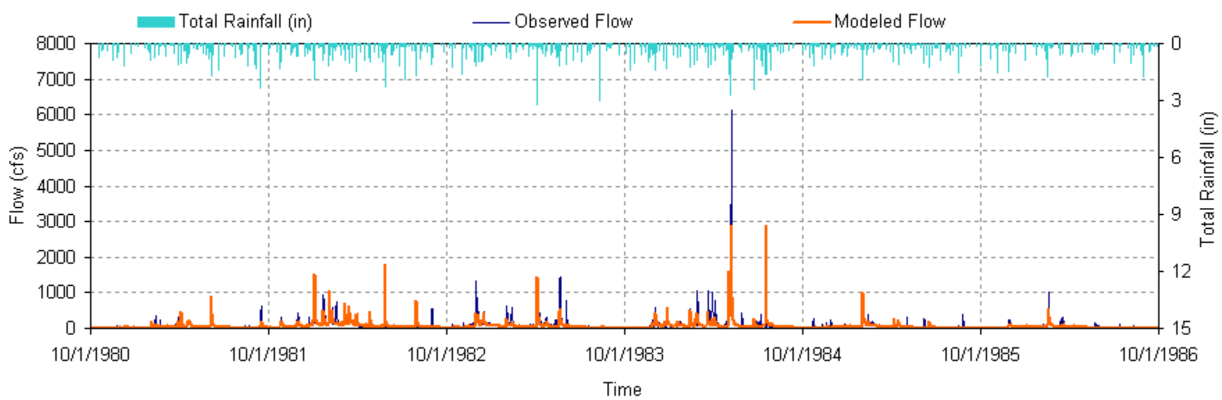


Figure D-2. 6-Year Hydrologic Comparison: Bullrun Creek, USGS 03535000

APPENDIX E

Determination of WLAs & LAs

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

For pathogen TMDLs in each impaired subwatershed, WLA terms include:

- $[\sum WLAs]_{WWTF}$ is the allowable load associated with discharges of NPDES permitted WWTFs located in impaired subwatersheds. Since NPDES permits for these facilities specify that treated wastewater must meet instream water quality standards at the point of discharge, no additional load reduction is required. WLAs for WWTFs are calculated from the facility design flow and the Monthly Average permit limit.

- $[\sum WLAs]_{CAFO}$ is the allowable load for all CAFOs in an impaired subwatershed. All wastewater discharges from a CAFO to waters of the state of Tennessee are prohibited, except when either chronic or catastrophic rainfall events cause an overflow of process wastewater from a facility properly designed, constructed, maintained, and operated to contain:
    - All process wastewater resulting from the operation of the CAFO (such as wash water, parlor water, watering system overflow, etc.); plus,
    - All runoff from a 25-year, 24-hour rainfall event for the existing CAFO or new dairy or cattle CAFOs; or all runoff from a 100-year, 24-hour rainfall event for a new swine or poultry CAFO.

  Therefore, a WLA of zero has been assigned to this class of facilities.

- $[\sum WLAs]_{MS4}$ is the required load reduction for discharges from MS4s. Fecal coliform and/or E. coli loading from MS4s is the result of buildup/wash-off processes associated with storm events. The percent load reductions for MS4s are considered to be equal to the load reductions developed for TMDLs.

LA terms include:

- $[\sum LAs]_{DS}$ is the allowable fecal coliform and/or E. coli load from "other direct sources". These sources include leaking septic systems, leaking collection systems, illicit discharges, and animals access to streams. The LA specified for all sources of this type is zero counts/day (or to the maximum extent practicable).

- $[\sum LAs]_{SW}$ represents the required reduction in fecal coliform and/or E. coli loading from nonpoint sources indirectly going to surface waters from all land use areas (except areas covered by a MS4 permit) as a result of the buildup/wash-off processes associated with storm events. The percent load reductions for precipitation-induced nonpoint sources are considered to be equal to the load reductions developed for TMDLs (and specified for MS4s).

Explicit MOS has already been incorporated into TMDL development as stated in Appendix C. TMDLs, WLAs, & LAs are applied to the entire subwatershed. WLAs & LAs for Little River waterbodies are summarized in Table E-1.

Table E-1. WLAs & LAs for Little River, Tennessee

HUC-12 Subwatershed (06010201__) or Drainage Area	Impaired Waterbody	Impaired Waterbody ID	WLAs		LAs	
			Leaking Collection Systems[a]	MS4s[b]	Precipitation Induced Nonpoint Sources	Other Direct Sources[c]
			[cts./day]	[% Red.]	[% Red.]	[cts./day]
0103	Short Creek	TN06010201032 – 0800	**NA**	**79.3**	**79.3**	**0**
0104	Little Ellejoy Creek	TN06010201033 – 0100	**NA**	**88.9**	**88.9**	**0**
	Pitner Creek	TN06010201033 – 0200				
	Ellejoy Creek	TN06010201033 – 1000 & 2000				
0105	Crooked Creek	TN06010201028 – 1000	**NA**	**96.5**	**96.5**	**0**
	Wildwood Branch	TN06010201034 – 0200				
	Nails Creek	TN06010201034 – 1000				
0106	Roddy Branch	TN06010201026 – 0100	**NA**	**87.6**	**87.6**	**0**
0107	Pistol Creek	TN06010201026 – 0400	**NA**	**71.6**	**71.6**	**0**
0108	Grandview Branch	TN06010201066 – 0300	**NA**	**88.0**	**88.0**	**0**
	High Bluff Branch	TN06010201066 – 0600				
	Stock Creek	TN06010201066 – 1000 & 2000				
	Gun Hollow Branch	TN06010201066 – 1200				

a. *The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*
b. *Applies to any MS4 discharge loading in the subwatershed.*
c. *The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

APPENDIX F

Calculation of Stock Creek *E. coli* loads and partitioning of *E. coli* loads into that attributable to bovine using Bruce Cleland's Flow Duration Curve Models (Layton, 2004)

Calculation of Stock Creek *E. coli* loads and partitioning of *E. coli* loads in to that attributable to bovine using Bruce Cleland's Flow duration Curve Models

November 2004

Alice Layton, Randy Gentry, and Larry McKay

The Stock Creek Watershed was monitored 12 times between 4/30/2003 and 2/19/2004. Flow (cfs) was measured at six sites for 12 sample dates. *E. coli* CFU/100ml was measured at 16 sites for 12 sample dates by Knoxville Regional Laboratories (KRL). Microbial source tracking using real-time PCR assays to quantify *Bacteroides* 16S rRNA genes was used to determine the percent of fecal contamination attributable to cattle.

Calculation of Flow Duration Curves

Flows (cfs) and percentile values for flow duration curves were calculated using the "Flow Duration Tool (Template)" Excel spreadsheet provided by Bruce Cleland (America's Clean Water Foundation). Flow duration curves were presented in Power Point files also provided by Bruce Cleland.

The flow duration curve analysis as presented by Bruce Cleland was originally designed for gauged streams with data available from USGS (http://waterdata.usgs.gov/nwis/). However, there is a lack of gauged streams in east Tennessee. The Stock Creek Watershed has one gauge (Pickens Gap), but this gauge only measures stream height and data is not available to calculate flow.

Several people have speculated that general flow duration curves can be created from known data that will be applicable to other streams in a geographic region. This hypothesis was tested by creating flow duration curves for 13 gauged data sets from the Lower Clinch Watershed (USGS 06010207). This watershed was chosen because it is geographically close and geographically similar to the Stock Creek Watershed and because data was available for a number of streams with very small drainage areas. The gauged data sets used are summarized in Table 1. In this watershed stream gauge data were excluded based on the following criteria: 1) very large drainage areas (>100 sq. miles), 2) gauges near dammed areas, 3) gauges with very high flow for the drainage area (EF popular creek). Flow (cfs) was graphed versus Flow Duration Interval (%) in Power Point figures (electronic version available). In addition, a regression analysis was performed across the 13 data sets in Excel comparing the log of the drainage and the log of each Flow Duration Intervals (1-100%) (Table 2). The drainage area and flow was highly correlated (r^2>0.9) at the high flow to mid flow ranges (1% to 50%). The correlations between flow and drainage area decreased with increasing percentile to r^2=0.60 at dry conditions (100%). These results suggest that Linear Regresssion formulas may be used to predict flows in un-gauged watersheds in geologically and geographically similar areas based on the drainage area of stream. It is expected that these curves will be reliable in the regions of the graph representing moderate to high flows. However, the ability to reliably predict the flow in small streams under very low flow conditions is questionable.

The linear regression values presented in Table 2 were used to create presumptive Flow Duration Curves for 7 sites on the main creek in the Stock Creek Watershed (Table 3, PowerPoint File). During the 1 year sampling period flows were measured and calculated for 6 sites 12 times (Table 4). The percentile rank for each flow measurement was estimated to the nearest 5% (Table 5) based on the percentile calculations shown in Table 3. Assuming that the relative percentile rank at each site should be similar on any sample date a mean percentile rank was calculated for each date and the flow for the whole watershed was classified as High, Moist, Mid-Range, Dry or Drought. Based on these analysis for 7 sample dates the flow were classified as Moist, 3 were classified as Mid-Range and 2 were classified as Dry.

Calculation of Load Duration Curves for E. coli

Load duration curves for 6 sites on the main creek and 3 sites on tributaries were calculated using the flow duration data and percentile ranks generated in Tables 3 and 5. An *E. coli* load duration curve was generated in the WQ Duration Tool (Template) Excel Spreadsheet. In this spreadsheet the load at each percentile flow was calculated for the acceptable water quality value of 126 *E. coli* CFU/100 ml. These curves were graphically presented in Power Point and are shown in Figure 1. For the 3 samples sites on the tributaries where flow data was not collected, an estimated flow was calculated based on the mean percentile for each date and the drainage area at the site.

The *E. coli* load for each sample data at each site was calculated using WQ Duration Tool (Template) spreadsheet, the measured flow and the measured *E. coli* CFU/100 ml. These load values were plotted against Percentile rand on the load duration curves in Power Point (Figure 1). Filled diamonds represent warm weather sample dates (April- October) and unfilled diamond represent cool weather sample dates (November-March). Diamonds above the load duration line represent samples above the equivalent 126 CFU/100ml threshold. In this analysis greater than 80% of the samples were above the threshold for SC-2, SC-3, SC-4, SC-5, SC-6, SC-7. However, for SC-7 and NS-1 only 25% and 30% of the samples were above the threshold (Figure1). There also was no apparent seasonal trend.

An attempt was made to use the bovine *Bacteroides* source tracking marker to determine the amount of *E. coli* attributable to cattle. In this analysis the amount of *Bacteroides* attributable to all fecal sources (AllBac) and the amount of *Bacteroides* attributable to cattle (BoBac) was calculated for each site and sample date. A percentage of bovine *Bacteriodes* was calculated (BoBac/AllBac *100) and multiplied by the *E. coli* CFU/100ml to determine the amount *E. coli* attributable to cattle. The implicit assumptions in this analysis are that all animal fecal sources have equivalent concentrations of *E. coli* and that *E. coli* concentration is proportional to *Bacteroides*. In this study, the correlation of the AllBac assay (mg/100ml) with *E. coli* concentrations was 0.31 suggesting that *E. coli* concentrations and *Bacteroides* concentrations are loosely correlated. *E. coli* loads attributable to cattle were calculated for each site using the WQ Duration Tool (Template) spreadsheet and displayed using Power Point graphics (Figure 1). The *E. coli* load attributable to cattle made a large contribution to the total *E. coli* load except at the HB-1 site (Figure1). At two sites SC-5 and GH-1, 50% and 75% of the *E. coli* attributable to cattle loads alone were above the 126 CFU/100 ml threshold, suggesting that removal of the *E. coli* attributable to cattle at these sites would reduce the total *E. coli* load to acceptable limits. In contrast, at the HB-1 site none of the sample dates had *E. coli* loads attributable to cattle above the threshold and 3 of the *E. coli* loads were below the 1x 10^7 graphing limit. This suggests that at this site removal of *E. coli* attributable to cattle would have little impact on the total *E. coli* loads. Therefore, the *E. coli* loads at this site must be due to another source such as human.

Table 1. Data sets from stream gauges used in this study from the Lower Clinch River Waterhsed.

Stream	Drainage area (sq.miles)	Gauge Number	Dates of Operation	Number of Sample Points
BULLRUN CREEK NEAR HALLS CROSSROADS, TN	68.5	03535000	1957-2003	11414
POPLAR CREEK NEAR OAK RIDGE, TN	82.5	03538225	1960-1989	10622
BEAR C AT ST HWY 95 NR OAK RIDGE, TN	4.34	03538270	1985-2000	5745
BEAR CREEK NEAR WHEAT, TN	3.2	035382673	1986-1991	1826
BEAR CREEK AT PINE RIDGE, NEAR WHEAT, TN	5.0	03538273	1986-1991	1832
WHITEOAK CREEK NEAR WHEAT, TN	2.10	03536380	1986-1995	3226
NORTHWEST TRIBUTARY NEAR OAK RIDGE, TN	0.67	03536440	1987-1995	3093
FIRST CREEK NEAR OAK RIDGE, TN	0.33	03536450	1987-1996	3530
WHITEOAK CREEK AT O R N L, NEAR OAK RIDGE, TENN	2.08	03536500	1950-1955	1870
WHITEOAK CR BL MELTON VALLEY DR NR OAK RIDGE	3.28	03536550	1985-2001	5698
WHITEOAK CR BL OAK RIDGE NATL LAB NR OAK RIDGE, TN	3.62	0353700	1950-1964	4383
MELTON BRANCH NEAR OAK RIDGE, TN	1.48	03537500	1955-1964 start at 1956	3226
MELTON BRANCH NR MELTON HILL NR OAK RIDGE, TN	0.52	03537100	1985-1995	3844

Table 2. Summary of linear regression for the log flow duration intervals versus log drainage areas in the Lower Clinch Watershed for each Percentile

	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	99	100
r^2	1.00	0.99	0.99	0.98	0.98	0.97	0.96	0.96	0.95	0.93	0.91	0.89	0.87	0.85	0.81	0.81	0.79	0.76	0.73	0.71	0.66	0.60
y(0)	1.25	0.78	0.57	0.44	0.34	0.24	0.16	0.08	0.01	-0.07	-0.16	-0.23	-0.29	-0.36	-0.47	-0.52	-0.39	-0.44	-0.53	-0.68	-0.88	-0.79
m	1.02	1.01	1.01	1.01	1.02	1.02	1.03	1.04	1.05	1.05	1.06	1.05	1.05	1.05	1.09	1.06	0.86	0.83	0.82	0.85	0.85	0.68

Table 3. Summary of Percentile flow (cfs) for 9 Stock Creek sites calculated using the linear regression values obtained for each Percentile (Table 2) and the drainage area.

Site	area	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	99	100
SC-2	14.15	262	88.3	53.6	40	32.2	26	22	19	16.3	13.7	11.6	9.66	8.24	7.1	6.1	5.08	3.92	3.27	2.64	1.97	1.23	0.98
SC-3	8.68	159	53.9	32.8	25	19.6	16	13	11	9.76	8.22	6.91	5.77	4.93	4.25	3.58	3.03	2.58	2.18	1.76	1.3	0.82	0.70
SC-4	7.4	135	45.9	27.9	21	16.7	14	11	9.6	8.26	6.95	5.84	4.88	4.17	3.59	3.01	2.55	2.25	1.91	1.55	1.13	0.71	0.63
SC-5	4.58	83	28.3	17.2	13	10.2	8.3	6.9	5.8	5	4.19	3.51	2.94	2.52	2.17	1.79	1.53	1.49	1.28	1.04	0.76	0.48	0.45
SC-6	4.13	75	25.5	15.5	12	9.22	7.5	6.2	5.2	4.48	3.76	3.15	2.64	2.26	1.95	1.6	1.38	1.36	1.18	0.96	0.69	0.44	0.42
SC-7	1.62	29	9.89	6.05	4.5	3.56	2.9	2.4	2	1.68	1.41	1.17	0.98	0.85	0.73	0.58	0.51	0.61	0.54	0.44	0.31	0.2	0.22
GH-1	0.44	7.7	2.65	1.63	1.2	0.95	0.8	0.6	0.5	0.43	0.36	0.29	0.25	0.22	0.18	0.14	0.13	0.2	0.18	0.15	0.1	0.07	0.09
HB-1	0.47	8.2	2.83	1.74	1.3	1.01	0.8	0.7	0.5	0.46	0.38	0.31	0.27	0.23	0.2	0.15	0.14	0.21	0.19	0.16	0.11	0.07	0.10
NS-1	2.42	44	14.8	9.06	6.8	5.35	4.3	3.6	3	2.56	2.14	1.78	1.5	1.29	1.11	0.89	0.78	0.86	0.76	0.62	0.44	0.28	0.29

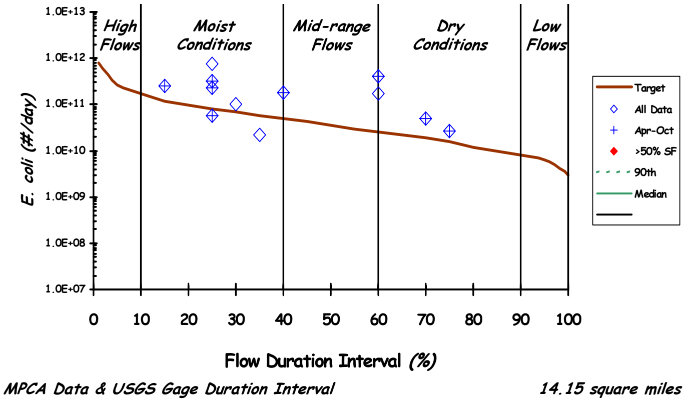
Table 4. Flow measurements (cfs) by date at 6 sites in the Stock Creek Watershed

Site	4/30/2004	6/4/2003	7/9/2003	8/13/2003	8/26/2004	9/16/2004	10/9/2003	10/30/2003	11/20/2003	12/11/2004	1/27/2004	2/19/2004
SC-2	24.4	15.02	36.23	43.79	8.24	16.37	6.26	5.23	28.25	8.24	23.17	18.4
SC-3	13.05	11.6	23	34.11	5.67	11.68	3.93	3.48	19.21	5.67	11.25	10.89
SC-4	14.32	7.1	27.4	8.64	4.24	9.75	2.99	2.175	13.42	4.24	11.16	8.83
SC-5	12.29	5.57	32.9	5.71	3.06	6.9	2.17	1.59	8.79	3.06	7.55	10.18
SC-6	6.29	3.8	9.8	5.37	2.56	3.92	1.93	1.59	6.5	2.56	5.93	4.83
SC-7	4.16	2.1	11.23	2.08	0.86	2.35	0.754	0.727	2.79	0.87	3.25	2.59

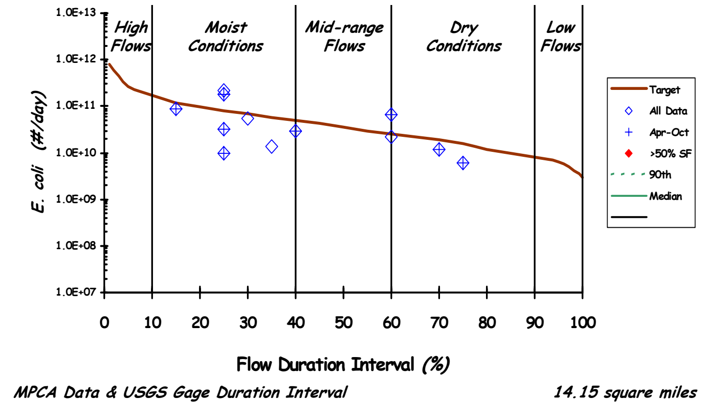
Table 5. Estimation of flow percentile based on presumptive flow duration curves calculated for each site.

			Site					
Sample Date	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	Mean	Range
4/30/2003	25	30	25	15	30	15	23	Moist
6/4/2003	40	50	50	59	45	35	47	Mid Range
7/9/2004	25	15	10	5	20	5	13	Moist
8/13/2003	15	10	40	35	35	35	28	Moist
8/26/2004	60	55	60	55	55	60	58	Mid Range
9/16/2004	25	35	35	30	45	30	33	Moist
10/9/2003	70	70	70	65	65	65	68	Dry
10/30/2003	75	70	80	75	70	65	73	Dry
11/20/2003	25	20	30	25	30	25	26	Moist
12/11/2003	60	55	60	55	55	60	58	Mid Range
1/27/2004	30	35	30	30	30	20	29	Moist
2/19/2004	35	35	20	20	40	30	30	Moist

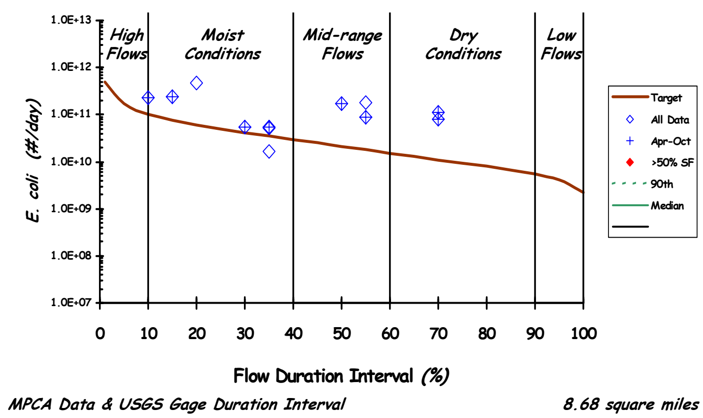
SC-2 *E. coli* load, flows based on predicted Load Duration Curve



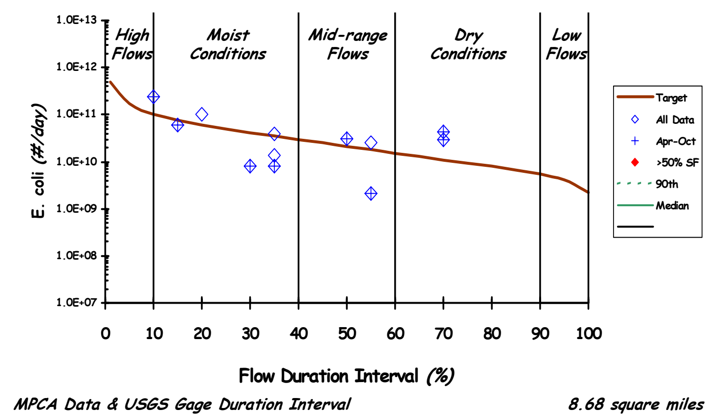
SC-2 *E. coli* load attributable to cattle using measured flows and predicted flow duration curves



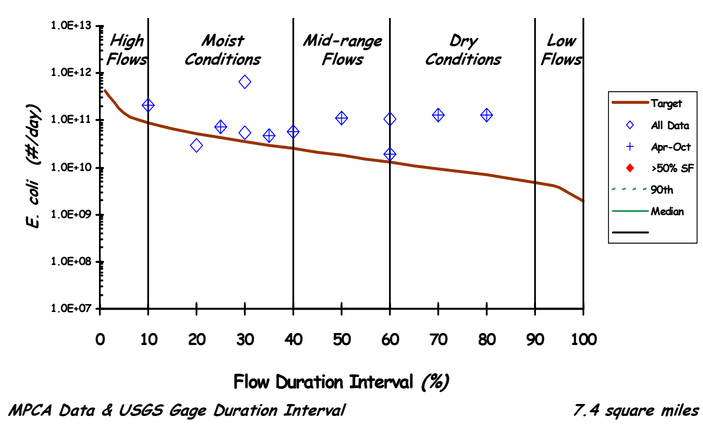
SC-3 *E. coli* load, flows based on predicted Load Duration Curve



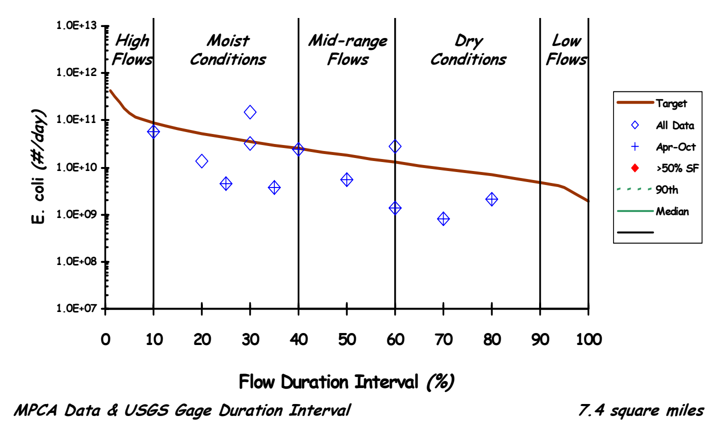
SC-3 *E. coli* loads attributable to cattle using measured flows and predicted flow duration curves



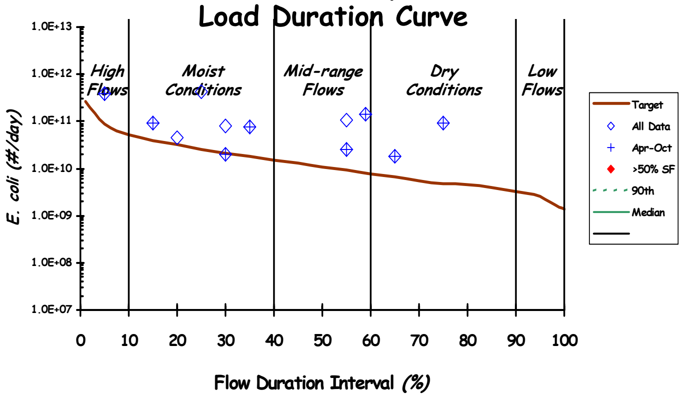
SC-4 *E. coli* load, flows based on predicted Load Duration Curve



SC-4 *E. coli* loads attributable to cattle using measured flows and predicted flow duration curves

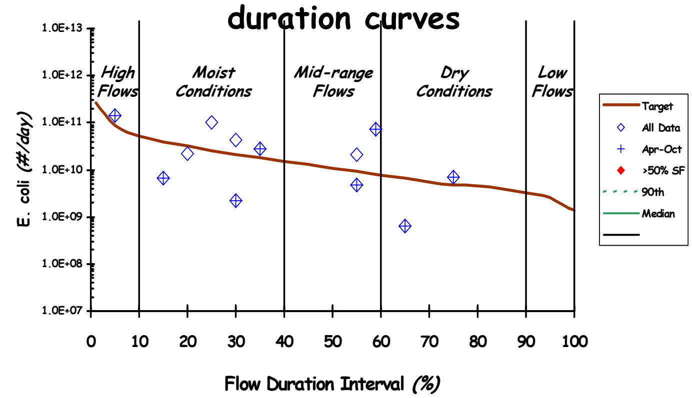


SC-5 *E. coli* load, flows based on predicted Load Duration Curve



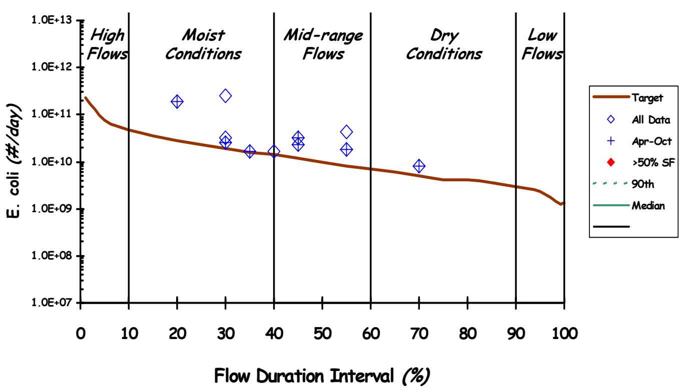
MPCA Data & USGS Gage Duration Interval *4.58 square miles*

SC-5 *E. coli* loads attributable to cattle using measured flows and predicted flow duration curves



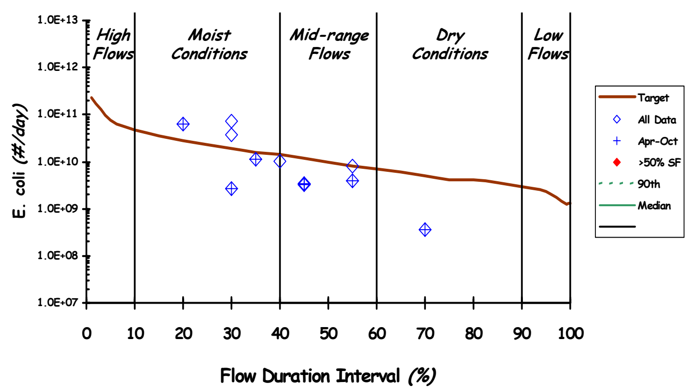
MPCA Data & USGS Gage Duration Interval *4.58 square miles*

SC-6 *E. coli* load, flows based on predicted Load Duration Curve



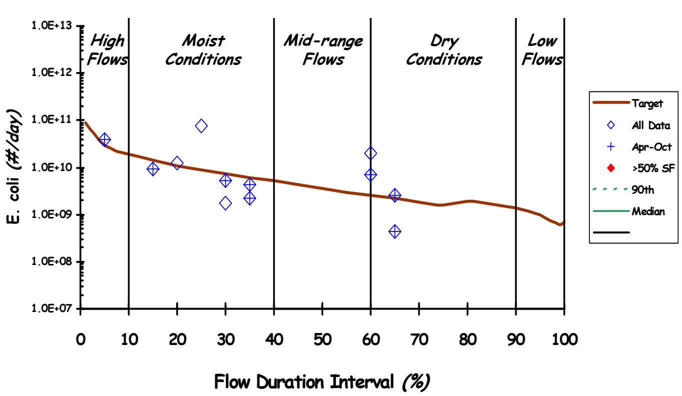
MPCA Data & USGS Gage Duration Interval *4.13 square miles*

SC-6 *E. coli* loads attributable to cattle using measured flows and predicted flow duration curves



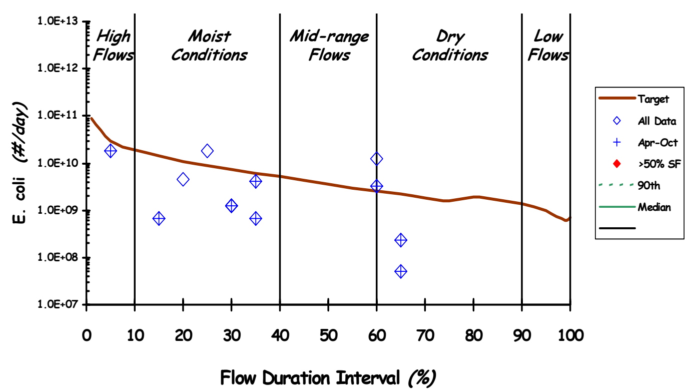
MPCA Data & USGS Gage Duration Interval *4.13 square miles*

SC-7 *E. coli* load, flows based on predicted Load Duration Curve



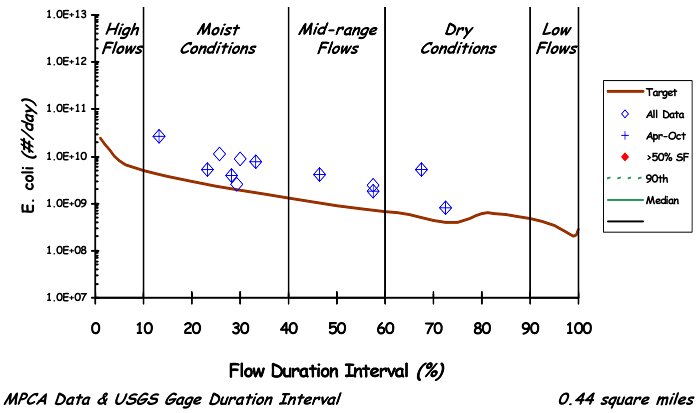
MPCA Data & USGS Gage Duration Interval *1.62 square miles*

SC-7 *E. coli* loads attributable to cattle using measured flows and predicted flow duration curves

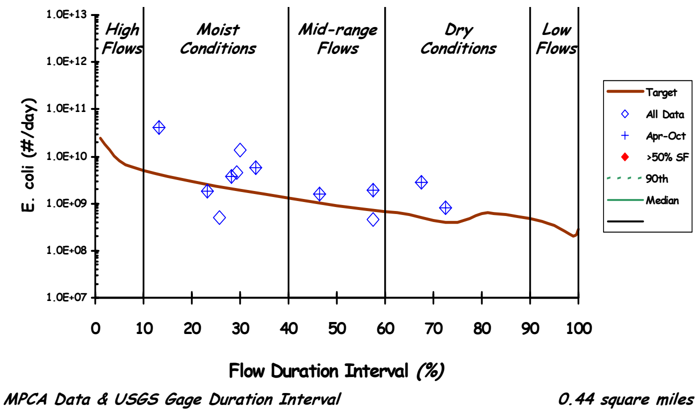


MPCA Data & USGS Gage Duration Interval *1.62 square miles*

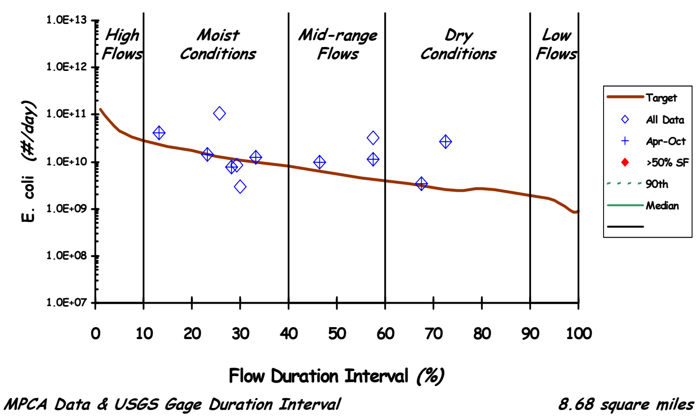
GH-1 *E. coli* load, flows based on predicted Load Duration Curve



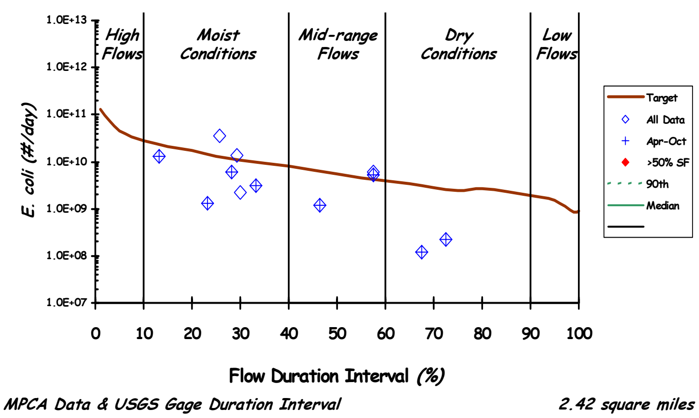
GH-1 *E. coli* loads attributable to cattle using measured flows and predicted flow duration curves



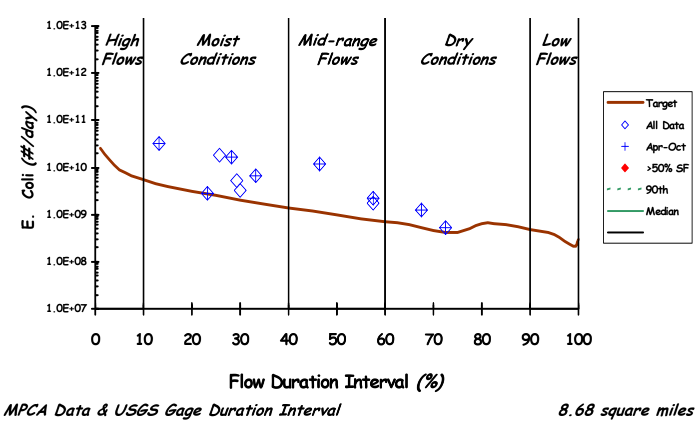
NS-1, *E. coli* load, flows based on predicted Load Duration Curve



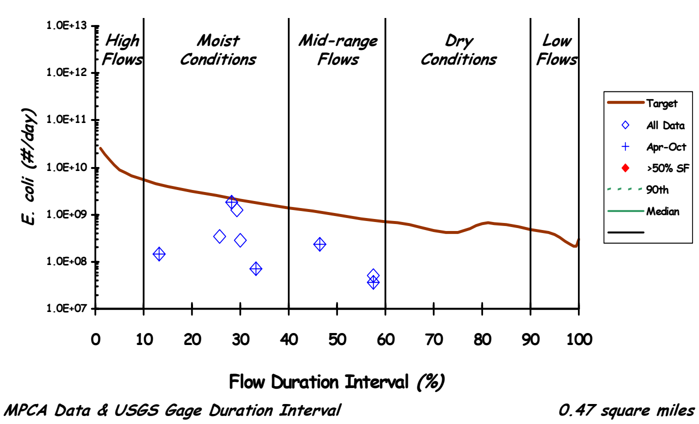
NS-1 *E. coli* loads attributable to cattle using measured flows and predicted flow duration curves



HB-1 *E. coli* load, flows based on predicted Load Duration Curve



HB-1 *E. coli* loads attributable to cattle using predicted flows and predicted flow duration curves



APPENDIX G

Watershed Projects in the Little River Subwatershed

604(b) PROJECT PROPOSAL: JULY 25, 2003; AMENDED AUGUST 14, 2003

NAME OF PROJECT

Little River Participatory Watershed Planning Process

LEAD ORGANIZATIONS

Blount County
The Community Partnership Center of the University of Tennessee, Knoxville

COOPERATING ORGANIZATIONS

The Tennessee Valley Authority will contribute technical assistance to the project. The TVA will also contribute $20,000 in non-federal matching funds to the project.

The Department of Urban and Regional Planning at the University of Tennessee will contribute a graduate assistant to the project.

The Little River Watershed Association will contribute technical assistance to the project.

PROJECT ABSTRACT

The Community Partnership Center (CPC) of the University of Tennessee, Knoxville is a leader in the development and implementation of participatory planning processes for community and economic development. The CPC will adapt these same tools and methods to address environmental and water quality issues and, in the process, create a model for stakeholder-driven watershed planning.

This focus of this effort will be the Little River Watershed, in Blount County, Tennessee. Flowing out of the Great Smokey Mountains National Park, the Little River is under increasing environmental pressure due to increasing development and unsustainable agricultural practices.

This project will result in the development of informed citizen workgroups that will address the protection and preservation of the Little River Watershed. These groups will form the foundation of a participatory planning process, which will subsequently develop recommendations for enhancing and preserving the Little River and its resources. The project will also create published research on the role and potential of public participation in the environmental planning process. In addition, the project will also lead to increased citizen awareness of water resources and increased capacity among residents to address environmental issues.

PROJECT OBJECTIVE

This project will test the effectiveness of participatory methods and tools in watershed planning, will lead to the development of new methods and tools, and will become a model for stakeholder-driven environmental planning for the nation. The project will also build capacity for future watershed restoration and protection efforts.

BACKGROUND INFORMATION

The University of Tennessee Community Partnership Center (CPC), a research and community outreach unit of the Department of Urban and Regional Planning, will be responsible for financial and program management of this project. The mission of the Community Partnership Center is to link university resources with urban and rural grassroots community groups to understand and address the core problems facing communities in Tennessee. We strive to create mutually respectful research and action partnerships that embody and promote equitable and democratic principles. We are committed to strengthening the capacity of both community and university partners to build healthy, flourishing communities.

Since 1994, the CPC has worked toward meeting this mission through local, regional, and national programs in several ways:

- By facilitating research, service-learning, and volunteer opportunities for University of Tennessee faculty and students,
- By developing and implementing participatory approaches and methods for research and planning for sustainable economic and community development,
- By working with at-risk youth and other groups to increase their capacity for positive personal and collective change,
- By conducting applied research, and program and service evaluations, and
- By providing technical assistance and contract services.

In the 1990s, the CPC gained national recognition for innovation in evaluation approaches and methods through the National Learning Initiative, a participatory evaluation for USDA of ten rural Empowerment Zone and Enterprise Communities across the United States. In 1998, CPC received funding from the Ford Foundation to refine and implement these approaches and to develop additional capacity for these approaches and methods to be used by community-based organizations, funding agencies, researchers, and local government. In recognition of its efforts, the CPC received a HUD Best Practices Award in 2000.

The CPC has implemented participatory evaluation and participatory planning projects in variety of contexts and settings. Recently, for example, the center developed and conducted an evaluation of a community environmental health grants program that has funded ten community coalitions across the United States to assess hazards in low-income housing and develop community-based remediation and enforcement strategies.

Since 2001 the CPC, as part of the Consortium of Appalachian Centers and Institutes convened by the Appalachian Regional Commission, initiated a combined teaching and research project based in Cocke County, Tennessee, an ARC designated distressed county. The resulting class, undertaken by the CPC and the University's Department of Urban and Regional Planning, helped residents of Cocke County establish values and visions for future sustainable economic and community development. Today, the CPC continues to work in Cocke County as students engage residents and conduct research to attract environmentally-friendly industries to the community.

Most recently, the CPC was named by the ARC as a technical assistance service provider for distressed Appalachian communities. As part of this program, the CPC is using a participatory planning approach to assist communities in three ARC-designated distressed counties in the preparation of action and funding plans to address local areas of concern, including environmental and land use issues.

KEY PERSONNEL

Tim Ezzell, Acting Director
Dr. Ezzell serves as acting director of the Community Partnership Center at the University of Tennessee. He is a graduate of Auburn University and the University of Tennessee and holds an M.A. and a Ph.D. in History as well as an M.S.P in Urban and Regional planning. In addition to his duties at the CPC, Dr. Ezzell also teaches courses in historic preservation planning and participatory methods for sustainable development in the University's Department of Urban and Regional Planning and serves as the University's liaison to the Consortium of Appalachian Centers of Learning. His research interests include participatory planning methods, sustainable development, historic preservation, new urbanism, and planning history.

Prior to joining the CPC, Dr. Ezzell taught in the History Department at the University of Tennessee and performed policy research for the University's Energy, Environment, and Resources Center. He has also worked for *Nine Counties. One Vision*, a nonprofit regional visioning and planning project in East Tennessee. He is the author of numerous reports and papers and has presented research before both professional and academic audiences.

Eric Ogle, Program Coordinator
Eric Ogle holds a Bachelor of Science in Business Administration in Marketing, Logistics, and Transportation, and a Master of Science in Environmental Planning from the University of Tennessee. Mr. Ogle has worked in the Marketing Communications department of the Tennessee Valley Authority in Knoxville and formerly served as Director of Tourism for Cocke County, Tennessee. He has also worked on a comprehensive plan for the town of Cumberland Gap, Tennessee and a sector plan for North Knoxville. He has performed cluster analyses and associated research for Chattanooga Area Regional Council of Governments (CARCOG) that helped determine future strategic direction of a 14-county region. Recently, he also developed programs and agendas, hosted visitors, and taught international participants for two of the University of Tennessee's International Sustainable Development Training programs. His research interests include the development of sustainable eco-tourism, economic development, and the diffusion of mobile information technology into rural and distressed communities.

INTRODUCTION

CPC's approach to planning is rooted in a deep-seated commitment to sustainable development through broad-based community participation. Our approach attempts to answer the challenges of the sustainability movement, to find ways to effectively manage growth, and to plan for the future in ways that will not compromise the quality for life of future generations. It assumes that decisions about growth management and future development are highly complex and embedded in the dynamics of social, economic, political, and environmental systems. It also assumes that within communities there are complexities of values, perceptions, and the relative power of the various stakeholder groups affected by these decisions, and uncertainties and urgency surrounding growth issues.

In order to make choices about how to use their limited resources, communities need choice processes based on an understanding of the important linkages and trade-offs that exist among their community's quality of life, their social, economic and environmental assets, along with the potential for various stakeholders to benefit differently from the choices made. Our approach includes processes, data gathering, and decision tools that can be used by communities to sustainably plan for their future. It takes into consideration stakeholder and other contextual differences, the collaborative development of information, and the collaborative development of appropriate decision tools and processes. In essence, it is focused on process and specific decision products. We believe that this approach will greatly enhance the potential for sustainable community-based growth management, conservation, and development choices in the target communities.[1]

The Planning Team process used by the CPC is derived from research on adult learning and our experience in the field of community participation. In this process, participants representing all segments of the community go through nine phases of research, evaluation, and decision-making. These phases, presented as informal questions, lead team members through a complete, circular, and ongoing research process that can continue to address community issues long after the initial question has been resolved. The questions, or phases of the process are:

1. How will we work together? What are our goals?
2. What do we need to learn and why?
3. How do we find out about what we need to learn?
4. Who will do what and when?
5. What are we learning and what does it mean?
6. How do we make changes with what we have learned?
7. What differences have we made?

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[1]For more information on the evolution of participatory planning methods, see John Gaventa, et. al., *The Evaluation and Learning Initiative of the National Empowerment Zone and Enterprise Community Program: Review and Recommendations for Phase II Support. Vol. II., Literature Review* (Knoxville: CPC/UT Department of Sociology, 1995), 97-106.

8. How do we celebrate our victories?
9. What next?

In the past, the CPC has used this approach to address a wide variety of community and neighborhood concerns, including sustainable development and the preservation of local environmental resources. Recently we also began looking for opportunities to apply and adapt these methods to address other issues, including water quality, air quality, and the preservation of cultural and historic resources. As part of this effort, we are currently working with the Tennessee Valley Authority and local watershed partnerships to develop a model of participatory watershed planning. The CPC's experience working in the Little River Watershed will provide the data necessary to create an effective, transferable model for meaningful citizen participation in the environmental planning process.

PROJECT IMPLEMENTATION

Phase I:
Building Citizen Workgroups

The project will begin with an overview of the Little River Watershed and the identification of its stakeholders. The CPC will conduct a qualitative evaluation of the watershed, its population, and related land uses. Based on these findings, CPC will divide the watershed into five Watershed Planning Zones (WPZ). Each of these zones will then become home to a Watershed Planning Group (WPG). These groups, composed of local stakeholders, will become the heart of the participatory watershed plan. In addition, CPC will also form a watershed plan Steering Committee which will consist of representatives from each of the WPGs.

Ideally, each of these WPGs will contain a broad representation of local stakeholders. To insure this, CPC will also conduct a preliminary stakeholder analysis of each zone. All stakeholders and residents will be invited to participate in the planning process. CPC, however, recognizes the importance of broad based participation in the planning process. Working with community leaders, business leaders, and elected officials CPC will identify key stakeholders representing various interests and groups within each zone. These individuals will then be personally invited to participate with other members of the community in their WPG.

It is important to note that this stakeholder analysis will continue for the life of the project. CPC will work to maintain this diverse representation to insure that all parties are "at the table."

The CPC will conduct an awareness building campaign that will coincide with these preliminary assessments. This campaign will be designed to heighten awareness of watershed and water quality issues. It will also promote the upcoming participatory process and will encourage community involvement through informative literature and an interactive website.

Throughout this initial phase of the project, CPC will work closely with the Little River Watershed Association (LRWA). LRWA staff and member will assist CPC in identifying stakeholders, creating educational media, and organizing events. In addition, CPC will consult with the LRWA to avoid the unnecessary duplication of materials and services related to the project.

At the close of the initial phase, CPC will conduct the first round of planning workshops. Introductory workshops will be held in each of the WPZ's. These initial sessions will have the following goals:

- Explain the participatory process
- Begin building familiarity among participants
- Explain goals of the planning process
- Begin educating participants about the watershed
- Begin building Watershed Planning Groups

Phase II:
Building Knowledge of the Watershed

The second phase of the project will concentrate on building awareness of the watershed, its problems, and its potential. To accomplish this, CPC will utilize a combination of traditional and innovative educational and research tools. WPG members will take part in a number of programs and exercises, including the following:

Watershed Forums

The CPC will conduct a series of watershed forums designed to highlight issues facing the Little River. Local and regional water quality experts, such as representatives from UT, TVA, TDEC, LRWA, and the Alcoa corporation, will give interactive talks with WPGs throughout the watershed. The talks will also be videotaped and made available to all participants and WPGs. Watershed forums, which will be digitally recorded, will also be made available to the general public on the project's website.

Participatory Research

Working with these local water quality experts, CPC will develop a series of participatory research projects. Residents and stakeholders, including local youth, will conduct basic research into local water quality and issues confronting the Little River. Research tools will include the use of stakeholder water quality testing exercises and participant use of IPSI, the Integrated Pollutant Source Identification database. Results of these research projects will be shared with the media and all project participants. These results, and the research methodology, will also be published on the project website.

Watershed Snapshot

One of the most effective participatory tools developed by CPC is the community snapshot exercise, an activity which utilizes photography to help identify and address local issues. CPC will adapt this tool for use in addressing environmental concerns. Participants will be given single use cameras and instructed to record opportunities and obstacles to watershed preservation.[2] Results of this exercise will be digitized and shared in subsequent workshops. Participants will also analyze results and share findings with other WPGs.

Watershed Mapping

Participants will take part in a watershed mapping exercise. Similar to community mapping, this activity will have participants draw maps of the watershed as they see it. These maps will then be compared with actual maps, revealing participant perception of the watershed and will point out gaps in their knowledge of the area. During this exercise, participants will also begin to identify "hot spots" or "flash points" which would indicate areas of critical concern throughout the watershed.

Watershed Tours

In further increase awareness of the watershed, CPC will also conduct a series of watershed tours for WPG members. These tours will be designed to help familiarize group members with portions of the watershed outside of their immediate community and help build awareness of impacts both upriver and downstream. Activities will include walking tours, and may also include guided auto or canoe trips as well.

Mentoring Trip

CPC will take representatives from each WPG on a day trip to a mentor watershed. Participants will visit a watershed in the region that has successfully addressed similar issues. There, they will meet with community and watershed leaders and learn how and if their methods could successfully applied to the Little River.

SUBSEQUENT ACTIVITIES

The activities undertaken as part of this project will establish a foundation for a planning process, to be undertaken the flowing year. As part of this process, to be funded separately, participants will utilize the knowledge and data collected during Phase I and Phase II to develop a detailed report and plan which would include specific recommendations for improving and protecting the Little River Watershed.

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[2] Virtually all elements of these cameras are recycled and reused.

During this second year of the program, participants will also develop implementation and evaluation plans. CPC will also compile data on the project and its successful implementation. At the close of the project, the CPC will develop and issue a report on the planning process and the applicability of participatory methods to watershed and environmental issues. Among the specific criteria for evaluation will be:

- Number of workshop participants
- Inclusiveness of process
- Number of recommendations implemented
- Environmental benefits
- Level of project visibility

Results of this study will be shared with TDA, TDEC, LRWA, TVA, and the EPA. Findings will also be published in appropriate professional and academic journals and delivered at national and regional conferences.

TIMETABLE

First Quarter

Promote project
Hold "kick-off" event and launch project web site
Hold initial workshops and form Watershed Planning Groups
Conduct stakeholder analysis
Submit first quarterly update

Second Quarter

Begin watershed forums
Initiate particpatory research projects
Continue stakeholder analysis
Submit second quarterly update

Third Quarter

Continue watershed forums
Continue participatory research projects
Conduct watershed mapping exercises
Conduct watershed tours
Submit third quarterly update

Fourth Quarter

Continue participatory research projects
Complete watershed tours
Conduct mentoring trip
Complete plans for next phase of project
Evaluate project and issue findings
Submit final project report

Third Quarterly Report
July-September, 2004
Little River Watershed Project
604(b) Grant
University of Tennessee Community Partnership Center

During the third quarter of the project, the Community Partnership Center (CPC) concluded the educational phase of the Little River process and continued with preparations for the planning phase of the project. The major tasks accomplished this quarter are as follows:

Awareness Building

CPC continued to promote the Little River, Big Future planning process, generating more than a half-dozen articles in the Maryville *Daily Times* and Knoxville *News-Sentinel.* CPC staff also conducted phone interviews with a local radio station. CPC staff also created and distributed mailings, such as the postcard below, to promote the project and announce project events.

Little River, Big Future

The Little River is one of East Tennessee's most important natural resources and is the source of Blount County's drinking water.

Because of all various types of resources found in the region, the Little River Watershed is one of the fastest developing areas in the State of Tennessee.

It is important that we work together now to insure mportant local resources are protected for future generations.

Take part in these free programs to learn about the multiple impacts on water quality and how you can help develop a plan to better manage the natural resources of the Little River Watershed.

Program sponsors include Tennessee Valley Authority, the Tennessee Department of Environment and Conservation, the Little River Water Quality Forum, and the Little River Watershed Association. Program facilitation provided by the University of Tennessee Community Partnership Center.

--- August Program Calendar ---

Growth, Development, and Water Quality
Tuesday, August 3, 2004
Begins at 6:30pm - 8:00pm
Blount County Library*

Discover the environmental impacts of increased development from local government officials as they tell about the work they do to insure resource quality.

Little River Watershed Field Trip
Tuesday, August 17, 2004
Repeating tours, 3:00pm - 7:00pm
Maryville Water Filtration Plant
3635 Sevierville Road

Join us at the City of Maryville's Open House as we tour the facility and understand the water treatment process.

It may be called the Little River, but it has a Big Future!

For more information call 974-4542 or click **www.littleriverbigfuture.org**

*Except for providing meeting space, the Blount County Public Library is not in any manner connected with this meeting, and neither the Library or the Board of Trustees endorses any position expressed by the group.

Watershed Forums

During the second quarter, CPC continued the series of watershed forums with two additional educational events. In July, the CPC hosted a public seminar on Urban Best Management Practices, featuring speakers from the stormwater management departments of the City of Maryville, the City of Alcoa, and Blount County.

Photos from the August Forum

In September, CPC held the final forum, an event titled "Watershed Success Stories." This forum featured three presenters. Suzi Wilkins Berl, a consultant for conservation organizations, spoke about her experiences with the Farmington River Watershed Association in Connecticut. Callie Dobson, Executive Director of the Hiwassee River Watershed Coalition spoke about her organization and projects. Muiread Craft discussed efforts to restore Southwest Virginia's Guest River, as spotlighted by EPA as a watershed success story.

Forums were generally well attended and were effective at not only educating the public, but also stimulating discussion of local water quality issues. Residents expressed particular concern over sediment and other development issues, reflecting the rapid residential growth in the area.

Field Exercise

In August, CPC joined with the City of Maryville to conduct an open house of the community's newly renovated water treatment facility. CPC staff occupied a table with the Little River Watershed Association, distributed *Little River, Big Future* posters and fact sheets, and answered questions from residents. Visitors were also able to take a tour of the water treatment plant, and learn - firsthand - the impact the Little River has on their supply of drinking water.

  

Photos from the Field Exercise

Additional Activities

CPC staff continued to meet with local stakeholders to coordinate future project activities. Additional funding from the ALCOA foundation was delayed, but future receipt of the funds was confirmed. Project partners agreed to conduct the planning phase of the process in 2005, after the holiday season. Local partners also expressed concern about possible confusion among residents between this process and the existing Blount County planning process being conducted ny Hunter Interests.

Fourth Quarterly Report
October - December, 2004
Little River Watershed Project
604(b) Grant
University of Tennessee Community Partnership Center

Summary

During the fourth quarter of the project, the Community Partnership Center (CPC) concluded the educational phase of the Little River process and continued with preparations for the planning phase of the project. The major tasks accomplished this quarter are as follows:

- CPC staff evaluated results from the watershed forums and field exercises and reviewed comments from workshop participants.
- CPC staff began preparations for the planning phase of the watershed process.
- CPC secured funding to promote and conduct the planning phase.

Workshop Results

The workshops and field exercises conducted in the Spring and Summer of 2004 established a knowledge base for the upcoming planning phase of the project. Participants benefitted from these events in the following ways:

- Participants gained a better understanding of watersheds and watershed dynamics.
- Participants gained a better understanding of watershed issues, including urban runoff, impervious surfaces, agricultural pollution, and rain events.
- Participants acquired a basic knowledge of best management practices for development, agriculture, and residential living.
- Participants gained a better understanding of the natural and cultural resources of the Little River Watershed.
- Participants learned about the relationship between the water quality in the river and the water they drink and use in their daily lives.
- Participants learned about successful water quality programs in peer communities and saw the potential for such programs in their communities.

Other Activities

In December CPC received a $12,500 grant from the ALCOA Foundation to conduct the planning phase of the little river process. After meeting with project partners, CPC agreed to conduct a series of four planning workshops to be conducted in watershed communities in Spring, 2005.

Next Steps

In preparation for the planning phase, CPC is conducting the following activities:

- CPC is developing a methodology for the planning workshops
- CPC is working with project partners to promote these workshops
- CPC is evaluating dates and sites for these workshops

Proposal to the Tennessee Department of Environment and Conservation
Nonpoint Source Program
FY 2005

NAME OF PROJECT
Pistol Creek TMDL Project

LEAD ORGANIZATION
Blount County Extension
219 Court Street
Maryville, TN 37804
865-982-6430

CONTACT PERSON
Melissa Nance-Richwine
Little River Watershed Assn.
1004 E. Lamar Alexander Parkway
Maryville, TN 37804
865-980-2130

COOPERATING ORGANIZATIONS
Little River Watershed Association (LRWA)
Little River Water Quality Forum
TDEC, Water Pollution Control
Tennessee Valley Authority
City of Alcoa
City of Maryville

Estimated Start Date
July 1st 2005

Estimated End Date
July 1st 2006

Progress Reports
Prepared every quarter and sent to division

PROJECT ABSTRACT
The Blount County Extension (BCE) is the lead organization for a project located in the lower portion of the Little River watershed in Blount County, Tennessee. The objective of this project is to collect water samples that can be used to produce a TMDL for Pistol Creek, which is impacted, by siltation and Escherichia Coli. BCE will contract Little River Watershed Association to do the work on this project.

The Little River is a river of special economic, biological, and scenic value that has shown signs of degradation caused by growth and human activity in the Blount County area; currently the Little River is classified as threatened on the 305(b) list. The designated uses of Pistol Creek have been identified as impaired primarily by siltation from contaminated sediment, land development, and hazardous waste.

The project outputs will include an organized volunteer/stakeholder team that will collect water samples and identify pollution sources and make recommendations for solutions to be summarized in a final report. Expected outcomes are data to develop a TMDL, an informed public with an organizational basis for positive sustained actions focused on removal of Pistol Creek from the impaired list. Another outcome is a transferable model of community-based watershed stewardship.

PROJECT OBJECTIVE

This project will seek to organize a community-based volunteer effort focused on collecting water samples, identify pollution sources and make recommendations for solutions. Efforts to improve water quality frequently fail due to lack of sufficient orientation, preparation and support of stakeholder involvement. This project will be a community-based stakeholder involved effort.

PROJECT LOCATION

The project will be located in Blount County, Tennessee. Pistol Creek is a tributary watershed of the Little River (HUC # 06010201-030). Pistol Creek is listed as impaired on the 2002 TDEC 303(d) report under segment number TN06010201026-0400. This sub-watershed is located in Maryville and Alcoa, TN.

PROJECT LEADER EXPERIENCE

The project leader is Melissa Nance-Richwine. Nance-Richwine is the Executive Director of the LRWA. This individual will oversee the project and assure coordination of the project with board members, cooperating agencies, stakeholders, and volunteers.

Nance-Richwine has a B.A. in Environmental Sociology from the University of Tennessee and has over 6 years experience working with environmental organizations. She has designed and implemented many successful projects and programs, raised funds, and managed several complex projects funded by private foundations, donors and government agencies. Working with volunteers she has just completed collecting samples on Short Creek to be used for a TMDL.

INTRODUCTION

The Little River originates in the Clingman's Dome area of the Great Smoky Mountain National Park and travels through the cities of Townsend, Maryville, Alcoa, and Rockford, and then flows into the Tennessee River. The Little River watershed covers an area of 380 square miles including most of Blount County as well as portions of Sevier and Knox counties. This waterway serves as a source of drinking water for 85,000 residents; provides resources for farmers; businesses and industry in the area, supports recreational activities for both residents and the 1,600,000 tourists who visit this area annually; and is home to several federally endangered species.

Some signs of degradation in the river caused by development, poor agricultural practices, failing septic systems and other conditions in the watershed have been observed in recent years. Twenty Two stream segments within the watershed are included on the State of Tennessee 2004 303(d) water quality list of impaired streams. The importance of the Little River watershed is such that analysis and elimination of potential problems is essential for the maintenance of the economic, biological, and scenic value of the area. The river is a vital life support and the entire community benefits if the Little River remains healthy. Local residents have the greatest direct impact on the river especially downstream. The people of the area are the primary source of problems as well as solutions for the Little River's future. Thus a community-based effort will ensure the success of any water quality improvement project on the Little River.

The Blount County Extension (BCE) will work with, LRWA a grassroots non-profit organization, that was formed through citizen and business input at community meetings held throughout the past several years. The mission of LRWA is to protect, preserve, and enhance the Little River and its tributaries through mobilizing public support, building public awareness and promoting best management practices. The key objectives of the Association are to promote educational activities that benefit the river and the watershed, focus on efforts to protect the river, distribute current information to the community, and assist citizens in taking positive action.

Pistol Creek is a tributary of the Little River. TDEC monitoring of Pistol Creek --benthic surveys, bacteriological data and chemical grab samples--has shown that siltation and pathogens are the major cause of impairment. 7.66 miles of the stream are listed for not supporting its designated usage. The source of this contamination is attributed to discharges from MS4 area.

PROJECT IMPLEMENTATION

This project is designed to collect samples for use in a TMDL, assist a sub-watershed community of the Little River in gaining a local watershed perspective, and build a base from which to initiate community water quality improvements impacting a 303(d) stream. Lack of public awareness and basic knowledge of watersheds and the absence of an established organizational infrastructure for sustained community-based planning combine to constrain water quality improvement efforts. This project is designed to demonstrate how such formidable obstacles can be overcome.

The project will use a community-based model to focus on the accomplishment of our goals within a small manageable watershed. Key features of this model are community ownership, grass-roots involvement, focused volunteer management, and balanced representation. The approach (a) allows local people to participate in the development of a TMDL (b) develop and implementation of proactive watershed management assessment, (c) attempts to bring all the affected interests, both private and pubic, together to establish common objectives and resolve issues as a team, and (d) establishes a process open to everyone who has an interest in watershed issues.

A base of volunteers from the community would act to shape and implement project activities serving the goals of this proposal. The central feature of the project would be a volunteer support and development system. This system would include management of a volunteer development process structured to prepare, recruit, select, assign work and role responsibilities to, recognize and evaluate volunteers. The support system would be managed to seek facts, share information, build knowledge and awareness, encourage participation and bring positive results in light of project aims.

The first step of the project would be to complete final preparations such as brief agency cooperators, complete list of volunteer task descriptions, training modules, and test participation models. A process for recruiting interested volunteers from within the Pistol Creek watershed as well as the larger Little River watershed community would include advertisements, flyers, canvassing of community-based organizational membership and word-of-mouth. Interested volunteers would attend project orientation sessions. Each individual signing on to volunteer their services and skills would be required to participate in a comprehensive training session where they would learn about project objectives and procedures, water quality basics, and Pistol Creek watershed. They would be given work assignments, which would clarify their responsibilities, the nature of their specialized training, and team membership. Two teams would be composed of individuals who would either measure flow or take grab samples. Overall results of the volunteer effort would be compiled into a final project report. Volunteer effort and results would be given positive recognition at regular intervals during the project and at the end of the project. TDEC will work with the Blount County Extension (BCE) and LRWA to assure quality control of the sampling and coordinate with the analyses that will be done.

SITE LOCATIONS & PARAMETERS

#1 N 35.75923 W 83.95798
#2 N 35.73803 W 83.97804
#3 N 35.773500 W 84.00408
#4 N 35.75299 W 84.00636
#5 N 35.76935 W 83.98254

#6 N 35.79257 W 83.97089
#7 N 35.78605 W 83.95652
#8 N 35.81527 W 83.94209

Pathogens – Fecal Coliform
Enterococcus
E. Coli

Nutrients - NH3
No2/No3
Total Phosphorus
TRN

Siltation - TSS (suspended residue)
Residue, settleable
Residue, dissolved
Turbidity

PH, Flow, Conductivity, Dissolved oxygen, Temperature

MILESTONES

- Within one month of the contract start date; Volunteer job descriptions and role responsibilities will be addressed
- Within two months of the contract start date; training modules and materials will be prepared, purchased and ready for implementation.
- Within two months of the contract start date; a coordinating meeting with cooperating organizations will be held.
- Within three months of the contract start date; two required comprehensive volunteer training sessions would be held.
- Within four months of the contract start date; sampling will begin (total sample times is 12)
- Within six months of the contract start date; a meeting with cooperating organizations will be held.
- Within eight months of the contract start date; a benthic Survey will be conducted.
- Within one year of the contract start date; sampling will be completed.
- Within one year of the contract start date; a volunteer recognition and program review event will be held.
- Within one year of the contract start date: a final report and the raw data will be given to the Division.

MEASURES OF SUCCESS

- Increased knowledge of basic water issues measured through pre-project and post-project evaluations.
- Development of a volunteer base representing diverse segments of the watershed community including those not currently associated with LRWA.
- Identification of pollution/contamination sources.
- Data to be used in the development of a TMDL

WORK PLAN

Task 1 - (getting started) recruit volunteers through public meetings and from Short Creek Team, Meet with Jonathon Burr to select sampling locations, gather training materials, schedule training dates, hold training workshops

Task 2 - (Sampling) work with volunteers to collect samples 12 times during the one year time frame

Task 3 – (wrapping it up) gather data into report and submit to division, hold volunteer appreciation event

umption: start date is 1, 2005													
							'06						
Month:	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY
k One: getting started													
k Two: sampling													
k Three: wrap it up													

APPENDIX H

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR PATHOGENS IN THE LITTLE RIVER SUBWATERSHED FORT LOUDOUN LAKE WATERSHED (HUC 06010201), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Load (TMDL) for pathogens in the Fort Loudoun watershed, located in eastern Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

Little River and its tributaries are listed on Tennessee's final 2002 303(d) list as not supporting designated use classifications due, in part, to discharge of pathogens from pasture land and discharges from MS4 areas. The TMDL utilizes Tennessee's general water quality criteria, continuous flow data from a USGS discharge monitoring station located in proximity to the watershed, site specific water quality monitoring data, a calibrated hydrologic model, load duration curves, and an appropriate Margin of Safety (MOS) to establish allowable loadings of pathogens which will result in the reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions of up to 96% for the Little River subwatershed and its tributaries.

The proposed Fort Loudoun Lake pathogen TMDL may be downloaded from the Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, P.E., Watershed Management Section
Telephone: 615-532-0707

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656

Persons wishing to comment on the proposed TMDLs are invited to submit their comments in writing no later than May 23, 2005 to:

Division of Water Pollution Control
Watershed Management Section
7th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6th Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.

APPENDIX I

Public Notice Comments Received

CITY OF ALCOA

DEPARTMENT OF PUBLIC WORKS & ENGINEERING
Sanitation Service | Street Service | Water Quality Service
Water & Sewer Service | Landfill Service | Engineering Service
"Quality Services for a Quality Community"

1050 SPRINGBROOK ROAD, ALCOA, TENNESSEE 37701 (865) 380-4800 FAX: (865) 380-4803

May 20, 2005

Ms. Sherry Wang, PhD, Manager
Watershed Management Section
Division of Water Pollution Control
Tennessee Department of Environment & Conservation
L&C Annex, 7th Floor
401 Church Street
Nashville, TN 37243-1534

Re: Draft Proposed TMDL for Pathogens
Little River Subwatershed of the Ft. Loudoun Lake Watershed (HUC 06020201)

Dear Ms. Wang:

Thank you for forwarding the Proposed Total Maximum Daily Load (TMDL) for Pathogens in the Little River Subwatershed. After reviewing the document I offer the following comments:

(1) Designated Uses, page xi
The draft proposes the tributaries to Little River be classified for fish & aquatic life, irrigation, livestock watering & wildlife, and recreation. I agree with each of these designations except recreation. As a lifelong resident of Blount County, the listed streams have never been community sources for recreation – especially body contact recreation. Using this as a designation and its accompanying limits for pathogens is impractical and unrealistic.

(2) Summary of TMDLs, WLAs, & LAs for Impaired Waterbodies (page xiii)
The percent reductions assigned to MS4s in this table seem unreasonably high, especially when it is noted on page 3 of the draft that only 4.1% of the Little River watershed is urban. How were these numbers derived? Did anyone calculate the percentage of urbanized watershed for each tributary's drainage area?

(3) Proposed Final 2004 303(d) List for Pathogen Impaired Waterbodies (page 10)
In this table and elsewhere in the report, Pistol Creek and Laurel Bank Branch are noted. However, nowhere in the draft did I find any reference to Culton Creek. This omission is odd since Laurel Bank Branch empties into Culton Creek, which then feeds Pistol Creek.

(4) Table 5. Summary of Water Quality Monitoring Data (page 23)
Some of the worst streams are outside the urban areas. This could be seen as in indicator that the MS4s aren't the greatest contributors to the streams' problems. See comment (2)

Ms. Sherry Wang
Page 2
May 20, 2005

(5) Section 9.1.2, NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s), 1st paragraph (page 36)

The 2nd sentence states that MS4s "will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards." Please define "maximum extent practicable." I am concerned with varying interpretations of "practicable" by regulators, field offices, etc.

(6) Section 9.1.2, NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s), 2nd paragraph (page 36)

This paragraph notes that "pollutants of concern will be controlled" and that "Specific measures and BMPs … must also be identified." What are TDEC's plans to assist MS4s in compliance with this requirement?

(7) Section 9.1.2, NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s), 3rd paragraph (36)

The 1st sentence states "Implementation…will require effluent or instream monitoring…" Up until this draft, our conversations with TDEC regulators have indicated there were no plans to require stream sampling and monitoring by MS4s and that such steps would be voluntary. While we have long-range plans to consider stream monitoring, the requirement of the same may be an unnecessary burden on many smaller MS4s.

I appreciate your consideration of these comments. Please call me if you'd like to discuss.

Sincerely,

Kenny Wiggins, PE
Engineering & Public Works Director

KDW/ls

cc: Mr. John West, TDEC-WPC Knoxville
Mr. Andrew Sonner, Assistant Director / Chief Engineer

APPENDIX J

Response to Public Comments

Note: responses correspond to numbered comments (see Appendix I).

1. According to *State of Tennessee Water Quality Standards, Chapter 1200-4-4 Use Classification for Surface Waters, January 2004*, the designated use classifications for Stock Creek and Pistol Creek are fish & aquatic life, recreation, irrigation, and livestock watering & wildlife. The remaining waterbodies covered under this TMDL are covered by the statement: "all other surface water named and unnamed in the Upper Tennessee River Basin, with the exception of wet weather conveyance, which have not been specifically noted shall be classified for fish & aquatic life, recreation, irrigation, and livestock watering & wildlife".

2. The percent reduction assigned to MS4s is the same percentage assigned to all WLAs and LAs for impaired waterbodies. The reduction is unrelated to the percentage of urban land area in the watershed. While urban areas represent approximately 4.1% of the total drainage area of the Little River watershed, the percentage of urban area varies from 0.0% in the Gun Hollow Branch subwatershed to 24.9% in the Pistol Creek subwatershed (see Appendix A).

3. Although Laurel Bank Branch empties into Culton Creek, which then feeds Pistol Creek, Culton Creek is not included in the Proposed Final 2004 303(d) List. Only impaired waterbodies on the 303(d) List were analyzed in this TMDL. However, the TMDL developed for the Pistol Creek subwatershed applies to the entire HUC-12, including Culton Creek.

4. See #2 above.

5. The language in question is quoted from the NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems. According to section 7 of the permit, "maximum extent practicable" is defined as "the technology-based discharge standard for Municipal Separate Storm Sewer Systems to reduce pollutants in storm water discharges that was established by CWA §402(p). A discussion of MEP as it applies to small MS4s is found at 40CFS §122.34."

6. The Watershed Approach is a decision making process that reflects a common strategy for information collection and analysis as well as a common understanding of the roles, priorities, and responsibilities of all stakeholders within a watershed. It relies on participation at the federal, state, local and nongovernmental levels to be successful. The Watershed Approach is based on the concept that many water quality problems, like the accumulation of pollutants or nonpoint source pollution, are best addressed at the watershed level. In addition, a watershed focus helps identify the most cost-effective pollution control strategies to meet clean water goals.

   Within the Little River watershed, a project funded by TDEC was recently completed by a group of organizations, including the University of Tennessee Community Partnership Center, the Tennessee Valley Authority, the University of Tennessee Dept. of Urban and Regional Planning, and the Little River Watershed Association. The objective of the project was to test the effectiveness of participatory methods and tools in watershed planning, to develop new methods and tools, and to become a model for stakeholder-driven environmental planning for the nation. The project was also intended to build capacity for future watershed restoration and protection efforts.

Another project is currently being funded by TDEC. The Blount County Extension is the lead organization for a project located in Pistol Creek, a tributary of the Little River. The objective of the project is to organize a community-based volunteer effort focused on collecting water samples, identifying pollution sources, and making recommendations for solutions.

Additional resources are available at the following websites:

http://www.franklin-gov.com/engineering/STORMWATER/ms4.htm

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm

http://www.mtas.utk.edu/bmptoolkit.htm.

7. The city of Alcoa, Tennessee, has been issued coverage under the General Permit for Small Municipal Separate Storm Sewer Systems, permit number TNS075132. The following are excerpts from the general permit:

3. SPECIAL CONDITIONS

3.1 Discharges to Water Quality Impaired Waters

3.1.1 Applicability: You must:

3.1.1.1 ***Determine whether storm water discharge from any part of the MS4 significantly contributes directly or indirectly to a 303(d) listed (i.e., impaired) waterbody.*** Water quality impaired waters means any segment of surface waters that has been identified by the division as failing to support classified uses**.** ***If you have discharges meeting these criteria, you must comply with Part 3.1.1.2 and 3.1.2*****;** if you do not, the remainder of this Part 3.1 does not apply to you.

3.1.1.2 ***If you have "303(d)" discharges described above, you must also determine whether a Total Maximum Daily Load (TMDL) has been developed by the division and approved by EPA for the listed waterbody.*** If there is a TMDL, you must comply with both Parts 3.1.2 and3.1.3; if no TMDL has been approved, ***Part 3.1.3 does not apply until a TMDL has been approved***.

3.1.2 Water Quality Controls for Discharges to Impaired Waterbodies. The storm water management program review submitted to the division must include a section describing how your program will control the discharge of the pollutants of concern.. This section must identify the measures and BMPs that will collectively control the discharge of the pollutants of concern. The measures should be presented in order of priority with respect to controlling the pollutants of concern.

3.1.3 ***Consistency with Total Maximum Daily Load (TMDL). If a TMDL has been approved for any waterbody into which you discharge, you must follow the procedure below and report on these activities in annual reports to the division:***

3.1.3.1 Determine whether the approved TMDL is for a pollutant likely to be found in storm water discharges from your MS4.

3.1.3.2 ***Determine whether the TMDL includes a pollutant wasteload allocation (WLA), implementation recommendations, or other performance requirements specifically for storm water discharges from your MS4.***

3.1.3.3 Determine whether the TMDL addresses a flow regime likely to occur during periods of storm water discharge.

3.1.3.4 ***After the determinations above have been made and if it is found that your MS4 must implement specific provisions of the TMDL, evaluate whether the implementation of existing storm water control measures is meeting the TMDL provisions, or if additional control measures are necessary.***

3.1.3.5 Document all control measures currently being implemented or planned to be implemented. Include a schedule of implementation for all planned controls. ***Provide your rationale (e.g., calculations, assessments, reports and/or other evidence) that shows that you will comply with the TMDL provisions.*** For control measures that are expected to be implemented and evaluated beyond the term of this permit, you should also include longer schedule of implementation as necessary to describe the control measure.

3.1.3.6 ***Describe a method to evaluate whether the storm water controls are adequate to meet the requirements of the TMDL.***

3.1.3.7 If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions.

Note, in particular, the bolded, italicized portions of the above excerpts. Section 3.1.3.2 specifically addresses TMDL implementation recommendations and Section 3.1.3.6 requires a method to evaluate whether storm water controls are adequate to meet the requirements of the TMDL. The fundamental requirement of the TMDL is improvement of water quality such that Little River supports its designated use classifications. Effluent or in-stream monitoring is the only method for documenting improvement in water quality and attainment of water quality standards.