TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Fecal Coliform

In

Oostanaula Creek
Hiwassee River Watershed (HUC 06020002)
McMinn & Monroe Counties, Tennessee

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LIST OF ABBREVIATIONS

AUB	Athens Utility Board
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - FORTRAN
HUC	Hydrologic Unit Code
IPSI	Integrated Pollution Source Inventory
LA	Load Allocation
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPSM	Nonpoint Source Model
NRCS	Natural Resources Conservation Service
Rf3	Reach File 3
SETRCDC	Southeast Tennessee Resource Conservation and Development Council
SWMP	Storm Water Management Program
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TMDL	Total Maximum Daily Load
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWA	Unified Watershed Assessment
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WWTP	Wastewater Treatment Plant
WY	Water Year (October-September)

SUMMARY SHEET
Total Maximum Daily Load (TMDL)
Oostanaula Creek, Hiwassee River

1. Waterbody Information

State: Tennessee
Counties: McMinn, Monroe

Major River Basin: Lower Tennessee River Basin
Watershed: Hiwassee River (HUC 06020002)

Waterbody Name: Oostanaula Creek
Waterbody ID: TN06020002083
Location: Oostanaula Creek from mouth to origin
Impacted Stream Length: 111.8 miles
Watershed Area: 70.3 square miles
Tributary to: Hiwassee River

Constituent(s) of Concern: Fecal Coliform Bacteria

Designated Uses: Fish & Aquatic Life, Recreation, Irrigation, and Livestock Watering & Wildlife

Applicable Water Quality Standard for Recreation (most stringent standard):

> The concentration of the fecal coliform group shall not exceed 200 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. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml.

2. TMDL Development

Analysis/Modeling: The Non-Point Source Model (NPSM) was used to develop this TMDL. An hourly timestep was used to simulate hydrologic and water quality conditions with results expressed as daily averages.

Critical Conditions: A simulation period of 10 years was used to assess the water quality standards for this TMDL representing a range of hydrologic and meteorological conditions.

Seasonal Variation: A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period includes seasonal variations.

3. Watershed/Stream Reach Allocation

Wasteload Allocation (WLA): 6.428×10^{11} counts/30 days

> Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200/100 ml.

Load Allocation (LA): 9.880×10^{12} counts/30 days

Margin of Safety (MOS): 20 counts/100 ml; conservative modeling assumptions

Total Maximum Daily Load (TMDL): 1.052×10^{13} counts/30 days, 180 counts/100 ml

FECAL COLIFORM TOTAL MAXIMUM DAILY LOAD (TMDL)
HIWASSEE RIVER WATERSHED (HUC 06020002)

Oostanaula Creek (TN06020002083)

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 water bodies that are not meeting designated uses. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

2.0 WATERSHED DESCRIPTION

The Hiwassee River watershed (HUC 06020002) is located in eastern Tennessee, northern Georgia, and southwest North Carolina (Figure 1). The Tennessee portion of the watershed falls primarily within the Level III Ridge and Valley (67) ecoregion. The Oostanaula Creek watershed lies in the Level IV Southern Limestone/Dolomite Valleys and Low Rolling Hills (67f) and Southern Dissected Ridges and Knobs (67i) ecoregions. Ecoregion 67f is heterogeneous, composed predominately of limestone and dolomite, but including other rock formations and strata with varying characteristics. The ridges of 67i are primarily those with abundant shale that have prominent topographic expressions.

Oostanaula Creek is a tributary of the Hiwassee River and has a drainage area of approximately 70.3 square miles (Figure 2). Oostanaula Creek flows south to southwest and enters the Hiwassee River at mile 19.8. 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. Land use is summarized in Table 1 and shown in Figure 3. Predominate land use in the Oostanaula Creek watershed is forest (64.6%) followed by agriculture (31.1%). Urban areas represent less than 5% of the total drainage area, but are considered a potential source of impairment.

3.0 PROBLEM DEFINITION

EPA Region IV approved Tennessee's final 1998 303(d) list (TDEC, 1998) on September 17, 1998. The list identified Oostanaula Creek as not fully supporting designated use classifications due, in part, to pathogens. The fecal coliform group is an indicator of the presence of pathogens in a stream. Therefore, the objective of this study is to develop a fecal coliform TMDL for Oostanaula Creek in the Hiwassee River watershed.

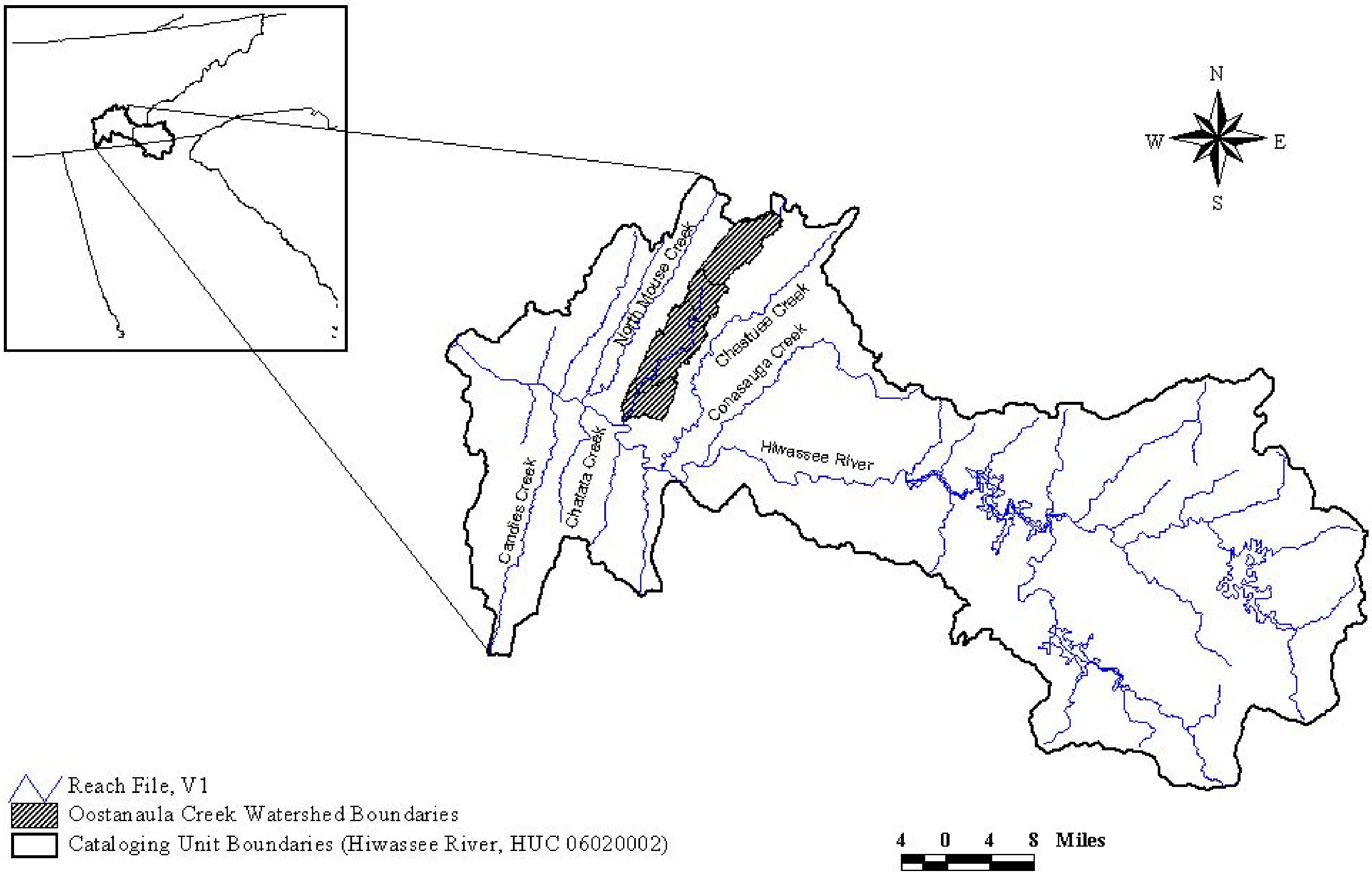

Figure 1. Location of the Hiwassee River and Oostanaula Creek Watersheds.

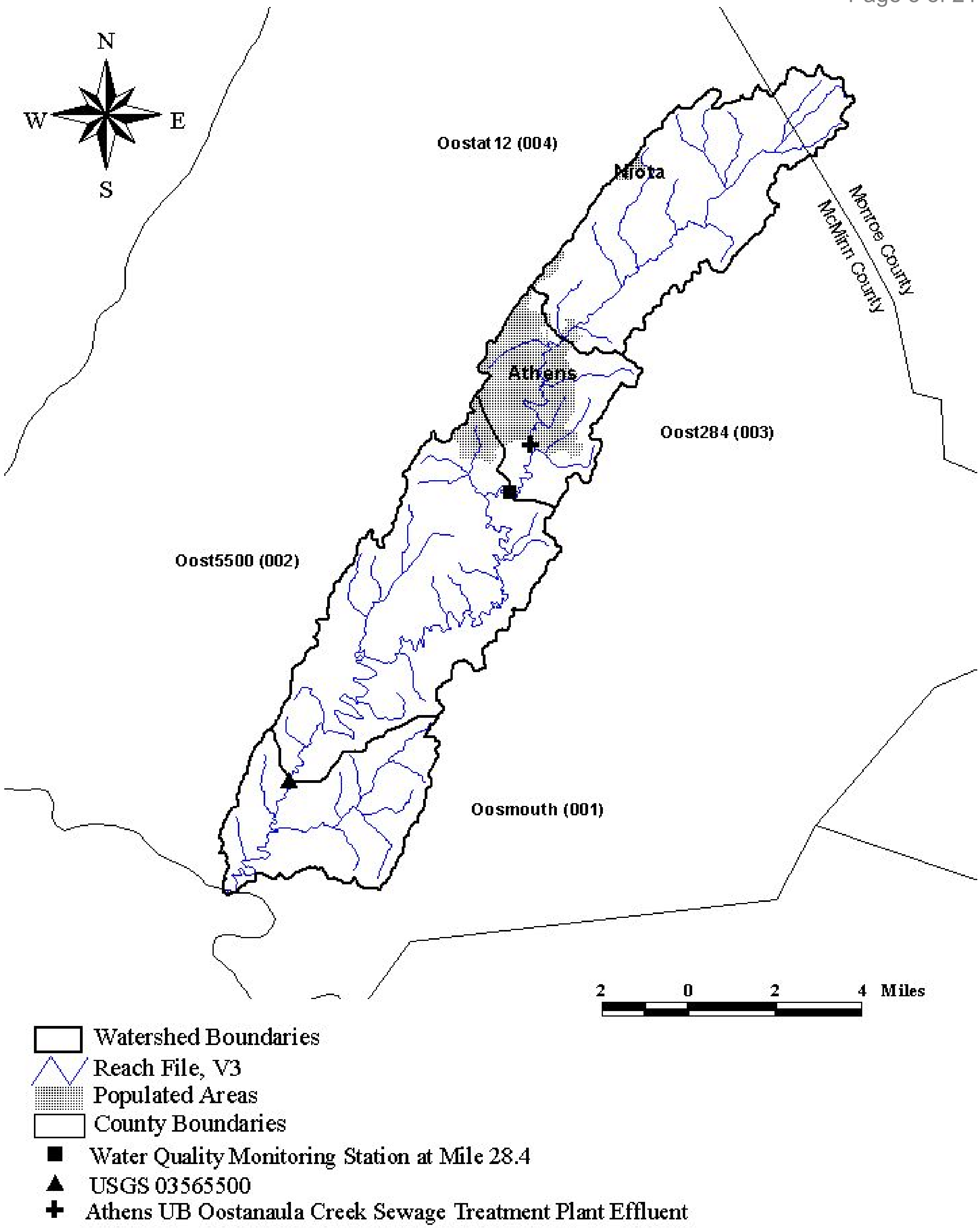

Figure 2. Watershed Boundaries.

Table 1. MRLC Land Use Distribution by Subwatershed

	Oosmouth (001)		Oost5500 (002)		Oost284 (003)		Oostat12 (004)		Watershed Total	
Land Use	Area (ac)	%	Area (ac)	%	Area (ac)	%	Area (ac)	%	Area (ac)	%
Deciduous	2871	35.6	5270	31.3	882	13.6	2090	15.3	11113	24.7
Evergreen Forest	2115	26.2	2329	13.8	1388	21.5	1883	13.8	7715	17.2
High Intensity Comm./Industrial/ Transportation	0	0.0	55	0.3	349	5.4	30	0.2	434	1.0
High Intensity Residential	0	0.0	8	0.0*	166	2.6	0	0.0	174	0.4
Low Intensity Residential	12	0.1	194	1.2	766	11.8	26	0.2	998	2.2
Mixed Forest	1793	22.2	3785	22.5	1565	24.2	2590	19.0	9733	21.6
Open Water	0	0.0	8	0.0*	4	0.1	20	0.2	32	0.1
Other Grasses (Urb./recreation; e.g. parks, lawns)	0	0.0	109	0.6	354	5.5	7	0.1	470	1.0
Pasture/Hay	868	10.8	4148	24.7	769	11.9	5340	39.2	11125	24.7
Quarries/Strip Mines/Gravel	6	0.1	0	0.0	0	0.0	0	0.0	6	0.0*
Row Crops	311	3.9	825	4.9	221	3.4	1516	11.1	2873	6.4
Transitional	91	1.1	96	0.6	0	0.0	113	0.8	300	0.7
Total (mi^2)	8067 (12.6)	100	16826 (26.3)	100	6464 (10.1)	100	13617 (21.3)	100	44973 (70.3)	100

* < 0.05%

4.0 TARGET IDENTIFICATION

The designated use classifications for all surface waters in the Oostanaula Creek watershed include Fish & Aquatic Life, Recreation, Irrigation, and Livestock Watering & Wildlife. Use classifications for partial segments of Oostanaula Creek also include Domestic Water Supply and Industrial Water Supply. Of the use classifications with numeric criteria for fecal coliform bacteria, the recreation use classification is the most stringent and will be used as the target level for TMDL development. The fecal 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, October, 1999*. Section 1200-4-3-.03 (4) (f) states that the concentration of the fecal coliform group shall not exceed 200 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. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml. The geometric mean standard is the target value for the TMDL.

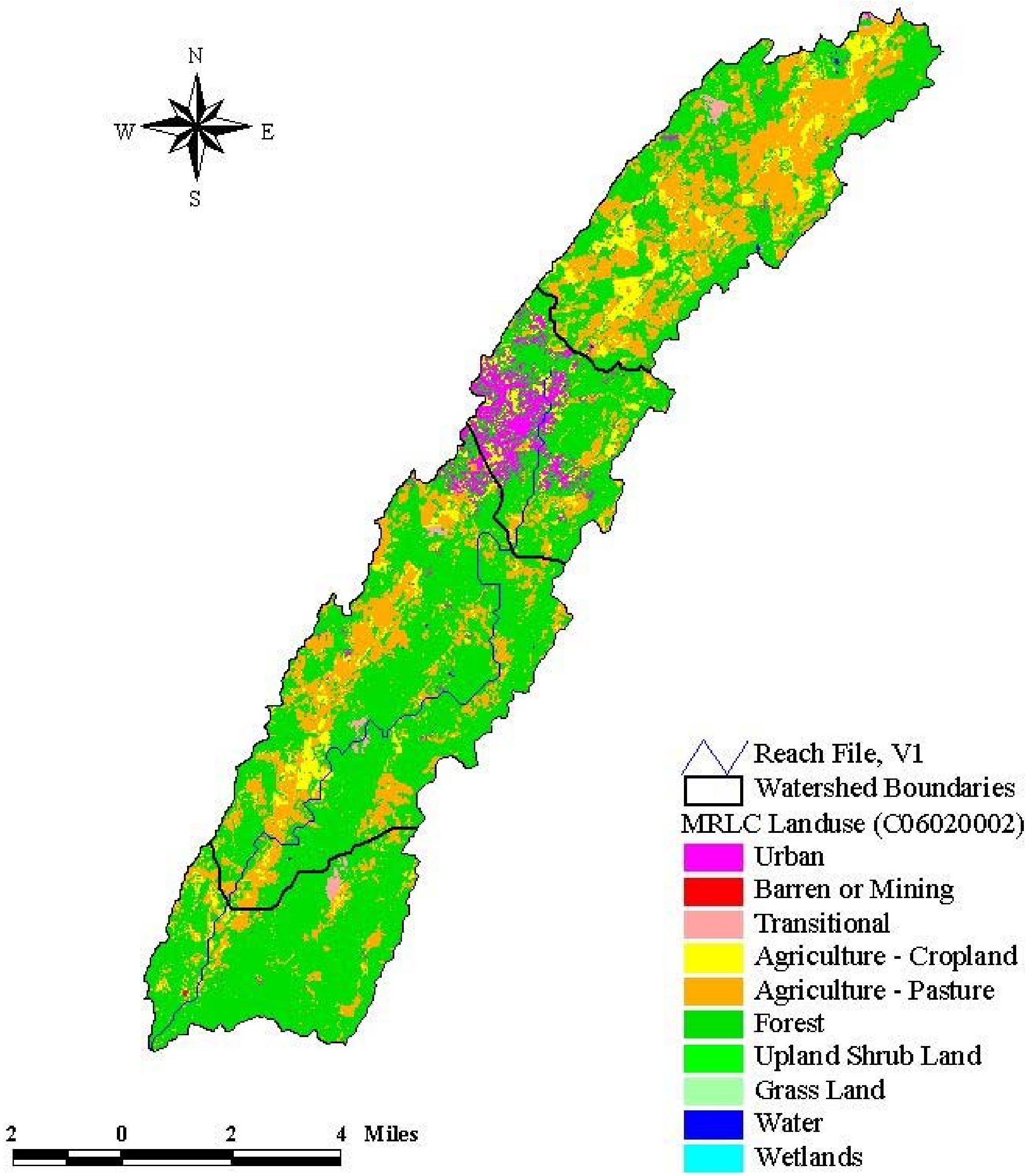

Figure 3. Land Use Distribution.

The geometric mean standard of 200 counts/100 ml has been selected as the primary target value for the TMDL because it is representative of average stream conditions. In the TMDL, simulated concentrations are expressed in terms of a 10-year plot of the 30-day geometric mean. Critical conditions are determined from this ten-year period (see Section 8.1). A 10-year plot with the proposed reductions is used to show compliance with the geometric mean criteria and to illustrate the criteria has been met for all seasons. An explicit margin of safety (MOS) of 20 counts/100 ml has been included to address uncertainties in the analysis, resulting in an effective target geometric mean concentration of 180 counts/100 ml.

The instantaneous criteria are difficult to model and insufficient data are available to calibrate the water quality model for the instantaneous maximum. By meeting the geometric mean criteria, compliance with the instantaneous criteria is expected to be met during most flow regimes.

5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

Fecal coliform water quality data have been collected quarterly at Oostanaula Creek mile 28.4 since December 1982. Due to the extensive coverage of this data set and lack of comprehensive data sets at the mouth and/or other downstream locations on Oostanaula Creek, data collected at this location (mile 28.4) were used to calibrate the TMDL model:

Data were not collected at sufficient frequency to calculate 30-day geometric mean values; however, individual samples exceeded the 1000 counts/100 ml maximum (see Table 2). At the water quality sampling location (mile 28.4) utilized for TMDL model calibration, 54% of samples had fecal coliform concentrations exceeding 1000 colonies per 100 ml. Therefore, Oostanaula Creek was scheduled for TMDL evaluation. Due to availability of precipitation data for use in the model, only data collected through December 1999 were used in the water quality calibration.

Table 2. Water Quality Monitoring Data

Watershed/Sampling Location (Mile)	Samples (#)	Samples >200[1] (# / %)	Samples >1000[1] (# / %)	Concentrations (Counts/100 ml)			
				Minimum	Maximum	Mean	Median
Oostanaula Creek (28.4)	70	60 / 86	38 / 54	10	150000	6876	1360

[1] Counts/100 ml

6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of fecal coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source can be defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater, treated sanitary wastewater, stormwater associated with industrial activity, and stormwater from municipal separate storm sewer systems (MS4) that serve over 100,000 people must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. In March

2003, small MS4s serving urbanized areas will be required to obtain permits under the Phase II stormwater regulations. 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 1000 people per square mile. The city of Athens will be covered under Phase II of the NPDES Storm Water Program. NPDES-permitted facilities discharging treated sanitary wastewater are considered primary point sources of fecal coliform bacteria.

Non-point sources of fecal 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 fecal coliform bacteria on land surfaces and wash off as a result of storm events. Typical non-point sources of fecal coliform bacteria include:

- Urban development (including leaking sewer collection lines)
- Leaking septic systems
- Animals having access to streams
- Land application of agricultural manure
- Livestock grazing
- Wildlife

6.1 Point Sources

There is one point source located in the drainage area of Oostanaula Creek that has been issued an NPDES permit for discharge of treated sanitary wastewater. The Athens Utilities Board (AUB) Oostanaula Creek Wastewater Treatment Plant (WWTP) discharges to Oostanaula Creek at mile 30.1.

6.2 Nonpoint Source Assessment

6.2.1 Wildlife

Wildlife deposit fecal coliform bacteria, with their feces, onto land surfaces where it can be transported during storm events to nearby streams. Deer population data were provided by the Tennessee Wildlife Resources Agency (TWRA) for the state of Tennessee. However, no county-specific data were available for east Tennessee nor were statistics available for other animals. Therefore, deer were assumed to populate the Oostanaula Creek watershed according to the upper limit of available population data of 36 per square mile. In addition, in order to account for other forms of wildlife, a deer density of 45 animals/square mile is used. Fecal coliform loading due to deer is estimated by EPA to be 5.0×10^8 counts/animal/day.

6.2.2 Agricultural Animals

Agricultural animals are the source of several types of fecal coliform loading to streams in the Oostanaula Creek watershed:

- As with wildlife, agricultural livestock grazing on pastureland deposit fecal coliform bacteria with their feces onto land surfaces where it can be transported during storm events to nearby streams.

- Processed agricultural manure from confined feeding operations is generally collected in lagoons and applied to land surfaces during the months April through October. Data sources for confined feeding operations are tabulated by county and include the Census of Agriculture (USDA, 1997) and the Natural Resources Conservation Service (NRCS). In addition, the Tennessee Valley Authority (TVA) has conducted an Integrated Pollution Source Inventory (IPSI) (TVA 1999) in Oostanaula Creek. The TVA IPSI provides detailed source information on a watershed scale.

- Agricultural livestock and other unconfined animals (i.e., deer and other wildlife) often have direct access to streams that pass through pastures.

Livestock data for Oostanaula Creek in the Hiwassee River watershed are listed in Table 3. These data were derived from the TVA IPSI. Cattle are the predominate livestock in the watershed. Fecal coliform loading rates for livestock in the watershed are estimated to be: 1.06×10^{11} counts/day/beef cow, 1.04×10^{11} counts/day/dairy cow, 1.24×10^{10} counts/day/hog, 4.18×10^{8} counts/day/horse, and 1.38×10^{8} counts/day/chicken (NCSU, 1994).

Table 3. Livestock Distribution in the Oostanaula Creek Watershed

Livestock	Oosmouth (001)	Oost5500 (002)	Oost284 (003)	Oostat12 (004)	Watershed Total
Poultry	2909	2909	0	0	5818
Beef Cattle	385	1740	100	295	2520
Dairy	100	0	100	1050	1250
Swine	0	0	60	0	60
Horses	10	50	0	25	85

6.2.3 Failing Septic Systems

Some fecal coliform loading in the Oostanaula Creek watershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from county census data of people in the Oostanaula Creek subwatersheds utilizing septic systems are shown in Table 4. In eastern 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.

Table 4. Estimated Population on Septic Systems in the Oostanaula Creek Watershed

Subwatershed	No. of People on Septic Systems
Oosmouth (001)	779
Oost5500 (002)	1604
Oost284 (003)	519
Oostat12 (004)	1265
Oostanaula Creek (Total)	4167

6.2.4 Urban Development

Fecal coliform loading from urban areas is potentially attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Urban runoff and storm water processes are considered to be potential contributors to fecal coliform impairment in the Oostanaula Creek watershed. In addition, leaks and overflows from the sanitary sewer system and bypasses at the WWTP have historically been significant contributors to fecal coliform impairment in Oostanaula Creek downstream from Athens.

7.0 ANALYTICAL APPROACH

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. In this section, the numerical modeling techniques developed to simulate fecal coliform bacteria fate and transport in the watershed are discussed.

7.1 Model Selection

A dynamic computer model was selected for fecal coliform analysis in order to: a) simulate the time-varying nature of fecal coliform bacteria deposition on land surfaces and transport to receiving waters; b) incorporate seasonal effects on the production and fate of fecal coliform bacteria; and c) identify the critical conditions for the TMDL analysis. Several computer-based tools and the TVA IPSI were also utilized to generate input data for the model.

The Nonpoint Source Model (NPSM) is a watershed model capable of simulating nonpoint source runoff and associated pollutant loadings, accounting for point source discharges, and performing flow and water quality routing through stream reaches. NPSM is based on the Hydrologic Simulation Program - Fortran (HSPF). In this TMDL, NPSM was used to simulate point source discharges, simulate the deposition and transport of fecal coliform bacteria from land surfaces, and compute resulting water quality response.

The Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to support water quality model simulations for the Oostanaula Creek watershed. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics. In addition, the TVA IPSI, a GIS-based nonpoint source inventory, provided relatively updated (1999) subwatershed-level livestock data for enhancement of source characterization. Results of the WCS and TVA IPSI characterizations are input to a spreadsheet developed by Tetra Tech, Inc. to estimate NPSM input parameters associated with fecal coliform buildup (loading rates) and washoff from land surfaces. In addition, the spreadsheet can be used to estimate direct sources of fecal coliform loading to water bodies from leaking septic systems and animals having access to streams. Information from the WCS, TVA IPSI, and spreadsheet tools were used as initial input for variables in the NPSM model.

7.2 Model Setup

Four subwatersheds were delineated in order to characterize relative fecal coliform bacteria contributions from each of the contributing drainage areas to the impaired stream (see Figure 2). Boundaries were constructed so that subwatershed "pour points" coincided with the mouth on the Hiwassee River, the USGS stream gaging station, the primary water quality monitoring station, and the drainage area above the city of Athens. Watershed delineation was based on the Reach File 3 (Rf3) stream coverage and Digital Elevation Model (DEM) data. This discretization allows management and load reduction alternatives to be varied by subwatershed.

An important factor influencing model results is the precipitation data contained in the meteorological data file used in the simulation. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Weather data from the Conasauga meteorological station were used for all simulations in the Oostanaula Creek watershed.

7.3 Model Calibration

Calibration of the watershed models included both hydrology and water quality components. Hydrologic calibration was performed first and involved adjustment of the model parameters used to represent the hydrologic cycle until acceptable agreement was achieved between simulated flows and historic streamflow data from a U.S. Geological Survey (USGS) stream gaging station for the same period of time. The USGS stream gaging station located at mile 5.66 on Oostanaula Creek (USGS Station 03565500) was used for flow calibration (see Figure 2). The drainage area contributing to this gage is approximately 57.7 square miles. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge.

The model was also calibrated for water quality. Appropriate model parameters were adjusted to obtain acceptable agreement between simulated in-stream fecal coliform concentrations and observed data collected at the sampling station located at mile 28.4 on Oostanaula Creek. Results show that the model adequately simulates peaks in fecal coliform bacteria in response to storm events and base concentrations during low-flow events.

The details and results of the hydrologic and water quality calibrations are presented in Appendix B.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

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), which 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 (e.g. pounds per day), toxicity, or other appropriate measure.

8.1 Critical Conditions

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 simulated in the water quality model.

The ten-year period from January 1, 1990, to December 31, 1999 was used to simulate a continuous 30-day geometric mean concentration to compare to the target. This 10-year period contained a range of hydrologic conditions that included both low and high streamflows from which critical conditions were identified and used to derive the TMDL values.

The ten-year simulated geometric mean concentrations for existing conditions are presented in Appendix C. From these figures, critical conditions can be determined. The 30-day critical period for each subwatershed is the period preceding the largest simulated violation of the geometric mean standard (USEPA, 1991). Meeting water quality standards during this period ensures that water quality standards can be achieved throughout the ten-year period. For each of the segments evaluated in the Oostanaula Creek watershed, the highest violations of the 30-day geometric mean occurred on October 1, 1993. Therefore, the critical period is September 2 through October 1, 1993.

8.2 Existing Conditions

The existing fecal coliform load for the Oostanaula Creek watershed was determined in the following manner:

- The calibrated model, corresponding to the mouth of Oostanaula Creek, was run for a time period that included the critical condition (9/2/93 – 10/1/93).
- The daily fecal coliform load indirectly going to surface waters from all land uses was added to the direct daily discharge load of modeled point sources and the result summed for the 30 day critical period. This value represents the existing load.

Model results indicate that direct inputs of fecal coliform bacteria from “direct sources” (i.e., leaking sewer collection lines, failing septic systems, illicit discharges of fecal coliform bacteria, and animal access to streams) have a significant impact on bacteria loading in the watershed. Non-point sources related to urban land uses are also shown to have an impact on the fecal coliform bacteria loading in the Oostanaula Creek watershed downstream from the city of Athens. Reductions in these loading rates reduce the in-stream fecal coliform bacteria levels. Non-point source loading rates representing existing conditions in the model are shown in Table 5.

In general, point source loads from NPDES facilities do not significantly contribute to the impairment of Oostanaula Creek since discharges from these facilities are required to be treated to levels corresponding to in-stream water quality criteria. However, the AUB sanitary sewage collection system and Oostanaula Creek WWTP (NPDES permit TN0024201) had documented problems with overflows and bypasses, respectively, during the 10-year evaluation period (1/1/90 – 12/31/99). Since August 1990, AUB has operated under Agreed Order 89-3192 that imposed a moratorium (partially relaxed since) on line extensions, new connections to the collection system, and increased flows from existing dischargers. Though significant progress has been made with respect to the frequency and magnitude of overflow/bypass events, these categories of violations continue to occur (mostly during high-flow periods) and contribute to fecal coliform loading to Oostanaula Creek.

Table 5. Nonpoint Source Loading Rates and In-stream Fecal Coliform Concentrations for Existing Conditions

Subwatershed	Runoff from all Lands	Direct sources	In-Stream Fecal Coliform Concentration
	[Counts/30 days]	[Counts/30 days]	[Counts/100 ml]
At Mile 28.4	4.353×10^{12}	1.025×10^{14}	6496
At Mouth (Total)	5.319×10^{12}	5.158×10^{14}	10,899

8.3 Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In this TMDL, both explicit and implicit MOS were used. The explicit MOS is 20 counts/100 ml below the in-stream target concentration on each watershed. The implicit MOS includes the use of conservative modeling assumptions and a 10-year continuous simulation that incorporates a range of meteorological events. Conservative modeling assumptions used include: septic systems discharging directly into the streams; development of the TMDL using loads based on the design flow and fecal coliform permit limits of NPDES facilities; and all land uses connected directly to streams.

8.4 Determination of TMDLs, WLAs, & LAs

The TMDL is the total amount of pollutant that can be assimilated by a waterbody while maintaining water quality standards. Fecal coliform bacteria TMDLs are expressed as counts per 30-day period since this is how the water quality standard is expressed. The TMDL, therefore, represents the maximum fecal coliform bacteria load that can be assimilated by a stream during the critical 30-day period while maintaining the fecal coliform bacteria water quality standard (including the explicit MOS) of 180 counts/100 ml. As previously stated, the TMDL is calculated using the equation:

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

With MOS = 20 (explicit MOS), the TMDL, $\sum$WLAs, & $\sum$LAs were determined according to the following procedure:

- The calibrated model was run for a time period that included the critical condition (9/2/93 – 10/1/93).
- Fecal coliform land loading variables and the magnitude of loading from sources modeled as “direct sources” were adjusted within reasonable range of known values

until the resulting fecal coliform concentration at the pour point of the subwatershed is less than the water quality standard (minus the explicit MOS) of 180 counts/100ml.

- The ∑WLAs is the load associated with the daily discharge loads of all modeled NPDES permitted facilities summed over the 30-day critical period. The existing NPDES permitted facility (Oostanaula Creek WWTP) was assumed to discharge at design flow and a fecal coliform permit limit of 200 counts/100 ml.

- The ∑LAs is the daily fecal coliform load indirectly going to surface waters from all modeled land use areas as a result of buildup/washoff processes plus the daily discharge load sources modeled as “direct sources” and the result summed over the 30-day critical period. (Note: For loading resulting from buildup/washoff processes, there is no distinction in the model between point source discharges covered by an MS4 permit and non-point source discharges. Therefore, storm water discharges covered, in the future, by the Athens MS4 are included in the calculation for ∑LAs).

- The percent reduction is based on the maximum simulated geometric mean concentration for the 30-day critical period for existing and TMDL conditions. The maximum simulated concentrations for the TMDL scenario were less than or equal to 180 counts/100 ml.

The TMDLs, WLAs, & LAs for the two evaluated subwatersheds, at mile 28.4 and the mouth, are summarized in Table 6.

Table 6. TMDL Components

Subwatershed	∑WLAs	∑LAs	MOS	TMDL
	[Counts/30 days]	[Counts/30 days]		[Counts/30 days]
At Mile 28.4	6.428×10^{11}	3.084×10^{12}	Explicit[1] & Implicit	3.726×10^{12}
At Mouth (Total)	6.428×10^{11}	9.880×10^{12}	Explicit[1] & Implicit	1.052×10^{13}

[1] Explicit MOS = 20 counts/100 ml

8.4.1 Waste Load Allocations

There is one (1) NPDES-permitted facility that discharges treated sanitary wastewater into Oostanaula Creek. Future facility permits will require end-of-pipe limits equivalent to the water quality standard of 200-counts/100 ml. Future facilities discharging at concentrations less than the water quality standard will not cause or contribute fecal coliform impairment in the watershed.

8.4.2 Load Allocations

There are two modes of transport for non-point source fecal coliform bacteria loading in the model. First, loading from leaking sewer system collection lines, failing septic systems, illicit connections, and animals in the stream (etc.), are modeled as direct sources to the stream and are independent of precipitation. The second mode involves loading resulting from fecal coliform accumulation on land surfaces and wash-off during storm events. Fecal coliform applied to land is subject to a die-off rate and an absorption rate before it is transported to the stream.

Model results indicate that non-point sources related to direct inputs and urban runoff have the greatest impact on the fecal coliform bacteria loadings in the Oostanaula Creek watershed. Possible allocation scenarios that would meet in-stream water quality standards for Oostanaula Creek include: 83.4% reduction from runoff and reduction to the maximum extent practicable from "direct sources" of fecal coliform in the stream, resulting in an overall reduction of 98.0%.

Best management practices (BMPs) and control measures that could be used to implement this TMDL include controlling pollution from urban runoff, identification and elimination of illicit discharges and other unknown "direct sources" of fecal coliform to the streams, animal exclusion from streams, riparian buffers, continued repair and rehabilitation of leaking sewer collection lines, repair of failing septic systems, and rehabilitation of the Oostanaula Creek WWTP. Fecal coliform loading rates for the allocation scenarios are shown in Table 7. Additional monitoring and surveys of the watersheds may be conducted to validate and verify the various direct sources of fecal coliform bacteria.

Table 7. TMDL Allocations for the Oostanaula Creek Watershed

Subwatershed	Runoff Load	"Direct Sources"	Point Sources	Overall Reduction (Existing to Allocated Conditions)
	[Counts/30 days]	[Counts/30 days]	[Counts/30 days]	[%]
At Mile 28.4	6.183×10^{11}	2.465×10^{12}	6.428×10^{11}	96.5
At Mouth (Total)	8.852×10^{11}	8.995×10^{12}	6.428×10^{11}	98.0

8.4.3 Seasonal Variation

Seasonal variation was incorporated in the continuous simulation water quality models by using varying monthly loading rates and daily meteorological data over a ten-year period.

9.0 IMPLEMENTATION PLAN

The TMDL analysis was performed using the best data available to specify WLAs and LAs that will meet the water quality criteria for pathogens (fecal coliform) in the Oostanaula Creek watershed in order to support the Recreation use classification. This TMDL suggests the need for a multi-phased comprehensive process to meet the applicable water quality standards. Furthermore, the plan needs to recognize ongoing efforts and assure that current planned water quality improvements are not delayed. The following recommendations and strategies are targeted toward: (1) citizen awareness and education, (2) collection of data to document improvements in water quality resulting from implementation actions while supporting additional modeling and evaluation, and (3) actions to be undertaken within the watershed.

9.1 Awareness and Education

The TMDL model supports existing evidence suggesting there are many sources of fecal coliform bacteria entering Oostanaula Creek along its 111.8 miles, inclusive of tributaries, from the headwaters in Monroe County to the mouth on the Hiwassee River in McMinn County. Before many of these sources can be tackled, the citizens of the watershed must be made aware of the different sources, how those sources are contributing to Oostanaula Creek, and what action alternatives are available to stop these sources of fecal coliform bacteria from reaching the creek and its tributaries. The following actions will be undertaken:

ELEMENTS OF AWARENESS AND EDUCATION PROGRAM		
ACTION ITEM	**PARTICIPANTS**	**MILESTONE**
Obtain copies of available public education materials that address the various sources of fecal coliform bacteria contamination reaching Oostanaula Creek (e.g., operation and maintenance of septic tanks and field lines, urban area stormwater, pet and animal waste, and other appropriate topics);	NRCS (Lead), Athens Utility Board (AUB), City of Athens, McMinn County, Monroe County, TVA, Southeast TN Resource Conservation and Development Council (SETRCDC), TN Department of Agriculture (TDA), TN Department of Environment and Conservation (TDEC)	2002 thru 2003
Develop new public education materials for specific fecal coliform bacteria sources and/or alternative solutions for which existing materials are either inadequate or not available;	SETRCDC (Lead), AUB, City of Athens, NRCS, McMinn County, Monroe County, TDA	2002 thru 2003
Distribute educational materials to targeted audiences via various methods (e.g., mass mailings, exhibits at special events, classrooms, web sites, and "one-on-one" discussions);	AUB (Lead), City of Athens, McMinn County, Monroe County, NRCS, SETRCDC, TDA	2002 thru 2007
Develop presentation modules and establish an "Oostanaula Creek Clean Water Speakers Bureau" and seek opportunities to speak to social, civic and business groups, churches, and schools that exist within the watershed;	McMinn County (Lead), Monroe County, AUB, City of Athens, NRCS	2002 thru 2007
Offer a water quality education program to area schools and incorporate a lesson element on non-point sources of pollution.	AUB (Lead), City of Athens	2002 thru 2007

9.2 Monitoring Program

Documenting progress in reducing the quantity of fecal coliform bacteria entering Oostanaula Creek is an essential element of the TMDL Implementation Plan. Documentation requires that data and information be collected, analyzed, and periodically reported to the residents of the Oostanaula Creek Watershed. The following actions will be taken:

ELEMENTS OF MONITORING PROGRAM		
ACTION ITEM	**PARTICIPANTS**	**MILESTONE**
Establish streamflow gaging stations at three locations on Oostanaula creek;	AUB (Lead), City of Athens, McMinn County, Monroe County, U. S. Geological Survey (USGS), TDA, TDEC	2002 thru 2007
Monitor fecal coliform bacteria at several locations along Oostanaula Creek at regular intervals, including low, normal, and high flow conditions;	AUB (Lead), City of Athens, McMinn County, Monroe County, TDEC	2002 thru 2007
Conduct project-specific monitoring, which would document the improvements in water quality when various Best Management Practices (BMPs) are installed to solve specific source problems.	SETRCDC (Lead), NRCS, McMinn County, Monroe County, City of Athens	Variable Dates

9.3 Actions

The goal of a clean Oostanaula Creek requires that the citizens, local governments, businesses, and organizations work together to reduce and remove the numerous sources of fecal coliform bacteria entering the Creek. The following elements of the TMDL Implementation Plan will help achieve the goal:

ELEMENTS OF ACTION PROGRAM		
ACTION ITEM	**PARTICIPANTS**	**MILESTONE**
Plant trees along Oostanaula Creek on the Mayfield Dairy property providing a natural riparian zone which will serve to filter stormwater before entering the creek;	AUB (Lead), Dean Foods, TVA, City of Athens	2002

ELEMENTS OF ACTION PROGRAM (CONT.)		
ACTION ITEM	**PARTICIPANTS**	**MILESTONE**
Identify and prioritize subwatersheds within the Oostanaula Creek watershed for their potential to contribute large quantities of fecal coliform bacteria to the creek by use of the TVA IPSI database and other methods;	TVA (Lead), NRCS, McMinn County, Monroe County	2002
Focus the Unified Watershed Assessment (UWA) Project, administered by the Southeast Tennessee RC&D Council, on the agricultural sources located within the prioritized subwatersheds of Oostanaula Creek and utilize Agricultural Resource Funds administered by NRCS to install BMPs on farms;	SETRCDC (Lead), NRCS, TDA	2002 thru Life of Grants
Submit a PL 566 Project Proposal for the cost share and installation of agricultural BMPs on farms within the Oostanaula Creek watershed;	NRCS	2002
Continue an aggressive Inflow and Infiltration (I&I) Reduction Program for the Athens wastewater collection system;	AUB	2002 thru 2007
Continue progress with the design and construction of new wastewater treatment facilities at Athens with expanded treatment capacity;	AUB	2002 thru 2007
Submit NPDES Municipal Separate Storm Sewer System (MS4) Permit application to TDEC for coverage of the City of Athens;	City of Athens	March 10, 2003
Develop a Storm Water Management Program (SWMP). The SWMP shall cover the duration of the MS4 permit (5-year renewable) and comprise a comprehensive planning process which involves public participation and intergovernmental coordination to reduce the discharge of pollutants to the maximum extent practicable using management practices, control techniques, public education, and other appropriate methods and provisions*;	City of Athens	2003 thru 2008
Stormwater Management Policy	City of Athens	*Adopted April 18, 2000*

ELEMENTS OF ACTION PROGRAM (CONT.)		
ACTION ITEM	**PARTICIPANTS**	**MILESTONE**
Recommended to support the SWMP: Field screening and monitoring programs to identify the types and extent of fecal coliform water quality problems, relative degradation or improvement over time, areas of concern, and source identification;	City of Athens, AUB, TDEC	2003 thru 2008
Recommended to support the SWMP: Requirements that all new and replacement sanitary sewage systems are designed to minimize discharges from the system into the storm sewer system;	City of Athens, AUB	2003 thru 2008
Recommended to support the SWMP: Mechanisms for reporting and correcting illicit connections, breaks, surcharges, and general sanitary sewer system problems with potential to release to the municipal separate storm sewer system;	City of Athens, AUB	2003 thru 2008
Recommended to support the SWMP: Require NPDES facilities to comply with permit limits;	City of Athens, TDEC, AUB	2003 thru 2008
Prepare an Annual Oostanaula Creek Clean Water Report, which describes the accomplishments achieved in each of the major parts of the Implementation Plan.	McMinn County (Lead), Monroe County, NRCS, TSERCDC, AUB, City of Athens, TDA, TDEC, TVA, USGS	2002 thru 2007

* Grading Permit Policy adopted 2/19/02 – includes checklist for grading permit approval process.

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR § 130.7, announcement of the availability of the proposed fecal coliform TMDL for Oostanaula Creek was made to the public, affected dischargers, and other concerned parties and comments solicited. Steps taken in this regard include:

1) Notice of the proposed TMDLs was posted on the TDEC website on April 22, 2002 (see Appendix D). The announcement invited public comment until May 27, 2002.

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 are sent to approximately 90 interested persons or groups who have requested this information.

3) A meeting was held at the AUB Oostanaula Wastewater Treatment Plant in Athens on March 7, 2002 to discuss the proposed TMDL and fecal coliform model results. Attendees included representatives of TDEC, McMinn County, the City of Athens, AUB, Mayfield Dairy Farms, NRCS, TDA, TVA, TDA Forestry Division, and the Daily Post-Athenian. Draft copies of the proposed TMDL (excluding Implementation Plan) were provided to each attendee.

4) An Oostanaula Creek TMDL Implementation Plan development meeting was held at the NRCS Office in Athens on March 12, 2002. Attendees included representatives of TDEC, McMinn County, the City of Athens, AUB, Mayfield Dairy Farms, NRCS, TDA, TVA, TDA Forestry Division, and the U.S. Department of Agriculture – Farm Service Administration. Attendees identified essential elements for inclusion in the TMDL Implementation Plan, which was then drafted by TDEC, Chattanooga Environmental Assistance Center personnel. The Draft Implementation Plan was subsequently provided to each contributor for comments and revisions. Only minor revisions were suggested; therefore, follow-up meetings were not required.

No written comments were received during the Proposed TMDL public comment period. No requests to hold public meetings were received regarding the proposed TMDL as of close of business on May 27, 2002.

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.htm

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

Dennis M. Borders, P.E., Watershed Management Section
e-mail: Dennis.Borders@state.tn.us

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

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APPENDIX A

Monitoring Data for the Oostanaula Creek Watershed

Table A-1. Monitoring Data for Oostanaula Creek, Mile 28.4.

Date	Fecal Coliform (Counts/100 ml)
12/16/82	19200
3/8/83	1290
6/7/83	420
9/20/83	4400
12/13/83	3300
3/13/84	14500
6/12/84	100
9/11/84	230
12/11/84	8700
3/12/85	420
9/10/85	2300
12/10/85	280
3/11/86	30
6/18/86	670
9/23/86	400
12/9/86	150000
3/10/87	40000
6/9/87	1730
9/15/87	70
12/8/87	400
3/15/88	10
6/7/88	720
9/13/88	800
12/13/88	200
3/7/89	12000
6/7/89	4500
3/15/90	15000
6/13/90	980
9/11/90	3000
12/12/90	30
3/12/91	3000
6/11/91	460
9/10/91	1000
12/4/91	26000
6/9/92	31000
6/10/92	31000
9/15/92	420
12/9/92	480
3/31/93	14700
6/23/93	1400
9/1/93	1800
12/6/93	12800

Date	Fecal Coliform (Counts/100 ml)
3/14/94	810
6/20/94	1400
9/13/94	960
12/12/94	1320
3/13/95	1260
6/12/95	7600
9/18/95	2700
12/11/95	250
3/18/96	1600
6/10/96	17000
9/1/96	470
12/1/96	150
3/1/97	2500
6/1/97	1800
9/1/97	220
12/1/97	4900
3/1/98	5700
6/1/98	3100
9/1/98	160
12/15/98	8000
3/9/99	2900
5/24/99	3900
6/8/99	97
6/14/99	200
7/19/99	670
8/11/99	280
9/13/99	240

APPENDIX B

Model Development and Calibration

B.1 Model Set Up

The Oostanaula Creek watershed was delineated into 4 subwatersheds in order to characterize relative fecal coliform contributions from significant contributing drainage areas (see Figures 1 and 2). Boundaries were constructed so that watershed “pour points” coincided, when possible, with water quality monitoring stations or USGS stream gages. Watershed delineation was based on the Rf3 stream coverage and Digital Elevation Model (DEM) data. This discretization allows management and load reduction alternatives to be varied by watershed. Initial input for model variables was developed using TVA IPSI data and WCS and the associated spreadsheet tools.

An important factor influencing model results is the precipitation data contained in the meteorological data file used in the simulation. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Weather data from the Conasauga meteorological station were available for the time period from January 1970 through December 1999. Meteorological data for the period 1/1/89-12/31/99 were used for all simulations. The model was allowed to stabilize for one year (1989) before results from the subsequent 10-year simulation were analyzed.

B.2 Model Calibration

The calibration of the NPSM watershed model involves both hydrology and water quality components. The model must be calibrated to appropriately represent hydrologic response in the watershed before subsequent calibration and reasonable water quality simulations can be performed.

B.2.1 Hydrologic Calibration

Hydrologic calibration of the watershed model involves comparing simulated streamflows to historic streamflow data from a USGS stream gaging station for the same period of time. The hydrology portion of the model was derived using a continuous USGS flow gage on Oostanaula Creek: Station No. 03565500, Oostanaula Creek near Sanford, Tennessee during the period from January 1, 1980 through March 31, 1991. The Oostanaula Creek model was calibrated by adjusting model parameters based on physical characteristics of the watershed and best professional judgment.

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. Results of the hydrology calibration for water year 1982 are shown in Figure B-1.

B.2.2 Water Quality Calibration

Oostanaula Creek watershed data, generated by IPSI and WCS, were processed through the spreadsheet applications developed by Tetra Tech, Inc. to generate fecal coliform loading data for use as <u>initial</u> input to the NPSM model.

B.2.2.1 Point Sources

For existing conditions, NPDES facilities located in modeled watersheds are represented as point sources of varying flow and concentration based on the facility's flow and effluent fecal coliform concentration as reported on Discharge Monitoring Reports (DMRs).

B.2.2.2 Nonpoint Sources

A number of nonpoint source categories are not associated with land loading processes and are represented as direct, in-stream source contributions in the model. These may include, but are not limited to, failing septic systems, leaking sewer lines, animals in streams, illicit connections, direct discharge of raw sewage, and undefined sources. All other nonpoint sources involve land loading of fecal coliform bacteria and washoff as a result of storm events. Only a portion of the load from these sources are actually delivered to streams due to the mechanisms of washoff (efficiency), decay, and incorporation into soil (adsorption, absorption, filtering) before being transported to the stream. Therefore, land loading nonpoint sources are represented as indirect contributions to the stream. Buildup, washoff, and die-off rates are dependent on seasonal and hydrologic processes.

Initial input for nonpoint sources of fecal coliform loading in the water quality model was developed using watershed information generated with IPSI, WCS and the Tetra Tech loading calculation spreadsheets.

B.2.2.2.1 Wildlife

Fecal coliform loading from wildlife is considered to be uniformly distributed to forest, pasture, and cropland areas in the Oostanaula Creek watershed. A loading rate of 5.0×10^8 counts/animal/day for deer is based on best professional judgment (BPJ). An animal density of 45 animals/square mile is used to account for deer and all other wildlife. The resulting fecal coliform loading is 3.52×10^7 counts/acre/day and is considered background.

B.2.2.2.2 Land Application of Agricultural Manure

In the water quality model, livestock populations (see Table 4) are distributed to subwatersheds based on information derived from the TVA IPSI data. Fecal coliform loading rates were calculated from livestock populations based on manure application rates, literature values for bacteria concentrations in livestock manure, and the following assumptions:

- Fecal content in manure was adjusted to account for die-off due to known treatment/storage methods.
- Manure application rates from the various animal sources are applied according to application practices throughout the year.
- The fraction of manure available for runoff is dependent on the method of manure application. In the water quality model, the fraction available is estimated based on incorporation into the soil.
- Fecal coliform production rates used in the model for beef cattle, dairy cattle, hogs, horses, and chicken are 1.06×10^{11} counts/day/beef cow, 1.04×10^{11}

counts/day/dairy cow, 1.24×10^{10} counts/day/hog, 4.18×10^{8} counts/day/horse, and 1.38×10^{8} counts/day/chicken (NCSU, 1994).

B.2.2.2.3 Grazing Animals

Cattle spend time grazing on pastureland and deposit feces onto the land. During storm events, a portion of this material containing fecal coliform bacteria is transported to streams. Beef cattle are assumed to spend all their time in pasture. The percentage of feces deposited during grazing time is used to estimate fecal coliform loading rates from pastureland. Because there is no assumed monthly variation in animal access to pastures in eastern Tennessee, the fecal loading rate does not vary significantly throughout the year. Therefore, the loading rate to pastureland used in each subwatershed is assumed to be relatively constant. However, this rate varies across subwatersheds due to the variable beef cattle populations in each subwatershed. Contributions of fecal coliform from wildlife (as noted in Section B.2.2.2.1) are also included in these rates.

B.2.2.2.4 Urban Development

Urban land use represented in the MRLC database includes areas classified as: high intensity commercial, industrial, transportation, low intensity residential, high intensity residential, and transitional. Associated with each of these classifications is a percent of the land area that is impervious. A single, area-weighted loading rate from urban areas is used in the model and is based on the percentage of each urban land use type in the watershed and build-up and accumulation rates referenced in Horner (1992). In the water quality calibrated model, this rate is 1.0×10^{9} counts/acre-day and is assumed constant throughout the year.

B.2.2.2.5 Other Sources

As previously stated, there are a number of nonpoint sources of fecal coliform bacteria that are not associated with land loading and washoff processes. These include animal access to streams, failing septic systems, leaking sewer lines, illicit discharges, and other undefined sources. In each watershed, these miscellaneous sources have been modeled as point sources of constant flow and fecal coliform concentration. The <u>initial</u> baseline values of flow and concentration were estimated using the Tetra Tech, Inc. developed spreadsheets and the following assumptions:

- The load attributed to animals having access to streams is initially based on the beef cow population in the watershed. The percentage of animals having access to streams is derived from the TVA IPSI and is based on animals in operations that are adjacent to streams and seasonal and behavioral assumptions. Literature values were used to estimate the fecal coliform bacteria concentration in beef cow manure.

- The initial baseline loads attributable to leaking septic systems is based on an assumed failure rate of 20 percent.

These flow and concentration variables were adjusted during water quality calibration to alter simulated in-stream fecal concentrations during dry weather conditions.

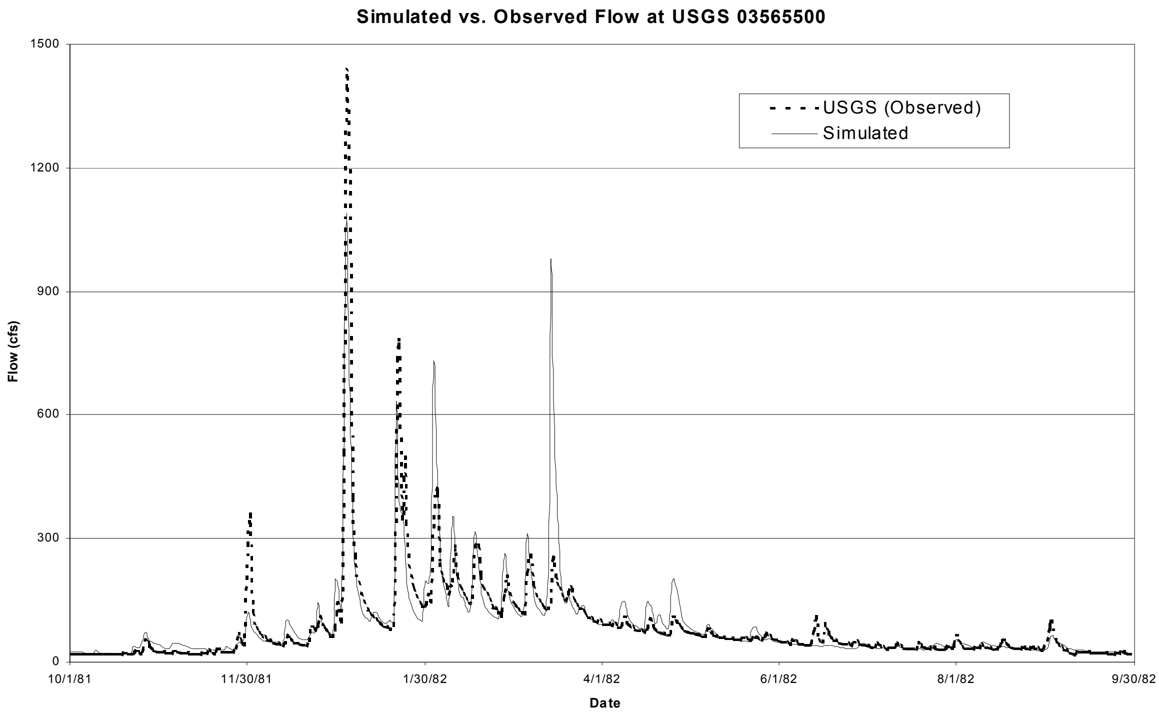
B.2.2.3 Water Quality Calibration Results

During water quality calibration, model parameters were adjusted within reasonable limits until acceptable agreement between simulation output and in-stream observed data was achieved. Model variables adjusted include:

- Rate of fecal coliform bacteria accumulation
- Maximum storage of fecal coliform bacteria
- Rate of surface runoff that will remove 90% of stored fecal coliform bacteria
- Concentration of fecal coliform bacteria in interflow
- Concentration of fecal coliform bacteria in groundwater
- Concentration of fecal coliform bacteria and rate of flow of direct sources described in B.2.2.2.5

Fecal coliform grab samples, collected quarterly at the sampling station at mile 28.4 on Oostanaula Creek in the Hiwassee River watershed were used for comparison with the simulated daily model results. Water quality calibration was conducted at mile 28.4 and extended, through model simulation, to the mouth of Oostanaula Creek to complete the TMDL evaluation.

Comparison of simulated and observed daily fecal coliform concentrations at the sampling station at mile 28.4 on Oostanaula Creek is shown in Figure B-2. Results show that the model adequately simulates peaks in fecal coliform bacteria in response to rainfall events and pollutant loading dynamics. Often a high observed value is not simulated in the model due to lack of rainfall at the meteorological station as compared to the rainfall occurring in the watershed, or is the result of an unknown source that is not included in the model.



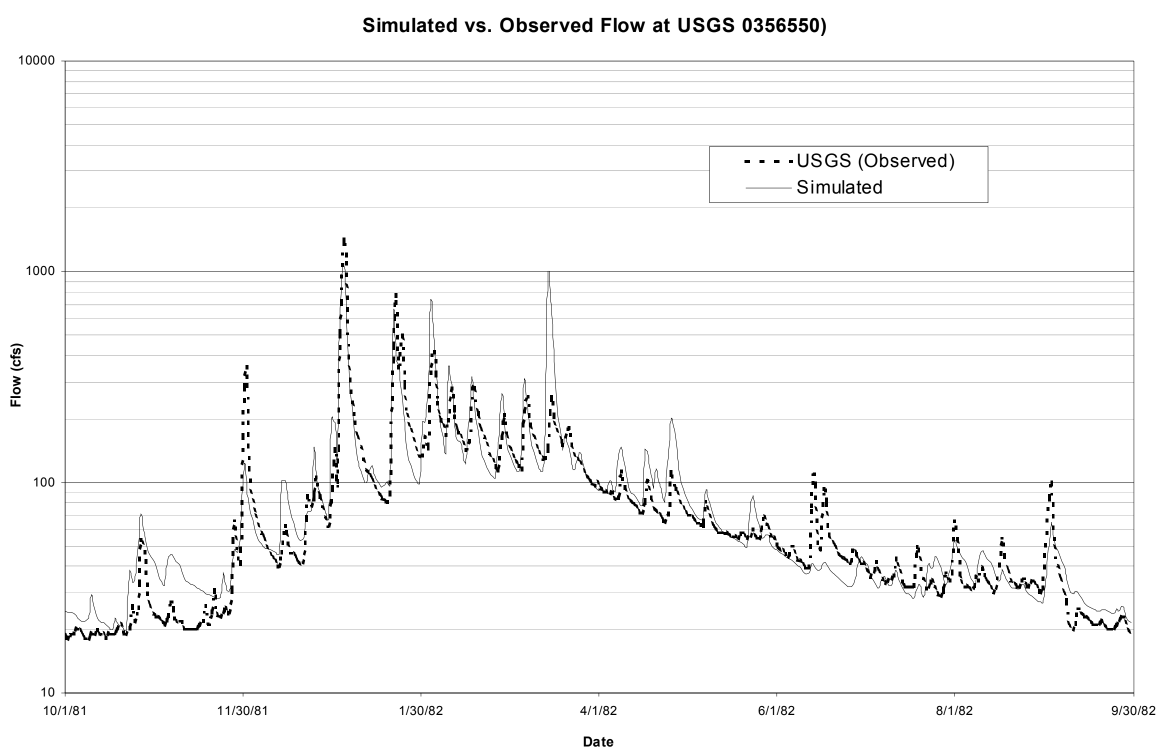


Figure B-1. Hydrologic Calibration at USGS 03565500 (WY1982).

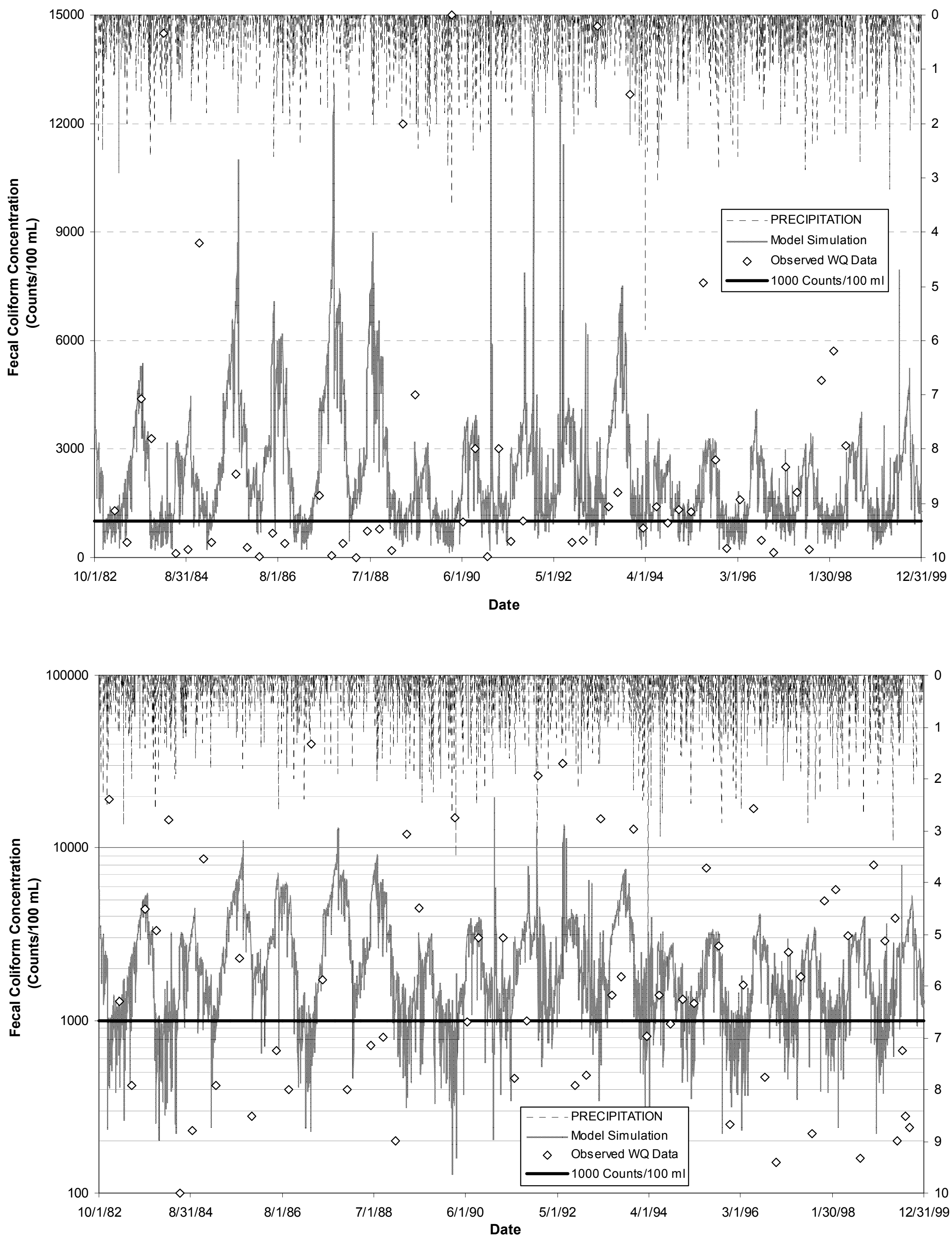


Figure B-2. Water Quality Calibration – Oostanaula Creek at Mile 28.4 (10/1/82 - 12/31/99).

APPENDIX C

Determination of Critical Conditions

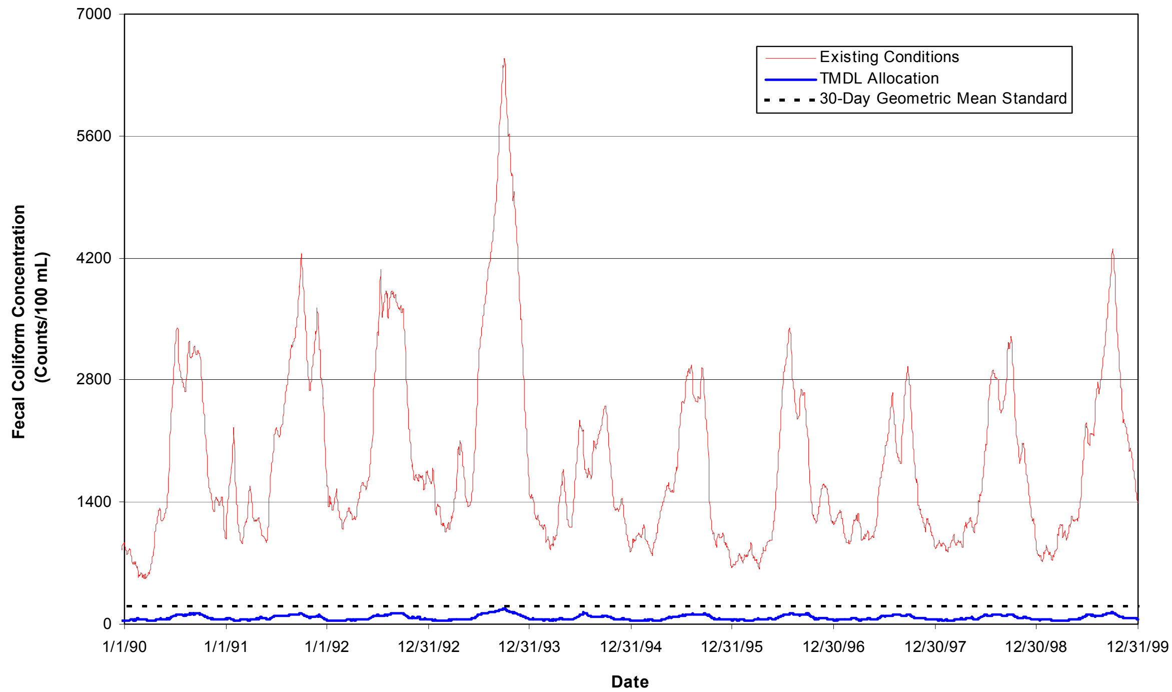


Figure C-1. Simulated 30-DayGeometric Mean Fecal Coliform Concentrations for Oostanaula Creek at Mile 28.4.

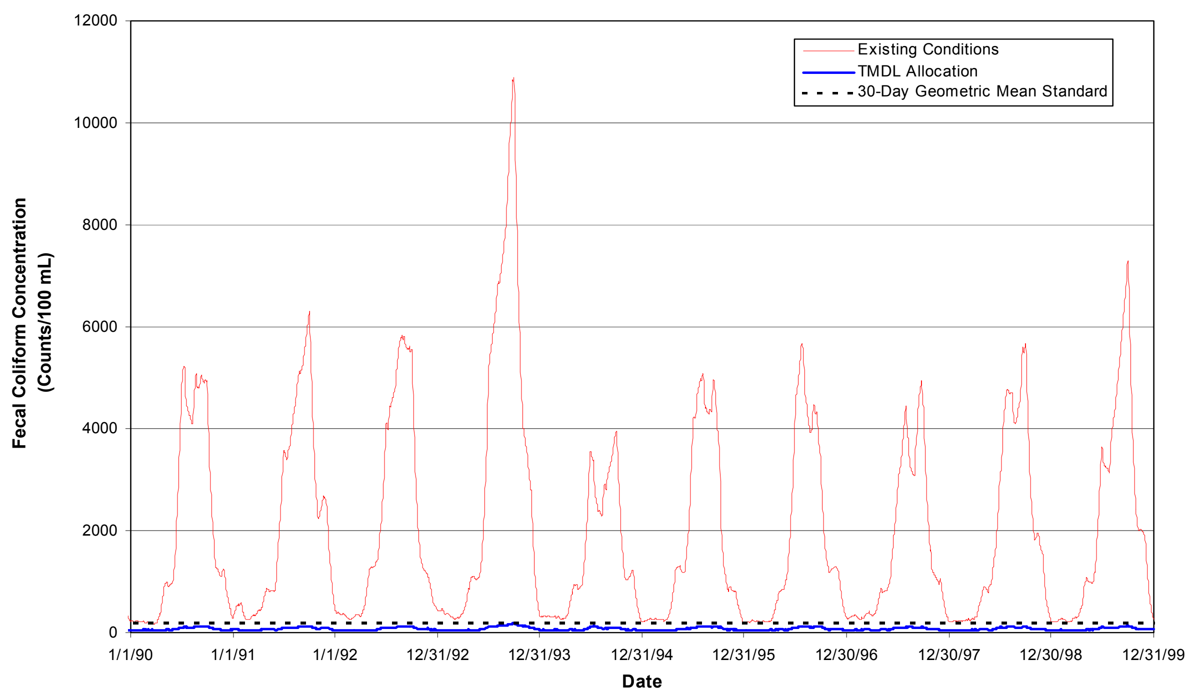


Figure C-2. Simulated 30-Day Geometric Mean Fecal Coliform Concentrations for Oostanaula Creek at Mouth.

APPENDIX D

Public Notice of Proposed Total Maximum Daily Load (TMDL) for Fecal Coliform in Oostanaula Creek Hiwassee River Watershed (HUC 06020002)

DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR FECAL COLIFORM IN OOSTANAULA CREEK HIWASSEE RIVER WATERSHED (HUC 06020002), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed total maximum daily load (TMDL) for fecal coliform in the Oostanaula Creek watershed, which drains to Hiwassee River. 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.

Oostanaula Creek is listed on Tennessee's final 1998 303(d) list as not supporting its designated use classifications due, in part, to discharge of fecal coliforms from Septic Tanks and Grazing Related Sources. The TMDL utilizes Tennessee's general water quality criteria, recently collected site specific water quality data, continuous flow data from a USGS discharge monitoring station located in the watershed, and a calibrated dynamic water quality model to establish allowable loadings of fecal coliform which will result in reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions on the order of 98% for the Oostanaula Creek Watershed.

The proposed Oostanaula Creek fecal coliform TMDL can be downloaded from the following website:

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

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

Dennis M. Borders, P.E., Watershed Management Section
Telephone: 615-532-0706

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

Persons wishing to comment on the proposed TMDL are invited to submit their comments in writing no later than May 27, 2002 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, 7th 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.