

Total Maximum Daily Load
Evaluation
for
Seventeen Stream Segments
in the
Ochlockonee River Basin
for
Fecal Coliform

Submitted to:
The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

January 2006

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EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories with respect to designated uses: 1) supporting, 2) partially supporting, or 3) not supporting. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years. This document is available on the Georgia Environmental Protection Division (GA EPD) website.

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDLs in this document are based on the draft 2004 303(d) listing, which is available on the GA EPD website. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and instream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

The State of Georgia has identified seventeen (17) stream segments located in the Ochlockonee River Basin as water quality limited due to fecal coliform. A stream is placed on the partial support list if more than 10% of the samples exceed the fecal coliform criteria and on the not support list if more than 25% of the samples exceed the standard. Water quality samples collected within a 30-day period that have a geometric mean in excess of 200 counts per 100 milliliters during the period May through October, or in excess of 1,000 counts per 100 milliliters during the period November through April, are in violation of the bacteria water quality standard. There is also a single sample maximum criteria (4,000 counts per 100 milliliters) for the months of November through April. The water use classification of all of the impacted streams is Fishing.

An important part of the TMDL analysis is the identification of potential source categories. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of fecal coliform bacteria on land surfaces that wash off as a result of storm events.

The process of developing fecal coliform TMDLs for the Ochlockonee River Basin listed segments includes the determination of the following:

- The current critical fecal coliform load to the stream under existing conditions;
- The TMDL for similar conditions under which the current critical load was determined; and
- The percent reduction in the current critical fecal coliform load necessary to achieve the TMDL.

The calculation of the fecal coliform load at any point in a stream requires the fecal coliform concentration and stream flow. The availability of water quality and flow data varies considerably among the listed segments. The Loading Curve Approach was used to determine the current fecal coliform load and TMDL. The fecal coliform loads and required reductions for each of the listed segments are summarized in the table below.

Fecal Coliform Loads and Required Fecal Coliform Load Reductions

Stream Segment	Current Load (counts/ 30 days)	TMDL Components					Percent Reduction
		WLA (counts/ 30 days) ¹	WLA _{sw} (counts/ 30 days)	LA (counts/ 30 days)	MOS (counts/ 30 days)	TMDL (counts/ 30 days)	
Attapulgus Creek	1.00E+15			2.58E+14	2.87E+13	2.87E+14	71
Aucilla River	2.68E+13	3.62E+10		9.88E+12	1.10E+12	1.10E+13	59
Big Creek - Woodhaven Rd. E. of Coolidge to Ochlockonee River	7.93E+14			5.28E+14	5.87E+13	5.87E+14	72
Big Creek - Headwaters to Little Creek near Meigs	4.71E+13			1.48E+13	1.65E+12	1.65E+13	65
Bridge Creek	3.71E+13	2.89E+10		1.03E+13	1.15E+12	1.15E+13	69
Little Attapulgus Creek	5.26E+14			1.72E+14	1.91E+13	1.91E+14	64
Little Ochlockonee River - Slocumb Branch to downstream SR 111 near Moultrie	1.98E+14			1.32E+14	1.47E+13	1.47E+14	51
Little Ochlockonee River - Big Creek to Ochlockonee River near Ochlockonee	7.21E+13	4.46E+10		6.95E+13	7.73E+12	7.73E+13	0
Little Tired Creek	1.63E+13			5.05E+12	5.62E+11	5.62E+12	65
Lost Creek	6.32E+12			1.72E+12	1.91E+11	1.91E+12	70
Ochlockonee River - Headwaters, upstream Ga. Hwy. 112 near Sylvester to Bay Branch	7.55E+12			2.24E+12	2.49E+11	2.49E+12	67
Ochlockonee River - SR 37 downstream Moultrie to Bridge Creek	3.44E+13	1.03E+12		2.66E+13	3.07E+12	3.07E+13	11
Olive Creek	1.94E+12			9.10E+11	1.01E+11	1.01E+12	48
Oquina Creek	1.15E+14	1.21E+12		7.54E+13	8.51E+12	8.51E+13	89
Parkers Mill Creek	2.90E+14			1.14E+14	1.26E+13	1.26E+14	85
Swamp Creek	1.29E+13			9.51E+12	1.06E+12	1.06E+13	18
Tired Creek	1.25E+13			8.41E+12	9.35E+11	9.35E+12	25

Notes: ¹ The assigned fecal coliform load from each NPDES permitted facility for WLA was determined as the product of the fecal coliform permit limit and the facility average monthly discharge at the time of the critical load.

Management practices that may be used to help reduce fecal coliform source loads include:

- Compliance with NPDES permit limits and requirements;
- Adoption of NRCS Conservation Practices; and
- Application of Best Management Practices (BMPs) appropriate to reduce nonpoint sources.

The amount of fecal coliform delivered to a stream is difficult to determine. However, by requiring and monitoring the implementation of these management practices, their effects will improve stream water quality, and represent a beneficial measure of TMDL implementation.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories with respect to designated uses: 1) supporting, 2) partially supporting, or 3) not supporting. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that addresses the assessment process, and are published in *Water Quality in Georgia* every two years. This document is available on the Georgia Environmental Protection Division (GA EPD) website.

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDLs in this document are based on the draft 2004 303(d) listing, which is available on the GA EPD website. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

The list identifies the waterbodies as either partially supporting or not supporting their designated use classifications, due to exceedances of water quality standards for fecal coliform bacteria. Fecal coliform bacteria are used as an indicator of the potential presence of pathogens in a stream. Table 1 presents the streams of the Ochlockonee River Basin included on the draft 2004 303(d) list for exceedances of the fecal coliform standard criteria. A total of five stream segments were listed as partially supporting their designated use and twelve stream segments were listed as not supporting their designated use.

1.2 Watershed Description

The Ochlockonee River Basin is located in the southwest part of Georgia, occupying an area of 6,330 square miles of which approximately 1,460 square miles are within Georgia. The basin lies within the Coastal Plain physiographic province, which extends throughout the southeastern United States. The Ochlockonee River drains into the Gulf of Mexico. One of the unique features of the Ochlockonee River is the presence of two smaller watersheds, the Aucilla River and Ward Creek watersheds, each of which discharge their waters separately into the Gulf of Mexico without ever merging with the Ochlockonee River.

Table 1. Water Bodies Listed for Fecal Coliform Bacteria in the Ochlockonee River Basin

Stream Segment	Location	Segment Length (miles)	Designated Use	Listing
Attapulgus Creek	Callahan Bridge to Little Attapulgus Creek (Decatur Co)	8	Fishing	PS
Aucilla River	Masse Branch to Brooks County line near Boston (Thomas Co)	10	Fishing	NS
Big Creek	Headwaters to Little Creek near Meigs (Mitchell/Thomas Co)	12	Fishing	NS
Big Creek	Woodhaven Rd. E. of Coolidge to Ochlockonee River (Thomas Co)	12	Fishing	NS
Bridge Creek	Mill Creek to upstream Georgia Hwy. 111 near Moultrie (Colquitt Co)	7	Fishing	NS
Little Attapulgus Creek	Downstream Crescent Lake to Attapulgus Creek (Decatur Co)	4	Fishing	NS
Little Ochlockonee River	Slocumb Branch to downstream SR 111 near Moultrie (Colquitt Co)	9	Fishing	NS
Little Ochlockonee River	Big Cr. to Ochlockonee River near Ochlockonee (Thomas Co)	9	Fishing	NS
Little Tired Creek	SR188 downstream Cairo to Tired Cr. (Grady Co)	6	Fishing	PS
Lost Creek	Upstream Ga. Hwy. 93 N.E. of Cotton to Little Ochlockonee River (Mitchell/Colquitt Co)	9	Fishing	NS
Ochlockonee River	Headwaters, upstream Ga. Hwy. 112 near Sylvester to Bay Branch, E. of Bridgeboro (Worth Co)	8	Fishing	NS
Ochlockonee River	SR 37 downstream Moultrie to Bridge Creek (Colquitt/Thomas Co)	14	Fishing	PS
Olive Creek	Headwaters to upstream US Hwy 19, Thomasville (Thomas Co)	3	Fishing	PS
Oquina Creek	Bruces Branch to Cassidy Road, Thomasville (Thomas Co)	2	Fishing	NS
Parkers Mill Creek	Headwaters to Tired Creek, Cairo (Grady Co)	5	Fishing	NS
Swamp Creek	SR 262 to Stateline (Decatur Co)	4	Fishing	NS
Tired Creek	Turkey Creek to Ochlockonee River (Grady Co)	6	Fishing	PS

Notes:

PS = Partially Supporting designated uses

NS = Not Supporting designated uses

The USGS has divided the Ochlockonee River Basin into four sub-basins, or Hydrologic Unit Codes (HUCs). Three of these (03110103, 03120002, 03120003) contain streams included on the 303(d) list for exceeding fecal coliform standards. Figure 1 shows the locations of these sub-basins, the listed segments within each sub-basin, and the associated counties within each sub-basin.

The land use characteristics of the Ochlockonee River Basin watersheds were determined using data from the National Land Cover Dataset (NLCD) for Georgia. This coverage was produced from Landsat Thematic Mapper digital images developed in 1995. Land use classification is based on a modified Anderson level one and two system. Table 2 lists the watershed land coverage distribution of the 17 stream segments on the 303(d) list.

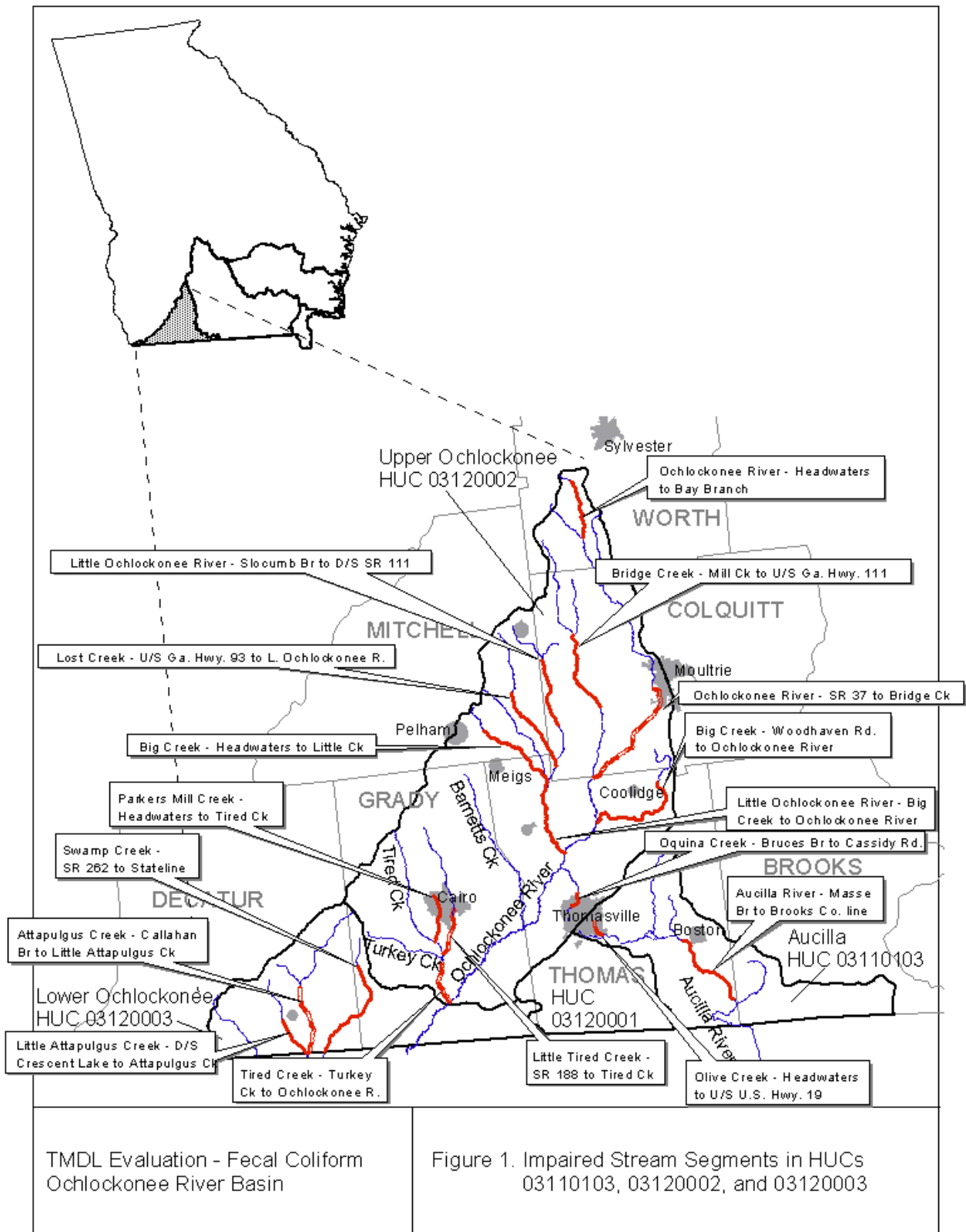
1.3 Water Quality Standard

The water use classification for the listed stream segments in the Ochlockonee River Basin is Fishing. The criterion violated is listed as fecal coliform. The potential cause(s) listed include urban runoff, nonpoint sources, and municipal facilities. The use classification water quality standards for fecal coliform bacteria, as stated in the *State of Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(6)(c)(iii) (GA EPD, 2004), are:

Bacteria: For the months of May through October, when water contact recreation activities are expected to occur, fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200/100 ml (geometric mean) occasionally, then the allowable geometric mean fecal coliform shall not exceed 300 per 100 ml in lakes and reservoirs and 500 per 100 ml in free flowing freshwater streams. For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. The State does not encourage swimming in surface waters since a number of factors, which are beyond the control of any State regulatory agency, contribute to elevated levels of fecal coliform. For waters designated as approved shellfish harvesting waters by the appropriate State agencies, the requirements will be consistent with those established by the State and Federal agencies responsible for the National Shellfish Sanitation Program. The requirements are found in the National Shellfish Sanitation Program Manual of Operation, Revised 1988, Interstate Shellfish Sanitation Conference, U. S. Department of Health and Human Services (PHS/FDA), and the Center for Food Safety and Applied Nutrition. Streams designated as generally supporting shellfish are listed in Paragraph 391-3-6-.03(14).

Any interstate waters in the Ochlockonee watershed must also meet the Florida standard for fecal coliform:

Fecal Coliform Bacteria: Most Probable Number (MPN) or Membrane Filter(MF) counts shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one day. Monthly averages must be expressed as a geometric mean.



TMDL Evaluation - Fecal Coliform
 Ochlockonee River Basin

Figure 1. Impaired Stream Segments in HUCs
 03110103, 03120002, and 03120003

Table 2. Ochlockonee River Basin Land Coverage

Stream/Segment	Landuse Categories - Acres (Percent)												Total	Landuse Source
	Open Water	Residential	High Intensity Commercial, Industrial, Transportation	Bare Rock, Sand, Clay	Quarries, Strip Mines, Gravel Pits	Transitional	Forest	Row Crops	Pasture, Hay	Other Grasses (Urban, recreational; e.g. parks, lawns)	Woody Wetlands	Emergent Herbaceous Wetlands		
Attapulugus Creek	109 (0.5)	246 (1.2)	116 (0.5)	0 (0.0)	0 (0.0)	1,255 (5.9)	9,819 (46.4)	3,732 (17.7)	256 (1.2)	6 (0.0)	5,370 (25.4)	229 (1.1)	21,139	NLCD
Aucilla River	654 (1.0)	3,712 (5.5)	461 (0.7)	2 (0.0)	0 (0.0)	5,621 (8.4)	21,250 (31.6)	20,711 (30.8)	2,482 (3.7)	524 (0.8)	10,444 (15.5)	1,426 (2.1)	67,286	NLCD
Big Creek - Woodhaven Rd to Ochlockonee River	105 (0.3)	245 (0.7)	81 (0.2)	16 (0.0)	0 (0.0)	3950 (11.3)	7716 (22.1)	14810 (42.4)	3740 (10.7)	97 (0.3)	3926 (11.2)	220 (0.6)	34906	NLCD
Big Creek - Headwaters to Little Creek near Meigs	220 (0.8)	291 (1.1)	152 (0.6)	25 (0.1)	56 (0.2)	812 (3.1)	6,964 (26.5)	12,786 (48.6)	2,776 (10.6)	83 (0.3)	2,131 (8.1)	16 (0.1)	26,312	NLCD
Bridge Creek	331 (1.0)	69 (0.2)	43 (0.1)	22 (0.1)	0 (0.0)	1,108 (3.2)	7,781 (22.5)	18,265 (52.7)	5,377 (15.5)	2 (0.0)	1,610 (4.6)	33 (0.1)	34,642	NLCD
Little Attapulugus Creek	158 (1.0)	279 (1.8)	109 (0.7)	68 (0.4)	0 (0.0)	1,435 (9.3)	5,662 (36.8)	4,970 (32.3)	258 (1.7)	5 (0.0)	2,238 (14.5)	209 (1.4)	15,392	NLCD
Little Ochlockonee River - Slocumb Branch to d/s SR 111	274 (1.0)	55 (0.2)	16 (0.1)	22 (0.1)	0 (0.0)	779 (2.8)	5,122 (18.2)	14,244 (50.5)	4,344 (15.4)	27 (0.1)	3,305 (11.7)	17 (0.1)	28,206	NLCD
Little Ochlockonee River - Big Creek to Ochlockonee River	979 (0.9)	626 (0.6)	283 (0.3)	87 (0.1)	132 (0.1)	4,523 (4.3)	24,719 (23.4)	48,489 (45.9)	11,749 (11.1)	122 (0.1)	13,625 (12.9)	265 (0.3)	105,600	NLCD
Little Tired Creek	146 (0.9)	1,403 (8.4)	318 (1.9)	0 (0.0)	0 (0.0)	1,196 (7.2)	4,314 (25.9)	6,073 (36.5)	455 (2.7)	0 (0.0)	2,576 (15.5)	168 (1.0)	16,649	NLCD
Lost Creek	134 (0.6)	5 (0.0)	4 (0.0)	29 (0.1)	0 (0.0)	994 (4.3)	4,679 (20.4)	10,726 (46.8)	2,800 (12.2)	0 (0.0)	3,451 (15.1)	86 (0.4)	22,908	NLCD
Ochlockonee River – Headwaters to Bay Branch	151 (0.9)	3 (0.0)	1 (0.0)	11 (0.1)	0 (0.0)	1,042 (6.3)	4,238 (25.5)	7,783 (46.7)	3,120 (18.7)	0 (0.0)	296 (1.8)	6 (0.0)	16,651	NLCD
Ochlockonee River - SR 37 to Bridge Creek	1,204 (1.0)	1,529 (1.3)	512 (0.4)	131 (0.1)	85 (0.1)	6,526 (5.3)	33,240 (27.2)	52,816 (43.2)	17,223 (14.1)	315 (0.3)	8,143 (6.7)	524 (0.4)	122,245	NLCD
Olive Creek	17 (1.1)	853 (55.5)	79 (5.1)	0 (0.0)	0 (0.0)	35 (2.3)	158 (10.3)	40 (2.6)	1 (0.1)	43 (2.8)	258 (16.8)	53 (3.5)	1,536	NLCD

Stream/Segment	Landuse Categories - Acres (Percent)												Total	Landuse Source
	Open Water	Residential	High Intensity Commercial, Industrial, Transportation	Bare Rock, Sand, Clay	Quarries, Strip Mines, Gravel Pits	Transitional	Forest	Row Crops	Pasture, Hay	Other Grasses (Urban, recreational; e.g. parks, lawns)	Woody Wetlands	Emergent Herbaceous Wetlands		
Oquina Creek	21 (0.3)	2,293 (37.4)	460 (7.5)	24 (0.4)	0 (0.0)	380 (6.2)	1,032 (16.9)	615 (10.0)	53 (0.9)	0 (0.0)	1,202 (19.6)	43 (0.7)	6,124	NLCD
Parkers Mill Creek	123 (2.6)	1,408 (29.2)	148 (3.1)	25 (0.5)	0 (0.0)	296 (6.1)	884 (18.3)	989 (20.5)	175 (3.6)	0 (0.0)	714 (14.8)	57 (1.2)	4,819	NLCD
Swamp Creek	216 (0.8)	103 (0.4)	178 (0.7)	10 (0.0)	145 (0.5)	2,012 (7.6)	9,927 (37.6)	8,376 (31.7)	924 (3.5)	0 (0.0)	4,231 (16.0)	313 (1.2)	26,434	NLCD
Tired Creek	715 (1.1)	479 (0.7)	169 (0.3)	0 (0.0)	87 (0.1)	5,607 (8.5)	21,134 (31.9)	23,038 (34.8)	2,286 (3.5)	0 (0.0)	11,916 (18.0)	772 (1.2)	66,205	NLCD

2.0 WATER QUALITY ASSESSMENT

Stream segments are placed on the 303(d) list as partially supporting or not supporting their water use classification based on water quality sampling data. A stream is placed on the partial support list if more than 10% of the samples exceed the fecal coliform criteria and on the not support list if more than 25% of the samples exceed the standard. Water quality samples collected within a 30-day period that have a geometric mean in excess of 200 counts per 100 milliliters during the period May through October, or in excess of 1000 counts per 100 milliliters during the period November through April, are in violation of the bacteria water quality standard. There is also a single sample maximum criterion (4000 counts per 100 milliliters) for the months of November through April.

Fecal coliform data were collected during calendar years 1991, 1998, and 2003. Sources of these data include the following:

- United States Geological Survey (USGS) basin water quality data, 1998 and 2003;
- Georgia Environmental Protection Division (GA EPD) Trend Monitoring data, 2003; and
- Thomasville spill data, 1991.

These sources contained enough information to calculate a 30-day geometric mean. The data used for these TMDLs are presented in Appendix A.

3.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of potential source categories. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of fecal coliform bacteria on land surfaces that wash off as a result of storm events.

3.1 Point Source Assessment

Title IV of the Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES) permit program. Basically, there are two categories of NPDES permits: 1) municipal and industrial wastewater treatment facilities, and 2) regulated storm water discharges.

3.1.1 Wastewater Treatment Facilities

In general, industrial and municipal wastewater treatment facilities have NPDES permits with effluent limits. These permit limits are either based on federal and state effluent guidelines (technology-based limits) or on water quality standards (water quality-based limits).

The EPA has developed technology-based guidelines, which establish a minimum standard of pollution control for municipal and industrial discharges without regard for the quality of the receiving waters. These are based on Best Practical Control Technology Currently Available (BPT), Best Conventional Control Technology (BCT), and Best Available Technology Economically Achievable (BAT). The level of control required by each facility depends on the type of discharge and the pollutant.

The EPA and the states have also developed numeric and narrative water quality standards. Typically, these standards are based on the results of aquatic toxicity tests and/or human health criteria and include a margin of safety. Water quality-based effluent limits are set to protect the receiving stream. These limits are based on water quality standards that have been established for a stream based on its intended use and the prescribed biological and chemical conditions that must be met to sustain that use.

Municipal and industrial wastewater treatment facilities' discharges may contribute fecal coliform to receiving waters. There are six NPDES permitted discharges with flows greater than 0.1 MGD identified in the Ochlockonee River Basin that discharge treated municipal wastewater. Table 3 provides the monthly average discharge flows and fecal coliform concentrations for the municipal and industrial treatment facilities, obtained from calendar year 2003 Discharge Monitoring Report (DMR) data. The permitted flow and fecal coliform concentrations for these facilities are also included in this table.

Combined sewer systems convey a mixture of raw sewage and storm water in the same conveyance structure to the wastewater treatment plant. These are considered a component of municipal wastewater treatment facilities. When the combined sewage exceeds the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are no permitted CSO outfalls in the Ochlockonee River Basin.

Table 3. NPDES Facilities Discharging Fecal Coliform in the Ochlockonee River Basin

Facility Name	NPDES Permit No.	Receiving Stream	Actual 2003 Discharge		NPDES Permit Limits		Number of Violations Jan 2001 - Jan 2005
			Average Monthly Flow (MGD) ¹	Geometric Mean (No./ 100 mL) ²	Average Monthly Flow (MGD)	Average Monthly FC (No./ 100mL)	
Affinity Foods, Inc.	GA0001279	Steam Mill Branch/Oquina Creek	0	0	No flow limit	200	0
Boston Pond	GA0033715	Aucilla Creek	0.22	3,952.1	0.21	200	5
Doerun Pond	GA0021717	Bridge Creek Tributary	0.15	161.5	0.15	200	0
Meigs WPCP	GA0048178	North Branch of Oaky Wood	0.17	1,590.5	0.15	200	0
Moultrie WPCP	GA0024660	Ochlockonee River	3.67	50.8	4.0	200	0
Thomasville WPCP	GA0024082	Oquina Creek Tributary	5.19	17.7	6.5	200	0

Source: GA EPD Regional Offices

Notes: ¹ Values shown are the annual average of the monthly average flows.
² Values shown are the annual average of the monthly geometric means.

3.1.2 Regulated Storm Water Discharges

Some storm water runoff is covered under the NPDES Permit Program. It is considered a diffuse source of pollution. Unlike other NPDES permits that establish end-of-pipe limits, storm water NPDES permits establish controls “to the maximum extent practicable” (MEP). Currently, regulated storm water discharges that may contain fecal coliform bacteria consist of those associated with industrial activities including construction sites disturbing one acre or greater, and large, medium, and small municipal separate storm sewer systems (MS4s) that serve populations of 50,000 or more.

Storm water discharges associated with industrial activities are currently covered under a General Storm Water NPDES Permit. This permit requires visual monitoring of storm water discharges, site inspections, implementation of Best Management Practices (BMPs), and record keeping.

Storm water discharges from MS4s are very diverse in pollutant loadings and frequency of discharge. At present, all cities and counties within the state of Georgia that had a population of greater than 100,000 at the time of the 1990 Census, are permitted for their storm water discharge under Phase I. This includes 60 permittees in Georgia, with about 45 located in the greater Atlanta metro area.

Phase I MS4 permits require the prohibition of non-storm water discharges (i.e., illicit discharges) into the storm sewer systems and controls to reduce the discharge of pollutants to the maximum extent practicable, including the use of management practices, control techniques and systems, as well as design and engineering methods (Federal Register, 1990). A site-specific Storm Water Management Plan (SWMP) outlining appropriate controls is required by and referenced in the permit. There are no Phase I MS4s in the Ochlockonee River Basin.

As of March 10, 2003, small MS4s serving urbanized areas are required to obtain a storm water permit under the Phase II storm water 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 1,000 people per square mile. Thirty counties and 56 communities are permitted under the Phase II regulations in Georgia. There are no counties or communities located in the Ochlockonee River Basin that are covered by the Phase II General Storm Water Permit.

3.1.3 Confined Animal Feeding Operations

Confined livestock and confined animal feeding operations (CAFOs) are characterized by high animal densities. This results in large quantities of fecal material being contained in a limited area. Processed agricultural manure from confined hog, dairy cattle, and select poultry operations is generally collected in lagoons. It is then applied to pastureland and cropland as a fertilizer during the growing season, at rates that often vary monthly.

In 1990, the State of Georgia began registering CAFOs. Many of the CAFOs were issued land application or NPDES permits for treatment of wastewaters generated from their operations. The type of permit issued depends on the operation size (i.e., number of animal units). Table 4 presents the swine and non-swine (primarily dairies) CAFOs located in the Ochlockonee River Basin that are registered or have land application permits.

Table 4. Registered CAFOs in the Ochlockonee River Basin

Name	County	Animal Type	Total No. of Animals	Permit No.
Hambone Farms, 9-Mile Swine Unit	Thomas	Swine	1,400	GAU700000
Hambone Farms, Boston Swine Unit	Thomas	Swine	850	GAU700000
Hambone Farms, Paramore Floor	Thomas	Swine	1,100	GAU700000
Johnson Ranch	Grady	Dairy	650	GAU700000
S.L. Jones Dairy	Brooks	Dairy	350	GAU700000
Manley Farm	Mitchell	Swine	1,100	GAU700000
Martin Dairy Inc.	Mitchell	Dairy	600	GAU700000
Rowland Floor	Thomas	Swine	2,000	GAU700000
T.A. Perkins & Sons, Inc.	Grady	Swine	1,700	GAU700000
Providence Dairy	Decatur	Dairy	770	GAG930000
S.L. Jones Dairy	Brooks	Dairy	698	GAU700000
Sparkman Dairy	Colquitt	Dairy	698	GAU700000

Sources: Permitting Compliance and Enforcement Program, EPD, GA EPD, 2004
 GA Dept. of Agriculture, 2005

3.2 Nonpoint Source Assessment

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. Typical nonpoint sources of fecal coliform bacteria include:

- Wildlife
- Agricultural Livestock
 - Animal grazing
 - Animal access to streams
 - Application of manure to pastureland and cropland
- Urban Development
 - Leaking sanitary sewer lines
 - Leaking septic systems
 - Land Application Systems
 - Landfills

In urban areas, a large portion of storm water runoff may be collected to storm sewer systems and discharged through distinct outlet structures. For large urban areas, these storm sewer discharge points may be regulated as described in Section 3.1.2.

3.2.1 Wildlife

The importance of wildlife as a source of fecal coliform bacteria in streams varies considerably, depending on the animal species present in the subwatersheds. Based on information provided by the Wildlife Resources Division (WRD) of GA DNR, the animals that spend a large portion of their time in or around aquatic habitats are the most important wildlife sources of fecal coliform. Waterfowl, most notably ducks and geese, are considered to potentially be the greatest contributors of fecal coliform. This is because they are typically found on the water surface, often in large numbers, and deposit their feces directly into the water. Other potentially important animals regularly found around aquatic environments include racoons, beavers, muskrats, and to a lesser extent, river otters and minks. Population estimates of these animal species in Georgia are currently not available.

White-tailed deer have a significant presence throughout the Ochlockonee River Basin. The average deer population for years 1995 through 2003 for counties in the Ochlockonee River Basin are presented in Table 5.

Table 5. Deer Census Data in the Ochlockonee River Basin

County	1995-2003 Average Population (number/sq mi)
Brooks	21
Colquitt	21
Decatur	21
Grady	21
Mitchell	21
Thomas	21
Worth	21

Source: Wildlife Resources Division, GA DNR, 2005

Fecal coliform bacteria contributions from deer to water bodies are generally considered less significant than that of waterfowl, racoons, and beavers. This is because a greater portion of their time is spent in terrestrial habitats. This also holds true for other terrestrial mammals such as squirrels and rabbits, and terrestrial birds (GA WRD, 2002). However, feces deposited on the land surface can result in the introduction of fecal coliform to streams during runoff events. It should be noted that between storm events, considerable decomposition of the fecal matter might occur, resulting in a decrease in the associated fecal coliform numbers. This is especially true in the warm, humid environments typical of the southeast.

3.2.2 Agricultural Livestock

Agricultural livestock are a potential source of fecal coliform to streams in the Ochlockonee River Basin. The animals grazing on pastureland deposit their feces onto land surfaces, where it can be transported during storm events to nearby streams. Animal access to pastureland varies monthly, resulting in varying fecal coliform loading rates throughout the year. Beef cattle spend all of their time in pastures, while dairy cattle and hogs are periodically confined. In addition, agricultural livestock will often have direct access to streams that pass through their pastures, and can thus impact water quality in a more direct manner (USDA, 2002).

Table 6 provides the estimated number of beef cattle, dairy cattle, goats, horse, swine, sheep, and chickens by category reported by county. These data were provided by the Natural Resources Conservation Service (NRCS) and are based on 2003 data (NRCS, 2000).

Table 6. Estimated Agricultural Livestock Populations in the Ochlockonee River Basin

County	Livestock								
	Beef Cattle	Dairy Cattle	Swine	Sheep	Horses	Goats	Chickens-Layers	Chickens-Broilers Sold	Chickens-Breeders
Brooks	10,000	5,700	2,800	100	500	500	-	216,000	-
Colquitt	14,559	485	1,650	24	956	884	240,000	2,162,000	140,000
Decatur	9,500	-	-	-	528	300	80,000	1,564,000	-
Grady	14,060	840	2,015	35	295	725	80,000	1,530,000	162,000
Mitchell	21,100	4,500	2,000	100	3,525	500	158,100	4,342,500	158,100
Thomas	15,764	685	618	-	1,430	65	40,000	506,000	-
Worth	22,500	400		-	480	-	-	322,000	-

Source: NRCS, 2003

3.2.3 Urban Development

Fecal coliform from urban areas are attributable to multiple sources, including: domestic animals, leaks and overflows from sanitary sewer systems, illicit discharges, leaking septic systems, runoff from improper disposal of waste materials, and leachate from both operational and closed landfills.

Urban runoff can contain high concentrations of fecal coliform from domestic animals and urban wildlife. Fecal coliform bacteria enter streams by direct washoff from the land surface, or the runoff may be diverted to a storm water collection system and discharged through a discrete outlet structure. For large, medium, and small urban areas (populations greater than 50,000), the storm water outlets are regulated under MS4 permits (see Section 3.1.2). For smaller urban areas, the storm water discharge outlets currently remain unregulated.

In addition to urban animal sources of fecal coliform, there may be illicit connections to the storm sewer system. As part of the MS4 permitting program, municipalities are required to conduct dry-weather monitoring to identify and then eliminate these illicit discharges. Fecal coliform bacteria may also enter streams from leaky sewer pipes, or during storm events when combined sewer overflows discharge.

3.2.3.1 Leaking Septic Systems

A portion of the fecal coliform in the Ochlockonee River Basin may be attributed to failure of septic systems and illicit discharges of raw sewage. Table 7 presents the number of septic systems in each county of the Ochlockonee River Basin existing in 1990, based on U.S. 1990 Census Data, and the number existing in 2003, based on the Georgia Department of Human Resources, Division of Public Health data. In addition, an estimate of the number of septic systems installed and repaired during the thirteen-year period from 1990 to 2003 is given.

Table 7. Number of Septic Systems in the Ochlockonee River Basin

County	Existing Septic Systems (1990)	Existing Septic Systems (2003)	No. of Septic Systems Installed (1990 to 2003)	No. of Septic Systems Repaired (1990 to 2003)
Brooks	3,858	6,258	2,400	*
Colquitt	6,327	9,531	3,204	283
Decatur	4,764	8,453	3,689	1,265
Grady	6,508	10,458	3950	518
Mitchell	3,634	6,425	2,145	594
Thomas	5,350	7,495	2,145	715
Worth	4,292	7,433	3,141	596

Source: 1990 Census Data, and the Georgia Dept. of Human Resources, Div. of Public Health, 2004 (* data not available)

These data show that a substantial increase in the number of septic systems has occurred in several counties. Often, this is a reflection of population increases outpacing the expansion of sewage collection systems during this period. Hence, a large number of septic systems are installed to contain and treat the sanitary waste. It is estimated that there are approximately 2.37 people per household on septic systems (EPA, personal communication).

3.2.3.2 Land Application Systems

Many smaller communities use land application systems (LAS) for treatment of their sanitary wastewaters. These facilities are required through LAS permits to treat all their wastewater by land application and are to be properly operated as non-discharging systems that contribute no runoff to nearby surface waters. However, runoff during storm events may carry surface residual containing fecal coliform bacteria to nearby surface waters. Some of these facilities may also exceed the ground percolation rate when applying the wastewater, resulting in surface runoff from the field. If not properly bermed, this runoff, which probably contains fecal coliform bacteria, may discharge to nearby surface waters. There are five permitted LAS systems located in the Ochlockonee River Basin (Table 8).

Table 8. Permitted Land Application Systems in the Ochlockonee River Basin

LAS Name	County	Permit No.	Type	Flow (MGD)
Cairo LAS	Grady	GA02-087	Municipal	2.5
Coolidge	Thomas	GA02-145	Municipal	0.083
Glen Mor Nursing Home	Thomas	GA03-706	Private	0.008
Pelham LAS	Mitchell	GA02-161	Municipal	1.5
Twin Oaks Rental Comm	Thomas	GA03-802	Private	0.03

Source: Permitting Compliance and Enforcement Program, GA EPD, 2004

3.2.3.3 Landfills

Leachate from landfills may contain fecal coliform bacteria that may at some point discharge into surface waters. Sanitary (or municipal) landfills are the most likely to serve as a source of fecal coliform bacteria. These types of landfills receive household wastes, animal manure, offal, hatchery and poultry processing plant wastes, dead animals, and other types of wastes. Older sanitary landfills were not lined and most have been closed. Those that remain active and have not been lined operate as construction/demolition landfills. Currently active sanitary landfills are lined and have leachate collection systems. All landfills, excluding inert landfills, are now required to install environmental monitoring systems for groundwater and methane sampling. There are 25 known landfills in the Ochlockonee River Basin (Table 9). Of these, three are active landfills and 22 are inactive or closed. As shown in Table 9, many of the older, inactive landfills were never permitted.

Table 9. Landfills in the Ochlockonee River Basin

Name	County	Permit No.	Type	Status
Center Hill	Colquitt	Not Applicable		Inactive
Colquitt Co-CR 15 Sunset Ph 1	Colquitt	035-002D(SL)	Sanitary Landfill	Closed
Coolridge	Colquitt	Not Applicable		Inactive
Doerun	Colquitt	Not Applicable		Inactive
J.E. Jordan	Colquitt	Not Applicable		Inactive
Moultrie (Old Site)	Colquitt	Not Applicable		Inactive
Schley	Colquitt	Not Applicable		Inactive
Sunset Community	Colquitt	035-015P(INC)		Inactive
Attapulugus	Decatur	Not Applicable		Inactive
Engelhard Minerals-Attapulugus-General Refuse	Decatur	043-003D(LI)	Industrial Landfill	Operating
Cairo	Grady	Not Applicable		Inactive
Cairo-6th Ave	Grady	065-002D(SL)	Unlined Sanitary Landfill	Operating
Whigham	Grady	Not Applicable		Inactive
Boston	Thomas	Not Applicable		Inactive
J.H. Arnold - Hwy 122	Thomas	Not Applicable		Inactive
Meigs	Thomas	Not Applicable		Inactive
Ochlocknee	Thomas	Not Applicable		Inactive
Southwestern State Hospital Landfill	Thomas	136-013D(L)	Dry Trash Landfill	Inactive
Thomas Co - Thomasville/Sunset Dr PH 3	Thomas	136-012D(SL)(4)	Construction and Demolition Landfill	Operating
Thomas Co. (NE)	Thomas	Not Applicable		Inactive
Thomas Co. (SE)	Thomas	Not Applicable		Inactive
Thomas Co-Thomasville/Sunset Dr PH 2 MSWL	Thomas	136-012D(SL)	Sanitary Landfill	Closed
Thomas County - Thomasville - Sunset Drive PH3	Thomas	136-014D(L)	Construction and Demolition Landfill	Inactive
Thomasville	Thomas	Not Applicable		Inactive
Thomasville/Sunset Dr PH 1	Thomas	136-002D(SL)	Sanitary Landfill	Closed

Source: Land Protection Branch, GA DNR, 2005

4.0 ANALYTICAL APPROACH

The process of developing fecal coliform TMDLs for the Ochlockonee River Basin listed segments includes the determination of the following:

- The current critical fecal coliform load to the stream under existing conditions;
- The TMDL for similar conditions under which the current load was determined; and
- The percent reduction in the current critical fecal coliform load necessary to achieve the TMDL.

The calculation of the fecal coliform load at any point in a stream requires the fecal coliform concentration and stream flow. The Loading Curve Approach was used to determine the current fecal coliform load and the TMDL. For the listed segments, fecal coliform sampling data were sufficient to calculate at least one 30-day geometric mean to compare with the regulatory criteria (see Appendix A).

4.1 Loading Curve Approach

For those segments in which sufficient water quality data were collected to calculate at least one 30-day geometric mean that was above the regulatory standard, the loading curve approach was used. This method involves comparing the current critical load to summer and winter seasonal TMDL curves.

As mentioned in Section 2.0, the USGS monitored many of the listed segments and collected stream flow information concurrently with water quality samples. Stream depths were measured and used to determine stream flows, based on rating curves developed by the USGS for each sampling location.

In cases where no stream flow measurements were available, flow on the day the fecal coliform samples were collected was estimated using data from a nearby gaged stream. The nearby stream had relatively similar watershed characteristics, including landuse, slope, and drainage area. The stream flows were estimated by multiplying the gaged flow by the ratio of the listed stream drainage area to the gaged stream drainage area. Table 10 lists those segments for which no flow data were available and indicates the gaged station that was used to estimate the flow.

Table 10. Monitoring Stations with Estimated Flow

Monitoring Station	USGS Station Name	Station No.
Attapulgus Creek (US HWY 27) near Attapulgus	Little Attapulgus Creek at Attapulgus, GA	02329342
Little Attapulgus Creek (GA 241) near Attapulgus	Little Attapulgus Creek at Attapulgus, GA	02329342
Ochlockonee River near Bridgeboro, Georgia	Little Attapulgus Creek at Attapulgus, GA	02329342

The current critical loads were determined using fecal coliform data collected within a 30-day period to calculate the geometric means, and multiplying these values by the arithmetic means of the flows measured at the time the water quality samples were collected. Georgia's instream fecal coliform standards are based on a geometric mean of samples collected over a 30-day period, with samples collected at least 24 hours apart. To reflect this in the load calculation, the

fecal coliform loads are expressed as 30-day accumulated loads with units of counts per 30 days. This is described by the equation below:

$$L_{\text{critical}} = C_{\text{geomean}} * Q_{\text{mean}}$$

Where:

- L_{critical} = current critical fecal coliform load
- C_{geomean} = fecal coliform concentration as a 30-day geometric mean
- Q_{mean} = stream flow as an arithmetic mean

The current estimated critical load is dependent on the fecal coliform concentrations and stream flows measured during the sampling events. The number of events sampled is usually 16 per year. Thus, these loads do not represent the full range of flow conditions or loading rates that can occur. Therefore, it must be kept in mind that the current critical loads used only represent the worst-case scenario that occurred among the time periods sampled.

The maximum fecal coliform load at which the instream fecal coliform criteria will be met can be determined using a variation of the equation above. By setting C equal to the seasonal, instream fecal coliform standards, the load will equal the TMDL. However, the TMDL is dependent on stream flow. Figures in Appendix A graphically illustrate that the TMDL is a continuum for the range of flows (Q) that can occur in the stream over time. There are two TMDL curves shown in these figures. One represents the summer TMDL for the period May through October when the 30-day geometric mean standard is 200 counts/100 mL. The second curve represents the winter TMDL for the period November through April when the 30-day geometric mean standard is 1,000 counts/100 mL. The equations for these two TMDL curves are:

$$\text{TMDL}_{\text{summer}} = 200 \text{ counts (as a 30-day geometric mean)/100 mL} * Q$$

$$\text{TMDL}_{\text{winter}} = 1,000 \text{ counts (as a 30-day geometric mean)/100 mL} * Q$$

The graphs show the relationship between the current critical load (L_{critical}) and the TMDL. The TMDL for a given stream segment is the load for the mean flow corresponding to the current critical load. This is the point where the current load exceeds the TMDL curve by the greatest amount. This critical TMDL can be represented by the following equation:

$$\text{TMDL}_{\text{critical}} = C_{\text{standard}} * Q_{\text{mean}}$$

Where:

- $\text{TMDL}_{\text{critical}}$ = critical fecal coliform TMDL load
- C_{standard} = seasonal fecal coliform standard (as a 30-day geometric mean)
 - summer - 200 counts/100 mL
 - winter - 1,000 counts/ 100 mL
- Q_{mean} = stream flow as an arithmetic mean (same as used for L_{critical})

A 30-day geometric mean load that plots above the respective seasonal TMDL curve represents an exceedance of the instream fecal coliform standard. The difference between the current critical load and the TMDL curve represents the load reduction required for the stream segment to meet the appropriate instream fecal coliform standard. There is also a single sample maximum criterion (4,000 counts per 100 milliliters) for the months of November through April.

If a single sample exceeds the maximum criterion, and the seasonal geometric mean criteria is also exceeded, then the TMDL is based on the criteria exceedance requiring the largest load reduction. The load reduction can be expressed as follows:

$$\text{Load Reduction} = \frac{L_{\text{critical}} - \text{TMDL}_{\text{critical}}}{L_{\text{critical}}} * 100$$

5.0 TOTAL MAXIMUM DAILY LOADS

A Total Maximum Daily Load (TMDL) is the amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard; in this case, the seasonal fecal coliform standards. A TMDL is the sum of the individual waste load allocations (WLAs) from point sources and load allocations (LAs) for nonpoint sources, as well as natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For fecal coliform bacteria, the TMDLs are expressed as counts per 30 days as a geometric mean.

A TMDL is expressed as follows:

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

The TMDL calculates the WLAs and LAs with margins of safety to meet the stream's water quality standards. The allocations are based on estimates that use the best available data and provide the basis to establish or modify existing controls so that water quality standards can be achieved. In developing a TMDL, it is important to consider whether adequate data are available to identify the sources, fate, and transport of the pollutant to be controlled.

TMDLs may be developed using a phased approach. Under a phased approach, the TMDL includes: 1) WLAs that confirm existing limits and controls or lead to new limits, and 2) LAs that confirm existing controls or include implementing new controls (USEPA, 1991). A phased TMDL requires additional data be collected to determine if load reductions required by the TMDL are leading to the attainment of water quality standards.

The TMDL Implementation Plan establishes a schedule or timetable for the installation and evaluation of point and nonpoint source control measures, data collection, assessment of water quality standard attainment, and if needed, additional modeling. Future monitoring of the listed segment water quality will then be used to evaluate this phase of the TMDL, and if necessary, to reallocate the loads.

The fecal coliform loads calculated for each listed stream segment include the sum of the total loads from all point and nonpoint sources for the segment. The load contributions to the listed segment from unlisted upstream segments are represented in the background loads, unless the unlisted segment contains point sources that had permit violations for fecal coliform. In these cases, the upstream point sources are included in the wasteload allocations for the listed segment. In situations where two or more adjacent segments are listed, the fecal coliform loads to each segment are individually evaluated on a localized watershed basis. Point source loads originating in upstream segments are included in the background loads of the downstream segment. The following sections describe the various fecal coliform TMDL components.

5.1 Waste Load Allocations

The waste load allocation is the portion of the receiving water's loading capacity that is allocated to existing or future point sources. WLAs are provided to the point sources from municipal and industrial wastewater treatment systems with NPDES effluent limits. There are six active NPDES permitted facilities with fecal coliform permit limits in the Ochlockonee River Basin

watershed that discharge into listed segments or have permit violations upstream of a listed segment. The maximum allocated fecal coliform loads for these municipal wastewater treatment facilities are given in Table 11. These WLA loads were calculated from the permitted or design flows and permitted fecal coliform concentrations. If the permit had no fecal coliform limit, a concentration of 200 counts/100 mL was used. These were expressed as accumulated loads over a 30-day period, and presented in units of counts per 30 days. If a facility expands its capacity and the permitted flow increases, the wasteload allocation for the facility would increase in proportion to the flow.

Table 11. WLAs for the Ochlockonee River Basin

Facility Name	Permit No.	Receiving Stream	Listed Stream Segment	WLA (counts/30 days)
Affinity Foods, Inc.	GA0001279	Steam Mill Branch/Oquina Creek	Oquina Creek – Bruces Branch to Cassidy Road	7.96E+10
Boston Pond	GA0033715	Aucilla Creek	Aucilla River-Masse Branch to Brooks County Line near Boston	4.85E+10
Doerun Pond	GA0021717	Bridge Creek Tributary	Bridge Creek – Mill Creek to upstream Georgia Hwy.111 near Moultrie	3.41E+10
Meigs WPCP	GA0048178	North Branch of Oaky Wood	Little Ochlockonee River – Big Cr. To Ochlockonee River near Ochlocknee	3.41E+10
Moultrie WPCP	GA0024660	Ochlockonee River	Ochlockonee River – SR 37 downstream Moultrie to Bridge Creek	9.10E+11
Thomasville WPCP	GA0024082	Oquina Creek Trib	Oquina Creek– Bruces Branch to Cassidy Road	1.48E+12

State and Federal Rules define storm water discharges covered by NPDES permits as point sources. However, storm water discharges are from diffuse sources and there are multiple storm water outfalls. Storm water sources (point and nonpoint) are different than traditional NPDES permitted sources in four respects: 1) they do not produce a continuous (pollutant loading) discharge; 2) their pollutant loading depends on the intensity, duration, and frequency of rainfall events, over which the permittee has no control; 3) the activities contributing to the pollutant loading may include the various allowable activities of others, and control of these activities is not solely within the discretion of the permittee; and 4) they do not have wastewater treatment plants that control specific pollutants to meet numerical limits.

The intent of storm water NPDES permits is not to treat the water after collection, but to reduce the exposure of storm water to pollutants by implementing various controls. It would be infeasible and prohibitively expensive to control pollutant discharges from each storm water outfall. Therefore, storm water NPDES permits require the establishment of controls or BMPs to reduce the pollutants entering the environment.

The waste load allocations from storm water discharges associated with MS4s (WLA_{sw}) are estimated based on the percentage of urban area in each watershed covered by the MS4 storm water permit. At this time, the portion of each watershed that goes directly to a permitted storm sewer and that which goes through non-permitted point sources, or is sheet flow or agricultural runoff, has not been clearly defined. Thus, it is assumed that approximately 70 percent of storm water runoff from the regulated urban area is collected by the municipal separate storm sewer systems.

CAFOs are located within the Ochlockonee River Basin (see Section 3.1.3). These facilities are either included under an LAS General Permit or an NPDES General Permit. A small number

have an individual NPDES permit. However, presently no CAFOs discharge wastewater and therefore, they were not provided a WLA.

This TMDL will use a phased approach. Future phases of TMDL development will attempt to further define the sources of pollutants and the portion that enters the permitted storm sewer systems. As more information is collected and these TMDLs are implemented, it will become clearer as to which BMPs are needed and how the water quality standards can be achieved.

5.2 Load Allocations

The load allocation is the portion of the receiving water's loading capacity that is attributed to existing or future nonpoint sources or to natural background sources. Nonpoint sources are identified in 40 CFR 130.6 as follows:

- Residual waste;
- Land disposal;
- Agricultural and silvicultural;
- Mines;
- Construction;
- Saltwater intrusion; and
- Urban storm water (non-permitted).

The LA is calculated as the remaining portion of the TMDL load available, after allocating the WLA and the MOS, using the following equation:

$$\sum LA = TMDL - (\sum WLA + \sum WLA_{sw} + \sum MOS)$$

As described above, there are two types of load allocations: loads to the stream independent of precipitation, including sources such as failing septic systems, leachate from landfills, animals in the stream, and leaking sewer system collection lines, or background loads; and loads associated with fecal coliform accumulation on land surfaces that is washed off during storm events, including runoff from saturated LAS fields. At this time, it is not possible to partition the various sources of load allocations. Table 12 presents the total load allocation expressed as counts per 30 days, or as winter instantaneous maximum counts for the 303(d) listed streams located in the Ochlockonee River Basin for the current critical condition. In the future, after additional data has been collected, it may be possible to partition the load allocation by source.

5.3 Seasonal Variation

The Georgia fecal coliform criteria are seasonal. One set of criteria applies to the summer season, while a different set applies to the winter season. To account for seasonal variations, the critical loads for each listed segment were determined from sampling data obtained during both summer and winter seasons, when possible. However, in some cases, the available data was limited to a single season for the calculation of the critical load. The TMDL and percent reduction given in Table 12 for each listed segment was based on the season in which the critical load occurred. The TMDLs for each season, for any given flow, are presented as equations in Section 5.5.

Analyses of the available fecal coliform data and corresponding flows were performed to determine if the fecal coliform violations occurred during wet weather (high flow) or dry weather

(low flow) conditions. The flow data from each sampling site were normalized by dividing the measured flow by the product of the average annual runoff (cfs/sq mile), published in Open-File Report 82-577, and the appropriate drainage area (Carter, 1982). Plots of the normalized flows (Q/Q_0) versus fecal coliform are shown in Appendix B. The plots do not show a consistent relationship between fecal coliform concentrations and flow. The summer and winter plots show that the fecal coliform violations occur during both high (wet weather) and low (dry weather) flow conditions.

5.4 Margin of Safety

The MOS is a required component of TMDL development. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative modeling assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For this TMDL, an explicit MOS of 10 percent of the TMDL was used. The MOS values are presented in Table 12.

5.5 Total Fecal Coliform Load

The fecal coliform TMDL for the listed stream segment is dependent on the time of year, the stream flow, and the applicable state water quality standard.

The maximum seasonal fecal coliform loads for Georgia are given below:

$$\text{TMDL}_{\text{summer}} = 200 \text{ counts (as a 30-day geometric mean)}/100 \text{ mL} * Q$$

$$\text{TMDL}_{\text{winter}} = 1,000 \text{ counts (as a 30-day geometric mean)}/100 \text{ mL} * Q$$

$$\text{TMDL}_{\text{winter}} = 4,000 \text{ counts (instantaneous)}/100 \text{ mL} * Q$$

Three listed stream segments are interstate waters. The TMDLs for Attapulgus Creek, Little Attapulgus Creek, and Swamp Creek must result in both the Georgia and Florida water quality standards being met at the State Line. The maximum fecal coliform loads for Florida are given below:

$$\text{TMDL} = 200 \text{ counts (as a 30-day geometric mean)}/100 \text{ mL} * Q$$

$$\text{TMDL} = 800 \text{ counts (instantaneous)}/100 \text{ mL} * Q$$

For purposes of determining necessary load reductions required to meet the instream water quality criteria, the current critical TMDL was determined. This load is the product of the applicable seasonal fecal coliform standard and the mean flow used to calculate the current critical load. It represents the sum of the allocated loads from point and nonpoint sources located within the immediate drainage area of the listed segment, the NPDES-permitted point discharges with recorded fecal coliform violations from the nearest upstream subwatersheds, and a margin of safety (MOS). For these calculations, the fecal load contributed by each facility to the WLA was not the maximum presented in Table 11, but rather was the product of the fecal coliform permitted limit and the average monthly discharge at the time of the critical load. The current critical loads and corresponding TMDLs, WLAs, LAs, MOSs, and percent load reductions for the Ochlockonee River Basin 303(d) listed stream segments are presented in Table 12.

The relationships of the current critical loads to the TMDLs are shown graphically in Appendix A. The vertical distance between the two values represents the load reductions necessary to achieve the TMDLs. If no TMDL or Critical Load is given on the graphs in Appendix A, the TMDL given in Table 12 is based on the instantaneous maximum standard. As a consequence of the localized nature of the load evaluations, the calculated fecal coliform load reductions pertain to point and nonpoint sources occurring within the immediate drainage area of the listed segment. These current critical values represent a worst-case scenario for the limited set of data. Thus, the load reductions required are conservative estimates, and should be sufficient to prevent exceedances of the instream fecal coliform standard for a wide range of conditions.

Evaluation of the relationship between instream water quality and the potential sources of pollutant loading is an important component of TMDL development, and is the basis for later implementation of corrective measures and BMPs. For the current TMDLs, the association between fecal coliform loads and the potential sources occurring within the subwatersheds of each segment was examined on a qualitative basis.

Table 12. Fecal Coliform Loads and Required Fecal Coliform Load Reductions

Stream Segment	Current Load (counts/30 days)	TMDL Components					Percent Reduction
		WLA (counts/30 days) ¹	WLASw (counts/30 days)	LA (counts/30 days)	MOS (counts/30 days)	TMDL (counts/30 days)	
Attapulgus Creek	1.00E+15			2.58E+14	2.87E+13	2.87E+14	71
Aucilla River	2.68E+13	3.62E+10		9.88E+12	1.10E+12	1.10E+13	59
Big Creek - Woodhaven Rd. E. of Coolidge to Ochlockonee River	7.93E+14			5.28E+14	5.87E+13	5.87E+14	72
Big Creek - Headwaters to Little Creek near Meigs	4.71E+13			1.48E+13	1.65E+12	1.65E+13	65
Bridge Creek	3.71E+13	2.89E+10		1.03E+13	1.15E+12	1.15E+13	69
Little Attapulgus Creek	5.26E+14			1.72E+14	1.91E+13	1.91E+14	64
Little Ochlockonee River - Slocumb Branch to downstream SR 111 near Moultrie	1.98E+14			1.32E+14	1.47E+13	1.47E+14	51
Little Ochlockonee River - Big Creek to Ochlockonee River near Ochlockonee	7.21E+13	4.46E+10		6.95E+13	7.73E+12	7.73E+13	0
Little Tired Creek	1.63E+13			5.05E+12	5.62E+11	5.62E+12	65
Lost Creek	6.32E+12			1.72E+12	1.91E+11	1.91E+12	70
Ochlockonee River - Headwaters, upstream Ga. Hwy. 112 near Sylvester to Bay Branch	7.55E+12			2.24E+12	2.49E+11	2.49E+12	67
Ochlockonee River - SR 37 downstream Moultrie to Bridge Creek	3.44E+13	1.03E+12		2.66E+13	3.07E+12	3.07E+13	11
Olive Creek	1.94E+12			9.10E+11	1.01E+11	1.01E+12	48
Oquina Creek	1.15E+14	1.21E+12		7.54E+13	8.51E+12	8.51E+13	89
Parkers Mill Creek	2.90E+14			1.14E+14	1.26E+13	1.26E+14	85
Swamp Creek	1.29E+13			9.51E+12	1.06E+12	1.06E+13	18
Tired Creek	1.25E+13			8.41E+12	9.35E+11	9.35E+12	25

Notes: ¹ The assigned fecal coliform load from each NPDES permitted facility for WLA was determined as the product of the fecal coliform permit limit and the facility average monthly discharge at the time of the critical load.

6.0 RECOMMENDATIONS

The TMDL process consists of an evaluation of the 303(d) listed stream segments' subwatersheds to identify, as best as possible, the sources of the fecal coliform loads causing the stream to exceed instream standards. The TMDL analysis was performed using the best available data to specify WLAs and LAs that will meet fecal coliform water quality criteria so as to support the use classification specified for each listed segment.

This TMDL represents the first phase of a long-term process to reduce fecal coliform loading to meet water quality standards in the Ochlockonee River Basin. Implementation strategies will be reviewed and the TMDLs will be refined as necessary in the next phase (next five-year cycle). The phased approach will support progress toward water quality standards attainment in the future. In accordance with USEPA TMDL guidance, these TMDLs may be revised based on the results of future monitoring and source characterization data efforts. The following recommendations emphasize further source identification and involve the collection of data to support the current allocations and subsequent source reductions.

6.1 Monitoring

Water quality monitoring is conducted at a number of locations across the state each year. The GA EPD has adopted a basin approach to water quality management that divides Georgia's major river basins into five groups. This approach provides for additional sampling work to be focused on one of the five basin groups each year and offers a five-year planning and assessment cycle. The Ochlockonee, Satilla, St. Marys and Suwannee River Basins were the subjects of focused monitoring in 2003 and will again receive focused monitoring in 2008.

The TMDL Implementation Plan will outline an appropriate water quality monitoring program for the listed streams in the Ochlockonee River Basin. The monitoring program will be developed to help identify the various fecal coliform sources. The monitoring program may be used to verify the 303(d) stream segment listings. This will be especially valuable for those segments where no data, old data, or spill data resulted in the listing.

6.2 Fecal Coliform Management Practices

Based on the findings of the source assessment, NPDES point source fecal coliform loads from wastewater treatment facilities do not significantly contribute to the impairment of the listed stream segments. This is because most facilities are required to treat to levels corresponding to instream water quality criteria. Fecal coliform loads from NPDES permitted MS4 areas may be significant, but these sources cannot be easily segregated from other storm water runoff. Other sources of fecal coliform in urban areas include wastes that are attributable to domestic animals, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, leaking septic systems, runoff from improper disposal of waste materials, and leachate from both operational and closed landfills. In agricultural areas, potential sources of fecal coliform may include CAFOs, animals grazing in pastures, dry manure storage facilities and lagoons, chicken litter storage areas, and direct access of livestock to streams. Wildlife and waterfowl can be an important source of fecal coliform bacteria.

Management practices are recommended to reduce fecal coliform source loads to the listed 303(d) stream segments, with the result of achieving the instream fecal coliform standard criteria. These recommended management practices include:

- Compliance with NPDES permit limits and requirements;
- Adoption of NRCS Conservation Practices; and
- Application of Best Management Practices (BMPs) appropriate to agricultural or urban land uses, whichever applies.

6.2.1 Point Source Approaches

Point sources are defined as discharges of treated wastewater or storm water into rivers and streams at discrete locations. The NPDES permit program provides a basis for municipal, industrial and storm water permits, monitoring and compliance with limitations, and appropriate enforcement actions for violations.

In accordance with GA EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times. In the future, all municipal and industrial wastewater treatment facilities with the potential for the occurrence of fecal coliform in their discharge will be given end-of-pipe limits equivalent to the water quality standard of 200 counts/100 mL. An exception is constructed wetland systems, which have a natural level of fecal coliform input from animals attracted to the artificial wetlands. In addition, the permits will include routine monitoring and reporting requirements.

6.2.2 Nonpoint Source Approaches

The GA EPD is responsible for administering and enforcing laws to protect the waters of the State. The GA EPD is the lead agency for implementing the State's Nonpoint Source Management Program. Regulatory responsibilities that have a bearing on nonpoint source pollution include establishing water quality standards and use classifications, assessing and reporting water quality conditions, and regulating land use activities that may affect water quality. Georgia is working with local governments, agricultural and forestry agencies such as the Natural Resources Conservation Service, the Georgia Soil and Water Conservation Commission, and the Georgia Forestry Commission, to foster the implementation of BMPs to address nonpoint source pollution. In addition, public education efforts are being targeted to individual stakeholders to provide information regarding the use of BMPs to protect water quality. The following sections describe, in more detail, recommendations to reduce nonpoint source loads of fecal coliform bacteria in Georgia's surface waters.

6.2.2.1 Agricultural Sources

The GA EPD should coordinate with other agencies that are responsible for agricultural activities in the state to address issues concerning fecal coliform loading from agricultural lands. It is recommended that information (e.g., livestock populations by subwatershed, animal access to streams, manure storage and application practices, etc.) be periodically reviewed so that watershed evaluations can be updated to reflect current conditions. It is also recommended that BMPs be utilized to reduce the amount of fecal coliform bacteria transported to surface waters from agricultural sources to the maximum extent practicable.

The following three organizations have primary responsibility for working with farmers to promote soil and water conservation, and to protect water quality:

- University of Georgia (UGA) - Cooperative Extension Service;
- Georgia Soil and Water Conservation Commission (GSWCC); and
- Natural Resources Conservation Service (NRCS).

UGA has faculty, County Cooperative Extension Agents, and technical specialists who provide services in several key areas relating to agricultural impacts on water quality.

The GA EPD designated the GSWCC as the lead agency for agricultural Nonpoint Source Management in the State. The GSWCC develops nonpoint source management programs and conducts educational activities to promote conservation and protection of land and water devoted to agricultural uses.

The NRCS works with federal, state, and local governments to provide financial and technical assistance to farmers. The NRCS develops standards and specifications for BMPs that are to be used to improve, protect, and/or maintain our state's natural resources. In addition, every five years, the NRCS conducts the National Resources Inventory (NRI). The NRI is a statistically based sample of land use and natural resource conditions and trends that covers non-federal land in the United States.

The NRCS is also providing technical assistance to the GSWCC and the GA EPD with the Georgia River Basin Planning Program. Planning activities associated with this program will describe conditions of the agricultural natural resource base once every five years. It is recommended that the GSWCC and the NRCS continue to encourage BMP implementation, education efforts, and river basin surveys with regard to river basin planning.

6.2.2.2 Urban Sources

Both point and nonpoint sources of fecal coliform bacteria can be significant in the Ochlockonee River Basin urban areas. Urban sources of fecal coliform can best be addressed using a strategy that involves public participation and intergovernmental coordination to reduce the discharge of pollutants to the maximum extent practicable. Management practices, control techniques, public education, and other appropriate methods and provisions may be employed. In addition to water quality monitoring programs, discussed in Section 6.1, the following activities and programs conducted by cities, counties, and state agencies are recommended:

- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;
- Further develop and streamline mechanisms for reporting and correcting illicit connections, breaks, surcharges, and general sanitary sewer system problems;
- Sustained compliance with storm water NPDES permit requirements; and
- Continue efforts to increase public awareness and education towards the impact of human activities in urban settings on water quality, ranging from the consequences of industrial and municipal discharges to the activities of individuals in residential neighborhoods.

6.3 Reasonable Assurance

Permitted discharges will be regulated through the NPDES permitting process described in this report. Georgia is working with both federal and state agencies, such as the NRCS and the GSWCC, and with local governments, to foster the implementation of BMPs to address nonpoint sources. In addition, public education efforts will be targeted at individual stakeholders to provide information regarding the use of BMPs to protect water quality.

6.4 Public Participation

A thirty-day public notice will be provided for this TMDL. During this time, the availability of the TMDL will be public noticed, a copy of the TMDL will be provided upon request, and the public will be invited to provide comments on the TMDL. This TMDL will be modified to address the comments received.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

GA EPD has coordinated with EPA to prepare this Initial TMDL Implementation Plan for this TMDL. GA EPD has also established a plan and schedule for development of a more comprehensive implementation plan after this TMDL is established. GA EPD and EPA have executed a Memorandum of Understanding that documents the schedule for developing the more comprehensive plans. This Initial TMDL Implementation Plan includes a list of best management practices and provides for an initial implementation demonstration project to address one of the major sources of pollutants identified in this TMDL while State and/or local agencies work with local stakeholders to develop a revised TMDL implementation plan. It also includes a process whereby GA EPD and/or Regional Development Centers (RDCs) or other GA EPD contractors (hereinafter, "GA EPD Contractors") will develop expanded plans (hereinafter, "Revised TMDL Implementation Plans").

This Initial TMDL Implementation Plan, written by GA EPD and for which GA EPD and/or the GA EPD Contractor are responsible, contains the following elements.

1. EPA has identified a number of management strategies for the control of nonpoint sources of pollutants, representing some best management practices. The "Management Measure Selector Table" shown below identifies these management strategies by source category and pollutant. Nonpoint sources are the primary cause of excessive pollutant loading in most cases. Any wasteload allocations for wastewater treatment plant facilities will be implemented in the form of water-quality based effluent limitations in NPDES permits. Any wasteload allocations for regulated storm water will be implemented in the form of best management practices in the NPDES permits. NPDES permit discharges are a secondary source of excessive pollutant loading, where they are a factor, in most cases.
2. GA EPD and the GA EPD Contractor will select and implement one or more BMP demonstration projects for each River Basin. The purpose of the demonstration projects will be to evaluate by River Basin and pollutant parameter the site-specific effectiveness of one or more of the BMPs chosen. GA EPD intends that the BMP demonstration project be completed before the Revised TMDL Implementation Plan is issued. The BMP demonstration project will address the major pollutant categories of concern for the respective River Basin as identified in the TMDLs. The demonstration project need not be of a large scale, and may consist of one or more measures from the Table or equivalent BMP measures proposed by the GA EPD Contractor and approved by GA EPD. Other such measures may include those found in EPA's "*Best Management Practices Handbook*," the "*NRCS National Handbook of Conservation Practices*," or any similar reference, or measures that the volunteers, etc., devise that GA EPD approves. If for any reason the GA EPD Contractor does not complete the BMP demonstration project, GA EPD will take responsibility for doing so.
3. As part of the Initial TMDL Implementation Plan, the GA EPD brochure entitled "*Watershed Wisdom -- Georgia's TMDL Program*" will be distributed by GA EPD to the GA EPD Contractor for use with appropriate stakeholders for this TMDL. Also, a copy of the video of that same title will be provided to the GA EPD Contractor for its use in making presentations to appropriate stakeholders on TMDL Implementation Plan development.

4. If for any reason the GA EPD Contractor does not complete one or more elements of a Revised TMDL Implementation Plan, GA EPD will be responsible for getting that (those) element(s) completed, either directly or through another contractor.
5. The deadline for development of a Revised TMDL Implementation Plan is the end of December 2007.
6. The GA EPD Contractor helping to develop the Revised TMDL Implementation Plan, in coordination with GA EPD, will work on the following tasks involved in converting the Initial TMDL Implementation Plan to a Revised TMDL Implementation Plan:
 - A. Generally characterize the watershed;
 - B. Identify stakeholders;
 - C. Verify the present problem to the extent feasible and appropriate (e.g., local monitoring);
 - D. Identify probable sources of pollutant(s);
 - E. For the purpose of assisting in the implementation of the load allocations of this TMDL, identify potential regulatory or voluntary actions to control pollutant(s) from the relevant nonpoint sources;
 - F. Determine measurable milestones of progress;
 - G. Develop a monitoring plan, taking into account available resources, to measure effectiveness; and
 - H. Complete and submit to GA EPD the Revised TMDL Implementation Plan.
7. The public will be provided an opportunity to participate in the development of the Revised TMDL Implementation Plan and to comment on it before it is finalized.
8. The Revised TMDL Implementation Plan will supersede this Initial TMDL Implementation Plan once GA EPD approves the Revised TMDL Implementation Plan.

Management Measure Selector Table

Land Use	Management Measures	Fecal Coliform	Dissolved Oxygen	pH	Sediment	Temperature	Toxicity	Mercury	Metals (copper, lead, zinc, cadmium)	PCBs, toxaphene
Agriculture	1. Sediment & Erosion Control	—	—		—	—				
	2. Confined Animal Facilities	—	—							
	3. Nutrient Management	—	—							
	4. Pesticide Management		—							
	5. Livestock Grazing	—	—		—	—				
	6. Irrigation		—		—	—				
Forestry	1. Preharvest Planning				—	—				
	2. Streamside Management Areas	—	—		—	—				
	3. Road Construction & Reconstruction		—		—	—				
	4. Road Management		—		—	—				
	5. Timber Harvesting		—		—	—				
	6. Site Preparation & Forest Regeneration		—		—	—				
	7. Fire Management	—	—	—	—	—				
	8. Revegetation of Disturbed Areas	—	—	—	—	—				
	9. Forest Chemical Management		—			—				
	10. Wetlands Forest Management	—	—	—		—		—		

Land Use	Management Measures	Fecal Coliform	Dissolved Oxygen	pH	Sediment	Temperature	Toxicity	Mercury	Metals (copper, lead, zinc, cadmium)	PCBs, toxaphene
Urban	1. New Development	—	—		—	—			—	
	2. Watershed Protection & Site Development	—	—		—	—		—	—	
	3. Construction Site Erosion and Sediment Control		—		—	—				
	4. Construction Site Chemical Control		—							
	5. Existing Developments	—	—		—	—			—	
	6. Residential and Commercial Pollution Prevention	—	—							
Onsite Wastewater	1. New Onsite Wastewater Disposal Systems	—	—							
	2. Operating Existing Onsite Wastewater Disposal Systems	—	—							
Roads, Highways and Bridges	1. Siting New Roads, Highways & Bridges	—	—		—	—			—	
	2. Construction Projects for Roads, Highways and Bridges		—		—	—				
	3. Construction Site Chemical Control for Roads, Highways and Bridges		—							
	4. Operation and Maintenance-Roads, Highways and Bridges	—	—			—			—	

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Appendix A
30-day Geometric Mean Fecal Coliform Monitoring Data

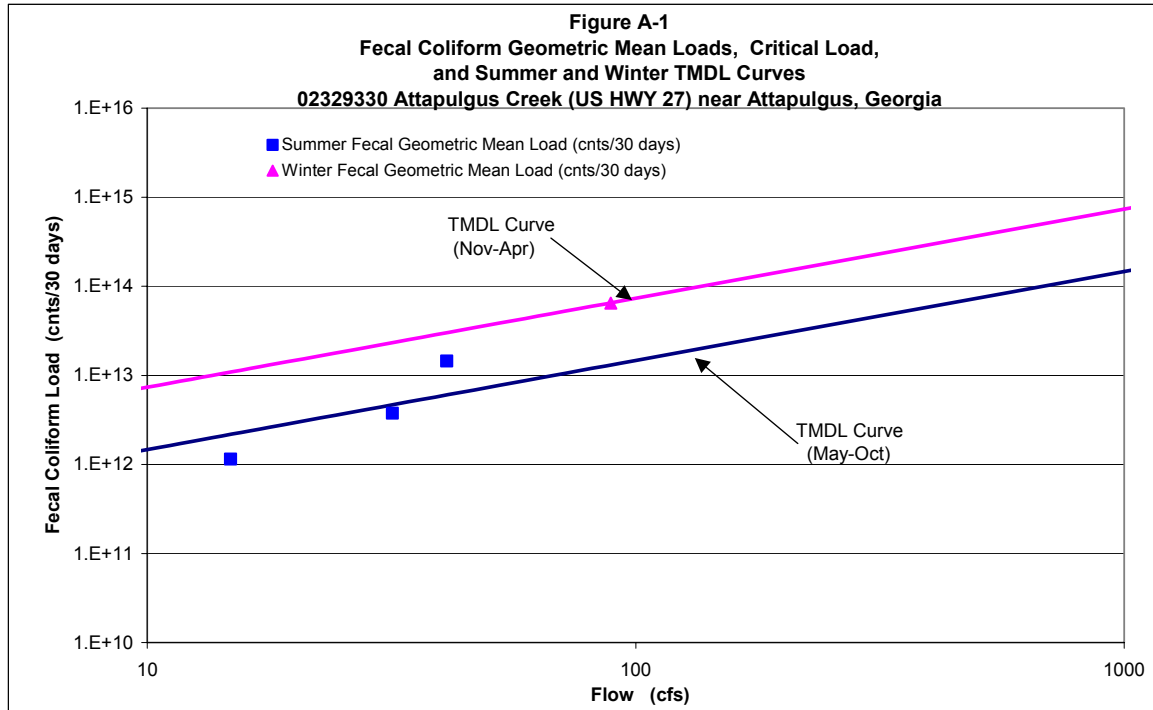


Table A-1. Data for Figure A-1

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
23-Feb-98	1,300	115.3				
2-Mar-98	170	76.2				
9-Mar-98	14,000	97.7				
24-Mar-98	310	66.5	990	88.9	6.46E+13	6.53E+13
27-May-98	130	15.6				
1-Jun-98	70	17.0				
8-Jun-98	80	12.1				
24-Jun-98	170	14.5	105	14.8	1.15E+12	2.17E+12
6-Aug-98	110	23.5				
10-Aug-98	80	21.5				
17-Aug-98	330	33.2				
2-Sep-98	230	48.9	161	31.8	3.75E+12	4.66E+12
1-Oct-98	1,400	58.6				
5-Oct-98	210	54.7				
22-Oct-98	230	27.4				
26-Oct-98	790	23.5	481	41.0	1.45E+13	6.03E+12

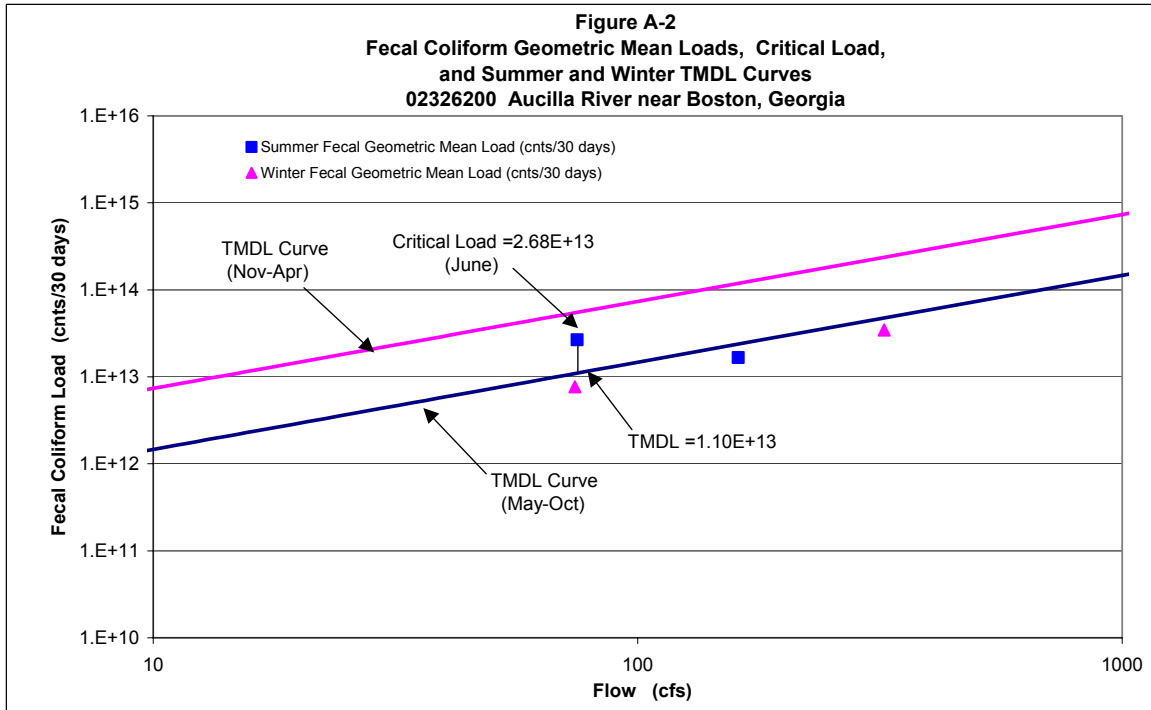


Table A-2. Data for Figure A-2

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
20-Jan-98	130	180.6				
2-Feb-98	20	328.9				
9-Feb-98	220	187.0				
17-Feb-98	790	593.4	146	322.5	3.45E+13	2.37E+14
8-Jun-98	20	40.0				
15-Jun-98	7,000	36.8				
25-Jun-98	820	148.3	486.0	75.0	2.68E+13	1.10E+13
28-Jul-98	4,900	425.7				
10-Aug-98	20	70.9				
18-Aug-98	50	83.8				
25-Aug-98	80	64.5	140.7	161.2	1.67E+13	2.37E+13
4-Nov-98	700	77.4				
12-Nov-98	940	83.8				
22-Nov-98	20	70.9				
2-Dec-98	160	70.9				
9-Dec-98	130	70.9	141	74.2	7.66E+12	5.44E+13

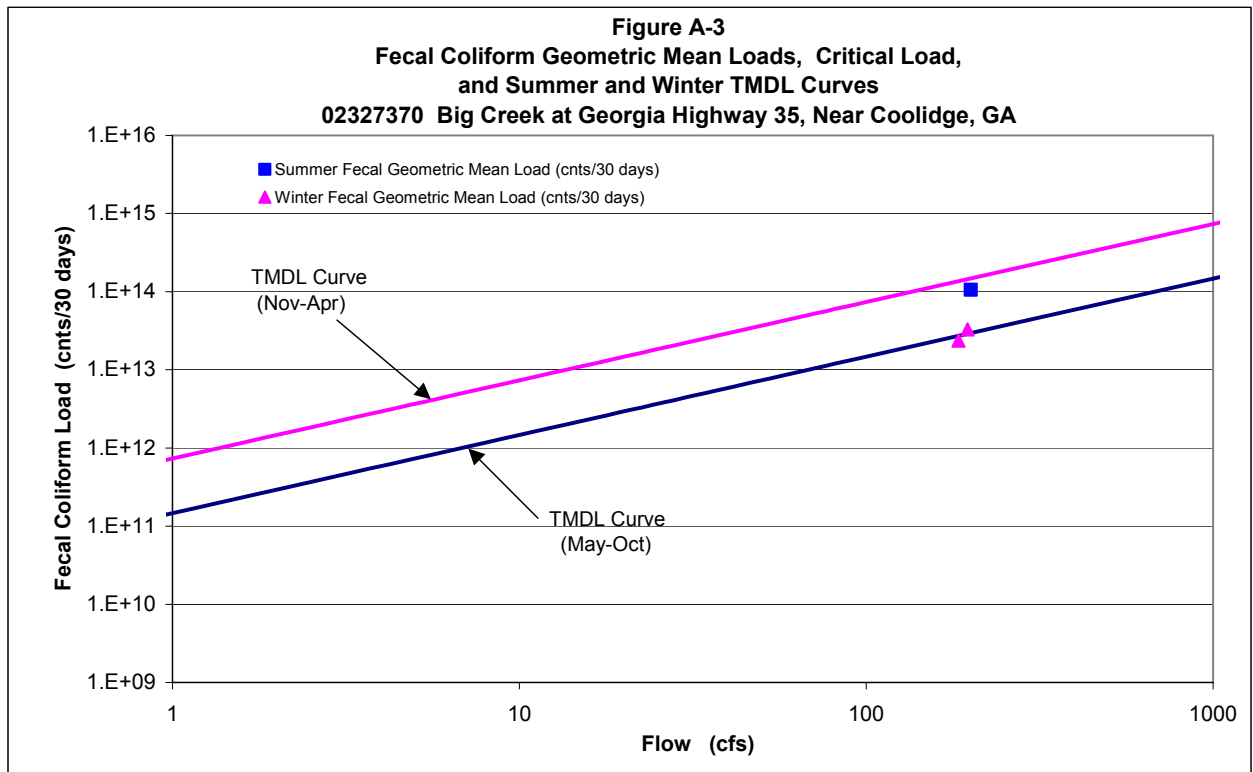


Table A-3. Data for Figure A-3

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
25-Feb-03	80	200.0				
4-Mar-03	80	200.0				
12-Mar-03	80	183.0				
18-Mar-03	5,400	200.0	229	195.8	3.29E+13	1.44E+14
18-Mar-03	5,400	200.0				
2-Apr-03	170	200.0				
9-Apr-03	20	137.0				
16-Apr-03	50	200.0	174	184.3	2.35E+13	1.35E+14
23-Jul-03	2,400	200.0				
5-Aug-03	700	200.0				
14-Aug-03	230					
19-Aug-03	700	200.0	721	200.0	1.06E+14	2.94E+13

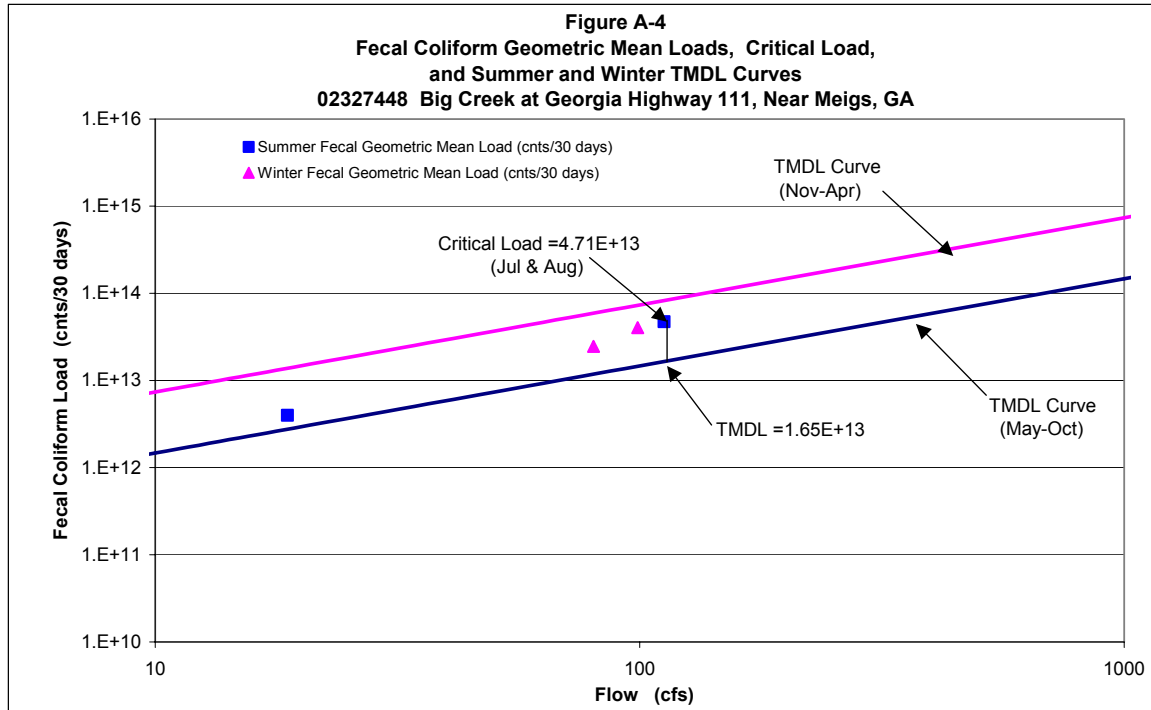


Table A-4. Data for Figure A-4

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
25-Feb-03	490	29.0				
4-Mar-03	3,500	140.0				
12-Mar-03	70	87.0				
18-Mar-03	790	140.0	555	99.0	4.03E+13	7.27E+13
18-Mar-03	790	140.0				
2-Apr-03	330	24.0				
9-Apr-03	1,300	140.0				
16-Apr-03	90	17.0	418	80.3	2.46E+13	5.89E+13
23-Jul-03	1,300	140.0				
5-Aug-03	790	122.0				
13-Aug-03	80	47.0				
19-Aug-03	1,300	140.0	572	112.3	4.71E+13	1.65E+13
10-Sep-03	220	21.0				
16-Sep-03	130	13.0				
23-Sep-03	790	31.0				
8-Oct-03	310	10.0	289	18.8	3.98E+12	2.75E+12

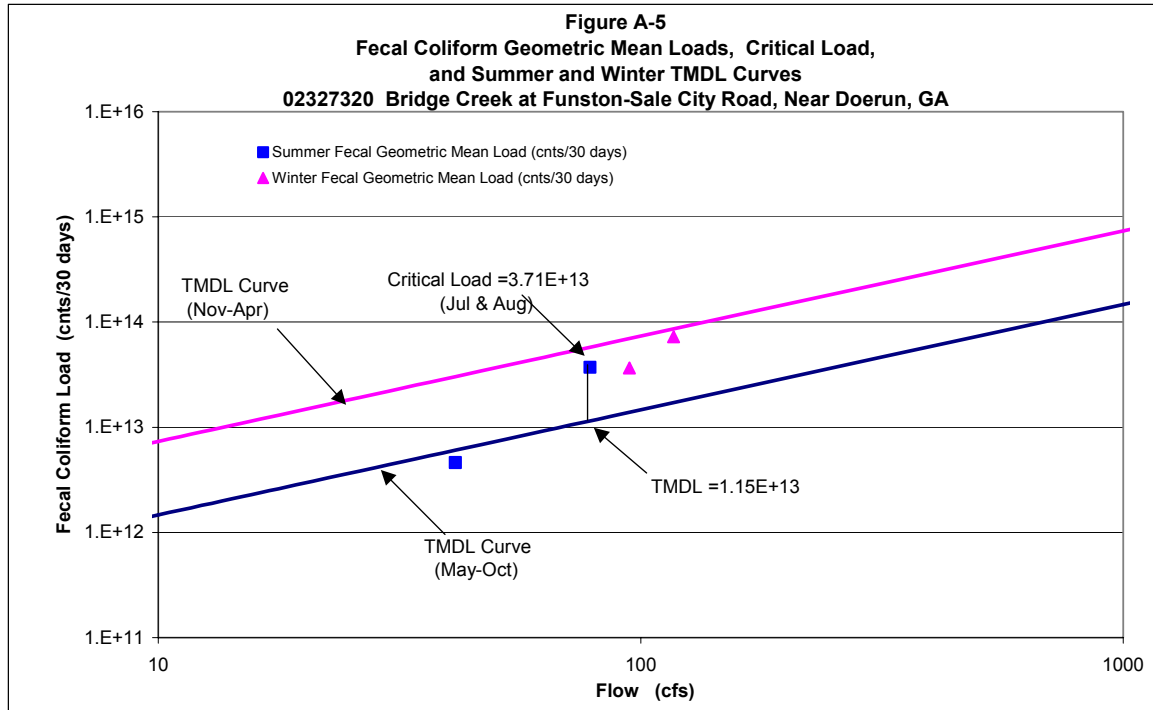


Table A-5. Data for Figure A-5

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
24-Feb-03	2,400	75.0				
3-Mar-03	460	225.0				
12-Mar-03	270	97.0				
17-Mar-03	1,700	71.0	844	117.0	7.25E+13	8.59E+13
17-Mar-03	1,700	71.0				
1-Apr-03	70	36.0				
9-Apr-03	2,400	239.0				
15-Apr-03	270	33.0	527	94.8	3.66E+13	6.95E+13
22-Jul-03	2,800	31.0				
6-Aug-03	330	135.0				
12-Aug-03	1,100	73.0				
19-Aug-03	170	75.0	645	78.5	3.71E+13	1.15E+13
9-Sep-03	130	24.0				
16-Sep-03	20	21.0				
23-Sep-03	294	116.0				
7-Oct-03	700	4.2	152	41.3	4.61E+12	6.06E+12

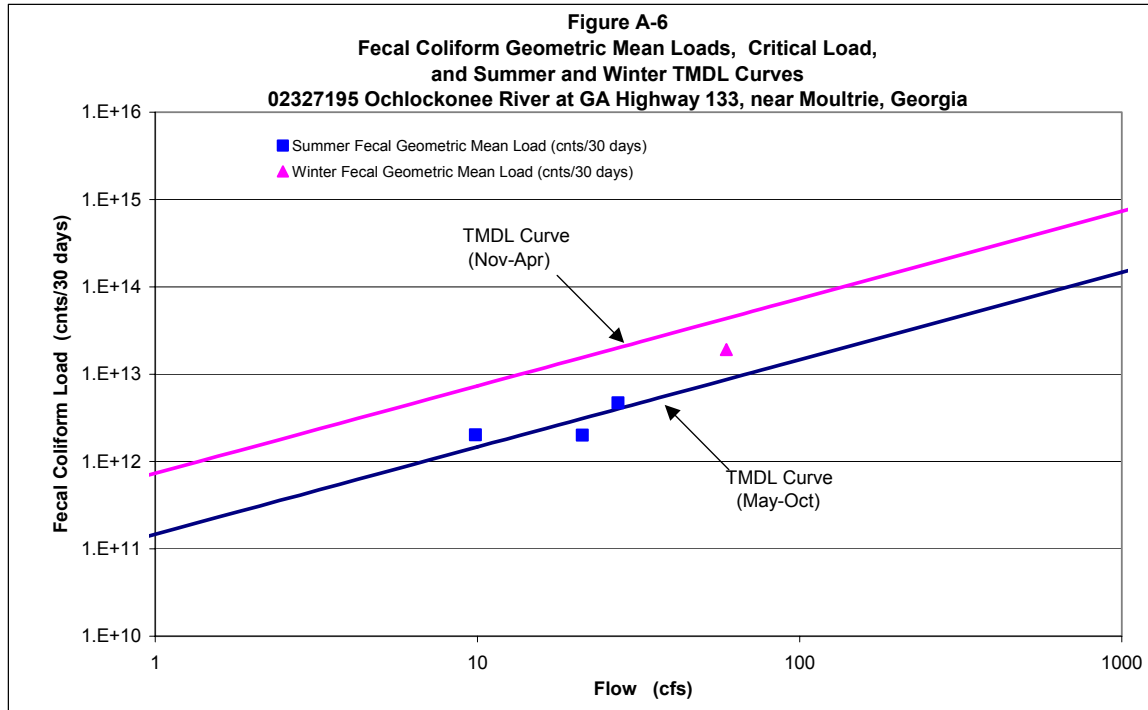


Table A-6. Data for Figure A-6

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
23-Feb-98	790	76.8				
2-Mar-98	110	50.8				
9-Mar-98	11,000	65.1				
24-Mar-98	40	44.3	442	59.2	1.92E+13	4.35E+13
27-May-98	160	10.4				
1-Jun-98	460	11.3				
8-Jun-98	170	8.1				
24-Jun-98	490	9.6	280	9.9	2.03E+12	1.45E+12
6-Aug-98	260	15.6				
10-Aug-98	20	14.3				
17-Aug-98	110	22.1				
2-Sep-98	490	32.5	129	21.2	2.01E+12	3.11E+12
1-Oct-98	1,700	39.1				
5-Oct-98	230	36.4				
22-Oct-98	110	18.2				
26-Oct-98	70	15.6	234	27.3	4.70E+12	4.01E+12

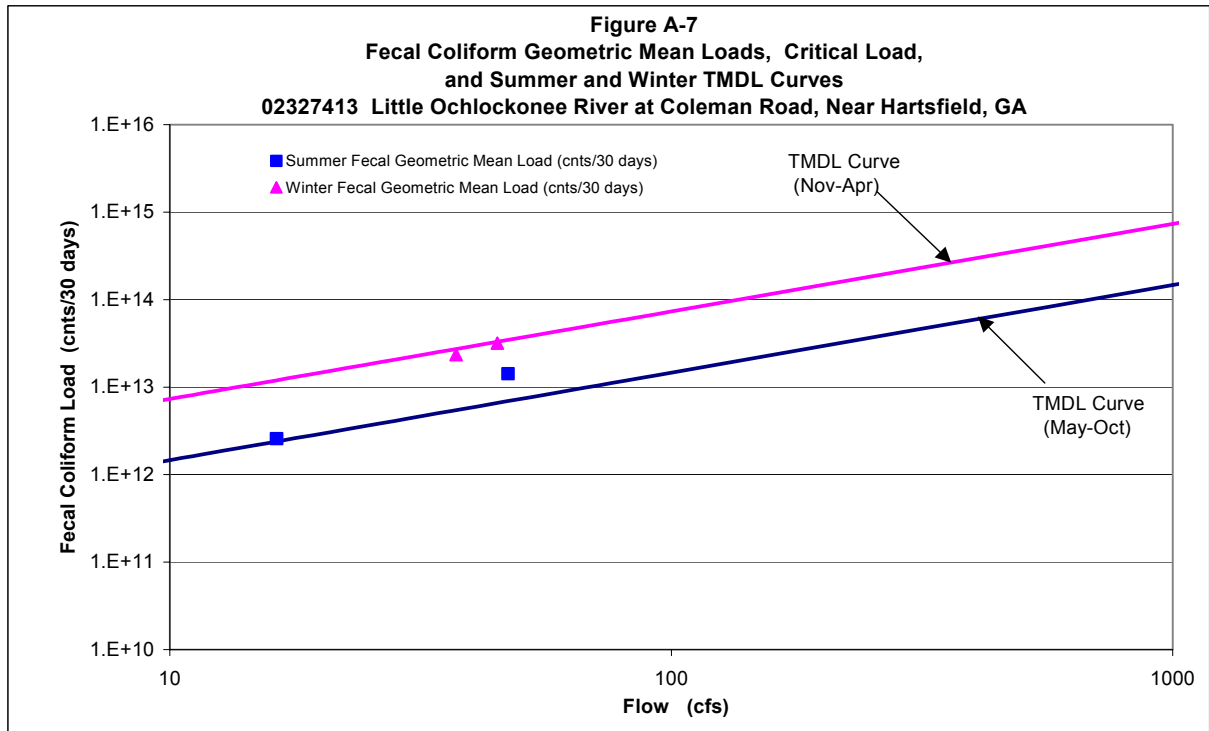


Table A-7. Data for Figure A-7

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
25-Feb-03	220	34.0				
4-Mar-03	3,500	55.0				
12-Mar-03	210	41.0				
18-Mar-03	5,400	50.0	967	45.0	3.19E+13	3.30E+13
18-Mar-03	5,400	50.0				
2-Apr-03	110	29.0				
9-Apr-03	5,400	45.0				
16-Apr-03	170	25.0	859	37.3	2.35E+13	2.73E+13
23-Jul-03	3,500	51.0				
5-Aug-03	230	59.0				
13-Aug-03	130	30.0				
19-Aug-03	270	49.0	410	47.3	1.42E+13	6.94E+12
10-Sep-03	50	25.0				
16-Sep-03	90	13.0				
23-Sep-03	2,800	27.0				
8-Oct-03	170	0.3	215	16.3	2.58E+12	2.40E+12

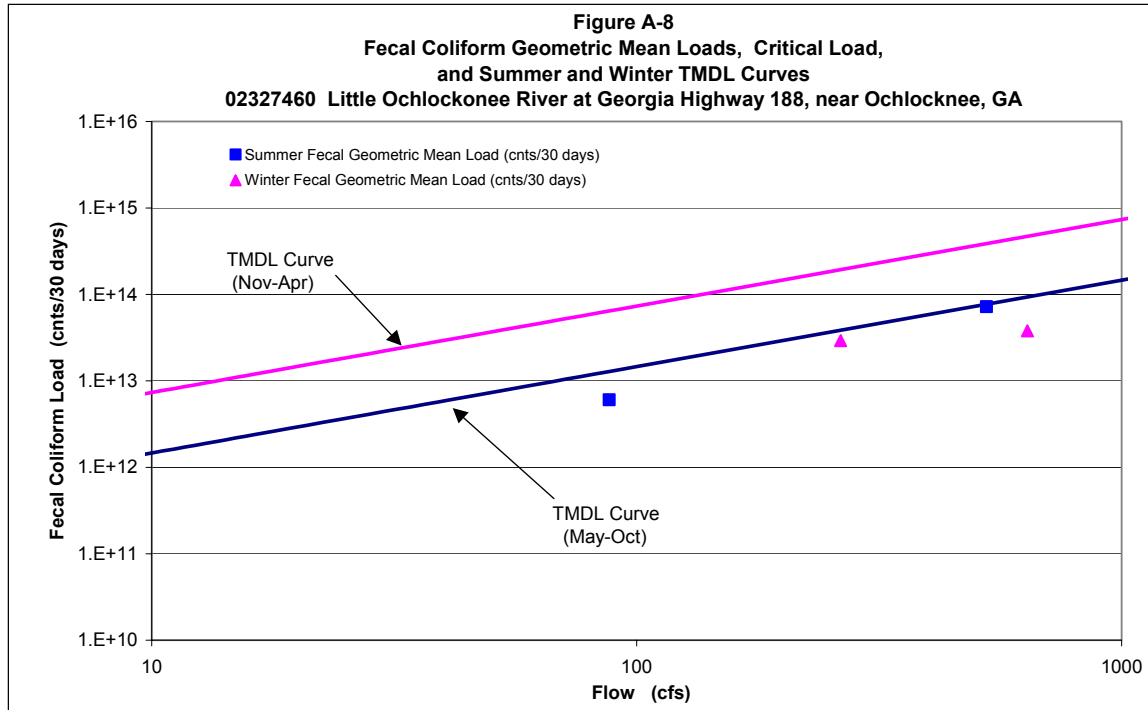


Table A-8. Data for Figure A-8

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
26-Feb-03	20	257.0				
4-Mar-03	130	874.0				
11-Mar-03	50	883.0				
19-Mar-03	330	543.0	81	639.3	3.80E+13	4.69E+14
19-Mar-03	330	543.0				
3-Apr-03	50	169.0				
8-Apr-03	790	217.0				
17-Apr-03	40	125.0	151	263.5	2.92E+13	1.93E+14
24-Jul-03	2,400	591.0				
7-Aug-03	90	619.0				
14-Aug-03	80	206.0				
20-Aug-03	70	690.0	186	526.5	7.21E+13	7.73E+13
11-Sep-03	50	126.0				
17-Sep-03	80	67.0				
24-Sep-03	490	76.0				
9-Oct-03	40	82.0	94	87.8	6.06E+12	1.29E+13

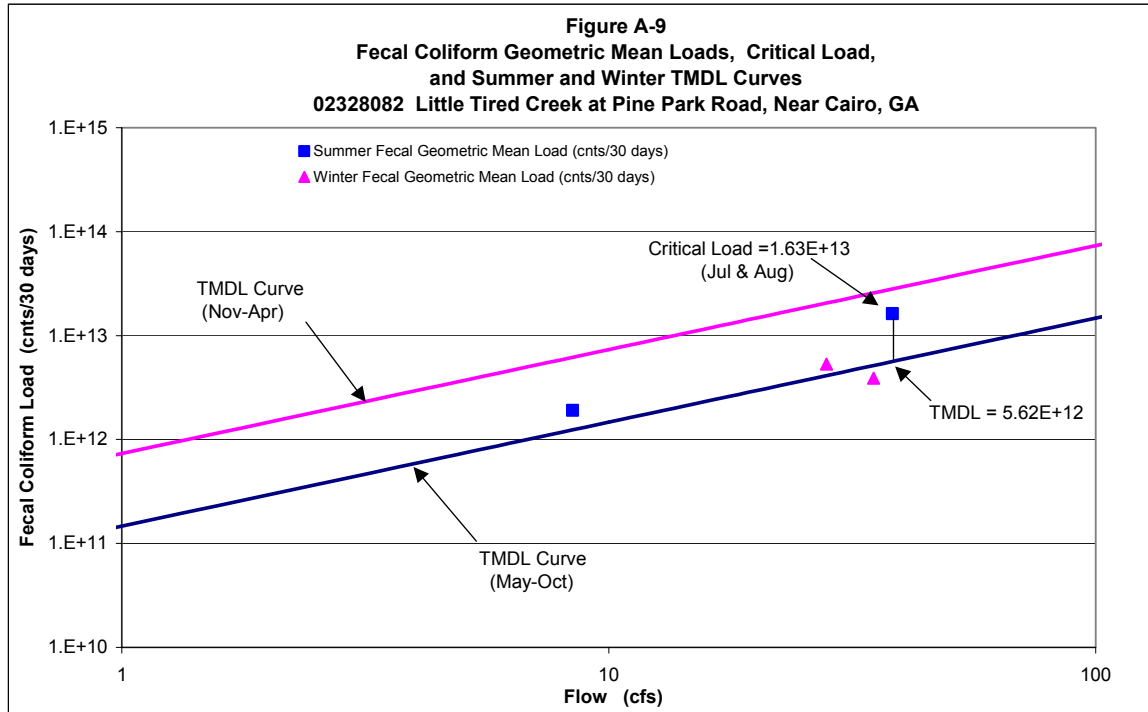


Table A-9. Data for Figure A-9

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
26-Feb-03	20	20.0				
4-Mar-03	490	40.0				
11-Mar-03	110	40.0				
19-Mar-03	490	40.0	152	35.0	3.89E+12	2.57E+13
19-Mar-03	490	40.0				
3-Apr-03	20	17.0				
8-Apr-03	3,500	40.0				
17-Apr-03	130	15.0	258	28.0	5.31E+12	2.06E+13
24-Jul-03	5,400	40.0				
7-Aug-03	330	40.0				
14-Aug-03	790	40.0				
20-Aug-03	80	33.0	579	38.3	1.63E+13	5.62E+12
11-Sep-03	230	10.0				
17-Sep-03	220	8.7				
24-Sep-03	230	8.7				
9-Oct-03	790	6.3	310	8.4	1.91E+12	1.24E+12

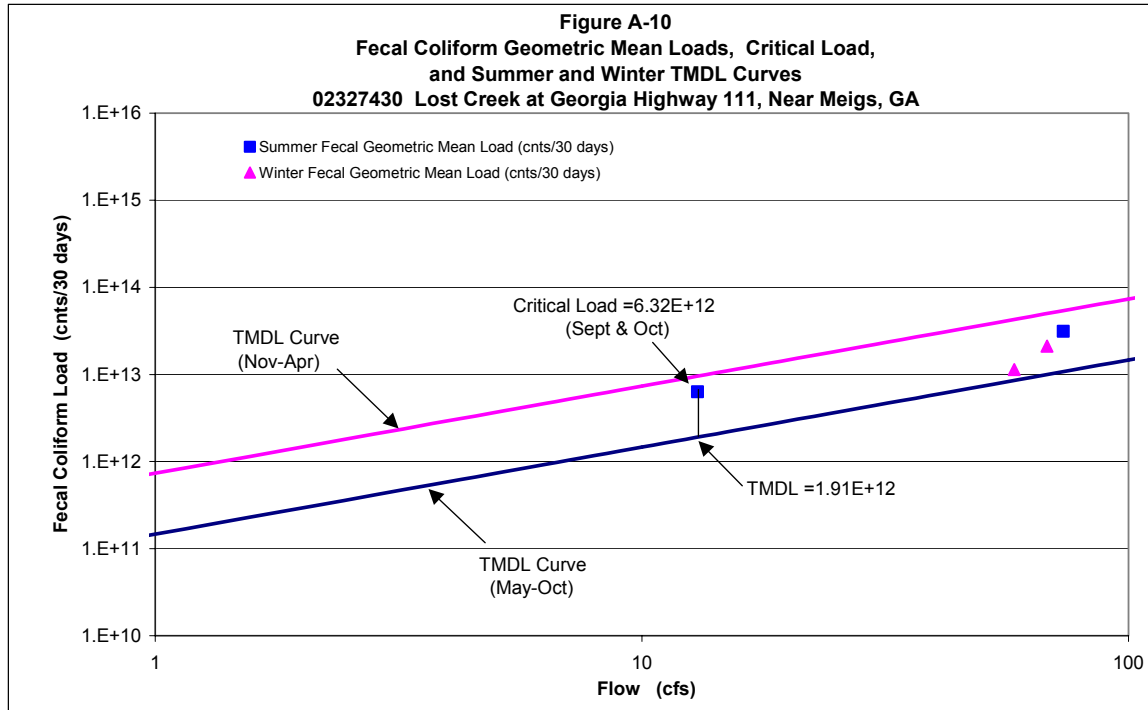


Table A-10. Data for Figure A-10

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
25-Feb-03	130	52.0				
4-Mar-03	1,300	84.0				
12-Mar-03	80	65.0				
18-Mar-03	2,400	71.0	424	68.0	2.12E+13	4.99E+13
18-Mar-03	2,400	71.0				
2-Apr-03	20	47.0				
9-Apr-03	1,300	76.0				
16-Apr-03	80	39.0	266	58.3	1.14E+13	4.28E+13
23-Jul-03	1,700	85.0				
5-Aug-03	1,700	84.0				
13-Aug-03	80	50.0				
19-Aug-03	490	75.0	580	73.5	3.13E+13	1.08E+13
10-Sep-03	790	26.0				
16-Sep-03	220	0.0				
23-Sep-03	1,400	26.0				
8-Oct-03	790	0.0	662	13.0	6.32E+12	1.91E+12

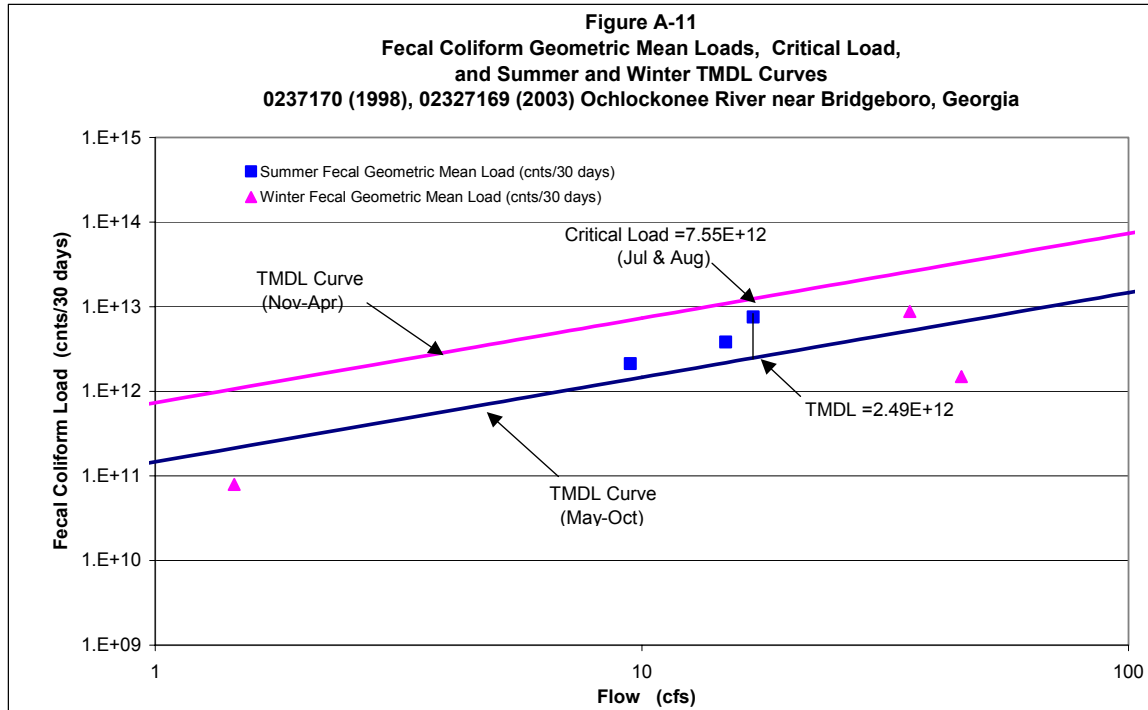


Table A-11. Data for Figure A-11

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
26-Feb-98	330	26.9				
5-Mar-98	130	30.7				
12-Mar-98	1,100	56.7				
26-Mar-98	270	27.9	336	35.5	8.76E+12	2.61E+13
28-May-98	1,100	5.9				
11-Jun-98	20	5.7				
17-Jun-98	170	5.0				
25-Jun-98	2,300	21.4	305	9.5	2.12E+12	1.39E+12
23-Jul-98	790	18.6				
30-Jul-98	1,800	27.9				
5-Aug-98	80	12.1				
13-Aug-98	1,200	9.2	608	16.9	7.55E+12	2.49E+12
8-Oct-98	170	20.4				
15-Oct-98	490	13.9				
21-Oct-98	230	13.9				
29-Oct-98	790	11.1	351	14.9	3.83E+12	2.18E+12
1/14/2003	230	3.6				
1/30/2003	330	1.7				
2/5/2003	20	0.5				
2/11/2003	20	0.0	74	1.5	7.91E+10	1.07E+12
3/25/2003	80	9.3				
4/3/2003	50	2.9				
4/9/2003	20	166.0				
4/15/2003	50	3.2	45	45.4	1.49E+12	3.33E+13

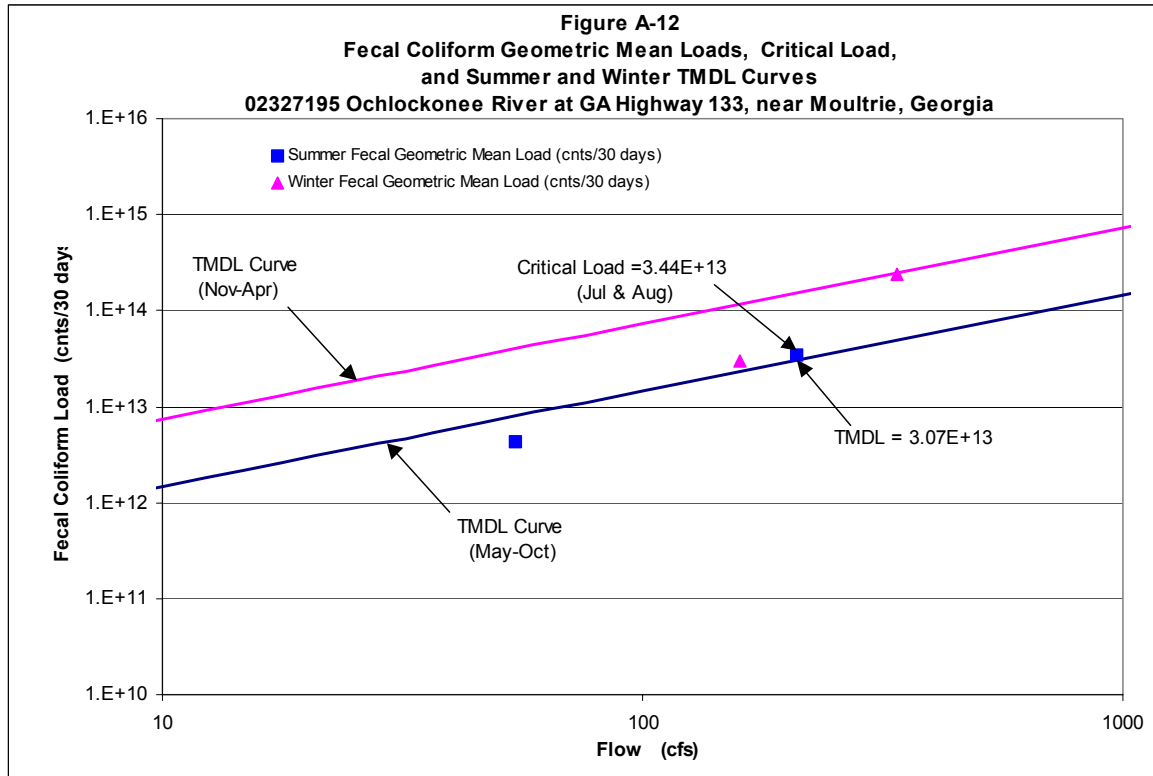


Table A-12. Data for Figure A-12

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
24-Feb-03	3,500	283.0				
3-Mar-03	2,800	673.0				
13-Mar-03	110	200.0				
17-Mar-03	790	195.0	961	337.8	2.38E+14	2.48E+14
17-Mar-03	790	195.0				
1-Apr-03	80	97.0				
9-Apr-03	490	263.0				
15-Apr-03	130	81.0	252	159.0	2.94E+13	1.17E+14
22-Jul-03	3,500	52.0				
6-Aug-03	130	373.0				
12-Aug-03	110	247.0				
19-Aug-03	50	165.0	224	209.3	3.44E+13	3.07E+13
9-Sep-03	80	168.0				
16-Sep-03	20	17.0				
23-Sep-03	490	25.0				
7-Oct-03	170	6.7	107	54.2	4.27E+12	7.95E+12

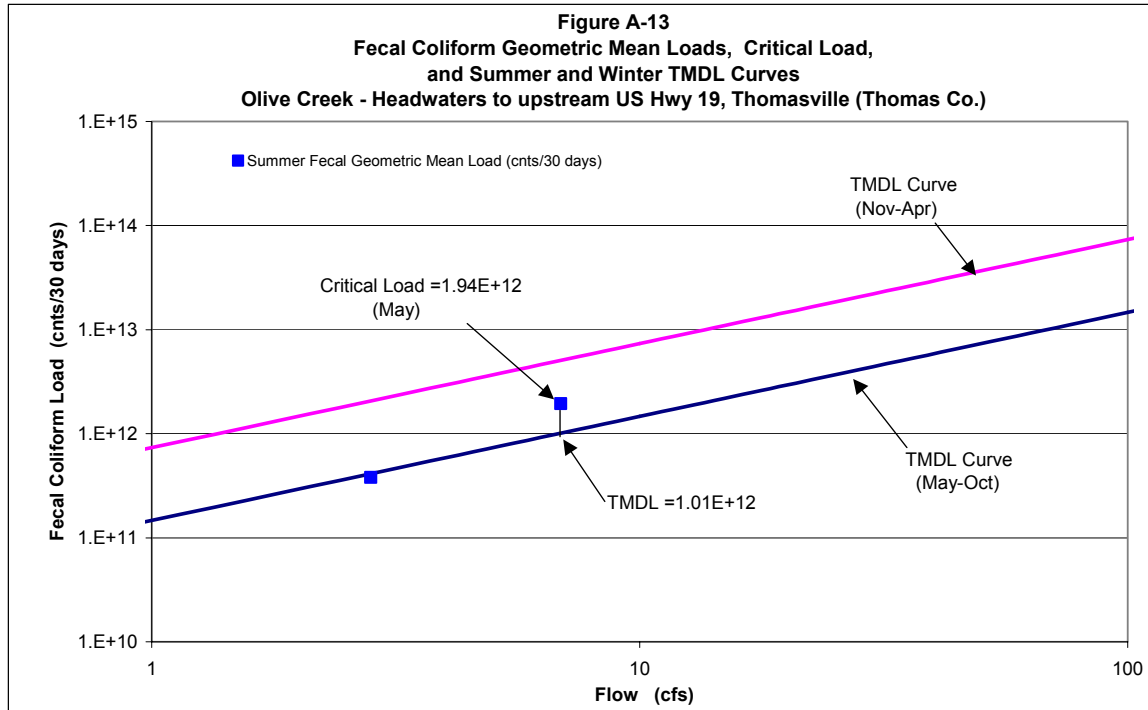


Table A-13. Data for Figure A-13

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
4-May-91	370	7.9				
25-May-91	376	6.2				
26-May-91	302	6.1				
27-May-91	520	7.4	384	6.9	1.94E+12	1.01E+12
5-Jun-91	204	3.7				
12-Jun-91	62	1.0				
19-Jun-91	200	0.7				
26-Jun-91	460	5.9	185	2.8	3.81E+11	4.13E+11

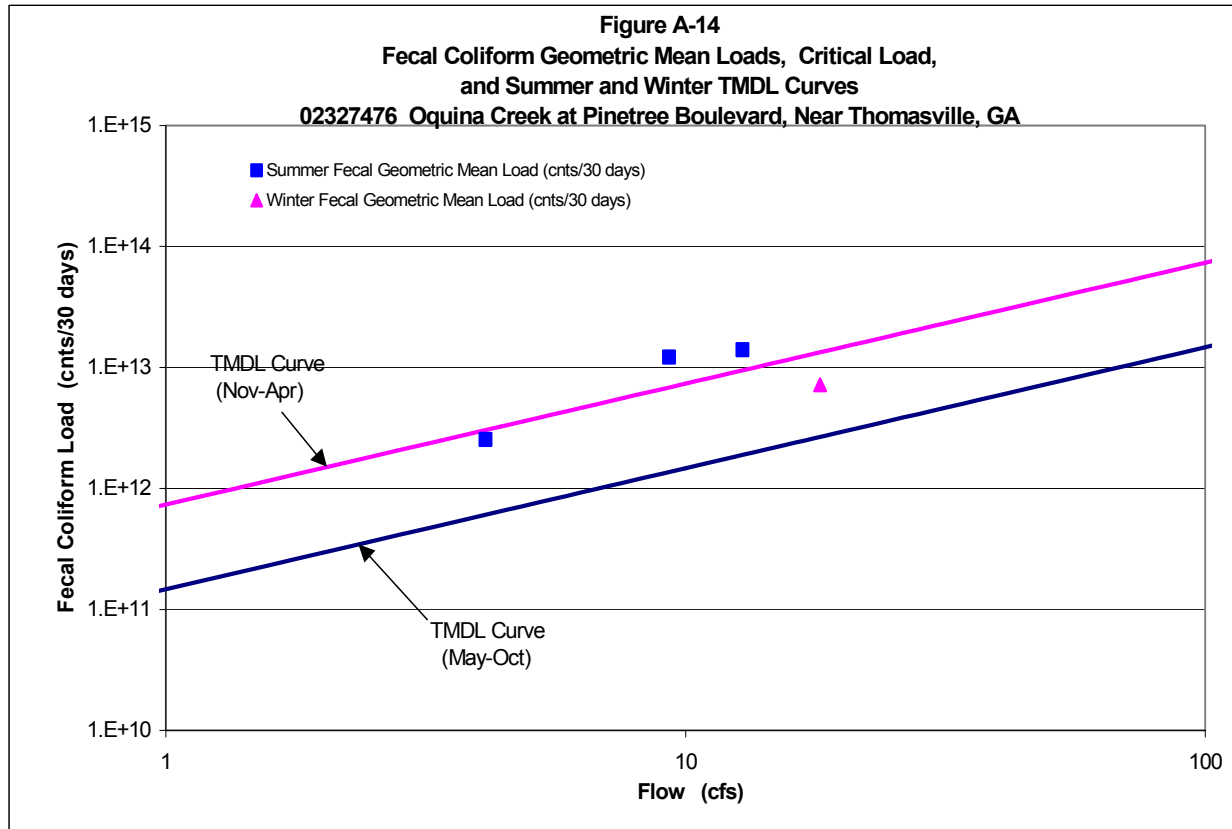


Table A-14. Data for Figure A-14

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
26-Feb-03	20	6.6				
4-Mar-03	2,400	24.0				
11-Mar-03	330	13.0				
19-Mar-03	5,400	29.0	541	18.2	7.20E+12	1.33E+13
19-Mar-03	5,400	29.0				
3-Apr-03	630	7.5				
8-Apr-03	1,300	10.0				
17-Apr-03	1,100	5.0	1485	12.9	1.40E+13	9.45E+12
24-Jul-03	2,400	8.4				
7-Aug-03	790	8.8				
14-Aug-03	2,400	13.0				
20-Aug-03	2,200	7.0	1779	9.3	1.21E+13	1.37E+12
11-Sep-03	330	3.5				
17-Sep-03	1,100	4.6				
24-Sep-03	790	4.8				
9-Oct-03	1,700	3.6	836	4.1	2.53E+12	6.06E+11

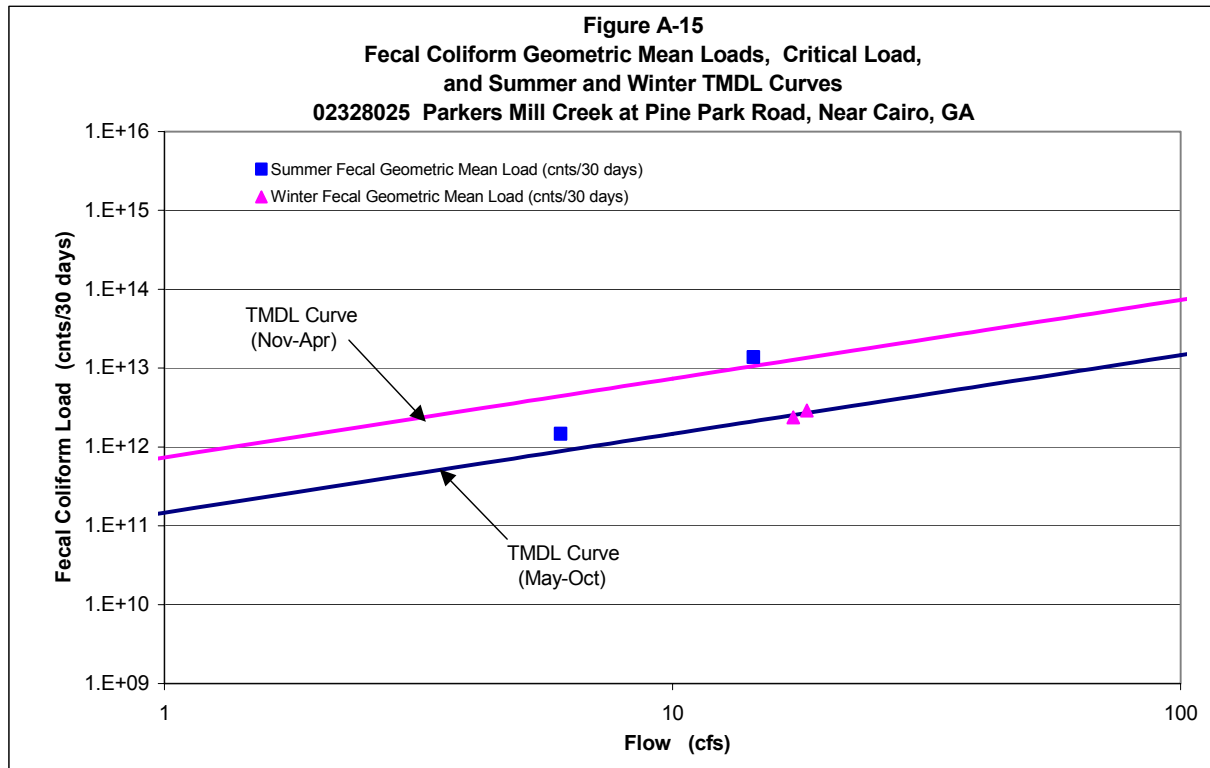


Table A-15. Data for Figure A-15

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
26-Feb-03	20	8.5				
4-Mar-03	700	32.0				
11-Mar-03	460	20.0				
19-Mar-03	330	13.0	215	18.4	2.90E+12	1.35E+13
19-Mar-03	330	13.0				
3-Apr-03	20	7.3				
8-Apr-03	9,200	43.0				
17-Apr-03	20	5.8	187	17.3	2.37E+12	1.27E+13
24-Jul-03	24,000	35.0				
7-Aug-03	490	7.6				
14-Aug-03	3,500	7.4				
20-Aug-03	70	7.7	1303	14.4	1.38E+13	2.12E+12
11-Sep-03	330	5.3				
17-Sep-03	230	5.4				
24-Sep-03	490	6.9				
9-Oct-03	330	6.5	333	6.0	1.47E+12	8.84E+11

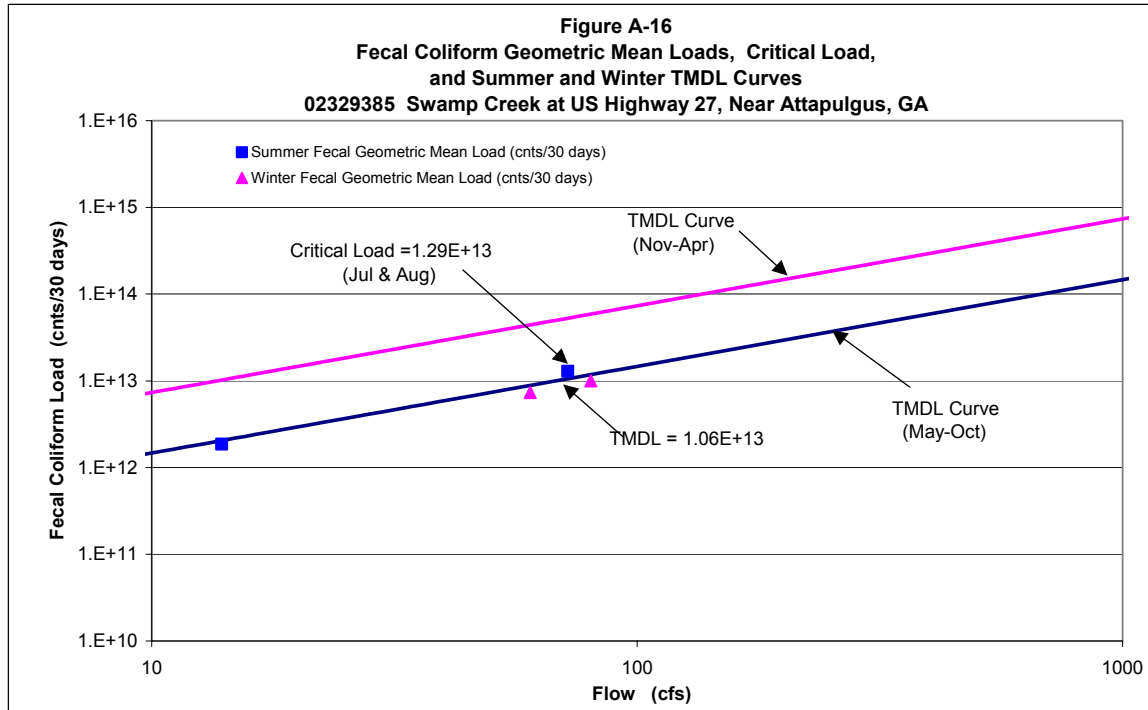


Table A-16. Data for Figure A-16

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
26-Feb-03	20	21.0				
4-Mar-03	460	100.0				
11-Mar-03	330	100.0				
19-Mar-03	270	100.0	169	80.3	9.97E+12	5.89E+13
19-Mar-03	270	100.0				
3-Apr-03	20	24.0				
8-Apr-03	3,500	100.0				
17-Apr-03	40	17.0	166	60.3	7.33E+12	4.42E+13
24-Jul-03	1,300	100.0				
7-Aug-03	110	72.0				
14-Aug-03	490	93.0				
20-Aug-03	50	23.0	243	72.0	1.29E+13	1.06E+13
11-Sep-03	80	11.0				
17-Sep-03	170	9.8				
24-Sep-03	293	18.0				
9-Oct-03	270	17.0	181	14.0	1.85E+12	2.05E+12

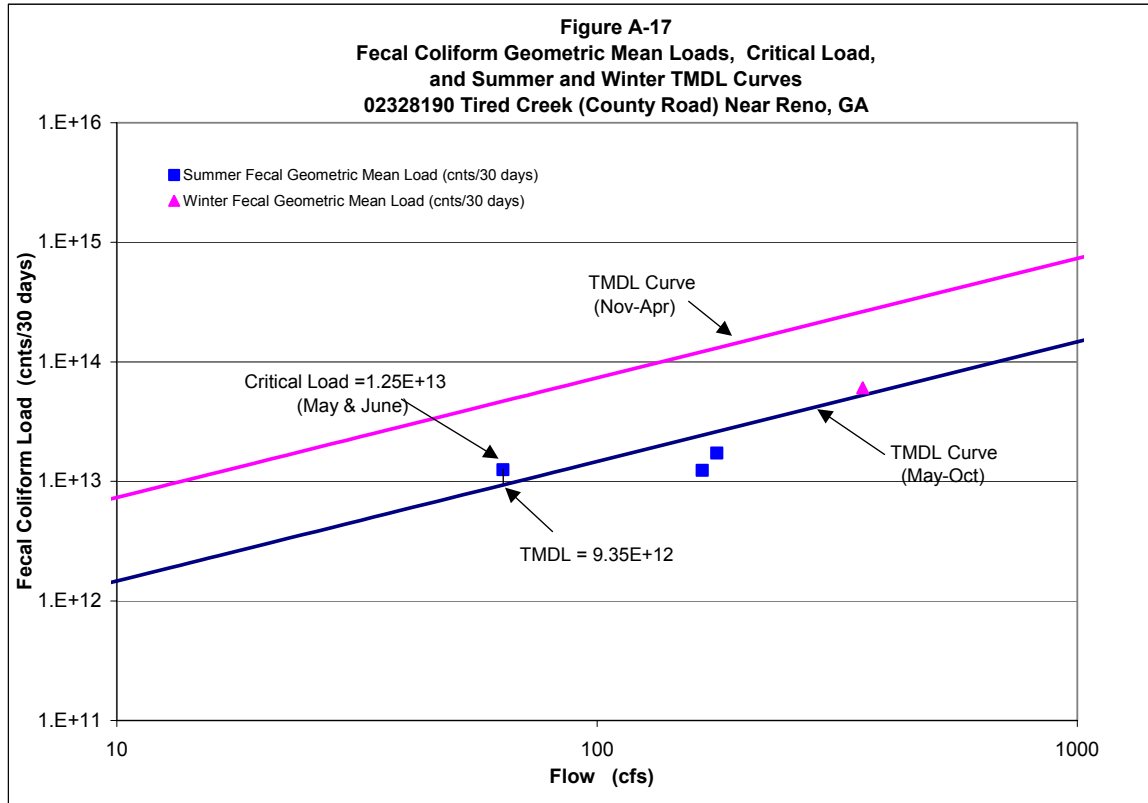


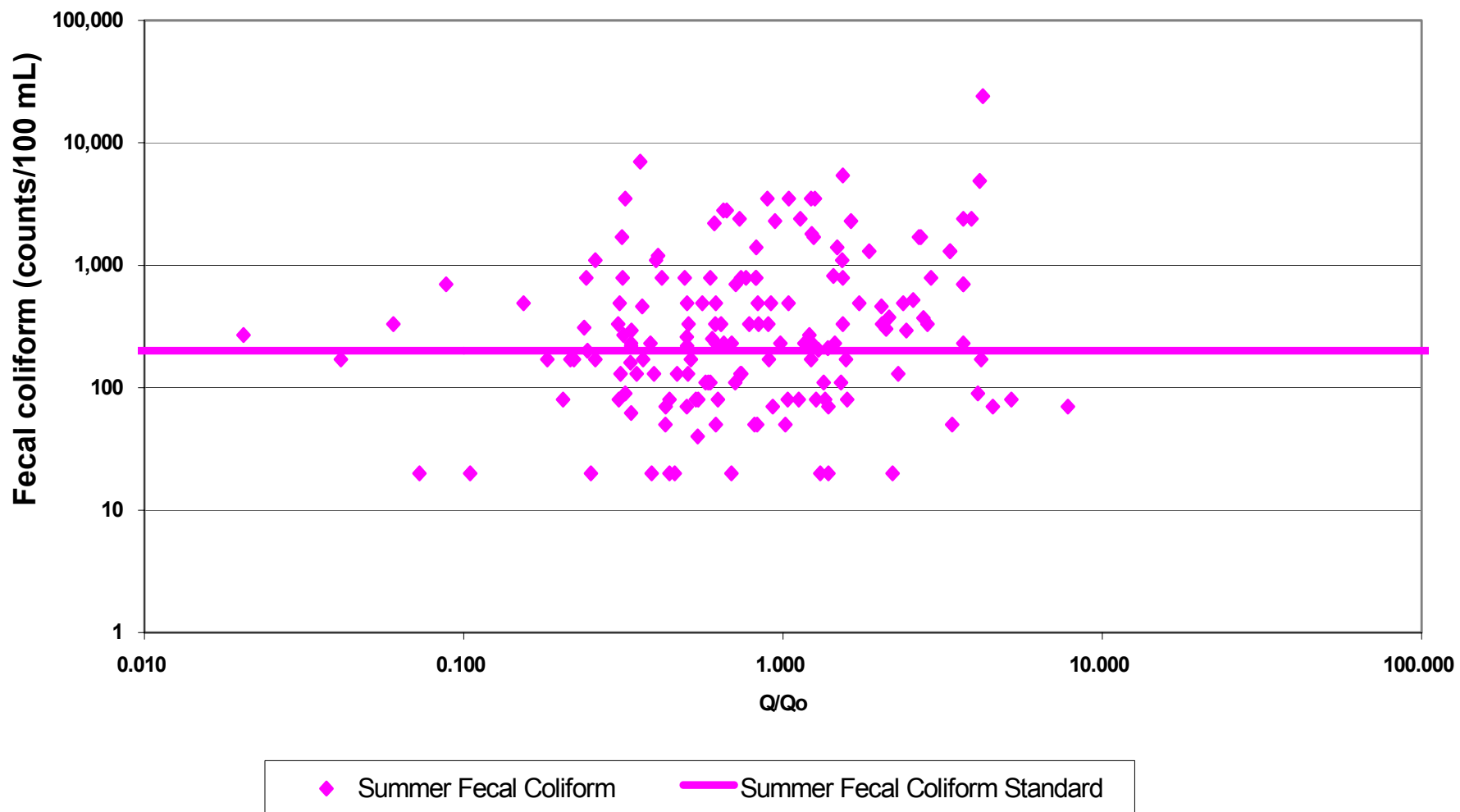
Table A-17. Data for Figure A-17

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
25-Feb-98	1,300	293.5				
10-Mar-98	240	473.4				
17-Mar-98	140	378.7				
26-Mar-98	65	284.0	231	357.4	6.06E+13	2.62E+14
26-May-98	700	82.4				
9-Jun-98	330	58.7				
15-Jun-98	130	54.0				
23-Jun-98	170	59.6	267	63.7	1.25E+13	9.35E+12
21-Jul-98	2,300	189.3				
27-Jul-98	20	255.6				
3-Aug-98	20	160.9				
11-Aug-98	330	104.1	132	177.5	1.72E+13	2.61E+13
6-Oct-98	330	236.7				
13-Oct-98	20	151.5				
19-Oct-98	70	160.9				
27-Oct-98	230	113.6	102	165.7	1.23E+13	2.43E+13

Appendix B

Normalized Flows Versus Fecal Coliform Plots

Normal Distribution



Normal Distribution

