TOTAL MAXIMUM DAILY LOAD (TMDL) DEVELOPMENT

For FECAL COLIFORM in the

BUTLER CREEK WATERSHED

In the Savannah River Basin

(HUC 03060106)

Richmond County, Butler Creek, Augusta, Georgia

APPROVAL PAGE

for FECAL COLIFORM TMDL in

Butler Creek, GA

Georgia=s final 1998 303(d) list identified Butler Creek near Augusta, GA as not supporting its designated use, with the pollutant of concern being fecal coliform bacteria. This total maximum daily load (TMDL) is being established pursuant to the 1998 Georgia 303(d) list and the Consent Decree in the Georgia TMDL Lawsuit.

The TMDL calculation is based on the results of the Stormwater Management Model (SWMM) and the Water Quality Analysis Simulation Program (WASP5) model to determine the appropriate 30-day fecal coliform load that will achieve water quality standards.

The maximum load that caused a water quality standard was calculated for 1997 by analyzing the WASP model results. It was determined that the largest 30-day geometric fecal coliform concentration occurred in Segment 8 between 7/4/97 to 8/4/97 with a value of 2774 counts/100 ml. This is equivalent to 2.39E+15 counts/30 days. Using the WASP model it was determined that to achieve the water quality standard of 200 counts/100 ml as a 30-day geometric mean the fecal load coming from the Butler Creek watershed would have to be reduced by 98%.

For the Butler Creek watershed a 98% load reduction would have to occur to achieve the 200-counts/100 ml or no more than 3.45E+13 counts/30 days.

APPROVED BY:

_________________________ ___________________

Robert F. McGhee, Director Date

Water Management Division

EPA-Region 4

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Introduction

Section 303(d) of the Clean Water Act (CWA) as Amended by the Water Quality Act of 1987, Public Law 100-4, and the United States Environmental Protection Agency's (USEPA/EPA) Water Quality Planning and Management Regulations [Title 40 of the Code of Federal Regulation (40 CFR), Part 130] require each State to identify those waters within its boundaries not meeting water quality standards applicable to the waters' designated uses. The identified waters are prioritized based on the severity of pollution with respect to designated use classifications. Total maximum daily loads (TMDLs) for all pollutants violating or causing violation of applicable water quality standards are established for each identified water. Such loads are established at levels necessary to implement the applicable water quality standards with seasonal variations and margins of safety. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body, based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

Problem Definition

Georgia's final 1998 Section 303(d) list identified Butler Creek, which flows into the Savannah River just below the City of Augusta, Georgia as not supporting its designated use as fishing water, with the pollutant of concern being Fecal Coliform. A limited dataset has been previously collected. An analysis of the data shows water quality impairment due to Fecal Coliform, primarily due to stormwater discharge. The most likely cause of the elevated Fecal Coliform concentrations are due to leaky sewers and stormwater runoff. This TMDL will consider the effects of storm events on Fecal Coliforms and will calculate the percent reduction in Fecal Coliform runoff that will need to occur to meet the water quality standard. Butler Creek has 109 stormwater outfalls draining stormwater from the surrounding urban watershed. Urban landuse comprises most of the Butler Creek watershed. Because a large portion of the watershed is impervious to water infiltration, pollutant runoff is a major concern.

Target Identification

The target level for the development of the Fecal Coliform TMDL in the Butler Creek segment is the numeric criterion established in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6, Revised July 6, 1999. Georgia Regulations establish the freshwater criterion for Fecal Coliform expressed in terms of a geometric mean concentration of no more than 200 counts/100ml.

Background

The segment that is impaired is Butler Creek, which is an urban area located in the City of Augusta. Butler Creek drains into the Savannah River. The 10-mile segment of Butler Creek is on the State of Georgia's 1998 §303 (d) list for violating the total Fecal Coliform standard for the State of Georgia. The primary sources of water to Butler Creek are from urban runoff and Phinizy Ditch, which conveys water from Rocky Creek. A TMDL for Fecal Coliform was previously developed for Rocky Creek, which is on the State's 303(d) list. The load reductions calculated for the fecal coliform TMDL on Rocky Creek will be used as boundary conditions for the Butler Creek TMDL. This TMDL calculates the percent load reduction of fecal coliform that will need to occur for Butler Creek to achieve water quality standards.

Numeric Targets and Sources - Model Development

Determining the causes of elevated fecal coliform concentrations within Butler Creek will need further investigations in the future because current data is inconclusive in determining sources. Richmond County has just initiated a stormwater sampling program to better assess sources and quantities of fecal coliform draining into Butler Creek during storm events. Initial data collected by Richmond County indicate dramatic increases in fecal coliform concentrations during storm events.

Assessing the impacts of storm runoff on stream water quality is a very difficult task, accounting for the dynamics of rapidly changing stream flows coupled with the flushing of constituents from the land surface into the receiving waterbody. This requires the application of two separate models: 1) to predict the quantity and quality running off of the land surface, 2) a water quality model that combines the pollutagraph and hydrograph produced by the runoff model that transports and predicts in-stream fecal concentrations. Richmond County, as part of its NPDES Stormwater Permit renewal, developed a dynamic model for evaluating the impacts of storm events in Butler Creek. The Stormwater Management Model (SWMM), a dynamic simulation model that utilizes rainfall data, was used to predict the quantity and quality of water washing off the watershed. Richmond County has a limited dataset of sampled storm events in Butler Creek. This limited data will be used to calibrate the SWMM model using best professional judgment. Richmond County has data starting in spring 1997 through the fall of 1997. SWMM was calibrated and applied to the time period starting April 1, 1997 through October 1, 1997. The SWMM model predicts both flow and fecal coliform concentrations running off the watershed and entering Butler Creek through the 109 outfalls. The SWMM model provides a continuous time series (April 1 – October 1, 1997) of flow and fecal coliform concentration. The water quality model, to determine in-stream fecal coliform concentrations and to calculate the TMDL, will use this time series.

The Water Quality Analysis Simulation Program (WASP5) was used to evaluate the impact of the stormwater loads on the instream fecal concentrations. WASP5 is a dynamic model that is capable of reading time series of flows and concentrations as model boundary conditions and then combines these time series with in-stream hydraulics and water quality to calculate fecal concentrations. The WASP5 model was used to calculate the current fecal coliform load within a 30-day period that causes the largest violation within the modeling period. Once done, WASP5 was used to calculate the percent reduction in fecal coliform load that would have to occur for Butler Creek to achieve water quality standards.

Critical Condition Determination

Determining the most critical condition for stormwater impacted streams require long-term historical data. This type of information is usually not available for smaller watersheds. Because Richmond County developed a stormwater model for 1997 and collected a limited dataset to support the model , this time period was selected for the TMDL development. The quantity of fecal coliform that is washed off the watershed is a function of storm frequency and the period of time between the storms. This period of time includes both short and long term storms with varying periods of times between storms. 1997 provided an adequate time series of rainfall that was representative of an average season.

The base flow of Butler Creek was set to a constant 7Q10 flow of 2 cubic feet per second (cfs), which represents the most critical condition of the creek that storms can impact.

Total Maximum Daily Load (TMDL)

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while achieving water quality standards. Butler Creek is currently not meeting water quality standards. Richmond County, Georgia does have an MS4/NPDES stormwater discharge permit for this area. The TMDL is expressed as a percent reduction in fecal coliform load that will need to occur to meet water quality standards.

Margin of Safety

The margin of safety (MOS) is part of the TMDL development process. There are two basic methods for incorporating the MOS (USEPA, 1991a):

1. Implicitly incorporating the MOS using conservative model assumptions to develop allocations, or
2. Explicitly specifying a portion of the total TMDL as the MOS; using the remainder for allocations.

The MOS is incorporated implicitly into this modeling process by the most conservative fecal coliform wash off rates.

Stormwater Model Results

The Stormwater Management Model (SWMM) was first applied to the Butler Creek watershed using the initial setup by Richmond County. The model was calibrated using literature values for fecal coliform wash off rates that have been used in previous modeling studies using SWMM. The SWMM model input divided the Butler Creek watershed into five landuse categories:

1. Single Family
2. Multi-Family
3. Commercial
4. Industrial
5. Open

These landuses were parameterized in the model to provide a portion of the fecal coliform load coming from the watershed. Both the fecal coliform and the water flow were collected and left the system through the 109 outfalls located on Butler Creek. Using the detailed information from the SWMM model, the 109 outfalls were combined into 5 major outfalls that would be input to the water quality model. Figure 1 illustrates a model schematic, which depicts where the SWMM runoff predictions are entered in the WASP model network.

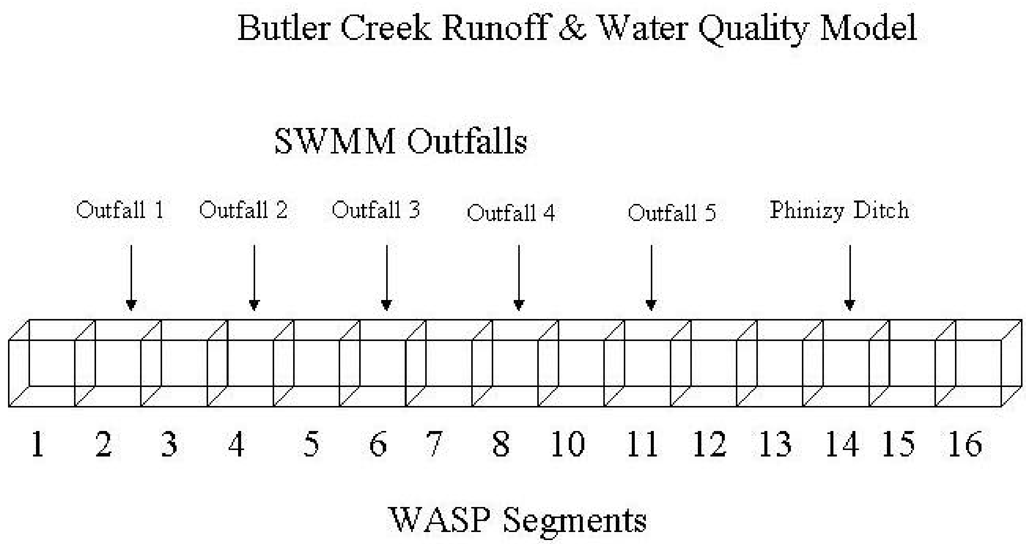


Figure 1 SWMM and WASP Model Network

The SWMM model results are presented first. The first 20 most upstream outfalls from the SWMM model were composited into one outfall that enters the WASP model at segment 2. When SWMM outfalls are composited, a flow weighted fecal coliform concentration was calculated to best represent the individual outfalls to the water quality model. Only the fecal coliform concentrations were flow averaged for WASP. The flows were summed together from all of the SWMM outfalls.

Figure 2 illustrates the predicted runoff hydrograph for outfall 1.

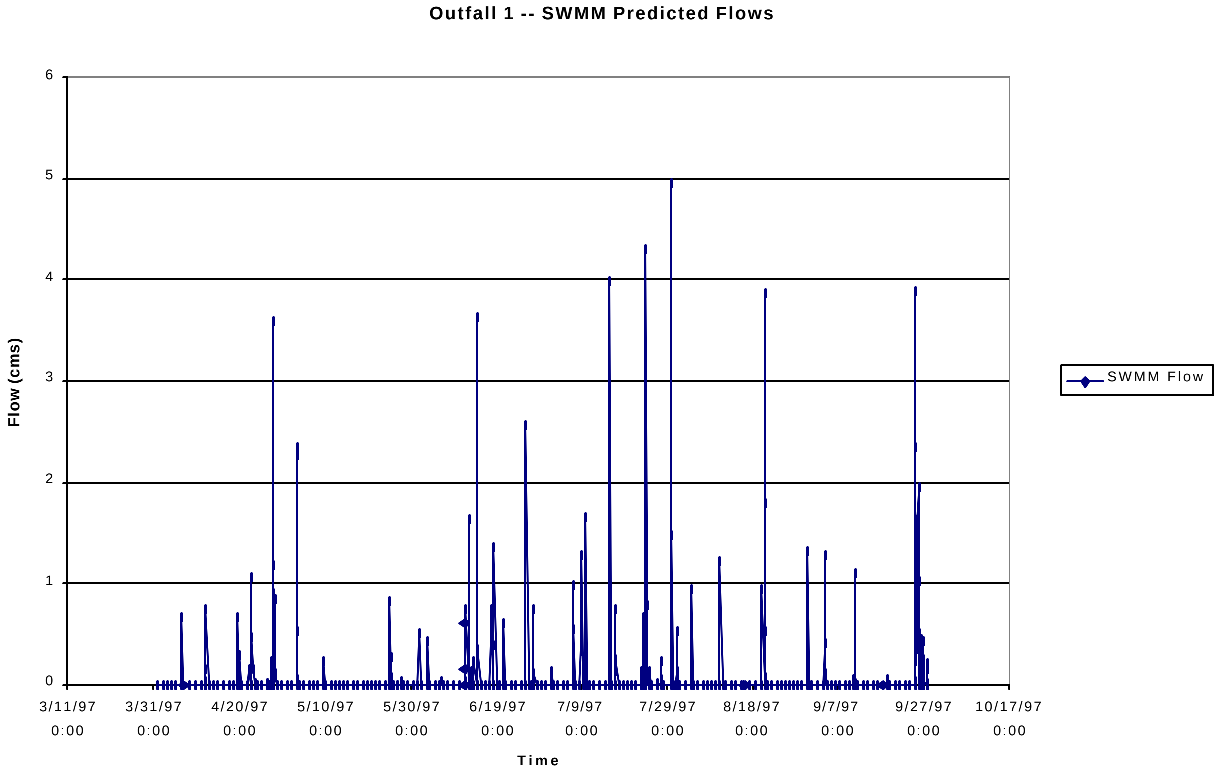


Figure 2 SWMM Predicted Flows for Outfall 1

Figure 3 illustrates the flow weighted fecal coliform concentrations coming from the Butler Creek watershed during storm events. Note that larger runoff concentrations occur as a function of larger storms and after long periods of time when no rain fell on the watershed.

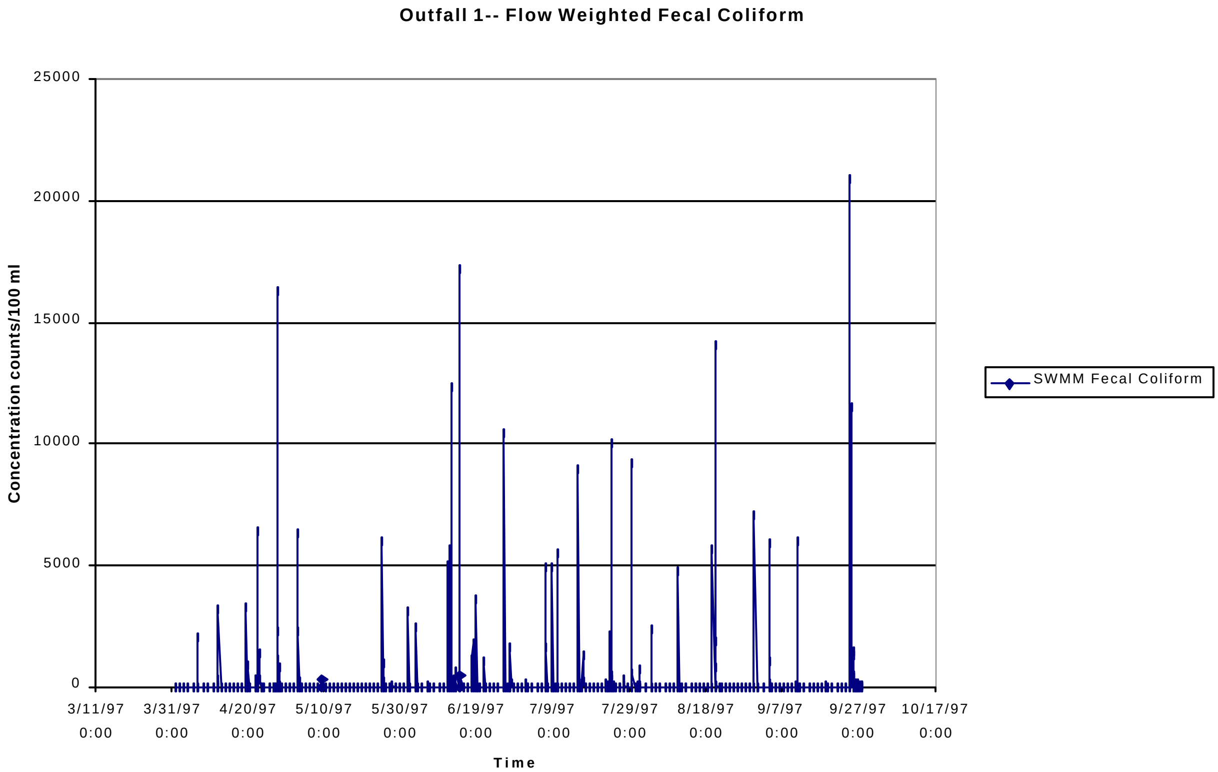


Figure 3 SWMM Flow Weighted Fecal Coliform Concentrations for Outfall 1

Figure 4 and Figure 5 illustrate the stormwater flow and fecal coliform concentrations for outfall 2.

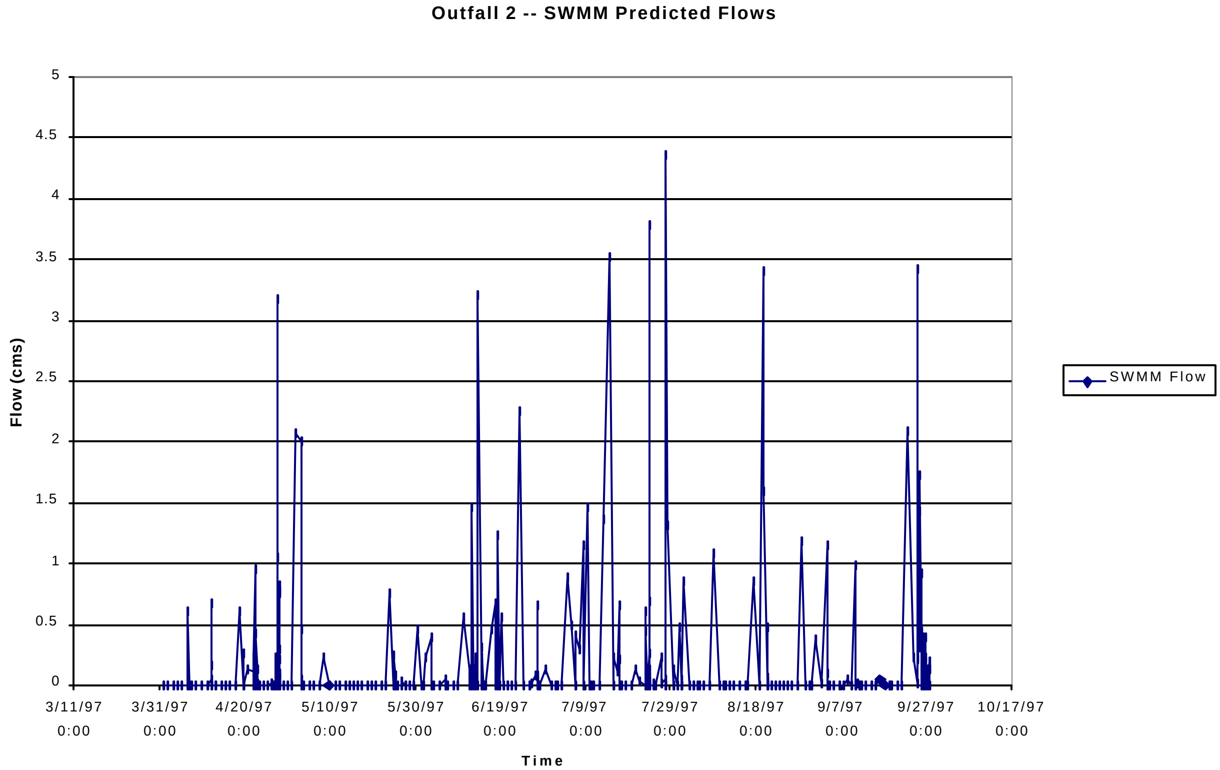


Figure 4 SWMM Predicted Flows for Outfall 2

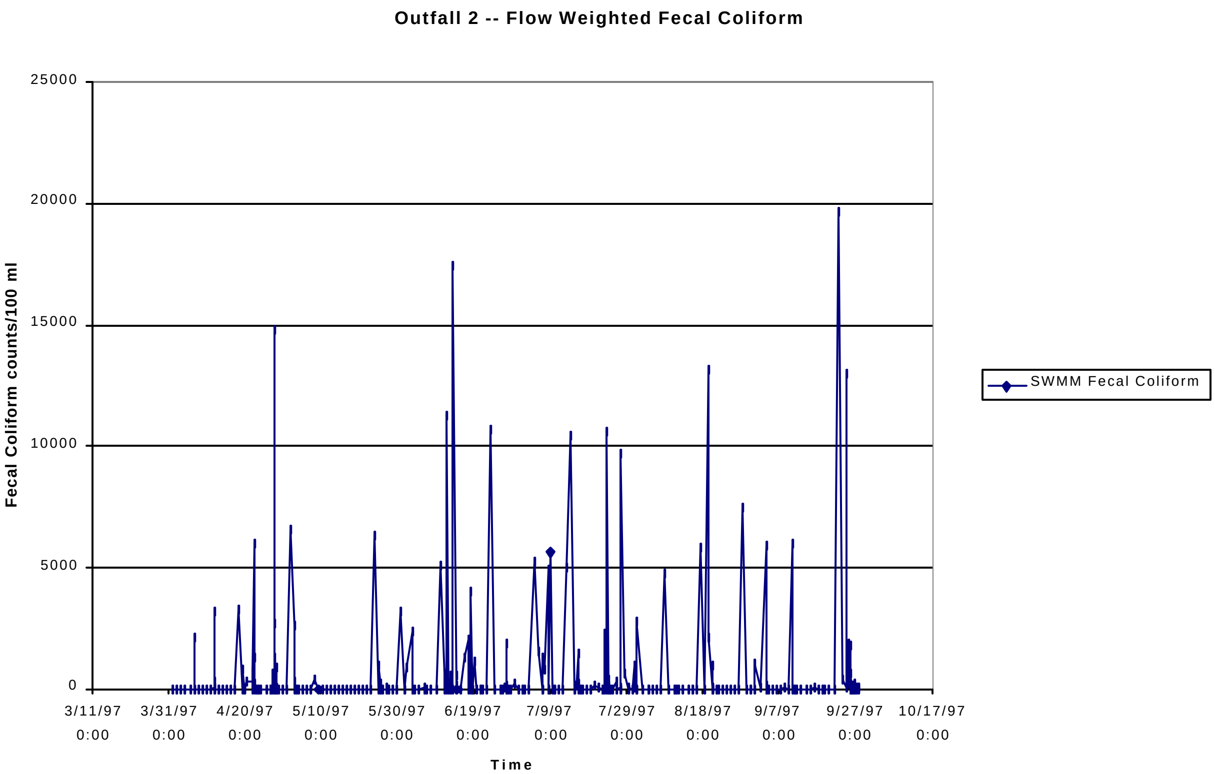


Figure 5 SWMM Flow Weighted Fecal Coliform Concentrations for Outfall 2

Figure 6 and Figure 7 illustrate the stormwater flow and fecal coliform concentrations for outfall 3.

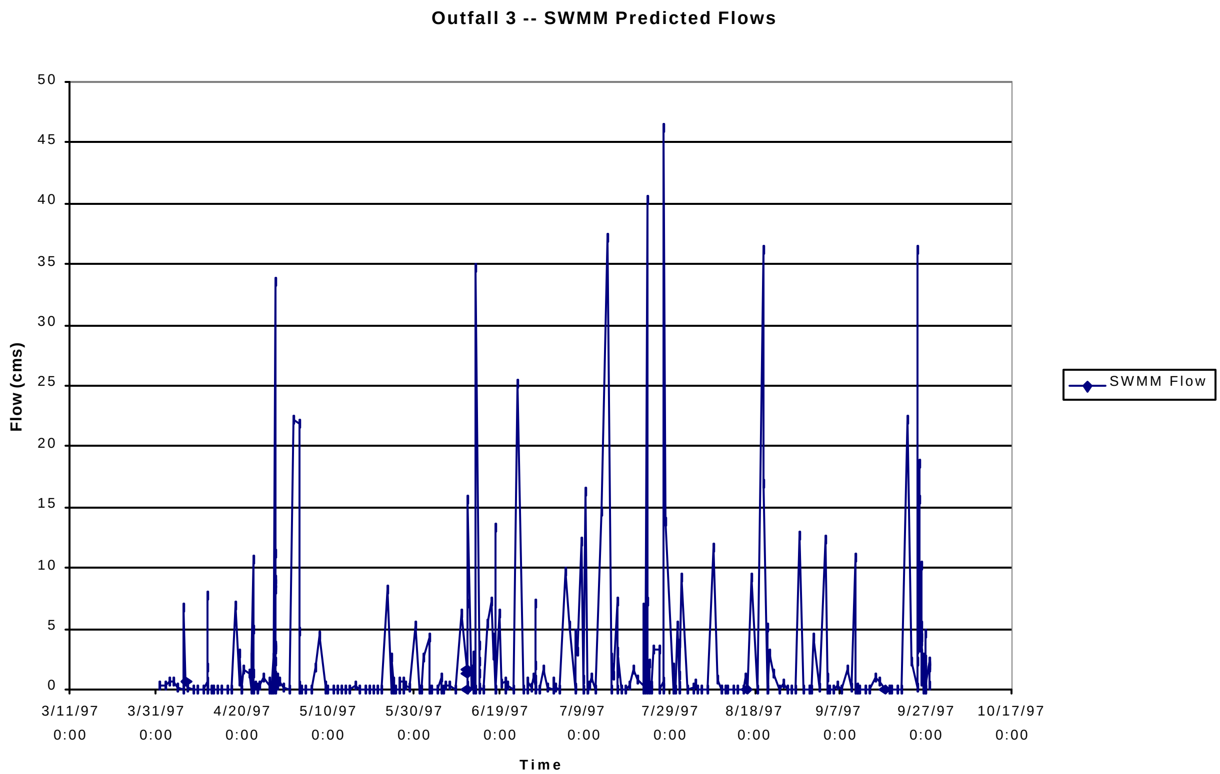


Figure 6 SWMM Predicted Flows for Outfall 3

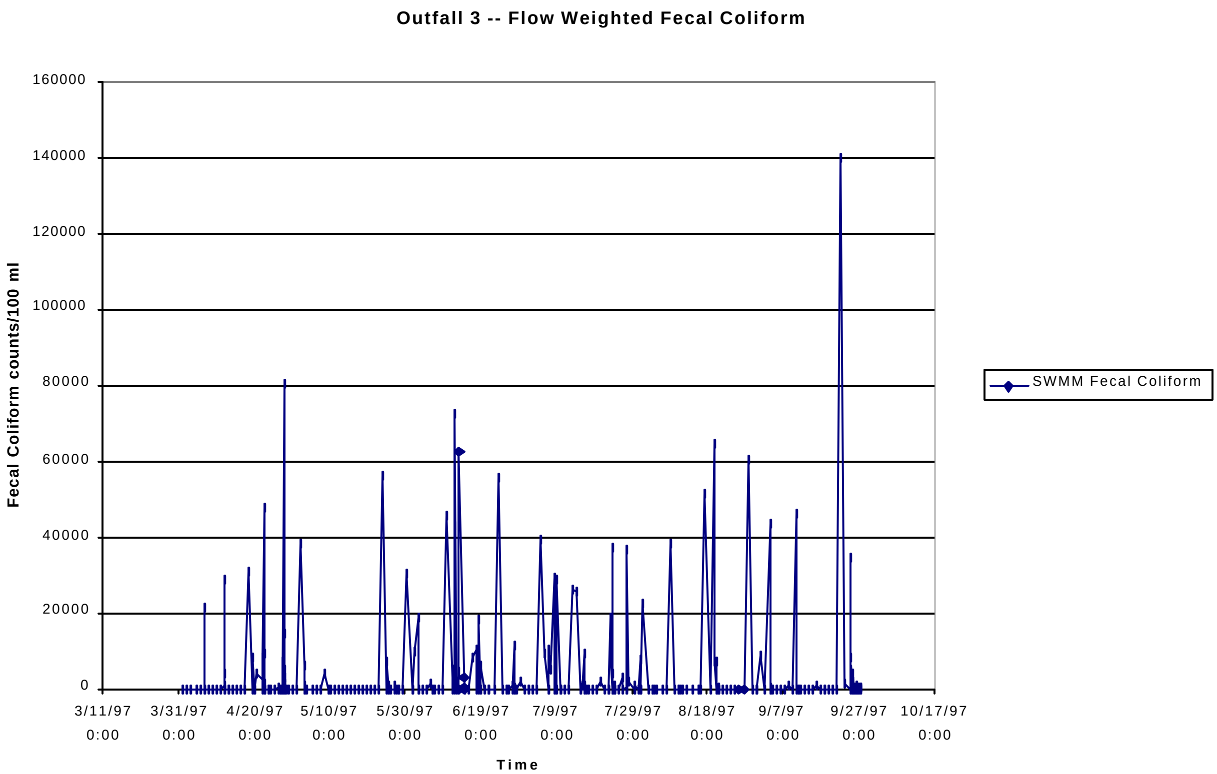


Figure 7 SWMM Flow Weighted Fecal Coliform Concentrations for Outfall 3

Figure 8 and Figure 9 illustrate the stormwater flow and fecal coliform concentrations for outfall 4.

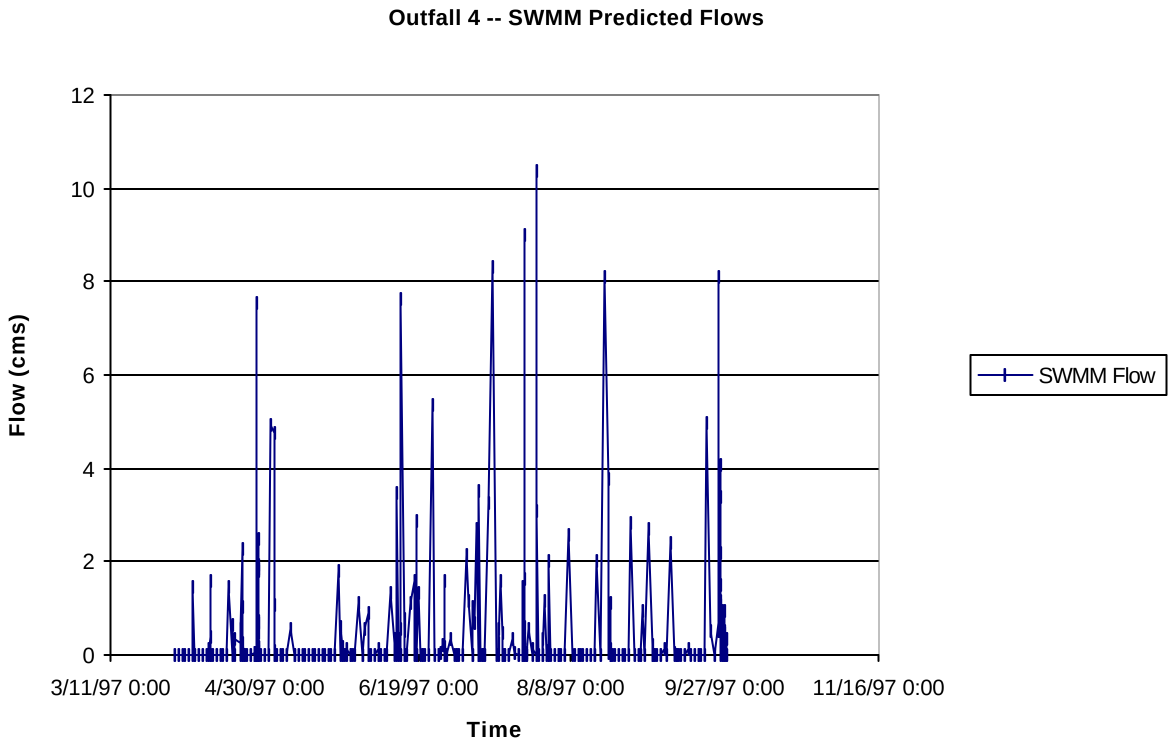


Figure 8 SWMM Predicted Flows for Outfall 4

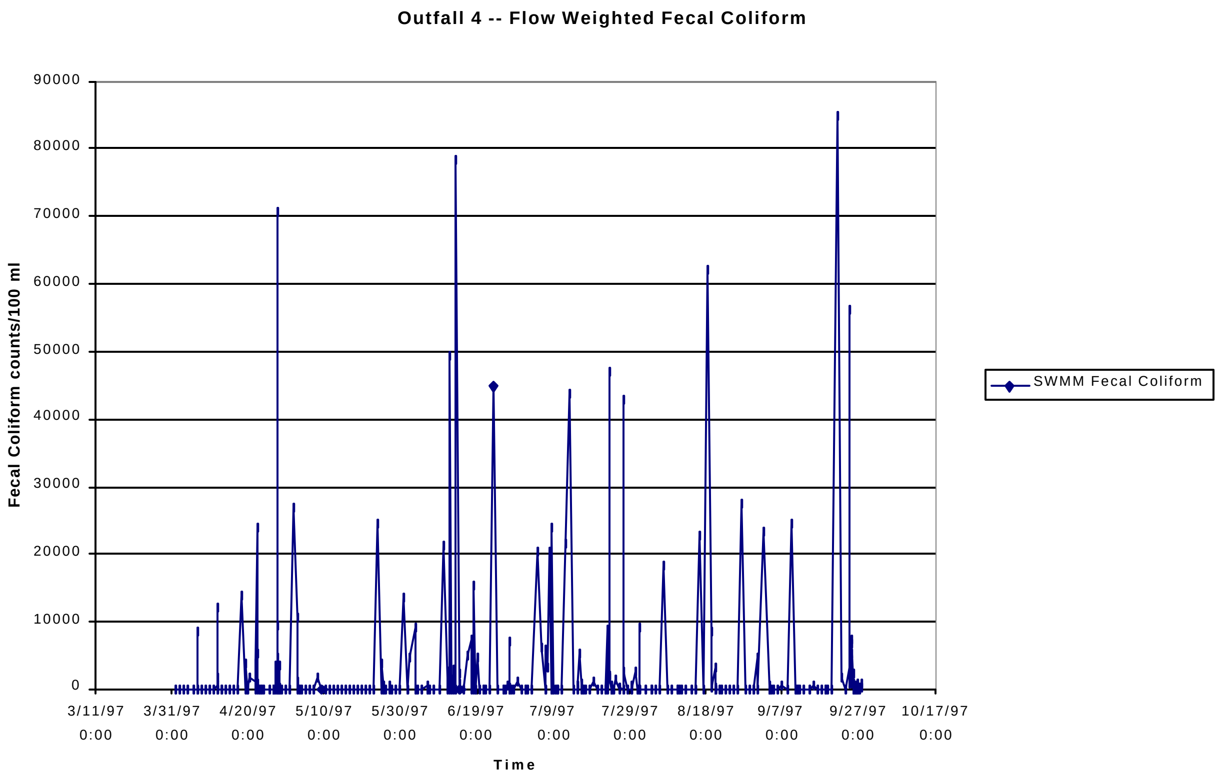


Figure 9 SWMM Flow Weighted Fecal Coliform Concentrations for Outfall 4

Figure 10 and Figure 11 illustrate the stormwater flow and fecal coliform concentrations for outfall 5.

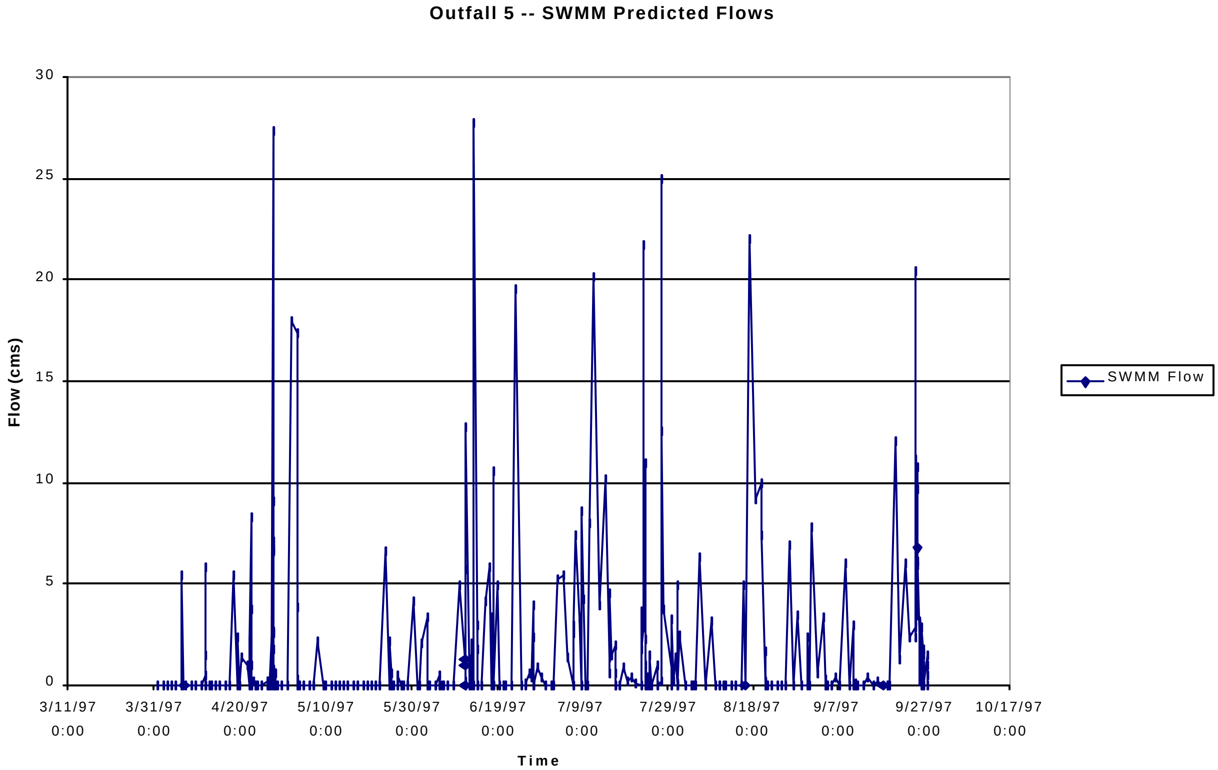


Figure 10 SWMM Predicted Flows for Outfall 5

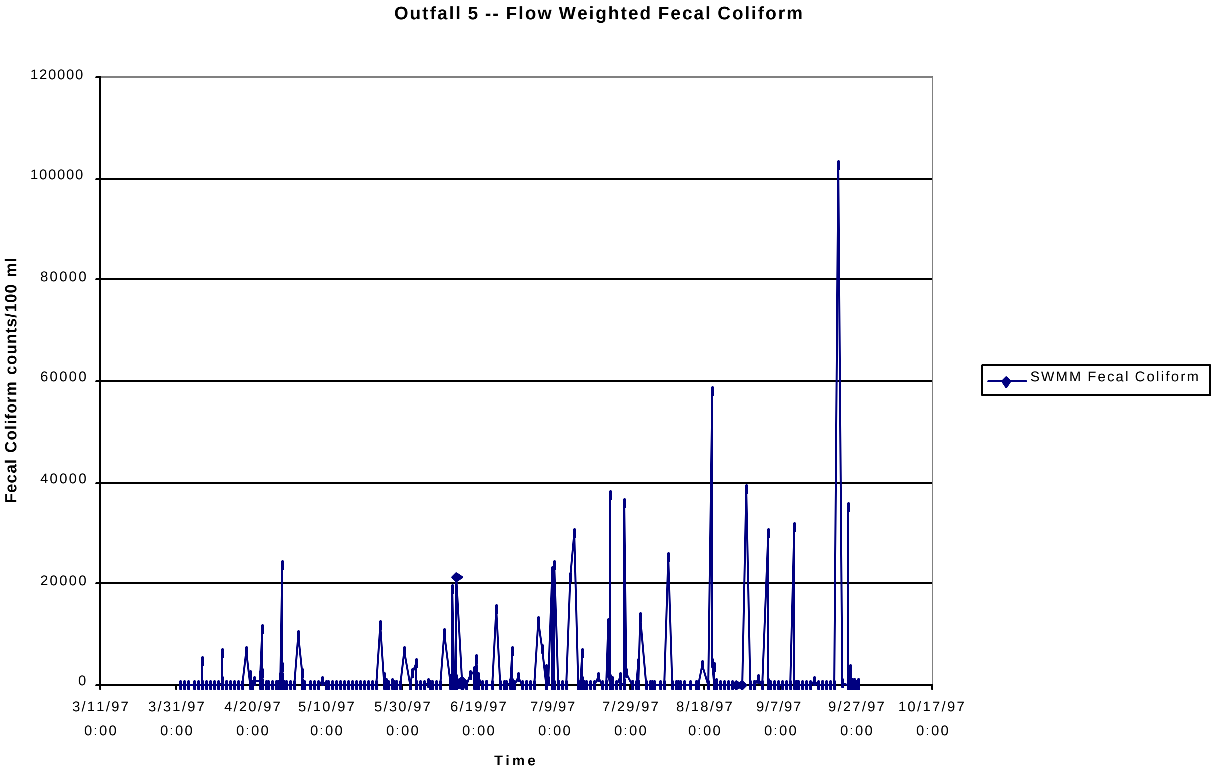


Figure 11 SWMM Flow Weighted Fecal Coliform Concentrations for Outfall 5

These predicted time series of flow and fecal coliform concentrations were used as inputs into a water quality model where their impact will be combined and transported within Butler Creek.

Water Quality Model

The Water Quality Analysis Simulation Program (WASP5) was used to predict the instream water quality as a function of changes in flow and load provided by SWMM. Butler Creek was broken down into 16 segments (Figure 1), with 5 flows and load times series entering segment 2, 4, 6, 8, and 10. The outflows from Rocky Creek and Phinizy Ditch enter at segment 14. The model will combine these flows and loads to predict a fecal coliform concentration for each of the 16 segments.

Figure 12, Figure 13 and Figure 14 illustrate the flows within the segments over the model simulation period. During storm events the flows increase as you move downstream due to the flow from five outfalls from SWMM.

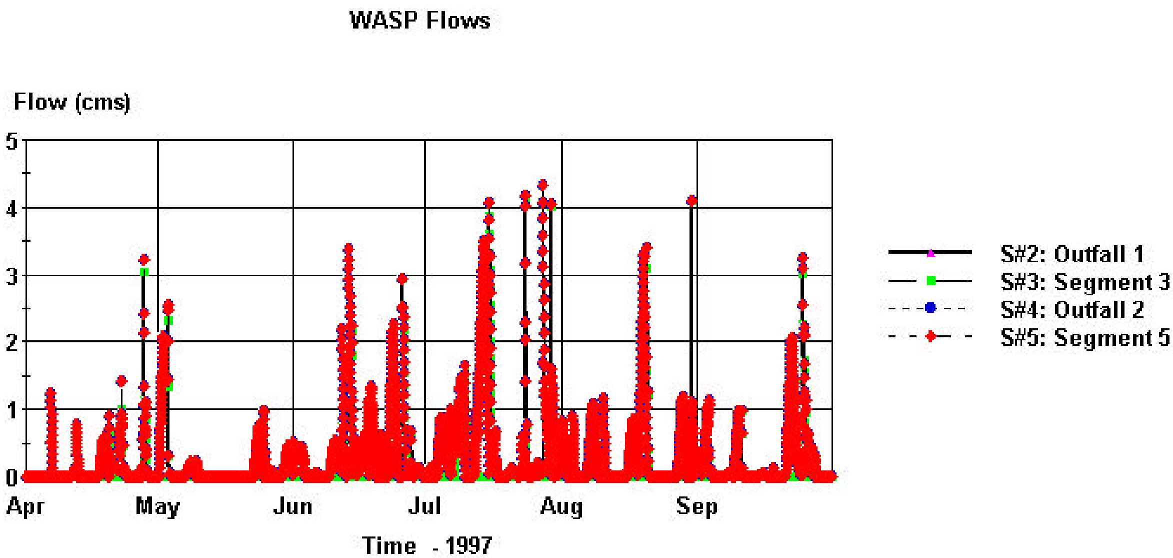


Figure 12 WASP Flows Segment 2 - 5

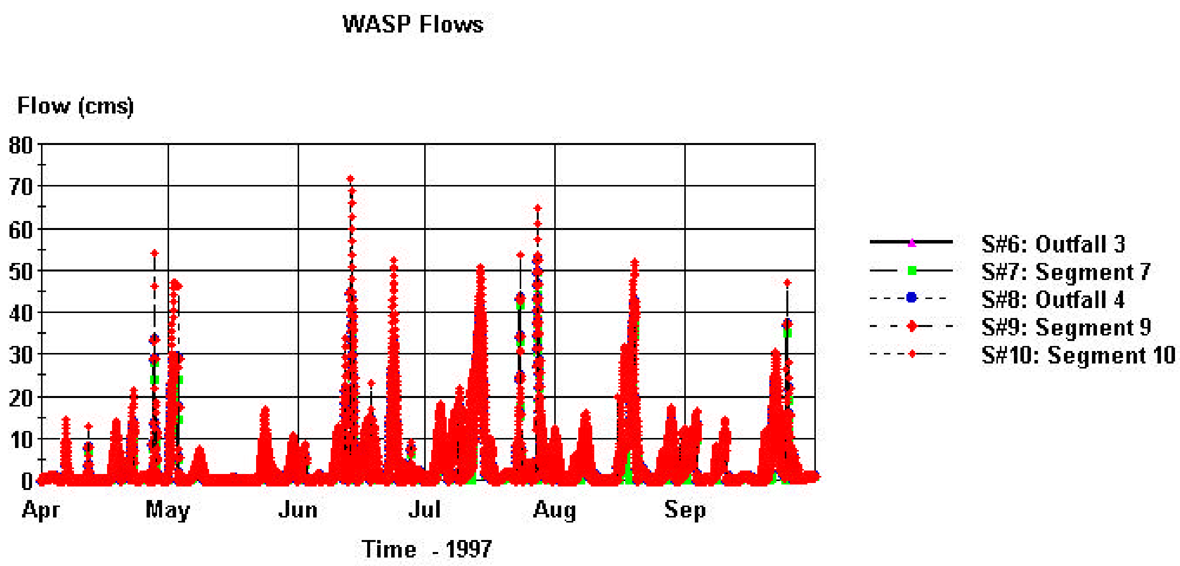


Figure 13 WASP Flows Segment 6-10

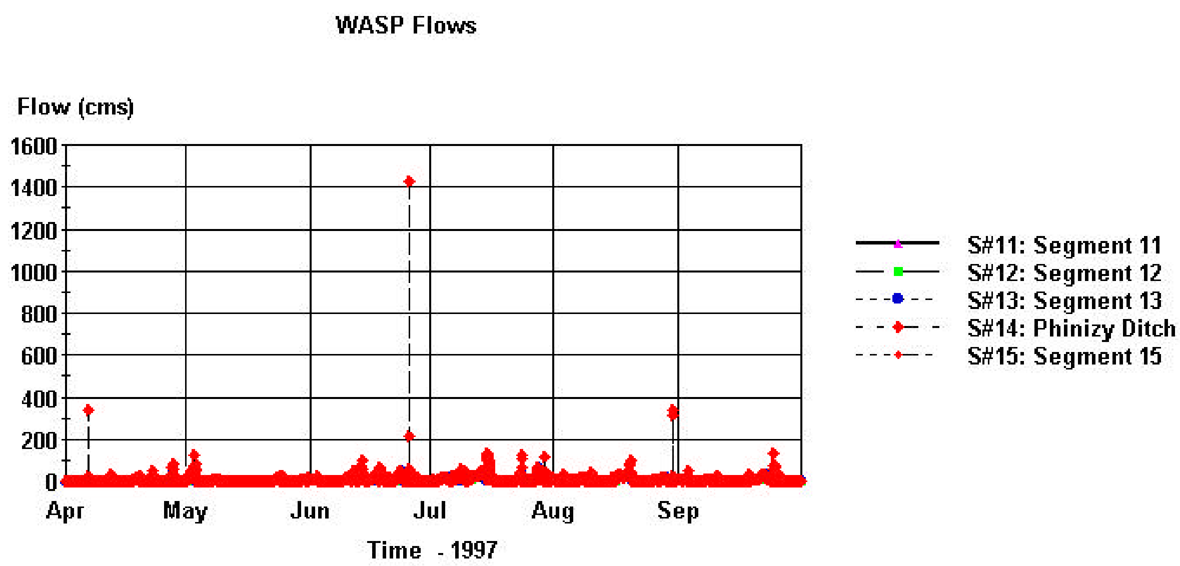


Figure 14WASP Flows Segment 11- 15

Figure 15, Figure 16 and Figure 17 illustrate the predicted fecal coliform concentrations over the simulation period. The fecal coliform decay/die off constant was set to 1 per day, which represents a typical coliform die off rate.

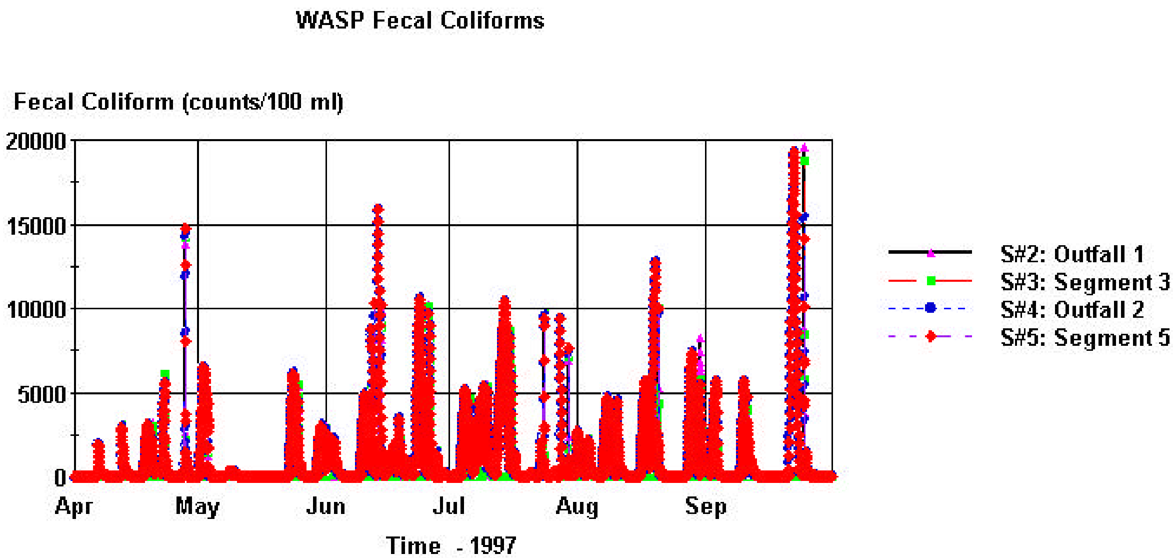


Figure 15 WASP Predicted Fecal Coliform Concentrations Segment 2 -5

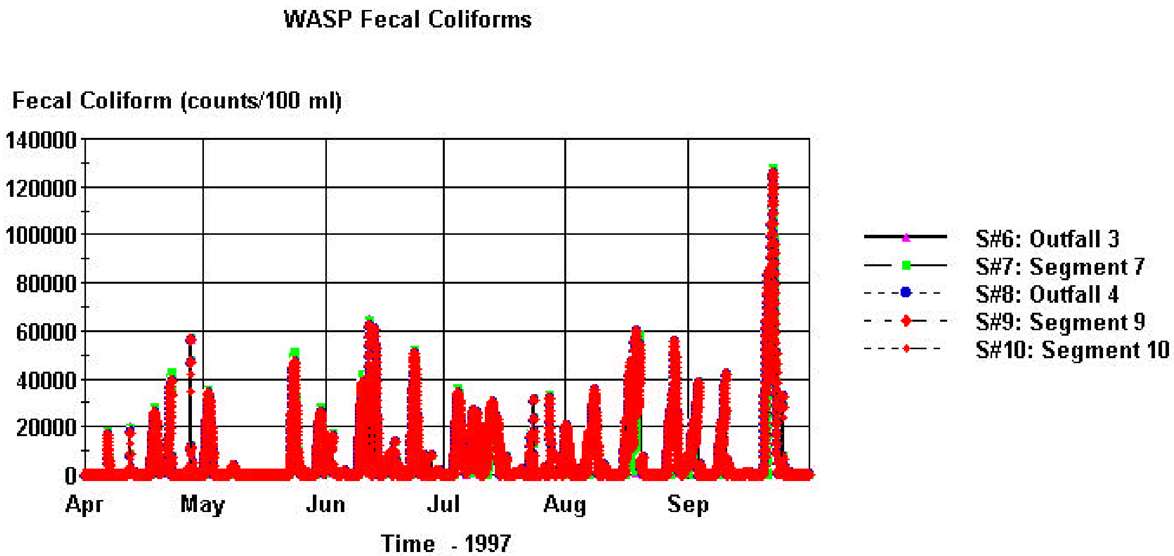


Figure 16 WASP Predicted Fecal Coliform Concentrations Segment 6 – 10

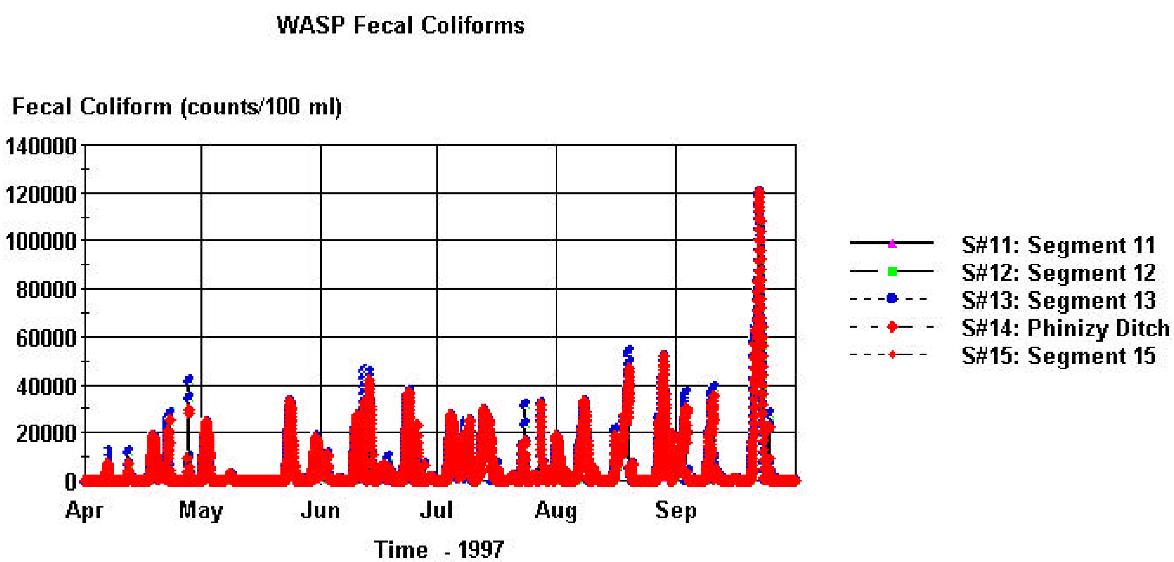


Figure 17 WASP Predicted Fecal Coliform Concentrations Segment 9 - 12

The WASP model predictions were used to determine the current 30-day geometric mean that is causing the water quality violation and a subsequent percent load reduction needed to meet water quality standards.

TMDL Calculation

The TMDL calculation utilized the results of the SWMM and WASP model to determine the appropriate 30-day fecal coliform load that will achieve water quality standards.

The maximum load that caused a water quality standard violation was calculated for 1997 by analyzing the WASP model results. It was determined that the largest 30-day geometric mean fecal coliform concentration occurred in Segment 8 between 7/4/97 to 8/4/97 with a value of 2774 counts/100 ml. This is equivalent to 2.39E+15 counts/30 days. Using the WASP model it was determined that to achieve the water quality standard of 200 counts/100 ml as a 30-day geometric the fecal load coming from the Butler Creek watershed would have to be reduced by 98%.

For Butler Creek watershed a 98% load reduction would have to occur to achieve the 200-counts/100 ml or no more than 3.45E+13 counts/30 days.

Seasonal Variation

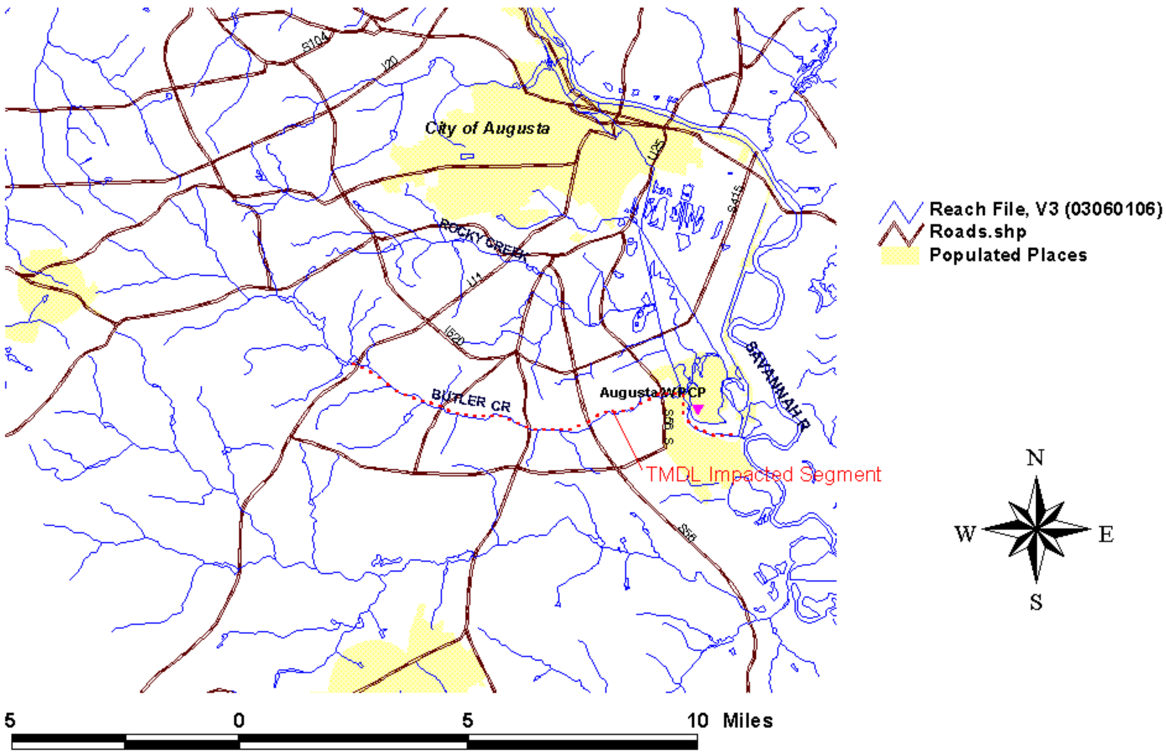
Seasonal variation is taken into the TMDL calculation by applying models for continuous periods that span several seasons. The models were applied to the spring, summer and early fall when fecal coliform concentrations are elevated due to stormwater runoff.

Allocation of Responsibility and Recommendations

Because this waterbody already exceeds the maximum load for fecal coliform due to non-point sources, a percent reduction is expressed for this TMDL. It has been determined that a 98% reduction in fecal loads to Butler Creek would have to occur to achieve the water quality standards. Efforts should be made to identify major sources of fecal coliform sources to Butler Creek and the development of a detailed best management practices plan for reducing the loadings. Any point source discharges to Butler Creek in the future should be permitted as criteria at end of pipe.

Appendix A -- Site Map

Butler Creek TMDL
Site Location Map



Appendix B – Units Conversion Table

From	To	Multiply by:
Million Gallons per Day (MGD)	Cubic Meters per Second (cms)	0.04381
Cubic Feet per Second (cfs)	Cubic Meters per Second (cms)	0.02832
Pounds (lbs)	Kilograms (Kg)	0.4536
Tons (Short)	Kilograms (Kg)	907.1848
Tons (Long)	Kilograms (Kg)	1016.00

Administrative Record

1. Ambrose Jr R.B., Wool, T.A., Connolly J.P. and Schanz R.W. (1988) *WASP4, A Hydrodynamic and Water Quality Model – Model Theory, User's Manual, and Programmer's Guide*. U.S. Environmental Protection Agency. Environmental Research Laboratory, Athens, Georgia. EPA/600/3-87/039. Model available at http://www.epa.gov

2. Augusta, Georgia Municipal Separate Storm Sewer System Suburban Stormwater District NPDES Stormwater Permit No. GAS000201. 1998-99 Annual Report.

3. Compilation of Georgia's Current Modeling Guidelines for the Development of Wasteload Allocations and NPDES Permit Limitations. January 1991

4. Huber, W.C. & R.E. Dickinson, (Oct 1988) SWMM-4., EPA-600/9-89-001, Denver, CO, pp. 21-32, Reference No. S2203 Model available at http://www.epa.gov

5. Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03, Water Use Classifications and Water Quality Standards

6. Shivalingaiah, B. and James, W. (June 1984) Algorithms for buildup washoff and routing pollutants in urban runoff., Proceedings of 3rd International Conference on Urban Storm Drainage, Goteborg Sweden, pp. 1445-1456., Reference No. I3147

7. STORET Water Quality Data

8. Georgia Environmental Protection Division Stream Monitoring Data

9. City of Augusta Stormwater Monitoring Data

10. Stored on TMDL Shared drive m:/apps32/tmdl/butler/fecal WASP Input Datasets

11. Stored on TMDL Shared drive m:/apps32/tmdl/butler/fecal Excel Spreadsheet to calculate geometric means

12. Stored on TMDL Shared drive m:/apps32/tmdl/butler/fecal SWMM Runoff Input Files

Response to Public Comment on Proposed TMDL

COMMENT

Commenters have concerns about EPA=s apparent interpretation of the model results through calculation of a geometric mean of all fecal levels during a 30-day period.

Mr. Michael E. Wilder, Water Resources Workgroup Chair, and Mr. James R. Baker, Chair, Georgia Industry Environmental Coalition, 112 Town Park Drive, Kennesaw, Georgia 30144, December 14, 1999

RESPONSE

Comment noted. It is difficult to understand the commenter's concerns when they are not fully explained.

COMMENT

The low flow scenario is not the only water quality limited situation for this water. It is not legally or technically acceptable for a TMDL to fail to address all pertinent critical flow scenarios. Failure to address high flow scenarios at this time will allow the most serious fecal problems to go un-addressed for a long time.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

This TMDL addresses both the low and high flow conditions.

COMMENT

EPA needs to justify its intention to set a TMDL at low flow and to use that as a margin of safety. There must be some accounting of nonpoint loads of fecal. The evident desire of EPA to split fecal into two separate TMDLs in order to address high flow TMDL considerations at a later time is not an appropriate approach and it fails to adequately address the required seasonal variation component of a TMDL.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

This TMDL considers both point and non-point sources of fecal coliform to Butler Creek.

COMMENT

Fecal problems occur mostly at higher flows from nonpoint sources, from sewer leaks/overflows, as well as from some permitted discharges. A standard protocol is needed for addressing typical fecal TMDLs where site-specific models are not available.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

Site-specific models need to be developed to determine the impacts of nonpoint source loads to a waterbody. It is the only way to link sources with the impairment and determine the TMDL and load allocations (WLA, LA).

COMMENT

EPA guidance requires that, where nonpoint sources cannot be reduced through enforceable controls, the reduction burden must be placed on permitted sources. The TMDL has applied the standard to the end of the pipe with an expectation that any necessary reductions would come from unregulated, uncontrolled, or unknown nonpoint sources. In the TMDL, the WLA for the point sources should be established at a lower level than the in-stream standard before there can be any contention that EPA has incorporated any MOS. This is especially true because the TMDL only addresses the low flow situation where there would be zero MOS.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

If a facility is discharging at criteria end of pipe, EPA has determined that it is not causing or contributing to a water quality violation during any flow regime including low flow.

COMMENT

The TMDL addresses only the single criterion of 200/100 ml geometric mean. There is other criterion in the regulations. If EPA contends that its reference to the single criterion is sufficient to address all other regulatory standards, this needs to be stated, explained, and supported.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

The protection of the 30-day geometric mean of 200 counts/100ml during wet weather events is the most critical standard to apply where stormwater outfalls influence the listed segment.

COMMENT

The TMDL can serve to develop defaults applicable for TMDL development for waters where less specifics are known.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

The runoff and collection system employed in this watershed is site-specific as reflected in the modeling approach. Creating default setups for urban areas is not recommended.

COMMENT

If there's a NPDES storm water permit related to this stream, the loads need to be incorporated into the permit as limits to meet the standard.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

All of the point source dischargers with NPDES permits have criteria at the end of the pipe. The TMDL has been modified to address load reductions that will be needed by the stormwater discharges.

COMMENT

The TMDL is expressed as % reduction. It would be best if this and all TMDLs were expressed as a daily maximum load where possible - perhaps in addition to the % reduction. In this way, the load can stand-alone and not be tied to a percentage of a load value that is hoped to change.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

EPA agrees, unfortunately the fecal coliform standard is a function of flow.

COMMENT

The margin of safety (MOS) is implicit, even with site-specific data. Inclusion of an explicit MOS should be possible and should be included based on the level of information and study for this stream.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

Comment noted. Using a time series that contains varying degrees of storms with different periods of time between storms provides adequate margin of safety.

COMMENT

It is stated that 109 storm outfalls are being combined for modeling purposes. Does this result in the loads being averaged over stream segments ? The compliance with standards needs to be accomplished at all locations, at all times. If this is the case here, it needs to be explained.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

The load is not being averaged. A series of outfalls that enter a segment of the water quality model are composited into a single representation from the stormwater runoff into the model segment.

COMMENT

The outfall number is omitted on the last line on the page regarding Figure 2.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

This was corrected in the final TMDL.

COMMENT

It is unclear to the average reader how the graph information shows or relates to the acceptable load of the stream.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

The graphs are provided to show the major impact storms have on the fecal coliform concentrations in Butler Creek. It would be very difficult to determine which 30-day period has the highest 30-day geometric mean without putting the data into a spreadsheet for analysis.

COMMENT

In the TMDL Calculation section, it is not clear how the value of 2774 counts/100 ml converts to 2.39E+15 counts/30 days, and relates to the standard and the daily maximum load. This section might be expanded to explain how the detailed data and analysis of this TMDL converts to the bottom line of the TMDL. Here, the TMDL is given as a load in addition to the % reduction. The load is not given as a daily maximum, but as a monthly. Is this mean or total?

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

The percent reduction that is given was calculated by taking the highest 30-day geometric mean and determines how much reduction would need to occur to meet the 200-counts/100ml standard. Calculating a daily maximum would be inconsistent with the standard.

COMMENT

In the Allocation section, it is stated that the TMDL will be given as a % reduction. It is also stated that the criteria should be met at the end of the pipe, however, the permit limit would have to be set below the criterion to achieve any reduction if there are not other regulated sources that can be limited.

Mr. Douglas P. Haines, Executive Director, Georgia Legal Watch, 264 North Jackson Street, Athens, Georgia 30601, December 22, 1999

RESPONSE

All of the point source dischargers with NPDES permits have criteria at the end of the pipe. The TMDL has been modified to address load reductions that will be needed by the stormwater discharges.

COMMENT

The storm water permit and the sewage treatment plant permit for the City of Augusta should both be subject to a wasteload allocation and load allocation designation, and the TMDL should be revised accordingly.

Mr. Eric E. Huber, EarthJustice Legal Defense Fund, 400 Magazine Street, Suite 401, New Orleans, Louisiana 70130-2453, December 7, 1999

RESPONSE

All of the point source dischargers with NPDES permits have criteria at the end of the pipe. The TMDL has been modified to address load reductions that will be needed by the stormwater discharges.

References:

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