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FECAL COLIFORM TMDL DEVELOPMENT

CONASAUGA RIVER WATERSHED

COSSA -RIVER BASIN

Introduction:

Levels of fecal coliform can be elevated in water bodies as the result of both point and nonpoint sources of pollution. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for their water bodies that are not meeting designated uses under technology-based controls for pollution. 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).

General Steps to the Fecal Coliform TMDL Development

Step 1. Problem Definition

Objective: *Identify the background information and framework for a specific TMDL-listed water that will guide the TMDL development process.*

The impaired stream segment, Conasauga River (03150101001), has a designated use classification of Fishing. Data collected from this stream segment were used for determining the stream segment impairment and for listing the water on the Georgia 1996 303(d) list. The determination for impairment and inclusion on the Georgia 303(d) list, was that greater than 20% of the samples had a fecal coliform concentration greater than 400 cfu/100 ml, where a cfu is a coliform unit that can be measured as membrane filter or multiple tube methods. This screening determination may or may not indicate a water quality standard violation since the Georgia fecal coliform standard is based on a 30 day geometric mean.

Step 2. Target Identification

Objective: *Identify numeric or measurable parameter target values that can be used to evaluate the TMDL and restoration of water quality in the listed water body.*

The target levels are the fecal coliform levels established in Georgia's Water Quality Standards. Georgia State Water Quality Standards for Fecal Coliform are established in Georgia Rule and Regulations for Water Quality, November 1996. The criterion for fecal coliform bacteria from May through October is a 30 day geometric mean of 200 mpn/100 ml and from November through April a 30 day geometric mean of 1,000 mpn/100 ml with a maximum of 4,000 mpn/100 ml. Note mpn is defined as most probable number and is equivalent to cfu.

Step 3. Source Assessment

Objective: *Characterize type, magnitude, and location of sources of fecal coliform loading to the water body.*

Potential Sources of Fecal Coliform:
Both point and nonpoint sources may contribute fecal coliform to a water body. Potential sources of fecal coliform are numerous, and often occur in combination. Poorly treated municipal sewage comprises a major source of fecal coliform. Urban storm water runoff, sanitary sewer overflows, and combined sewer overflows (CSOs) can be a source of fecal coliform. Rural storm water runoff can transport significant loads of fecal coliform from livestock pastures and animal feedlots. Wildlife can also contribute fecal coliform. Most sources of fecal coliform loads can be assigned to two broad classes: point source loads, and nonpoint source load.

Point Source Loads: *Loads from Municipal and Industrial Water Pollution Control Plants*
The greatest potential source of human fecal coliform is raw sewage. Raw sewage typically has a total coliform count of 10^7 to 10^9 MPN/100 ml (Novotny et al., 1989), along with significant concentrations of fecal coliform bacteria, viruses, protozoans, and other parasites. Typical treatment in a municipal plant reduces the total coliform count in effluent by about 3 orders of magnitude, to the range of 10^4 to 10^6 MPN/100 ml. Georgia requires disinfection of the treated wastewater discharge which results in significantly reducing the fecal coliform levels and a regulatory NPDES permit limit of 200 colonies/100 ml.. Raw sewage, while usually not discharged intentionally, may reach water bodies through leaks in sanitary sewer systems, overflows from surchaged sanitary sewers (non-combined systems), illicit connections of sanitary sewers to storm sewer collection systems, and for a few communities in Georgia through combined sewer overflows (CSOs).

Nonpoint Sources Loads:
Nonpoint sources of fecal coliform are typically separated into urban and rural components. Runoff and load generation processes differ systematically between these environments. In urban or suburban settings with high amounts of paved impervious area, important sources of loading are surface storm flow, failing septic tanks, and leakage of sanitary sewer systems. In rural settings, impervious area is usually much lower, and sources of fecal coliform may include diffuse runoff of animal wastes associated with the erosion of sediments, runoff from concentrated animal operations, and failing septic tanks.

Most nonpoint loads result from storm water and rainfall washoff, and estimation of load requires both flow volume and pollutant concentration in runoff. Modeling techniques can provide good estimates of surface storm flow volume, in both urban and rural settings. Modeling is typically conducted for single targets such as fecal coliform. All loading data are complicated by a lack of data and high variability in available monitoring data.

Fecal coliform bacteria have been detected in storm runoff from urban areas at densities high enough to suggest a potential health risk. Fecal coliform concentrations in urban storm water may be higher than concentrations in treatment plant effluent. The origins of urban bacterial loads are diverse, and may include leakage from sanitary sewers, failing septic tanks and direct loading of human fecal matter, as well as bacteria derived from dog and cat feces (which generally contain few fecal coliform of concern to humans).

Buildup and washoff of pollutants on urban impervious surfaces may be simulated directly. This physically based approach is incorporated into many popular storm water models, such as the Storm Water Management Model (SWMM) and Hydrological Simulation Program-Fortran (HSPF). Buildup refers to all of the complex spectrum of dry-weather processes that deposit or remove pollutants between storms, including deposition, street cleaning, etc. These processes lead to an accumulation of material associated with solids which are then Washed off during storm events.

The rural nonpoint sources of fecal coliform of greatest concern are typically associated with animal operations, in which large quantities of fecal matter are generated. Fecal coliform from these areas may reach water bodies either through direct runoff, or following the spreading of waste on fields. Land application of municipal waste sludge may also be a significant source of fecal coliform load. Outside of these areas, a lower background loading rate can be expected, resulting from the net inputs of domestic and wild animals, and so on.

Step 4. Linkage Between Numeric Targets and Sources - Model Development

Objective: *Define a linkage between the selected targets and the identified sources. The linkage or model is defined as the cause and effect relationship between the selected endpoint and the identified sources. This linkage can be derived from data analysis, best professional judgment, and previously documented relationships. The linkage or model is used in determining what loading is acceptable to achieve the target value. Margin of safety is also considered in the linkage or modeling effort.*

The model is essential to defining a relationship between the source and the impact on the receiving water. Where appropriate monitoring data are available, the linkage between fecal coliform loading and exposure concentrations can be accomplished by comparing historical records of load and exposure concentrations empirically. In other cases, the linkage will need to be assessed using water quality models that attempt to address transport of fecal coliform and natural die-off in the environment.

The U.S.EPA BASINS system and the Nonpoint Source Model (NPSM) were used to derive the linkages between the measured fecal coliform levels in the stream and the sources of fecal coliform. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) is a multipurpose environmental analysis system for use in performing watershed and water quality-based studies. A geographic information system (GIS) provides the integrating framework for BASINS. GIS organizes spatial information so it can be displayed and provides techniques for analyzing land scape information. The NPSM simulates nonpoint source runoff and pollutant loadings in runoff from selected watersheds and transport of the flow and pollutant runoff through stream reaches. The NPSM is a windows-interface to that allows the user to take advantage of most of the features available in the comprehensive watershed model HSPF, including simulating overland flow and water quality processes on land surfaces and flow routing and water quality within a network of river reaches.

MODEL PARAMETER DEVELOPMENT:

Model default values, based on literature review and Georgia specific values, were developed for the fecal coliform loading and transport model used in this watershed analysis. Flow runoff from the land and flow in the stream are the driving forces for pollutant (fecal coliform) transport. The pollutant transport and water transport modules of NPSM computes the surface runoff, interflow and groundwater flow on pervious and impervious land segments. The stream reach hydrodynamic and quality modules calculates the channel flow and the pollutant decay through the stream channels. The parameters necessary to run this model are derived or estimated from existing land use data, rainfall data, available stream geometry information, land slope data, soil characteristics, literature values, best professional judgement, etc. A number of articles discussing fecal coliform nonpoint source loads were used to develop the default parameters. Georgia specific agriculture data and STASTGO data was used to adjust the parameter values.

Fecal Coliform Parameters:

Initial default value, determined from literature and adjusted to take into account Georgia climate and soils, were used initially for fecal coliform bacteria buildup and washoff parameters. Note: In this case, parameters for pasture were assigned the same values as agricultural and those for barren were assigned the same values as urban (pervious). The following values are the Georgia default values to use initially for fecal coliform bacteria buildup and washoff parameters.

ACQOP (rate of accumulation of fecal coliform) - buildup rates were derived from literature.

Urban Pervious	1.59 E +10 (count/ac-day)
Agriculture Pervious	7.6 0E +10
Pasture Pervious	7.60 E +10
Forest Pervious	1.33 E +09
Barren Pervious	1.59 E +10
Urban Impervious	5.01 E +08

SQOLIM (maximum storage of fecal coliform) - this was taken as 9 x ACQOP. The average number of days between storms for Georgia was determined, and this value was then multiplied by 1.5.

Urban Pervious	1.43 E +11 (count/ac-day)
Agriculture Pervious	6.84 E +11
Pasture Pervious	6.84 E +11
Forest Pervious	1.20 E +10
Barren Pervious	1.43 E +11
Urban Impervious	4.60 E +09

The agriculture loading and storage rates can be adjusted to better represent the agriculture activities in the county.

WSQOP (rate of surface runoff which will remove 90% of stored fecal coliform per hour). These are typical values for different land uses. This parameter is similar to the one used in SWMM.

Urban Pervious	4.2 (in / hr)
Agriculture Pervious	3.8
Pasture Pervious	3.8
Forest Pervious	3.2
Barren Pervious	4.2
Urban Impervious	5.2

IOQC and **AOQC** (concentration of the constituent in the interflow outflow and groundwater outflow, respectively). Interflow and groundwater flow bacteria concentrations were assumed to be the same. The value for AOQC has an apparent effect on model results, as it is essentially the bacteria concentration in the base flow. The default values will yield a base flow fecal concentration 20 cfu/100 ml.

Urban Pervious	7932.0 (count/ft^3)
Agriculture Pervious	9915.0
Pasture Pervious	9915.0
Forest Pervious	5666.0
Barren Pervious	7932.0

LSUR (maximum length of assumed overland flow path) and **SLSUR** (slope of assumed overland flow path). These parameters affect the timing of the overland flow, how long it takes the flow to reach a channel. Default values were used unless better information was available then these values were adjusted to reflect this information.

These rate of agriculture related accumulation and storage values were adjusted to reflect the amount of dry tons ated in the county. Adjustments were maanimal waste generde to the agriculture loading and waste accumulation values based on an animal waste generated table in the USDA Georgia Watershed Agriculture Nonpoint Source Pollution Assessment August 1993 final report

Where monitoring data indicated a base flow fecal coliform levels consistently greater than 20 to 50 cfu/100ml and point sources are not the cause, the pervious concentration of fecal coliform in the interflow outflow and groundwater outflow (IOQC and AOQC) were increased in the appropriate land use category to match the general range of fecal coliform base levels measured. There could be numerous causes for this above normal fecal coliform level in base flow, including septic tank seepage, leaking sanitary sewers pipes, illicit connections, animal feed lots, etc.

Flow Parameters:

The runoff from the land types and the stream flows are calculated from land and soil runoff parameters and rainfall patterns. The runoff from the land and resultant flow in the stream were regionally calibrated to available USGS gage flow records.

DATA AVAILABILITY AND ANALYSIS:

Watershed Characteristics:

The majority of the Conasauga River is located in Lumpkin County. The following table list general watershed information needed by the NPSM model.

Conasauga River at Helen, GA Watershed		
Land Use:	Acres:	Pervious / Impervious (assumed)
03150101001		
Urban	8,050	50% Perv/50% Impervious
Agricultural	10,712	100% Pervious
Forest	48,623	100% Pervious
Barren	298	100% Pervious
03150101002		
Urban	1,686	50% Perv/50% Impervious
Agricultural	6,467	100% Pervious
Forest	67,162	100% Pervious
Barren	47,551	100% Pervious
03150101005		
Urban	114	50% Perv/50% Impervious
Agricultural	893	100% Pervious
Forest	2788	100% Pervious
Barren	0	100% Pervious
03150101006		
Urban	908	50% Perv/50% Impervious
Agricultural	5,692	100% Pervious
Forest	6,589	100% Pervious
Barren	204	100% Pervious

Conasauga River at Helen, GA Watershed		
03150101007		
Urban	674	50% Perv/50% Impervious
Agricultural	8600	100% Pervious
Forest	17,727	100% Pervious
Barren	0	100% Pervious
03150101008		
Urban	1,308	50% Perv/50% Impervious
Agricultural	31,322	100% Pervious
Forest	126,700	100% Pervious
Barren	1,428	100% Pervious
031501010021		
Urban	12,858	50% Perv/50% Impervious
Agricultural	32,734	100% Pervious
Forest	72,349	100% Pervious
Barren	1,903	100% Pervious

Existing Data:

Existing fecal coliform data:

The available data used by Georgia in making 303(d) listing decisions was used to develop the model and the resultant TMDLs. The appendix contains these data or the reference to the report were the data were found.

Existing flow data:

The predicted stream flow data were based on historical flow data from USGS Gage #02387000.

Wastewater Treatment Facility data:

Several NPDES permitted dischargers are located with the Conasauga Watershed and are identified as follows:

Discharger	Permit No.
COURTRY SKILLET POULTRY	GA0035700
WHITFIELD CO WPCP	GA0047848
VULCAN MATERIALS	GA0003972
PLAYFIELD IND	GA0033456
CHATSWORTH WP	GA0048631
DNR FT. MOUNTAIN PARK	GA0049191
CHATSWORTH WPCP	GA0032492

SPRING PLACE ELEM SCH	GA0034967
WESTSIDE ELEM SCH	GA0049158
WHITEFIELD CO PUB SCH	GA0047660
ANTIOCH ELEM SCH	GA0048488
DALTON WP	GA0036251
WHISPERING PINES MHP	GA0023426
PERLIS TRUCK STOP	GA0034240
DAWNVILLE ELEM SCH	GA0034002
DAVIS BROTHERS LODGE	GA0048887
PAPAW'S PARK	GA0022560
EASTBROOK MDL SCH	GA0034037
VARNELL ELEM SCH	GA0034029
DUG GAP ELEM SCH	GA0034011
COHUTTA SPRINGS	GA0035696
FARM & INDUSTRIAL CHEM	GA0048020
C & J CO TRUCK TERM	GA0000574
METRO LAMINATORS	GA0031810
DOW CHEMICAL CO.	GA0000426

Model calibration process:

First, predicted flows were compared to observed flows in sub-watersheds, where available, to achieve reasonable agreement between predicted instream flows values and the range of measured flows for both base flow and rainfall events. If existing flows were not available then the regional flow parameters were assumed. For the Conasauga River Watershed, a cumulative probability distribution of observed flows was computed to serve as a basis of comparison with the distribution of predicted flows. To the extent possible, model flow calibration was carried out until a reasonable agreement between the distribution of predicted and observed flows was achieved. Individual comparisons between observed and predicted flows were also performed.

Second, predicted fecal coliform concentrations were compared to available fecal coliform data, including baseflow levels, rainfall induced levels and overall distribution of observed data. Model parameters were adjusted as needed to achieve reasonable agreement and to attempt to be as realistic as possible. The adjusted parameters are listed in the appendix. Where limited fecal data were available, initial default parameters or parameters that were consistent with other watersheds in the region were used.

A cumulative probability distribution was computed from observed measurements of fecal coliform. To the extent possible, successive simulation runs were carried out to in order to achieve reasonable agreement in the distribution of predicted with the probable distribution of observed concentrations. Individual comparisons between observed and predicted fecal coliform concentrations were also made for calibration purposes.

Step 5: TMDL Development

Background:
Current EPA guidance (1991) allows water quality-based effluent limits for toxics to be based on either steady state or dynamic water quality models. The intent in the use of both types of models is to limit the occurrence of instream toxicity to a frequency of no greater than once in three years.

The steady-state model provides predictions for only a single set of environmental conditions. For permitting purposes, steady-state models are applied for "critical" environmental conditions that represent extremely low assimilative capacity. For discharges to riverine systems, critical environmental conditions correspond to drought upstream flows. The assumption behind steady-state modeling is that permit limits that protect water quality during critical conditions will be protective for the large majority of environmental conditions which occur. While this assumption works reasonable well for point sources, it is not appropriate for nonpoint sources, the discharges from which occur in an episodic manner related to rain storms or to snow melt.

Continuous simulation generates daily values of stream flow and pollutant concentrations. With a well calibrated model, the simulated stream flows and pollutant concentrations represent the real-world conditions. Continuous simulation, as well as other dynamic modeling approaches, explicitly consider the variability in all model inputs, and define effluent limits which will be in direct compliance with the once in three year goal by basing the calculation on the biological flow (4B3) or the more traditionally used 7Q10 flow.

It is not appropriate to attempt to define a Critical stream flow for wet weather problems that is analogous to the critical (low flow) condition traditionally used with continuous point source discharges. Furthermore, even when continuous simulation is used for point source dischargers, the appropriate method of analysis is to examine the model generated data (receiving water concentrations) in terms of frequency and duration (as described below) rather than to examine concentrations at a Critical flow@ (e.g., 7Q10 or 4B3).

The Technical Support Document For Water Quality-Based Toxics Control (USEPA, 1991) states that daily receiving water concentrations can then be ranked from the lowest to the highest without regard to time sequence. A probability plot can be constructed from these ranked values, and the occurrence frequency of any 1-day concentration of interest can be determined. Running average concentrations for 4 days (i.e., the chronic design flow), or for any other averaging period (30-day geometric means), also can be computed from the daily concentrations. The probability plot generated by the continuous simulation model will indicate whether criteria are predicted to be exceeded more frequently than desired.

A long period of record, 20 years or more, is generally used to account for year-to-year variations in weather and resulting stream flows. It probably is reasonable to assume that spatial differences within the geographic confines of the river basin do not result in appreciable differences in the *pattern* of stream flow. Therefore, it is reasonable to conduct one (1) 20 year simulation for the purpose of identifying the year that has the combination of storm frequency and duration that results in the greatest number of criteria exceedences. The remainder of the simulations for this geographic area can then be conducted with a two year simulation where the second year uses meteorological data from the year that resulted in the greatest number of exceedences. (The first year of the simulation conditions the model so that initial conditions do not effect the results.)

Critical condition determination:
For this TMDL, the time period 1973 through 1992 was evaluated to select a critical time period. Based on an evaluation of the period of record, the summer time period of May through October, 1987 was selected for a representative summer time critical period and November, 1987 through April 1988 as a representative winter time critical period.

Total maximum daily loads (TMDLs):
Total maximum daily loads (TMDLs) are comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels for a given watershed. The sum of these components may not result in the accedence of water quality standards (WQSs) for that watershed. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relation between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

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

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while achieving water quality standards. TMDLs establish allowable water body loadings that are less than or equal to the TMDL and thereby provide the basis to establish water-quality-based controls.

For some pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For bacteria, however, TMDLs can be expressed in terms of organism counts (or resulting concentration), in accordance with 40 CFR 130.2(I): TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure, and NPDES regulations at 40 CFR 122.45(f): All pollutants limited in permits shall have limitations ...expressed in terms of mass except...pollutants which cannot appropriately be expressed by mass. The TMDL equation does require that the sum of WLAs, LAs, and MOS not exceed the loading capacity. This may require evaluation of each source on a loading basis (even if effluent limits are expressed as concentration) to determine the resulting in stream load and concentration.

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

> Implicitly incorporate the MOS using conservative model assumptions to develop allocations, or
> Explicitly specify a portion of the total TMDL as the MOS; use the remainder for allocations.

The MOS is incorporated implicitly into this modeling process by selecting a critical time period and critical default values for each of the summer and winter seasons and running a dynamic model simulating daily fecal coliform instream values. The model results are compared against the Georgia WQS for geometric mean of 200cfu/100ml for summer and 1000 cfu/100ml for winter. Note that during high strong rainfall events that instantaneous winter fecal coliform criteria will not be met, at all times, even in undisturbed areas. This is to be expected because the basis for the fecal coliform criteria is EPA Ambient Quality for Bacteria - 1986 and the 1976 Redbook - Quality Criteria for Water and this criteria recommends sampling for compliance is during steady state (non rainfall) conditions.

Where limited flow and fecal coliform data were available and the model results compared favorably to the measured data a MOS value of 25 cfu/100 ml was incorporated into the TMDL Where limited fecal coliform data and no stream specific flow data were available an additional explicit MOS value of 50 cfu/100 ml was incorporated into the TMDL. A degree of professional judgement was used to select the appropriate MOS.

For the Conasauga River Watershed, the target TMDL level is 175 cfu/100 ml.

Step 6. Allocation of Responsibility

Objective: *Develop recommendations for load allocation which are distributed among the various point and nonpoint sources.*

Existing loadings:
The model was run for the 1987 and 1988 critical time periods (Step 5) using the "calibrated" fecal and flow parameters as determined in Step 4. This model run resulted in a summer fecal coliform 30 day geometric mean of ~295 cfu/100 ml.

Assessing Alternatives:
The model was run for the critical time periods (Step 5) reducing the fecal parameters as determined in the model calibration process (Step 4) until both the resulting summer fecal coliform 30 day geometric mean of 175 cfu/100ml and the winter fecal coliform 30 day geometric mean of 1000 cfu/100ml are maintained. Since numerous activities and land uses contribute fecal coliform loadings to the stream system at various rates and time, the TMDL may present numerous allocation scenarios reflecting different reduction strategies for the various sources and their respective loadings.

Unlike conventional wastewater treatment technologies which can frequently achieve very high pollutant removal efficiencies, nonpoint source control technologies and/or practices are limited mostly to source separation, physical removal & separation mechanisms (i.e., settling and filtration), pollution prevention, and land cover modifications (e.g., use of buffer strips, and contour terracing in agricultural lands) to achieve nonpoint source load reductions. Adjustments to the ACQOP and, to a limited extent, the WSQOP factors in HSPF, can be used to simulate the equivalent performance of prevailing nonpoint source controls. The assumption is made that a percent reduction in ACQOP is "physically" equivalent to same percent reduction in loadings achieved using specific non-structural and structural controls. With respect to the WSQOP factor, this represents the overland flow rate (expressed in inches of surface runoff) at which 90% of a constituent will be removed from a particular land surface. An increase in the WSQOP factor is, in effect, equivalent to a decrease in the amount of exported pollutant.

Information is not readily available to support an assumption as to what percent increases in WSQOP are realistically achievable given what the WSQOP factor physically represents. It is assumed that a greater percent increase in the WSQOP factor is achievable in agricultural areas as opposed to urban areas due to the diversity of management practices available for use in agricultural areas. For the preliminary allocation, increases to WSQOP were limited to no more than 20% of the calibrated value(s) for agricultural areas and to no more than 10% of final calibrated values for urban and barren areas.

A field-scale and/or design model would be approrpriate to determine what specific controls are the most appropriate to achieve the requisite reductions to meet State standards. A more detailed reconnaisance survey of the watershed is also necessary to characterize contributions from unknown sources contributing to nonattainment of state standards.

A preliminary allocation strategy that will allow the target TMDL of 175 cfu/100ml to be maintained is as follows:

75% reduction in base flow fecal coliform loading and/or resultant concentrations;
99% reduction in loading and/or resultant concentrations from agriculture or pasture land uses;
75% reduction in loading and/or resultant concentrations from urban impervious land uses;
70% reduction in loading and/or resultant concentrations from urban pervious land uses;
0% reduction in loading and/or resultant concentrations from forest land uses;
70% reduction in loading and/or resultant concentrations from barren land uses.

Wastewater Treatment Facilities:

A WLA allocation is not proposed in this preliminary allocation. A test of the significance of point source inputs from WTPs revealed that even if a zero discharge limit for fecal coliform were imposed on each facility, the predicted improvement (in terms of lower geometric mean and total duration of exceedance) in maintaining standards is neglible. Imposing even a minor WLA would be ineffectual and would not contribute meaningfully to attaining and maintaining water quality standards. This does not exclude the possibility that WTPs are contributing excessive amounts of fecal coliform due to occasional system by-passes, sanitary sewer overflows, or leaking sanitary systems. Elimination of these sources would be required to maintain compliance with the standard. Therefore, the source loading reductions are applied exclusively to nonpoint sources.

The loading capacity and the allocation of loads were developed for the major land use groups and point source discharges contributing fecal coliform loads in the watershed. The allocation of loads meet the regulatory requirements of 40 CFR 130.2(g) in that they are "best estimates of the loading, which may range from reasonably accurate measurements to gross allotments..."

This allocation of fecal "loads" to the watershed is applied as:

- fecal counts per acre per day, the ACQOP (rate of accumulation of fecal coliform);
- Concentration of interflow outflow from watershed to stream, the IOQC; and
- Concentration of groundwater outflow from watershed to stream, the AOQC

terms in the Non Point Source Model (NPSM). This meets the regulatory definition that "TMDLs can be expressed in terms of either mass per time, toxicity units, or other appropriate measure," (40 CFR 130.2) This annual TMDL could be converted into daily loads, but expressing the TMDL as a daily average counts per acre per day and concentration in interflow and groundwater better reflects the major land use groups contributions and direct sources of fecal coliform contribution to the interflow and groundwater, such as septic tanks and leaky sewage pipes.

In the following "Watershed Load Allocation" table, the final loading rate column (ACQOP, IOQC and AOQC) expresses the allocation of the fecal "loads" to the watershed. For a more complete explanation of how these terms are incorporated in the NPSM see the HSPF10 or HSPF11 User Manual.

Conasauga River Watershed Load Reduction Scenario

Conasauga River Watershed: Load Reduction Scenario				
Land Type	Acres	Initial Loading Rate	Percent Reduction	Final Loading Rate
		ACQOP (rate of accumulation of fecal coliform)		**ACQOP** (rate of accumulation of fecal coliform)
Urban Pervious	12,798	2.14E10	70%	1.50E10
Urban Impervious	12,798	7.58E8	75%	5.62E8
Agricultural	96,422	1.14E11	99%	1.14E9
Forest	341,942	2.00E9	0%	2.00E9
Barren	3,880	1.59E10	70%	1.12E10
		Initial **IOQC** and **AOQC** (concentration of the constituent in the interflow outflow and groundwater outflow		Final **IOQC** and **AOQC** (concentration of the constituent in the interflow outflow and groundwater outflow
All land uses	AOQC	21,246 cfu/cu.ft. (~75 # / 100ml)	AOQC	5,665 # / cu.ft. (~20 # / 100ml)

Conasauga River Watershed: Load Reduction Scenario				
	IOQC	21,246 #/cu.ft. (~75 cfu / 100ml)	IOQC	5,665 # / cu.ft. (~20 # / 100ml)
Permitted Dischargers*	Name	Initial Fecal Coliform Limit (cfu/100 ml)	Flow (mgd)	Final Fecal Coliform Limit (cfu/100 ml)
See list above	Various	200	<0.1 mgd	200

* Many of these permitted facilities operate small package wastewater treatment plants.

This TMDL is based on the limited fecal coliform data that was readily available and used to put the stream segment on the 303(d) list. No watershed specific or stream specific modeling data were collected. This TMDL should be considered a level 1 TMDLs that is useful in making screening level decisions, used as one factor to priority rank the watersheds for additional monitoring or for planning the implementation of pollution controls, and/or determine additional intensive monitoring needs to better define the cause and effect relationships. Updated land use and flow monitoring would increase the confidence of the model results.

FINAL AGENCY ACTION

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Technical Modeling Appendix:

Model Parameters & Other Information		
Primary Runoff Coefficients		
INFILT	0.16 0.2	Urban Pervious Agricultural, Forest, and Barren Areas
IRC	0.50	for all land use types
DEEPFR	0.250	for all land use types
LSUR (ft)	300	for all land use types
SLSUR	3%-4%	for all land use types
Other Information		
Major County	Whitfield & Murray	
Meteorological Station	Jasper	
Stream Length (miles) 03150101001 03150101002 03150101005 03150101006 03150101007 03150101008 031501010021	 24.3 8.0 5.0 8.1 17.8 9 5.1	
Stream slope	~2%	

Default parameter values are 300 feet for LSUR and 0.035 ft/ft for SLSUR. LSUR also was estimated at 25% of the average watershed width and SLSUR adjusted to 0.015 ft/ft for the coastal plain region

The following tables illustrate the existing loads incorporated into the calibrated model run.

Conasauga River - Existing Load Critical Condition Model Run			
Land Type	Acres	Final Calibrated Loading Rates (cfu/day)	Preliminar Allocation Loading (cfu/day)

Conasauga River - Existing Load Critical Condition Model Run

Urban Pervious			
03150101001	4,024	3.77E+10	3.40E+10
03150101002	846	1.66E+09	1.49E+09
03150101005	57	6.94E+06	6.26E+06
03150101006	454	4.81E+08	4.34E+08
03150101007	337	2.64E+08	2.38E+08
03150101008	654	9.96E+08	8.99E+08
031501010021	6,429	9.62E+10	8.69E+10
Urban Impervious			
03150101001	4,024	2.68E+12	2.48E+12
03150101002	846	1.18E+11	1.09E+11
03150101005	57	5.29E+08	4.89E+08
03150101006	454	3.41E+10	3.15E+10
03150101007	337	1.87E+10	1.73E+10
03150101008	654	7.09E+10	6.56E+10
031501010021	6,429	6.83E+12	6.32E+12
Forest Pervious			
03150101001	48,624	1.82E+10	1.46E+10
03150101002	67,163	2.51E+10	2.02E+10
03150101005	2,788	1.04E+09	8.38E+08
03150101006	6,589	2.46E+09	1.98E+09
03150101007	17,727	6.63E+09	5.33E+09
03150101008	126,700	4.74E+10	3.81E+10
031501010021	72,350	2.71E+10	2.18E+10
Barren Pervious			
03150101001	298	6.06E+08	5.42E+08
03150101002	48	1.54E+07	1.38E+07
03150101005	0	0.00E+00	0.00E+00
03150101006	204	2.84E+08	2.54E+08
03150101007	0	0.00E+00	0.00E+00
03150101008	1428	1.39E+10	1.24E+10
031501010021	1902	2.47E+10	2.21E+10

Conasauga River - Existing Load Critical Condition Model Run			
Agriculture Pervious			
03150101001			
03150101002	10,712	1.23E+11	5.76E+10
03150101005	6,467	4.50E+10	2.10E+10
03150101006	892	8.57E+08	4.00E+08
03150101007	5,692	3.49E+10	1.63E+10
03150101008	8,600	7.96E+10	3.72E+10
031501010021	31,322	1.06E+12	4.93E+11
	1,903	1.15E+12	5.38E+11

Data Appendix:

See attachements:
Consau-c.uci
Consau-a.uci

The following fecal concentration data were used for purposes of developing this TMDL:

1980	4	22	2300
1980	5	28	750
1980	6	24	40
1980	7	29	750
1980	8	26	430
1980	9	24	430
1980	10	28	750
1980	11	24	2300
1980	12	8	230
1981	1	27	9300
1981	2	25	40
1981	3	24	230
1981	4	28	430
1981	5	26	230
1981	6	23	150
1981	7	27	40
1981	9	29	90
1981	10	27	2300

CONASAUGA RIVER,WATERSHED

1981	11	23	90
1982	1	27	130
1982	2	24	2800
1982	3	31	330
1982	4	29	790
1982	5	25	330
1982	6	29	330
1982	7	28	2300
1982	8	25	1100
1982	9	29	790
1982	10	27	170
1982	11	30	25250
1983	1	27	220
1983	2	24	4300
1983	4	27	170
1983	5	24	490
1983	6	29	4900
1983	7	27	330
1983	8	31	50
1983	9	28	50
1983	10	26	230
1983	11	30	7900
1983	12	28	2200
1984	1	24	33000
1984	2	29	7900
1984	3	27	285
1984	4	24	3300
1984	5	30	2300
1984	6	26	120
1984	7	24	230
1984	8	29	1730
1984	9	25	490
1984	10	24	7900
1984	11	27	130
1985	1	30	1300
1985	2	26	790
1985	3	27	490
1985	4	22	130
1985	5	28	230
1985	6	26	120

1985	7	29	80
1985	8	28	490
1985	10	30	790
1985	11	19	125
1985	12	18	460
1986	1	30	1300
1986	2	27	170
1986	3	26	80
1986	4	30	80
1986	5	28	110
1986	7	30	20
1986	8	26	70
1986	9	24	1300
1986	10	28	33000
1986	10	29	490
1986	11	24	23000
1986	12	29	1100
1987	1	28	330
1987	2	24	330
1987	4	29	170
1987	5	28	20
1987	6	24	170
1987	8	25	230
1987	9	22	130
1987	11	23	170
1988	1	27	3950
1988	2	23	4600
1988	3	29	490
1988	5	25	170
1988	7	26	490
1988	8	23	790
1988	9	27	330
1988	10	26	260
1988	11	29	13000
1988	12	27	140
1989	1	25	790
1989	2	27	1300
1989	3	29	170
1989	6	28	2300
1989	7	25	1100

CONASAUGA RIVER WATERSHED

1989	8	29	790
1989	9	26	11000
1989	10	25	500
1989	11	28	20
1989	12	27	20
1990	1	30	2200
1990	3	28	275
1990	4	23	230
1990	5	29	3300
1990	7	25	4900
1990	8	28	110
1990	9	25	2300
1990	10	30	170
1990	11	27	70
1990	12	19	1100
1991	1	28	80
1991	2	26	790
1991	3	26	330
1991	4	23	490
1991	5	28	310
1991	6	25	130
1991	7	30	1700
1991	8	27	790
1991	9	25	15000
1991	10	29	170
1991	11	18	1100
1991	12	16	4900
1992	1	13	490
1992	2	25	1700
1992	3	24	2300
1992	4	28	80
1992	5	26	70
1992	6	23	1100
1992	7	28	3300
1992	8	25	595
1992	9	29	170
1992	10	27	2615
1992	11	12	1700
1992	12	21	3000
1993	1	26	2300

CONASAUGA RIVER.WATERSHED

1993	2	23	4600
1993	3	23	230
1993	4	27	2300
1993	5	25	130
1993	6	15	1300
1993	7	22	1300
1993	8	24	1700
1993	9	28	790
1993	10	26	1300
1993	11	22	1400
1993	12	22	6300
1994	1	26	1300
1994	2	22	790