Total Maximum Daily Load

Evaluation

for

Headstall Creek

in the

Savannah River Basin

for

Sediment

(Biota Impacted)

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

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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 (GA EPD, 2002-2003).

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 TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a waterbody 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 to restore and maintain water quality.

The State of Georgia has identified one (1) stream segment located in the Savannah River Basin as water quality limited (i.e., 303(d) listed as Biota Impacted) due to sedimentation. The water use classification of the impacted stream is Fishing. The general water quality criteria not being met states:

> All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses (GA EPD, 2004).

The Biota Impacted designation indicates that studies have shown a modification of the biological community; more specifically, fish. In 1998, 1999, 2000, and 2001 the Georgia Department of Natural Resources (DNR) Wildlife Resources Division (WRD) conducted studies of fish populations. WRD used the Index of Biotic Integrity (IBI) and modified Index of Well-Being (IWB) to identify affected fish populations. The IBI and IWB values were used to classify the populations as Excellent, Good, Fair, Poor, or Very Poor. Stream segments with biological populations rated as Poor or Very Poor were included in the partially supporting list. As a result, Headstall Creek was added to the State's 303(d) list and scheduled for a TMDL evaluation. Nine stream segments, assessed and rated as Excellent, Good, and/or Fair, were considered as supporting uses.

On April 2, 2000, EPA sent a letter to Georgia EPD, suggesting that the State consider listing Rocky Creek for biological impairment. This suggestion was based on information contained in biological assessment reports from March 1997 and March 1998, which were authored by EPA Region 4's Science and Ecosystem Support Division and Tetra Tech, Inc., respectively. Thus, a 12-mile segment of Rocky Creek was included on Georgia's 2000 303(d) list as biota impacted. EPA will develop the TMDL for Rocky Creek.

The general cause of the biological impairments is the lack of habitat due to stream sedimentation. To determine the relationship between the instream water quality and the source loadings, each watershed was modeled. The analysis performed to develop sediment TMDLs for the 303(d) listed watersheds utilized the Universal Soil Loss Equation (USLE). The USLE predicts the average annual soil loss caused by erosion. The USLE method considered the characteristics of the watershed including land use, soil type, ground slope, and road surface.

National Pollutant Discharge Elimination System (NPDES) permitted discharges were also considered. Modeling assumptions were considered conservative and provide the necessary implicit margin of safety for the TMDL.

The USLE was applied to the 303(d) listed watershed and those not biologically impacted to determine both the existing sediment loading rates and the sediment load reductions needed to support beneficial use (i.e., unimpacted conditions). The sediment load in the 303(d) listed watershed is 0.17 tons/acre-yr. The average annual sediment loads of the watersheds in the Piedmont and Southeastern Plains Ecoregions not on the 303(d) list are 0.22 tons/acre-yr (ranging from 0.07 to 0.51 tons/acre-yr) and 0.22 tons/acre-yr (ranging from 0.07 to 0.33 tons/acre-yr), respectively. These values represent sediment load contributions from all land uses within unimpaired watersheds.

Table 1 shows that approximately 89.84 percent of the average annual sediment load in the Savannah River Basin watersheds modeled results from row crops with an average annual sediment load of 1.25 tons/acre-yr. Approximately 1.26 percent of the total sediment load is from quarries, strip mines and gravel pits, with an average load of 3.17 tons/acre-yr. In the modeled Savannah River Basin watersheds, pastureland contributes approximately 2.80 percent of the total sediment load (average load of 0.08 tons/acre-yr). Roads contribute approximately 3.44 percent of the total sediment load, forests make up about 0.71 percent of the total load (average load of 0.0024 tons/acre/year), and urban land contributes approximately 0.68 percent of the total sediment load (average load of 0.09 tons/acre-yr). Estimates of the sediment contribution from construction are not available, but could represent a relatively high sediment load per acre.

Table 1. Summary of Current Conditions in the Savannah River Basin

Land Use	**Average Percent Land Use**	**Average Percent Sediment Load**	**Average Annual sediment Load (tons/acre-yr)**
Open Water	0.27%	0.00%	0.00
Urban	1.62%	0.68%	0.09
Bare Rock, Sand and Clay	0.09%	0.00%	0.00
Quarries, Strip Mines, Gravel Pits	0.09%	1.26%	3.17
Transitional Land	5.38%	0.26%	0.01
Forest	65.72%	0.71%	0.00
Pasture/Hay	7.91%	2.80%	0.08
Row Crops	16.10%	89.84%	1.25
Grasses, Wetland	2.82%	1.00%	0.08
Roads		3.44%	

These data indicate that row crops are the major source of sediment to the rivers and streams in the Savannah River Basin. However, over the last century there has been a dramatic decrease in the amount of land farmed in Georgia. Since 1950, there has been a 57 percent reduction in farmland. With this reduction in farmland, there has also been a decrease in the amount of soil erosion. This suggests that the sedimentation observed in the listed stream segments may be legacy sediment resulting from past land use practices. It is believed that if sediment loads are maintained at acceptable levels, streams will repair themselves over time.

This TMDL determines the allowable sediment loads to the listed Savannah River Basin stream and is based on the hypothesis that an impaired watershed having an average annual sediment loading rate similar to the biologically least impacted watersheds will remain stable and become biologically unimpaired due to sediment. Within the Savannah River Basin, the average annual sediment load of the least impacted watersheds with IBI scores greater than 45 in the Piedmont Ecoregion is 0.15 tons/acre-yr (ranging from 0.07 to 0.24 tons/acre-yr). In the Southeastern Plains Ecoregion, the average annual sediment load of the unimpaired watersheds with IBI scores greater or equal to 40 is 0.22 tons/acre-yr (ranging from 0.07 to 0.33 tons/acre-yr). The average annual sediment loads for the impaired watershed is summarized in the table below, along with any required sediment load reductions.

Average Annual Sediment Loads and the Required Sediment Load Reductions

Name	Current Load (tons/yr)	WLA (tons/yr)	LA (tons/yr)	Total Load (tons/yr)	% Reduction
Headstall Creek	2,154.26	-	2,154.26	2,154.26	0%

Management practices that may be used to help reduce and/or maintain the average annual sediment loads include:

- Compliance with the requirements of the NPDES permit program
- Implementation of storm water Best Management Practices (BMPs) for Permitted Construction and Industrial Activities and Municipal Separate Storm Sewer Systems
- Implementation of Georgia Forestry Commission (GFC) BMPs for forestry
- Adoption of Natural Resources Conservation Service (NRCS) Conservation Practices
- Adherence to the Mined Land Use Plan prepared as part of the Surface Mining Permit Application
- Adoption of proper unpaved road maintenance practices
- Implementation of Erosion and Sedimentation Control Plans for land disturbing activities
- Mitigation and prevention of stream bank erosion due to increased streamflow velocities caused by urban runoff
- Implementation of Watershed Protection Plans

The amount of sediment delivered to a stream is difficult to determine. However, by requiring and monitoring the implementation of these practices, their effects will improve stream habitats and 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 (GA EPD, 2002-2003).

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 TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and instream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and to restore and maintain water quality.

In 1998, 1999, 2000, and 2001, the Department of Natural Resources (DNR) Wildlife Resources Division (WRD) conducted studies of fish populations. WRD used the Index of Biotic Integrity (IBI) and modified Index of Well-Being (IWB) to identify affected fish populations. The IBI and IWB values were used to classify the population as Excellent, Good, Fair, Poor, or Very Poor. Stream segments with biological populations rated as Poor or Very Poor were included in the partially supporting list. As a result, Headstall Creek was added to the State's 303(d) list and scheduled for a TMDL evaluation (see Table 2). Nine stream segments, assessed and rated as Excellent, Good, and/or Fair, were considered as supporting uses.

On April 2, 2000, EPA sent a letter to Georgia EPD, suggesting that the State consider listing Rocky Creek for biological impairment. This suggestion was based on information contained in biological assessment reports from March 1997 and March 1998, which were authored by EPA Region 4's Science and Ecosystem Support Division and Tetra Tech, Inc., respectively. Thus, a 12-mile segment of Rocky Creek was included on Georgia's 2000 303(d) list as biota impacted. EPA will develop the TMDL for Rocky Creek.

1.2 Watershed Description

The listed stream segment is located in the Savannah River Basin in east Georgia (see Figure 1). The watershed is located in McDuffie County. The nine unimpaired watersheds are located in Burke, Clarke, Columbia, Hart, Jenkins, Madison, McDuffie, Oglethorpe, Richmond, and Wilkes counties.

Table 2. 303(d) Listed Stream Segment Located in the Savannah River Basin

STREAM	STATUS	LOCATION	MILES
Headstall Creek	Partially Supporting	U/S Tudor Road to Brier Creek (McDuffie Co.)	6

Source: GA EPD, 2002-2003. *Water Quality in Georgia, 2002-2003,* Georgia Department of Natural Resources, Environmental Protection Division, Atlanta, Georgia.

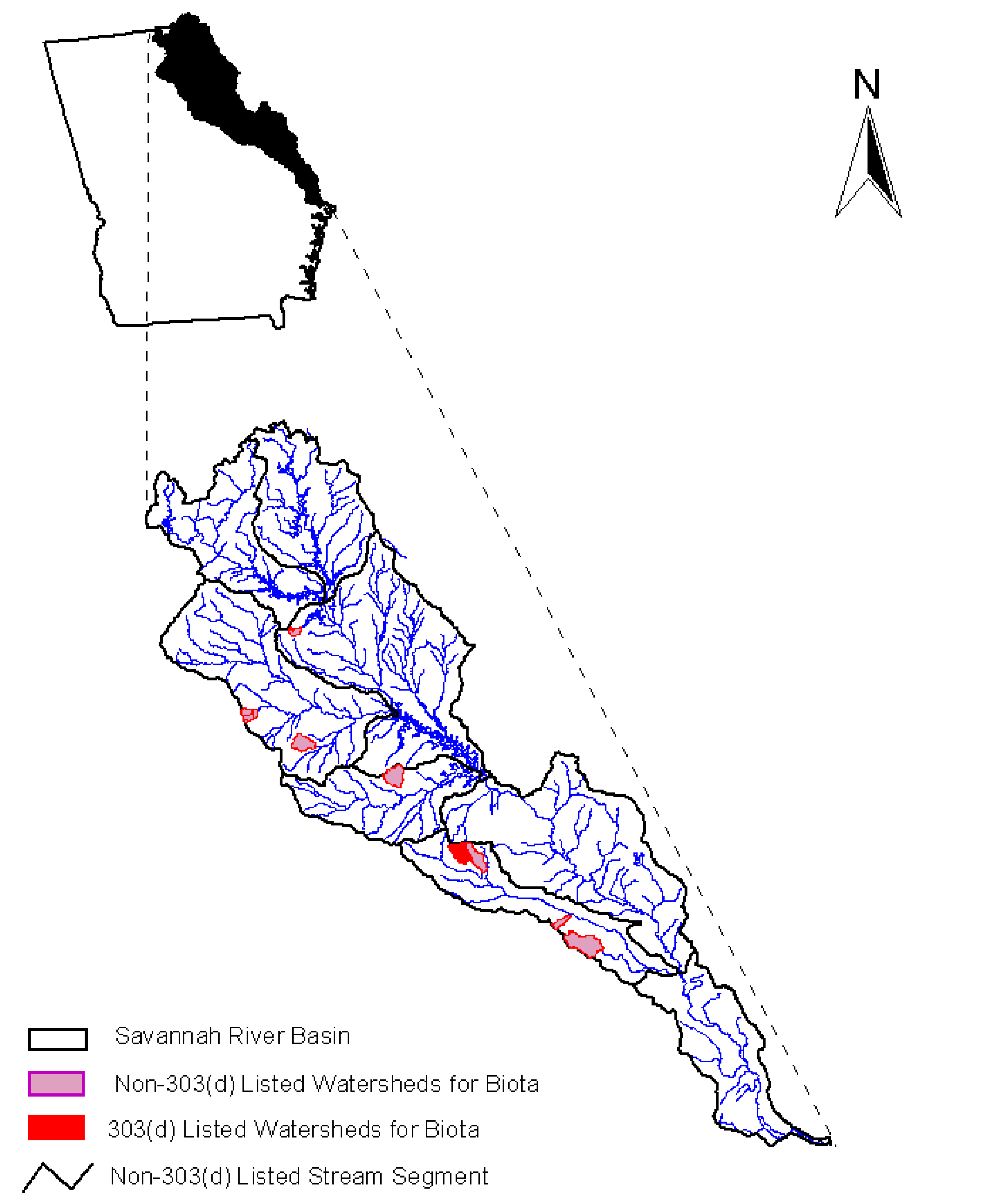
The land use characteristics of the Savannah River Basin watersheds were determined using data from the National Land Cover Dataset (NLCD) for Georgia. This coverage is based on Landsat Thematic Mapper digital images developed in 1995. The classification is based on a modified Anderson level one and two system. Table 3 lists the land coverage distribution of the ten watersheds monitored in 1999, 2000 and 2001. The watersheds are grouped by those that are not on the 303(d) list and those that are on the 303(d) list, as well as by ecoregion (Piedmont and Southeastern Plains). Table 4 lists the land coverage percentages for all the Savannah River Basin watersheds monitored. The data show that the watersheds are predominately forested with approximately 64.5 percent (ranging from 46.1 to 88.6 percent) in forest use. Agriculture is the next predominate land use with approximately 15.6 percent row crop (ranging from 3.1 to 31.6 percent) and approximately 10.6 percent pastureland (ranging from 0.7 to 27.9 percent).

The soil characteristics of the Savannah River Basin watersheds were determined using data from the State Soil Geographic (STATSGO) coverage. This coverage provides major soil type classifications. Table 5 lists the soil type distribution of the monitored watersheds.

1.3 Water Quality Standard

The water use classification for the impaired watershed in the Savannah River Basin is Fishing. The criterion violated is listed as Biota Impacted, which indicates studies have shown an impact on the fish community. The potential cause listed includes nonpoint sources. The purpose of the narrative standard is to prevent objectionable conditions that interfere with legitimate water uses, as stated in *Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(5)(c) (GA EPD, 2004):

> All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses.



TMDL Evaluation - Biota
Savannah River Basin

Figure 1. Non-303(d) Listed and 303(d) Listed Watersheds Monitored in the Savannah River Basin for Biota

Table 3a. Land Coverage Distribution (Unimpaired – Piedmont Ecoregion)

	Area (acres)															
Name	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial/ Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands	Total
Biger Creek upper	24.24	45.81	0.22	3.78	2.67	0.00	0.00	1,014.97	366.94	373.61	552.41	381.84	8.90	9.34	3.11	2,787.84
Biger Creek mid	31.58	402.74	25.57	41.81	9.12	0.00	0.00	1,832.25	1,288.51	961.60	786.14	539.29	41.81	19.57	3.11	5,983.10
Biger Creek lower	35.14	431.65	25.57	42.25	10.01	0.00	0.00	2,412.68	1,487.77	1,155.97	1,072.13	807.04	41.81	23.57	3.56	7,549.15
Indian Creek	14.01	3.78	0.00	3.78	4.00	0.00	102.30	4,839.81	4,244.26	1,641.66	826.61	376.50	12.45	33.80	2.22	12,105.19
Lightwood Log Creek	4.89	0.67	0.00	0.00	0.89	0.00	0.00	1,140.18	271.31	350.70	932.91	629.80	0.00	7.78	0.67	3,339.81
Upton Creek	26.46	0.00	0.00	0.44	8.23	0.00	504.82	3,269.98	5,957.08	1,651.45	2,037.51	1,548.04	0.00	22.46	0.89	15,027.35

Table 3b. Land Coverage Distribution (Unimpaired – Southeastern Plains Ecoregion)

	Area (acres)															
Name	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial/ Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands	Total
Beaverdam Creek	57.60	0.00	0.00	0.00	8.90	1.11	2,076.20	4,967.90	7,614.75	2,914.60	601.33	7,855.15	0.00	1,491.9	43.59	27,633.14
Boggy Gut Creek	33.36	34.69	4.00	0.44	22.91	0.00	2,627.72	1,697.03	5,050.63	1,713.71	92.96	1,098.81	1.11	513.94	0.89	12,892.22
Fitz Branch	4.00	0.00	0.00	0.00	1.78	0.22	429.21	990.73	928.91	328.02	155.89	1,536.69	0.00	472.79	22.68	4,870.94

Table 3c. Land Coverage Distribution (Impaired - Southeastern Plains Ecoregion)

	Area (acres)															
Name	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial/ Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands	Total
Headstall Creek	44.70	184.14	15.12	47.15	23.35	5.34	426.98	2,224.76	3,388.51	1,769.09	219.94	3,678.50	10.23	567.75	2.67	12,608.23

Table 4a. Land Coverage Percentages (Unimpaired – Piedmont Ecoregion)

Name	Percent Total Land Coverage														
	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial/ Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands
Biger Creek upper	0.87%	1.64%	0.01%	0.14%	0.10%	0.00%	0.00%	36.41%	13.16%	13.40%	19.81%	13.70%	0.32%	0.34%	0.11%
Biger Creek mid	0.53%	6.73%	0.43%	0.70%	0.15%	0.00%	0.00%	30.62%	21.54%	16.07%	13.14%	9.01%	0.70%	0.33%	0.05%
Biger Creek lower	0.47%	5.72%	0.34%	0.56%	0.13%	0.00%	0.00%	31.96%	19.71%	15.31%	14.20%	10.69%	0.55%	0.31%	0.05%
Indian Creek	0.12%	0.03%	0.00%	0.03%	0.03%	0.00%	0.85%	39.98%	35.06%	13.56%	6.83%	3.11%	0.10%	0.28%	0.02%
Lightwood Log Creek	0.15%	0.02%	0.00%	0.00%	0.03%	0.00%	0.00%	34.14%	8.12%	10.50%	27.93%	18.86%	0.00%	0.23%	0.02%
Upton Creek	0.18%	0.00%	0.00%	0.00%	0.05%	0.00%	3.36%	21.76%	39.64%	10.99%	13.56%	10.30%	0.00%	0.15%	0.01%

Table 4b. Land Coverage Percentages (Unimpaired – Southeastern Plains Ecoregion)

Name	Percent Total Land Coverage														
	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial/ Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands
Beaverdam Creek	0.21%	0.00%	0.00%	0.00%	0.03%	0.00%	7.51%	17.98%	27.56%	10.55%	2.18%	28.43%	0.00%	5.40%	0.16%
Boggy Gut Creek	0.26%	0.27%	0.03%	0.00%	0.18%	0.00%	20.38%	13.16%	39.18%	13.29%	0.72%	8.52%	0.01%	3.99%	0.01%
Fitz Branch	0.08%	0.00%	0.00%	0.00%	0.04%	0.00%	8.81%	20.34%	19.07%	6.73%	3.20%	31.55%	0.00%	9.71%	0.47%

Table 4c. Land Coverage Percentages (Impaired – Southeastern Plains Ecoregion)

Name	Percent Total Land Coverage														
	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial/ Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands
Headstall Creek	0.35%	1.46%	0.12%	0.37%	0.19%	0.04%	3.39%	17.65%	26.88%	14.03%	1.74%	29.18%	0.08%	4.50%	0.02%

Table 5a. Soil Type Distribution (Unimpaired – Piedmont Ecoregion)

	Soil Types (acres)												
NAME	**GA025**	**GA026**	**GA030**	**GA032**	**GA033**	**GA038**	**GA040**	**GA043**	**GA046**	**GA049**	**GA050**	**GA051**	**GA052**
K-Factor	**0.27**	**0.25**	**0.27**	**0.43**	**0.43**	**0.15**	**0.14**	**0.21**	**0.16**	**0.14**	**0.15**	**0.12**	**0.13**
Biger Creek upper	2,786	1											
Biger Creek mid	5,982	1											
Biger Creek lower	7,073	476											
Indian Creek	5,918	6,181	6										
Lightwood Log Creek	3,340												
Upton Creek	3,776			9,201	2,050								

Table 5b. Soil Type Distribution (Unimpaired – Southeastern Plains Ecoregion)

	Soil Types (acres)												
NAME	**GA025**	**GA026**	**GA030**	**GA032**	**GA033**	**GA038**	**GA040**	**GA043**	**GA046**	**GA049**	**GA050**	**GA051**	**GA052**
K-Factor	**0.27**	**0.25**	**0.27**	**0.43**	**0.43**	**0.15**	**0.14**	**0.21**	**0.16**	**0.14**	**0.15**	**0.12**	**0.13**
Beaverdam Creek								7,564		13,293	2,045	3,614	1,116
Boggy Gut Creek						10,902	1,796					194	
Fitz Branch						232			652		3,987		

Table 5c. Soil Type Distribution (Impaired - Southeastern Plains Ecoregion)

	Soil Types (acres)												
NAME	**GA025**	**GA026**	**GA030**	**GA032**	**GA033**	**GA038**	**GA040**	**GA043**	**GA046**	**GA049**	**GA050**	**GA051**	**GA052**
K-Factor	**0.27**	**0.25**	**0.27**	**0.43**	**0.43**	**0.15**	**0.14**	**0.21**	**0.16**	**0.14**	**0.15**	**0.12**	**0.13**
Headstall Creek						12,608							

2.0 WATER QUALITY ASSESSMENT

Biological monitoring is a method used to evaluate the health of a biological system in order to assess degradation from various sources. It is based on direct observations of aquatic communities. The results of these studies were the basis for the listing of Biota Impacted stream segments on Georgia's 1996 303(d) list.

2.1 Fish Sampling

In 1998 and 1999, the Georgia DNR WRD conducted studies of fish communities in the Piedmont Ecoregion. In 2000 and 2001, WRD evaluated stream segments in the Southeastern Plains Ecoregion. The results of these studies were the basis for the listing of Biota Impacted stream segments on Georgia's 2002 303(d) list.

The work performed by the WRD looked at patterns of fish communities within the various ecoregions. An ecoregion is a region of relative homogeneity in ecological systems or in relationships between organisms and their environment. Seven major ecoregions have been identified in Georgia based upon the soil types, potential natural vegetation, land surface form, and predominant land uses. These include the Blue Ridge Mountains, Ridge and Valley, Southwestern Appalachians, Piedmont, Middle Atlantic Coastal Plain, Southeastern Plains, and Southern Coastal Plain.

Reference sites within the Piedmont and Southeastern Plains Ecoregions were established. These sites represented the least impacted sites that exist given the prevalent land use within the ecoregion. Ten sites were sampled within the Savannah River Basin (see Tables 6, 7, and 8). These sites had to be accessible, wadeable, and representative of the stream under investigation. The length of the fish sampling site was thirty-five times the mean stream width, up to 500 meters. This sampling length was found to be long enough to include the major habitat types present. Electrofishing and seining techniques were used for sampling the fish population (GA WRD, 2000).

Two indices of fish community health were used to assess the biotic integrity of the aquatic systems: the IBI and modified IWB. The IWB and IBI scores were classified as Excellent, Good, Fair, Poor, or Very Poor. Segments with fish populations (IBI) rated as Poor or Very Poor were listed as Biota Impacted.

The modified IWB measures the health of the aquatic community based on the density and diversity or structural attributes of the fish community. The IWB is calculated based on four parameters: the relative density of fish, the relative biomass of fish, the Shannon-Wiener Index of Diversity based on number, and the Shannon-Wiener Index of Diversity based on biomass.

The IBI assesses the biotic integrity of aquatic communities based on the functional and compositional attributes of the fish community. The IBI consists of twelve measurements or metrics, which assess three facets of the fish population: species richness and composition, trophic composition and dynamics, and fish abundance and condition. Each metric is scored by comparing its value to the value of the regional reference site. Factors that affect the structure and function of a fish community include stream location and size. Thus, the metrics were developed for regional drainage basins, e.g. the Atlantic Slope Drainage Basin, which includes the Ocmulgee, Oconee, Altamaha, Ogeechee, and Savannah River Basins. To account for the fact that streams with larger drainage basins normally have greater species richness, Maximum Species Richness plots were developed for the species richness metric (GA WRD, 2000).

To supplement the findings of the fish community data, habitat assessments were performed at each sampling site. Habitat scores evaluate the physical surroundings of a stream because these affect and influence the quality of the water resource and its resident aquatic community. These data may also help clarify the results of the biotic indices. The habitat assessment used was developed by personnel with the Water Protection Branch (WPB) of the Georgia Environmental Protection Division (EPD) and is a modification of the EPA Rapid Bioassessment Protocol III (GA WPB, 2000). It incorporates different assessment parameters for riffle/run and glide/pool prevalent streams.

The habitat assessment evaluates the stream's physical parameters and is broken into three levels. Level one describes instream characteristics that directly affect biological communities (instream cover, epifaunal substrate, embeddedness, and riffle frequency). Level two describes the channel morphology (channel alteration, sediment deposition and channel flow status). Level three describes the riparian zone surrounding the stream, which indirectly affects the type of habitat and food resources available in the stream (bank vegetation, bank stability, and riparian zone width). The total habitat scores obtained for each sampling station are compared to a site-specific control or regional reference site. The ratio between the station of interest and the reference site provides a percent comparability that can be used to classify the stream.

Table 6 summarizes WRD's study scores. The IBI, IWB, and Habitat Assessment scores are listed and the watersheds are grouped by those that were not 303(d) listed streams and those that were, as well as by ecoregions (Piedmont and Southeastern Plains). In addition, the table includes the drainage areas upstream of the monitoring points, and the county in which the monitoring points are located. Table 7 provides the detailed habitat assessment scores.

During the fish community studies, physical characteristics of the stream were measured at the monitoring sites. These characteristics included the number of bends, number of riffles, number of pools, depth of the deepest pool, average stream depth, and average stream width. In addition, stream water quality measurements were taken at the time of the fish sampling. The parameters measured included water temperature, dissolved oxygen, conductivity, pH, turbidity, total hardness and alkalinity. Table 8 provides a summary of these field measurements.

The IBI values were used to classify the populations as Excellent, Good, Fair, Poor, or Very Poor. One stream segment in the Savannah River Basin was rated as Very Poor, and this segment was listed as Biota Impacted. Nine stream segments were rated as Excellent, Good, or Fair and assessed as supporting their designated water use.

On April 2, 2000, EPA sent a letter to Georgia EPD, suggesting that the State consider listing Rocky Creek for biological impairment. This suggestion was based on information contained in biological assessment reports from March 1997 and March 1998, which were authored by EPA Region 4's Science and Ecosystem Support Division and Tetra Tech, Inc., respectively. Thus, a 12-mile segment of Rocky Creek was included on Georgia's 2000 303(d) list for biota impacted. EPA will develop the TMDL for Rocky Creek.

Table 6. 1998-2001 WRD's Fish Community Study Scores

Name	Drainage Area upstream from the monitoring point	County	Ecoregion	Date	IBI Score	IBI Category	IWB Score	IWB Category	Habitat Total
Biger Creek upper	4.8	Madison	Piedmont	09/16/98	42	Fair	7.3	Fair	66.00
Biger Creek mid	10.1	Madison	Piedmont	09/16/98	46	Good	7.7	Fair	64.30
Biger Creek lower	12.5	Madison	Piedmont	09/16/98	40	Fair	7.5	Fair	73.70
Indian Creek	19.8	Ogelthorpe	Piedmont	08/26/99	46	Good	8	Fair	70.20
Lightwood Log Creek	5.9	Hart	Piedmont	09/24/98	34	Fair	7	Fair	93.30
Upton Creek	24	Wilkes	Piedmont	08/26/99	46	Good	8.6	Good	104.50
Beaverdam Creek	43.9	Burke	Southeastern Plain	08/08/00	40	Fair	7.4	Fair	106.45
Boggy Gut Creek	21.4	Richmond	Southeastern Plain	08/08/00	40	Fair	7.3	Fair	110.03
Fitz Branch (2000)	8.0	Burke	Southeastern Plain	05/24/00	46	Good	7.4	Fair	102.00
Fitz Branch (2001)	8.0	Burke	Southeastern Plain	6/6/2001	40	Fair	6.7	Fair	109.63
Headstall Creek	20.5	McDuffie	Southeastern Plain	08/09/00	16	Very Poor	3.3	Very Poor	69.33

Table 7. 1998-2001 WRD's Habitat Assessment Scores

Name	Bottom Substrate	Pool Substrate	Pool Variability	Channel Sinuosity	Instream Cover	Epifaunal Substrate	Embeddedness	Riffle Frequency	Channel Alteration	Sediment Deposition	Channel Flow Status	Bank Vegetation (Left)	Bank Vegetation (Right)	Bank Stability (Left)	Bank Stability (Right)	Riparian Zone (Left)	Riparian Zone (Right)	Habitat Total
Biger Creek upper					10.00	6.33	2.00	5.00	5.00	8.00	9.00	4.00	2.67	2.33	1.67	6.67	3.00	66.00
Biger Creek mid					6.00	6.33	4.33	2.33	4.00	9.67	9.00	3.33	3.33	2.67	2.67	3.33	7.67	64.30
Biger Creek lower					13.00	6.00	2.00	4.33	5.33	2.00	9.00	4.33	3.67	4.00	3.00	8.33	9.00	73.70
Indian Creek					5.90	2.20	2.00	11.00	4.60	0.00	10.30	3.90	4.30	4.20	4.20	8.70	8.90	70.20
Lightwood Log Creek					7.00	6.33	6.33	9.00	7.00	11.00	8.33	4.33	4.33	5.33	5.67	9.00	9.33	93.30
Upton Creek					7.40	10.70	10.10	16.20	7.40	11.50	8.90	5.80	6.80	5.80	6.30	3.70	3.90	104.50
Beaverdam Creek	10.67	9.65	8.57	16.00				17.77	5.43		7.53	3.47	2.90	4.57	4.47	8.00	7.77	106.45
Boggy Gut Creek	15.27	14.10	7.33	9.00				10.33	9.83		8.57	6.23	5.77	5.77	4.60	5.90	7.33	110.03
Fitz Branch (2000)	8.07	7.33	6.33	16.00				14.10	5.17		7.00	4.93	5.40	4.67	4.40	8.43	9.67	102.00
Fitz Branch (2001)	8.50	8.50	10.50	13.00				17.00	7.00		6.83	4.00	5.23	5.33	5.57	8.83	9.33	109.63
Headstall Creek	2.67	2.00	0.00	16.00				16.67	4.33		2.17	2.33	2.00	5.33	5.33	3.67	6.33	69.33

Table 8. 1998-2001 WRD's Field Measurements

Name	Number of Bends	Number of Riffles	Number of Pools	Deepest Pool (m)	Average Stream Depth (m)	Average Stream Width (m)	Water Temperature (deg C)	Dissolved Oxygen (mg/L)	Conductivity (uS)	pH	Turbidity (NTU)	Total Hardness (mg/L)	Alkalinity (mg/L)
Biger Creek upper		4	10	0.59	0.14	5.3	24.8	6.59	371.0	7.08	10.0	-	-
Biger Creek mid		4	5	0.58	0.09	7.2	21.4	8.01	33.6	7.04	10.7	-	-
Biger Creek lower		2	17	1.16	0.12	5.9	22.9	7.46	38.4	6.88	9.98	-	-
Indian Creek		0	9	1.42	0.30	7.6	22.9	5.79	62.3	6.42	10.1	19	35
Lightwood Log Creek		7	4	0.58	0.10	5.0	20.2	9.19	29.7	7.03	2.9	-	-
Upton Creek		2	4	1.00	0.20	8.1	26.3	8.66	137.1	7.78	6.0	45	60
Beaverdam Creek	6		6	1.50	0.28	5.0	25.5	6.01	264.2	7.50	9.3	154	125
Boggy Gut Creek	2		9	1.09	0.34	4.7	30.1	6.14	14.0	6.5	2.87	2	5
Fitz Branch (2000)	5		2	0.75	0.18	3.4	20.3	7.95	105.2	7.25	4.54	68	55
Fitz Branch (2001)	2		3	1.05	0.15	3.6	21.4	6.41	100.0	7.00	4.59	68	80
Headstall Creek	4		0	0.00	0.11	2.3	25.3	0.6	107.8	6.00	7.92	30	15

3.0 SOURCE ASSESSMENT

A healthy aquatic ecosystem requires a healthy habitat. The major disturbance to stream habitats is erosion and sedimentation. As sediment is carried into the stream, it changes the stream bottom and smothers sensitive organisms. Turbidity associated with sediment loads may also impair recreational and drinking water uses (GA EPD, 1997).

A source assessment characterizes the known and suspected sources of sediment in the watershed for use in a water quality model and the development of the TMDL. The general sources of sediment are point and nonpoint sources. National Pollutant Discharge Elimination System (NPDES) permittees discharging treated wastewater and permitted storm water are the primary point sources of sediment as total suspended solids (TSS) and/or turbidity.

Nonpoint sources of sediment are diffuse sources that cannot be identified as entering the waterbody at a single location. These sources generally involve land use activities that contribute sediment to streams during a rainfall runoff event. Nonpoint sources of sediment included in the source assessment analysis are:

- Silviculture
- Agriculture
- Grazing areas
- Mining sites
- Roads
- Urban Development

For nonpoint sources involving silviculture, the Georgia Forestry Commission (GFC) was consulted for information and parameters regarding silviculture activities. The Natural Resources Conservation Service (NRCS) was consulted for information and parameters regarding agricultural activities. Data regarding mining sites was from the Watershed Characterization System developed by Tetra Tech for EPA Region IV. The Georgia Department of Transportation (DOT) provided the road coverage and other information, including road surface type.

3.1 Point Source Assessment

For purposes of this TMDL, facilities permitted under the NPDES will be considered point sources. Discharges from municipal and industrial facilities may contribute biologically active and inert solids to receiving waters as TSS and/or turbidity. There are no permitted NPDES discharges identified upstream from the listed segment.

Soil erosion from construction sites is a major source of sediment in Georgia's streams. Georgia requires construction sites over one acre to have a General Storm Water NPDES permit. A Notice of Intent (NOI) must be submitted to the State for each construction site over one acre in order for its storm water to be covered under this permit. The permits authorize the discharge of storm water associated with construction activity to the waters of the State in accordance with the limitations, monitoring requirements, and other conditions set forth in the permit. All sites are required to have an Erosion and Sedimentation Control Plan; to implement, inspect and maintain BMPs; and to monitor storm water for turbidity.

3.2 Nonpoint Source Assessment

Eroded soils from forests, cropland, mining sites, and other land are transported to Georgia streams through runoff. Excessive sediment that reaches streams can cause several changes. It can make streams shallower and wider, affecting the stream's temperature, dissolved oxygen, flow rate, and velocity. It can affect the ability of the streams to assimilate pollutants. It can change the diversity of fish populations and other biological communities in the streams. It can also cause increased flooding. In addition, harmful pollutants attached to the sediment can be transported to rivers and streams.

3.2.1 Silviculture

Georgia has 23.6 million acres of commercial forests. This represents approximately 64 percent of all of Georgia's land use. Approximately 68 percent of the commercial forests are privately owned, 25 percent are owned by industry, and 7 percent are publicly held (GA EPD, 1999).

The majority of soil erosion from forested land occurs during timber harvesting and the period immediately following, as well as during, reforestation. Once the forest is re-established, very little soil erosion occurs. Timber harvesting includes the layout of access roads, log decks, and skid trails; the construction and stabilization of these areas; and the cutting of trees. Both hardwoods and pines are harvested throughout Georgia. A minimum harvest is usually ten acres and the percent of forest that is harvested each year varies from county to county. Table 9 lists the percent timberland and percent harvested per year by county.

Table 9. Percent Timberland and Percent Harvested per Year by County

County	Total Area (1000 acres)	Timberland (1000 acres)	Percent Timberland	Growing Stock Volume (million ft^3)[a]	Annual Volume Removal (million ft^3)	Annual Percent Removal
Banks	149.6	103.0	68.9%	149.1	5.5	3.69%
Burke	531.6	338.7	63.7%	336.2	25.7	7.64%
Chatham	281.9	86.6	30.7%	153.0	7.3	4.77%
Clarke	77.3	34.9	45.1%	76.5	0.9	0.11%
Columbia	185.6	120.8	65.1%	259.9	15.1	5.81%
Effingham	306.9	235.0	76.6%	257.4	17.5	6.80%
Elbert	236.0	165.3	70.0%	234.9	6.7	2.85%
Franklin	168.5	90.6	53.8%	145.7	4.5	3.09%
Glascock	92.3	71.8	77.8%	82.1	4.1	4.99%
Greene	248.6	197.7	79.5%	267.1	26.2	9.81%
Habersham	178.0	121.7	68.4%	263.7	5.3	2.01%
Hart	148.6	65.8	44.3%	124.7	0.2	0.16%
Jackson	219.1	126.8	57.9%	161.8	8.0	4.94%
Jefferson	337.7	214.1	63.4%	335.5	10.1	3.01%
Jenkins	223.9	150.5	67.2%	176.8	16.9	9.56%
Lincoln	135.1	105.1	77.8%	186.7	7.5	4.02%
Madison	182.0	111.8	61.4%	178.7	1.9	1.06%
McDuffie	166.3	109.1	65.6%	182.9	7.9	4.32%
Oglethorpe	282.3	225.7	80.0%	309.9	23.0	7.42%
Rabun	237.5	190.4	80.2%	470.8	1.1	0.23%
Richmond	207.4	121.2	58.4%	154.4	4.8	3.11%
Screven	182.7	153.9	84.2%	192.8	12.8	6.64%
Stephens	114.7	80.1	69.8%	118.7	5.7	4.80%
Taliaferro	182.7	153.9	84.2%	192.8	12.8	6.64%
Towns	106.6	84	73.8%	131.8	27.9	21.17%
Warren	182.7	153.9	84.2%	192.8	12.8	6.64%
Wilkes	301.7	230.9	76.5%	320.0	22.5	7.03%

[a] Estimate - does not include trees less than 5" DBH. Source: Thomas, Michael T., 1997. *Forest Statistics for Georgia.*

3.2.2 Agriculture

Agriculture can be a significant contributor of nonpoint pollutants to rivers and streams. Sediment and nutrients are two of the major pollutants of concern and cropland is one of the major sources of soil loss due to sheet and rill erosion. Over the last century there has been a dramatic decrease in the amount of land farmed in Georgia. In 1950, there were 208,000 farms encompassing 26 million acres in Georgia (U.S. Department of Agriculture, National Agricultural Statistics Service website). In 2000, there were approximately 11.1 million acres of farmland in Georgia, with the number of farms estimated to be 50,000 and the average farm size being approximately 222 acres. This represents a 57 percent reduction in farmland.

With this reduction in farmland, there has also been a decrease in the amount of soil erosion. The National Resources Inventory found the total wind and water erosion on cropland and Conservation Reserve Program land in Georgia declined 38 percent, from 3.1 billion tons in 1982 to 1.9 billion tons in 1997. This suggests that the source of sediment in many of the listed streams in the Savannah River Basin may be the result of past land use practices. Thus, it is believed that if sediment loads are maintained at acceptable levels, streams will repair themselves over time.

3.2.3 Grazing Areas

Farm animals grazing on pasture land can leave areas of ground with little or no vegetative cover. During a rainfall runoff event, the soil in the pastures is eroded and transported to nearby streams, typically by gully erosion. The amount of soil loss from gully erosion is generally less than that caused by sheet and rill erosion. Work in small grazed catchments in New Mexico found that gully erosion contributed only 1.4 percent of the total sediment load as compared to sheet and rill erosion. Other research found that gully erosion typically contributes less than 30 percent of the total sediment load; however, contributions have ranged from 0 to 89 percent (USEPA, 2001b).

Beef cattle spend their time grazing in pastures, while dairy cattle and hogs are periodically confined. Hog farms confine the animals or allow them to graze in small pastures or pens. On dairy farms, the cows are confined for a limited period each day, during which time they are fed and milked. In addition, beef cattle and other unconfined animals often have direct access to streams that pass through pastures. As these animals walk down to the stream, they often damage stream banks. Stream bank vegetation is destroyed and the banks often collapse, resulting in increased sedimentation to the waterway.

3.2.4 Mining Sites

Minerals, rocks, and ores are found in natural deposits on or in the earth. Kaolin, clays, granite, marble, sand, gravel, and other mineral products are the materials primarily mined in Georgia. Surface mining involves the activities used to remove and process minerals, ores, or other solid material. Tunnels, shafts and dimension stone quarries are not considered to be surface mines. Surface mining encompasses a variety of activities from sand dredging to open pit clay mining to hard rock aggregate quarrying.

Removal of vegetation, displacement of soils and other significant land disturbing activities are typically associated with surface mining. These operations can result in accelerated erosion and sedimentation of surface waters. Table 10 lists the active, inactive, and exploratory mines located in the watersheds monitored in the Savannah River Basin. None of these mines are located in the watershed of the listed segment, although there may be gravel pits.

Table 10. Mines Located in the Savannah River Basin Watersheds

Name	Type	County	Current Status	Material Mined
Banister Mine	Surface-Underground	Hart	Past Producer	Mica
Garner Mine	Surface-Underground	Hart	Past Producer	Mica
Hubert Creek Deposit	Unknown	Hart	Raw Prospect	Mica
Isam Sanders Deposit	Unknown	Hart	Raw Prospect	Mica
Kiefer Adams Deposit	Unknown	Hart	Raw Prospect	Mica

Source: USEPA, 2001a. *Watershed Characterization System (WCS)* Data, Georgia, Tetra Tech, U.S. Environmental Protection Agency, Region IV, Atlanta, Georgia, Jan. 31, 2001.

3.2.5 Roads

Erosion from unpaved roadways can be a significant source of sediment to rivers and streams. Erosion occurs when soil particles are loosened and carried away from the roadway, ditch, or road bank by water, wind, or traffic. The physical aspects of road construction (including erosive road-fill soil types, shape and size of coarse surface aggregate, poor subsurface and/or surface drainage, poor road bed construction, roadway shape, and inadequate runoff discharge outlets or “turn-outs” from the roadway) may aggravate roadway erosion. In addition, other factors such as roadway shading and light exposure, traffic patterns, and road maintenance may also affect roadway erosion.

Exposed soils, high runoff velocities and volumes, and poor road compaction all increase the potential for erosion. Loose soil particles are often carried from the road bed into adjacent drainage ditches. Some of these particles settle out, but usually they do not, causing diminished ditch carrying capacity, which leads to roadway flooding and subsequent, increased roadway erosion (Choctawhatchee, et al., 2000).

3.2.6 Urban Development

Soil erosion from land disturbing activities is a major source of sediment in Georgia’s streams. Land-disturbing activities are defined as any activity that may result in soil erosion and the movement of sediments into state waters or on lands of the state. Examples of land disturbing activities include clearing, grading, excavating, and filling of land. The following activities are unconditionally exempt from the provisions of the Erosion and Sedimentation Act (GA EPD, 2001); surface mining, granite quarrying, minor land-disturbing activities such as home gardens and landscaping, agricultural and silvicultural operations, and any project carried out under the technical supervision of the NRCS.

Conversion of forest to urban land use is often associated with water quality degradation. Since the early 1980s the area classified as commercial forest within the Savannah River Basin has significantly decreased. It should be noted that forest undergoing conversion to another land use is not considered silviculture, but rather a land disturbing activity.

Storm water runoff from developed urban areas can also have an impact on the transport of sediment to and within streams. Urbanization increases imperviousness, resulting in an increase in the volume of runoff entering the streams. In addition, the streamflow rates may increase significantly from pre-construction rates, causing stream bank erosion and stream bottom down-cutting.

4.0 MODELING APPROACH

Establishing the relationship between the instream water quality and the source loadings is an important component of TMDL development. It provides for both the identification of sources and their relative contribution, as well as the examination of potential water quality changes resulting from varying management options to meet the water quality standard. This relationship can be developed using a variety of techniques, ranging from simple methods based on scientific principles to more complex numerical computer modeling techniques.

In this section, the numerical modeling techniques used to simulate sediment fate and transport in the watershed are discussed. The limited amount of sediment loading data and instream sediment information prevents GA EPD from using a dynamic watershed runoff model, which requires a great deal of data for model development and calibration. Instead, GA EPD determined the annual sediment loads delivered to the stream from the surrounding watershed using the Universal Soil Loss Equation (USLE). This TMDL does not address instream sedimentation processes, such as bank erosion and stream bottom down-cutting, since computer models that simulate these processes are not available at this time.

4.1 Model Selection

The Agricultural Research Station (ARS) developed the USLE over 30 years ago. It is the most widely accepted and most used soil loss equation. It was designed as a method to predict average annual soil loss caused by sheet and rill erosion. The USLE can estimate long-term soil loss and can assist in choosing proper cropping, management and conservation practices. However, it cannot be used to determine erosion for a specific year or specific storm. Because of its wide acceptance by the forestry, agricultural, and academic communities, the USLE was selected as the tool for estimating long-term annual soil erosion, assessing the impacts of various land uses, and evaluating the benefits of various BMPs.

4.2 Universal Soil Loss Equation

For each of the watersheds monitored in the Savannah River Basin, the existing average annual sediment load was estimated using the USLE. The USLE predicts the average annual soil loss caused by sheet and rill erosion. Soil loss from sheet and rill erosion is mainly due to detachment of soil particles during rainfall events. It is the major source of soil loss from crop production, animal grazing areas, logging areas, mine sites, unpaved roads, and construction sites. The equation used for estimating average annual soil erosion is:

$$A = RKLSCP$$

Where:

A = average annual soil loss (tons/acre)
R = rainfall erosivity index
K = soil erodibility factor
LS = topographic factor
 L = slope length
 S = slope
C = cropping factor
P = conservation practice factor

4.2.1 Rainfall Erosivity Index

The R factor, or rainfall erosivity index, describes the kinetic energy generated by the frequency and intensity of the rainfall. It is statistically calculated from the annual summation of rainfall energy in every storm, which correlates to the raindrop size, multiplied by its maximum 30-minute intensity. This factor varies geographically, and Table 11 gives the R factors for the counties in which watersheds were modeled within the Savannah River Basin.

Table 11. R Factors by County

County	R factor
Banks	300
Burke	262.5
Chatham	350
Clarke	275
Columbia	350
Effingham	350
Elbert	250
Franklin	300
Glascock	250
Greene	250
Habersham	300
Hart	275
Jackson	275
Jefferson	262.5
Jenkins	300
Lincoln	250
Madison	275
McDuffie	250
Oglethorpe	250
Rabun	300
Richmond	250
Screven	300
Stephens	300
Taliaferro	250
Towns	300
Warren	250
Wilkes	250

Source: USEPA, 2001a. *Watershed Characterization System (WCS)*, Georgia, Tetra Tech, U.S. Environmental Protection Agency, Region IV, Atlanta, Georgia, Jan. 31, 2001.

4.2.2 Soil Erodibility Factor

The K factor, or soil erodibility factor, represents the susceptibility of soil to be eroded. This factor quantifies the cohesive or bonding character of the soil, as well as the ability of the soil to resist detachment and transport during a rainfall event. It is a function of the soil type, a parameter provided by the STATSGO data. Table 5 provides a breakdown of the soil type within each modeled watershed and the corresponding K factor. STATSGO soil data has a resolution of 1:250,000 and is available for all of Georgia. A higher-resolution (1:25,000) soil data, SSURGO, is available for fourteen Georgia counties. For consistency, however, it was decided that STATSGO data would be used for the first phase of sediment TMDLs because of its availability for all of Georgia. During the second phase of sediment TMDLs, SSURGO data may be used if it is available for all counties in Georgia.

4.2.3 Topographic Factor

The LS factor, or topographic factor, represents the effect of slope length and slope steepness on erosion. Steeper slopes produce higher overland flow velocities. Longer slopes accumulate more runoff from larger areas and also result in higher overflow velocities. The slope length and slope steepness are based on the grid size and ground slope provided by the USGS 30 by 30 meter Digital Elevation Model (DEM) grids, which were downloaded from the Georgia GIS Clearinghouse (http://gis1.state.ga.us/).

4.2.4 Cropping factor

The C factor, or cropping factor, represents the effect plants, soil cover, soil biomass, and soil disturbing activities have on erosion. It is the most complicated of all the USLE factors. It incorporates the effects of tillage, crop type, cropping history, and crop yield. Cropping factors for forested, agricultural, and urban lands were provided by the GFC, NRCS, and EPA, respectively.

Forested land includes both mature trees and those being harvested. The forest C factor for each watershed was calculated based on the percent of forest harvested in each county (see Table 9). If a watershed is in multiple counties, the percent forest harvested is determined by area-weighting the forested area within each county. C factors for cropland and pasture for each county were developed by NRCS under the National Resource Inventory Program and are listed in Table 12.

These values were developed based on the 1995 MRLC data. Low-level aerial photography was performed and the photographs were interpreted to identify land features. If data were not available for a given county, the C factor was calculated by averaging the C factors from all the surrounding counties. The cropland and pasture C factors for watersheds in multiple counties were determined by area-weighting the agricultural land use within each county.

Table 12. Cropland and Pasture C Factors by County

County	C factor	
	Cropland	Pasture
Banks	0.070	0.013
Burke	0.405	0.007
Chatham	0.429	0.004
Clay	0.307	0.004
Clarke	0.182	0.005
Columbia	0.132	0.011
Effingham	0.448	0.004
Elbert	0.155	0.011
Franklin	0.144	0.007
Glascock	0.193	0.005
Greene	0.241	0.005
Habersham	0.275	0.012
Hart	0.189	0.009
Jackson	0.130	0.013
Jefferson	0.328	0.005
Jenkins	0.357	0.041
Lincoln	0.090	0.006
Madison	0.143	0.012
McDuffie	0.173	0.006
Oglethorpe	0.130	0.020
Rabun	0.510	0.006
Richmond	0.132	0.013
Screven	0.350	0.003
Stephens	0.173	0.019
Taliaferro	0.202	0.003
Towns	0.358	0.011
Warren	0.349	0.009
Wilkes	0.150	0.004

Source: USDA-NRCS, 1997. *National Resources Inventory*, USDA-NRCS, Athens, Georgia, 1997.

C factors for the road networks were determined based on the road surface type and are given in Table 13. Road information, including road surface type, was provided by the Georgia DOT. Data gaps were filled based on adjacent road surfaces and road types (i.e., state, county, private).

Table 13. Road C Factors

Road Surface	Type	C factor
Rigid and Highly Flexible Road	1	0.13
Bituminous Surfaced Road	2	0.25
Gravel or Stone Road	3	0.65
Soil-Surfaced Road	4	0.75
Primitive or Unimproved Road	5	0.75

C factors for other land uses, including urban, mining, transitional, grass, and wetlands, are listed in Table 14. These values were provided by EPA and are used in all watersheds.

Table 14. Various Land Use C Factors

Land Use	C factor
Water	0
Low Intensity Residential	0.02
High Intensity Residential	0.005
High Intensity Commercial, Industrial, Transportation	0.003
Bare rock, sand, clay	0
Quarries, strip mines, gravel pits	0.75
Transitional	0.002
Other Grasses	0.003
Woody Wetlands	0.011
Emergent Herbaceous Wetlands	0.003

4.2.5 Conservation Practice Factor

The P factor, or conservation practice factor, represents the effects of conservation practices on erosion. The conservation practices include BMPs such as contour farming, strip cropping and terraces. In all cases, it was assumed that no BMPs were used and the P factor for all land uses was 1.0.

4.3 WCS Sediment Tool

EPA Region IV and Tetra Tech developed the Arcview-based Watershed Characterization System (WCS) to provide tools for characterizing various watersheds (USEPA, 2001a). WCS was used to display and analyze geographic information system (GIS) data including land use, soil type, ground slope, road networks, point source discharges, and watershed characteristics.

An extension of WCS is the Sediment Tool, which incorporates the USLE. The Sediment Tool can be used to perform the following tasks:

- Estimate the extent and distribution of soil erosion within a watershed
- Estimate the sediment delivery to the receiving waterbody
- Evaluate the effects of land use, BMPs, and road networks on erosion and sediment delivery

The watersheds of interest were delineated based on the stream coverage (RF3) and elevation data. If there was no RF3 segment within the delineated watershed, the WCS Sediment Tool could not be used.

A stream grid for each delineated watershed was created based on elevation data. The stream grid corresponded to a stream network with twenty-five 30 by 30 meter headwater cells (5.5 acres). The stream grid network incorporates flow and has the capability of accumulating flow.

For each 30 by 30 meter grid cell within the watershed, the WCS Sediment Tool calculates the potential erosion using the USLE and each cell's specific characteristics. The model then calculates the potential sediment delivery to the stream grid network. Sediment delivery can be calculated using one of the four available sediment delivery equations:

- Distance-based equation

$$M_d = M * (1 - 0.97 * D/L)$$

where M_d = mass moved (tons/acre-yr)
M = sediment mass eroded (ton)
D = least cost distance from a cell to the nearest stream grid (ft)
L = maximum distance the sediment may travel (ft)

- Distance Slope-based equation

$$DR = \exp(-0.4233 * L * S_f)$$

where DR = sediment delivery ratio
$S_f = \exp(-16.1 * (r / L + 0.057)) - 0.6$
L = distance to the stream (m)
r = relief to the stream (m)

- Area-based equation

$$DR = 0.417762 * A^{(-0.134958)} - 1.27097, \qquad DR \leq 1.0$$

where DR = sediment delivery ratio
A = area (sq miles)

- WEPP-based regression equation

$$Z = 0.9004 - 0.1341 * X - 0.0465 * X^2 + 0.00749 * X^3 - 0.0399 * Y + 0.0144 * Y^2 + 0.00308 * Y^3$$

where Z = percent of source sediment passing to the next grid cell
X = cumulative distance downslope
Y = percent slope in the grid cell

Based on work previously performed by EPA on the Chattooga River Watershed, it was determined that the distance slope-based equation provided the best prediction of the sediment delivery (USEPA, 2001b).

The WCS Sediment Tool estimates the total annual soil erosion and sediment delivered to the stream from each grid cell according to its land cover and roads.

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 narrative water quality standard for aquatic life. A TMDL is the sum of the individual waste load allocations (WLAs) from point sources and load allocations (LAs) from nonpoint sources and 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 waterbody. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For sediment, the TMDLs are expressed as tons per year (tons/yr).

Conceptually, a TMDL can be expressed as follows:

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

This TMDL determines the allowable sediment loads to the listed Savannah River Basin stream and is based on the hypothesis that an impaired watershed having an average annual sediment loading rate similar to the biologically least impacted watersheds will remain stable and become biologically unimpaired due to sediment. Within the Savannah River Basin, the average annual sediment load of the least impacted watersheds with IBI scores greater than 45 in the Piedmont Ecoregion is 0.15 tons/acre-yr (ranging from 0.07 to 0.24 tons/acre-yr). In the Southeastern Plains Ecoregion, the average annual sediment load of the unimpaired watersheds with IBI scores greater or equal to 40 is 0.22 tons/acre-yr (ranging from 0.07 to 0.33 tons/acre-yr). The following sections describe the various sediment TMDL components.

5.1 Waste Load Allocations

The waste load allocation (WLA) 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, as well as permitted storm water discharges. There are no NPDES permitted facilities in the impaired Savannah River Basin watershed.

The sediment load allocation from future construction sites within the watershed will have to meet the requirements outlined in the Georgia General Storm Water NPDES Permit for Construction Activities. This permit authorizes the discharge of storm water associated with construction activity to the waters of the State in accordance with the limitations, monitoring requirements, and other conditions set forth in Parts I through VII of the Georgia Storm Water Permit. The conditions of the permit were established to assure that the storm water runoff from these sites does not cause or contribute sediment to the stream. Georgia's General Storm Water Permit can be considered a water quality-based permit in that the numeric limits in the permit, if met, will not cause a water quality problem.

5.2 Load Allocations

The USLE was used to determine the relative sediment contributions from each significant land use. The USLE was applied to those watersheds that are biologically impaired and those that are not, in order to estimate the current sediment loading rates to the streams. The current sediment load allocation for each stream by land use, including roads, is reported in Table 15. The watersheds are grouped according to 303(d) listing. For comparison purposes, the total sediment load in tons per acre per year is also given. Table 16 gives each source's percent contribution to the total sediment load.

Understanding the potential sediment sources and the changes in land use that have occurred over the last century provides insight into the streams' current water quality conditions. The average annual sediment load per unit area for the unimpaired and impaired watersheds are generally within the same range. Over the last century there has been a dramatic decrease in the amount of land farmed in Georgia. Since 1950, there has been a 57 percent reduction in farmland. With this reduction in farmland, there has also been a decrease in the amount of soil erosion. This suggests that the sedimentation observed in the listed stream segments may be legacy sediment resulting from past land use practices. It is believed that if sediment loads are maintained at acceptable levels, streams will repair themselves over time.

5.3 Seasonal Variation

Sediment is expected to fluctuate according to the amount and distribution of rainfall. Since rainfall is greatest in the spring and winter seasons, it is expected that sediment loadings would be highest during these seasons. However, these seasonal fluctuations and other short-term variability in loadings due to episodic events are usually evened out by the response of the biological community to habitat alteration, which is a long-term process. Therefore, the average annual sediment load was considered to be an appropriate indicator of potential stream impairment due to sediment.

5.4 Margin of Safety

The MOS is a required component of a TMDL. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative model 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, the MOS was implicitly incorporated in the use of conservative modeling assumptions including:

- Selection of average USLE factors
- Use of no conservation practices (P factor = 1.0) for all land uses
- Use of average reference watershed sediment loading rates for the numeric targets

Table 15. Sediment Loads

Name	Sediment Load (tons/yr) Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands	Road	Total	Load (tons/acre-yr)
Biger Creek upper	0.00	2.61	0.00	0.02	0.00	0.00	0.00	1.39	0.34	0.41	52.61	394.37	0.01	2.09	0.25	27.41	481.49	0.17
Biger Creek mid	0.00	46.34	0.13	0.58	0.00	0.00	0.00	2.57	1.41	1.17	69.60	701.33	0.50	3.08	0.21	71.95	898.87	0.15
Biger Creek lower	0.00	57.10	0.13	0.59	0.00	0.00	0.00	3.65	1.77	1.45	90.18	1,024.24	0.50	3.48	0.21	95.46	1,278.75	0.17
Indian Creek	0.00	0.07	0.00	0.04	0.00	0.00	1.93	15.79	10.26	5.00	167.92	443.57	0.14	6.91	0.12	148.66	800.41	0.07
Lightwood Log Creek	0.00	0.07	0.00	0.00	0.00	0.00	0.00	8.65	1.63	2.39	138.37	1,482.35	0.00	2.48	0.05	54.94	1,690.93	0.51
Upton Creek	0.00	0.00	0.00	0.00	0.00	0.00	13.88	16.29	17.36	6.13	76.83	3,324.49	0.00	3.42	0.03	168.21	3,626.65	0.24
Beaverdam Creek	0.00	0.00	0.00	0.00	0.00	5.99	15.38	4.38	5.98	2.37	14.38	8,716.75	0.00	72.35	0.50	266.19	9,104.27	0.33
Boggy Gut Creek	0.00	4.99	0.09	0.01	0.00	0.00	19.44	3.89	8.25	3.53	3.35	732.25	0.00	89.14	0.08	53.99	919.00	0.07
Fitz Branch	0.00	0.00	0.00	0.00	0.00	0.26	5.31	0.44	0.25	0.13	1.38	1,150.70	0.00	32.39	0.16	6.27	1,197.29	0.25
Headstall Creek	0.00	8.05	0.16	0.23	0.00	0.16	4.59	2.82	4.41	2.77	6.55	1,995.55	0.07	53.94	0.04	74.93	2,154.26	0.17

Table 16. Sediment Load Percentages

Name	Percent Total Sediment Load															
	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/ Industrial Transportation	Bare Rock Sand and Clay	Quarries Strip Mines Gravel Pits	Transitional	Deciduous Forest	Evergreen Forest	Mixed Forest	Pasture/Hay	Row Crops	Other Grasses (Urban Recreational)	Woody Wetland	Emergent Herbaceous Wetlands	Road
Biger Creek upper	0.00%	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.29%	0.07%	0.08%	10.93%	81.91%	0.00%	0.43%	0.05%	5.69%
Biger Creek mid	0.00%	5.16%	0.01%	0.06%	0.00%	0.00%	0.00%	0.29%	0.16%	0.13%	7.74%	78.02%	0.06%	0.34%	0.02%	8.00%
Biger Creek lower	0.00%	4.46%	0.01%	0.05%	0.00%	0.00%	0.00%	0.29%	0.14%	0.11%	7.05%	80.10%	0.04%	0.27%	0.02%	7.46%
Indian Creek	0.00%	0.01%	0.00%	0.01%	0.00%	0.00%	0.24%	1.97%	1.28%	0.63%	20.98%	55.42%	0.02%	0.86%	0.01%	18.57%
Lightwood Log Creek	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.51%	0.10%	0.14%	8.18%	87.66%	0.00%	0.15%	0.00%	3.25%
Upton Creek	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.38%	0.45%	0.48%	0.17%	2.12%	91.67%	0.00%	0.09%	0.00%	4.64%
Beaverdam Creek	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.17%	0.05%	0.07%	0.03%	0.16%	95.74%	0.00%	0.79%	0.01%	2.92%
Boggy Gut Creek	0.00%	0.54%	0.01%	0.00%	0.00%	0.00%	2.12%	0.42%	0.90%	0.38%	0.36%	79.68%	0.00%	9.70%	0.01%	5.87%
Fitz Branch	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.44%	0.04%	0.02%	0.01%	0.11%	96.11%	0.00%	2.71%	0.01%	0.52%
Headstall Creek	0.00%	0.37%	0.01%	0.01%	0.00%	0.01%	0.21%	0.13%	0.20%	0.13%	0.30%	92.63%	0.00%	2.50%	0.00%	3.48%

5.5 Total Sediment Load

Within the Savannah River Basin, the average annual sediment load of the least impacted watersheds with IBI scores greater than 45 in the Piedmont Ecoregion is 0.15 tons/acre-yr (ranging from 0.07 to 0.24 tons/acre-yr). In the Southeastern Plains Ecoregion, the average annual sediment load of the unimpaired watersheds with IBI scores greater than or equal to 40 is 0.22 tons/acre-yr (ranging from 0.07 to 0.33 tons/acre-yr). The current sediment load was determined by adding the WLA and the LA. The MOS, as described above, was implicitly included in the TMDL analysis. If the current sediment load is less than the load from the least impacted watershed, then the total allowable load becomes the current load and no reductions are required. If the current sediment load is more than the load from the least impacted watershed, then the total allowable load is calculated by multiplying the appropriate least impacted watershed annual load by the drainage areas listed in Table 3. The WLA is then subtracted from the TMDL to determine the LA. The average annual sediment loads for the listed watershed is summarized in Table 17, which includes the required sediment load reduction. A Summary Memorandum for the watershed is provided in Appendix A.

The USLE method used indicates that the largest sediment loads come from areas with close proximity to the stream grid, especially dirt roads and croplands. The model does not account for any BMPs that are currently being used to control erosion from these areas, and thus may overestimate some sediment loads.

Table 17. Average Annual Sediment Load and Required Sediment Load Reduction

Name	Current Load (tons/yr)	WLA (tons/yr)	LA (tons/yr)	Total Load (tons/yr)	% Reduction
Headstall Creek	2,154.26	-	2,154.26	2,154.26	0%

Note: WLA for Future Construction Sites shall meet requirements of General Storm Water Permit

6.0 RECOMMENDATIONS

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; an approach that divides Georgia's major river basins into five groups. This approach provides for additional monitoring to be focused on one of the five basin groups each year. The Savannah and Ogeechee River Basins were the basins of focused monitoring in 2002 and will again receive focused monitoring in 2007. Additional monitoring of these streams will be initiated, as appropriate, during the next monitoring cycle to determine if there has been improvement in the biological communities.

6.2 Sediment Management Practices

Based on the findings of the source assessment, it was determined that most of the sediment found in the Savannah River Basin streams is due to past land use practices and is referred to as "legacy" sediment. Therefore, it is recommended that there be no net increase in sediment delivered to the listed stream segment, in order that this stream may recover over time.

The measurement of sediment delivered to a stream is difficult, if not impossible, to determine. Therefore, setting a numeric TMDL may be ineffective given the difficulty in measuring it. In addition, habitat and aquatic communities are usually slow to respond, which is why monitoring will continue according to the five-year monitoring cycle. Thus, this TMDL recommends compliance with NPDES permits and the implementation of BMPs. The effects of compliance with NPDES permits and the implementation of BMPs will contribute to the improvement of stream habitats and water quality, and will represent a beneficial measure of TMDL implementation.

Management practices recommended include:

- Compliance with the requirements of the NPDES permit program
- Implementation of storm water BMPs for Permitted Construction and Industrial Activities and Municipal Separate Storm Sewer Systems
- Implementation of Georgia Forestry Commission (GFC) BMPs for forestry
- Adoption of Natural Resources Conservation Service (NRCS) Conservation Practices
- Adherence to the Mined Land Use Plan prepared as part of the Surface Mining Permit Application
- Adoption of proper unpaved road maintenance practices
- Implementation of Erosion and Sedimentation Control Plans for land disturbing activities
- Mitigation and prevention of stream bank erosion due to increased streamflow velocities caused by urban runoff
- Implementation of Watershed Protection Plans

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. Treated wastewater tends to be discharged at relatively stable rates; whereas, storm water is discharged at irregular, intermittent rates, depending on precipitation and runoff. 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 NPDES dischargers are required to meet their current NPDES permit limits. Currently, there are no NPDES facilities with total suspended solid permit limits in the impaired watershed. It is recommended that there be no authorized increase in the WLA, unless it can be offset by a reduction in the LA. The removal of mined material involves water pumped from the mine pit, and mineral processing involves the disposal of process waters. These waters are treated through either sedimentation ponds or detention basins prior to being discharged to the stream and are regulated by NPDES permits. For mining facilities that may be located within the impaired watershed, it is recommended that monitoring frequencies be increased in order to better characterize the total average annual sediment loads coming from these facilities.

GA EPD has developed three General Storm Water NPDES Permits for Construction Activities. The permits are required for all construction sites disturbing one or more acres. All sites required to have a permit are authorized to discharge storm water associated with construction activity to the waters of the State in accordance with the limitations, monitoring requirements, and other conditions set forth in Parts I through VII of the Georgia Storm Water NPDES Permits for Construction Activities. The permits require all sites to have an Erosion, Sedimentation and Pollution Control Plan; to implement, inspect and maintain BMPs; and to monitor storm water for turbidity. Georgia's General Storm Water NPDES Permits for Construction Activities can be considered a water quality-based permit, in that the numeric limits in the permit, if met and enforced, will not cause a water quality problem.

It is recommended that construction sites within impaired watersheds that are located within 100 feet of the listed stream or its tributaries use DIRT II techniques to model and manage storm water runoff from these sites. In addition, all construction sites will monitor their storm water runoff as required by the General Storm Water NPDES Permit for Construction Activities.

6.2.2 Nonpoint Source Land Use Approaches

GA EPD is responsible for administering and enforcing laws to protect the waters of the State. GA EPD is the lead agency for implementing the State's Nonpoint Source Management Program. Regulatory responsibilities include establishing water quality standards and use classifications, assessing and reporting water quality conditions, issuing point source permits, issuing water withdrawal and ground water permits, and regulating land-disturbing activities that may affect water quality. Georgia is working with local governments, and agricultural and forestry agencies such as the NRCS, the Georgia Soil and Water Conservation Commission, and the GFC to foster the implementation of BMPs that address nonpoint source pollution. In addition, public education efforts are being targeted at individual stakeholders to provide information regarding the use of BMPs to protect water quality. The following sections describe in more detail the specific measures to reduce nonpoint sources of sediment by land use type.

6.2.2.1 Forested Land

In 1978, GA EPD designated the GFC to be the lead agency in managing and implementing the silvicultural portion of Georgia's Nonpoint Source Management Program. The GFC is responsible for coordinating water quality issues with regard to forested land in Georgia. The GFC is basically responsible for:

- Developing BMPs for the forestry industry
- Educating the forestry community on BMPs
- Conducting site inspections for measuring compliance with the established BMPs

The GFC formed a Forestry Nonpoint Source Pollution Technical Task Force to assess the extent of water pollution caused by forestry practices, and to develop recommendations to reduce or eliminate erosion and sedimentation. After a three-year field study, the task force developed a set of BMPs that address all aspects of silviculture including forest road construction, timber harvesting, site preparation, and forest regeneration. The task force recommended the BMPs be implemented through a voluntary program, exempt from permitting under the Georgia Erosion and Sedimentation Control Act, emphasizing educational and training programs instead. In 1997, the original BMP document was revised to incorporate the 1989 Wetland BMP manual developed by the Georgia Forestry Association. The current BMP manual, *Georgia's Best Management Practices for Forestry,* was developed and became effective June 1, 1999 (GA EPD, 1999).

It is the responsibility of the GFC to educate and inform the forestry community (landowners, procurement and land management foresters, consulting foresters, loggers, site prep and tree planting contractors, etc.) on the importance of BMPs. The GFC statewide coordinator, along with twelve district coordinators, conducts these educational programs across the State. The district coordinators receive specialized training in erosion and sedimentation control, forest road layout and construction, stream habitat assessment, rapid bioassessment (macroinvertebrate) monitoring, wetland delineation, and fluvial geomorphology. The GFC has developed training videos, slide programs, tabletop exhibits, and BMP billboards that are displayed at wood yards across the state. For the benefit of private landowners selling timber, the GFC has developed a Sample Forest Products Sale Agreement, which includes fill-in-the-blank spaces for specific BMP incorporation. Since December 1995, the GFC has been cooperating with the University of Georgia School of Forest Resources, the Georgia Forestry Association, and the American Forest and Paper Association member companies in the ongoing education of loggers and timber buyers through the Sustainable Forestry Initiative Master Timber Harvester program. This includes an intensive training session on the BMPs conducted by the GFC.

To determine if educational efforts have been successful and if the BMPs are effective at minimizing erosion and sedimentation, the GFC conducted BMP compliance surveys in 1991 and 1992. In 1998, another BMP survey was conducted using a newly developed and more rigorous protocol recommended by a Southern Group of State Foresters Task Force. The GFC sampled about 10 percent of the forestry operations that occur annually. The number of samples taken in each county was based on the volume of wood harvested as reported in the state's latest Product Drain Report. Sites were randomly selected to reflect various forest types (non-industrial private forest, forest industry, and publicly owned lands). The survey results show that of the number of acres evaluated, the number in BMP compliance was generally high. In 1991, approximately 86 percent of the acres evaluated were in compliance. In 1992, the figure increased to 92 percent compliance and in 1998, compliance rose to 98 percent.

The GFC also investigates and mediates complaints or concerns involving forestry operations on behalf of the GA EPD and the Army Corps of Engineers (COE) when stream water quality and wetlands are involved, respectively. Complaints from citizens are also received, particularly in counties growing in population where landowners are living close to commercial forestry operations. After notifying the forest owner, the GFC District Coordinator conducts a field inspection to determine if BMPs were followed, if the potential for water quality problems exists, and the identity of the responsible party. If the complaint is valid, GFC will work with the responsible party until the problem is corrected. However, the GFC has no regulatory authority. In situations where the GFC cannot get satisfactory compliance, the case is turned over to the GA EPD or COE for enforcement actions under the Georgia Water Quality Control Act or Section 404 of the Federal Clean Water Act.

It is recommended that the GFC continue to encourage BMP implementation, educational training programs, and site compliance surveys. The numbers of individuals trained and the number of site compliance inspections conducted should be recorded each year. In addition, the number of complaints received, the actions taken, and the enforcement actions written should be recorded.

6.2.2.2 Agricultural Land

There are a number of agricultural organizations that work to support Georgia's more than 40,000 farmers. The following three organizations have primary responsibility for working with farmers to promote soil and water conservation:

- University of Georgia (UGA) - Cooperative Extension Service
- Georgia Soil and Water Conservation Commission (GSWCC)
- 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. These include classroom instruction, basic and applied research, consulting assistance, and information on nonpoint source water quality impacts.

GSWCC was created in 1937 by a Georgia Legislative Act. In 1977, 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. In September 1994, the GSWCC developed a BMP manual, *Agricultural Best Management Practices for Protection of Water Quality in Georgia,* for the agricultural community (GSWCC, 1994).

NRCS cooperates with Federal, State, and local governments to provide financial and technical assistance to farmers. NRCS develops standards and specifications for BMPs that are to be used to improve, protect, or maintain our State's natural resources. Practice standards establish the minimum level of acceptable quality for planning, designing, installing, operating, and maintaining BMPs. Practice specifications describe the technical details and workmanship required to install a BMP and the quality and extent of materials to be used in a BMP.

NRCS provides Conservation Practice Standards and Job Sheets on their website (http://www.nrcs.usda.gov/technical/efotg/). Some of these BMPs may be used for farming operations to reduce soil erosion. It is recommended that the agricultural communities with crop land close to listed streams, and pasture land where grazing animals have access to the stream, investigate the various BMPs available to them in order to reduce soil erosion and bank collapse.

The 1996 Farm Bill and Public Law 83-566 Small Watershed Program provided new financial assistance programs to address high priority environmental protection goals. Some programs that specifically address erosion and sedimentation are:

- Environmental Quality Incentives Program
- Conservation Reserve Program
- Small Watershed Program

The Environmental Quality Incentives Program (EQIP) is a USDA cost-share program available to farmers to address natural resource problems. EQIP offers financial, educational, and technical assistance funding for installing BMPs that reduce soil erosion, improve water quality, or enhance wildlife habitats.

The Conservation Reserve Program (CRP) was originally designed by NRCS to provide incentive and offer assistance to farmers to convert highly erodible and other environmentally sensitive land normally devoted to crop production into land with other long-term resource-conserving cover. The CRP has been expanded to place eligible acreage into filter strips, riparian buffers, grassed waterways, or contour grass strips. Each of these practices helps to reduce erosion and sedimentation and improve water quality.

The Small Watershed Program provides financial and technical assistance funding for the installation of BMPs in watersheds less than 250,000 acres. This program is used to augment ongoing conservation programs where serious natural resource degradation has, or is, occurring. Agricultural water management, which includes projects that reduce soil erosion and sedimentation and improve water quality, is one of the eligible purposes of this program.

NRCS is authorized by Public Law 83-566 to conduct river basin surveys and investigations. The NRCS River Basin Planning Program is designed to collect data on natural resource conditions within the river basins of focus. The river basins of focus are on a five-year rotation. NRCS is 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.

Every five years, the USDA-NRCS conducts the National Resources Inventory (NRI). The NRI is a statistically based sample of land use and natural resource conditions and trends, covering non-federal land in the United States. The NRI found the total wind and water erosion from cropland and Conservation Reserve Program land in Georgia declined 38 percent from 3.1 billion tons per year in 1982 to 1.9 billion tons in 1997 (USDA-NRCS, 1997).

NRCS also provides a web-based database application, Performance and Results Measurement System (PRMS), so that conservation partners and the public can gain fast and easy access to the accomplishments and the progress made toward strategies and performance goals.

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. The five year NRI activities should be continued, and GA EPD supports the PRMS.

6.2.2.3 Mine Sites

Surface mining and mineral processing convey two sediment sources to surface water. The first source is the wastewater from mining and mineral processing operations. These treated discharges are considered point sources and therefore are regulated by NPDES permits, as discussed in Section 6.2.1 above. The second source involves mine reclamation activities. Reclamation occurs throughout the mining operation. From the first cut to the last, overburden is moved twice. With each movement of the soil and rock debris, the overburden must be managed to prevent soil and mineral erosion. Until the mine is re-vegetated, and hence reclaimed, BMPs must be implemented to prevent point and nonpoint source pollution.

The Georgia Surface Mining Act of 1968 provides for the issuance of mining permits at the discretion of the Director of GA EPD. These permits are administered by the Land Protection Branch of EPD. The surface mining permit application must include a Mined Land Use Plan, reclamation strategies, and surety bond requirements to guarantee proper management and reclamation of surface mined areas. The Mined Land Use Plan specifies that all activities prior to, during, and following mining include disposal of refuse and erosion and sedimentation control. The reclamation strategy includes the use of operational BMPs and procedures. The BMPs used are drawn from the *Field Manual for Erosion and Sediment Control in Georgia* (GSWCC, 1997), *Georgia's Best Management Practices for Forestry* (GA EPD, 1999), and from other states. Thus, the issuance of a surface mining permit in effect addresses BMPs to control nonpoint source pollutants. The regional GA EPD offices monitor and inspect surface mining sites to assess their permit compliance.

It is recommended that special attention be given to facilities that may be located in impaired watersheds. The implementation and maintenance of BMPs used to control erosion should be reviewed during the site inspections.

The Georgia Mining Association (GMA) is an informal trade association of the mining industry. It serves more than 200 members, 47 mining companies and over 150 associate companies. The association monitors legislative developments and coordinates industry response. It educates miners about the laws and regulations that affect them and provides a forum for the exchange of ideas. Through its newsletters, seminars, workshops, and annual conventions, the Georgia Mining Association serves as a source for mining industry information. It has several committees, including the Environmental Committee, that meet three to four times a year. The mining industry is conducting informal discussions on the potential of developing industry-wide standards for BMPs to prevent and reduce nonpoint source pollution. If these standards are adopted, the mining industry would likely conduct demonstration projects to gauge the effectiveness of the BMPs.

6.2.2.4 Roads

Unpaved roads can be a major contributor of sediment to our waterways if not properly managed. The following guidance for the maintenance and service of unpaved roadways, drainage ditches, and culverts can be used to minimize roadway erosion. Some additional guidance may be found in *Recommended Practices Manual, A Guideline for Maintenance and Service of Unpaved Roads* (Choctawhatchee, et al, 2000).

Disturbances to unpaved roadway surfaces and ditches, and poor road surface drainage leading to deterioration of the road surface. This causes increased roadway erosion and results in stream sedimentation. Unpaved roads are typically maintained by the blading and/or scraping of the roads to remove loose material. Proper, timely, and selective surface maintenance can prevent or minimize erosion of unpaved roadways. This in turn lengthens the life of the road and reduces maintenance costs. Roadway blading that occurs during periods when there is enough moisture content allows for immediate re-compaction. In addition, roadwork performed near streams or stream crossings during "dry" months of the year can reduce the amount of sediment that enters a stream.

Roadside ditches convey storm water runoff to an outlet. A good drainage ditch is shaped and lined with appropriate vegetative or structural material. A well-vegetated ditch slows, controls, and filters the storm water runoff, providing an opportunity for sediments to be removed from the runoff before it enters surface waters. Energy dissipating structures to reduce velocity and dissipate turbulence in ditches are often necessary. Efficient disposal of runoff from the road helps preserve the roadbed and banks. Properly installed "turn-outs", or intermittent discharge points, help to maintain a stable velocity and proper flow capacity within the ditch. This, in turn, alleviates roadway flooding, erosion, and maintenance problems. Properly placed "turn-outs" distribute roadway runoff and sediment over a larger vegetative filtering area, helping to reduce road side ditch maintenance to remove accumulated sediment.

Culverts are conduits used to convey water from one side of a road to another. Installation, modification, and/or improvements of culverts when streamflows and expected rainfall are low can reduce the amount of sediment that enters a stream. If the entire installation process, from beginning to end, can be completed before the next rainfall event, stream sedimentation can be minimized. Diverting all existing or potential streamflows while the culvert is being installed can also help reduce or avoid sedimentation below the installation. The culvert design can have a significant impact on the biological community if the size and species of fish passing through it are not considered. Changes in water velocities and the creation of vertical barriers also affect the biological communities.

6.2.2.5 Urban Development

The Erosion and Sedimentation Act, established in 1975, provides the mechanism for controlling erosion and sedimentation from land-disturbing activities. This Act establishes a permitting process for land-disturbing activities. Many local governments and counties have adopted erosion and sedimentation ordinances and have been given authority to issue and enforce permits for land-disturbing activities. Approximately 32 counties and 240 municipalities in Georgia have been certified as the local issuing authority for land-disturbing permits. In areas where local governments have not been certified as an issuing authority, the GA EPD is responsible for permitting, inspecting, and enforcing the Erosion and Sedimentation Act.

To receive a land-disturbing permit, an applicant must submit an erosion and sedimentation control plan that incorporates specific conservation and engineering BMPs. The *Field Manual for Erosion and Sediment Control in Georgia,* developed by the GSWCC, may be used as a guide to develop erosion and sedimentation control plans (GSWCC, 1997).

Local governments, with oversight by the GA EPD, and the Soil and Water Conservation Districts, are primarily responsible for implementing the Erosion and Sedimentation Act. Reports of suspected violations are made to the agency that issued the permit. In cases with local issuing authority, if the violation continues, the compliant is referred to the appropriate Soil and Water Conservation District. If the situation remains unresolved, the complaint is then referred to GA EPD for enforcement action. Enforcement may include administrative orders, injunctions, and civil penalties. It is recommended that the local and state governments continue to work on the implementation of the revised June 2001 Erosion and Sedimentation Act.

Storm water runoff from developed urban areas (post-construction) can also have an impact on the transport of sediment to and within streams. Urbanization increases imperviousness, resulting in an increase in the volume of runoff that enters the streams. In addition, the streamflow rates may increase significantly from pre-construction rates. These changes in the streamflow can result in stream bank erosion and stream bottom down-cutting. It is recommended that local governments review and consider implementation of practices presented in the *Land Development Provisions to Protect Georgia Water Quality* (GA EPD, 1997).

6.3 Reasonable Assurance

Permitted discharges will be regulated through the NPDES permitting process described in this report. Georgia is working with local governments, and agricultural and forestry agencies, such as the NRCS, the GSWCC, and the GFC, to foster the implementation of best management practices to address nonpoint sources. In addition, public education efforts will be targeted at individual stakeholders to provide information regarding the use of best management practices 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 BMPs 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 in this TMDL will be implemented in the form of water-quality based effluent limitations in NPDES permits issued under CWA Section 402. [See 40 C.F.R. § 122.44(d)(1)(vii)(B)]. 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 2006.

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

Average Annual Sediment Load Summary Memorandum

SUMMARY MEMORANDUM
Average Annual Sediment Load
Headstall Creek

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**McDuffie**
Major River Basin:	**Savannah**
8-Digit Hydrologic Unit Code(s):	**03060108**
Waterbody Name:	**Headstall Creek**
Location:	**Upstream from Tudor Road to Brier Creek**
Stream Length:	**6 miles**
Watershed Area:	**20.5 square miles**
Tributary to:	**Brier Creek**
Ecoregion:	**Southeastern Plains**
Constituent(s) of Concern:	**Sediment**
Designated Use:	**Fishing (partially supporting designated use)**

Applicable Water Quality Standard:

All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses.

2. TMDL Development

Analysis/Modeling:

Universal Soil Loss Equation was used to determine the average annual sediment load

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA):

Future Construction Sites	**Meet requirements of General Storm Water Permit**
Load Allocation (LA):	**2,154.3 tons/yr**
Margin of Safety (MOS):	**implicit**
Average Annual Sediment Load:	**2,154.3 tons/yr**