TOTAL MAXIMUM DAILY LOAD (TMDL)

For
Sediment

In the Flint River Basin

Red Oak Creek

HUC 03130005

Spring Creek

HUC 03130006

Upper Chickasawhatchee Creek

HUC 03130009

February 2003

United States Environmental Protection Agency

Region 4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et.seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S Environmental Protection Agency is hereby establishing Total Maximum Daily Loads (TMDLs) for sediment for Red Oak Creek, Spring Creek, and Upper Chickasawhatchee Creek in the Flint River Basin. Subsequent actions must be consistent with this TMDL.

Signed February 28, 2003

James D. Giattina, Director

Date

Water Management Division

TOTAL MAXIMUM DAILY LOAD (TMDL)

Sediment

In the Flint River Basin

Under the authority of Section 303(d) of the Clean Water Act, 33 U.S.C. 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the U.S. Environmental Protection Agency is hereby proposing a TMDL for sediment for the protection of aquatic life in the following segments of the Flint River Basin in Georgia:

Red Oak Creek in Southern Lower Piedmont Ecoregion (habitat due to sediment)

Spring Creek in Coastal Plain Red Uplands Ecoregion (biota due to sediment)

Upper Chickasawhatchee Creek in Dougherty Plain Ecoregion (biota due to sediment)

The calculated allowable load of sediment that may come into the Red Oak Creek of the Southern Lower Piedmont Ecoregion in the Flint River Basin without exceeding the water quality target is an annual loading of 0.4 tons/acre/year. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife for the protection of aquatic life to determine the applicable water quality target. Based on the current estimated annual loading for the listed segments, Red Oak Creek will need a twenty (20) percent reduction in existing estimated watershed sediment.

The calculated allowable load of sediment that may come into the Spring Creek segment of the Coastal Plain Red Uplands Ecoregion in the Flint River Basin without exceeding the water quality target is an annual loading of 1.1 tons/acre/year. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife to determine the applicable water quality target. Based on the current estimated annual loading for the listed segments, Spring Creek will need a seventy (70) percent reduction in existing estimated watershed sediment.

The calculated allowable load of sediment that may come into Upper Chickasawhatchee Creek segment of the Dougherty Plain Ecoregion in the Flint River Basin without exceeding the water quality target is an annual loading of 1.1 tons/acre/year. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife to determine the applicable water quality target. Based on the current estimated annual loading for the listed segments, Upper Chickasawhatchee Creek will has an existing load of 0.75 tons/acre/year. The majority of the sediment problems are probably due to historic landuse practices and migration of sediment from the headwater areas via tributaries to the main stem segments that caused high instream bedload sediment volume. (Trimble 1969). Although watershed sediment load reductions are not needed, it is recommended that Best Management Practices and continued compliance with the State of Georgia's stormwater construction permit be maintained and enforced to allow the stream to purge itself of the historic sediment loads.

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1. Executive Summary

1. 303(d) Listed Waterbody Information

State: Georgia

County: Mitchell, Macon and Meriwether

Major River Basin: Flint River Basin

Impaired Waterbodies (1998 303(d) List):

Table 1: Impaired Waterbody List

Waterbody ID	**Segment Name**	**Ecoregion**	**Designated Use Not Support [mi.]**
GA03130005011	Red Oak Creek HUC 03130005	Southern Lower Piedmont	10
GA03130006000491	Spring Creek. HUC 03130006	Coastal Plain Red Uplands	2
GA03130009002	Chickasawhatchee Creek	Dougherty Plain	10

Constituent(s) Causing Impairment: Sediment causing habitat and biota problems

Designated Uses: Fishing

Applicable Water Quality Standard for Recreation (most stringent):

The calculated allowable load of sediment that may come into the identified segments of the Upper Piedmont Ecoregion in the Flint River Basin without exceeding the water quality target is an annual loading of 0.4 tons/acre/year. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife to determine the applicable water quality target.

The calculated allowable load of sediment that may come into the identified segments of the Coastal Plain Red Uplands and Dougherty Plain Ecoregions in the Flint River Basin without exceeding the water quality target is an annual loading of 1.1 tons/acre/year. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife to determine the applicable water quality target.

2. TMDL Development

Analysis/Modeling:

The link between the habitat alteration due to sediment loads and the identified sources of sediment is the basis for the development of the TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and identified sources. This provides the basis for estimating the total assimilative capacity of the river and any needed load reductions. Watershed-scale loading of sediment in water was simulated using the Watershed Characterization System (WCS) (USEPA, 2001). The complexity of this loading function model falls between that of a detailed simulation model, which attempts a mechanistic, time-dependent representation of pollutant load generation and transport, and simple export coefficient models, which do not represent temporal variability. The WCS provides a mechanistic, simplified simulation of precipitation-driven runoff and sediment delivery, yet is intended to be applicable without calibration. Solids load from runoff can then be used to estimate pollutant delivery to the receiving waterbody from the watershed. This estimate is based on sediment concentrations in wet and dry deposition, which is processed by soils in the watershed and ultimately delivered to the receiving waterbody by runoff, erosion and direct deposition.

Critical Conditions:

The annual average watershed load represents the long-term processes of accumulation of sediments in the stream habitat areas that are associated with the potential for habitat alteration and aquatic life effects.

Seasonal Variation:

The average annual load addresses seasonal variation.

3. Watershed Allocation by Stream Reach for Sediment:

Table 2: TMDL Allocations

Waterbody	WLA Tons/Acre/Year	LA Tons/Acre/Year	MOS	TMDL Tons/Acre/Year	Percent Reduction
Red Oak Creek	0.1	0.4	Implicit	0.4	20
Spring Creek	0.1 plus 68 ton/year from GA0020486 *	1.08	Implicit	1.1	75
Chickasawhatchee Creek	0.1	1.1	Implicit	1.1	none

Notes: Since the WLA on an areal basis is less than the allowable load allocation, the WLA will have no impact on the overall area weighted TMDL load. For example if total watershed size is 100 acres and 10% or 10 acres are covered by construction stormwater permit and the remaining 90 acres meet the LA of 0.4 tons/acre/year, then the actual loading from the watershed is: 10 acres*0.1 tons/acre/year + 90 *0.4 tons/acre/year = 37 tons/year per 100 acres or an area weighted total load of 0.37 tons/acre/year.

* Based on Montezuma Waste Treatment Facility design flow of 1.5 mgd and effluent limit of 30 mg/l total suspended solids concentration

2. Background

2.1. Creek Locations

Red Oak Creek, Spring Creek and Chickasawhatchee Creek are located in middle Georgia in Meriwether, Macon and Terrell Counties respectively. Red Oak Creek, which is located northeast of Molena, flows southeast from the town of Rocky Mount before discharging to the Flint River near Carrolls (Figure 1). Spring Creek, which is located south of Montezuma, flows east from the town of Spalding before discharging to the Flint River near Montezuma (Figure 2). Chickasawhatchee Creek, which located near City of Dawson, flows south before discharging to Ichawaynochaway Creek near Elmodel (Figure 3). The land use characteristics of the Flint River watersheds were determined using data from Georgia's Multiple Resolution Land Coverage (MRLC). 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 1 below lists the land use distribution of Red Oak Creek, Spring Creek and Chickasawhatchee Creek. Red Oak Creek, Spring Creek and Chickasawhatchee Creek were listed on the State of Georgia 1996 303(d) list for habitat modification. The confirmed pollutant found impairing the designated use was sedimentation.

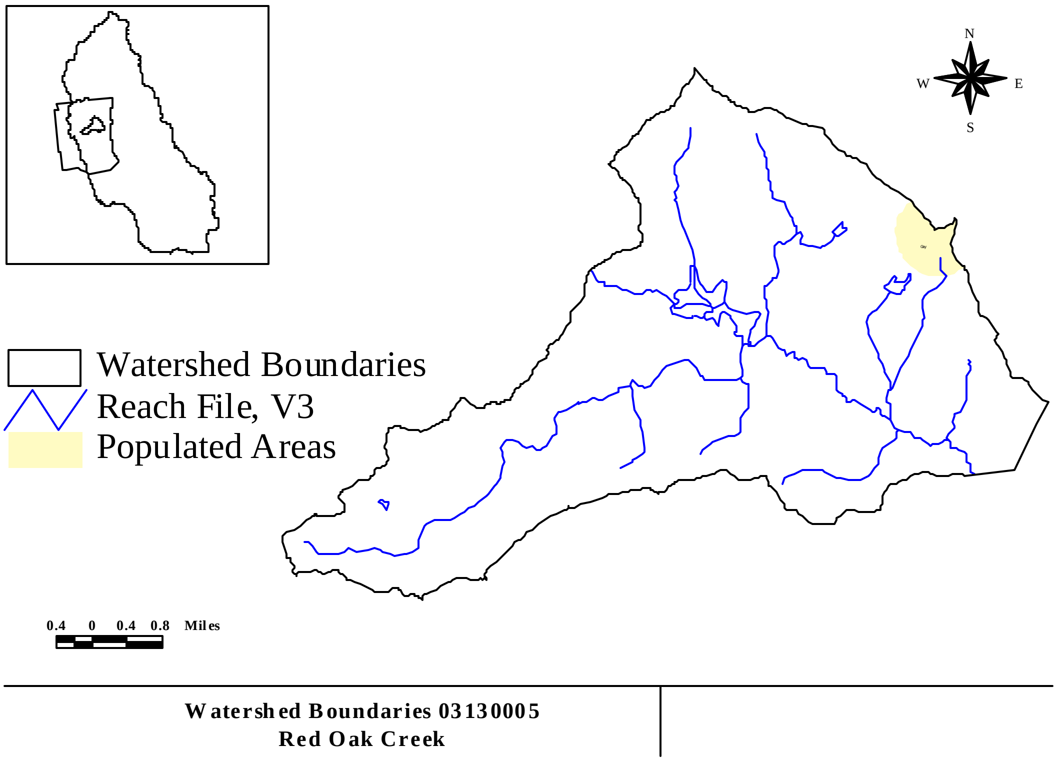

Figure 1: Red Oak Creek Watershed Location Map

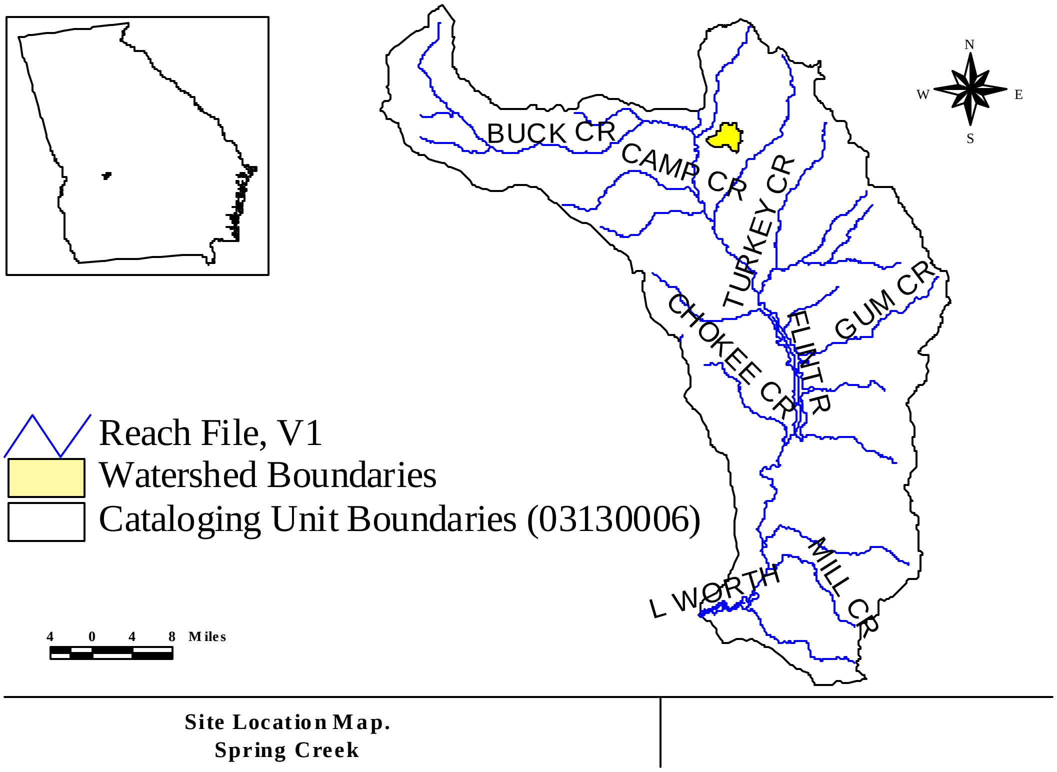

Figure 2: Spring Creek Site Location

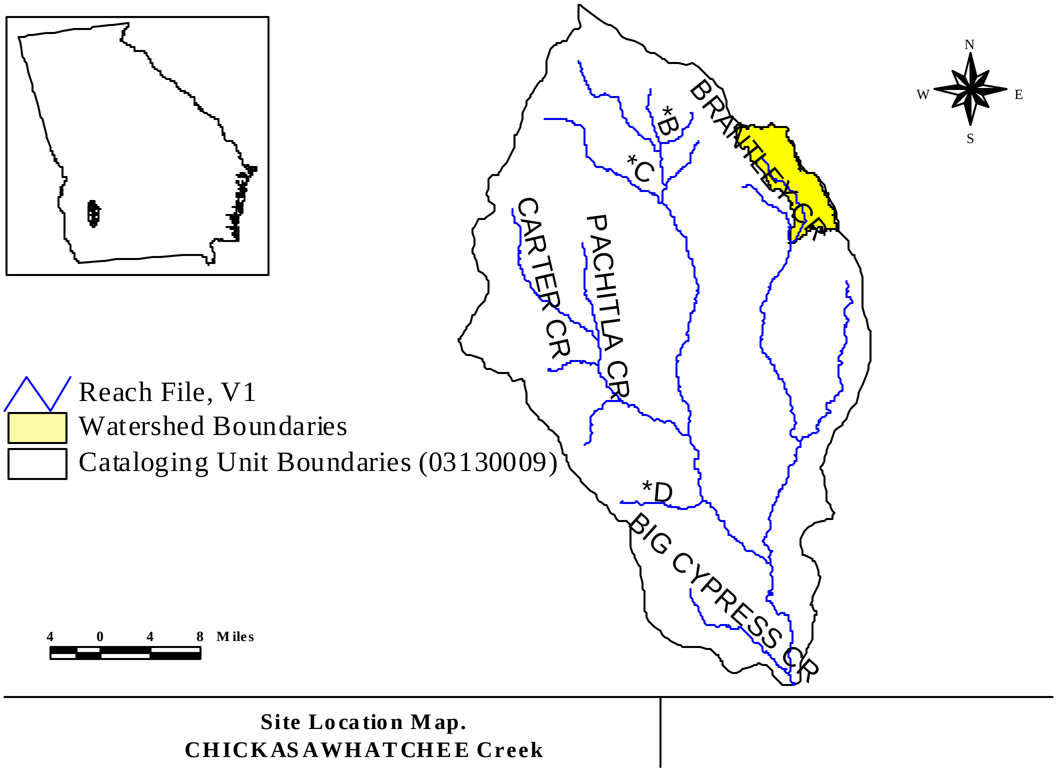

Figure 3: Chickasawhatchee Creek

Table 3: Landuse in the Hazel Creek and White Creek Watershed (acres)

	Deciduous Forest	Pasture/Hay	Mixed Forest	Evergreen Forest	Row Crops	Low Intensity Residential	High Intensity Commercial/Industrial Transportation	Other Grasses (Urban/recreational; e.g. parks)	Open Water	Quarries/Strip Mines/Gravel Pits	High Intensity Residential	Transitional	Woody Wetlands	Emergent Herbaceous Wetlands	Bare Rock/Sand/Clay
Red Oack Creek	2928	1756	3117	4576	912	16	25	2	163	0	0	324	1086	19	0
Spring Creek	197	1179	147	138	1824	31	58	43	6	0	30	33	98	36	2
Chickasawhatchee Creek	2969	4838	1494	645	6416	31	3	55	300	0	3	813	2264	121	0

EPA developed TMDLs for each of the listed segments in the watersheds. Each watershed contains several different types of land uses. Different land uses collect and distribute sediment at different rates as a function of runoff, slope, soil erositivity and erosion.

A TMDL evaluation examines the known potential sources of the pollutant in the watershed, including point sources, nonpoint sources, and background levels. For the purpose of this TMDL, facilities permitted under the National Pollutant Discharge Elimination System (NPDES) Program are considered point sources.

2.1.1. Source Assessment

A TMDL evaluation examines the known potential sources of the pollutant in the watershed, including point sources, nonpoint sources, and background levels. For the purpose of this TMDL, facilities permitted under the National Pollutant Discharge Elimination System (NPDES) Program are considered point sources.

2.1.2. **Point Sources*:***

One minor continuous NPDES permitted discharge from a municipal wastewater treatment facility is located in the Georgia portion of the 303(d) listed streams. This is a minor contributor of biological reactive solids and is not considered in the WLA. Red Oak and Chickasawhatchee Creeks do not have NPDES point source dischargers.

Table 4: Point Source Loads

Facility	Permit Number	Receiving Water	Existing Flow (MGD)	Average Solids Concentration (mg/l)	Solids Load (lbs/yr)
Montezuma WPCP #2	GA0020486	Spring Creek	0.9019	20.5833	68.92

Other potential point sources discharges in the Georgia portion of the listed streams are storm water discharges associated with construction activities. The State of Georgia Department of Natural Resources, Environmental Protection Division (EPD) has developed a general storm water permit, which covers all existing and new storm water point source discharges. Under this permit, storm water point sources associated with construction activity, are authorized to 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 General Permit. The permit limitations are established to assure that the storm water runoff from these point source sites do not cause or contribute to the existing sediment impairment. A Comprehensive Monitoring

Plan with turbidity monitoring requirements is required to assure any storm water discharge from the site does not cause or contribute to the existing sediment problem.

The Georgia General Storm Water Permit for Construction Activities (Storm Water Permit) was developed to reduce the input of sediment from construction activities. As an example, in the Middle Flint Watershed, based on the available mid 1990s landuse information, it was estimated that, absent the limitations established by the Storm Water Permit, construction would contribute 450 tons/square-mile/year to the stream sediment load. Implementation of the Storm Water Permit in the Middle Flint Watershed, which has the highest contribution from construction activities, should reduce the sediment contributed by these construction activities to 0.1 tons/acre/year. This level is below the target of 0.4 tons/acre/year. This reduced load would be less than 25% of the total allowable sediment area weighted load for the Flint River Basin and will not cause or contribute to the sediment problem if stormwater permit levels are met.

The Georgia General Storm Water Permit can be considered to be a water quality-based permit, in that the numeric limits in the permit, if met and enforced, will not cause a water quality problem in a unimpaired stream or contribute to an existing problem in an impaired stream. It is recommended that for impaired watersheds, the cold water (trout stream) turbidity table be used.

2.1.3. Existing Nonpoint Watershed Sediment Loads:

The long–term sediment watershed load was calculated using the Universal Soil Loss Equation (USLE) and broken down by land use sediment sources and road erosion sediment sources. Appendix A contains the estimated loads from roads and various landuse for Red Oak, Spring and Chickasawhatchee Creek Watersheds.

2.1.4. Flint River Basin

The current estimated long–term area weighted watershed sediment loads for the listed streams in the Flint River Basin are shown in Table 5.

Table 5: Flint Watershed Sediment Loads

Listed Streams – Georgia	Watershed	Area (Acres)	Area Weighted (Tons/Acre/Year)
Red Oak Creek	03130005	15,300	0.5
Spring Creek	03130006	3,970	3.3
Chickasawhatchee Creek	03130009	20,500	0.75

3. EPA Region 4 Biological/Habitat Data and Information

3.1.1. Establishment of Reference Site

In 2001, EPA's Science Ecosystem and Support Division (SESD) conducted field studies to determine appropriate reference sites for Red Oak Creek, Spring Creek and Chickasawhatchee Creek. Because these waters are located in differing ecoregions[1], the goal of the investigation was to find an appropriate reference site from within the correct ecoregion for each stream.

The criteria SESD used in selecting these reference sites included:

1) Level of human disturbance – The reference stream selected needed to be within the same ecoregion and have a low level of human disturbance. This site would represent the least impacted watersheds given the prevalent land use within the ecoregion. Other consideration included lack of permitted discharges, landuse classifications, and good riparian condition.

2) Accessibility - These sites had to be accessable and wadable.

3) Representativeness - The streams selected as reference sites had to be representative of the stream(s) being investigated.

1 An ecoregion is a region of relative homogeneity in ecological systems 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. White Creek and Hazel Creek are both located in the Upper Piedmont Ecoregion.

4) Health of the Stream – The stream must have good biology. As further described below, the biotic integrity of the reference streams was determined to be good.

Based on the results of the SESD field studies, North Prong of Kolomoki Creek was selected as the reference site for Red Oak Creek, Spring Creek and Chickasawhatchee Creek.

Once the reference site was selected, SESD used established metrics to assess the biotic integrity of the study stream. Each metric was scored and a comparsion of its value to the value of the selected regional reference site was used to determine the condition of the community. SESD collected macroinvertebrates to provide additional information and insight concerning water quality conditions. Macroinvertebrate sampling was conducted using a modified version of EPA's Rapid Bioassessment Protocol III. Macroinvertebrate data results were evaluated using four metrics as a measure of diversity, community composition (e.g., prevalence of tolerant or intolerant organisms), and environmental stress from a variety of possible sources.

In addition, habitat assessments were completed for the reference sites as well as the 303(d) listed stream segments. Habitat scores evaluate stream channel conditions and the physical surroundings of a stream as they affect and influence the quality of the water resource and its resident aquatic community. The habitat assessment evaluates the stream's physical parameters and is broken into three levels. One level describes in-stream characteristics that directly affect biological communities (in-stream cover, epifaunal substrate, embeddedness, and riffle frequency). Another level describes the channel morphology (channel alteration, sediment deposition and channel flow status). A third 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 were compared to the 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. These data may also help clarify the results of the biotic indices. These data and metric calculation results for the impaired streams were compared to the appropriate reference stream.

3.1.2. Red Oak Creek

The aquatic macroinvertebrate community was determined to be impaired when compared to the reference site based on sampling results from December 2001. The qualitative analyses of habitat parameters showed that the habitat was adversely impacted by sediment.

3.1.3. Spring Creek

The aquatic macroinvertebrate community was determined to be impaired when compared to the reference site based on sampling results from December 2001. Based on the qualitative habitat analysis, the habitat quality was determined to be impacted when compared to the reference site. The qualitative analyses of habitat parameters showed that the habitat was adversely impacted by sediment. Storm event samples showed that the levels of suspended sediments and turbidity were higher in Spring Creek than in the reference stream.

3.1.4. Upper Chickasawhatchee Creek

The aquatic macroinvertebrate community of Upper Chickasawhatchee Creek near Dawson Georgia was determined to be impaired when compared to the reference site based on sampling results from December 2001. Based on the qualitative habitat analysis, the habitat quality was determined to be impacted when compared to the reference site. Storm event samples showed that the levels of suspended sediments and turbidity were much higher in Chickasawhatchee Creek than in the reference stream. These sediment depositions may have been caused by historic land use practices and are not evident in the middle or downstream reaches of Chickasawhatchee Creek.

4. Model Development

The link between the habitat alteration due to sediment loads and the identified sources of sediment is the basis for the development of the TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and identified sources. This provides the basis for estimating the total assimilative capacity of the river and any needed load reductions. Details of the sediment-loading model used for the Flint River Basin Sediment TMDL can be found in Appendix A.

5. Numeric Sediment Target Determination

5.1.1. Numeric Target

The working hypothesis for the sediment watershed load is that if the Flint River Basin has a long–term annual sediment load similar to a relatively biologically unimpacted healthy stream, then the Flint River Basin will remain stable and not be biologically impaired due to sediment. Biologically unimpacted streams in the Flint River Basin were used to develop a target sediment watershed load.

The calculated allowable load of sediment that may come into the Red Oak Creek of the Southern Lower Piedmont Ecoregion in the Flint River Basin without exceeding the water quality target is an annual loading of 0.4 tons/acre/year. Whitewater Creek, a stream that is located in same eight digit hydrologic unit was used to develop this TMDL target. The target streams have been determined to have habitat of acceptable quality and a macroinvertebrate community that is not adversely impacted by sediment. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife to determine the applicable water quality target. Based on the current estimated annual loading for the listed segments, Red Oak Creek will need a twenty (20) percent reduction in existing estimated watershed sediment.

The calculated allowable load of sediment that may come into the Spring Creek segment of the Coastal Plain Red Uplands Ecoregion in the Flint River Basin without exceeding the water quality target is an annual loading of 1.1 tons/acre/year. This is based on Georgia EPD's target of 1.07 tons/acre/year for Southeastern Plains Ecoregion and EPA's sampling and analyses of Pachitla Creek habitat and macroinvertebrate data. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife to determine the applicable water quality target. Based on the current estimated annual loading for the listed segments, Spring Creek will need a seventy (70) percent reduction in existing estimated watershed sediment.

The calculated allowable load of sediment that may come into Upper Chickasawhatchee Creek segment of the Dougherty Plain Ecoregion in the Flint River Basin without exceeding the water quality target is an annual loading of 1.1 tons/acre/year. EPA interpreted the State of Georgia's narrative water quality standard for fish and wildlife for the protection of aquatic life to determine the applicable water quality target. Based on the current estimated annual loading for the listed segments, Upper Chickasawhatchee Creek will has an existing load of 0.75 tons/acre/year. The majority of the sediment problems are probably due to historic landuse practices and migration of sediment from the headwater areas via tributaries to the main stem segments that caused high instream bedload sediment volume. (Trimble 1969). Although watershed sediment load reductions are not needed, it is recommended that Best Management Practices and continued compliance with the State of Georgia's stormwater construction permit be maintained and enforced to allow the stream to purge itself of the historic sediment loads.

5.1.2. Critical Condition Determination

The annual average watershed load represents the long-term processes of accumulation of sediments in the stream habitat areas that are associated with the potential for habitat alteration and aquatic life effects.

5.1.3. Seasonal Variation

The average annual load addresses seasonal variation.

5.1.4. Margin of Safety

A Margin of Safety (MOS) is a required component of a TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody. The MOS is typically incorporated into the conservative assumptions used to develop the TMDL. A MOS is incorporated into this TMDL by selection of the average sediment loading numeric target rather than the greatest allowable sediment loading value for streams that have been identified as having good habitat and biology.

5.1.5. TMDL Formula:

TMDL = WLA + LA + MOS, where:

- TMDL = 0.4 tons/acre/year
- Spring Creek Point Source WLA = 20 mg/l of non biodegradable solids or 70 tons per year (less than 2 percent of the annual load)
- Wasteload Allocation (WLA) = WLA from wet weather discharges subject to the General Storm Water Permit = 0.1 tons/acre/year;
- Load Allocation (LA) from nonpoint source runoff and roads = 0.4 tons/acre/year

The Flint River Basin existing and TMDL loads are presented in Table 6.

Table 6: TMDL by Watershed

Waterbody	WLA Tons/Acre/Year	LA Tons/Acre/Year	TMDL Tons/Acre/Year	TMDL for Listed Segments (Tons/Year)	Percent Reduction
Red Oak Creek	0.1	0.4	0.4	6120	20
Spring Creek	0.2 Plus 68 ton/year*	1.08	1.1	4367	75
Chickasawhatchee Creek	0.1	1.1	1.1	22550	None

*Based on Montezuma Waste Treatment Facility design flow of 1.5 mgd and effluent limit of 30 mg/l total suspended solids concentration

5.1.6. TMDL Assumptions

The allocations in this TMDL reflect the following assumptions regarding ongoing watershed restoration and/or pollution control activities in the Flint watershed:

EPA assumes that construction activities in the watershed will be conducted in compliance with Georgia's Storm Water General Permit for construction activities, including discharge limitations and monitoring requirements contained in the General Storm Water Permit. Compliance with these permits will lead to sediment loadings from construction sites at or below applicable targets.

With respect to all land disturbance activities, including road building and maintenance, if the BMPs, as outlined above are implemented, then EPA believes that water quality targets for sediment will be achieved throughout the Flint Watershed.

The wasteload allocation component of this TMDL reflects the following additional assumptions:

- No NPDES point source will be authorized to increase its concentration of sediment above levels reflected in current water quality-based effluent limitations or allowed in the State's General Storm Water Permit.
- The permitting authority will establish the shortest reasonable period of time for compliance with permit limitations and conditions based on this TMDL.

These assumptions provide reasonable assurance that the allocation of loads in this TMDL, described in more detail below, are appropriate. During Phase 1 of this TMDL, EPA and Georgia will gather data and information to determine whether continued reliance on these assumptions is reasonable. The Phase 2 TMDL may revise the allocation of the allowable load, as necessary, should EPA or Georgia be required to change the assumptions underlying that allocation. Phase 2 should also include a more detailed monitoring and analyses on how Spring Creek's point source discharge is impacting the habitat of Spring Creek below the discharge site.

6. Allocation of Loads

In a TMDL assessment, the total allowable load is divided and allocated to the various pollutant sources – both point sources and nonpoint sources. Allocations provided to point sources are wasteload allocations (WLAs). Based on the numeric limits of the storm water permit the area loading from point sources will be 0.1 tons/acre/year, which is below the target of 0.4 tons/acre/year, which is below the target of 0.4 tons/acre/year, which is based on sediment loadings from streams with healthy biology and good habitat. For Spring Creek the point source continuous loading of 70 ton/year was subtracted from the overall TMDL area load.

Allocations to nonpoint sources are load allocations (LAs). Roads, agriculture and bare ground (construction sites, etc.) are the major sediment producing areas in the watershed. If best management practices (BMPs), as outlined in "Georgia's Best Management Practices for Forestry" (GaEPD 1999), for these practices and other sediment producing activities are implemented at the sites that are near the stream's drainage network and the stream's riparian zone or buffer zones are maintained or restored, then the TMDL targets can be met. Detailed BMP measures are discussed in Georgia Environmental Protection Division's Proposed Flint River Basin TMDL report (GaEPD 2002).

The calculated allowable load of sediment that can come into the Flint River Basin without exceeding the applicable narrative water quality standard, as interpreted by EPA, is 0.4 tons/acre/year. For example, in the Flint River Basin, this assessment indicates that over 99% of the loading of sediment is from nonpoint sources and construction activity prior to issuance of Georgia's Storm Water Permit. Additional sediment reduction activities should target nonpoint sources, including the unpaved roads, to gain the greatest water quality benefit.

6.1.1. Storm Water and NPDES Point Sources

Compliance with the Georgia General Storm Water Permit will ensure construction sites meet the TMDL area weighted loading. The Georgia General Storm Water Permit can be considered to be a water quality-based permit, in that the numeric limits in the permit, if met and enforced, will not cause a water quality problem in an unimpaired stream or contribute to an existing problem in an impaired stream. A Comprehensive Monitoring Plan with turbidity monitoring requirements is required to assure any storm water discharge from the site does not cause or contribute to the existing sediment problem. Based on the numeric limits of the storm water permit, the area loading will be 0.086 tons/acre/year, which is below the target of 0.4 tons/acre/year. This will ensure that permitted point source sediment loads in the watersheds will contribute less than 25% of the total allowable area weighted sediment loads.

The Georgia General Storm Water Permit can be considered to be a water quality-based permit, in that the numeric limits in the permit, if met and enforced, will not cause a water quality problem in a unimpaired stream or contribute to an existing problem in an impaired stream.

This TMDL accords the permitting authority a certain amount of discretion in incorporating these wasteload allocations into NPDES permits. The permitting authority can determine the appropriate frequency, duration and location of monitoring associated with the sediment characterization component of the wasteload allocation. The permitting authority also has the discretion to determine the level of oversight in connection with the development of sediment minimization plans and the discharger's choice of appropriate, cost-effective measures to implement such plans. EPA believes that each of these decisions is heavily fact-dependent and that the permitting authority is the appropriate decision maker in this regard.

6.1.2. Allocation to Nonpoint Sources

It is recommended that the Flint watershed be considered a high priority for riparian buffer zone restoration and other sediment reduction BMPs, especially for the road crossings, agricultural activities, and construction activities. Further ongoing monitoring needs to be completed to monitor progress and to assure further degradation does not occur.

For those land disturbing activities related to silviculture that may occur on public lands, it is recommended that practices as outlined for landowners, foresters, timber buyers, loggers, site preparation and reforestation contractors, and others involved with silvicultural operations follow the practices to minimize nonpoint source pollution as outlined in "Georgia's Best Management Practices for Forestry (GaEPD 1999).

7. Implementation

EPA has coordinated with the Georgia Environmental Protection Division (EPD) to prepare this Initial Implementation Plan for this TMDL. EPD has also established a plan and schedule for the development of a more comprehensive implementation plan to be completed after this TMDL is established. EPD and EPA have executed a Memorandum of Understanding (MOU) that documents the schedule for developing the more comprehensive plans.

This initial Implementation Plan includes a list of best management practices (BMPs) and provides for an initial implementation of demonstration projects to address one or more of the major sources of pollutants identified in the TMDL, while State and/or local agencies work with local officials to develop a revised TMDL Implementation Plan. The Initial TMDL Implementation Plan also includes a process whereby EPD and/or Regional Development Centers (RDCs), will develop expanded plans (hereinafter,"Revised TMDL Implementation Plans").

This Initial TMDL Implementation Plan, written by EPD and for which EPD and/or the 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. EPD and the EPD Contractor will select and implement one or more best management practice (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. 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 category of contribution of the pollutant(s) of concern for the respective River Basin as identified in the TMDLs of the watersheds in the River Basin. 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 EPD Contractor and approved by 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 EPD approves. If for any reason the EPD Contractor does not complete the BMP demonstration project, EPD will take responsibility for doing so.

3. As part of the Initial TMDL Implementation Plan the EPD brochure entitled "Watershed Wisdom -- Georgia's TMDL Program" will be distributed by EPD to the EPD Contractor for use with appropriate stakeholders for this TMDL, and a copy of the video of that same title will be provided to the EPD Contractor for its use in making presentations to appropriate stakeholders, on TMDL Implementation plan development.

4. If for any reason an EPD Contractor does not complete one or more elements of a Revised TMDL Implementation Plan, 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 August, 2003.

6. The EPD Contractor helping to develop the Revised TMDL Implementation Plan, in coordination with EPD, will work on the following tasks involved in converting the Initial TMDL Implementation Plan to a Revised TMDL Implementation Plan:

- Generally characterize the watershed;
- Identify stakeholders;
- Verify the present problem to the extent feasible and appropriate, (e.g., local monitoring);
- Identify probable sources of pollutant(s);
- 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;
- Determine measurable milestones of progress;
- Develop monitoring plan, taking into account available resources, to measure effectiveness; and
- Complete and submit to 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 when the Revised TMDL Implementation Plan is approved by EPD.

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	_	_	_		_		_		
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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9. Appendix A

9.1. Watershed Sediment Loading Model

An analysis of watershed loading could be conducted at various levels of complexity, ranging from a simplistic gross estimate to a dynamic model that captures the detailed runoff from the watershed to the receiving waterbody. The limited amount of data available for the Flint River Basin prevented EPA from using a detailed dynamic watershed runoff model, which needs a great deal of data for calibration. Instead, EPA determined the sediment contributions to the Flint River Basin from the surrounding watershed based on an annual mass balance of sediment in water and sediment loading from the watershed.

Watershed-scale loading of sediment in water and sediment was simulated using the Watershed Characterization System (WCS) (USEPA, 2001). The complexity of this loading function model falls between that of a detailed simulation model, which attempts a mechanistic, time-dependent representation of pollutant load generation and transport, and simple export coefficient models, which do not represent temporal variability. The WCS provides a mechanistic, simplified simulation of precipitation-driven runoff and sediment delivery, yet is intended to be applicable without calibration. Solids load from runoff can then be used to estimate pollutant delivery to the receiving waterbody from the watershed. This estimate is based on sediment concentrations in wet and dry deposition, which is processed by soils in the watershed and ultimately delivered to the receiving waterbody by runoff, erosion and direct deposition.

9.1.1. Universal Soil Loss Equation

The Universal Soil Loss Equation (USLE), developed by Agriculture Research Station (ARS) scientists W. Wischmeier and D. Smith, has been the most widely accepted and utilized soil loss equation for over 30 years. Designed as a method to predict average annual soil loss caused by sheet and rill erosion, the USLE is often criticized for its lack of applications. While it can estimate long-term annual soil loss and guide conservationists on proper cropping, management, and conservation practices, it cannot be applied to a specific year or a specific storm. The USLE is mature technology and enhancements to it are limited by the simple equation structure. However based on its long history of use and wide acceptance by the forestry and agriculture communities, it was selected as an adequate tool for estimating long-term annual soil erosion, for evaluating the impacts of land use changes and evaluating the benefits of various Best Management Practices (BMPs).

The Sediment Tool, which incorporates the USLE equation, is an extension of the Watershed Characterization System (WCS). For more detailed information on WCS, refer to the WCS User's Manual. The Sediment Tool can be used to perform the following tasks:

- Estimate extent and distribution of potential soil erosion in the watershed.
- Estimate potential sediment delivery to receiving waterbodies.
- Evaluate effects of land use, BMPs, and road network on erosion and sediment delivery.

Soil loss from sheet and rill erosion is mainly due to detachment of soil particles during rainfall. It is the major soil loss from crop production and grazing areas, construction sites, mine sites, logging areas, and unpaved roads. The magnitude of soil erosion is normally estimated through the use of the Universal Soil Loss Equation (USLE). The USLE equation is a multiplicative function of crop and site specific factors that represent rainfall erosivity (*R*), soil erodibility (*K*), soil slope (*S*), slope length (*L*), cropping or conservation management practices (*C*), and erosion control practices (*P*). The R factor describes the kinetic energy generated by the frequency and intensity of rainfall. The *K* factor represents the susceptibility of soil to erosion (i.e. soil detachment). The *L* and *S* factors represent the effect of slope length and slope steepness on erosion, respectively. The *C* factor represents the effect of plants, soil cover, soil biomass and soil disturbing activities on erosion including crop rotations, tillage and residue practices. Finally, the *P* factor represents the effects of conservation practices such as contour farming, strip cropping and terraces.

The USLE equation for estimating average annual soil erosion is:

$A = RKLSCP$

- **A** = average annual soil loss in t/a (tons per acre)
- **R** = rainfall erosivity index
- **K** = soil erodibility factor
- **LS** = topographic factor - L is for slope length & S is for slope
- **C** = cropping factor
- **P** = conservation practice factor

Evaluating the factors in USLE:

R - the rainfall erosivity index

Most appropriately called the erosivity index, it is a statistic calculated from the annual summation of rainfall energy in every storm (correlates with raindrop size) times its maximum 30 - minute intensity. As expected, it varies geographically.

K - the soil erodibility factor

This factor quantifies the cohesive or bonding character of a soil type and its resistance to dislodging and transport due to raindrop impact and overland flow.

LS - the topographic factor

Steeper slopes produce higher overland flow velocities. Longer slopes accumulate runoff from larger areas and also result in higher flow velocities. Thus, both result in increased erosion potential, but in a non - linear manner. For convenience L and S are frequently lumped into a single term.

C - the crop management factor

This factor is the ratio of soil loss from land cropped under specified conditions to corresponding loss under tilled, continuous fallow conditions. The most computationally complicated of USLE factors, it incorporates effects of: tillage management (dates and types), crops, seasonal erosivity index distribution, cropping history (rotation), and crop yield level (organic matter production potential).

P - the conservation practice factor

Practices included in this term are contouring, strip cropping (alternate crops on a given slope established on the contour), and terracing.

Appropriate values for the USLE parameters should be provided for each of the management activities. Literature values are available, but site-specific values should be used when available. Estimates of the USLE parameters and thus the soil erosion as computed from the USLE equation are provided by the Natural Resources Conservation Service's National Resources Inventory (NRI) 1994. The NRI database contains information of the status, condition and trend of soil, water and related resources collected from approximately 800,000 sampling points across the country.

Soil loss from gully erosion occurs in sloping areas mainly as a result of natural processes.

Farming practices such as livestock grazing exacerbates it. The deepening of rill erosion causes gullies. The amount of sediment yield from gully erosion is generally less than that caused by sheet and rill erosion. There are no exact methods or equations to quantify gully erosion, but Dunne and Leopold (1978) provide percent sediment yield estimates for various regions of the country. In a small grazed catchment near Santa Fe, New Mexico, gully erosion was found to contribute only 1.4 percent of the total sediment load as compared to sheet erosion and rain splash, which contributed 97.8 percent of the sediment load. Dunne and Leopold report that in most cases (nationally and internationally) gully erosion contributes less than 30 percent of the total sediment load, although the percentages have ranged from 0 percent to 89 percent contribution (Dunne and Leopold, 1978).

The soil losses from the erosion processes described above are localized losses and not the total amount of sediment that reaches the stream. The fraction of the soil losses in the field that is eventually delivered to the stream depends on several factors, which include the distance of the source area from the stream, the size of the drainage area, and the intensity and frequency of rainfall. Soil losses along the riparian areas are expected to be delivered into the stream with runoff-producing rainfall.

9.1.2. Sediment Analysis

The watershed sediment loads for selected watersheds are determined using the USLE and available GIS coverage. The sediment analysis produces the following outputs:

- Source Erosion and Sediment
- Stream Grid
- Sediment Delivery on Stream

The sediment analysis is also able to evaluate default scenarios by, for example, changing land uses and BMPs. The following are some of the parameters that may be altered:

- C and P Lookup values
- Land Use Change Layer
- BMP Layers
- Add/Delete Roads
- Create Road Control Structure Layer

The sediment analysis can be run for a single watershed or multiple watersheds. For TMDL development purposes the basic sediment analysis was used for developing relative impacts. Other applications used in developing the TMDL include the evaluation of the effectiveness of BMPs and development of implementation plans.

9.1.3. Sediment Modeling Methodology

The watersheds of interest are first delineated. The stream grid for each delineated watershed, based on the Digital Elevation Maps (DEM) data, is created so that the stream matches the elevation (i.e., the stream corresponds to the lower elevations in the watershed). The system uses this threshold to determine whether a particular grid cell corresponds to a stream. Grid cells having flow accumulation values higher than the threshold will be considered as part of the stream network. The RF3 stream network is used as a reference or basis of comparison to obtain the desired stream density. A stream grid corresponding to the stream network that has fifty 30 by 30 meter headwater cells is the default.

For each 30 by 30 meter grid cell the potential erosion based on USLE and potential sediment delivery to the stream network is estimated. The potential erosion from each cell is calculated using the USLE and the sediment delivery to the stream network can be calculated using one of four available sediment delivery equations.

(1) Distance-based equation 1 (Sun and McNulty 1988)

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

$$L = 5.1 + 1.79 * M,$$

Where Md is the mass moved from each cell to the closest stream network (US tons/acre/yr);

D (feet) is the least cost distance from a cell to the nearest stream network; and

L (feet) is the maximum distance that sediment with mass M (US ton) may travel.

(2) Distance-based equation 2 (Yagow et al. 1998)

$$DR = \exp(-0.4233 * L * Sf),$$

$$Sf = \exp(-16.1 * (r / L + 0.057)) - 0.6,$$

Where DR is the sediment delivery ration;

L is the distance to stream in meters and

r is the relief to stream in meters.

(3) Area-based equation (converted from a curve from National Engineering Handbook by Soil Conservation Service 1983

$$DR = 0.417762 * A ^\wedge (-0.134958) - 0.127097,$$

$$DR <=1.0,$$

Where DR is the sediment delivery ratio and

A is area in square miles;

(4) WEPP-based regression equation (L.W.Swift, Jr.,2000)

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

$X>0, Y>0,$

Where Z is percent of source sediment passing to next grid cell,

X is cumulative distance downslope,

Y is percent slope in grid cell.

The sediment analysis provides the calculations for six new parameters.

- Source Erosion – estimated erosion from each grid cell due to the land cover
- Road Erosion – estimated erosion from each grid cell representing a road
- Composite Erosion – composite of the source and road erosion layers
- Source Sediment – estimated fraction of the soil erosion from each grid cell that reaches the stream (sediment delivery)
- Road Sediment – estimated fraction of the road erosion from each grid cell that reaches the stream
- Composite Sediment – composite of the source and erosion sediment layers

The sediment delivery can be calculated based on the composite sediment, road sediment, or source sediment layer. The sources of sediment by each land use type is determined showing the types of land use, the acres of each type of land use, and the tons of sediment estimated to be generated from each land use. The information and estimates developed using this methodology were summarized in Tables 1 through 5 in Section 5.

9.1.4. Sediment Analysis Inputs

Before conducting a sediment analysis, a number of data layers must be available. These include the following:

- DEM (grid) – The DEM layers that come with the WCS distribution system are shape files and are of coarse resolution (300 m x 300 m). The user needs to import a DEM grid layer. A higher resolution DEM grid layer (30m x 30 m) was downloaded from USGS web site or from a state's GIS data clearinghouse

- Road – The road layer is needed as a shape file and requires additional attributes such as C (road type), P (road practice) and ditch (value of either 3 or 4, indicating presence or absence of side ditch, respectively). If these attributes are not provided, the Sediment Tool automatically assigns default values of road type 2 (secondary paved roads) ditch 3 (with ditch) and road practice 1 (no practices).

- Soil – The SSURGO (1:24k) soil data may be imported into the WCS project if higher-resolution soil data is required for the estimation of potential erosion. If the SSURGO soil database not available, the system uses the STATSGO Soil data (1:250k) by default.

- The Multi-Resolution Land use Classification (MRLC) data are also used.

- Rainfall erosivity index is either provides based on a rainfall index of the USA or can be calculated based on precipitation data.

The Universal Soil Loss Equation (USLE) R, K, LS, C, and P factors are calculated from the above data as follows:

$A = RKLSCP$

- **A** = average annual soil loss in t/a (tons per acre) is calculated.

- **R** = rainfall erosivity index is provide based on a rainfall index of the USA.

- **K** = soil erodibility factor calculated based on soil types.
- **LS** = topographic factor - L is for slope length set at 30 meters and S is for slope calculated based on the 30 meter DEM data. Presently a watershed average LS term is used.
- **C** = cropping factor or land use factor.
- **P** = conservation practice factor or BMP implementation.

9.1.5. Sediment Load Development Methodology

For each watershed of interest, the "existing" long–term sediment loading is estimated via the USLE sediment analysis, using default parameters and estimated C and P values. The USLE is designed as a method to predict average annual soil loss caused by sheet and rill erosion. While it can estimate long - term annual soil loss and guide on proper cropping, management, and conservation practices, it cannot be applied to a specific year or a specific storm.

The resultant sediment load calculation for each watershed is therefore expressed as a long-term annual soil loss expressed in tons per year calculated for the R - the rainfall erosivity index, a statistic calculated from the annual summation of rainfall energy in every storm (correlates with raindrop size) times its maximum 30 - minute intensity.

The watershed sediment load target is based on the long - term annual soil loss expressed in tons per year calculated for relatively unimpacted watershed with demonstrated healthy biology and habitat. For the initial sediment load development consistent default parameters and inputs are used for each watershed. These include the MRLC land use data, the USGS DEM data, STASTGO soil information and watershed average C and P values for each land use type.

Red Oak Creek USLE Parameters

Red Oak Creek USLE Parameters			
Factors	Min	Max	Mean
LS Factor	Min	Max	Mean
K Factor	0.076	3.31	0.37
P Factor	0.250	0.27	0.267
C Factor	1.00	1.0	1.0
R Factor	0	0.36	0.080
Weighted R Factor	325	325	0325
Composite Erosion	325	325	0325
Composite Sediment	0	17.24	0.172
Spring Creek USLE Parameters			
Factors	Min	Max	Mean
LS Factor	0.076	2.627	0.411
K Factor	0.130	0.160	0.157

P Factor	1.0	1.0	1.0
C Factor	0	0.49	0.236
R Factor	325	325	325
Weighted R Factor	325	325	325
Composite Erosion	0	13.277	1.101
Composite Sediment	0	12.169	0.791

Chickasawhatchee Creek USLE Parameters			
Factors	Min	Max	Mean
LS Factor	0.076	1.236	0.198
K Factor	0.150	0.180	0.158
P Factor	1.0	1.0	1.0
C Factor	0	0.343	0.114
R Factor	350	350	350
Weighted R Factor	350	350	350
Composite Erosion	0	4.357	0.270
Composite Sediment	0	3.175	0.173

9.1.6. Red Oak Creek Estimated Contributors to Sediment Load

Soil type, land slope and distance the sediment source is from the stream determine the amount of sediment that reaches the streams from the various parts of the watershed. Figure 2 shows the landuses in Red Oak Creek Watershed. Road types and road nearness to the streams determine how much sediment is caused by road or roadside erosion.

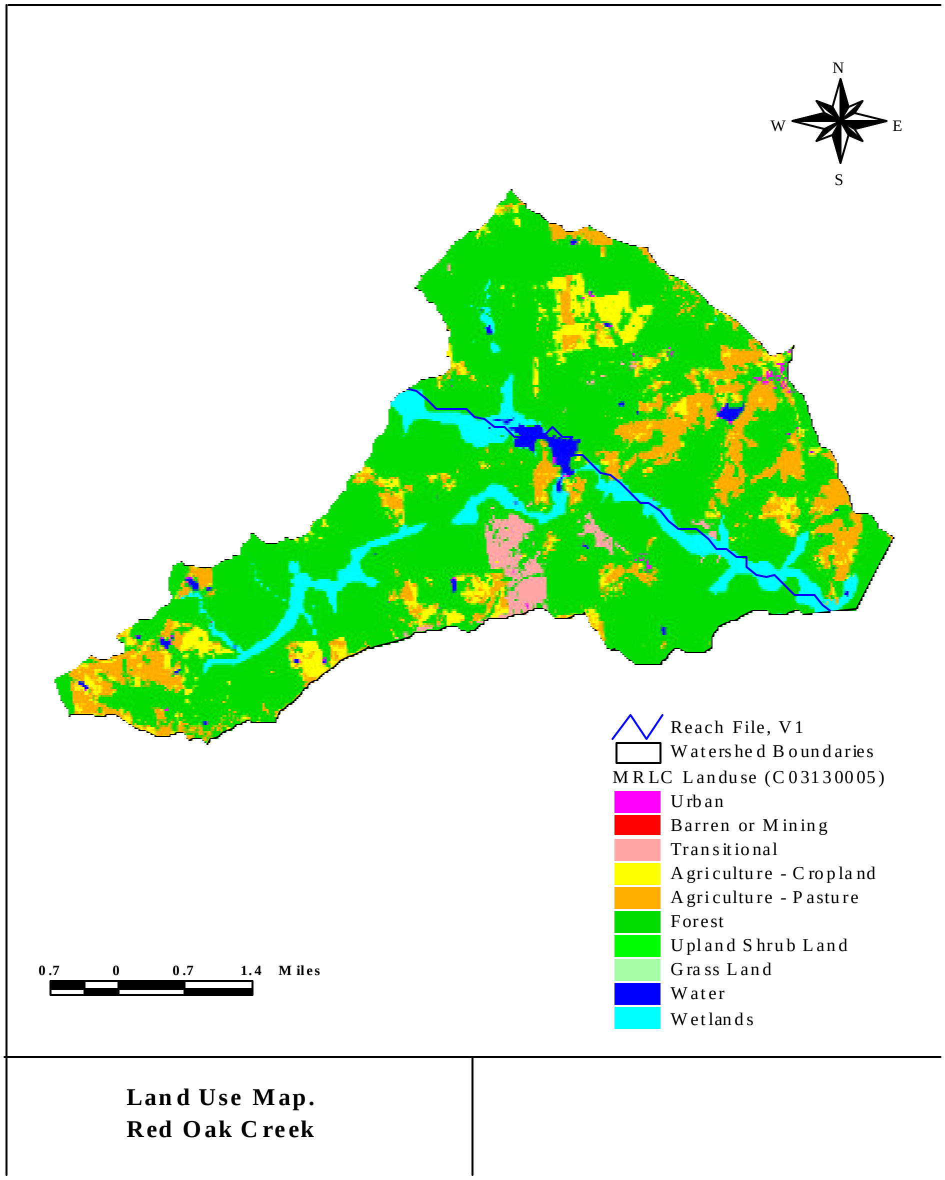


Figure 4: Landuse for Red Oak Creek Watershed

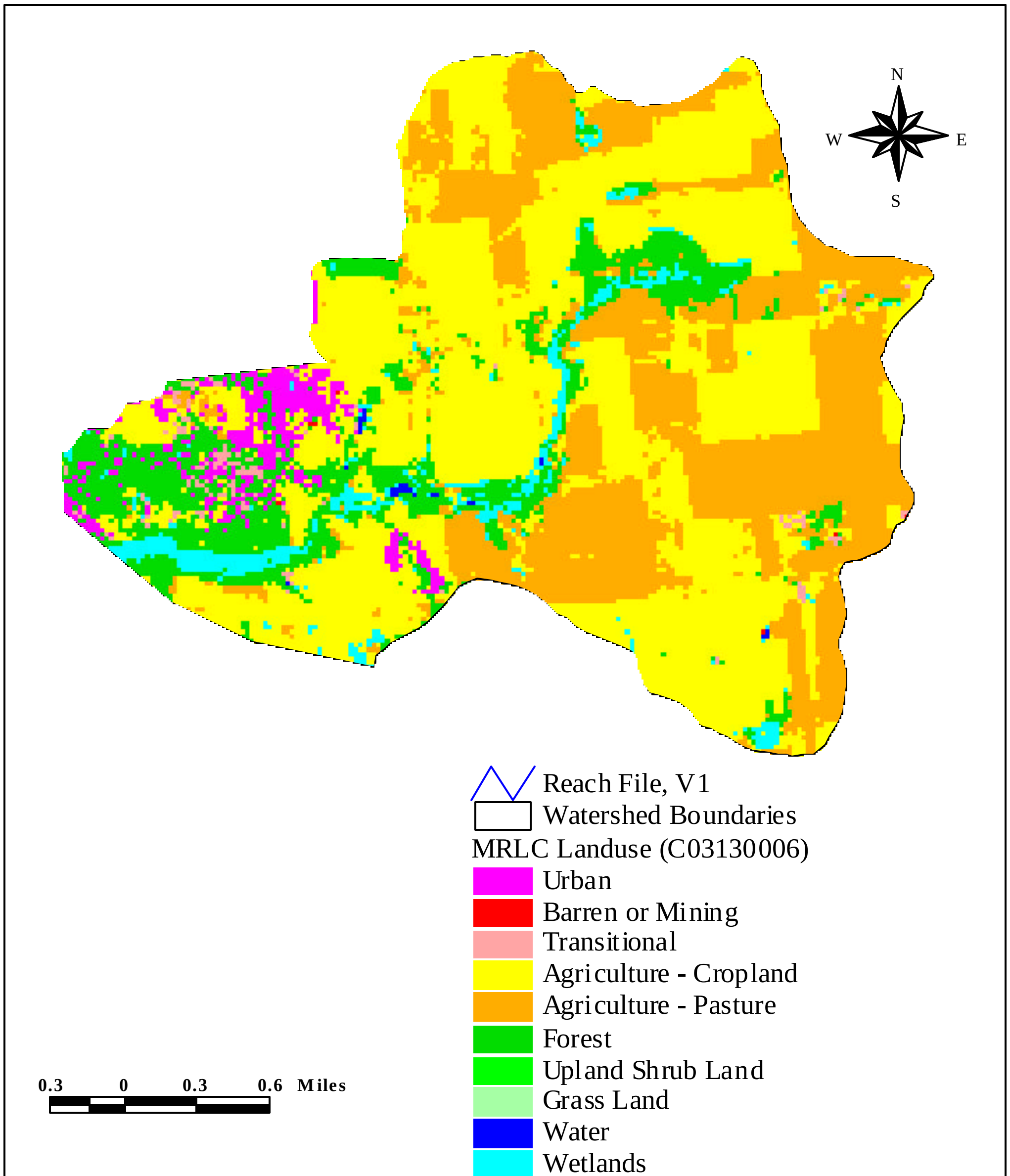
9.1.7. Red Oak Creek Watershed Sediment Sources

Roads are estimated to contribute a sediment load of 1300 tons per year and runoff from the watershed contributes 6850 tons per year.

Landuse	Area (acres)	Total (US ton)
Open Water	162.56	0.00
Low Intensity Residential	16.46	1.08
High Intensity Commercial/Industrial/Transportation	25.13	1.49
Transitional	324.02	132.53
Deciduous Forest	2928.39	22.26
Evergreen Forest	4576.28	29.27
Mixed Forest	3117.87	22.99
Pasture/Hay	1756.19	130.55
Row Crops	912.68	6296.70
Other Grasses (Urban/recreational; e.g. parks	1.78	0.06
Woody Wetlands	1086.36	240.33
Emergent Herbaceous Wetlands	18.90	0.92

9.1.8. Spring Creek Estimated Contributors to Sediment Load

Soil type; land slope and distance the sediment source is from the stream determined the amount of sediment that reaches the streams from the various parts of the watershed. Figure 2 shows the landuse in Spring Creek Watersheds. Road types and road nearness to the streams determine how much sediment is caused by road or roadside erosion.



Land Use Map.
Spring Creek

Figure 5: Landuse for Spring Creek Watershed

9.1.9. Spring Creek Watershed Sediment Sources

Roads are estimated to contribute a sediment load of 375 tons per year and runoff from the watershed contributes 13,750 tons per year.

Landuse	Area (acres)	Total (US ton)
Open Water	6.23	0.00
Low Intensity Residential	30.69	0.99
High Intensity Residential	30.47	1.29
High Intensity Commercial/Industrial/Transportation	57.82	1.76
Bare Rock/Sand/Clay	1.56	0.00
Transitional	33.36	6.02
Deciduous Forest	196.59	0.30
Evergreen Forest	138.32	0.25
Mixed Forest	147.44	0.26
Pasture/Hay	1178.87	139.56
Row Crops	1824.02	13570.90
Other Grasses (Urban/recreational; e.g. parks	42.92	1.25
Woody Wetlands	98.07	21.74
Emergent Herbaceous Wetlands	35.80	2.07

9.1.10. Chickasawhatchee Creek Estimated Contributors to Sediment Load

Soil type; land slope and distance the sediment source is from the stream determine the amount of sediment that reaches the streams from the various parts of the watershed. Figure 2 shows the landuses in Chickasawhatchee Watershed. Road types and road nearness to the streams determine how much sediment is caused by road or roadside erosion.

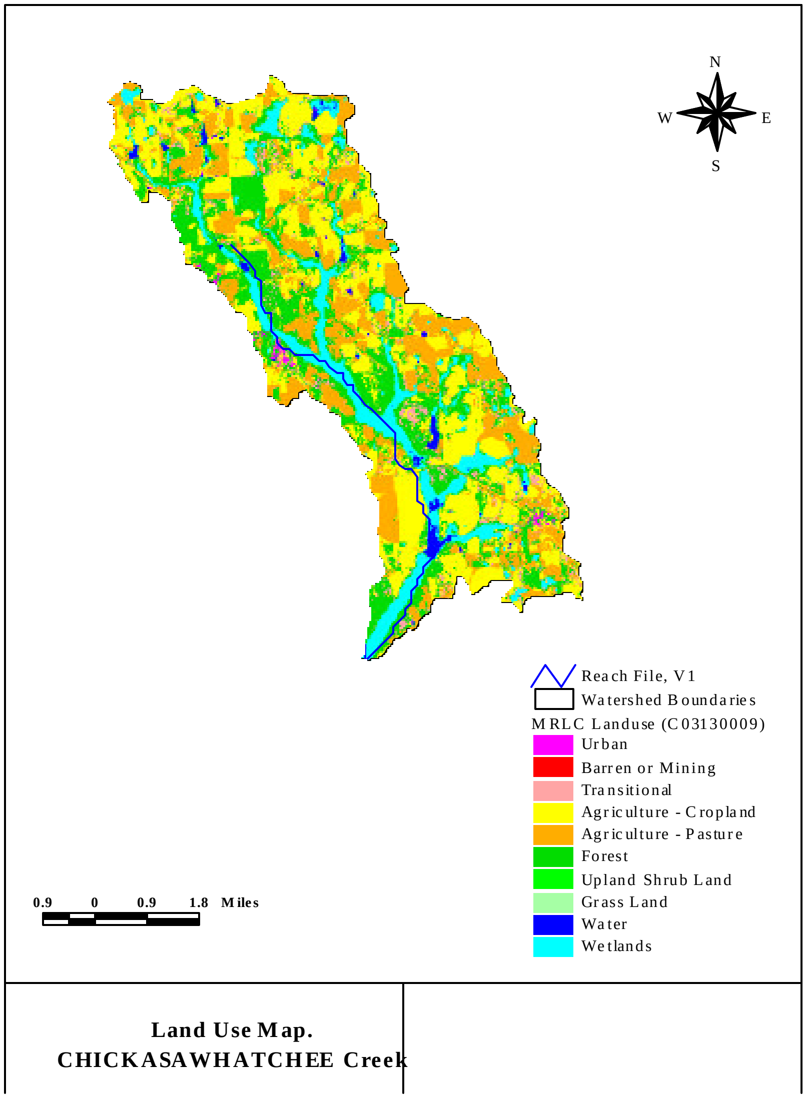


Figure 6: Land Use Map Upper Chickasawhatchee Creek

9.1.11. Chickasawhatchee Creek Watershed Sediment Sources

Roads are estimated to contribute a sediment load of 650 tons per year and runoff from the watershed contributes 15,300 tons per year.

Landuse	Area(acres)	Total (US ton)
Open Water	299.56	0.00
Low Intensity Residential	31.13	0.67
High Intensity Residential	2.89	0.09
High Intensity Commercial/Industrial/Transportation	53.82	1.12
Transitional	813.27	125.77
Deciduous Forest	2969.09	5.04
Evergreen Forest	645.14	1.14
Mixed Forest	1494.44	2.76
Pasture/Hay	4838.25	104.71
Row Crops	6416.09	14910.32
Other Grasses (Urban/recreational; e.g. parks	55.37	1.18
Woody Wetlands	2264.12	146.53
Emergent Herbaceous Wetlands	121.20	1.47