Total Maximum Daily Load (TMDL)
For Turbidity

Final Report

EPA Approved Date: April 12, 2005

Lower Creek (Subbasin 03-08-31)
Catawba River Basin
North Carolina

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INDEX OF TMDL SUBMITTAL

303(d) List Information

State: North Carolina
Counties: Caldwell and Burke
Basin: Catawba River Basin

303(D) LISTED WATERS

Stream name	Description	Class	Index #	Subbasin	Miles
Lower Creek	From Zack's Fork to Caldwell Co SR 1143	C	11-39-(0.5)b	30831	5.1
Lower Creek	From Caldwell County SR1143 to a point 0.7 miles downstream of Bristol Creek	WS-IV	11-39-(6.5)	30831	6.8
Lower Creek	From a point 0.7 miles downstream of Bristol Creek to Rhodhiss Lake, Catawba	WS-IV CA	11-39-(9)	30831	1.8

14 digit HUC or Cataloging Unit(s):	03050101080010 and 03050101080020
Area of Impairment:	13.7 miles
Water Quality Standard Violated:	Turbidity
Pollutant of Concern	Turbidity
Applicable Water Quality Standards for Class C and WS-IV Waters:	Turbidity not to exceed 50 NTU
Sources of Impairment:	Urban Runoff/Storm Sewers, Municipal Point Sources, Non-urban development

Public Notice Information

A draft of the TMDL was publicly noticed through various means, including notification in a local newspaper, *Lenoir News Topic*, on 02/10/05. The TMDL was also available from the Division of Water Quality's website during the comment period at: http://h2o.enr.state.nc.us/tmdl/TMDL_list.htm. The public comment period began 02/10/05 and was held for 30 days.

Public notice date: *February 10, 2005*
Submittal date: *March 16, 2005*
Establishment date:
Did notification contain specific mention of TMDL proposal? *Yes*
Were comments received from the public? *No*
Was a responsiveness summary prepared? *No*

TMDL Information

Critical conditions:	Turbidity exceedences occur under both wet and dry conditions predominantly during late spring to early fall seasons. The TMDL was developed using WARMF using data from 1992-2003. Water years 1992-1997 were used to calibrate the model and verification was performed using water years 1998-2003.
Seasonality:	Seasonal variation in hydrology, climatic conditions, and watershed activities are represented through the use of a continuous flow gage and the use of all readily available water quality data collected in the watershed.
Development tools:	WARMF model
Supporting documents:	Total Maximum Daily Load (TMDL) For Turbidity in Lower Creek, NC Division of Water Quality (2004)

TMDL summary

TMDL Allocations	Existing TSS Load 1998-2003 (kg/day)	TMDL - TSS Load (kg/day)	Required Reduction (%)
Wasteload Allocations			
WLA - NC0023981 (6.0 MGD, 30 mg TSS/L limit)	**-----**	**681**	**0%**
WLA - NC0043231 (0.009 MGD, 30 mg TSS/L limit)	**-----**	**1.0**	**0%**
WLA - NC0048755 (0.005 MGD, 30 mg TSS/L limit)	**-----**	**0.6**	**0%**
WLA – MS4 stormwater [1]	**15,639**	**4,377**	**72%**
WLA – NCG010000 (General Construction Permits)		**50 NTU**	
Sum of WLAs		***5,060***	
Load Allocations/ non permitted			
Load Allocation [2]	**48,284**	**13,542**	**72%**
Non-Permitted Stormwater below MS4 area [3]	**41,587**	**11,682**	**72%**
Sum of LAs		***25,224***	
Margin of Safety - Explicit 10%			
Total TSS Load at outlet to Lake Rhodhiss (kg/day)	**105,500**	**30,280**	**72%**

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1.0 Introduction

Problem Definition

The 2002 North Carolina Water Quality Assessment and Impaired Waters List (also known as the Integrated 305(b) and 303(d) Report) identified Lower Creek in the Catawba River Basin as impaired by elevated turbidity. Based on this report, the impaired segments (assessment units 11-39-(0.5)b, 11-39-(6.5), and 11-39-(9)) include the portion of Lower Creek from the confluence of Zack's Fork and Lower Creek in Caldwell County to Rhodhiss Lake in Burke County (subbasin 03-08-31). As per the 2002 Integrated Report, the three stream segments of interest totaled 12.7 miles. Recently, tools that improve the accuracy of measuring stream length have been used to measure theses segments and have determined a total length of 13.7 miles. This report will establish a Total Maximum Daily Load (TMDL) for turbidity for Lower Creek downstream of the confluence with Zack's Fork and will serve as a management approach or restoration plan aimed toward reducing loadings of sediment from various sources in order to attain applicable surface water quality standards for turbidity.

TMDL Components

In accordance with Section 305(b) of the Federal Clean Water Act (CWA) (33 U.S.C. 1315(B)), the State of North Carolina is required to biennially prepare and submit to the USEPA a report addressing the overall water quality of the State's waters. This report is commonly referred to as the 305(b) Report or the Water Quality Inventory Report. In accordance with Section 303(d) of the Clean Water Act (CWA), the State is also required to biennially prepare and submit to USEPA a report that identifies waters that do not meet or are not expected to meet surface water quality standards (SWQS) after implementation of technology-based effluent limitations or other required controls. This report is commonly referred to as the 303(d) List. The 303(d) process requires that a TMDL be developed for each of the waters appearing on Category 5 of North Carolina's Water Quality Assessment and Impaired Waters List (formerly Part 1 of North Carolina's 303(d) list). The objective of a TMDL is to quantify the amount of a pollutant a water body can assimilate without violating a state's water quality standards and allocate that load capacity to point and nonpoint sources in the form of wasteload allocations (WLAs), load allocations (LAs), and a margin of safety (MOS) (USEPA, 1991). Generally, the primary components of a TMDL, as identified by EPA (1991, 2000) and the Federal Advisory Committee (USEPA FACA, 1998) are as follows:

Target identification or selection of pollutant(s) and end-point(s) for consideration. The pollutant and end-point are generally associated with measurable water quality related characteristics that indicate compliance with water quality standards. North Carolina indicates known pollutants on the 303(d) list.

Source assessment. All sources that contribute to the impairment should be identified and loads quantified, where sufficient data exist.

Reduction target. Estimation or level of pollutant reduction needed to achieve water quality goal. The level of pollution should be characterized for the waterbody, highlighting how current conditions deviate from the target end-point. Generally, this component is identified through water quality modeling.

Allocation of pollutant loads. Allocating pollutant control responsibility to the sources of impairment. The wasteload allocation portion of the TMDL accounts for the loads associated with existing and future point sources. Similarly, the load allocation portion of the TMDL accounts for the loads associated with existing and future non-point sources, stormwater, and natural background.

Margin of Safety. The margin of safety addresses uncertainties associated with pollutant loads, modeling techniques, and data collection. Per EPA (2000), the margin of safety may be expressed explicitly as unallocated assimilative capacity or implicitly due to conservative assumptions.

Seasonal variation. The TMDL should consider seasonal variation in the pollutant loads and end-point. Variability can arise due to stream flows, temperatures, and exceptional events (e.g., droughts, hurricanes).

Critical Conditions. Critical conditions indicate the combination of environmental factors that result in just meeting the water quality criterion and have an acceptably low frequency of occurrence.

Section 303(d) of the CWA and the Water Quality Planning and Management regulation (USEPA, 2000) require EPA to review all TMDLs for approval or disapproval. Once EPA approves a TMDL, then the waterbody may be moved to Category 4a of the Integrated 305(b) and 303(d) Report. Waterbodies remain in Category 4a until compliance with water quality standards is achieved. Where conditions are not appropriate for the development of a TMDL, management strategies may still result in the restoration of water quality.

The goal of the TMDL program is to restore designated uses to water bodies. Thus, the implementation of sediment controls throughout the watershed will be necessary to restore uses in the most downstream portion of Lower Creek. Although a site-specific implementation plan is not included as part of this TMDL, reduction strategies are needed. The involvement of local governments and agencies will be critical in order to develop implementation plans and reduction strategies. Implementation discussion will begin during public review of the TMDL.

Water Quality Target

Turbidity is a unit of measurement quantifying the degree to which light traveling through a water column is scattered by the suspended organic and inorganic particles. The scattering of light increases with a greater suspended load. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU), but may also be measured in Jackson Turbidity Units (JTU).

Lower Creek has been classified by the NC DWQ as Class C above its intersection with Caldwell County SR 1143. From Caldwell County SR 1143 to a point 0.7 miles down stream of Bristol Creek, Lower Creek is classified as WS-IV. The remainder of Lower Creek (to Rhodhiss Lake) is classified as WS-IV CA. Class C waters are defined as "Waters protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class C. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner." Water supply watershed (WS) classification is assigned to watersheds based on land use characteristics of the area. A Critical Area (CA) designation is also listed for watershed areas within a half-mile and draining to the water supply intake or reservoir where an intake is located. For turbidity, Class WS-IV, and WS-IV (CA) have the same water quality standard as Class C. The North Carolina fresh water quality standard for turbidity in Class C waters (T15A: NCAC 2B.0211 (3)k) states:

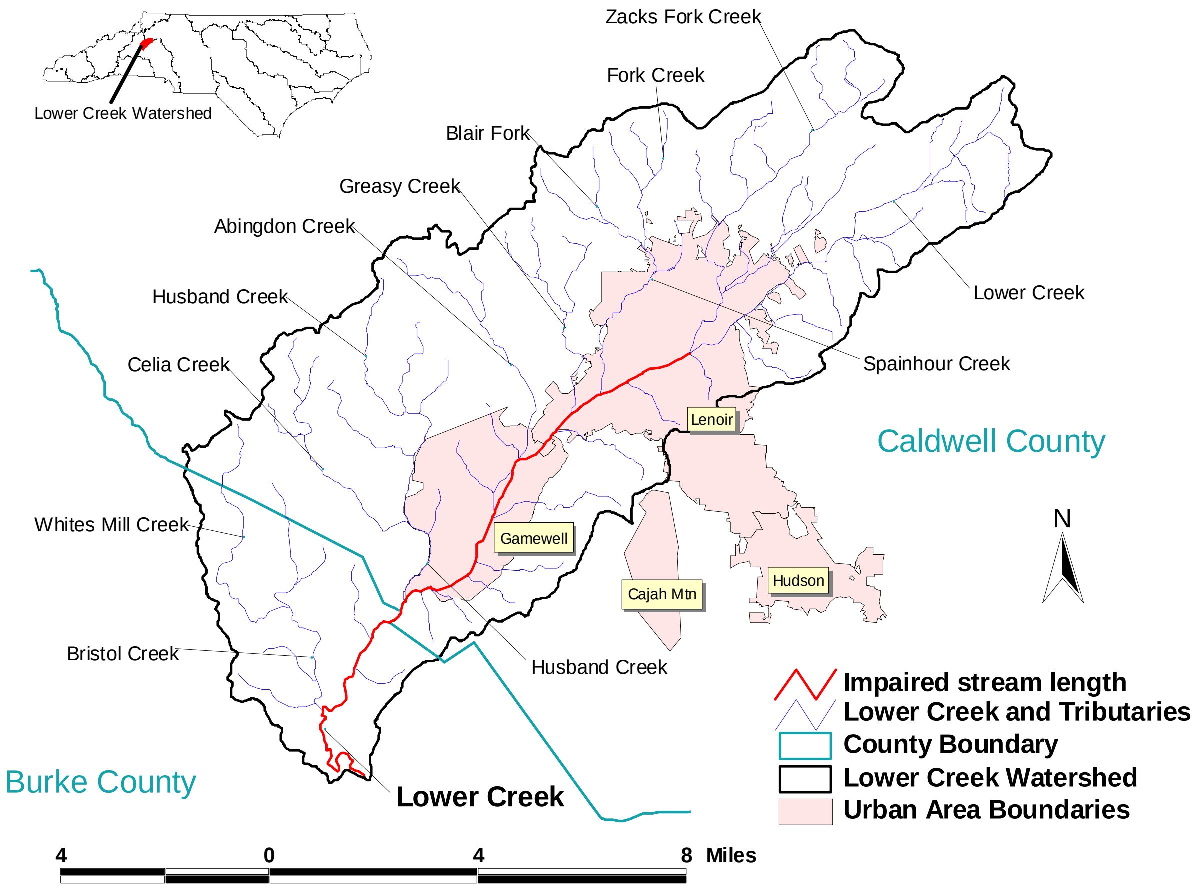
> *The turbidity in the receiving water shall not exceed 50 Nephelometric Turbidity Units (NTU) in streams not designated as trout waters and 10 NTU in streams, lakes or reservoirs designated as trout waters; for lakes and reservoirs not designated as trout waters, the turbidity shall not exceed 25 NTU; if turbidity exceeds these levels due to natural background conditions, the existing turbidity level cannot be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule .0202 of this Section] recommended by the Designated Nonpoint Source Agency [as defined by Rule .0202 of this Section]. BMPs must be in full compliance with all specifications governing the proper design, installation, operation and maintenance of such BMPs;*

The in-stream numeric target is the restoration objective that is expected to be reached by implementing the specified load reductions in this TMDL. The target allows for evaluation of progress toward the goal of reaching water quality standards for the impaired stream by comparing the in-stream data to the target. In the Lower Creek watershed, the applicable water quality target is the 50 NTU standard.

Watershed Description

The Lower Creek watershed includes the City of Lenoir and drains primarily the southwest portion of Caldwell County into the upper reaches of Lake Rhodhiss (see Figure 1). Lower Creek is predominantly located within the Northern Inner Piedmont ecoregion, however, portions of the headwaters are located in the Eastern Blue Ridge Foothills region. The watershed also includes Zacks Fork Creek [AU#11-39-1, 8.2 mi.], Spainhour Creek [AU#11-39-3, 4.3 mi.], Greasy Creek [AU#11-39-4, 4.5 mi.], and Bristol Creek [AU#11-39-8, 5.6 mi.]. Lower Creek consists of two USGS 14-digit hydrologic unit codes (HUCs); units 03050101080010 and 03050101080020.

Figure 1. Lower Creek watershed and surrounding area. Impaired stream length is based on the 2004 Integrated List of Impaired Waters (2004 Integrated 305(b) and 303(d) Report).



1.1.1 Land use/ Land cover

The land use/land cover characteristics of the watershed were determined using 1996 land cover data that were developed from 1993-94 LANDSAT satellite imagery. The North Carolina Center for Geographic Information and Analysis, in cooperation with the NC Department of Transportation and the United States Environmental Protection Agency Region IV Wetlands Division, contracted Earth Satellite Corporation of Rockville, Maryland to generate comprehensive land cover data for the entire state of North Carolina. Land cover/land use data for the Lower Creek watershed is identified in Figure 2. During the formation of this geographic dataset, the proportion of synthetic cover was used to identify developed land as either low density developed (50-80% synthetic cover) or high density developed (80-100% synthetic cover) (Earth Satellite Corporation, 1997).

Figure 2. Land use/ land cover distribution within the Lower Creek watershed.

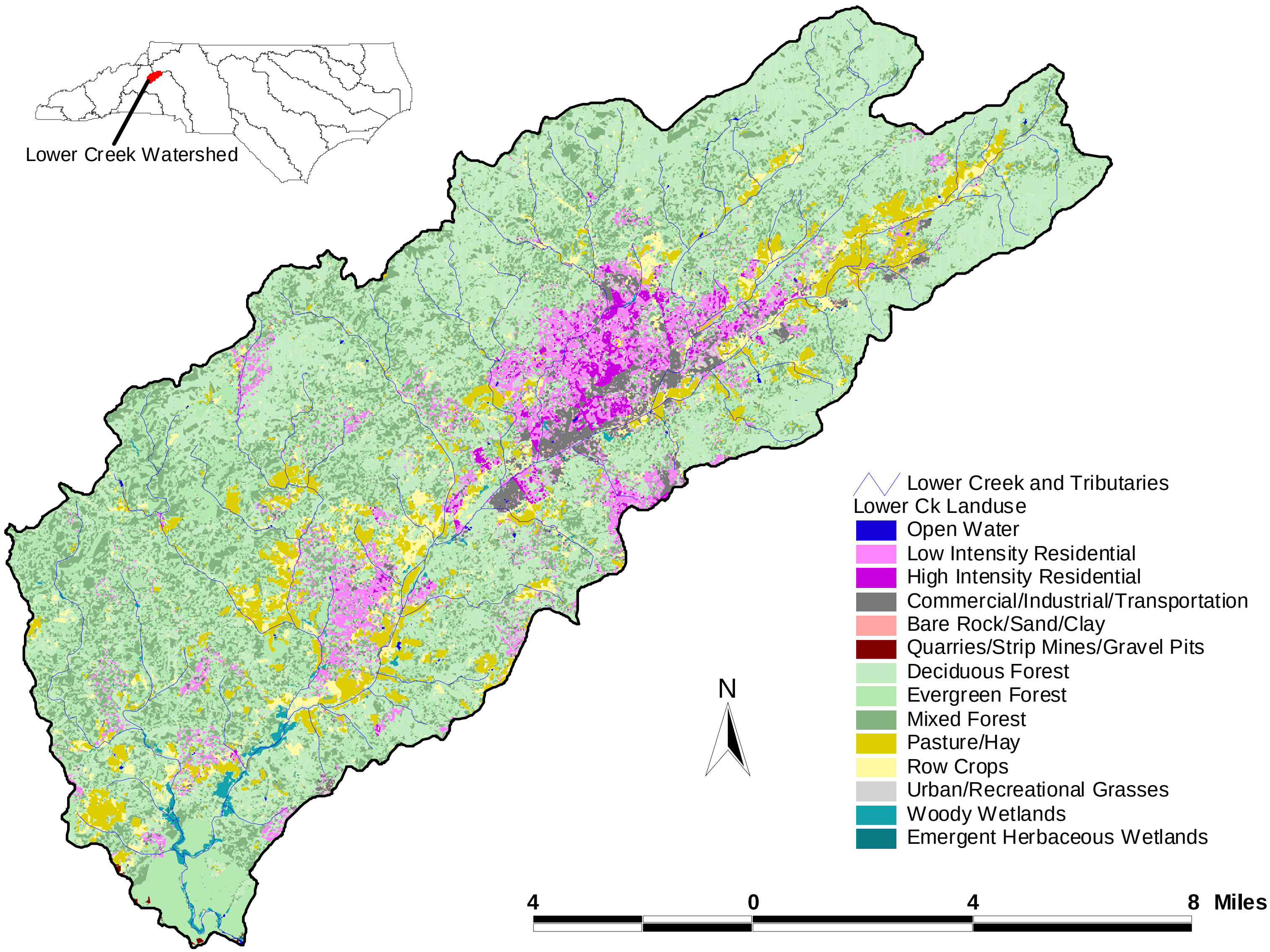


Table 1 Detailed land use/ land cover distribution within Lower Creek watershed.

Land use/ Land cover		Acres	Watershed area (%)
Water	Open Water	57	0.1%
Developed	Low Intensity Residential	3,824	6.1%
	High Intensity Residential	772	1.2%
	Commercial/Industrial/Transportation	1,538	2.4%
Forested Upland	Deciduous Forest	22,840	36.4%
	Evergreen Forest	13,377	21.3%
	Mixed Forest	13,127	20.9%
Herbaceous Planted/Cultivated	Pasture/Hay	3,854	6.1%
	Row Crops	2,594	4.1%
	Urban/Recreational Grasses	271	0.4%
Wetlands	Woody Wetlands	434	0.7%
	Emergent Herbaceous Wetlands	25	0.04%
Barren	Bare Rock/Sand/Clay	88	0.1%
	Transitional	21	0.03%

As identified in Table 1, 1993-94 LANDSAT satellite imagery identify Forest (78.6%), Herbaceous Planted/Cultivated (10.6), and Developed area (9.7%) as the predominant landuses in the Lower Creek watershed.

1.1.2 Geology

Portions of Burke and Caldwell Counties lie within the Northern Inner Piedmont and Southern Crystaline Ridge and Mountain Ecoregions (Level 4). Predominantly, two rock types occur in the Lower Creek watershed; metamorphic rocks of the Inner Piedmont, Milton belt, and Raleigh belt (gneiss, schist and amphibolite) and metamorphosed granitic rock, (NCGS, 1991).

1.1.3 Soils

Soils types and characteristics vary throughout the Lower Creek watershed. A full list of soils found in Caldwell County is located in Appendix A. As seen in Appendix A, the predominant soils include Cecil sandy loam, Chestnut gravelly loam, Chestnut and Edneyville soils, Evard fine sandy loam, and Pacolet fine sandy loam. (USDA, 1991). Each of these soils has an erosion hazard of “severe” or “very severe” indicating their potential for future erosion in inadequately protected areas. The estimated erosion for each erosion classification is based on estimated annual soil loss in metric tons per hectare. Values were determined using the Universal Soil Loss Equation assuming bare soil conditions and using rainfall and climate factors for North Carolina. A “severe” classification indicates a estimated loss of 10 to 25 tons per hectare and a “very severe” indicates more than 25 tons per hectare of annual erosion.

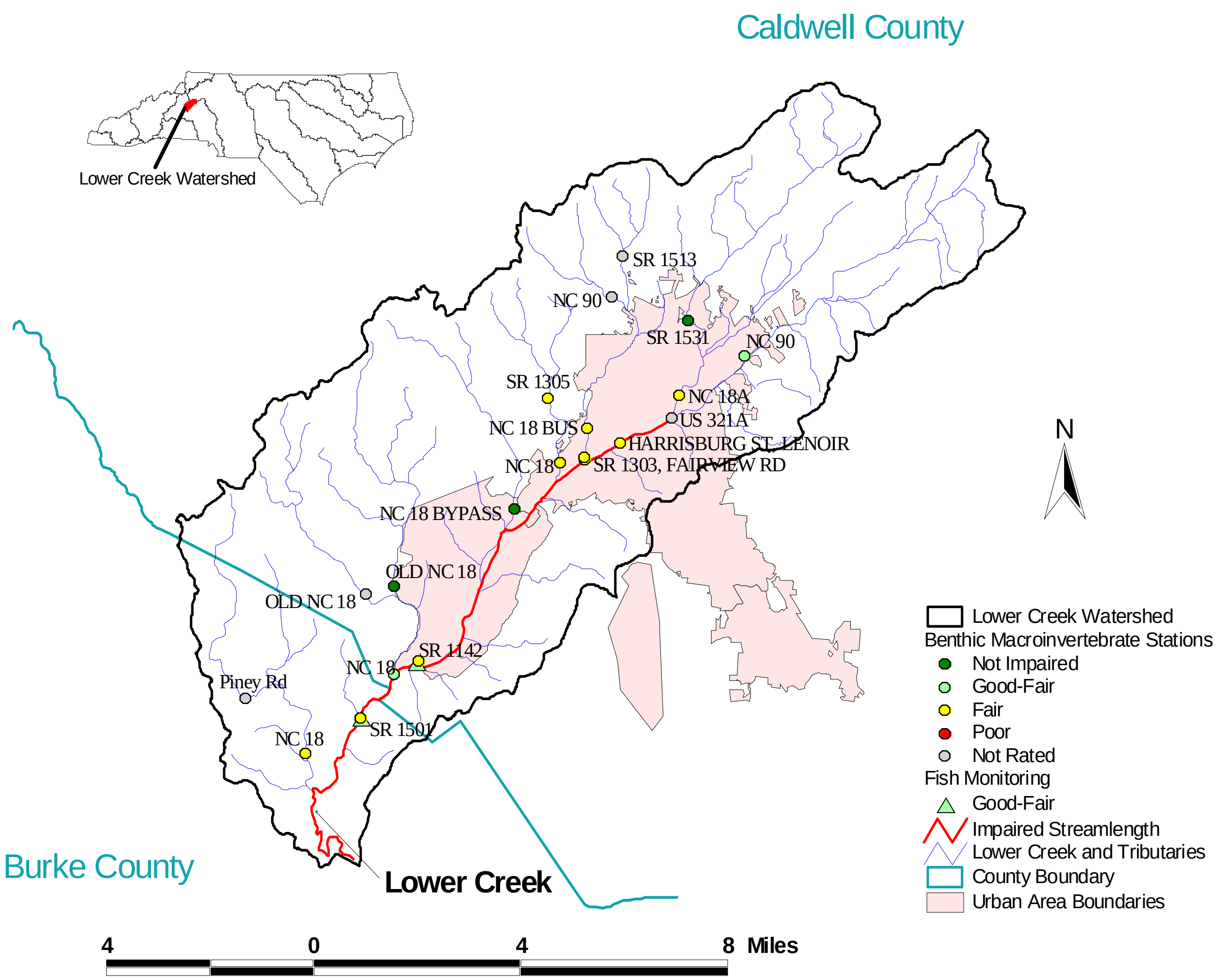
Water Quality Monitoring Program

Water quality monitoring performed by the NCDENR has shown occasional violations of the water quality standard for turbidity (81 out of 81 samples or 22% between 1/1997 and 3/2004). As part of this TMDL, chemical and biological assessments were conducted throughout the Lower Creek watershed to characterize the impact of turbidity impairment. Both chemical and biological assessments suggest significant water quality and habitat impairment and support the inclusion of Lower Creek on the Impaired Waters List (2002 Integrated 305(b) and 303(d) Report).

1.1.4 Biological Monitoring

The DWQ maintains an extensive biological monitoring network of ambient stations. In the Lower Creek watershed recent monitoring conducted by DWQs Environmental Sciences Branch has included a watershed survey (1997), a reconnaissance survey (May 2002), an assessment for basin wide monitoring plans (1999 and 2004), and monitoring for biological stressors (2003). Most recently, in March 2003, an intensive monitoring effort was conducted that included benthic macroinvertebrate populations, fish populations, physical and water chemistry characteristics, and site descriptions and instream and riparian habitats at seventeen locations in the Lower Creek watershed. These locations are shown in Figure 3. A summary of fish and benthic invertebrate results from this study are presented in Appendix B.

Figure 3. Lower Creek watershed including fish and benthic macroinvertebrate monitoring, locations.



Most notable in this study was the widespread finding of severe streambank erosion with little riparian buffer protection. Each site sampled in the 2002 Lower Creek study showed impacted water quality resulting in reduced benthic fauna. Sandy habitat coupled with urban/industrial runoff from the City of Lenoir produced the most stressed benthic communities as demonstrated in Lower Creek, lower Zack's Fork and lower Spainhour Creek. Tributary catchments such as Abingdon Creek, Greasy Creek, Husband Creek, Bristol Creek, and the UT to Spainhour Creek that were not affected by urban nonpoint runoff from the City of Lenoir supported more diverse benthic communities. Agricultural runoffs from farms (cropland and animals) located in tributary catchments were thought to affect the benthic communities in these streams, but not as severely as urban runoff from the City of Lenoir. The UT to Spainhour Creek and the Bristol Creek watershed (including White Mill Creek) were the only streams that supported a benthic community that contained long-lived stoneflies and philopotamid caddisflies. For more extensive discussion of results, see NCDWQ (2003) and Appendix B. While this biological information is not used directly in calculation the TMDL, it will be a primary information source when implementing the load and wasteload reductions set forward in this TMDL.

1.1.5 Chemical Monitoring

Lower Creek was listed as impaired on North Carolina's 1998 and 2000 303(d) Reports based on turbidity data collected in the early 1990s throughout the Lower Creek watershed. Since that time, monitoring has continued at station C1750000 (Lower Creek at SR 1501 near Morganton) on a monthly basis and violations to the turbidity standard continue to occur. Turbidity concentrations at station C1750000 ranged from 4.4 NTU to 1400 NTU with an average of 64 NTU, a median value of 21 NTU, and mode value of 27 NTU. Turbidity monitoring for years 1997-2003 are presented below in Figure 4 and in Appendix C. Figure 5 shows the monitoring station locations in the Lower Creek watershed.

Figure 4. Water quality monitoring for turbidity in Lower Creek at ambient station C1750000 (Lower Creek at SR 1501 near Morganton) for years 1997-2003.

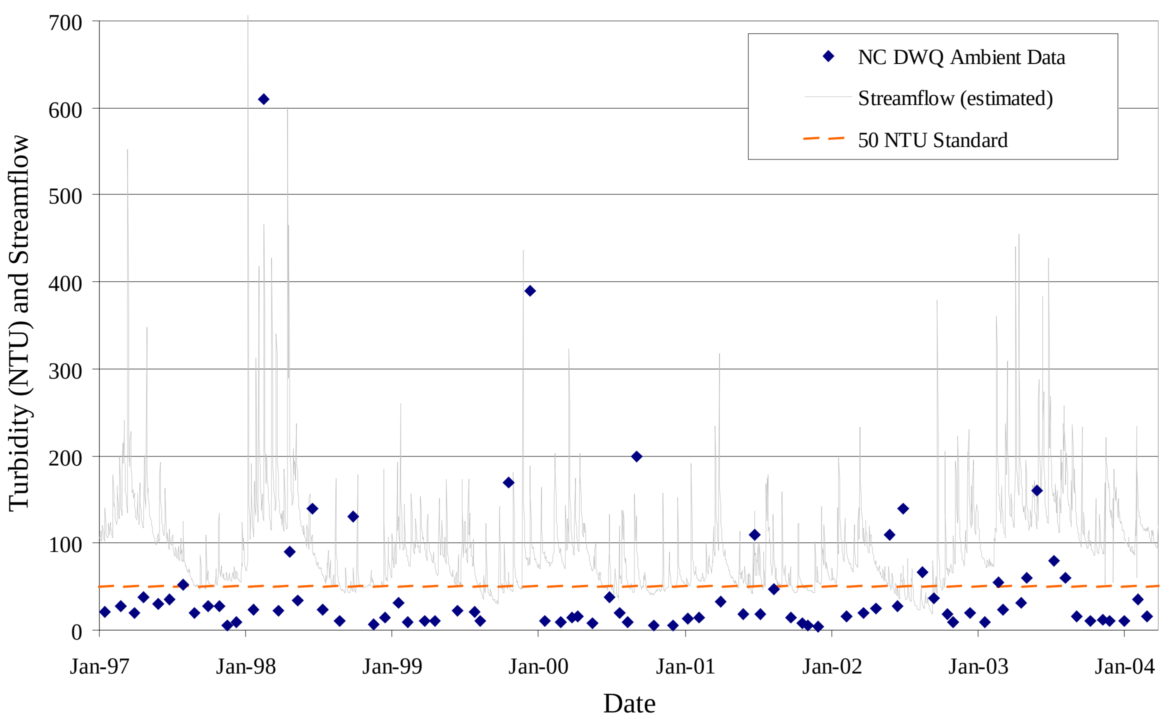
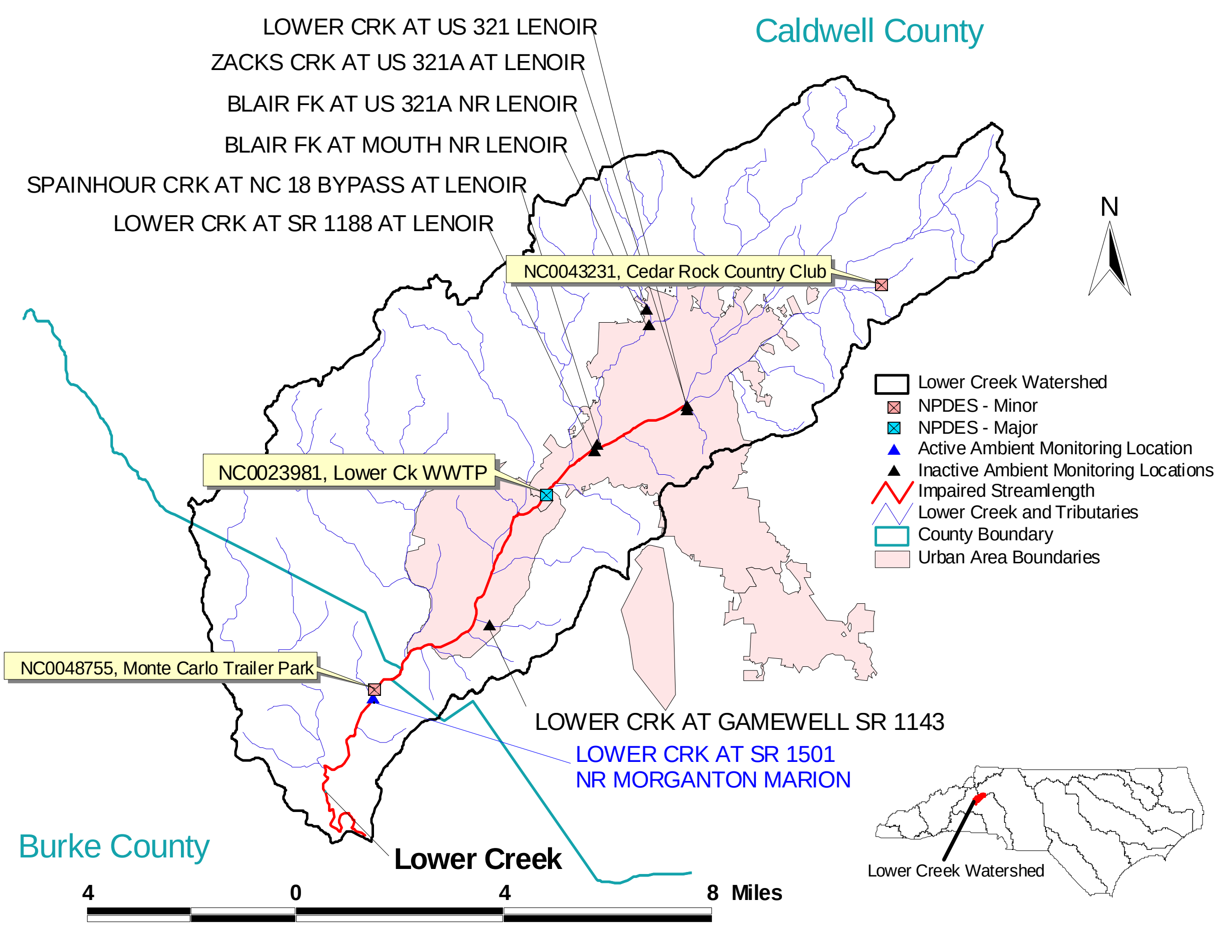


Figure 5. Lower Creek watershed including active and inactive ambient chemical monitoring, and major and minor NPDES permitted facilities.



2.0 Source Assessment

A source assessment is used to identify and characterize the known and suspected sources of turbidity in the Lower Creek watershed. This section outlines the assessment completed for the purpose of developing this TMDL. The NCDENR's Geographic Information System (GIS) was used extensively to watershed characterization. Data sources used in assessing Long Creek are identified in Appendix D.

Assessment of Point Sources

Two categories are included under this discussion; NPDES-regulated municipal and industrial wastewater treatment facilities and NPDES general permitted facilities.

2.1.1 NPDES-Regulated Municipal and Industrial Wastewater Treatment Facilities

Discharges from wastewater treatment facilities may contribute sediment to receiving waters as total suspended solids (TSS) and/or turbidity. Municipal treatment plants and industrial treatment plants are required to meet surface water quality criteria for turbidity in their effluent. Since these facilities are routinely achieving surface water quality criteria, this TMDL will not impose additional limits to current practices or existing effluent limits for POTWs and industrial treatment plants. When effluent turbidity concentrations exceed surface water quality criteria, and result in permit violations, action will be taken through the NPDES unit of North Carolina's Division of Water Quality.

Currently, there is one major NPDES permitted wastewater treatment plant discharger and two minor NPDES permitted facilities located in the Lower Creek watershed. The Lower Creek WWTP (NC0023981) has a permitted flow of 6.0 MGD with an effluent TSS limit of 30 mg/l on a monthly average and 45 mg/L on a weekly average. Cedar Rock Country Club (NC0043231) discharges to Lower Ck at a permitted flow of 0.009 MGD with a monthly average TSS limit of 30 mg/L and daily maximum TSS limit of 45 mg/L. Monte Carlo Trailer Park (NC0048755) discharges to Lower Creek at a permitted flow of 0.005 MGD with a monthly average TSS limit of 30 mg/L and daily maximum TSS limit of 45 mg/L. Monthly effluent averages for NC 0023981 are located in Appendix E.

2.1.2 NPDES General Permits

Twenty-six general permitted facilities are located in the Lower Creek watershed. A list of these facilities is presented in Appendix F. General permitted facilities, while not subject to effluent TSS or turbidity limitations, are required to develop a stormwater pollution prevention plan, and conduct qualitative and/or quantitative measurements at each stormwater discharge outfall and vehicle maintenance area. Sampling methodology and constituents to be measured are characteristic of the volume and nature of the permitted discharge. For example, general permits for mining operations require the permitee to measure settleable solids, total suspended solids, turbidity, rainfall, event duration, and flow in stormwater discharge areas. Measurements of pH, oil and grease, total suspended solids, rainfall, and flow are required in on-site vehicle maintenance areas. Similarly, monitoring is required in mine dewatering areas, wastewater associated with sand/gravel mining, and in overflow from other process recycle wastewater systems.

Facilities submitting a notice of intent (NOI) for coverage under a general permit, prior to establishment or approval of a TMDL for a priority pollutant(s) for stormwater discharges (i.e. wet weather flows), may be covered under a general permit during its term. For such facilities continued coverage under the reissuance of a general permit is subject to the facility demonstrating that it does not have a reasonable potential to violate applicable water quality standards for such pollutants due to the stormwater discharge(s). In part, the decision to reissue is based on the submission of water quality measurements. For facilities that do have a reasonable potential for violation of applicable water quality standards due to the stormwater discharge(s) the facility shall apply for an individual permit 180 days prior to the expiration of their general permit. Once the individual permit is issued and becomes effective the facility will no longer have coverage under the general permit.

All construction activities in the Lower Creek watershed that disturb one or more acres of land are subject to NC general permit NCG010000 and as such are required to not cause or contribute to violations of Water Quality Standards. As stated in Permit NCG010000, page 2, “The discharges allowed by this General Permit shall not cause or contribute to violations of Water Quality Standards. Discharges allowed by this permit must meet applicable wetland standards as outlined in 15A NCAC 2B .0230 and .0231 and water quality certification requirements as outlined in 15A NCAC 2H .0500”. Monitoring requirements for these construction activities are outlined in Section B (page 5) of NCG010000. As stated, “All erosion and sedimentation control facilities shall be inspected by or under the direction of the permittee at least once every seven calendar days (at least twice every seven days for those facilities discharging to waters of the State listed on the latest EPA approved 303(d) list for construction related indicators of impairment such as turbidity or sedimentation) and within 24 hours after any storm event of greater that 0.5 inches of rain per 24 hour period.” (NCG010000, Section B)

As per 40 CFR § 122.44(d)(1)(vii)(B), where a TMDL has been approved, NPDES permits must contain effluent limits and conditions consistent with the requirements and assumptions of the WLA in the TMDL. While effluent limitations are generally expressed numerically, EPA guidance on NPDES-regulated municipal and small construction storm water discharges is that these effluent limits be expressed as best management practices (BMPs) or other similar requirements, rather than numeric effluent limits (EPA, 2002). Compliance with the turbidity standard in Lower Creek is expected to be met when construction and other land management activities in the Lower Creek watershed employ adequate BMPs. Upon approval of this TMDL, DWQ will notify the NC Division of Land Resources (DLR) and other relevant agencies, including county and local offices in the Lower Creek watershed (Caldwell and Burke Counties) responsible in overseeing construction activities, as to the impaired status of Lower Creek and the need for a high degree of review in the construction permit review process.

Assessment of Nonpoint and Stormwater Sources

Nonpoint and stormwater sources include various erosional processes, including sheetwash, gully and rill erosion, wind, landslides, dry ravel, and human excavation that contribute sediment during storm or runoff events. Sediments are also often produced as a result of stream channel and bank erosion and channel disturbance (EPA, 1999).

Nonpoint sources account for the vast majority of sediment loading to surface waters. A few of these sources include:

- Natural erosion occurring from the weathering of soils, rocks, and uncultivated land; geological abrasion; and other natural phenomena.

- Erosion from agricultural activities. This erosion can be due to the large land area involved and the land-disturbing effects of cultivation. Grazing livestock can leave areas of ground with little vegetative cover. Unconfined animals with direct access to streams can cause streambank damage and erosion.

- Erosion from unpaved roadways can be a significant source of sediment to rivers and streams. Exposed soils, high runoff velocities and volumes and poor road compaction all increase the potential for erosion.

- Runoff from active or abandoned mines may be a significant source of solids loading. Mining activities typically involve removal of vegetation, displacement of soils and other significant land disturbing activities.

- Soil erosion from forested land that occurs during timber harvesting and reforestation activities. 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. Established forest areas produce very little erosion.

- Streambank and streambed erosion processes often contribute a significant portion of the overall sediment budget. The consequence of increased streambank erosion is both water quality degradation as well as increased stream channel instability and accelerated sediment yields. Streambank erosion can be traced to two major factors: stream bank characteristics (erodibility potential) and hydraulic/gravitational forces (Rosgen, online). The predominant processes of stream bank erosion include: surface erosion, mass failure (planar and rotational), fluvial entrainment (particle detachment by flowing water, generally at the bank toe), freeze-thaw, dry ravel, ice scour, liquifaction/collapse, positive pore water pressure, both saturated and unsaturated failures and soil piping.

2.1.3 Stormwater Discharges in the Lower Creek Basin

Urban runoff can contribute significant amounts of turbidity and is addressed and regulated under the Storm Water Phase II Final Rule (EPA, 2000). Amendments were made to the Clean Water Act in 1990 and most recently in 1999 pertaining to permit requirements for stormwater dischargers associated with industrial activities and municipal separate storm sewer systems (MS4s). MS4s can discharge sediment to waterbodies in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. This rule applies to a cities or counties which own or operate a municipal separate storm sewer system (MS4). As a result of the Phase II Rule, MS4 owners are required to obtain a National Point Source Discharge Elimination System (NPDES) permit for their stormwater discharges to surface waters.

An MS4 becomes part of the Phase II program in one of three ways; (1) automatic designation, (2) state designation, or (3) petitioning. According to the 2000 US Census Urbanized Area, the Lower Creek watershed includes portions of the Hickory “Urbanized area.” This area includes portions of Lenoir, Gamewell, and Cajah’s Mountain. The total Phase II area included as part of the Hickory Urbanized area within the Lower Creek watershed is approximately 13,187 acres (20.6 mi^2), or approximately 21% of the total Lower Creek watershed.

2.1.4 Water Quality Assessment

When streamflow gage information is available, a load duration curve (LDC) analysis is useful in identifying and differentiating between storm-driven and steady-input sources (Stiles 2002, Cleland 2002, ASIWPCA 2002).). This method determines the relative ranking of a given flow based on the percent of time that historic flows exceed that value. Flow data have been collected by USGS at the primary site (USGS Gage 02140991) from 1985 to the present. Excursions that occur only during low-flow events (flows that are frequently exceeded) are likely caused by continuous or point source discharges, which are generally diluted during storm events. Excursions that occur during high-flow events (flows that are not frequently exceeded) are generally driven by storm-event runoff. A mixture of point and nonpoint sources may cause excursions during normal flows. Table 2 identifies the number of turbidity samples exceeding the 50 NTU criterion under a variety of flow conditions.

Table 2 Number of violations to the 50 NTU turbidity standard in Lower Creek classified by flow range.

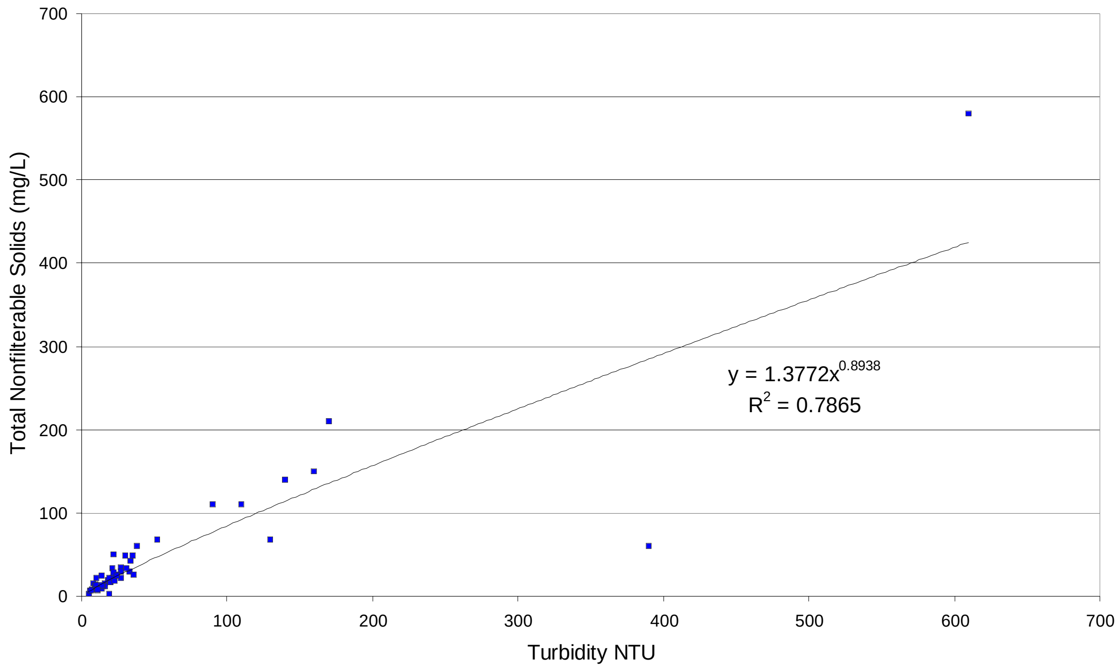
Percent of Time Flows are Equaled or Exceeded	Total number of samples	Number of samples >50 NTU
0% - 10% (high flows)	8	6
10% - 40% (moist conditions)	20	4
40% - 60% (mid-range flows)	15	2
60% - 95% (dry conditions)	34	5
95% - 100% (low flows)	4	1
All flows	81	18

Because turbidity is measured as NTUs and not as a concentration, another parameter that is measured as a concentration must be used to represent turbidity loadings in the watershed. For this TMDL, total nonfilterable solids (or TSS, method 00530) was selected based its correlation with turbidity. The correlation was determined using the below formula:

$$\rho_{xy} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu_x)(y_i - \mu_y)}{\sigma_x \cdot \sigma_y} \qquad \text{where: } -1 \le \rho_{xy} \le 1$$

Given this, a linear regression was developed between turbidity and TSS to allow for the use of TSS values in developing a LDC. This regression is shown in Figure 6. Steps used to develop the LDC are presented in Appendix G.

Figure 6. Power regression between Total Nonfilterable Solids and Turbidity at Lower Creek at station C1750000 using data collected during years 1997-2003.



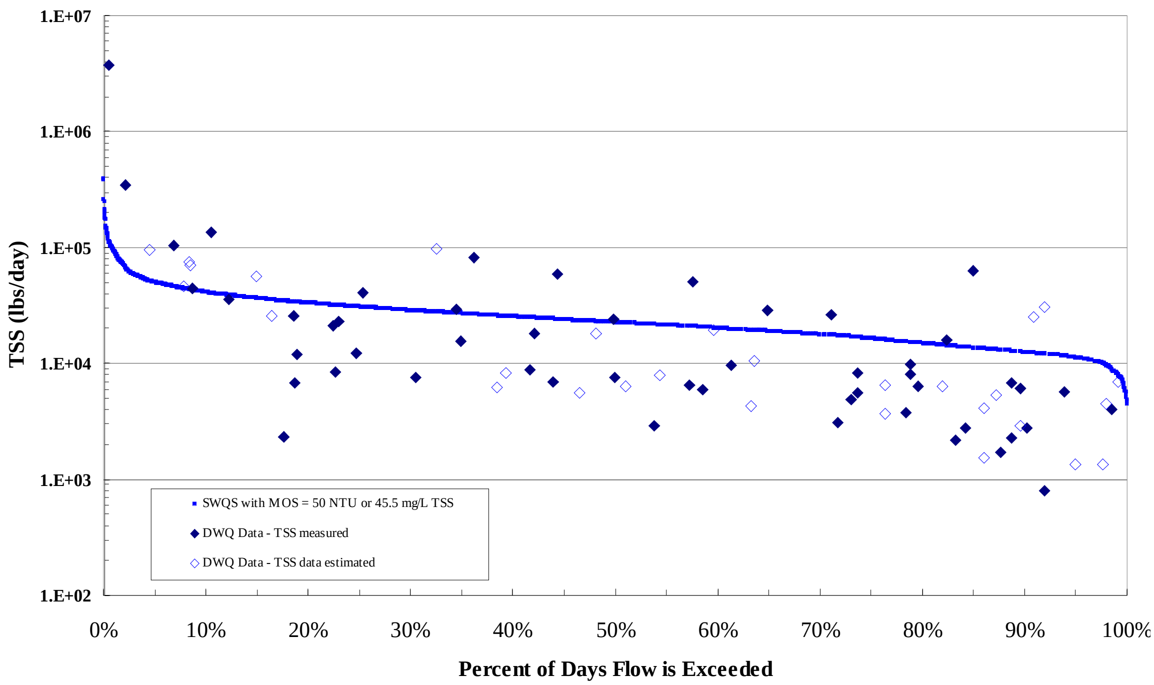
Using the drainage-area and point source adjusted flow values, flow duration graphs were developed for the Lower Creek ambient station. Monitoring data was then matched up with the flow duration ranking based on the collection date. Flow gage information is not available in the Lower Creek watershed, thus, daily flow data (during 1985 through 2004) from a nearby USGS Station #02140991, Johns River at Arneys Store, was used to establish the historic flow regimes and define ranges for the high, typical, and low flow conditions. Flows at the Lower Creek ambient station near SR 1501 were estimated based on a drainage area ratio between USGS station #02140991 and the watershed area upstream of SR 1501. Flows were also adjusted to account for the Lower Ck WWTP (NC0023981). Table 3 presents flow statistics for station #02140991 obtained from the USGS and LDC analysis.

Table 3 Flow statistics for USGS gage station #02140991 during years 1985-2004.

Parameter	Value
Drainage Area	201 mi^2
Average flow	346 cfs
Minimum flow	19 cfs
Maximum flow	16,100 cfs
High Flow Range (> 10% exceed)	> 607 cfs
Nonpoint Source Contributions from runoff (10-85%)	117- 607 cfs
Low Flow Range (95-100%)	< 86 cfs

Figure 7 shows TSS data as a function of estimated flow duration at the Lower Creek ambient station. As shown in Figure 7, the surface water quality violations occur under all flows ranges and are likely attributable to a variety of point and nonpoint sources.

Figure 7. Load duration curve for Turbidity at Lower Creek, ambient station C1750000 (years 1997-2003) and estimated flow at USGS 02141245 using flow data from USGS station 02140991 (Johns River at Arneys Store).



3.0 Technical Approach

Based on the preliminary source and data assessment, the Watershed Analysis Risk Management Framework (WARMF) model was selected to evaluate turbidity in Lower Creek. WARMF is a decision support system designed to support the watershed approach and TMDL calculations. The model has been applied to watershed regions in the USA and Taiwan (Systech Engineering, 2001).

WARMF contains several embedded models adapted from the ILWAS model, ANSWERS, SWMM, and WASP. The model simulates hydrology and water quality for the landscape of a river basin. WARMF divides a watershed into land catchments, river segments, and reservoirs and uses the continuously stirred tank reactor (CSTR) model for flow routing and mass balance within a given soil layer or river segment.

Simulated parameters include flow, temperature, water depth and velocity, and constituent concentrations. In the case of total suspended solids (surrogate for turbidity), the model simulates the deposition and transportation of sand, silt and clay from the land surface, instream sources, and point source discharges. The soil erosivity factor is a function of soil type and is available from Natural Resources Conservation Service. Data entry boxes are provided for a soil erosivity factor, and percents of clay, silt, and sand in the surface soil. The erosion and deposition of soil particles are calculated separately for clay, silt, and sand. Algorithms for sediment erosion and pollutant transport from farm lands and other land uses were adapted from ANSWERS and the universal soil loss equation. The model also includes a facility for calculating TMDLs for non-point source loads under different control levels of point source loads and vice versa.

In December 2003, NCDWQ entered into a contract with Systech to update the WARMF model to add three additional data years to extend the model database through September 2003. The new version of WARMF, used in the development of this TMDL, included updates or improvements to meteorology, air quality, USGS gage data, water quality data, NPDES point source data, septic system data, and reservoir release data.

Parameter Adjustment

The Lower Creek watershed is represented as 16 catchments within the model (Figure 8). Simulations were run for the Lower Creek watershed within WARMF. Hydrology and water quality results were compared to observed data. Model parameters were adjusted to improve the model results and reduce the error between simulated and observed data. During hydrology calibration, parameters for soil thickness, initial soil moisture, field capacity, saturated moisture and hydraulic conductivity were adjusted (see Appendix H). In addition precipitation weighting factors were adjusted to improve the water balance. Table 4 lists ranges of values set for the Lower Creek watershed. WARMF's autocalibrator tool was used to improve the hydrology calibration. Using this tool, multiple simulations are performed while small parameter adjustments are made until model results are improved.

Figure 8. Lower Creek as represented in the WARMF model. Subwatersheds were labeled 1-16 to assist in identifying wasteload and load allocations.

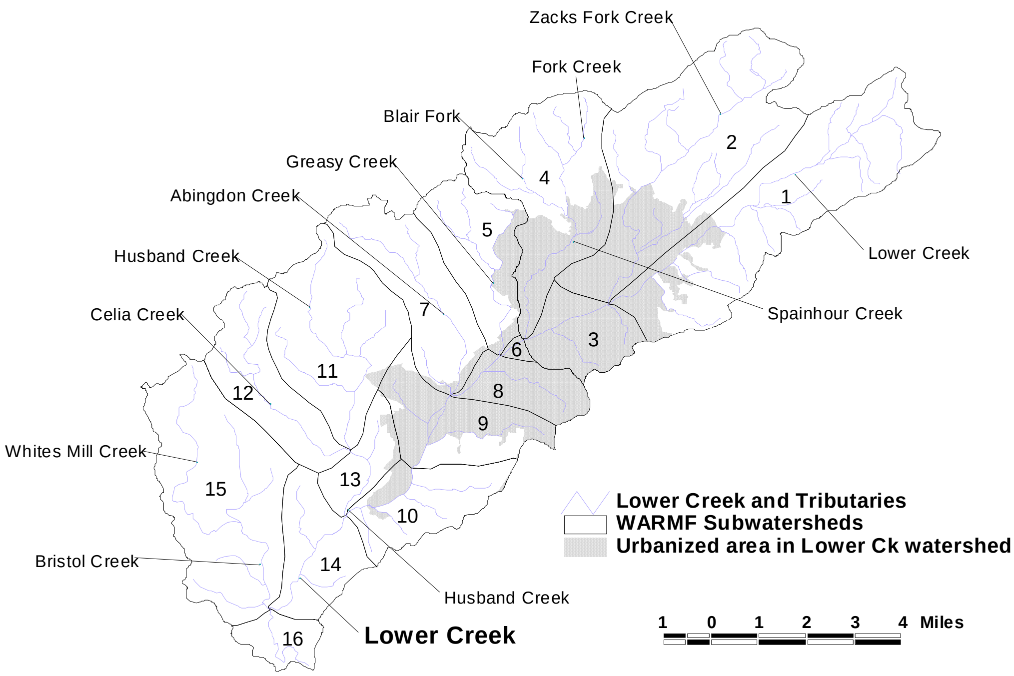


Table 4 Hydrology Parameter Ranges for Lower Creek Watershed.

Parameter	Lower Range	Upper Range
Soil thickness	20 cm	400 cm
Initial Mositure	0.3	0.4
Field Capacity	0.2	0.25
Saturated Moisture	0.35	0.5
Horizontal Conductivity	500 cm/d	10,000 cm/d
Vertical Conductivity	7.5 cm/d	300 cm/d
Precipitation weighting	0.8	1.3

Some of the input parameters that affect suspended sediment concentrations include buffer zone coefficients, livestock exclusion, and bank vegetation and stability factors. For each land catchment draining to a stream, a percent buffered parameter is specified. This is representative of the percent of runoff that will pass through a buffer before entering the stream. Other buffer inputs include buffer width, slope and roughness. Buffer parameters for the entire Catawba River Basin (including Lower Creek) were set based on a GIS study performed by a Duke Energy intern in 2001 (Job 2001). In the Lower Creek watershed, percent buffered ranged from 47% to 87% buffered, buffer width was assumed to be 20 m and slope and roughness were set at 0.01 and 0.3 respectively. In the

Lower Creek Watershed Report published by Western Piedmont Council of Governments (WPCOG 1998), it was stated that Lower Creek and many tributaries have steep incised banks that lack vegetation. The stream data collection performed by WPCOG indicated that bank erosion ranged from moderate to severe. It was also stated that at many locations, animals have direct access to the streams. Coefficients for bank erosion and vegetation as well as livestock exclusion BMPs were set based on this qualitative information. To account for livestock having direct access to streams, it was specified that in the pasture landuse, 5 percent of the loading from livestock was directly deposited to the stream instead of being applied to the land surface. Empirical factors for bank vegetation and bank stability factors were set to equal 0.003. A typical range for these parameters is from 0.0 to 0.01, with a higher value representing less vegetation and less bank stability. Based on stream substrate data collected by WPCOG (1998), which indicated a composition of mostly sand and some gravel and silt, the stream substrate for Lower Creek was set to be 60% sand, 20% silt and 40% clay in WARMF. Other parameters that were adjusted during calibration include soil and steam reaction rates. Table 5 summarizes a few reaction rates specified for the Lower Creek watershed.

Table 5 Reaction rates for Lower Creek Watershed.

Reaction	Soil	Stream
BOD Decay	0.1 day^{-1}	0.5 day^{-1}
Nitrification	0.01 day^{-1}	0.1 day^{-1}
Fecal Coliform Decay	0.1 day^{-1}	1 day^{-1}

Model Results

Simulated results were compared to all available data from 1992 through 2003 for the primary Lower Creek monitoring station at SR 1501 near Morganton. Measured stream flow data was only available from 1/1/1993 through 9/30/1994. Therefore, the hydrology calibration was performed for this time period. Water quality calibration was performed using water years 1992 through 1997. Then, model verification was performed by holding all model coefficients constant and running simulations on water years 1998 through 2003. The following plots show both calibration and verification results for hydrology and various water quality parameters. Figure 9 shows the simulated stream flow in Lower Creek compared to observed data for 1993 and 1994. The model captured the general hydrograph and recession though some peaks flows were under predicted and others were over predicted. Table 6 and Figure 10 present the summary statistics and a scatter plot for the hydrology calibration. This data shows a good comparison of mean, minimum and maximum flow values between simulated and observed. The correlation coefficient (R^2) is 0.698 and relative and absolute errors are 0.15 and 1.029 respectively. Figure 11 shows the frequency distribution of flow for both simulated and observed and Figure 12 shows a cumulative flow comparison. Both plots indicate good agreement with the overall water balance.

Figure 9. Simulated and observed flow at Lower Creek USGS station, 02141245.

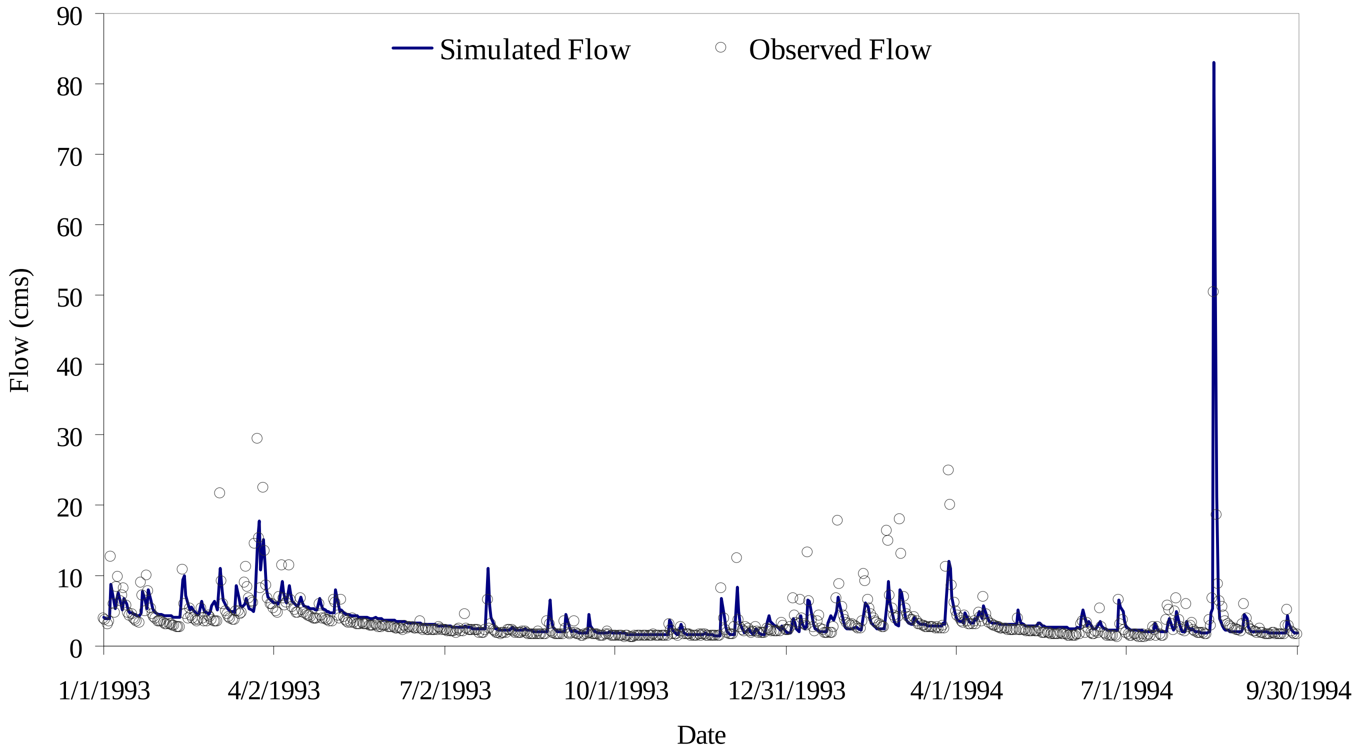


Table 6 Summary statistics for Lower Creek hydrology calibration, 1992-1997..

	Mean	Minimum	Maximum	# Points	Relative Error	Absolute Error	RMS Error	r-squared
Lower Ck 92-97	3.186	1.26	83.09	638	0.15	1.028	2.16	0.689
Observed	3.549	1.22	50.41	638	0	0	0	1

Figure 10. Scatter plot for Lower Creek hydrology calibration, 1992-1997.

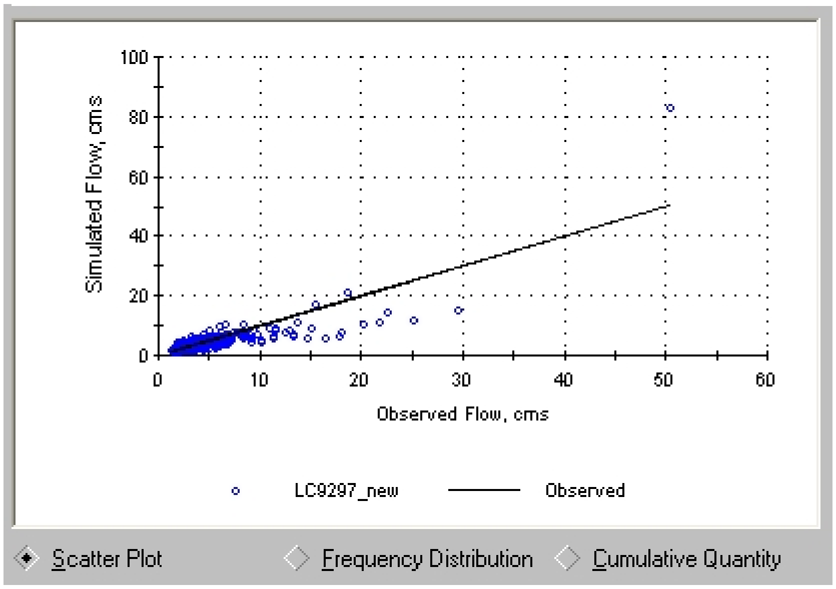


Figure 11. Frequency distribution of flow calibration for Lower Creek, 1992-1997.

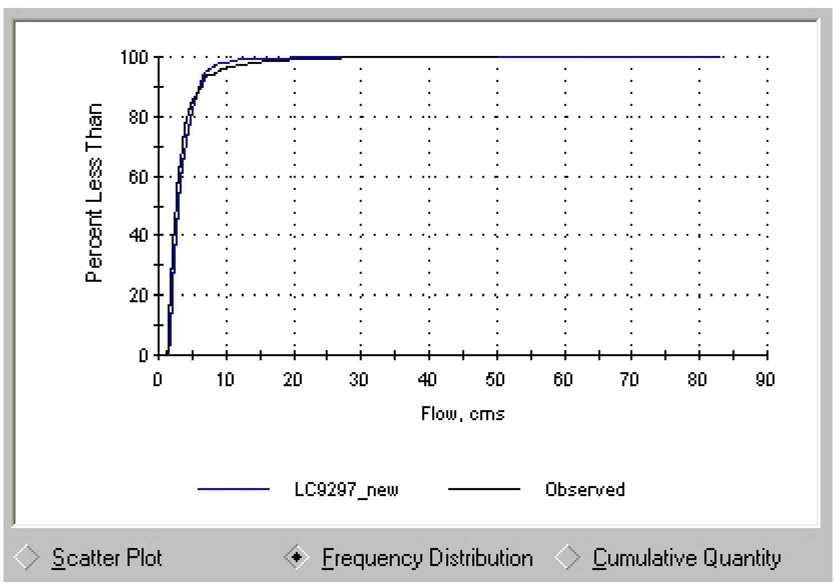


Figure 12. Cumulative flow plot calibration for Lower Creek, 1992-1997.

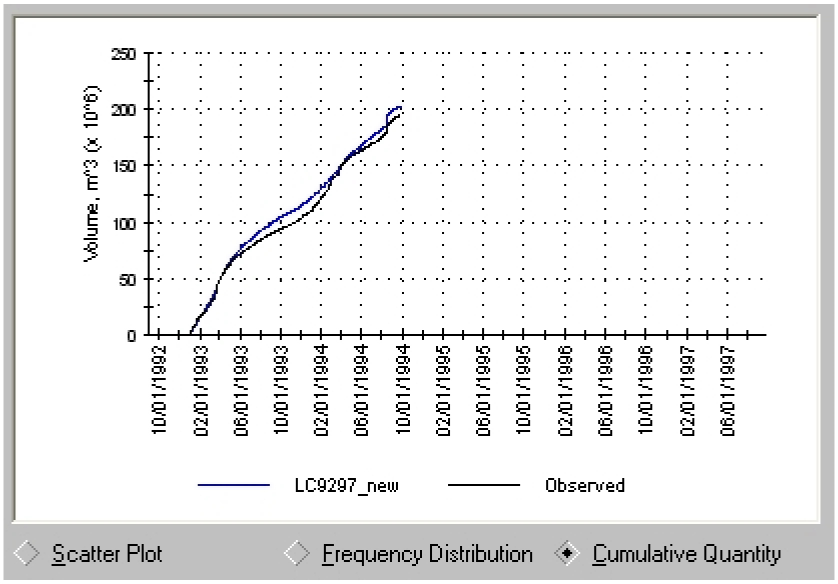


Figure 13 shows the simulated and observed temperature in Lower Creek for 1992-1997. The simulation shows good agreement with the seasonal pattern of temperature. Table 7 and Figures 14 and 15 show the summary statistics, scatter plot, and frequency distribution plot. The results indicate a good match of simulated with observed including an R^2 of 0.815. The seasonal pattern of temperature in years 1997-2003 also matched well with a resulting R^2 of 0.82.

Figure 13. Simulated and observed temperature calibration in Lower Creek, 1992-1997.

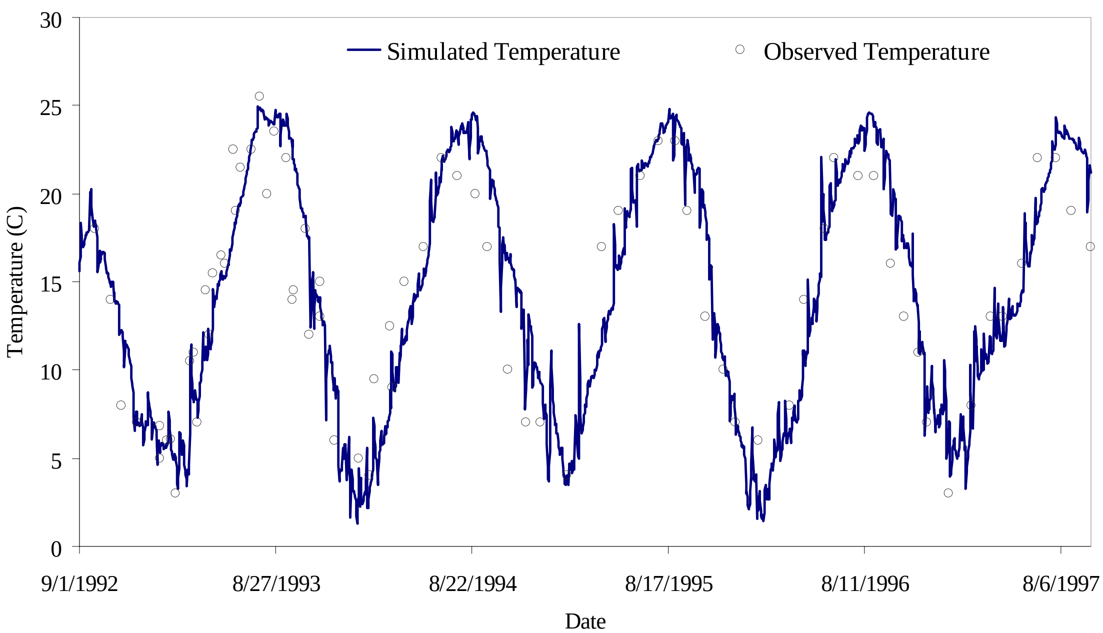


Table 7 Summary statistics for Lower Creek temperature calibration, 1992-1997.

	Mean	Minimum	Maximum	# Points	Relative Error	Absolute Error	RMS Error	r-squared
Lower Ck 92-97	14.28	1.326	24.97	76	0.512	2.212	2.902	0.815
Observed	14.05	3	25.5	76	0	0	0	1

Figure 14. Scatter plot for Lower Creek temperature calibration 1992-1997.

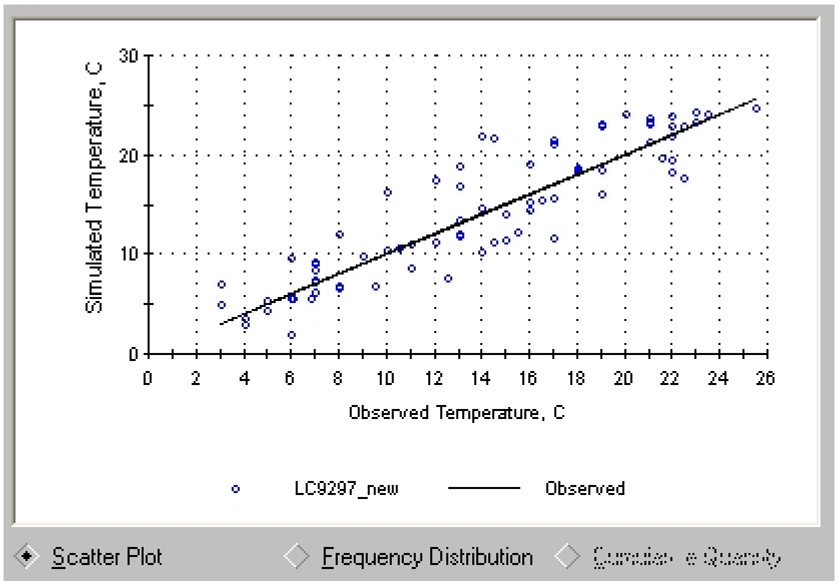


Figure 15. Frequency distribution of temperature calibration for Lower Creek, 1992-1997.

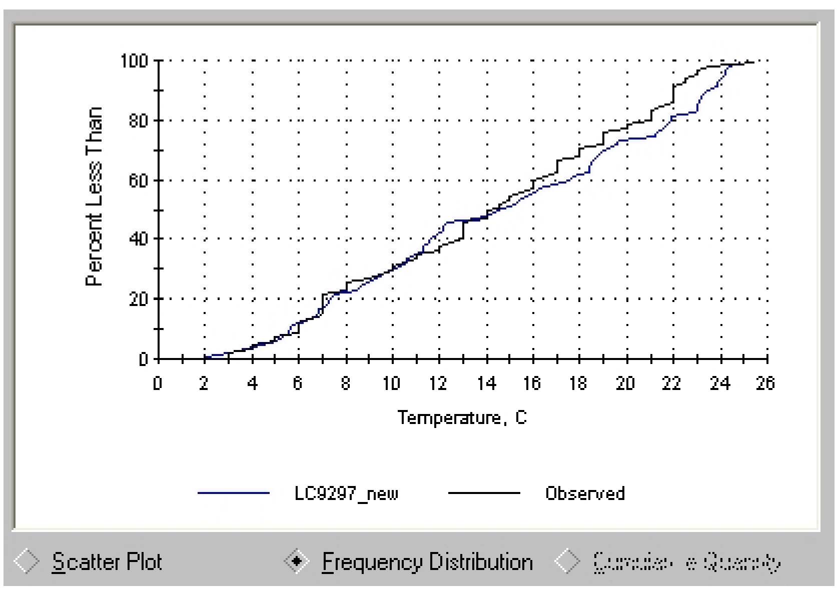


Table 8 and Figures 16 and 17 show the summary statistics, scatter plot, and frequency distribution plot for TSS calibration in Lower Creek for 1992-1997. The results indicate a good match of simulated with observed including an R^2 of 0.816. Similar results found for 1998-2003.

Table 8 Summary statistics for Lower TSS calibration 1992-1997.

	Mean	Minimum	Maximum	# Points	Relative Error	Absolute Error	RMS Error	r-squared
Lower Ck 92-97	75.54	8.281	35260	51	3.657	36.97	90.3	0.814
Observed	59.2	3	558	51	0	0	0	1

Figure 16. Scatter plot for Lower Creek TSS calibration 1992-1997.

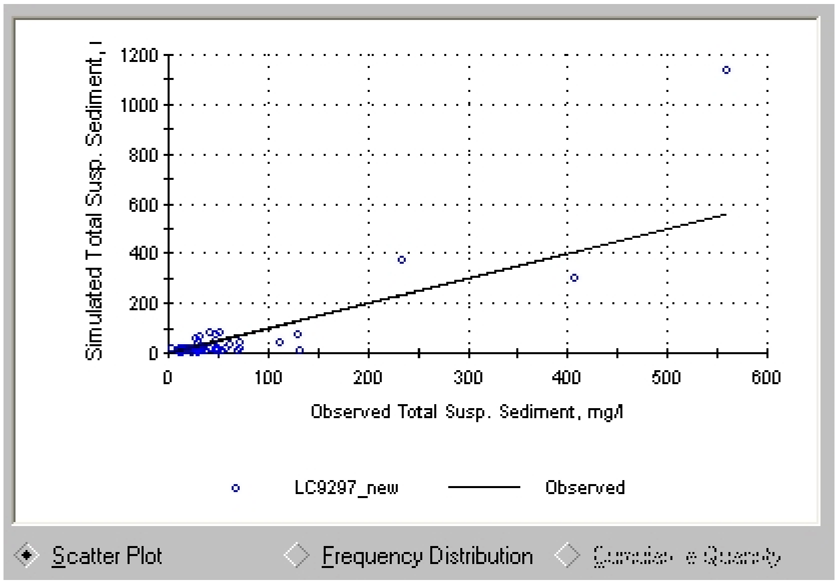
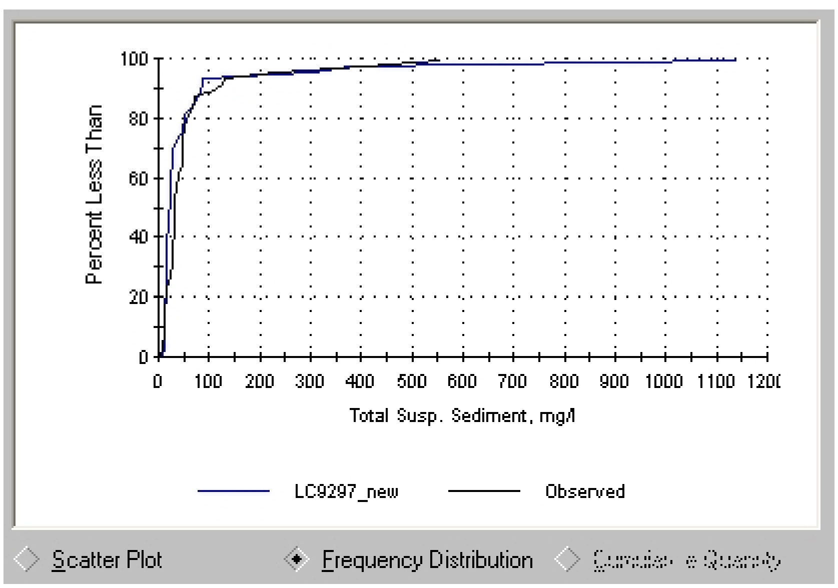


Figure 17. Frequency distribution of TSS calibration for Lower Creek, 1992-1997.



Figures 18 and 19 show a plot of observed and simulated TSS in Lower Creek for water years 1998-2003. The results indicate a good match of simulated with observed including an R^2 of 0.736. Figures 20 and 21 show the scatter plot and frequency distribution plot for TSS calibration in Lower Creek for 1998-2003

Figure 18. Simulated and observed TSS in Lower Creek during 1998-2003 using calibrated model.

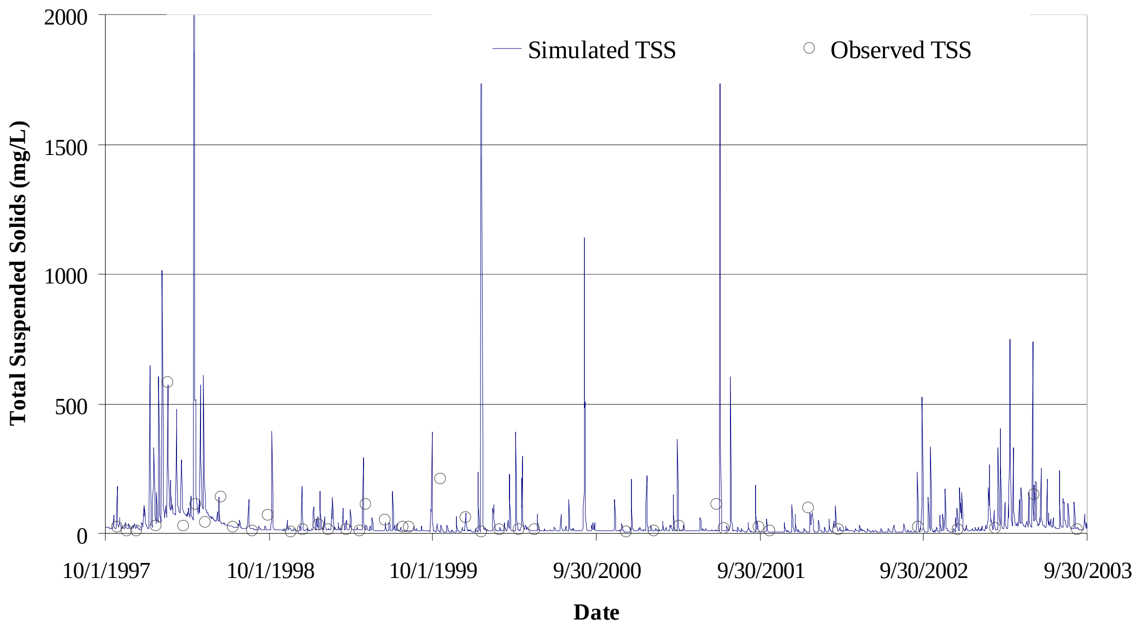


Figure 19. Simulated and observed TSS in Lower Creek, 1998-2003, close-up view.

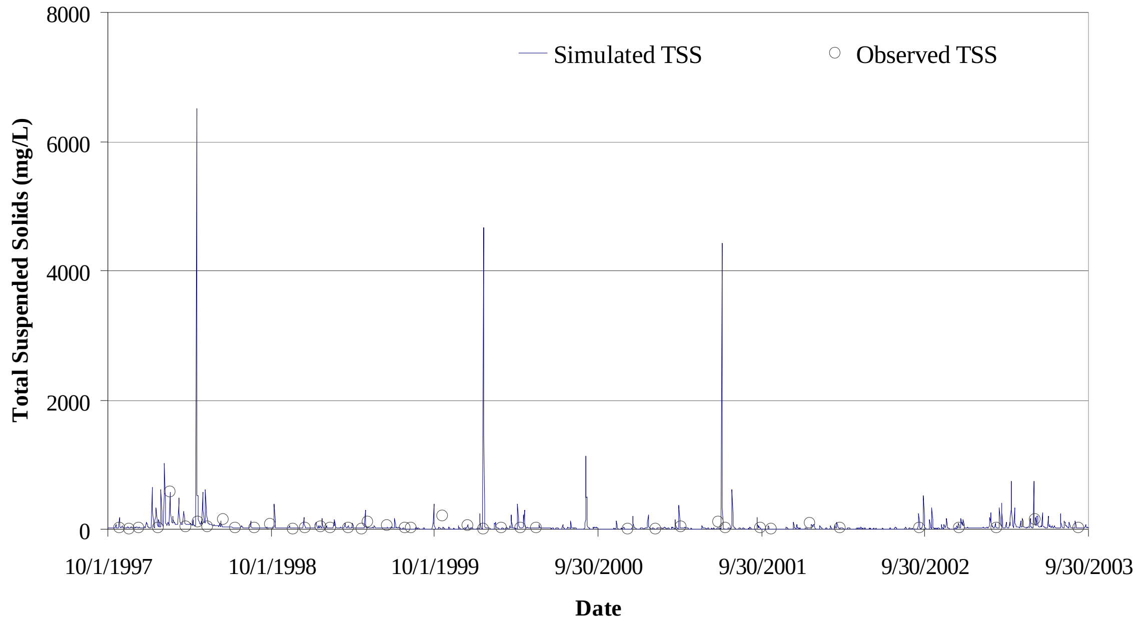


Table 9 Summary statistics for Lower Creek TSS 1998-2003.

	Mean	Minimum	Maximum	# Points	Relative Error	Absolute Error	RMS Error	r-squared*
Lower Ck 92-97	44.61	5.2	6518	43	27.68	62.97	226.2	0.736
Observed	52.23	3	580	43	0	0	0	1

* based on exclusion of one false recording measurement taken during 1/19/2000

Figure 20. Scatter plot for Lower Creek TSS 1998-2003.

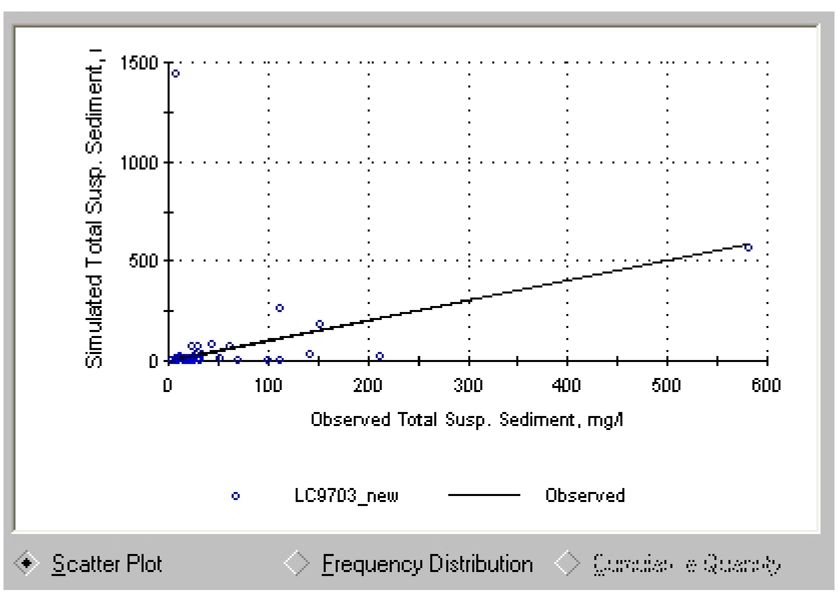
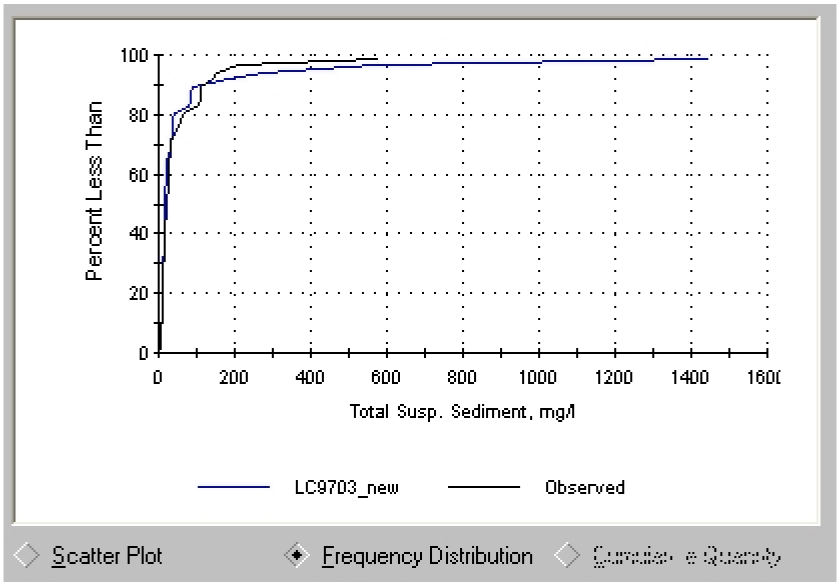


Figure 21. Frequency distribution of TSS for Lower Creek, 1998-2003.



Existing TSS loading (1998-2003) predicted by the calibrated model is presented below in Table 10. Streambank erosion was the largest TSS contributor at 98% of the total TSS load. The remaining 2% of the total TSS load was distributed among the remaining urban and nonurban landuses. The City of Lenior WWTP was the only significant point source in the Lower Creek watershed with TSS effluent requirements.

Table 10 Existing TSS loading by land use sources in the Lower Creek watershed.

Landuse/ Landcover	Simulated 1998-2003 TSS Load (kg/day)	Percent of Total TSS Load
Deciduous Forest	279	0.26%
Evergreen Forest	209	0.20%
Mixed Forest	206	0.20%
Pasture	294	0.28%
Cultivated	399	0.38%
Recreational Grasses	6.4	0.01%
Barren	32	0.03%
Low Int. Develop.	399	0.38%
High Int. Develop.	156	0.15%
Commercial / Industrial	301	0.29%
Stream Bank Erosion	103,204	97.9%
TOTAL	105,500	100%

4.0 TMDL Calculation

A Total Maximum Daily Load (TMDL) represents the assimilative or carrying capacity of a waterbody, taking into consideration point and nonpoint sources of pollutants of concern, natural background and surface water withdrawals. A TMDL quantifies the amount of a pollutant a water body can assimilate without violating a state's water quality standards (in our case, Class C and WS-IV freshwaters) and allocates that load capacity to known point and nonpoint sources in the form of wasteload allocations (WLAs), load allocations (LAs). In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. This definition is expressed by the following equation:

TMDL = ΣWLAs + ΣLAs + MOS

A TMDL is developed as a mechanism for identifying all the contributors to surface water quality impacts and setting goals for load reductions for pollutants of concern as necessary to meet the SWQS. The Code of Federal Regulations (40 CFR §130.2(1)) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. This TMDL will be expressed in terms of both a mass per time (kg/day) and percent reduction based on modeled stream flow and instream TSS concentrations and will be calculated for the most downstream water quality limited river segment of Lower Creek (segment above the confluence with the Catawba River). A total of 93 TSS values were used in this TMDL analysis; 51 collected during 1992-1997 period used in calibrating WARMF and 42 collected during 1998-2003 used to develop the TMDL reduction.

TMDL Endpoints

TMDL endpoints represent the instream water quality targets used in quantifying TMDLs and their individual components. As discussed in Section 3, turbidity as a measure is not applicable to the estimation of loading to a stream. TSS was selected as a surrogate measure for turbidity. Based on the regression analysis, a TSS limit of 46 mg/L was determined to be equivalent to a turbidity measure of 50 NTU. As will be discussed in Section 4.3, a 10% explicit margin of safety was applied to the endpoint and resulted in a reduction of the target value from 50 NTU to 45 NTU (46 mg TSS/L to 41 mg TSS/L). The criteria used to develop this TMDL was a 1 day maximum concentration of 41 mg TSS/L to be met 90% of the time.

Critical Conditions and Seasonal Variation

In Lower Creek, elevated turbidity concentrations occur under both low and high flow conditions (Figure 7). The majority of turbidity violations during 1998-2003 occurred during the summer months between April and September with the most violations occurring in May (four violations) and June (five violations). Table 11 shows the number of violations in each month during the 1998-2003 period. The TMDL has been set such that the turbidity standard is met under all seasons and flow conditions for the 1998-2003 period.

Table 11 Number of violations to the 50 NTU standard for each month during the 1998-2003 period.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Violations (#)	0	2	0	2	4	5	3	2	2	1	0	1

Margin of Safety

A Margin of Safety (MOS) is provided to account for "lack of knowledge concerning the relationship between effluent limitations and water quality" (40 CFR 130.7(c)). The MOS may be incorporated into a TMDL either implicitly, through the use of conservative assumptions to develop the allocations, or explicitly through a reduction in the TMDL target. For this TMDL, an explicit margin of safety was incorporated in the analysis by setting the TMDL target at 45 NTU, or equivalent 41 mg TSS/L, which is 10% lower than the water quality target of 50 NTU or equivalent 46 mg TSS/L.

Reserve Capacity

Reserve capacity is an optional means of reserving a portion of the loading capacity to allow for future growth. Reserve capacities are not included at this time. The loading capacity of each stream is expressed as a function of the current load (Section 4.0), and both WLAs and LAs are expressed as reductions for the entire Lower Creek watershed. Therefore, the reductions from current levels, outlined in this TMDL, must be attained in consideration of any new sources that may accompany future development. Strategies for source reduction will apply equally to new development as to existing development.

TMDL Calculation

Using WARMF model runs for water years 1998-2003, a TSS reduction of 72% is needed to order to meet water quality standards for turbidity at the outlet of the Lower Creek watershed.

Table 12 Unallocated TMDL load and percent reduction.

	Current Load (kg/day)	Target Load (kg/day)	Reduction Required
Lower Creek Watershed	105,500	30,280	72%

Allocations

Additional analysis is required to address the TMDL reduction by identifying point and nonpoint contributors of turbidity and calculating wasteload and load allocations.

4.1.1 Wasteload Allocations

As previously discussed, one major and two minor NPDES-permitted facilities are located in the Lower Creek watershed. Each of these facilities is subject to monthly TSS effluent limitation of 30 mg TSS/L. For the purposes of this TMDL, wasteload allocations for NC0023981, NC0043231, and NC0048755 are based on permitted flow and effluent TSS limits and do not result in additional reductions for these facilities.

As per Phase II stormwater rules, MS4 (small municipal separate storm sewer systems) permittees are responsible for reducing pollutant loads associated with stormwater outfalls for which it owns or otherwise has responsible control. The City of Lenior and Town of Gamewell are located in the Lower Creek watershed and are part of the overall Hickory Urbanized area as delineated by the 2000 US Census (NCDWQ, 2004b). To estimate turbidity loading for this MS4 area within the Lower Creek watershed, steps were taken to identify the percent of MS4 area within each of the 15 subwatersheds in the

Lower Ck watershed (as shown in the WARMF diagram in Figure 8) and the associated landuse / land cover within each MS4 area. WARMF allows the user to calculate landuse based loading within each subwatershed. Given this, subwatershed and landuse specific TSS loading from WARMF outputs were used in conjunction with the MS4 area and its corresponding landuse within each subwatershed to identify TSS loading on a subwatershed scale for the MS4 area.

TSS loading from streambank erosion represented a significant portion of the overall loading (See Appendix I). The fraction of loading from streambank erosion attributed to the MS4 area was determined in all subwatersheds that contained MS4 area by multiplying the annual streambank erosion load (kg/year) in each subwatershed by the percent of MS4 area in that subwatershed. To determine TSS stormwater loads in subwatersheds downstream of the MS4 area, scenarios were run in WARMF in which all of the urban area (low density, high density and commercial / industrial) was converted to the mixed forest landuse category. The relative difference between current conditions (1998-2003) and this altered landuse condition was used to determine the loading attributable to general, non-permitted stormwater and was determined only for subwatersheds 14 and 16. Streambank erosion TSS loading in 14 and 16 is further outlined in Appendix J. Wasteload allocations and are shown below in Table 9 and detailed in Appendices K and L.

4.1.2 Load Allocations

As earlier noted, Lower Creek is primarily composed of forested (78%) urbanized (10%) and agricultural (10%) land uses. Load allocations were calculated using WARMF and are shown below in Table 13 and detailed in Appendices M and N.

Table 13. Lower Creek TMDL Wasteload and Load Allocations for Turbidity expressed as kg/day TSS.

TMDL Allocations	Existing TSS Load 1998-2003 (kg/day)	TMDL - TSS Load (kg/day)	Required Reduction (%)
Wasteload Allocations			
WLA - NC0023981 (6.0 MGD, 30 mg TSS/L limit)	**-----**	**681**	**0%**
WLA - NC0043231 (0.009 MGD, 30 mg TSS/L limit)	**-----**	**1.0**	**0%**
WLA - NC0048755 (0.005 MGD, 30 mg TSS/L limit)	**-----**	**0.6**	**0%**
WLA – MS4 stormwater [1]	**15,639**	**4,377**	**72%**
WLA – NCG010000 (General Construction Permits)		**50 NTU**	
Sum of WLAs		***5,060***	
Load Allocations/ non permitted			
Load Allocation [2]	**48,284**	**13,542**	**72%**
Non-Permitted Stormwater below MS4 area [3]	**41,587**	**11,682**	**72%**
Sum of LAs		***25,224***	
Margin of Safety - Explicit 10%			
Total TSS Load at outlet to Lake Rhodhiss (kg/day)	**105,500**	**30,280**	**72%**

[1] WLA for MS4 based on the landuse area within the Hickory "Urbanized" area as defined by Phase II boundaries. The MS4 WLA was determined within each of the 16 subwatersheds based on the type of landuse in the MS4 area in that subwatershed and the landuse loading as determine by the WARMF model. Streambank erosion attributable to the MS4 area was determined by multiplying the relative percent of MS4 area in a subwatershed by the total TSS load within that watershed.

[2] Equal to TMDL minus WLA and nonpermitted stormwater. LA is further broken down by landuse in Appendix N.

[3] Nonpermitted stormwater TSS loading occurring in subwatersheds 14 and 16; subwatersheds in which no MS4 area exists. This load was determined by comparing current conditions to conditions in which urban landuses were converted to mixed forest. In subwatersheds 14 and 16, TSS loading increased 59% and 53%, respectively, when comparing current conditions to modified landuse WARMF scenarios. The load given is the sum of stormwater loads in subwatersheds 14 and 16.

5.0 Follow – up Monitoring

Turbidity monitoring will continue on a monthly interval at the ambient monitoring station at SR 1501 near Morganton and will allow for the evaluation of progress towards the goal of reaching water quality standards. Discuss EEP monitoring and study here.

Additional monitoring could focus on identifying critical areas of streambank erosion and turbidity source assessment in the watershed. This would further aid in the evaluation of the progress towards meeting the water quality standard.

6.0 Implementation

Turbidity impairments in the Lower Creek watershed are primarily due to excessive stream channel and bank erosion. This erosion is, in part, a result of higher flows and volumes associated with increased urbanization and impervious surface in the Lower Creek watershed. Enforcement of stormwater BMP requirements for construction sites, education on farm practices, and consideration of urban stormwater controls for sediment are potential management options for improving turbidity levels. Other TSS sources include runoff from disturbed landuses, such as agriculture and construction areas where conversion from rural to urban uses is occurring. While stormwater controls are required on construction sites, significant loadings can occur due to initial periods of land disturbance before controls are in place or during high rainfall periods during which the controls are inadequate. North Carolina Phase II rules require development, implementation, and enforcement of an erosion and sediment control program for construction activities that disturb one or more acres of land. In addition, Phase II rules require the development, implementation, and enforcement of a program to address discharges of post-construction storm water runoff from new development and redevelopment areas.

Implementation of conservation management plans and best management practices are the best means of controlling agricultural sources of suspended solids. Several programs are available to assist farmers in the development and implementation of conservation management plans and best management practices. The Natural Resource Conservation Service is the primary source of assistance for landowners in the development of resource management pertaining to soil conservation, water quality improvement, wildlife habitat enhancement, and irrigation water management. The USDA Farm Services Agency performs most of the funding assistance. All agricultural technical assistance is coordinated through the locally led Naturally Resource Conservation Service offices (Soil Conservation Districts). The funding programs include:

- **The Environmental Quality Incentive Program (EQIP)** is designed to provide technical, financial, and educational assistance to farmers/producers for conservation practices that address natural resource concerns, such as water quality. Practices under this program include integrated crop management, grazing land management, well sealing, erosion control systems, agri-chemical handling facilities, vegetative filter strips/riparian buffers, animal waste management facilities and irrigation systems.

- **The Conservation Reserve Program (CRP)** is designed to provide technical and financial assistance to farmers/producers to address the agricultural impacts on water quality and to maintain and improve wildlife habitat. CRP practices include the establishment of filter strips, riparian buffers and permanent wildlife habitats. This program provides the basis for the Conservation Reserve Enhancement

Program (CREP). In 1999 The North Carolina DENR Departments of Environmental Protection and Agriculture, in partnership with Commodity Credit Corporation (CCC), submitted a proposal to the USDA to offer financial incentives for agricultural landowners to voluntarily implement conservation practices on agricultural lands through CREP. The goals for this program are to significantly reduce the amount of nutrients entering estuaries from agricultural sources through a voluntary, incentive-based program; to assist North Carolina in achieving the nutrient reduction goals for agriculture in the area; to significantly reduce the amount of sediment entering water courses; to enhance habitat for a range of threatened and endangered species dependent on riparian areas; and to decrease excess pulses of freshwater in primary nursery areas. NC CREP will be part of the USDA's Conservation Reserve Program (CRP). The enrollment of farmland into CREP in North Carolina is expected to improve stream health through the installation of water quality conservation practices on North Carolina farmland.

- **The Soil & Water Conservation Cost-Sharing Program** is available to participants in a Farmland Preservation Program pursuant to the Agriculture Retention and Development Act. A Farmland Preservation Program (FPP) means any voluntary FPP or municipally approved FPP, the duration of which is at least 8 years, which has as its principal purpose as long-term preservation of significant masses of reasonably contiguous agricultural land within agricultural development areas. The maintenance and support of increased agricultural production must be the first priority use of the land. Eligible practices include erosion control, animal waste control facilities, and water management practices. Cost sharing is provided for up to 50% of the cost to establish eligible practices.

Management Strategies

Management measures are "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint and stormwater sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint and stormwater source pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives" (USEPA, 1993). Development of effective management measures depends on accurate source assessment. A few projects recently completed, underway and planned are identified below.

Lower Creek and its tributaries are currently the subject of an intensive watershed study under management of the North Carolina Ecosystem Enhancement Program (EEP) with involvement of the Western Piedmont Council of Governments (WPCOG) and MACTEC Engineering and Consulting, Inc. As part of this study, MACTEC will be conducting an extensive data-gathering effort, collecting water quality data, assessing riparian buffers, stream channel alteration, streambank erosion, stormwater runoff and non-point sources of pollution, and summarizing this information in the development of a watershed management plan for the Lower Creek watershed. The final report is envisioned to be the "blueprint" for state and local government and other stakeholders in the Lower Creek watershed when addressing watershed-wide problems such as turbidity. The final report will include recommendations toward selecting and implanting traditional and non-traditional restoration projects and/or actions. Final product deliverables are anticipated to be completed by December 2005.

7.0 Public Participation

The City of Lenoir in Caldwell County was notified of the Lower Creek turbidity TMDL. The TMDL was publicly noticed and comment on the TMDL was requested on February 10, 2005. The comment period was through March 11, 2005. No written comments were received. A copy of the public notification is located in Appendix O.

8.0 Additional Information

Further information concerning North Carolina's TMDL program can be found on the Internet at the Division of Water Quality website:
http://h2o.enr.state.nc.us/tmdl/index.htm

Technical questions regarding this TMDL should be directed to the following members of the DWQ Modeling/TMDL Unit:

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Appendix A. Caldwell County, NC Soils (NRCS, 1991)

Map symbol	Map unit name	Acres	Percent
ApB	Appling sandy loam, 2 to 8 percent slopes	475	0.2
ApD	Appling sandy loam, 8 to 15 percent slopes	1,245	0.4
AsF	Ashe stony sandy loam, 25 to 40 percent slopes	559	0.2
AsG	Ashe stony sandy loam, 40 to 80 percent slopes	1,045	0.3
Bn	Buncombe loamy sand, frequently flooded	1,040	0.3
BtF	Burton stony loam, 25 to 40 percent slopes	1,010	0.3
CeB2	Cecil sandy loam, 2 to 8 percent slopes, eroded	15,056	5.0
CeD2	Cecil sandy loam, 8 to 15 percent slopes, eroded	37,373	12.3
CfB2	Cecil-Urban land complex, 2 to 8 percent slopes, eroded	2,930	1.0
CfD2	Cecil-Urban land complex, 8 to 15 percent slopes, eroded	2,524	0.8
ChG	Chestnut gravelly loam, 50 to 80 percent slopes	37,545	12.4
CKE	Chestnut and edneyville soils, 15 to 25 percent slopes	5,861	1.9
CKF	Chestnut and edneyville soils, 25 to 50 percent slopes	36,352	12.0
Cm	Chewacla loam, occasionally flooded	8,874	2.9
Co	Congaree fine sandy loam, occasionally flooded	4,492	1.5
DnB	Davidson clay loam, 2 to 8 percent slopes	227	<0.1
DnD	Davidson clay loam, 8 to 15 percent slopes	184	<0.1
DoB	Dogue fine sandy loam, 2 to 8 percent slopes	1,084	0.4
EaE	Evard fine sandy loam, 15 to 25 percent slopes	11,044	3.6
EaF	Evard fine sandy loam, 25 to 50 percent slopes	23,179	7.6
ESF	Evard and Saluda fine sandy loams, 25 to 60 percent slopes	12,921	4.3
HaD	Hayesville fine sandy loam, 8 to 15 percent slopes	1,875	0.6
HaE	Hayesville fine sandy loam, 15 to 25 percent slopes	2,203	0.7
HbD	Hibriten very cobbly sandy loam, 8 to 15 percent slopes	1,254	0.4
HbF	Hibriten very cobbly sandy loam, 15 to 60 percent slopes	8,179	2.7
MaB	Masada loam, 2 to 8 percent slopes	2,508	0.8
MaD	Masada loam, 8 to 15 percent slopes	4,015	1.3
PaE	Pacolet fine sandy loam, 15 to 25 percent slopes	34,879	11.5
PaF	Pacolet fine sandy loam, 25 to 40 percent slopes	21,879	7.2
Po	Potomac very cobbly loamy sand, frequently flooded	662	0.2
Pt	Pits, quarries	96	<0.1
RnE	Rion sandy loam, 15 to 25 percent slopes	1,406	0.5
RnF	Rion sandy loam, 25 to 40 percent slopes	5,501	1.8
Ro	Roanoke loam	201	<0.1
RSF	Rock outcrop-Ashe complex, 25 to 80 percent slopes	4,368	1.4
SeB	State loam, 2 to 8 percent slopes	1,077	0.4
TaB	Tate fine sandy loam, 2 to 8 percent slopes	260	<0.1
TaE	Tate fine sandy loam, 8 to 25 percent slopes	2,639	0.9
UaB	Urban land-Arents complex, occasionally flooded	684	0.2
UmC	Urban land-Masada complex, 2 to 15 percent slopes	682	0.2
W	Water	2,112	0.7
Wk	Wehadkee loam, frequently flooded	2,161	0.7

Appendix B. Benthic macroinvertebrate results and site characteristics in the Lower Creek watershed Samples collected September 2002.

Lower Creek at NC 90 = LC1, SR 1303 = LC2, SR 1142 = LC3, SR 1501 = LC4, Zack's Fk at SR 1531 = ZFK1, US 321A = ZF2, Spainhour Cr at Bus 18 = SPH
UT Spainhour Cr = UT SPH, Blair Fk = BFK, Greasy Cr at SR 1305 = GCR1, off Hwy 18 = GCR2, Abingdon Cr = ABCR, Husband Cr at Old NC 18 = HCR1, NC Hwy 18 = HCR2
Celia Cr = CCR, Bristol Cr = BCR, White Mill Cr = WMCR, Gunpowder Cr = GPCR, Smoky Cr = SMCR

Station	LC1	LC2	LC3	LC4	ZFK1	ZFK2	SPH	UT SPH	BFK	GCR1	GCR2	ABCR	HCR1	HCR2	CCR	BCR1	WMCR	GPCR	SMCR
Sample Type	Full	Full	Full	Full	Qual 5	Qual 5	Full	Qual 5	Qual 5	Qual 5	Qual 5	Qual 5	Qual 5	Qual 5	Qual 5	Qual 5	Qual 5	EPT	EPT
Date	9/9/2002	9/10/2002	9/10/2002	9/11/2002	9/9/2002	9/10/2002	9/9/2002	9/9/2002	9/9/2002	9/10/2002	9/10/2002	9/10/2002	9/11/2002	9/11/2002	9/11/2002	9/11/2002	9/11/2002	8/21/02	8/21/02
Ephemeroptera	5	9	5	5	8	4	12	6	3	6	6	11	11	7	7	5	5	14	12
Plecoptera	0	0	0	2	3	0	0	2	0	2	1	3	5	3	1	3	2	3	3
Trichoptera	4	4	6	7	7	2	3	5	3	5	7	6	8	4	2	5	7	6	11
Coleoptera	4	7	4	2	4	4	5	3	2	3	6	6	6	4	3	6	2	-	-
Odonata	6	5	6	8	6	5	6	7	5	5	4	4	6	4	4	7	6	-	-
Megaloptera	1	1	2	1	1	0	1	0	0	2	1	1	3	0	1	3	1	-	-
Diptera: Chironomidae	19	21	16	20	15	9	15	3	6	15	13	15	11	10	12	14	9	-	-
Misc. Diptera	3	3	1	3	5	4	5	1	2	5	3	5	3	2	3	4	3	-	-
Oligochaeta	1	4	3	2	1	2	1	3	1	2	2	4	1	0	1	2	1	-	-
Crustacea	0	1	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	-	-
Mollusca	2	2	5	3	3	1	1	1	2	1	1	1	0	1	3	5	2	-	-
Other	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	-	-
Total Taxa Richness	45	57	50	55	54	32	49	32	24	47	45	57	55	36	39	55	37	-	-
EPT Richness	9	13	11	14	19	6	15	13	5	13	14	20	24	14	10	12	14	23	26
EPT Abundance	40	28	62	82	74	21	61	28	5	66	47	67	83	81	33	63	38	111	111
Biotic Index	6.47	6.68	6.53	6.15	5.68	6.88	6.46	4.66	6.42	4.86	5.71	5.61	5.26	5.25	5.79	5.56	4.87	-	-
Bioclassification	Poor	Fair	Fair	Fair	NI*	NR*	Fair	NR*	NR*	Fair	NR*	NI*	NI*	NR*	NR*	NR*	NR*	Good-Fair	Good-Fair
Width (m)	4	5	10	9	2	2	4	1	2	4	2	2	2	3	3	1	1	9	4
Drainage area (sq. miles)	10.6	40	63.7	82.8	8	13.3	8.7	2.3	2.7	4	4.9	5.4	8.3	16.3	5.4	9.1	4.4	19	7.8
Depth (Avg)	0.2	0.2	0.4	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.2
Canopy (%)	60	50	40	10	90	20	90	90	80	50	70	50	70	75	50	80	80	80	80
Substrate (%)																			
Boulder	0	0	20	0	5	0	15	15	0	5	0	5	0	0	0	0	0	5	15
Rubble	0	0	20	0	5	0	15	20	10	20	0	15	0	0	0	0	0	5	15
Gravel	10	35	10	20	20	10	30	20	0	20	20	15	30	20	30	0	25	0	20
Sand	80	60	40	60	65	90	40	40	60	45	60	55	50	60	50	90	65	80	20
Silt	10	5	10	20	5	0	0	5	30	10	20	10	20	20	20	10	10	10	25
Channel modification	4	3	4	2	5	0	3	4	3	5	5	5	5	5	5	5	5	5	5
Instream habitat	10	11	12	11	12	8	8	10	8	12	8	12	11	12	12	10	11	12	12
Bottom substrate	3	3	6	3	5	3	3	5	3	10	3	6	3	3	3	3	3	3	5
Pool variety	0	4	4	4	4	4	4	4	4	6	4	6	6	6	4	6	6	0	4
Riffle habitats	0	0	0	0	7	0	7	7	7	14	5	7	0	0	0	0	0	3	12
Bank stability and vegetation	4	6	4	6	6	4	6	6	6	6	3	6	6	6	6	10	6	12	6
Light penetration	5	7	7	7	10	3	10	10	10	10	0	7	10	10	7	10	10	10	10
Riparian zone width	3	4	3	5	6	4	3	6	4	7	6	2	0	7	5	0	0	3	0
Total Score (0-100)	**29**	**38**	**40**	**38**	**55**	**26**	**43**	**52**	**45**	**70**	**42**	**51**	**49**	**49**	**42**	**53**	**49**	**48**	**62**
Temperature	19	19	22	21	20	16	22	23	21	19	17	21	17	16	16	24	19	21	21
DO (mg/l)	8.6	9	7.3	5.6	8.5	8.1	7.3	7.3	7.3	7.6	9	7.9	6.4	8	8.4	8	5.8	7.8	9
Conductivity	97	115	167	161	75	1000	103	76	113	51	79	69	63	61	60	57	50	158	42
pH	7.1	7.3	7.2	7.1	7.2	7.3	7.3	7.2	7.3	7.4	7.1	7.6	7.3	7.4	7.2	6.9	6.9	7.6	7.7
County	Caldwell	Caldwell	Caldwell	Burke	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Caldwell	Burke
Latitude	355528	355344	355027	354931	355600	355437	355415	355900	355621	355443	355341	355256	355138	355013	355138	354956	354947	355039	354800
Longitude	813017	813335	813659	813810	813129	813147	813333	813253	813306	813424	813407	813503	813732	813729	813907	813918	814036	812610	813619

* Qual 5 sample ratings are based on EPT richness of sample with wash excluded. NI = Not Impaired (at least Good-Fair)
NR = Not Rated (Fair or Poor classification)

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Appendix C. NC DWQ Ambient Monitoring Results for TSS and Turbidity at Station C1750000

DATE	TOTAL NONFILTRABLE RESIDUE MG/L (method 00530)	TURBIDITY, NEPHELOMETRIC TURBIDITY UNITS NTU (method 82079)
1/14/97	33	21
2/25/97	34	27
3/31/97	3	19
4/22/97	60	38
5/27/97	49	30
6/25/97	48	35
7/29/97	68	52
8/26/97	22	19
9/30/97	29	27
10/28/97	22	27
11/18/97	7	5.7
12/10/97	11	9.7
1/21/98	26	24
2/17/98	580	610
3/24/98	28	22
4/21/98	110	90
5/13/98	42	34
6/17/98	140	140
7/14/98	24	24
8/25/98	10	9.9
9/29/98	68	130
11/18/98	6	6.4
12/16/98	13	14
1/19/99	33	31
2/10/99	13	9.5
3/24/99	13	9.9
4/21/99	8	11
5/5/99	110	1400
6/16/99	50	22
7/28/99	22	21
8/11/99	22	9.9
10/20/99	210	170
12/14/99	60	390
1/19/00	6	11
2/29/00	14	9.3
3/28/00		14
4/12/00	15	16
5/17/00	15	7.9
6/28/00		38
7/26/00		20
8/15/00		9.5
9/5/00		200
10/18/00		5.2
12/6/00	3	5.4
1/10/01		13

DATE	TOTAL NONFILTRABLE RESIDUE MG/L (method 00530)	TURBIDITY, NEPHELOMETRIC TURBIDITY UNITS NTU (method 82079)
2/7/01	9	14
4/3/01	30	33
5/31/01		18
6/26/01	110	110
7/12/01	19	18
8/15/01		47
9/27/01	24	14
10/23/01	8	7.6
11/7/01		4.6
12/4/01		4.4
2/13/02		16
3/26/02	16	20
4/25/02		25
5/31/02		110
6/18/02		27
7/2/02		140
8/20/02		67
9/18/02	25	36
10/23/02		18
11/4/02		9.7
12/17/02	16	20
1/22/03		9.2
2/25/03		55
3/10/03	18	23
4/23/03		31
5/7/03		60
6/4/03	150	160
7/16/03		80
8/12/03		60
9/9/03	12	16
10/14/03		9.9
11/13/03		12
12/2/03	9	11
1/7/04		10
2/10/04		35
3/3/04	12	15

Appendix D. Data Sources

The NCDENR's Geographic Information System (GIS) was used extensively to describe the Lower Creek watershed characteristics. The following is general information regarding the data used to describe the watershed:

- **Ambient chemical monitoring locations**: NC DENR Div of Water Quality, Water Quality Section, 9/30/2000, Ambient Water Quality Monitoring Sites: NC DENR Div of Water Quality, Water Quality Section, Raleigh, North Carolina.
- **Biological monitoring locations**: NC DENR Clean Water Management Trust Fund, NC DENR - Div. of Water Quality, Biological Assessment Unit, 11/15/2000, Benthic monitoring results: NC DENR - Div. of Water Quality, Biological Assessment Unit, Raleigh, North Carolina.
- **City of Lenoir Boundary**: NC Department of Transportation-GIS Unit, 2002, Municipal Boundaries - Powell Bill 1999: NC Department of Transportation, Raleigh, North Carolina.
- **County boundaries**: information NC Center for Geographic Information & Analysis, 12/01/1998, Boundaries - County (1:100,000): NC Center for Geographic Information & Analysis, Raleigh, North Carolina.
- **Detailed stream coverage**: North Carolina Center for Geographic Information and Analysis, 4/19/2001, Hydrography (1:24,000): North Carolina Center for Geographic Information and Analysis, Raleigh, NC.
- **Hydrologic Units**: USDA, Natural Resources Conservation Service, 12/01/1998, Hydrologic Units - North Carolina River Basins: USDA, Natural Resources Conservation Service, Raleigh, North Carolina.
- **Land use/Land cover information**: Earth Satellite Corporation (EarthSat), 6/12/1998, Statewide Land Cover - 1996: EarthSat, Raleigh, North Carolina.
- **NPDES Permitted Facilities**: NC DENR Division of Water Quality, Planning Branch, 10/11/2000, National Pollutant Discharge Elimination System Sites: NC DENR Division of Water Quality, Planning Branch, Raleigh, North Carolina.
- **Roads**: NC Department of Transportation - GIS Unit, 9/21/1999, Transportation - NCDOT Roads (1:24,000): NC Department of Transportation, Raleigh, NC.
- **Stream Gaging Stations**: NC DENR-Division of Water Resources, 12/01/1998, Stream Gaging Stations: NC DENR-Division of Water Resources, Raleigh, North Carolina.
- **Streamflow gage data** was obtained online from the United States Geological Survey (USGS) at: http://nc.water.usgs.gov/.

Appendix E. Monthly average effluent TSS concentrations (mg/L) at the City of Lenoir - Lower Creek WWTP during years 1999-2003.

City of Lenoir - Lower Creek WWTP (NC0023981)

	1999	2000	2001	2002	2003
January	20.9	14.6	8.4	10.7	5.8
February	40.2	13.7	16.0	7.6	69.4
March	28.3	12.1	74.6	9.6	14.7
April	75.9	8.7	7.1	8.3	9.8
May	103.4	6.6	7.1	9.4	7.6
June	76.1	10.0	7.6	13.1	14.1
July	28.8	5.1	7.4	6.5	7.9
August	7.6	7.3	7.5	5.9	6.3
September	6.6	8.4	7.9	5.1	
October	8.4	8.2	8.0	8.5	
November	8.1	10.7	8.0	5.8	
December	13.5	9.3	8.5	6.2	

Appendix F. General Permitees located within the Lower Creek watershed.

Permit Number	Facility Name	DWQ Description
NCG020026	Vulcan Construction Materials LP - Vulcan Construction Materials - Lenoir Quarry	Mining Activities Stormwater Discharge COC
NCG030148	Neptco Inc - Neptco Incorporated	Metal Fabrication Stormwater Discharge COC
NCG050023	Meridian Automotive Systems - Meridian Automotive Systems	Apparel/Printing/Paper/Leather/Rubber Stormwater Discharge COC
NCG050229	Sealed Air Corporation - Sealed Air Corporation	Apparel/Printing/Paper/Leather/Rubber Stormwater Discharge COC
NCG080186	United Parcel Service - United Parcel Service-Lenoir	Transportation w/Vehicle Maintenance/Petroleum Bulk/Oil Water Separator Stormwater Discharge COC
NCG080260	Caldwell Freight Lines Inc - Caldwell Freight Lines Incorporated	Transportation w/Vehicle Maintenance/Petroleum Bulk/Oil Water Separator Stormwater Discharge COC
NCG120060	Republic Services Of NC LLC - Republic Services Of NC LLC - Lenoir	Landfill Stormwater Discharge COC
NCG140097	Hamby Brothers Concrete Inc - Hamby Brothers Concrete Incorporated	Ready Mix Concrete Stormwater/Wastewater Discharge COC
NCG170313	American & Efird Inc - American & Efird Incorporated-Nelson	Textile Mill Products Stormwater Discharge COC
NCG180080	Broyhill Furniture Industries Inc - Broyhill Furniture Ind-Whitnel	Furniture and Fixtures Stormwater Discharge COC
NCG180081	Broyhill Furniture Industries Inc - Broyhill Furniture Ind- Harp	Furniture and Fixtures Stormwater Discharge COC
NCG180082	Broyhill Furniture Industries Inc - Broyhill Furniture Ind-Caldwel	Furniture and Fixtures Stormwater Discharge COC
NCG180084	Broyhill Furniture Industries Inc - Broyhill Furniture Ind Incorporated	Furniture and Fixtures Stormwater Discharge COC
NCG180101	Kincaid Furniture Co - Kincaid Furniture Co-Plant #5	Furniture and Fixtures Stormwater Discharge COC
NCG180152	Bernhardt Furniture Co - Bernhardt Furniture Co-Cen Lum	Furniture and Fixtures Stormwater Discharge COC
NCG180153	Bernhardt Furniture Co - Bernhardt Furniture Co-Plt 5	Furniture and Fixtures Stormwater Discharge COC
NCG180154	Bernhardt Furniture Co - Bernhardt Furniture Co-Plt 7	Furniture and Fixtures Stormwater Discharge COC
NCG180155	Bernhardt Furniture Co - Bernhardt Furniture Co-Plt 3	Furniture and Fixtures Stormwater Discharge COC
NCG180156	Bernhardt Furniture Co - Bernhardt Furniture Co-Plt 2	Furniture and Fixtures Stormwater Discharge COC
NCG180157	Bernhardt Furniture Co - Bernhardt Furniture Co-Plt 1	Furniture and Fixtures Stormwater Discharge COC
NCG180169	Thomasville Furniture Industries, Inc. - Thomasville Furniture Ind., Inc. - Lenoir Plant	Furniture and Fixtures Stormwater Discharge COC
NCG180189	Fairfield Chair Co - Fairfield Chair Co-Plnt #2	Furniture and Fixtures Stormwater Discharge COC
NCG180190	Fairfield Chair Co - Fairfield Chair Co-Plt #1	Furniture and Fixtures Stormwater Discharge COC
NCG180230	Broyhill Furniture Industries Inc - Broyhill Plant 54 & 123	Furniture and Fixtures Stormwater Discharge COC
NCG210133	H Parsons Inc - H Parsons Incorporated	Timber Products Stormwater Discharge COC
NCG500072	Thomasville Furniture Industries, Inc. - Thomasville Furniture Co - Lenoir	Non-contact Cooling, Boiler Blowdown Wastewater Discharge COC
NCG500178	Broyhill Furniture Industries Inc - Broyhill-Miller Hill Complex	Non-contact Cooling, Boiler Blowdown Wastewater Discharge COC
NCG500179	Broyhill Furniture Industries Inc - Broyhill - Virginia Street Complex	Non-contact Cooling, Boiler Blowdown Wastewater Discharge COC
NCG550801	Blessed Hope Church - Blessed Hope Church	Single Family Domestic Wastewater Discharge COC
NCG550977	Mountain View Pediatrics - Mountain View Pediatrics	Single Family Domestic Wastewater Discharge COC
NCS000066	Neptune Inc - Neptune Inc	Stormwater Discharge, Individual

Appendix G. Methodology for developing the Load Duration Curve

The load duration curve method is based on comparison of the frequency of a given flow event with its associated water quality load. In the case of applying the NTU criteria, a correlation is necessary between NTU and TSS to allow for calculation of a load in mass per time units. Data from the Lower Creek ambient station (Station Q3735000) was used in this TMDL resulted in the below equation:

TSS concentration (mg/L) = (1.3772* Turbidity (NTU)^0.8938)
R^2 = 0.8435

A LDC can be developed using the following steps:

1. Plot the Flow Duration Curve, Flow vs. % of days flow exceeded.
2. Develop TSS-turbidity correlation.
3. Translate turbidity values to equivalent TSS values using the linear regression equation from the correlation.
4. Translate the flow-duration curve into a LDC by multiplying the water quality standard (as equivalent TSS concentration), the flow and a units conversion factor; the result of this multiplication is the maximum allowable load associated with each flow.
5. Graph the LDC, maximum allowable load vs. percent of time flow is equaled or exceeded.
6. Water quality samples, expressed as estimated TSS values, are converted to loads (sample water quality data multiplied by daily flow on the date of sample).
7. Plot the measured loads on the LDC

Appendix H. Calibrated soil layer parameters in WARMF.

Subwatershed	Soil Layer	Area (m2)	Thickness (cm)	Initial Moisture	Field Capacity	Sat. Moisture	Horizontal Cond.	Vertical Cond.	Root Distribution	Density g/cm3	Soil Tortuosity
1	1	34165000	65	0.3	0.3	0.42	10020	8.5	0.75	0.2	10
	2	34165000	27.5	0.3	0.26	0.47	1320	51	0.1	1.3	10
	3	34165000	102.499	0.3	0.32	0.548	1000	99.5	0.1	1.3	10
	4	31895000	109.999	0.3	0.28	0.44	300	300	0.05	1.5	10
2	1	33897000	65	0.3	0.3	0.42	10020	8.2	0.75	0.2	10
	2	33897000	27.5	0.3	0.26	0.47	1320	50	0.1	1.3	10
	3	33897000	102.499	0.3	0.32	0.548	1000	98	0.1	1.3	10
	4	31647000	109.999	0.3	0.28	0.44	300	300	0.05	1.5	10
3	1	11808000	65	0.3	0.3	0.42	10020	8.2	0.75	0.2	10
	2	11808000	27.5	0.3	0.26	0.47	1320	50	0.1	1.3	10
	3	11808000	102.499	0.3	0.32	0.548	1000	100	0.1	1.3	10
	4	11808000	109.999	0.3	0.28	0.44	300	300	0.05	1.5	10
4	1	22815000	65	0.3	0.3	0.42	10020	7.5	0.75	0.2	10
	2	22815000	27.5	0.3	0.26	0.47	1320	50	0.1	1.3	10
	3	22815000	102.499	0.3	0.32	0.548	1000	98	0.1	1.3	10
	4	22815000	109.999	0.3	0.28	0.44	300	300	0.05	1.5	10
5	1	12295000	65	0.3	0.3	0.42	10020	8.5	0.75	0.2	10
	2	12295000	27.5	0.3	0.26	0.47	1320	50	0.12	1.3	10
	3	12295000	102.499	0.3	0.32	0.548	1000	101	0.1	1.3	10
	4	12295000	109.999	0.3	0.28	0.44	300	300	0.03	1.5	10
6	1	843051	65	0.1	0.3	0.42	10020	10	0.75	0.2	10
	2	843051	27.5	0.2	0.26	0.47	1320	49.5	0.1	1.3	10
	3	843051	102.499	0.28	0.32	0.548	1000	100	0.1	1.3	10
	4	843051	109.999	0.23	0.28	0.44	300	300	0.05	1.5	10

Subwatershed	Soil Layer	Area (m2)	Thickness (cm)	Initial Moisture	Field Capacity	Sat. Moisture	Horizontal Cond. cm/d	Vertical Cond. **cm/d**	Root Distribution	Density g/cm3	Soil Tortuosity
7	1	15621000	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	15621000	57.5	0.31	0.2	0.41	1460	48	0.1	1.3	10
	3	15621000	207.5	0.33	0.23	0.39	1200	98	0.1	1.3	10
	4	15621000	405	0.355	0.2	0.355	525	300	0.05	1.5	10
8	1	7525800	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	7525800	57.5	0.31	0.35	0.41	1460	50.5	0.1	1.3	10
	3	7525800	207.5	0.33	0.23	0.39	1200	100	0.1	1.3	10
	4	7525800	405	0.355	0.2	0.355	525	300	0.05	1.5	10
9	1	14150000	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	14150000	57.5	0.31	0.25	0.41	1460	50	0.1	1.3	10
	3	14150000	207.5	0.33	0.23	0.39	1200	99	0.1	1.3	10
	4	14150000	405	0.355	0.2	0.355	525	300	0.05	1.5	10
10	1	10651000	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	10651000	57.5	0.31	0.25	0.41	1460	49	0.1	1.3	10
	3	10651000	207.5	0.33	0.23	0.39	1200	100	0.1	1.3	10
	4	10651000	405	0.355	0.2	0.355	525	300	0.05	1.5	10
11	1	21611000	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	21611000	57.5	0.31	0.15	0.41	1460	48	0.1	1.3	10
	3	21611000	207.5	0.33	0.23	0.39	1200	99	0.1	1.3	10
	4	21611000	405	0.355	0.2	0.355	525	300	0.05	1.5	10
12	1	15144000	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	15144000	57.5	0.31	0.2	0.41	1460	49	0.1	1.3	10
	3	15144000	207.5	0.33	0.23	0.39	1200	99	0.1	1.3	10
	4	15144000	405	0.355	0.2	0.355	525	300	0.05	1.5	10
13	1	5697900	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	5697900	57.5	0.31	0.15	0.41	1460	48	0.1	1.3	10
	3	5697900	207.5	0.33	0.23	0.39	1200	98	0.1	1.3	10
	4	5697900	405	0.355	0.2	0.355	525	300	0.05	1.5	10

Subwatershed	Soil Layer	Area (m2)	Thickness (cm)	Initial Moisture	Field Capacity	Sat. Moisture	Horizontal Cond. cm/d	Vertical Cond. **cm/d**	Root Distribution	Density g/cm3	Soil Tortuosity
14	1	9346200	62.5	0.31	0.203	0.5	10220	10	0.75	0.2	10
	2	9346200	57.5	0.31	0.101	0.41	1460	50	0.1	1.3	10
	3	9346200	207.5	0.33	0.23	0.39	1200	100	0.1	1.3	10
	4	9346200	405	0.355	0.2	0.355	525	300	0.05	1.5	10
15	1	29122000	65	0.25	0.2	0.45	10000	7.5	0.75	0.2	10
	2	29122000	50	0.3	0.2	0.35	1300	50	0.1	1.3	10
	3	29122000	200	0.35	0.2	0.45	1000	100	0.1	1.3	10
	4	29122000	400	0.35	0.12	0.35	500	300	0.05	1.5	10
16	1	4267000	65	0.25	0.2	0.45	10000	10	0.75	0.2	10
	2	4267000	50	0.3	0.2	0.35	1300	50	0.1	1.3	10
	3	4267000	200	0.35	0.2	0.45	1000	100	0.1	1.3	10
	4	4267000	400	0.35	0.12	0.35	500	300	0.05	1.5	10

Appendix I. Streambank erosion values and total TSS loading values for years 92-97 (calibration dataset), 97-03 period, and TMDL period (based on 97-03 period) for each subwatershed in the Lower Creek Basin.

streambank erosion values from WARMF output
Values are in kg/day

Subwatershed	92-97	97-03	TMDL
1	181	36	10
2	164	25	7
3	3,170	999	279
4	93	32	9
5	3.80	0.30	0.08
6	6,880	2,210	619
7	149	41	11
8	11,800	3,710	1,040
9	31,600	9,010	2,520
10	41,100	11,400	3,190
11	304	77	22
11	13	649	182
12	138	36	10
14	122,000	31,500	8,840
15	418	78	22
16	179,000	43,400	12,200
Entire watershed	**397,013**	**103,204**	**28,961**

total TSS Loading values from WARMF output
Values are in kg/day

Subwatershed	92-97	97-03	TMDL
1	676	144	40
2	573	140	39
3	3,380	1,200	336
4	399	177	50
5	80.30	17.80	4.98
6	6,890	2,220	623
7	368	209	58
8	12,000	3,860	1,080
9	32,000	9,280	2,600
10	41,600	11,600	3,260
11	707	423	119
12	338	215	60
13	2,560	713	200
14	122,000	31,600	8,860
15	741	238	67
16	179,000	43,400	12,200
Entire watershed	**403,312**	**105,437**	**29,597**

Appendix J. Nonpermitted stormwater loading was identified in subwatersheds 14 and 16 based on the excessive streambank erosion load. Current condition 97-03 scenarios were compared to scenarios within WARMF in which all urban areas were converted to mixed forest. The percent change in loading between these scenarios became the bases for choosing the percent of current streambank erosion loading that is attributable to stormwater loading. Currently, no MS4 area is contained within either of the two subwatersheds.

	Subwatershed 14 with no Urban loading (LC9703_NPS)		**Subwatershed 16 with no Urban loading (LC9703_NPS)**	
	97-03 current conditions	97-03, urban LULC changed to mixed forest	97-03 current conditions	97-03, urban LULC changed to mixed forest
Managed Flow	0	0	0	0
Groundwater Pumping	0	0	0	0
Deciduous Forest	258	446	279	470
Evergreen Forest	181	267	209	299
Mixed Forest	182	403	206	434
Pasture	276	387	294	407
Cultivated	363	576	399	616
Recr. Grasses	6.13	17.3	6.36	17.6
Water	0	0	0	0
Barren	26.3	51.6	32.1	57.9
Low Int. Develop.	377	0	399	0
High Int. Develop.	155	0	156	0
Comm / Industrial	296	0	300	0
Wetlands	0	0	0	0
General Nonpoint Sources	0	0	0	0
Stream Bank Erosion	59700	24200	103000	48600
Direct Precipitation	0	0	0	0
Direct Dry Deposition	0	0	0	0
Type 1 Septic System	0	0	0	0
Type 2 Septic System	0	0	0	0
Type 3 Septic System	0	0	0	0
Unpermitted Surface Mines	0	0	0	0
Unpermitted Deep Mines	0	0	0	0
Permitted Surface Mines	0	0	0	0
Permitted Deep Mines	0	0	0	0
General Point Sources	0	0	0	0
TOTAL	61900	26300	106000	50900
Attributable to the Stormwater		**59%**		**53%**

Appendix K. TSS loading output from the WARMF model during the 1997-2003 for the MS4 ("Hickory Urbanized Area" within the Lower Creek watershed) area identified by landuse within each subwatershed..

MS4 Allocation - Load kg/day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Managed Flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Groundwater Pumping	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deciduous Forest	0.04	0.04	0.00	0.10	0.03	0.00	1.12	19.32	14.61	4.46	0.82	0.00	0.21	0.00	0.00	0.00
Evergreen Forest	0.03	0.03	0.00	0.05	0.02	0.00	0.38	6.47	7.33	1.45	0.52	0.00	0.17	0.00	0.00	0.00
Mixed Forest	0.02	0.03	0.00	0.06	0.02	0.00	0.38	8.98	7.32	2.11	0.37	0.00	0.13	0.00	0.00	0.00
Pasture	0.70	0.19	0.00	0.53	0.13	0.00	3.27	15.64	34.86	21.28	0.97	0.00	1.20	0.00	0.00	0.00
Cultivated	1.21	0.86	0.00	2.58	0.35	0.00	12.44	37.54	66.25	18.37	4.67	0.00	1.86	0.00	0.00	0.00
Recr. Grasses	0.10	0.14	0.00	0.39	0.10	0.00	0.34	0.42	4.55	0.00	0.00	0.00	0.19	0.00	0.00	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barren	0.08	0.04	0.00	0.13	0.10	0.00	0.00	4.49	4.74	0.60	0.36	0.00	0.11	0.00	0.00	0.00
Low Int. Develop.	12.03	48.84	34.15	58.81	10.17	3.25	3.72	15.38	33.44	6.99	0.00	0.00	7.00	0.00	0.00	0.00
High Int. Develop.	3.49	42.25	27.39	44.45	4.22	4.41	1.88	4.15	4.83	0.00	0.00	0.00	0.09	0.00	0.00	0.00
Comm / Industrial	17.66	61.06	71.04	40.22	5.67	3.51	1.10	28.50	11.57	2.35	0.00	0.00	2.81	0.00	0.00	0.00
Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Nonpoint Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stream Bank Erosion	5	6	999	11	0	2210	2	3710	6287	1469	1	0	3	0	0	0
Direct Precipitation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Direct Dry Deposition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 1 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 2 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 3 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Point Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MS4 Load per watershed (kg/day)	**40**	**160**	**1,132**	**158**	**21**	**2,221**	**27**	**3,851**	**6,477**	**1,527**	**9**	**0**	**17**	**0**	**0**	**0**
Total MS4 load (kg/day)	**15,639**															

Appendix L. TMDL scenario using TSS loading output from the WARMF model during the 1997-2003 period for the MS4 ("Hickory Urbanized Area" within the Lower Creek watershed) area identified by landuse within each subwatershed..

MS4 Allocation - Load kg/day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Managed Flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Groundwater Pumping	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deciduous Forest	0.01	0.01	0.00	0.03	0.01	0.00	0.31	5.43	4.08	1.25	0.23	0.00	0.06	0.00	0.00	0.00
Evergreen Forest	0.01	0.01	0.00	0.01	0.00	0.00	0.11	1.81	2.04	0.41	0.15	0.00	0.05	0.00	0.00	0.00
Mixed Forest	0.01	0.01	0.00	0.02	0.01	0.00	0.11	2.51	2.05	0.59	0.10	0.00	0.04	0.00	0.00	0.00
Pasture	0.20	0.05	0.00	0.15	0.04	0.00	0.92	4.37	9.75	5.96	0.27	0.00	0.34	0.00	0.00	0.00
Cultivated	0.34	0.24	0.00	0.72	0.10	0.00	3.48	10.51	18.53	5.11	1.31	0.00	0.52	0.00	0.00	0.00
Recr. Grasses	0.03	0.04	0.00	0.11	0.03	0.00	0.10	0.12	1.27	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barren	0.02	0.01	0.00	0.04	0.03	0.00	0.00	1.26	1.33	0.17	0.10	0.00	0.03	0.00	0.00	0.00
Low Int. Develop.	3.37	13.69	9.56	16.45	2.85	0.91	1.04	4.32	9.38	1.96	0.00	0.00	1.96	0.00	0.00	0.00
High Int. Develop.	0.98	11.84	7.64	12.46	1.18	1.23	0.53	1.16	1.35	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Comm / Industrial	4.94	17.13	19.89	11.21	1.59	0.98	0.31	8.00	3.24	0.66	0.00	0.00	0.79	0.00	0.00	0.00
Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Nonpoint Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stream Bank Erosion	1.43	1.69	279.00	3.08	0.02	619.00	0.55	1040.00	1758.45	411.16	0.26	0.00	0.97	0.00	0.00	0.00
Direct Precipitation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Direct Dry Deposition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 1 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 2 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 3 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Point Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MS4 Load per watershed (kg/day)	**11**	**45**	**316**	**44**	**6**	**622**	**7**	**1,079**	**1,811**	**427**	**2**	**0**	**5**	**0**	**0**	**0**
Total MS4 load (kg/day)	**4,377**															

Appendix M. TSS loading output from the WARMF model during the 1997-2003 for nonpoint sources (non- MS4, "Hickory Urbanized Area" and non permitted loading within the Lower Creek watershed) area identified by landuse within each subwatershed..

NPS Allocation - Load kg/year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Managed Flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Groundwater Pumping	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deciduous Forest	0.42	0.44	0.00	0.56	0.20	0.00	41.74	0.00	6.95	46.59	68.63	27.57	3.57	19.56	21.31	0.00
Evergreen Forest	0.18	0.15	0.00	0.23	0.08	0.00	19.25	0.00	5.64	27.08	57.67	37.91	4.84	17.31	28.46	0.04
Mixed Forest	0.16	0.18	0.00	0.37	0.13	0.00	26.79	0.00	4.66	23.85	51.85	39.90	4.16	15.93	27.68	0.00
Pasture	3.89	0.54	0.00	0.35	0.63	0.00	12.12	0.00	9.30	49.05	58.00	26.08	7.79	12.70	17.67	0.00
Cultivated	4.06	1.01	0.00	2.50	0.66	0.00	36.86	0.00	10.26	48.82	58.93	32.69	16.34	20.58	31.99	0.01
Recr. Grasses	0.05	0.00	0.00	0.04	0.03	0.00	0.81	0.00	0.77	0.00	0.00	0.00	0.45	0.98	0.30	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barren	0.16	0.03	0.00	0.26	0.05	0.00	2.62	0.00	1.50	2.04	2.26	1.88	1.66	0.72	1.05	0.01
Low Int. Develop.	9.97	4.09	0.00	4.97	4.34	0.00	17.24	0.00	5.91	14.67	37.76	1.08	23.35	15.07	24.78	0.00
High Int. Develop.	0.24	0.60	0.00	0.62	3.52	0.00	3.01	0.00	0.01	1.22	1.72	0.18	0.28	0.81	0.37	0.00
Comm / Industrial	23.47	0.61	0.00	4.13	1.74	0.00	3.58	0.00	1.66	6.85	5.87	0.00	3.06	4.57	7.02	0.00
Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Nonpoint Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stream Bank Erosion	31	19	0	21	0	0	39	0	2723	9931	76	649	33	12915	78	20398
Direct Precipitation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Direct Dry Deposition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 1 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 2 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 3 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Point Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NPS Load per watershed (kg/day)	**74**	**27**	**-**	**35**	**12**	**-**	**203**	**-**	**2,769**	**10,151**	**419**	**816**	**98**	**13023**	**239**	**20398**
Total NPS load (kg/day)	**48,264**															

Appendix N. TMDL scenario using TSS loading output from the WARMF model during the 1997-2003 for nonpoint sources (non- MS4, "Hickory Urbanized Area" and non permitted loading within the Lower Creek watershed) area identified by landuse within each subwatershed..

NPS Allocation - Load kg/year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Managed Flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Groundwater Pumping	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deciduous Forest	0.12	0.12	0.00	0.16	0.05	0.00	11.68	0.00	1.94	13.06	19.17	7.72	1.00	5.47	5.96	0.00
Evergreen Forest	0.05	0.04	0.00	0.06	0.02	0.00	5.38	0.00	1.57	7.61	16.10	10.61	1.36	4.84	7.96	0.01
Mixed Forest	0.04	0.05	0.00	0.10	0.04	0.00	7.49	0.00	1.30	6.69	14.48	11.17	1.17	4.46	7.75	0.00
Pasture	1.09	0.15	0.00	0.10	0.18	0.00	3.39	0.00	2.60	13.75	16.18	7.28	2.18	3.55	4.98	0.00
Cultivated	1.14	0.28	0.00	0.70	0.18	0.00	10.31	0.00	2.87	13.59	16.48	9.15	4.57	5.77	8.97	0.00
Recr. Grasses	0.01	0.00	0.00	0.01	0.01	0.00	0.23	0.00	0.22	0.00	0.00	0.00	0.13	0.27	0.08	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barren	0.04	0.01	0.00	0.07	0.01	0.00	0.73	0.00	0.42	0.57	0.63	0.53	0.46	0.20	0.29	0.00
Low Int. Develop.	2.79	1.15	0.00	1.39	1.22	0.00	4.81	0.00	1.66	4.11	10.57	0.30	6.55	4.23	6.95	0.00
High Int. Develop.	0.07	0.17	0.00	0.17	0.98	0.00	0.84	0.00	0.00	0.34	0.48	0.05	0.08	0.23	0.10	0.00
Comm / Industrial	6.56	0.17	0.00	1.15	0.49	0.00	1.00	0.00	0.47	1.92	1.64	0.00	0.86	1.28	1.96	0.00
Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Nonpoint Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stream Bank Erosion	8.67	5.40	0.00	5.78	0.07	0.00	10.85	0.00	761.55	2778.84	21.34	182.00	9.23	3624	22.00	5734
Direct Precipitation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Direct Dry Deposition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 1 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 2 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Type 3 Septic System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unpermitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Surface Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permitted Deep Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Point Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NPS Load per watershed (kg/day)	**21**	**8**	**-**	**10**	**3**	**-**	**57**	**-**	**775**	**2,840**	**117**	**229**	**28**	**3655**	**67**	**5734**
Total NPS load (kg/day)	**13,542**															

Appendix O. Public Notification of Public Review Draft of Lower Creek Turbidity TMDL .

Lower Creek, Catawba River Basin

Now Available Upon Request

Lower Creek Turbidity Total Maximum Daily Load

Is now available upon request from the North Carolina Division of Water Quality. This TMDL study was prepared as a requirement of the Federal Water Pollution Control Act, Section 303(d). The study identifies the sources of pollution, determines allowable loads to the surface waters, and suggests allocations for turbidity

TO OBTAIN A FREE COPY OF THE TMDL REPORT:

Please contact Ms. Robin Markham (919) 733-5083, extension 558 or write to:

Ms. Robin Markham
Water Quality Planning Branch
NC Division of Water Quality
1617 Mail Service Center
Raleigh, NC 27699-1617

Interested parties are invited to comment on the draft TMDL study by March 4, 2005. Comments concerning the reports should be directed to Narayan Rajbhandari at the above address. The draft TMDL is also located on the following website: *http://h2o.enr.state.nc.us/tmdl/*

PUBLIC NOTICE
STATE OF NORTH CAROLINA
DIVISION OF WATER QUALITY

Availability of the Total Maximum Daily Load (TMDL) for Turbidity for Lower Creek in North Carolina.

You are requested to review the TMDL and mail your comments to NCDWQ-Planning Branch, attn: Ms. Robin Markham, 1617 Mail Service Center, Raleigh, NC 27699-1617. Copies of the TMDL may be obtained by calling Ms. Robin Markham at (919) 733-5083, ext. 558 or on the internet at http://h2o.enr.state.nc.us/tmdl/. Written comments regarding the TMDL will be accepted until March 11, 2005.

February 10

NORTH CAROLINA,
CALDWELL COUNTY,
AFFIDAVIT OF PUBLICATION

Before the undersigned, a Notary Public of said County and State, duly commissioned, qualified, and authorized by law to administer oaths, personally appeared

Brenda W. Penley

who being first duly sworn, deposes and says: that he is Interim Ad Director of The Lenoir News-Topic, engaged in the publication of a newspaper known as Lenoir News-Topic, published, issued, and entered as second class mail in the City of Lenoir, in said County and State; that he is authorized to make this affidavit and sworn statement; that the notice or other legal advertisement, a true copy of which is attached hereto, was published in Lenoir News-Topic on the following dates:

Feb. 10

and that the said newspaper in which such notice, paper, document, or legal advertisement was published was, at the time of each and every publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statutes of North Carolina.

This 10th day of February 2005 [redacted]

Sworn to and subscribed before me, this 10th day of February 2005 [redacted]

Notary Public

My Commission expires: