Chestatee-Chattahoochee Resource Conservation and Development Council

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Mud and Little Mud Creeks: Watershed Management Plan

August 2007

Prepared In Association With:

Natural Resources Conservation Service
Georgia Forestry Commission
Georgia Environmental Protection Division
Georgia Soil and Water Conservation Commission
Upper Chattahoochee River Soil & Water Conservation Dist.
Hall County Soil & Water Conservation District
Habersham County
Hall County

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Contents

List of Tables

List of Figures

Appendices

Executive Summary

Mud Creek and Little Mud Creek drain almost 40 mi^2 of mixed-use land to the Chattahoochee River upstream of Lake Lanier, primarily in Habersham and Hall Counties. Both streams are listed as impaired for fecal coliform bacteria on Georgia's 2006 303(d) list, and Mud Creek is also listed as biologically impaired. A farm field survey and source assessment indicate that agriculture sources—including cattle application of poultry litter—are the primary sources of pathogens to Mud and Little Mud Creeks. Both agricultural and urban/development-related sources contribute sediment–a candidate stressor of biological communities—and other potential pollutants.

In 2006, the Georgia Environmental Protection Division (EPD) awarded the Chestatee-Chattahoochee Resource Conservation and Development (RC&D) Council an Agriculture Best Management Practice (BMP) Demonstration 319 grant to begin planning and implementing BMPs in the Mud and Little Mud Creek watersheds. The development of the *Mud and Little Mud Creeks Watershed Management Plan* represents the first step in the BMP targeting process and is intended to facilitate cooperation between landowners and the Chestatee-Chattahoochee RC&D, the local NRCS offices, and the Counties in identifying and resolving nonpoint source pollution problems. This plan is a cooperative effort of the RC&D Council, Natural Resources Conservation Service (NRCS), Georgia Forestry Commission, and other conservation agencies.

The *Mud and Little Mud Creeks Watershed Management Plan* identifies specific management measures to reduce pathogen and sediment loads to the streams over the course of 319 grant (2007-2009). The 319 grant monies will be used to support 60-percent cost share for the conservation practices. These "Phase 1" BMPs are currently projected to include:

- 19,000 linear feet of exclusion fencing
- 10,000 linear feet of riparian buffer
- 5 alternative water sources
- 4 heavy use area protection projects
- 5 stream crossings
- 800 acres of prescribed grazing
- 1 streambank stabilization project
- 2 animal waste management facilities

- 5 nutrient management plans
- 1 access road
- 2 low impact development practices

Actual measures to be implemented will depend upon specific project opportunities and landowner participation. The measures listed above are projected to achieve an approximate 30-percent reduction in pathogen loads to the streams. The project partners will utilize an adaptive watershed management method, whereby additional or alternative management measures will be determined after measurement of the success of the Phase 1 projects. Key measures of success will include number of BMPs implemented, number of landowners participating, and the actual water quality/biological response of the streams.

The *Mud and Little Mud Creeks Watershed Management Plan* includes a strong informational/education component, with the primary of educating watershed residents on water quality and nonpoint source pollution issues, and recruiting landowner participation in projects. Information/education elements will include public meetings, demonstration tours, an educational brochure, and a project web site to which progress updates will be periodically posted.

1. Introduction

Mud Creek and its tributary, Little Mud Creek, are located in Habersham and Hall Counties in northeastern Georgia. These streams drain almost 40 mi^2 of mixed-use land to the upper Chattahoochee River, including portions of the Towns of Cornelia and Baldwin. In addition to their designated beneficial use of fishing, Mud and Little Mud Creeks and their riparian corridor provide important wildlife/aquatic life habitat, and serve to assimilate treated effluent from growing communities in the upper watershed. Although the streams are not currently used as a public water supply, they are upstream of Lake Lanier, the primary drinking water supply for the City of Atlanta and much of northern Georgia.

Both Mud and Little Mud Creek are on Georgia's 2006 303(d) list of impaired waters due to elevated concentrations of fecal coliform bacteria, and Mud Creek is also listed as impaired for biota due to poor benthic macroinvertebrate indices. Increased sediment loads, altered hydrology, riparian disturbance, and urban contaminants are potential contributors to the biological impairment. Implementation of a strong watershed management plan is necessary to restore the water quality and biota of Mud and Little Mud Creeks, and also protect downstream uses such as the Lake Lanier public water supply.

The *Mud and Little Mud Creeks Watershed Management Plan* is intended to support watershed-partnering efforts. It seeks to facilitate cooperation between landowners and the Chestatee-Chattahoochee RC&D, the local NRCS offices, and the Counties in identifying and resolving nonpoint source pollution problems. This plan is a critical component of federal, state, and local watershed protection efforts. It addresses effective and efficient mechanisms to obtain the greatest watershed benefits from the available funding sources.

In 2006, the Georgia Environmental Protection Division (EPD) awarded the Chestatee-Chattahoochee Resource Conservation and Development (RC&D) Council an Agriculture Best Management Practice (BMP) Demonstration 319 grant to begin planning and implementing BMPs in the Mud and Little Mud Creek watersheds. The three-year project will run between 2007 and 2009. The development of the *Mud and Little Mud Creek Watershed Management Plan* represents the first step in the BMP targeting process, and is a required element of the 319 grant project. The plan has been prepared to address all nine elements required by USEPA for 319 projects:

1. Identification of pollutant sources.

2. Estimate of pollutant reductions needed or expected.
3. Identification of the management measures to be implemented.
4. Estimate of funding needs and sources.
5. Information/education component.
6. Schedule for implementation
7. Interim, measurable milestones for determine whether management practices are being implemented.
8. Criteria to determine progress and measures of success.
9. A monitoring component to evaluate effectiveness.

The *Mud and Little Mud Creeks Watershed Management Plan* is intended to serve as long-term plan for restoration of the streams to full beneficial uses. As such, the scope of the plan extends beyond the current 319 grant. However, as with most watershed management efforts, there is considerable uncertainty with regard to the current sources of pollutants, response of the stream to management measures, and availability of future funding. For this reason, the plan outlines an *adaptive management* implementation approach to restoring the creeks, whereby the planning recommendations are periodically updated to reflect new information and the actual response of the streams. The 319 grant and associated matching funds represent the first phase of implementation, which are emphasized in this document. All management practices described in the plan will be implemented on a cooperative, non-regulatory basis.

1.1. Watershed Management Planning Partners

The Chestatee-Chattahoochee RC&D Council is the lead agency on the 319 grant and took the lead role in developing this watershed management plan. However, both the plan development and implementation are cooperative efforts of several partner agencies listed in Table 1-1. In addition to approval by the partner agencies, the *Mud and Little Mud Creek Watershed Management Plan* has been subjected to review and comment by a team of watershed stakeholders. Section 5 (Implementation Program) provides additional information on the information/education component of the plan.

1.2. Watershed Management Plan Organization

Section 2 (Watershed Description) of this document characterizes the Mud and Little Mud Creek watersheds, including a summary of existing land use/cover, water quality, and stream condition. This section provides the results of two field investigations performed to support the planning process:

Table 1-1.
Watershed Management Planning Partner Agencies

Partner Name	Representative(s)
Chestatee-Chattahoochee RC&D Council	Joseph Riley, Nianne Mullis
Natural Resources Conservation Service	Russell Biggers, Harold Thompson, Buddy Belflower
Georgia Forestry Commission	Dennis Martin
Georgia Environmental Protection Division	TBD
Georgia Soil and Water Conservation Commission	TBD
Upper Chattahoochee River Soil & Water Conservation District	Morris Frady
Hall County Soil & Water Conservation District	Larry Nix
Habersham County	TBD
Hall County	TBD

- A *stream condition survey* performed in February 2007 to evaluate the physical condition of the streams according to the Stream Visual Assessment Protocol (SVAP).
- A *farm field survey* performed in April 2007 to evaluate current agricultural land uses, using the Farm Service Agency's (FSA) Common Land Unit (CLU) database as the basis for tracking.

Section 3 (Coliform Loading and Source Assessment) describes current and "attainment" loads of the specific constituent for which Mud and Little Creeks are currently 303(d) listed, using the loading curve approach that has been previously used by Georgia EPD to develop total maximum daily loads (TMDLs) for fecal coliform. Total required coliform reductions are quantified for Mud and Little Mud Creeks. This section also presents the results of a mass-balance method for estimating the current sources of fecal coliform bacteria to the streams.

Section 4 (Management Measures) provides an overview of the types and numbers of nonpoint source management practices that are estimated to be necessary to fully meet water quality standards, and also describes the management practices that will be pursued under the existing 319 grant. Section 5 (Estimation of Pollutant Reductions) describes the pathogen and sediment reductions expected from those practices. Section 6 (Implementation Program) addresses other USEPA-required elements of the watershed management plan, including information/education, funding sources, implementation schedule, interim milestones, and monitoring components.

2. Watershed Description

The project watershed is located in northeastern Georgia in the Upper Chattahoochee River basin (Figure 2-1). The Mud Creek basin (38.6 mi^2) is composed of two sub-basins, Mud Creek (19.6 mi^2) and Little Mud Creek (19.0 mi^2). Approximately 85 percent of the combined Mud-Little Mud Creek watershed area is within Habersham County (32.7 mi^2), with the lower 15 percent (5.8 mi^2) in Hall County. Banks County contains less than 0.1 percent of the total watershed area. Little Mud Creek empties into Mud Creek approximately 1.4 miles upstream of the confluence of Mud Creek with the Chattahoochee River.

2.1. Physical and Natural Features

The project watershed lies in the foothills of the Blue Ridge Mountains in the Piedmont Physiographic Province. The Mud Creek basin is moderately dissected and characterized by gently sloping topography. Elevations range from about +1,050 feet above mean sea level (amsl) near the Chattahoochee River confluence to over +1,680 feet amsl in the northeast corner of the watershed near the Town of Cornelia. Much of the Mud and Little Mud Creeks watershed has a trellis drainage pattern, whereby tributaries of the same order flow parallel to each others and enter the downgradient stream at approximate right angles. A northeast-southeast-trending topographic feature serves to separate Little Mud Creek from the main Mud Creek channel in the center of the watershed.

The climate of the project watershed is humid and of moderate temperature. Summers are warm with average daily temperatures in the 80s. Winters are mild with occasional cold snaps; temperatures rarely stay below freezing for extended periods. Annual precipitation is usually between 50 and 60 inches per year. Precipitation is moderate throughout the year, but slightly higher in the winter and early spring.

2.2. Land Use and Land Cover

Land use/cover information in the Mud Creek basin was obtained from the 2001 National Land Cover Data Set (NLCD) (Table 2-1; Figure 2-2). The dominant land cover within he both basins is forest, comprising 43-54 percent of the total land area. Pasture/hay fields and grassland/herbaceous lands are the next most abundant land cover with approximately 28-31 percent of the area. Developed areas of varying intensity make up approximately 8-11 percent of the land area, not including an additional 8-13 percent "developed open" area that includes lawns, athletic fields, and parkland.

Table 2-1.
Mud and Little Mud Creek Basin Land Use/Cover

Land Use/Cover	Mud Creek		Little Mud Creek	
	Acres	Percent	Acres	Percent
Open water	6	0.1%	17	0.1%
Developed, open space	1,564	12.9%	994	7.9%
Developed, low intensity	941	7.7%	623	5.0%
Developed, medium intensity	291	2.4%	199	1.6%
Developed, high intensity	95	0.8%	150	1.2%
Barren land	78	0.6%	74	0.6%
Forested, deciduous	4,409	36.2%	5,678	45.3%
Forested, evergreen	726	6.0%	950	7.6%
Forested, mixed	104	0.9%	145	1.2%
Scrub/shrub	106	0.9%	135	1.1%
Grassland/herbaceous	927	7.6%	841	6.7%
Pasture/hay	2,847	23.4%	2,689	21.4%
Wetlands, woody	73	0.6%	52	0.4%
TOTAL	12,167	100.0%	12,546	100.0%

Source: 2001 National Land Cover Data Set

A majority of the developed areas, particularly the medium and high intensity areas, lie in the uppermost and easternmost portion of the basin in the Towns of Cornelia and Baldwin, and along the Highway 365 and 441 corridors. The lower portions of the watershed to the southwest near the mouth are almost entirely forested, with a few areas of pasture/hay and several residences. A majority of the areas of pasture/hay and grassland/herbaceous are located in the central and northern portions of the basin.

2.3. Farm Field Survey

A farm field survey was performed in April 2007 to provide insight into current agricultural land uses and management practices in the Mud and Little Mud Creek watersheds. The results of the farm survey are documented in a geographic information system (GIS) datalayer, and so will serve as a valuable BMP targeting and tracking tool for the watershed management planning partners. Results of the farm survey also aided the estimation of current pollutant sources and recommended management measures, as described in following sections. The farm survey was conducted as follows:

The FSA's Common Land Use (CLU) GIS datalayer for Habersham County was obtained from the USDA. CLU datasets delineate farm field boundaries and reference individual fields by tract, farm, and CLU numbers. To protect individual privacy, individual landowner information was not supplied with the CLU data. The CLU dataset was combined in a GIS with 2005 Digital Ortho Quarter Quadrangle (DOQQ) electronic aerial photographs and other datalayers including roads and hydrography. CLU data for

Hall County were not available from the USDA; therefore, farm field boundaries in the Hall County portion of the watershed were delineated manually from the DOQQs.

The GIS datasets were used in conjunction with Global Positioning System (GPS) technology to provide real-time display of the GPS location on the GIS project database. The exact location, movements, and direction of movement were displayed on a laptop screen and were used to navigate to accessible farm fields within the Mud Creek basin. Information including land use, number of livestock/poultry houses, surface water presence, and existing management practices, was recorded for approximately 220 farm fields during the field survey conducted on April 2-4, 2007. Visual observations were incorporated as additional attributes in the GIS datalayer. Uses and locations of CLU and non-CLU farm fields surveyed during the field effort are shown in Figure 2-3.

2.4. Water Quality

Information on the water quality of Mud and Little Mud Creeks was primarily derived from monitoring performed in 2002-03 by the Environmental Protection Division (EPD) of the Georgia Department of Natural Resources at the following stations (Figure 2-1):

- Station #12030031: Mud Creek at Crane Mill Road near Alto, Georgia
- Station #12030041: Little Mud Creek at Coon Creek Road near Alto, Georgia

Table 2-2 summarizes the 2002-03 monitoring results. In general, both Mud Creek and Little Mud Creek have acceptable ammonia, dissolved oxygen, salinity (inferred from specific conductance), and pH to support aquatic life. Phosphorus and nitrate-plus-nitrate concentrations were significantly higher at the Mud Creek station than the Little Mud Creek station and indicative of agricultural influences on water quality. Turbidity and fixed solids concentrations were similar in both creeks, and the relatively high maximum values of these parameters were indicative of significant land or streambed erosion under wet weather conditions.

The primary water quality constituent of concern in Mud and Little Mud Creeks is fecal coliform bacteria. Both stream segments are designated for fishing uses, and the water quality criteria for fecal coliform are as follows:

- <u>May-October</u>: Geometric mean of at least 4 samples collected within a thirty-day period not to exceed 200 per 100 mL.
- <u>November-April</u>: Geometric mean of at least 4 samples collected within a thirty-day period not to exceed 1,000 per 100 mL.

Table 2-2.
Summary of George EPD Monitoring Results, 2002-2003

Constituent	Units	n	Station12030031 Mud Creek			Station 12030041 Little Mud Creek		
			Min	Mean	Max	Min	Mean	Max
Alkalinity, Carbonate as CaCO3	mg/L	22	11	22	46	8	14	33
Biochemical Oxygen Demand	mg/L	24	3.0	3.0	3.0	3.1	3.1	3.1
Carbon, Total Organic	mg/L	24	1.1	2.6	8.5	1.1	2.3	7.2
Escherichia coli	MPN	32	80	866	11,000	41	484	3,300
Fecal Coliform	MPN	33	70	1,359	17,000	20	836	7,900
Hardness, Ca + Mg	mg/L	24	18	49	120	12	20	40
Nitrogen, Ammonia as NH3	mg/L	24	0.03	0.07	0.16	0.03	0.10	0.38
Nitrogen, Nitrite + Nitrate as N	mg/L	24	0.69	5.13	14.0	0.26	0.79	1.10
Oxygen, Dissolved	mg/L	39	7.8	9.8	13.7	7.8	9.9	13.7
pH	s.u.	23	6.9	7.2	7.7	6.7	7.0	7.5
Phosphorus as P	mg/L	24	0.08	0.21	0.70	0.02	0.07	0.34
Solids, Fixed	mg/L	24	1	17	220	1	14	110
Specific Conductance	umho/cm	24	53	172	440	45	54	88
Turbidity	NTU	24	2.9	17.9	220	2.5	16.2	190

Mud and Little Mud Creeks were not shown to exceed the colder season criterion, but consistently exceeded the warmer season criterion (Table 2-3). For this reason, both stream segments are listed on Georgia's 2006 303(d) list as impaired by fecal coliform bacteria. As with nutrient concentrations, fecal coliform concentrations were usually higher in Mud Creek than in Little Mud Creek.

Table 2-3.
2002-2003 Fecal Coliform Geometric Means (count/100 mL)
[shading indicates exceedance of seasonal criterion]

Season	4-Sample Monitoring Period	12030031 Mud Creek at Crane Mill Rd	12030041 Little Mud Creek at Coon Creek Rd
May-October (geometric mean not to exceed 200 per 100 mL)	May 2002	806	356
	Aug 2002	1,057	172
	May-Jun 2003	315	376
	Aug-Sep 2003	1,215	473
November-April (geometric mean not to exceed 1,000 per 100 mL)	Feb 2002	339	190
	Nov 2002	887	489
	Feb-Mar 2003	219	79
	Nov 2003	486	353

Mud Creek is also listed as "biota impacted" on the 2006 303(d) list due to benthic macroinvertebrate metrics. A stressor identification study has not yet been performed to determine the cause of the lower biological metrics. Common causes of lower benthic macroinvertebrate scores include excessive sediment/siltation, high flow/scour effects, lack of suitable habitat or habitat degradation, and excessive nutrients/algae growth. As shown in Table 2-2, the Georgia EPD monitoring data does provide evidence of occasional elevated turbidity and suspended solids concentrations. This was also evident in the stream assessment work outlined in section 2.5. A number of sites contained extensive aggradation in the form of mid- and side-channel bars. Significant signs of bank degradation were also observed throughout the watershed. Potential causes of these conditions include the sand and gravel nature of the local geology, lack of riparian buffers sizes, livestock in the channel, and excess flow effects from impervious surfaces in the upper watershed.

2.5. Stream Condition

A physical stream conditions survey for Mud and Little Mud Creeks was conducted February 12-15, 2007. The purpose of the survey was to collect a broad set of data on a variety of physical stream condition parameters from accessible yet representative locations in Mud Creek, Little Mud Creek, and their tributaries. These data will be used to provide the following information:

- Baseline physical stream conditions
- Evolutionary status of existing channels
- Susceptibility to for future degradation
- Potential restorative actions available in the watershed

To supplement this field collection effort the following supplemental data were reviewed:

- Soils data from the U.S. Department of Agriculture (USDA)
- Geology data from the Georgia State Geological Survey
- Climate data from the National Weather Service (NWS)
- Land use history from available sources
- 100,000 and 24,000-scale topographic data from the U.S. Geological Survey (USGS)
- Normal Color aerial imagery from Habersham County and USGS
- Land ownership data from Habersham County
- Other Data obtained from the Chestatee-Chattahoochee Resource Conservation & Development Council

The USDA's Stream Visual Assessment Protocol or SVAP (USDA, 1999) was used as guidance to perform these assessments. The assessment was performed at 20 locations in the watershed (Figure 2-4). The SVAP involves the scoring up to 15 stream and riparian zone variables (Table 2-4). Only those variables that are applicable to the stream being assessed are utilized (scored), and each is scored from 1 to 10. Scoring is based on stream and riparian zone observations relative to the descriptions of conditions in the protocol and observed conditions from nearby reference streams. The sum of the variables scored divided by the number of variables utilized in the assessment provides an overall score that is then compared to a four level quality condition index. Overall scores less than 6.0 are considered "poor" quality streams; scores between 6.1 and 7.4 are "fair;" 7.5 to 8.9 are "good;" and overall scores greater than 9.0 are considered excellent quality streams. In addition to collecting data specified on the forms, photographs were recorded as well. These raw data and two photographs from each of the 20 stations are contained in Appendix A. The findings of this SVAP are summarized in Table 2-5.

Table 2-4.
Stream Visual Assessment Protocol Variables

Assessment Variable	Description	Indicators
Channel condition	Lateral and vertical channel stability	Evidence of channelization; head cutting, down-cutting; diversions; etc.
Hydrologic alteration	"Normal" flood regime; Stream with unimpeded access to its floodplain	No channel incision, dams, or water withdrawals
Riparian zone	Characteristic vegetative zone adjacent to stream channel	Width, structure, and species composition of natural vegetation
Bank stability	Potential for stream bank erosion to contribute to stream sediment load	Actively eroding banks with a lack of vegetative protection
Water appearance	Turbidity, color, and other visual water quality characteristics	Depth of visibility; cloudiness; color, etc.
Nutrient enrichment	High levels of nutrients (esp. nitrogen and phosphorus)	Water color; excess rooted aquatic macrophytes, algae, etc.
Barriers to fish movement	Structures or withdrawals that impede aquatic fauna mobility	Drop structures, culverts, dams, or water diversions
Instream fish cover	Availability of physical habitat cover in the stream channel	Scored by number of cover types: large woody debris, deep pools, overhanging vegetation, riffles, etc.
Pools	Depth and abundance of pools	Mixture of shallow and deep pools (definitions provided)
Invertebrate habitat	Stable benthic macroinvertebrate habitat	Number of habitat types: fine woody debris, leaf packs, undercut banks, coarse substrate, etc.
Canopy cover*	Varied canopy coverage desired based on "coldwater" vs. "warmwater" fishery stream	Amount of canopy coverage overhanging the stream (e.g. shading)
Manure presence*	Livestock operations or straight-pipe sewage discharges	Presence of manure or well worn livestock paths
Salinity*	Especially problematic in arid regions, highly irrigated regions, or oil and gas well operations	Burning or leaching of aquatic vegetation, stunted growth; whitish salt encrustments on stream banks
Riffle embeddedness*	Degree to which gravel or cobble are surrounded by finer sediment	Depth of embeddedness
Macroinverte-brates observed*	Presence of pollution intolerant insect species	Percent dominance of taxa per pollution tolerance group as defined in SVAP

Source: Somerville et al. 2004
*Optional Variable

Table 2-5.
SVAP Summary Scores

				SVAP Rating	
Site Number	Date	Stream Name	Reach Location	Descriptive	Numeric
1	2/12/2007	Mud Creek, North Fork	North Side of Old Cleveland Rd.	Fair	6.0
2	2/12/2007	Mud Creek, South Fork	320 Hodges St. NW at Chatahoochee Prof. Door & Carwash, Cornelia proper	Poor	4.0
3	2/12/2007	Little Mud Creek	Duncan Ridge Rd.	Good	7.3
4	2/12/2007	Little Mud Creek	North Side of Alto-Mud Creek Rd.	Fair	7.0
5	2/12/2006	Mud Creek	Crane Mill Rd.	Good	7.6
6	2/12/2007	Little Mud Creek	Old Athens Road	Fair	7.3
7	2/14/2007	Mud Creek, North Fork	At end of Elberta Street, Cornelia proper	Good	7.5
8	2/14/2007	Mud Creek, South Fork	South Fork of Mud Creek and Old Athens	Fair	7.1
9	2/14/2007	Little Mud Creek	200 ft upstream of Mud Creek confluence	Excellent	9.2
10	2/14/2007	Mud Creek	Start 100 ft upstream of confluence with Little Mud	Good	7.5
11	2/14/2007	Little Mud Creek	Upstream 0.5 mi from Mud Creek Rd.	Excellent	9.0
12	2/14/2007	Little Mud Creek	Crane Mill Rd.	Good	8.9
13	2/15/2007	Tributary to Mud Creek	1,000 ft up tributary from Mud Creek	Fair	7.2
14	2/15/2007	Mud Creek	Off field 100 feet US from confluence with Site 13	Good	7.5
15	2/15/2007	Mud Creek	John Loudermilk Rd.	Good	7.6
16	2/15/2007	Tributary to Mud Creek	0.4 mi from Mud Creek on John Loudermilk Road	Good	7.8
17	2/15/2007	Tributary to Little Mud Creek	Behind H. Wade's home	Good	7.8
18	2/15/2007	Tributary to Little Mud Creek	Off of Smokey Rd - No Access	Fair	6.2
19	2/15/2007	Tributary for Little Mud Creek	Off BC Grant on Alto Line	Fair	7.2
20	2/15/2007	Tributary for Mud Creek	River right and North Side of Old Cleveland Rd.	Fair	7.2

As shown in Table 2-5, most of the sites ranked in the "fair" to "good" range with one site, (#002) scoring a "poor" ranking. As illustrated by the photos in Appendix A, this was a highly impacted tributary to Mud Creek located in Cornelia that has been channelized and suffers from typical urban stormwater impacts (*i.e.*, flashy, high volume discharges). Two reaches were scored as "excellent". Both of these were located in the lower reaches of Little Mud Creek: Site #011 was a bedrock-controlled steep reach that contained relatively minimally impacted riparian buffers and very stable banks. Abundant in-channel habitat was present. Site #009 was located just above the confluence with Mud Creek. This reach has bedrock outcrops but was more sinuous. A history of incision was apparent, over a very long time frame, but banks were stable and habitat was abundant here as well.

The four most frequently low-scoring variables observed during the site work were channel condition, hydrologic alteration, riparian zone condition, and bank stability. These are the characteristics of a riparian system most likely to be impacted from agricultural activities or urbanization. Little in the way of re-channelization was observed; however, incision was evident throughout the watershed. In the steeper headwater systems this expressed itself as large failing banks (for example, see photos for Site #007, Appendix A). The flatter parts of the system experience lower failing banks and the resultant addition of solids to the channel. At most locations, it appeared that the streams had the hydraulic competency to move this solids load through the system or that the system was adjusting by incision and/or the deposition of sediment bars. An example of an incised and over-widened system can be seen in the photos for site #014 (Appendix A).

Although urban development in the upper watershed probably contributes to the stream channel conditions, incision was also noted in forested (*i.e.*, relatively unimpacted) tributaries to Mud Creek west of Site #009. These conditions are typical of watersheds that have been logged in the past and still exhibit hydraulic modifications resulting from a denuded landscape. The riparian zones adjacent to many of the streams observed were typical for areas with agricultural histories. Either no vegetated buffer was present or if one were there were only several species present and it was not as wide as the channel itself.

Many of the culverts had 1- to 4- foot deep drops on the downstream side. It was not clear of these were installed with such drops or if these drops were the result of channel degradation over time, thus, developing a head-cut. It is more likely that the drops are the result of headcuts developed over time and new culverts were installed without addressing these elevation changes.Several housing construction projects were observed. There was no sign of erosion and sedimentation control being practiced at these sites (*e.g.*, silt fence or sediment basins).

3. Pollutant Loading and Source Assessment

This pollutant loading and source assessment focuses on fecal coliform bacteria, the specific parameter for which Mud and Little Mud Creeks are 303(d)-listed. This section describes the current loading of fecal coliform bacteria to the streams, reductions needed to meet water quality standards, and probable sources of the pathogens.

Other pollutants could also contribute to the biotic impairment of Mud Creek. Results of the stream condition survey revealed that sediment, in particular, is an important candidate stressor for the biotic impairment, as are high flow effects. Sediment is derived from both land-based and in-stream sources. Georgia does not have numeric criteria for sediment, and it is beyond the scope of this analysis to quantify sediment mobilization and transport within the streams. However, management measures were selected to reduce both pathogens and sediment, and both pathogen and sediment load reductions associated with the recommended management measures were estimated as described in section 4.5 (Estimation of Pollutant Load Reductions).

3.1. Coliform Loading Assessment

The *loading curve approach* was used to estimate the required coliform reductions for Mud and Little Mud Creeks, following a procedure that the Georgia EPD has used to developed coliform TMDLs in the Chattahoochee River Basin and elsewhere (Georgia EPD, 2003). This procedure involves the estimation of:

- The observed coliform load as a function of streamflow.
- The coliform load that would result in attainment of water quality criteria, as a function of streamflow.
- The percent reduction in the observed coliform load necessary to attain water quality standards.

3.1.1. Streamflow Estimation

Application of the loading curve approach requires estimation of streamflow for the stations of interest. Streamflow data were not available for either Mud or Little Mud Creeks; therefore, daily streamflow values were estimated by a drainage area ratio approach, using streamflow data from USGS station 02331600 (Chattahoochee River near Cornelia, GA). This station is located only about 1.5 miles to the west of the project watershed, and provides continuous daily streamflow record for over 60 years (1957-present). The drainage area of this station (315 mi^2) is substantially higher than the drainage areas of stations 12030031 (17.6 mi^2) and 12030041 (19.0 mi^2). However, station 02331600 was deemed to be the best station for estimating streamflow in Mud and Little Mud Creeks due to the proximity, similar physiography, and long available record. Daily streamflow values for the two EPD monitoring stations were estimated by multiply the daily streamflow value at USGS station 02331600 by the ratio of the drainage of the EPD station to that of the USGS gage.

3.1.2. Observed Coliform Load

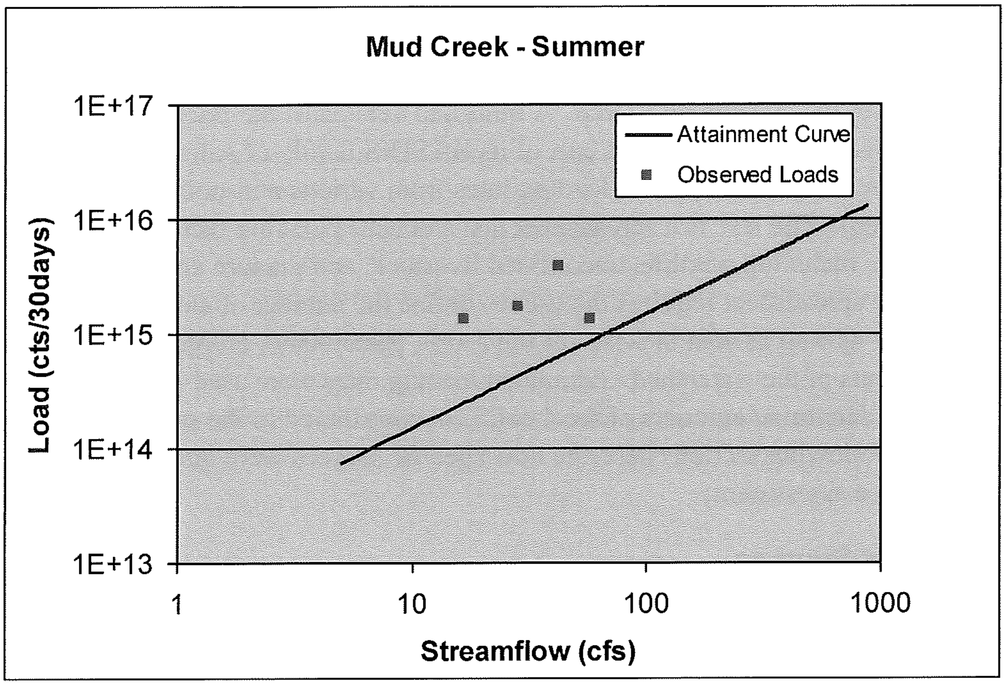
Because both Mud and Little Mud Creeks only showed non-attainment with coliform critiera in the warm season (May—Oct), the loading curve was developed using only water quality data collected during this season. The arithmetic mean 30-day streamflow was estimated each warm season 30-day period during which Ga EPD collected four coliform samples in 2002-2003. These streamflow values were multiplied by the respective geometric mean coliform values to estimate the observed coliform loads (Table 3-1; Figure 3-1).

3.1.3. Attainment Load and Required Reductions

The coliform loads that would attain water quality criteria were estimated by multiplying the summer geometric mean criteria (200 cts/100 mL) by each observed daily streamflow value. These loads were then plotted against the streamflow values, resulting in an "attainment curve" for each monitoring station (Figure 3-1). The required coliform load reductions were estimated as the difference between the attainment curve load and the observed coliform load that was highest above the attainment curve for each station (Table 3-1). The required coliform load reductions estimated by this method were 84 percent for Mud Creek and 54 percent for Little Mud Creek.

Table 3-1.
Results of Loading Curve Analysis
[shading indicates controlling reduction requirement]

Station	Date	Arithmetic Mean Streamflow (cfs)	30-Day Geometric Mean Coliform (ct/100 mL)	Current Load (ct/30 days)	Attainment Load (ct/30 days)	Reduction Required (Percent)
12030031: Mud Creek	May 2002	29	806	1.72E+15	4.26E+14	75
	Aug 2002	17	1057	1.32E+15	2.49E+14	81
	May-Jun 2003	58	315	1.34E+15	7.86E+14	41
	Aug-Sep 2003	43	1215	3.83E+15	6.31E+14	84
12030031: Little Mud Creek	May 2002	31	356	8.10E+14	4.55E+14	44
	Aug 2002	18	172	2.27E+14	2.64E+14	-16
	May-Jun 2003	63	376	1.74E+15	9.25E+14	47
	Aug-Sep 2003	46	472	1.59E+15	7.29E+14	54



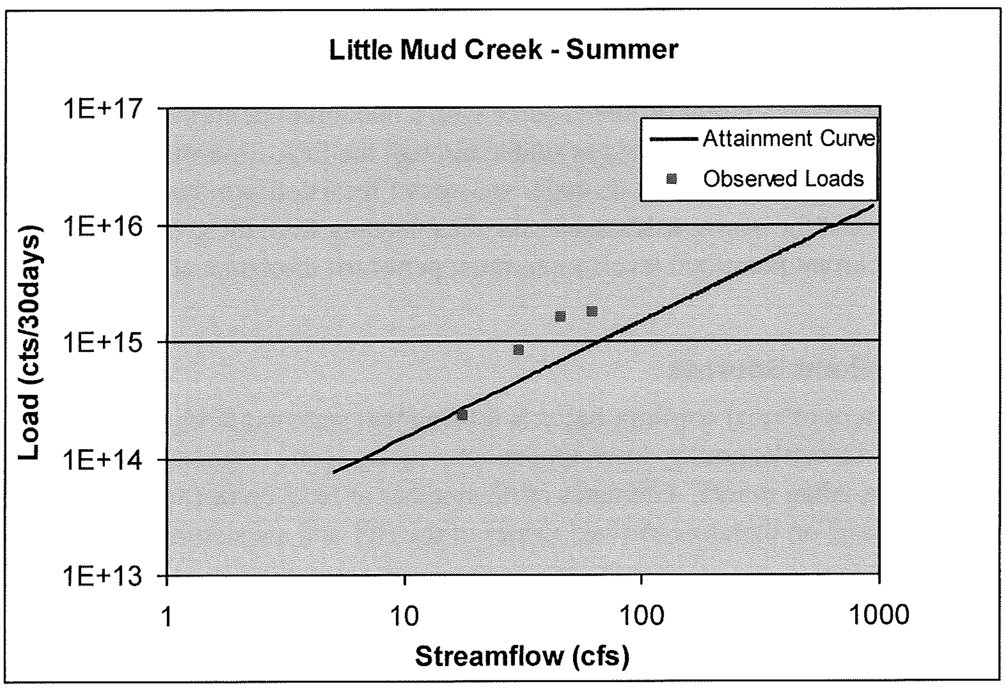


Figure 3-1: Observed coliform loading and attainment curves for Mud and Little Mud Creeks.

3.2. Coliform Source Assessment

The source assessment phase of this study involved the estimation of fecal coliform bacteria loads to the streams by source. A modified version of the Bacterial Indicator Tool (BIT) developed by USEPA as part of its BASINS family of software was used to quantify the fecal coliform bacteria loading rates from various non-point sources (USEPA, 2000a). The BIT is a spreadsheet that calculates loading factors for various animal sources including wildlife, unconfined livestock, and manure application as fertilizer. The spreadsheet requires the user to define the number of animals present in the watershed, as well as area in acres for the forest, pastureland, cropland and built-up land components of the watershed. Estimated loading rates were used in a mass balance calculation to determine amounts of fecal coliform contributed to the stream by various sources. The following sections describe how specific sources were quantified for the coliform source assessment:

3.2.1. Point Sources

There are two permitted wastewater discharge facilities in the project watershed (Cornelia Water Pollution Control Plant (WPCP) – GA0021504; Baldwin WPCP – GA0033243). Both facilities discharge treated wastewater effluent into South Fork of Little Mud Creek. Cornelia WPCP is classified as a major source of effluent with a maximum permitted discharge limit of 3 million gallons per day (MGD). Baldwin WPCP is classified as a minor effluent source with a maximum permitted discharge limit of 0.3 MGD. Based on effluent data available through the EPA Envirofacts database, these facilities are not expected to be major sources of fecal coliform bacteria. However, for the purposes of the source assessment, the fecal loading from these facilities were set equal to their current permitted levels (maximum permitted discharge at 200 cfu/100 mL).

3.2.2. Non-Point Sources

Non-point sources of fecal coliform bacteria loading that were explicitly considered included wildlife, cattle, poultry litter application, failing septic systems/straight pipe discharges, and urban runoff. Estimates of the number of fecal coliform loading rates by source were based on literature-derived values of the BIT and are summarized in Table 3-4.

3.2.2.1. Wildlife

A value of 20 deer per square mile was assumed for the entire project watershed, based on estimates provided for Habersham County by the Georgia Wildlife Resources Division (Kevin Lowrey, GA WRD, personal communication, 2007). A value of 31 raccoons per square mile was assumed for this same area. The number of feral hogs was estimated by the GA WRD as 10 per square mile of riparian forest. Although the actual feral hog density might be much lower, the upper end of the range was used to implicitly account for other wildlife such as birds, rodents, etc. Beaver abundance was estimated at 0.24 colonies per linear mile of stream with colonies represented by 6 individuals. GA WRD also estimated the presence of approximately 300 resident geese in Habersham County. Based on the proportion of land within the combined Mud-Little Mud Creek basin, a value of approximately 1 goose per square mile was used for goose loading calculations. In-stream contributions from wildlife sources were estimated by assuming that a fraction of the accumulated load on land is deposited directly to surface water.

Table 3-2.
Fecal Coliform Unit Loading Rates

Source	Fecal Coliform Loading Rate	Units	Reference Cited in BIT User's Manual (USEPA, 2000)
Deer	5.0×10^8	counts/animal/day	Best prof. judgment
Raccoon	1.2×10^8	counts/animal/day	Best prof. judgment
Feral Hog	1.1×10^{10}	counts/animal/day	Best prof. judgment
Beaver	2.5×10^8	counts/animal/day	Best prof. judgment
Geese	4.9×10^{10}	counts/animal/day	Best prof. judgment
Cattle	1.0×10^{11}	counts/animal/day	ASAE, 1998
Horse	4.2×10^8	counts/animal/day	ASAE, 1998
Goat	1.2×10^{10}	counts/animal/day	ASAE, 1998
Poultry litter	1.3×10^6	counts/gram litter	LIRPB,1978
Septage	1.0×10^4	counts/100 mL	Horsley & Witten, 1996
Developed Land	8.6×10^6	counts/acre/day	Horner, 1992

3.2.2.2. Cattle and Other Livestock

Cattle, horse, and goat densities on pastureland within the Mud and Little Mud Creek basins were estimated by dividing the total number of these livestock in Habersham County (according to the 2006 UGA Cooperative Extension Farm Gate Value Reporting System) by the proportional area of pastureland within the watersheds. This resulted in estimates of 1360 cattle, 112 horses, and 375 goats in the Mud Creek sub-basin and 1440 cattle, 112 horses, and 375 goats in the Little Mud Creek sub-basin. There were no dairy or feedlot operations observed in the project watershed, therefore, cattle were assumed to be evenly distributed on pastureland.

There are locations within the basin where cattle, horses, and goats can directly access surface waters; however, the percentage of time livestock spend in streams is not precisely known. As a result, best professional judgment was employed, and it was assumed that 10 percent of the total livestock coliform load was directly deposited in the streams with little to no attenuation.

3.2.2.3. Poultry Litter Application

The magnitude of poultry litter application was estimated largely based upon the local knowledge and professional judgment of the Habersham County Extension Coordinator, Steven Patrick. Poultry litter was assumed to be applied to both cropland (hay) and pastureland at a rate of 2 tons/acre. In any given year, the amount of litter applied can vary depending on litter availability. Litter application timing is also variable and depends on the litter availability and crop/grass being grown.

3.2.2.4. Septic Systems

A majority of the population residing within the Mud Creek basin are served by septic systems. The total number of septic systems within the project basin was estimated to be 1,650. The assumed number of people served by septic systems (approximately 4,208) was calculated based on a typical number of people served per septic system (approximately 2.55 people/septic). The total number of septic systems was derived by counting the number of single family dwellings in a random one square mile block of the watershed using 2005 aerial photography, and extrapolating to the total area of the basin (excluding areas within Baldwin and Cornelia City Limits).

The failure rate of septic systems was assumed to be approximately 5 percent, consistent with other coliform TMDL studies performed in the southeast. Implicitly included with failing septic systems are "straight pipe" discharges of wastewater directly to the stream. Default values of the BIT that were used for this project include 2.55 persons served per septic system, a volume of 70 gallons wastewater generated per person per day, and a fecal coliform count of 10,000 counts/100 mL in wastewater reaching the stream (Horsley and Witten, 1996).

3.2.2.5. Urban/Suburban Runoff

Runoff from developed land contributes fecal coliform loads mostly from domestic animals, and to a lesser extent, wildlife. Instead of explicitly calculating the number of domestic animals (e.g. cats, dogs, etc.) in the watershed, the BIT uses literature-based rates of fecal coliform accumulation on different types of built-up land. For the Mud Creek project area, an average value of 8.62×10^6 counts/acre/day was used based on the work of Horner (1992).

3.2.3. Empirical Coliform Attenutation Factors

As expected, the sum of estimated coliform loads from all sources was higher than the observed loads in the streams as determined from water quality monitoring data. This expected results is due to the fact that much of the coliform bacteria applied to the land surface does not reach the stream either because they are not washed off or they die off before reaching the stream. To reconcile the estimated coliform loads with observed loads, estimated land-based coliform loads were attenuated by empirical factors representing the die-off of coliform. The final attenuation factors the Mud Creek sub-basin were 65% for all land based loads (wildlife, livestock, and manure application). The final attenuation factors for the Little Mud Creek sub-basin were 87.5% for wildlife and livestock loads and 85.5% for manure application.

3.2.4. Summary of Source Assessment

Tables 3-2 and 3-3 summarize the results of the coliform source assessment. For both Mud and Little Mud Creek, livestock was determined to be the single largest source of fecal coliform bacteria, following by poultry little application and wildlife. Other sources were determined to be relatively insignificant. For both creeks, land-based cattle deposition was estimated to be higher in magnitude than direct deposition. This is in contrast to similar TMDL exercises conducted elsewhere, where direct deposition has been shown to dominate coliform loads due to the lack of attenuation. Regardless, the results of the source assessment demonstrate that both land-based and direct deposition are important sources of coliform and should be addressed by management measures.

Table 3-3.
Estimated Pathogen Loads by Source - Mud Creek Basin

Source	Mud Creek Sub-Basin Load (count per 30 days)	% of Mud Creek Sub-Basin Load
Point Source	0.00E+00	<0.1%
Septic	8.53E+10	<0.1%
Wildlife – Land	2.98E+13	1.5%
Wildlife – Stream	2.42E+13	1.2%
Livestock – Land	1.36E+15	66.4%
Livestock – Stream	4.33E+14	21.1%
Litter Application	2.01E+14	9.8%
Urban	5.29E+11	<0.1%

Table 3-4.
Estimated Pathogen Loads by Source - Little Mud Creek Basin

Source	Little Mud Creek Sub-Basin Load (count per 30 days)	% of Little Mud Creek Sub-Basin Load
Point Source	7.50E+11	0.1%
Septic	8.19E+10	<0.1%
Wildlife – Land	1.02E+13	0.9%
Wildlife – Stream	2.33E+13	2.1%
Livestock – Land	5.14E+14	47.0%
Livestock – Stream	4.57E+14	41.8%
Litter Application	8.82E+13	8.1%
Urban	7.70E+11	0.1%

The accuracy and precision of estimated loading rates are reduced by many sources of uncertainty and environmental variability. However, both local knowledge and a large body of previous studies and tools provide a basis for assessing the potential order-of-magnitude of various bacterial sources. Uncertainty in the source assessment is addressed by means of an adaptive watershed management strategy, as described in section 5 (Implementation Program).

3.3. Other Pollutants

Fecal coliform is the only water quality parameter for which the reaches are specifically 303(d)-listed, and therefore was the focus of the quantitative source assessment. However, other pollutants and alterations potentially contribute to the benthic macroinvertebrate impairments of Mud Creek. As described in section 2.5 (Stream Condition), Mud Creek and its tributaries showed evidence of degradation with respect to channel condition, hydrologic alteration, riparian zone condition, and bank stability. Urbanization and the associated increase in impervious surface causes increased peak flows to the stream, which in turn causes the channel to incise and/or overwiden, and greatly increases sediment loads to the stream. Sedimentation and altered hydrology are common stressors to benthic macroinvertebrate communities.

Like much of northern Georgia, the Mud and Little Mud Creek watersheds are experiencing high rates of urban/suburban development. Most of the current impervious surface is in the upper part of the watershed near Cornelia and Baldwin, or associated with major highway routes. Most new development converts forest or pasture to low to medium density development. Although fecal coliform loads are likely to decrease when pasture is developed, runoff and the loads of other contaminants (*e.g.*, metals, petroleum hydrocarbons) can actually increase.

Erosion associated with construction sites can also be a major source of sediment to the stream. Georgia law requires the installation of erosion and sedimentation (E&S) control practices for construction sites. However, in practice, these controls are often not properly installed or maintained, and local jurisdictions often lack the resources or programs to enforce the standards. Construction sites with inadequate E&S controls were observed during the stream survey, as described in section 2.5.

4. Management Measures

This section provides an overview of the high-priority practices for reducing pathogen and sediment loads to Mud and Little Mud Creeks. Results of the farm field survey and other local information are used to generally describe the extent to which conservation practices are current implemented. Recommended management measures are addressed at two levels: (1) measures currently planned to be implemented as part of the 319 grant-related activities, called Phase 1 implementation; and (2) longer-term management measures, representing the best available estimate of what would be required to fully attain fecal coliform criteria in the streams. The actual management measures to be implemented are subject to modification based upon landowner participation, specific opportunities, and future availability of funding.

4.1. Description of High-Priority Practices

Descriptions of BMPs that may be useful for pathogen and sediment load reduction in the project watershed are provided below. Descriptions and reduction efficiencies of specific BMPs were obtained from the Georgia Soil and Water Conservation Commission's (GA SWCC) 2007, *Best Management Practices for Georgia Agriculture* and Virginia Department of Environmental Quality's (VA DEQ) *Guidance Manual for Total Maximum Daily Load Implementation Plans* (2003).

4.1.1. Structural Controls

Exclusion Fencing: Exclusion fencing can provide reduction of direct inputs of livestock wastes to surface waters, reduction of sediment inputs, healing/prevention of unstable stream banks, and protection of aquatic habitats. In conjunction with alternative water sources, exclusion fencing can provide the most significant reduction of fecal loading in the Mud Creek basin by keeping livestock from directly depositing fecal matter into surface waters. Exclusion fencing has been shown to reduce suspended solids by 50-90 percent. Exclusion of livestock out of small, second-order streams has been shown to reduce pathogens by up to 99 percent.

Alternative Watering Systems: Systems such as shallow wells and tanks can serve as alternative water sources to areas of environmental sensitivity or concern to reduce the amount of direct fecal contribution to surface waters that occurs during livestock watering. Alternative watering systems are often used in conjunction with exclusion fencing.

Stream Crossings: Stream crossings can protect water quality by reducing nutrient, pathogen, and sediment inputs to surface waters. Crossings can also reduce stream bank erosion by being placed in areas with low erosion potential. Hardened stream crossings such as bridges or culverts can result in a 99-percent decrease in direct pathogen inputs particularly when combined with exclusion fencing and installation of alternative water sources.

Heavy Use Area Protection: Protection of heavy use areas can serve to protect water quality by reducing sediment, nutrient and pathogen runoff. Common heavy use areas include watering troughs, feeding areas, and livestock concentration areas. Heavy use area protection has been shown to provide erosion reduction by up to 80%.

Access Roads: If designed properly, access roads can be very useful for sediment reduction in heavily traveled areas. Access roads can reduce sediment runoff from affected areas by up to 70 percent.

Composting Facilities: Composting facilities can provide for use of animal litter (poultry) to increase the amount of ground cover and improve soil structure and water-holding capacity to reduce erosion and sediment runoff. Composting facilities also provide for an alternative use of litter as part of a nutrient management plan, and are a viable alternative to pit disposal which can lead to groundwater contamination.

Animal Waste Storage: Stackhouses prevent exposure of poultry litter to precipitation and runoff until it can be used or transported. Fecal coliform concentrations can be reduced by up to 96 percent in litter that stored for two weeks (Georgia SWCC, 2007).

Streambank Stabilization: Streambank stabilization provides multiple benefits including erosion and land loss reduction, water flow and storage capacity maintenance, nutrient input reduction, and aquatic habitat enhancement. This practice may be performed in areas that have been damaged by livestock and/or stream flow and that are susceptible to bank erosion. Streambank stabilization has been shown to significantly reduce the amount of sediment entering surface waters.

Septic Repair: Repair of failing septic systems in the watershed would provide benefits through decreasing the pathogen load in surface waters. Failing septic system repair is especially beneficial in areas in the immediate vicinity of surface waters and/or drainage features.

Urban Stormwater Controls or Low Impact Development Practices: Hydrologic and water quality impacts from development and urbanization can be ameliorated by a variety of engineering controls or low impact development (LID) practices. Common stormwater controls include detention/retention basins, water quality swales, outlet protection, and constructed wetlands. LID practices are integrated into development site plans at an early stage, and include bioretention filters (*i.e.*, rain gardens), porous pavement, cistern collection systems, narrower streets, and general reductions in impervious surface.

4.1.2. Non-Structural Controls

Riparian Buffers: Riparian buffers protect water quality by slowing nutrient, pathogen and sediment runoff from agricultural lands. Buffers may be either herbaceous or forested; both buffer vegetation types provide water quality protection, groundwater recharge, and wildlife habitat; however, forested buffers generally provide greater quality wildlife habitat in addition to surface water shading and aquatic habitat. Both grassed and forested buffers have been shown to reduce sediment runoff by 50-75 percent.

Prescribed Grazing: Prescribed or rotational grazing promotes thick, well-anchored vegetation, slows nutrient and pathogen runoff, and allows time for nutrient absorption and pathogen reduction. This practice is conducted through intensive management of livestock grazing and prevents pasture problems associated with overgrazing. Prescribed grazing has been shown to reduce sediment runoff from pastures by up to 75 percent.

Nutrient Management Plans: Comprehensive nutrient management reduces nutrient and pathogen loading to surface waters and improves and maintains soil condition. Nutrient management plans are required for all animal feeding operations receiving permits through GA EPD cost-share programs or funding from federal sources.

4.2. Existing Management Measures

Due to the large number of farms and field, it is not possible at this time to quantify or fully describe the condition of all existing conservation practices. However, the general extent to which common practices are or are not utilized was determined from the farm field survey (described in section 2.3) and local knowledge of the project partners, including the RC&D Council, NRCS, and Habersham County Cooperative Extension.

Agricultural practices within the basin include cattle, horse/donkey, and goat pasture, poultry rearing operations, row cropping, and hay farming. Livestock pastures were the most commonly observed agricultural operation in the basin. Of the livestock observed, cattle were present in the greatest numbers and ranged from 5 to 100 head per operation. Of the 222 properties evaluated, presence or evidence of cattle was observed on 70 properties. Horse/donkey pasture was relatively common and ranged from 1 to 5 head per operation. Several small goat farms were also observed. Tracts containing livestock were commonly located adjacent to surface waters. A majority of these farms did not appear to have any BMPs in place to prevent direct introduction of livestock related pathogens into accessible surface waters. However, several farms did appear to have exclusion fencing in place. These areas of exclusion fencing appeared to be in various states of repair. Due to lack of access to interior portions of many properties, it is unknown how water is delivered to livestock occupying farms that are not adjacent to surface waters. What appeared to be abandoned well heads were observed on several livestock farms.

Poultry rearing operations were also very common in the basin. Of the 35 poultry operations identified, 25 were currently operating while 10 had been abandoned. In general, the poultry operations in the basin appeared to be very clean with no poultry litter waste piles evident. Stack houses for storage of wastes as fertilizer were observed at several operations. Other BMPs were not visually evident. Waste piles were observed at several abandoned operations.

Hay fields and abandoned pastures were also relatively common in the basin. Abandoned pastures that were adjacent to surface waters generally had well-developed stream buffers. Stream buffers in hay fields that were adjacent to surface waters varied in presence and width.

Row cropping was relatively uncommon in the Mud Creek basin. Areas of row cropping observed were generally less than 1 acre and would be classified as gardens. Several larger areas of row cropping were observed adjacent to surface waters. Narrow grassed/wooded buffers were present at these tracts.

4.3. Recommended Management Measures – Phase 1

The Mud and Little Mud Creek 319 project provides an important opportunity to target high-priority BMPs and initiate the adaptive management of these watersheds. The 319-related activities are considered "Phase 1" of the implementation process, to be followed by additional management measures pending the monitoring of the stream response, availability of funding, and landowner participation, as discussed further in section 5 (Implementation Program). The extent of the Phase 1 implementation is determined by federal monies available under the 319 grant, which total $220,000. Assuming the typical 60-percent cost-share, the total available funding for Phase 1 implementation is estimated to be approximately $367,000. BMPs costs were derived from the Georgia NRCS Environmental Quality Incentives Program (EQIP) master cost list for 2007, adjusted based on knowledge of regional NRCS staff on the typical costs of specific practices.

The proposed breakdown of Phase 1 BMPs by type is listed in Table 4-1. A higher proportion of the BMPs are targeted for the Mud Creek watershed than Little Mud Creek, because Mud Creek requires greater coliform reductions and also experiences biotic impairments. The Phase 1 management measures have been selected based on both cost-effectiveness for reducing pathogens/sediment and historical landowner interest. The actual number and type of BMPs to be implemented on the 319 grant will be partially dependent on site-specific opportunities, landowner participation, and actual BMP costs.

The 319 grant monies will be targeted toward cost-effective practices such as exclusion fencing, alternative water sources, stream crossings, and heavy use area protection. To the maximum extent practical, additional practices (including nutrient management plans) and related incentive payments will be funded by programs such as the Environmental Quality Incentive Program (EQIP) and Conservation Reserve Program (CRP). It is not currently planned that 319 monies would be spent on septic system repairs. However, the Phase 1 goals include the repair of 15 septic systems, to be funded by homeowners or other sources. It is assumed that EQIP monies will provide cost-share for nutrient management planning.

The Phase 1 management measures include the installation of at least two LID practices associated with new development, to be partially funded with 319 monies. These practices could include bioretention filters or other innovative stormwater BMPs. Depending on the type and cost of practices selected, it might be possible to fund additional LID practices. The project partners hope that the LID practices will provide an opportunity to educate stakeholders and public about LID practices and urban stormwater controls, and advocate longer-term planning related to development impacts on water quality and stream condition.

Table 4-1.
Phase 1 Management Measures

BMP Type	Unit	Number of Units Proposed	
		Mud Creek	Little Mud Creek
Exclusion Fencing	Linear Feet	11,000	8,000
Alternative Water Source	Count	3	2
Stream Crossing	Count	3	2
Riparian Buffer (minimum 35' width)	Linear Feet	6,000	4,000
Heavy Use Area Protection	Count	2	2
Prescribed Grazing	Acres	500	300
Nutrient Management Plans	Count	3	2
Streambank Stabilization	Count	1	0
Septic Repair	Count	10	5
Combined Composters-Stackhouses	Count	1	1
Access Roads	Count	1	0
Low Impact Development Practices	Count	1	1

4.4. Potential Long-Term Management Measures

As with many pathogen-impaired streams across the country, loading calculations revealed that very high fecal coliform reductions (54-84 percent) would be required to meet water quality standards. According to simple load reduction estimation method employed (see section 4.5), this level of reduction could require exclusion fencing of almost all the farm fields in the watersheds (>50,000 linear feet), extensive riparian buffers (~25,000 linear feet), and agricultural BMPs at close to 100 percent of farm operations in the watershed. The level of implementation described in Table 4-2 is beyond the existing programmatic and funding resources. Moreoever, there is significant uncertainty in the actual source loadings, and monitoring after implementation of the Phase 1 BMPs might cause significant adjustments in the estimates of required management measures. For these reasons, rather than explicitly quantify the long-term BMPs that might be implemented, the project partners have elected to plan for longer-term implementation using an adaptive management approach as described in section 5 (Implementation Program).

A long-term management measure should include repair of all failing septic systems in the watershed, currently estimated to number about 80. Although these systems are not thought to be a major cause of pathogen impairments and are not a high priority for 319 grant monies, all septic systems should be in proper working order to protect both the environment and human health.

The physical stream assessment noted conditions in the watershed that have led to stream bank degradation. The detrimental effects of failing banks includes reduced water quality, reduced fisheries and invertebrate habitat, loss of private land and potential impacts to highways and other infrastructure. Long-term management measures should include the consideration of a watershed wide bank stability assessment to identify and prioritize reaches requiring stabilization. An example of one of these areas might be sites #002 and #007 (Figure 2-4) where public safety could be at risk if these channels continue to erode.

4.5. Estimation of Pollutant Reductions

Table 4-2 summarizes the pathogen reduction efficiencies of the selected management measures, as determined from the Georgia SWCC (2007) and VA DEQ (2003). These values were used to estimate pathogen and sediment reductions associated with the selected management measures, as described below.

4.5.1. Pathogen Reductions

The number of livestock farms in each sub-basin, as documented in the farm field survey, was used in combination with the source assessment to calculate an average fecal colifom load per farm. The GIS-based farm field database was used to identify the number of farms bordering streams and those not bordering streams. Pathogen reductions associated with the Phase 1BMPs outlined in Table 4-1 were then estimated by a two-step process:

1. *Estimation of reductions in direct deposition*: The reduction in direct loads from farms bordering streams was estimated from the extent of Phase 1 BMPs that reduce

or eliminate direct deposition, including exclusion fencing, alternative water sources, and stream crossing. This load reduction was added to the estimated pathogen loads to the land surface.

2. *Estimation of reduction in loads from land-surface runoff*: The reduction in runoff-derived loads was estimated from the extent of Phase 1 BMPs that reduce or eliminate pathogen in runoff, including heavy use area protection, animal waste management facilities, composters, prescribed grazing, nutrient management, and riparian buffers. As shown in Table 2-1, farms that utilize one or more of these practices can reduce land-based pathogen loads by 25-50 percent from fields or 50-100 percent from smaller areas.

Table 4-2.
BMP Pathogen and Sediment Reduction Efficiencies

BMP	Pathogen Reduction	Sediment Reduction	Source
Exclusion Fencing	100%	50 – 90%	GA SWCC
Alternative Watering Systems (Alone)	50 – 80%	50 – 80%	VA DEQ / Estimate – Similar to Exclusion Fencing
Stream Crossings (Hardened)	100%	100%	VA DEQ / Estimate – Similar to Exclusion Fencing
Heavy Use Area Protection*	50%	80%	VA DEQ / GA SWCC
Access Roads	na	70%	GA SWCC
Composting Facilities	99%	99%	VA DEQ / GA SWCC
Stackhouses	96%	na	GA SWCC
Streambank Stabilization	na	75%	VA DEQ
Septic Repair (All Failures)	100%	na	na
Riparian Buffers	50%	50 – 75%	VA DEQ / GA SWCC
Prescribed Grazing	25%	75%	BPJ / GA SWCC
Nutrient Management Plans	25%	na	BPJ

na – not applicable
BPF – Best Professional Judgment

By this method, it was estimated that Phase 1 implementation would decrease pathogen loads by 26-32 percent (Table 4-3). To attain water quality standards, it is currently estimated that loads would have to be reduced by 54-84 percent.

4.5.2. Sediment Reductions

Sediment reductions are more difficult to quantify than pathogen reductions for several reasons. Much of the sediment load in streams is typically derived from in-stream sources such as bank erosion and bed scour, particularly in urbanizing watersheds. No simple models exist to predict how individual bank stabilization or livestock exclusion would affect that total sediment load to the stream.

Table 4-3.
Estimated Phase I Pathogen Reductions

BMP Suite	Pathogen Reductions (cts/100 mL/30 days)	
	Mud Creek	Little Mud Creek
Direct Stream Deposition Reductions (livestock)	1.52E+14 (35%)	1.60E+14 (35%)
Land-Based Deposition Reductions (livestock/poultry)	3.83E+14 (40%)	1.84E+14 (40%)
Septic Repair	0	0
TOTAL	5.35E+14	3.44E+14
% Reduction	26%	32%

With these caveats, some generalizations can be made about potential sediment reductions associated with Phase 1 and longer-term implementation. Disturbance of bottom sediments by in-stream livestock can be expected to be the single-largest source of suspended sediment in the streams under dry-weather, base flow conditions. Complete exclusion of livestock from Mud and Little Mud Creeks and associated BMPs (stream crossings, alternative watering systems) could potentially reduce low-flow TSS concentrations by more than 90 percent (Table 4-2). The Phase 1 implementation includes exclusion fencing for about 38 percent of the stream length bordering pasture. Therefore, it can be estimated that Phase 1 implementation could decrease dry-weather TSS concentrations/loads by more than 35 percent of current levels. Cattle exclusion will also cause significant reductions in wet-weather loads due to more stable stream banks and bottoms.

BMPs such as heavy use area protection and access road can achieve 70-80 percent reductions in sediment load from relatively small problematic areas. Prescribed grazing and widespread used of riparian buffers provide benefits over larger areas, and can reduce sediment loads in runoff from pastures by 50-75 percent. The Phase 1 goal of 10,500 linear of riparian buffer represents approximately 40 percent of the total available buffer length. Combined with other land-based BMPs, they can be estimated to reduce sediment loads from pasture by 20-30 percent.

5. Implementation Program

The *Mud and Little Mud Creeks Watershed Management Plan* is intended to facilitate cooperation between landowners and the Chestatee-Chattahoochee RC&D and the local NRCS offices in identifying and resolving nonpoint source pollution problems. The plan will be implemented using an adaptive management approach. Phase 1 of the implementation will take place during 2007-2010, and will emphasize both 319-grant activities (2007-2009) and subsequent monitoring/evaluation of success. The watershed management plan will be open to revision in 2010 to reflect knowledge gained from the Phase 1 implementation. Potential revisions include adjustments to the type, number, and location of long-term management measures, or enhancements to information/education components of the program. The following subsections describe major implementation components: education/outreach, interim milestones/schedule, funding needs/sources, and criteria for measuring success.

5.1. Information and Education Components

The Chesatee-Chattahoochee RC&D Council will lead the implementation of the Mud and Little Mud Creeks Watershed Management Plan, in close association with NRCS staff. However, the key to successful implementation will be participation by local landowners. Therefore, the program includes strong outreach/education components to identify and enlist local landowners in cost-sharing projects, and also to encourage independent implementation of management practices.

5.1.1. Public and Organizational Meetings

The first major education/education component will be an open public meeting held in the watershed in September 2007. The meeting will be advertised in the local newspaper, and specific groups and landowners will also be contacted to inform them of the meeting. The primary purposes of the public meeting will be to:

1. Increase public awareness about the value and long-term environmental and economic advantages for protecting and improving water quality in the Mud Creek and Little Mud Creek watersheds.
2. Provide an overview of the *Mud and Little Mud Creeks Watershed Management Plan.*
3. Increase public awareness of how specific BMPs improve and protect water quality.

4. Educate the public/landowners on the availability of cost-share BMP monies under the 319 grant and other programs, and how to apply for such funding.
5. Elicit public feedback on the *Mud and Little Mud Creeks Watershed Management Plan*, including comments on the opportunities for and interest in specific management measures.

The project partners will also contact specific stakeholder organizations within the watershed (*e.g.*, Cattlemen's Association, Young Farmers) to present similar information and identify opportunities for BMPs implementation. The initial goal is to hold at least at least two such organization meetings by April 2008.

5.1.2. Informational Brochure and Website

By September 2007, the project partners will create a color brochure on the Mud and Little Mud Creeks 319 projects, providing a summary of the water quality issues, watershed management plan components, 319 grant funding availability, and contact information. Brochures will be distributed at public/organizational meetings and also provided to conservation agencies (NRCS, Farm Service Agency, Georgia Cooperative Extension, county agencies) for display and distribution to clients. Similar information will be posted to a dedicated page on the Chestatee-Chatthoochee RC&D Council website (http://www.chestchattrcd.org/). The web page will be the primary means for making information on project progress available to project partners and the public.

5.1.3. Demonstration Project Tours

Over the course of the project, the project partners will lead demonstration tours of BMPs implemented using 319 grant monies. The tours will be open to all interested individuals, and also will be advertised to particular organizations or landowners. The purpose of the tours will be to provide hand-on education of how specific BMPs are designed, constructed, and maintained. The demonstrations will also provide project partners with another opportunity to educate stakeholders on water quality issues, cost-share funding availability, and BMP opportunities. The project goal is to hold at least two demonstration tours by May 2009.

5.2. Interim Milestones and Schedule

The interim milestones and schedule for Phase 1 the *Mud and Little Mud Creeks Watershed Management Plan* are summarized in Table 6-1. It is acknowledged that some activities and practices may change or be revised as the plan is implemented, as new or additional data and information is obtained, or funding becomes available. The schedule for longer-term implementation of management practices will be determined after Phase 1 implementation, in accordance with adaptive management principles.

Table 5-1.
Interim Milestones and Schedule - Phase 1

Milestone Category	Interim Milestone	Completion Date
Information/Education	Draft watershed management plan	July 2007
	Finalize watershed management plan	September 2007
	Public Kick-Off Meeting	September 2007
	Brochure and Website	September 2007
	Targeted Organizational Meetings (2)	April 2008
	Demonstration Tour 1	September 2008
	Demonstration Tour 2	May 2009
	Website Updates on Project Progress & Success	As needed; not less frequently than semi-annually
BMP Identification & Implementation	Identify BMP locations and enroll landowners	Continuous; Phase 1 complete by mid-2009
	Phase 1 BMP Implementation – 30% Complete	December 2008
	Phase 1 BMP Implementation – 100% Complete	December 2009
	Long-Term Implementation	Long term
Measuring Progress and Success	Quantifying participation in public meetings and demo tours.	As meetings and tours are held.
	Tracking number and type of BMPs implemented; number of landowners participating.	Continuous; as implemented.
	Water quality and biological monitoring	Partially dependent upon EPD schedule; no later than 2010.
	De-303(d)-listing of streams	Based upon monitoring schedule; EPD 303(d) report schedule.
	Adaptive Reevaluation of WSM Plan	2010

5.3. Funding Needs and Sources

Funding for the Phase 1 implementation of the watershed management plan will be provided to the Chestatee-Chattahoochee RC&D through an EPA 319 program grant administered by EPD. This grant includes $220,000 to be used as 60-percent cost-share funding for BMP implementation, with the expectation that approximately $146,667 will be provided by landowners within the Mud and Little Mud Creek watersheds, for a total of $367,000 for implementation. The Phase 1 BMPs described in section 4.3 were scoped according to this funding availability.

The total funding needs to restore Mud and Little Mud Creeks cannot be precisely estimated at this time, given uncertainty in pollutant sources, stream responses, and the specific causes of biotic impairments. The total funding needs might exceed $2 million, or might be substantially less if the creeks can be shown to respond to the reduction of a relatively small number of pollutant sources. Funding sources and needs will be evaluated as part of the adaptive management approach. The NRCS and FSA also provide cost-share through a number of programs that may be beneficial to water quality improvement in the Mud Creek basin. Following are descriptions of several programs that may be useful in meeting the project objectives.

Conservation Reserve Program (CRP): This program was established as a conservation provision of the Farm Bill to encourage and assist producers who are willing to set aside highly erodible, riparian, and other environmentally sensitive lands from crop production for a 10 or 15-year period. Producers enroll in the program according to USDA program rules. If a landowner's CRP bid is accepted, a Conservation Plan of Operation is developed. In addition to an annual CRP payment, USDA will provide a 50-percent cost-share to establish the selected conservation practice. Landowners may receive a maximum of $50,000 annually in CRP payments.

Wetlands Reserve Program (WRP): This voluntary program for restoring wetlands is administered by NRCS with technical assistance from the Fish and Wildlife Service (FWS). Participating landowners can establish conservation easements of either permanent or 30-year duration or can enter into restoration costshare agreements where no easement is involved. The NRCS and FWS assist private landowners with site selection and development of restoration plans. Up to 100 percent of the cost of restoring the wetland is provided by USDA.

Environmental Quality Incentives Program (EQIP): This USDA program works primarily in conservation priority areas where there are significant natural resource problems. High priority is given to areas where state or local governments offer financial, technical, or educational assistance and to areas where agricultural improvements will help meet water quality objectives. Landowners can apply for assistance in addressing animal waste management, erosion, and other problems. EQIP will provide up to 50-percent costshare for restoration. A landowner may receive up to $50,000 annually in EQIP payments.

Wildlife Habitat Incentives Program (WHIP): This is a voluntary program for landowners who want to develop and improve wildlife habitat on private lands. Participants work with NRCS to prepare a wildlife habitat development plan. USDA provides technical assistance, and cost-share up to 75 percent of the cost of installing the wildlife habitat practices. USDA and the participant enter into a cost-share agreement that usually lasts a minimum of 10 years.

5.4. Measures of Success

This plan presents reasonable and cost-effective management options that can be locally implemented and maintained. However, it is recognized that even after reasonable steps have been taken, it may require a number of years to achieve the management plan goal or for water quality improvements to be realized. The primary measures of progress/success are listed in table 6-1 and including the following:

5.4.1. Measurement of Informational/Education Efforts

The success of informational/education efforts will be quantitatively measured by factors such as the attendance at meeting and demonstration tours and number of brochures distributed. These efforts will be qualitatively assessed by soliciting feedback on the value of the meetings/tours from participants. A more meaningful measure of the success of educational/informational efforts will be the actual participation by landowners in BMP implementation, as discussed in the following section.

5.4.2. Quantification of Management Measures

Chestatee-Chattahoochee RC&D Council and NRCS staff will maintain records of all management measures implemented on the 319 grant and associated nonpoint source pollution reduction programs within the Mud and Little Mud Creek watersheds. The GIS-based farm field database described in section 2.3 will be used to both target potential BMP opportunities and track the location of practices implemented. BMPs will be quantified by the number of participating landowners and the measures appropriate for specific practices (*e.g.*, linear feet of exclusion fencing, acreage of prescribed grazing, number of animal waste management facilities). The summary of management measures will be posted on the project web site and updated periodically, without specific locational information so that landowner privacy can be protected.

5.4.3. Water Quality and Biological Monitoring

The ultimate measure of success of the *Mud and Little Mud Creeks Watershed Management Plan* is the actual attainment of designated beneficial uses in the streams, and subsequent removal from the 303(d) list. Therefore, key monitoring parameters will include water quality (pathogens, turbidity, nutrients, etc.) and the benthic macroinvertebrate metrics at station 12030031 (Figure 2-1). It is preferred that Georgia EPD conduct monitoring of these stations in accordance with their five-year basin cycle. However, EPD is monitoring these stations in 2007 as part of an intensive study of the Lake Lanier watershed, and might not return to monitor them again until 2012 or later (pers. comm., Brandon Moody, Georgia EPD, 3 Jul 2007). Availability of future EPD funding for monitoring in the Upper Chattahoochee basin is uncertain. The project partners will communicate with the EPD regarding the funding and schedule for monitoring in Mud and Little Mud Creeks, and evaluate the need to conduct independent monitoring in 2010 or sooner.

5.4.4. 2010 Re-Evaluation

The project partners will conduct a formal review of the project progress success after completion of Phase 1 implementation. The review will include an evaluation of progress with regard to educational efforts, BMP implementation, and actual stream response. The *Mud and Little Mud Creeks Watershed Management Plan* will be updated at that time to reflect knowledge gained during the Phase 1 implementation, and to chart efforts for the next implementation phase.

6. References

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