Little Pee Dee River Nonpoint Source Assessment Project:

Load Reduction Management Plan

August 2005

Pee Dee Resource Conservation and Development Council

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EXECUTIVE SUMMARY

This report presents a Load Reduction Management Plan Supporting Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) Development for the impaired sections of the upper Little Pee Dee River above the Route 23 bridge ambient water quality monitoring station (PD-029E). The project watershed area encompasses a large stream system that includes a mainstem and tributaries extending to their headwaters from Dillon County into Marlboro County, South Carolina, Robeson County, North Carolina and Scotland County, North Carolina. A very small portion of the watershed reaches Richmond County, North Carolina; but because of the watershed extent in the County and distance from the impaired site, it will not be included in this study. The watershed is over 450 square miles in size. The percentages of the watershed area in South and North Carolina are 24 and 76, respectively. Water quality data collected at the PD-029E ambient water quality monitoring station that fecal coliform bacteria concentrations routinely exceed the standard.

Fecal Coliform Bacteria Impairment. The Clean Water Act requires that impaired water bodies be listed under Section 303(d) of the Act. Waters that are placed on the 303(d) list must have a TMDL determined for the pollutant of concern. The upper Little Pee Dee River is impaired at water quality monitoring station PD-029E located at the Route 23 Bridge five miles north of the Town of Dillon, South Carolina. Concentrations of fecal coliform bacteria exceeded the standard of 400 coliform forming units (cfu) per 100ml for more than ten percent of the samples acquired at this station. Due to these fecal coliform bacteria excursions, recreational uses are not supported. The State of South Carolina has, therefore, placed the upper Little Pee Dee River and its tributaries upstream of the Route 23 Bridge on their 303(d) list.

Sources of Fecal Coliform Bacteria. Although permitted wastewater discharge facilities are located in the large project watershed area of the upper Little Pee Dee River, their contribution of fecal coliform bacteria was not determined to have a substantial influence on fecal coliform bacteria concentrations. This Load Reduction Management Plan has, therefore, focused entirely on nonpoint sources of fecal coliform bacteria loading and permitted agricultural operations (i.e., hog operations). The nonpoint sources that have been determined to be contributors to the upper Little Pee Dee River impairment include wildlife; grazing livestock and livestock defecating directly into streams; land application of poultry litter; and failed, malfunctioning, and/or operational septic systems.

Agricultural Land Use Characterization. A Geographic Information System (GIS) Database was developed to characterize potential fecal coliform bacteria loading sources from agricultural land uses. Every United States Department of Agriculture Farm Service Agency (FSA) recognized farm field in the watershed was reviewed in the two South Carolina Counties of Dillon and Marlboro. Database attribute information includes the location of pastures, poultry litter application areas, and other information pertinent to fecal coliform bacteria loading. Information was compiled for approximately 2,500 farm fields from interviews with local agricultural agency experts, and field surveys.

Agricultural information that is pertinent to fecal coliform bacteria loading in the North Carolina portion of the watershed was acquired from interviews with local agricultural agency experts and was also included in the GIS database. The database will be used during TMDL implementation planning to identify viable pasture, poultry litter application and other types of farm field sites for BMP implementation.

Water Quality Assessment. The load-duration curve methodology was used to calculate the existing and TMDL loads for the upper Little Pee Dee River at water quality monitoring station PD-029E. This method develops TMDLs based on a frequency analysis of the historic hydrologic record and pollutant concentration data. Water quality data were obtained from the DHEC monitoring station PD-029E. The stream is not gauged at the impaired monitoring station, PD-029E. As a result, streamflow data was estimated using a paired watershed approach where the flow data obtained from a gauged stream (USGS station 02135000) with a long period of flow record having a similar land use and topography was used to estimate flow for the Little Pee Dee River at water quality monitoring station PD-029E. Fecal coliform bacteria loads contributed by various non-point sources were estimated by using a mass balance approach, and load reduction estimates were determined using a combination of the results obtained from the mass balance approach and the calculated loads from the load duration curve method.

Load Reduction Management Plan. The existing load for the Little Pee Dee River at monitoring station PD-029E was 1.09×10^{13} counts/day. The TMDL at monitoring station PD-029E was estimated to be 5.81×10^{12} counts/day, consisting a waste load allocation of 8.78×10^{10} counts/day, load allocation of 5.45×10^{12} counts/day and margin of safety of 2.72×10^{11} counts/day. To achieve compliance with water quality standards, it is recommended that fecal coliform bacteria loads be reduced from livestock sources, runoff from poultry litter application, runoff from sewer overflows, and failing septic systems by 64, 41, 100 and 100 percent at monitoring station PD-029E. The implementation of these load reduction allocation scenarios would result in an overall reduction of fecal coliform bacteria loading of 49.2 % at PD-029E, which is the amount of reduction necessary for the stream to achieve compliance at the impaired water quality monitoring station.

Stakeholder Development. Stakeholder recruitment and participation from a number of working group partners was prioritized throughout the development of this Load Reduction Management Plan. The final working group of stakeholders and community participants included:

- The Pee Dee Resource Conservation and Development (RC&D) Council;
- The Dillon and Marlboro Soil and Water Conservation Districts in South Carolina;
- The Scotland and Robeson Soil and Water Conservation Districts in North Carolina;
- The Dillon, Marlboro, Scotland and Robeson County Natural Resources Conservation Service (NRCS) field offices;

- The Dillon, Marlboro, Scotland and Robeson County Farm Service Agency (FSA) field offices;
- The South Carolina Department of Natural Resources;
- The North Carolina Division of Soil and Water Conservation;
- The North Carolina Cooperative Extension Service; and
- Consulting firms.

A stakeholder kick-off meeting was scheduled on January 26, 2005 in the Marlboro County, South Carolina Agriculture Service Center that included North and South Carolina agency support. Moreover, data collection meetings in the Marlboro and Robeson Agriculture Service Centers and a farm field survey of South Carolina agricultural land uses in the project watershed area occurred from Monday February 28, 2005 through March 2, 2005. The recruitment of localized support for the final Load Reduction Management Plan goals and activities will include a presentation in July/August 2005 to an assortment of local landowners and farmers, potential Farm Bureau representatives, and other organizations and agencies potentially affected by long-term TMDL implementation endeavors.

Recommendations for TMDL Implementation. This Load Reduction Management Plan supporting fecal coliform bacteria TMDL development for the upper Little Pee Dee River provides the framework and management tools for making informed decisions about the strategic selection, siting, and implementation of effective BMPs in the project watershed area. The long-term goal of the Load Reduction Management Plan is to develop a TMDL implementation plan that can be met through BMP implementation. To achieve this goal, three watershed planning components have been developed. Consultation with watershed stakeholders, including NRCS District Conservationists, has resulted in the development of a load reduction allocation scenario that can be both reasonably implemented and addresses the main sources of fecal coliform bacteria loading. In addition, a GIS database has been provided to watershed management decision makers that will assist to identify potential sources of fecal coliform bacteria loading, and target ideal farm field sites for corrective action implementation. Finally, a group of agency and farming organizations in South Carolina and North Carolina have been recruited to provide advocacy assistance during the implementation planning phase of the project.

These three watershed planning components provide a starting point for developing effective implementation strategies. For the most part, results from load-duration curves and monitoring assessments show that periods of low flow (summer months) are the most critical for water quality. This result points out the primary need to reduce fecal coliform bacterial loads resulting from in-stream and grazing livestock, and a secondary need to reduce runoff from fields receiving litter application (specifically poultry litter) and septic systems. Results from mass balance calculations did not show spray irrigation of treated swine waste to be a significant source of fecal coliform bacteria to the stream; however, the improper application of swine waste such as the application of excessive amounts of waste and application of the waste too close to streams can cause a potential problem. To meet the desired fecal coliform load reductions, implementation funding must be acquired from a variety of sources. With the periodic and sporadic acquisition of these funds, a phased implementation planning approach is recommended where an iterative process for implementation is adhered to. Sets of farm fields would be targeted and prioritized for implementation as funds are obtained. A continued review of sampling results acquired at the water quality monitoring station PD-029E and other strategically located sites in the project watershed area would occur following the implementation of prioritized farm field sets to measure (i.) the effectiveness of these implementation strategies, (ii.) the need for amending these strategies, and/or (iii.) progress toward the eventual removal of the impairment from the 303(d) list.

1.0 INTRODUCTION

1.1 Background

Levels of fecal coliform bacteria can be elevated in water bodies as the result of both point and nonpoint sources of pollution. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) requires states to develop total maximum daily loads (TMDLs) for water bodies that are not meeting designated uses under technology-based pollution controls. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions so that states can establish water quality-based controls to reduce pollution and restore and maintain the quality of water resources (USEPA, 1991).

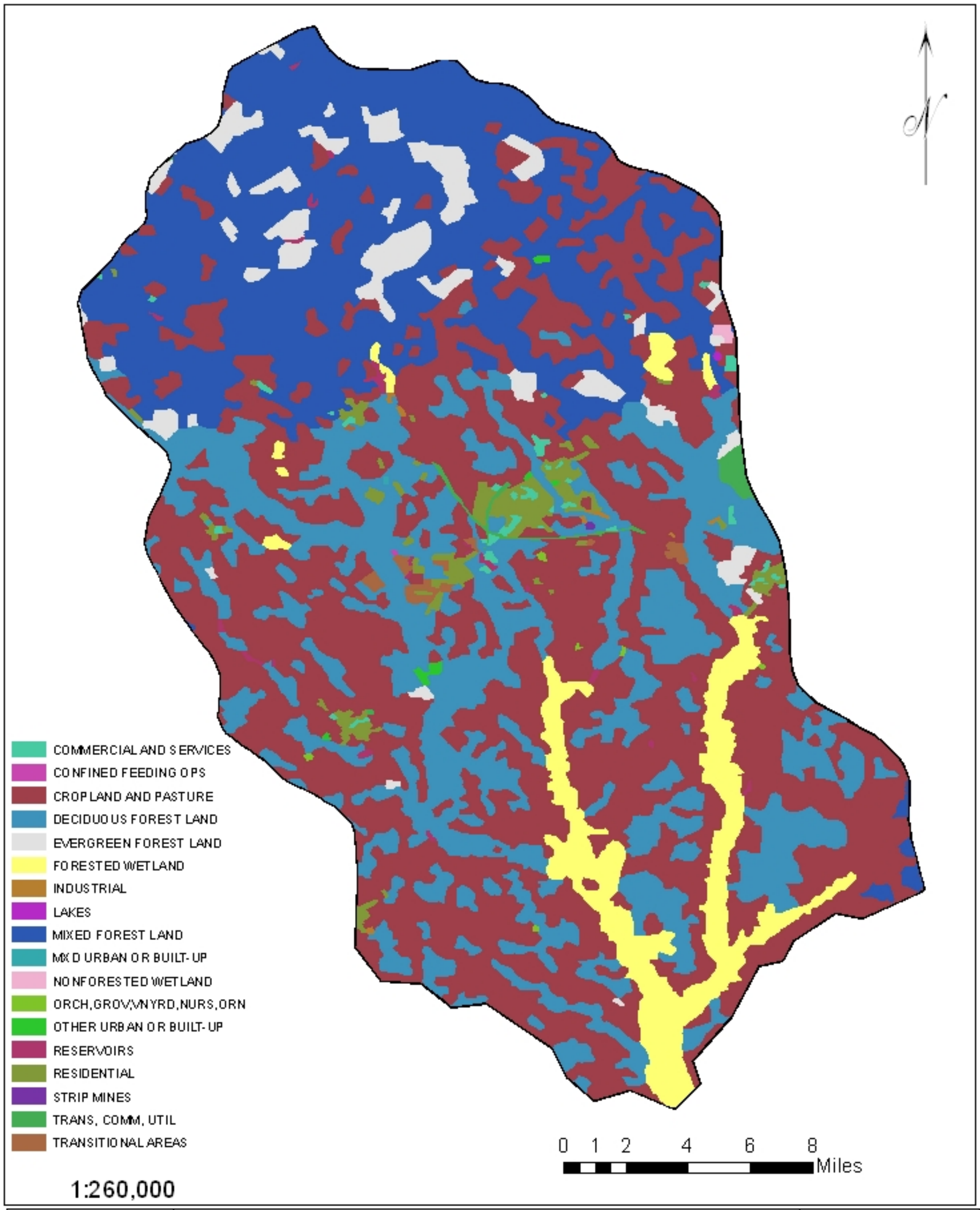
The South Carolina Department of Health and Environmental Control (DHEC) has identified the upper Little Pee Dee River upstream of highway Route 23 Bridge as being impacted by fecal coliform bacteria, as reported on the State of South Carolina 1998 303(d) list of water quality impaired waters. It is assumed that water bodies possessing high concentrations of fecal coliform bacteria may also be contaminated by pathogens, or disease producing bacteria or viruses, which may exist in fecal material. Some waterborne diseases associated with fecal material include typhoid fever, viral and bacterial gastroenteritis, and hepatitis A. The presence of fecal contamination is, therefore, an indicator that a potential health risk exists for individuals exposed to this water. The objective of this study is to develop a Load Reduction Management Plan supporting future TMDL development efforts that will result in a reduction of fecal coliform bacteria concentrations to levels that do not present a health risk, and that are below the state standard.

1.2 Watershed Description

The upper Little Pee Dee River watershed project area is located in the Little Pee Dee Watershed (Hydrologic Unit Codes 03040204 -010,-020, -040, and part of -030) of the Pee Dee River Basin in South Carolina and extends northwards into the North Carolina Lumber River Subbasin (state designation 03-07-55 Gum Swamp, Leith Creek, Shoe Heel Creek). The watershed area upstream of the impaired station is approximately 465 square miles. It occupies parts of the Upper Coastal Plain region of South Carolina and the Sand Hills ecoregion of North Carolina. The North and South Carolina portions of the watershed are approximately 362 square miles and 103 square miles in size, respectively. The predominant soil types consist of an association of the Norfolk-Lakeland-Wagram series. The erodibility of the soil (k) averages 0.14; and the slope of the terrain averages 5% with a range of 0-15%. The predominant land uses (NLCD, 1992) in the Little Pee Dee River watershed project area are forest (54.8%) and cropland/pasture/hay (42.7%). The remaining land use in the watershed is developed land (2.6%) (See Table 1-1 and Figure 1-1).

TABLE 1-1
Land Use Classification in the Little Pee Dee River Watershed above Water Quality Monitoring Station PD-029E

Land Use Class	Land Use	Area above PD-029E (acres)	Area above PD-029E (%)
Forest	Mixed Forest	67,939	23.0
	Deciduous Forest	66,318	22.4
	Evergreen Forest	11,023	3.7
	Forested Wetland	16,507	5.6
	Subtotal	**161,787**	**54.8**
Pasture/Hay		**57,808**	**19.6**
Cropland		**68,192**	**23.1**
Developed	Industrial	212	0.1
	Commercial and services	1,163	0.4
	Residential	4,905	1.7
	Trans, Comm, Util	1,085	0.4
	Other Urban or Built-up	346	0.1
	Subtotal	**7,711**	**2.6**
Total		***295,498***	***100.0***



MALCOLM PIRNIE | Pee Dee RC & D Upper Little Pee Dee River Watershed Project | FIGURE 1-1

Land Use Classification Above PD-029E | August, 2005

Major tributaries in the impaired South Carolina portion of the upper Pee Dee River system include sections of Leiths Creek, Carolina Branch, Shoe Heel Creek, Martins Branch, Beaverdam Creek, Panther Creek, and Gum Swamp. Tributaries originating in North Carolina include Swamp Creek, Leith Creek, Jordan Creek and Shoe Heel Creek.

As shown in Figure 1-2, numerous ambient water quality monitoring stations are located in the upper Little Pee Dee River project watershed area. DHEC monitoring stations include:

- Little Pee Dee River at Route 23 Bridge (PD-029E);
- Little Pee Dee River at Route 57 Bridge (PD-069);
- Little Pee Dee River at Route 363 Bridge (PD-365);
- Gum Swamp at Route 27 Bridge (PD-062);
- Panther Creek at Route 27 Bridge (PD-016);
- McLaurins Millpond on Beaverdam Creek at Route 381Bridge (PD-017A); and
- Panther Creek at Route 15 Bridge (PD-306).

Additional North Carolina monitoring stations include:

- Leiths Creek at Harry Malloy Road Bridge – Scotland County (I0490000);
- Leiths Creek at Hasty Road Bridge – Scotland County (I0510000); and
- Shoe Heel Creek at Gaddy Mill Road Bridge – Robeson County (I0530000).

The PD-029E and the I0510000 stations in South Carolina and North Carolina, respectively, are the only two stations in the project watershed area showing impaired concentrations of fecal coliform bacteria.

As depicted in Figure 1-2, the upper Little Pee Dee River project watershed area was divided into seven subwatersheds. These subwatersheds and their associated areas are listed below:

- Upper Gum Swamp Creek (63 square miles);
- Upper Shoe Heel Creek (76 square miles);
- Lower Shoe Heel Creek (81 square miles);
- Leiths Creek (76 square miles);
- Little Pee Dee River Mainstem (76 square miles);
- Sweat Swamp (33 square miles); and
- Beaverdam Creek (45 square miles).

According to the Pee Dee Watershed Water Quality Assessment Report, there exists a minor domestic effluent point source in South Carolina (Town of McColl Wastewater Treatment Plant - SC0041963) on the Gum Swamp tributary. EPA records indicate that this facility has gone through compliance evaluations from December 29, 1992 to November 29, 2004. No violations of pipe flow and fecal coliform bacteria concentration have been reported for monitoring end periods ranging from January 31, 2002 to April 30, 2005. There are also eight permitted Animal Feeding Operations (AFOs), five that are currently active, found within the South Carolina portion of the project watershed. Table 1-2 shows a list of the permitted AFOs and the types of field applications associated with the AFOs. In North Carolina, there are eleven NPDES wastewater point sources dischargers; including a minor discharger in the vicinity of the state border just a few miles from the Rte. 23 ambient water quality monitoring station (Table 3-1). In addition, there is one individual NPDES stormwater permit and approximately 30 registered swine operations in the North Carolina portion of the watershed. Improper maintenance of the NPDES discharge facilities can potentially contribute to fecal coliform impairment of the upper Little Pee Dee River. However, contributions to impairment from point sources is handled through existing DHEC enforcement mechanisms. It is estimated that approximately 9,800 septic systems are currently in use in the project area and are considered potential sources of fecal coliform bacteria loading. This total number of existing septic systems within the watershed was estimated by dividing the sum of the estimated number of people served by septic systems in four of the Counties where large portions of the Little Pee Dee project watershed exists (Robeson, Scotland, Dillon, Marlboro) by the average rate of people served per septic (refer to section 3). Also, sanitary sewer overflows occur in the highly urbanized areas such as in the city of Laurinburg, Scotland County. It was estimated that, in a typical year with frequented high storm conditions, approximately 15% of the sanitary sewer lines existing in Laurinburg can over flow (personal communication, Robert Ellis, City of Laurinburg Treatment Plant Director, February 23, 2005) and contribute fecal coliform bacteria load to the stream.

TABLE 1-2
Animal Feeding Operations (AFOs) within the South Carolina Portion of the Upper Little Pee Dee River Project Watershed

NPDES	FACILITY	STATUS	OPERATION	DESIGN COUNT	APPLICATOR
ND0009822	MCCALL JR, L S	ACTIVE	Swine	316	Spray Irrigation
ND0073113	BETHEA WATSON/SWINE/FIN/FACILITY	ACTIVE	Swine (Finishing Hogs)	3,520	Spray Irrigation
ND0081540	ROBINSON POULTRY FACILITY	ACTIVE	Poultry (Broilers)	116,000	Dry Spreader
ND0082562	MEADOW BROOK FARMS	ACTIVE	Poultry (Broilers)	120,000	Dry Spreader
ND0084140	KRISTEN AND CLINT FARMS	ACTIVE	Poultry (Broilers)	120,000	Dry Spreader
ND0084441	OAK RIDGE FARM	INACTIVE	Swine (Finishing Hogs)	3,520	Spray Irrigation
ND0084573	BIG BIDDY FARM	INACTIVE	Poultry (Roasters)	162,000	Dry Spreader
ND0084565	CHICKEN RUN FARM	INACTIVE	Poultry (Roasters)	162,000	Dry Spreader

Both agricultural and urban land uses are considered nonpoint sources of fecal coliform bacteria loading. Typically, the predominate agricultural land uses leading to fecal coliform bacteria loading are beef cattle direct deposition into the stream, runoff from cattle manure and poultry litter. Runoff resulting from spray irrigation of treated swine waste can also be a potential problem of fecal bacteria loading to streams during growing seasons, when a high percentage of the spray irrigation occurs, during high storm conditions and if the spray irrigation is applied to fields that are located in the vicinity of streams. Although the Town of Laurinburg, North Carolina is located in the headwater tributaries of the watershed system, agriculture is the largest contributor of fecal coliform bacteria. The types of agricultural operations that exist within the project watershed include crop farms (including cotton and soybean farms), poultry farms, and cow, horse, goat and hog operations (personal communication, Teresa Babb, Jimmie Harris and Dana Ashford, District Conservationists for Marlboro County, Dillon County, and Robeson and Scotland Counties, March, 2005) . The estimated numbers of animals that exist within the project watershed are 1,000 cattle, 138,600 swine, 1,436,000 chickens and 150 horses.

1.3 Water Quality Standard

The impaired upper Little Pee Dee River project watershed area above the Route 23 Bridge, is designated as Class Freshwater. Waters of this class are described as follows:

> Freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after convenient treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses. (R.61-68).

The South Carolina standard for fecal coliform bacteria in Freshwater is:

> Not to exceed a geometric mean of 200/100 ml, based on five consecutive samples during any 30-day period: nor shall more than 10 percent of the total samples during any 30-day period exceed 400/100 ml. (R.61-68).

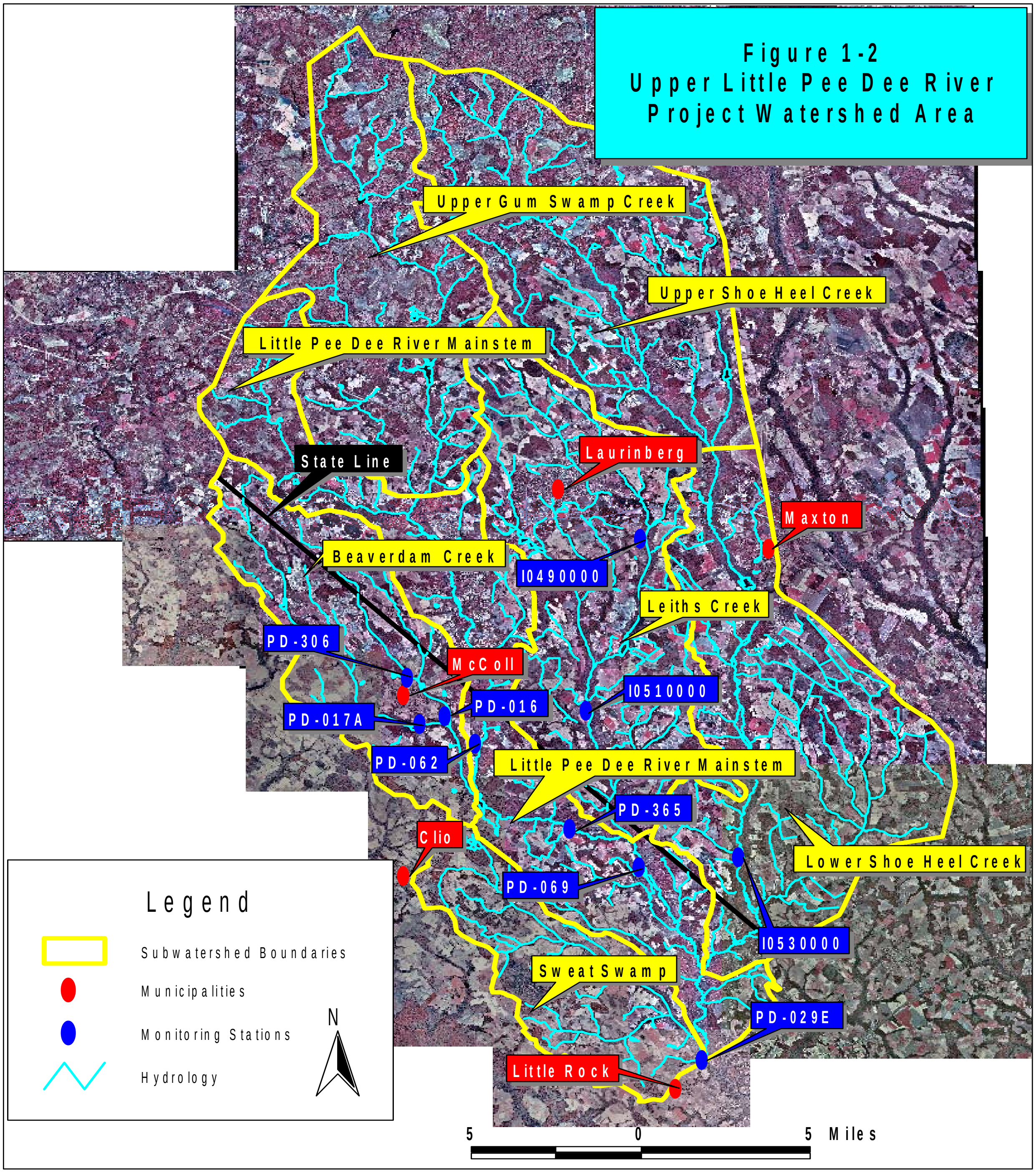
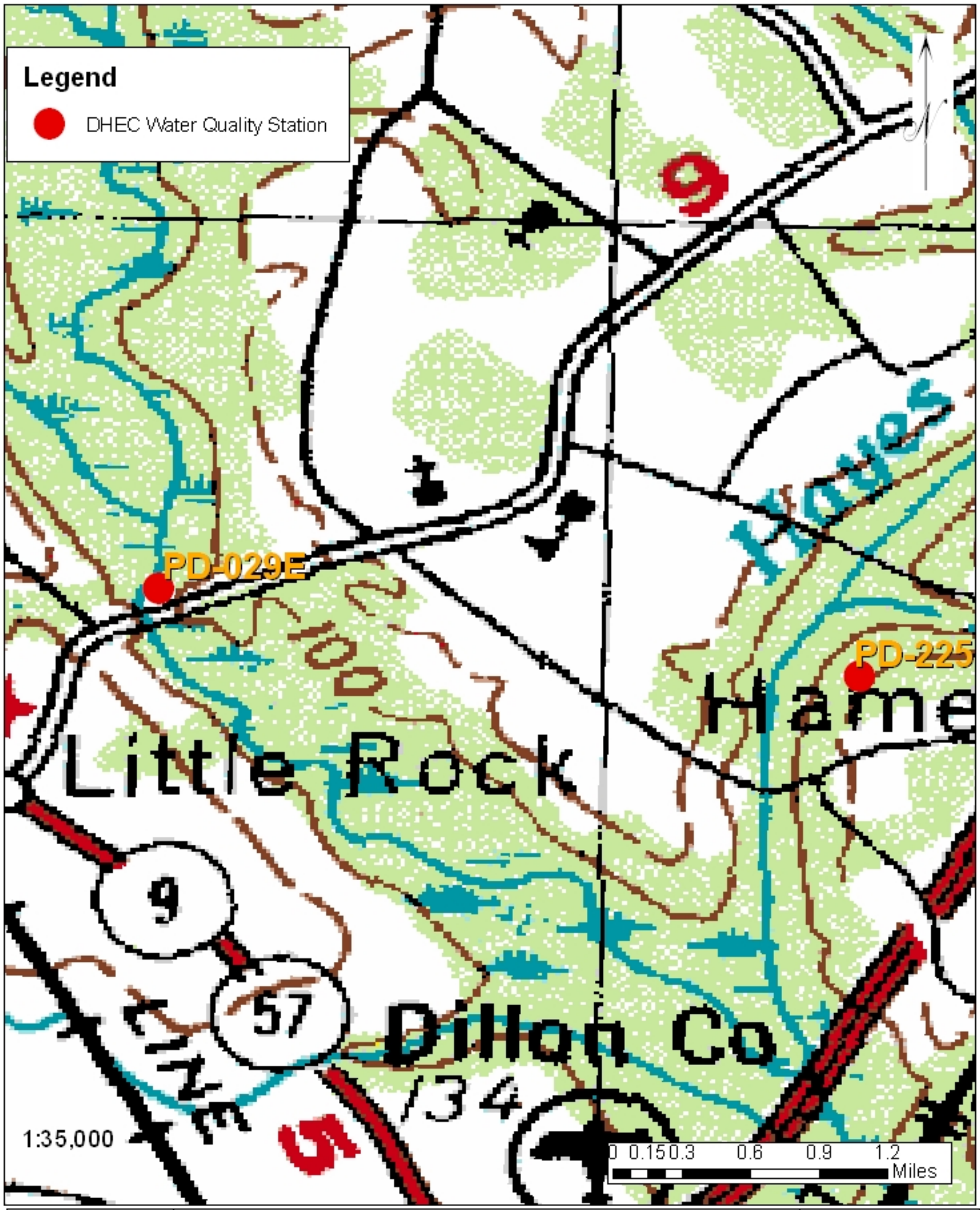


Figure 1-2
Upper Little Pee Dee River
Project Watershed Area
Upper Gum Swamp Creek
Upper Shoe Heel Creek
Little Pee Dee River Mainstem
State Line
Laurinberg
Maxton
Beaverdam Creek
I0490000
Leiths Creek
PD-306
McColl
I0510000
PD-017A
PD-016
PD-062
Little Pee Dee River Mainstem
PD-365
Clio
Lower Shoe Heel Creek
PD-069
I0530000
Sweat Swamp
PD-029E
Little Rock
Legend
Subwatershed Boundaries
Municipalities
Monitoring Stations
Hydrology
N
5
0
5 Miles

2.0 WATER QUALITY ASSESSMENT

The seasonal and hydrologic variability of fecal coliform data collected from 1990-2003 at ambient water quality monitoring station PD-029E was examined to provide insights into the contributing factors of high fecal coliform loading to the stream. For example, high concentrations during low flow conditions would be consistent with in-stream sources, whereas high concentrations only during storm events would indicate land-based sources.

DHEC collected bacteria samples at monitoring station PD-029E during warm weather months (May-October) prior to 2001 and every month of the year in 2003 post the 2001 change in monitoring strategy that occurred for PD-029E, which changed the sampling frequency to every month of a year in a recurrence interval of once every five years. Results from this monitoring station were the basis for the 303(d) listing of the stream for bacteria impairment. Fecal coliform data from DHEC monitoring station PD-029E is provided in Appendix A. The location of the PD-029 monitoring station is shown in Figure 2-1.



Pee Dee RC & D
Upper Little Pee Dee River Watershed Project
Water Quality Station Location

FIGURE 2-1

August, 2005

2.2 Seasonal Variability

As shown in Figure 2-2, the geometric mean fecal coliform bacteria concentrations were highest in July, a warm period of the year. The geometric mean fecal coliform concentrations were generally higher during the summer and early fall seasons, and the lowest geometric mean fecal coliform concentrations occurred during the winter and early spring months, between January and April and in December.

This general temperature-dependent pattern is due to: (1) higher fecal coliform bacteria die-off rates in colder temperatures; (2) livestock spending more time in the stream during hot weather than during cold weather; (3) poultry litter application in spring, summer, and early fall; and (4) dilution of fecal coliform concentration during the higher flows that are generally experienced during winter and spring, relative to lower flows in late summer and fall months.

2.3 Hydrologic Variability

To assess the hydrologic variability of fecal coliform bacteria concentrations, stream flow data were estimated from measured flow data at the USGS gauging station 02135000 on Little Pee Dee River, located downstream from the impaired DHEC water quality monitoring station PD-029E. Streamflow at DHEC water quality monitoring station PD-029E was estimated by multiplying flow data from the USGS gauge station 02135000 by the ratio of the drainage area above PD-029E to the drainage area above the USGS gauge station (i.e., a paired watershed approach).

The graph of fecal coliform concentration vs. flow (Figure 2-3) demonstrates that higher fecal coliform bacteria concentrations tend to occur during lower flow conditions. In fact, most of the fecal coliform bacteria concentrations that violated the water quality standard were observed to occur during low flow conditions. However, the water quality criterion was also exceeded under high flow conditions. This indicates that although dry-weather sources of fecal coliform bacteria are predominant, wet-weather sources of fecal coliform bacteria also exist. Under dry weather conditions, bacteria sources such as livestock in streams, failing septic systems, and straight pipe discharges may affect the stream. Under wet weather conditions, run-off related sources, such as livestock manure deposited on pastureland, wildlife, and poultry litter/or lagoon-treated swine waste are more important.

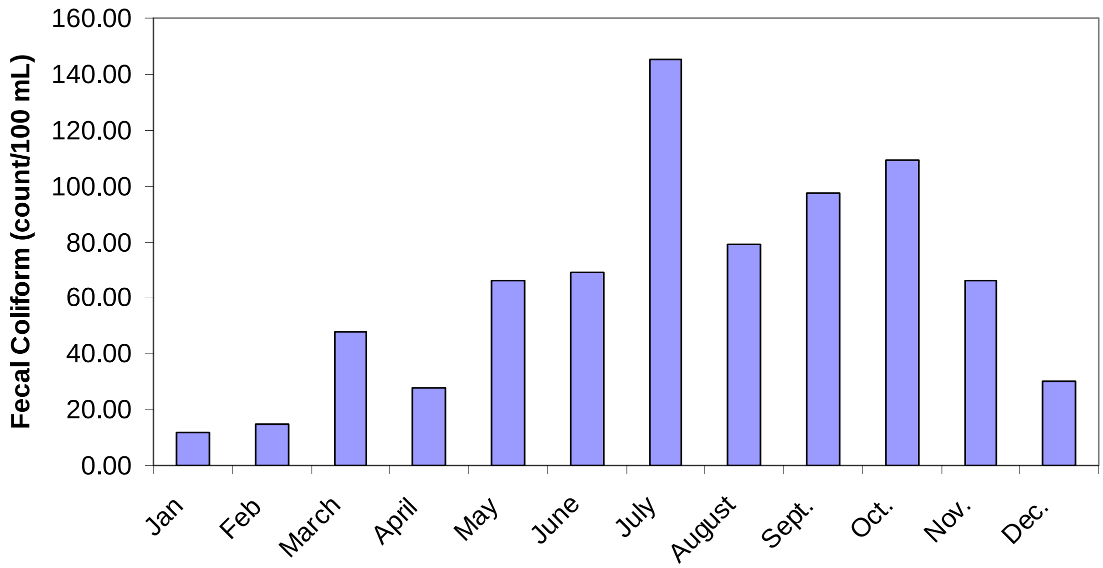


Figure 2-2: Geometric mean fecal coliform concentration vs. month in Little Pee Dee River at DHEC water quality monitoring station PD-029E. Geometric mean values were calculated using 1990-2003 data from DHEC water quality monitoring station PD-029E.

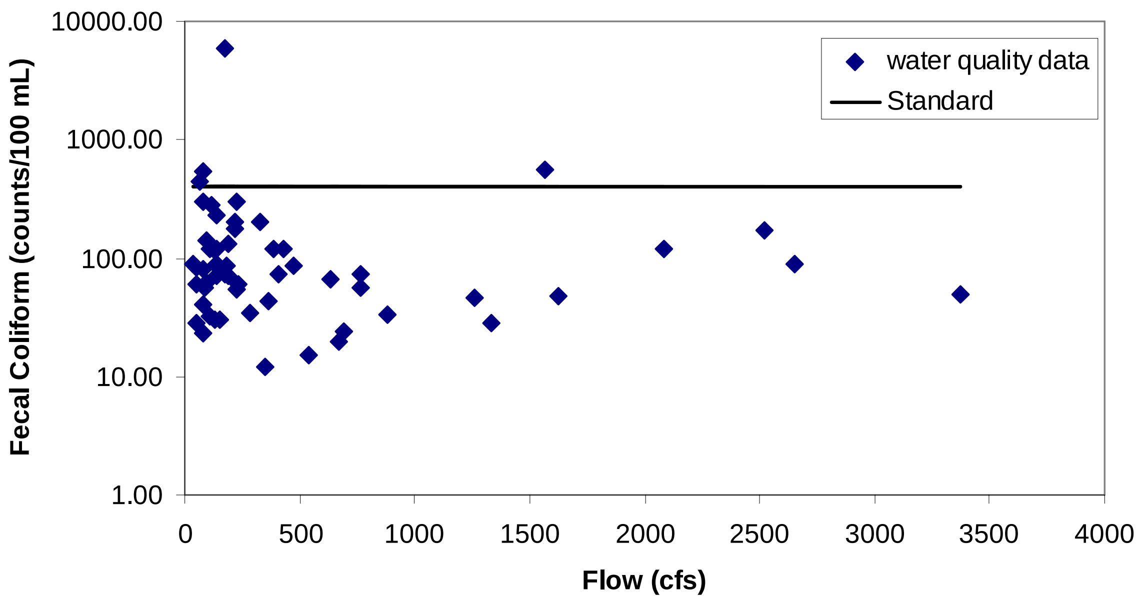


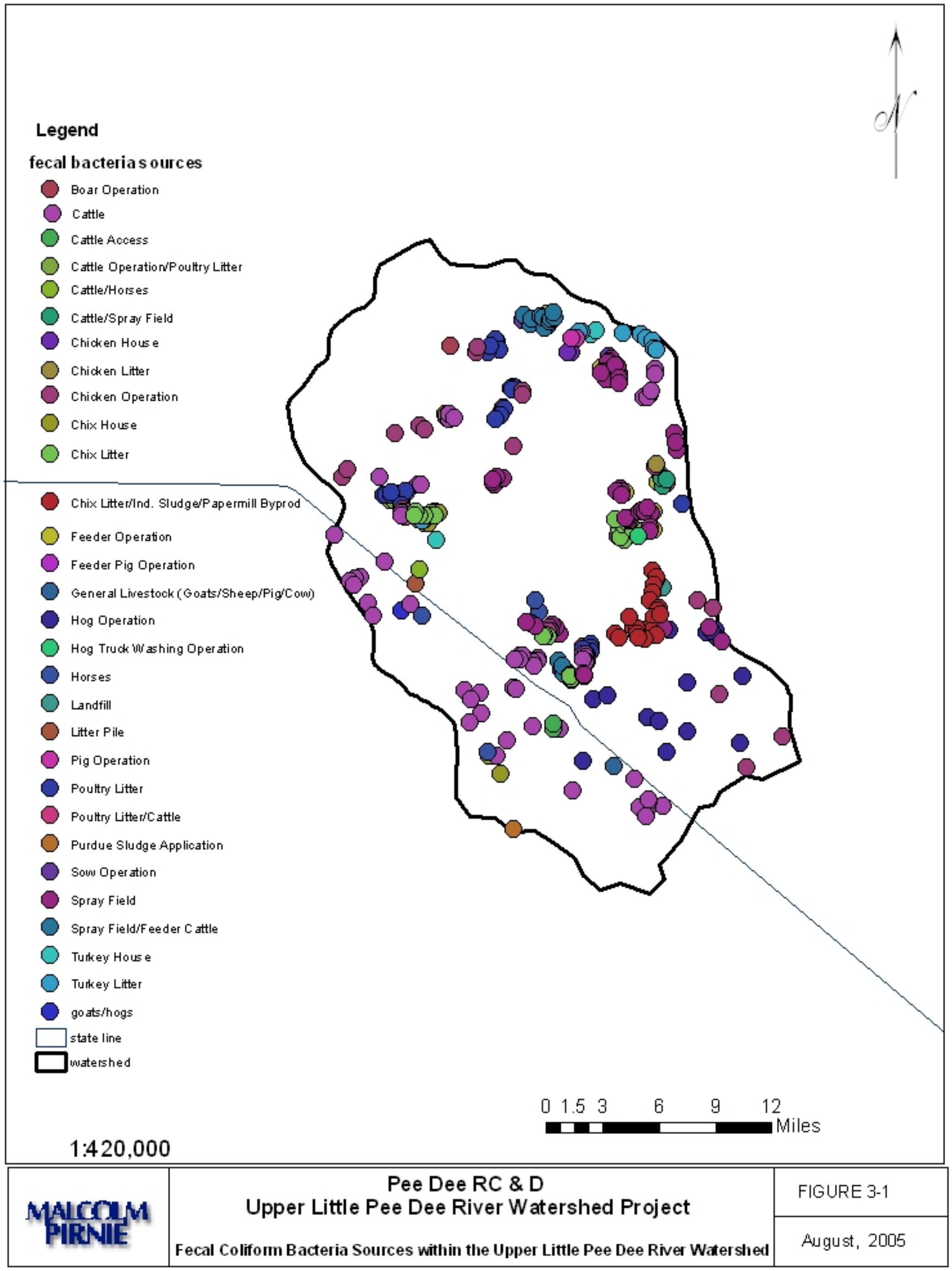
Figure 2-3: Fecal coliform concentration vs. estimated stream flow in Little Pee Dee River at DHEC water quality monitoring station PD-029E, 1990-2003.

3.0 SOURCE ASSESSMENT METHOD

Figure 1-1 and Table 1-1 show the distribution of land use categories in the Little Pee Dee River project area, obtained from the Multi Resolution Land Characteristics Consortium's National Land Cover Data (NLCD).

The source assessment phase of this study involved the identification and quantification of fecal coliform bacteria loads as applied to the land surface in the Little Pee Dee River project area, or directly to the stream, as in the case of failing septic systems. 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 (as described in section 4) to determine amounts of fecal coliform contributed to the stream by various sources. Figure 3-1 shows locations of potential sources of fecal coliform bacteria within the upper Little Pee Dee River project watershed as identified by local district conservationists.

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.



3.1 Point Sources

There is one permitted discharge facility in South Carolina (Town of McColl Wastewater Treatment Plant – SC0041963) that discharges a minor domestic effluent into the Gum Swamp tributary, and eleven permitted discharge facilities in North Carolina; including a minor discharger in the vicinity of the state border just a few miles from the ambient water quality monitoring station PD-029E, within the Little Pee Dee River watershed project area (Table 3-1). In addition, there is one individual NPDES stormwater permit and 30 registered swine operations in the North Carolina portion of the watershed. The total permitted flow of discharge of the point sources located within the project watershed is 5.8 MGD. Although the permitted discharge facilities are not expected to be major sources of fecal coliform bacteria, they were included in the TMDL calculations.

TABLE 3-1
NPDES Discharge Facilities within the upper Little Pee Dee River Project Watershed

NPDES Station	Facility Name	Facility Type	Discharge limit (MGD)
NC0005479	Laurel Hill/Maxton WWTP	Industrial Process & Commercial - permitted to discharge FC	0.3
NC0005754	Springfield Plant	Industrial Process & Commercial – permitted to discharge FC	0.03
NC0020656	Leiths Creek WWTP	Municipal – permitted to discharge FC	4.0
NC0021661	Libbey-Owens-Ford WWTP	Municipal – permitted to discharge FC	0.03
NC0027120	Maxton WWTP	Municipal – permitted to discharge FC	0.6
NC0029769	Scotland County Correctional Center	100% Domestic	0.018
NC0035777	Scotland Accelerated Academy	100% Domestic	0.0112
NC0036773	Laurinburg WTP	Water Plants and Water Conditioning	Not limited
NC0049514	Libbey-Owens-Ford Company/Plant 75	Industrial Process & Commercial	Not limited
NC0069612	Rowland WWTP	Municipal – permitted to discharge FC	0.387
NC0086894	Raemon Well WTP	Water Plants and Water Conditioning	Not limited
SC0041963	Town of McColl WWTP	Minor Domestic – permitted to discharge FC	0.4

3.2 Non-Point Sources

Non-point sources of fecal coliform bacteria loading that were explicitly considered included wildlife, cattle, poultry litter application, spray irrigation of lagoon-treated swine waste, sanitary sewer overflows and failing septic systems/straight pipe discharges. Estimates of the number of fecal coliform counts per animal per day were based on literature-derived values of the BIT and are summarized in Table 3-2. Other sources are expected to be relatively minor by comparison, and are implicitly included by inclusion in other sources. For example, the small number of horses, sheep and goats in the project watershed can be conceptually lumped into the cattle source.

TABLE 3-2
Fecal Coliform Unit Loading Rates

Source	Fecal Coliform Loading Rate	Units	BIT Reference
Deer	5.0×10^8	counts/animal/day	Best Professional Judgment
Raccoon	1.2×10^8	counts/animal/day	Best Professional Judgment
Cattle	1.0×10^{11}	counts/animal/day	ASAE, 1998
Poultry litter	1.3×10^6	counts/gram litter	LIRPB,1978
Lagoon Treated Swine Waste	5.4×10^5	counts/100 mL	Hill and Sobsey, 1998
Septage & Sanitary Sewer Overflow (SSO)	1.0×10^4	counts/100 mL	Horsley and Witten, 1996
Developed Land	1.1×10^7	counts/acre/day	Horner, 1992

3.2.1 Wildlife

A value of 20 deer per square mile was assumed for forest, pasture and cropland, based on estimates provided for East Marlboro and North Dillon Counties by the South Carolina Department of Natural Resources (personal conversation, Charles Ruth, Deer Project Supervisor, SCDNR, May 23, 2005). A value of 128 raccoons per square mile was assumed for these same land uses, based on the upper end of the raccoon density range given in the South Carolina coastal plain according to the SCDNR Wildlife Management Guide for Raccoon (1997). Although the actual raccoon density might be as much as 10 times lower, the upper end of the range was used to implicitly account for other wildlife such as birds, rodents, etc. Due to the presence of riparian wetlands near Little Pee Dee River and the tributaries of Little Pee Dee River within the project watershed, in-stream contributions from wildlife sources can occur. In-stream contributions from wildlife sources were estimated by assuming that wildlife loads to forested wetlands are direct load to the stream.

3.2.2 Cattle

According to the South Carolina NRCS District Conservationists for Marlboro County (Teresa Babb, March 2005) and Dillon County (Jimmie Harris, March 2005), there are approximately 750 cattle in the South Carolina portion of the Little Pee Dee River project watershed at any one time. Cattle density on pastureland within the North Carolina portion of the watershed was estimated by dividing the total number of cattle in Scotland and Robeson Counties (according to the USDA 1997 Census of Agriculture) by the area of pastureland within the watershed in those counties. This resulted in an estimate of about 256 cattle in the North Carolina portion of the Little Pee Dee River project watershed. There are no significant dairy or feedlot operations in this portion of the watershed (personal communication, Dana Ashford, District Conservationist for Robeson and Scotland Counties, March 21, 2005), and so cattle were assumed to be evenly distributed on pastureland. Cattle manure is not collected or applied as fertilizer to cropland in any parts of the watershed (personal communication, Teresa Babb, Jimmie Harris and Dana Ashford, March, 2005).

There are places where cattle can directly access Little Pee Dee River or its tributaries; however, uncertainties exist about the percentage of time cattle spend in streams. As a result, direct deposit of fecal coliform from in-stream cattle was not explicitly differentiated from deposition on land in the mass balance calculations.

3.2.3 Poultry Litter Application

An estimation of the magnitude of poultry litter application was based largely on the local knowledge and professional judgment of the District Conservationists, Teresa Babb, Jimmie Harris, and Dana Ashford.

Poultry litter was assumed to be applied to both Cropland and pastureland at a rate of 2 tons/acre in Scotland and Robeson Counties, NC and 1.5 tons/acre in Marlboro County, SC. In any given year, 60% of cropland and 50% of pastureland in Scotland and Robeson Counties, NC and 40% cropland and 30% pastureland in Marlboro County, SC were assumed to receive an application. Farm fields in Dillon County did not receive poultry litter application (personal communication, Jimmie Harris, District Conservationist, March, 2005). In general, a higher percentage of the litter application occurs during spring and fall seasons.

In addition to runoff from fields receiving litter application or spray irrigation, improper storage of poultry litter, such as stock piles of litter that is left uncovered for extended periods of time, is a potential source of fecal coliform bacteria. Loads contributed from such improper storage of litter were not explicitly estimated, but are implicitly included in the estimates of loads derived from poultry litter.

3.2.3 Treated Swine Waste Application

Lagoon-treated swine waste is also applied to farm fields within the Little Pee Dee River project watershed. Treated swine waste was assumed to be applied to both cropland and hay land at a rate of 75,000 gallons/acre in Scotland and Robeson Counties, NC and at a rate of 54,000 gallons/acre to cropland and pastureland in Marlboro and Dillon Counties, SC. In any given year, 3% of cropland and 99% of hay land in Scotland and Robeson Counties, NC; 5% cropland and 1% pastureland in Marlboro County, SC and 1% cropland and 0% pastureland in Dillon County, SC were assumed to receive an application. An average fecal coliform concentration of 5.4×10^5 counts/100mL was used for lagoon treated swine waste based on the work of Hill and Sobsey, 1998.

3.2.4 Failing Septic Systems and Sanitary Sewer Overflows

Much of the population residing in the project watershed of Little Pee Dee River uses septic systems as the primary means of domestic waste disposal. This includes approximately 60% of the population in Robeson County, 50% in Scotland and Dillon Counties, and 40% Marlboro County (personal communication, William Smith, Brian Lawry, Rodney Herring and Drake Rogers, County Health Department representatives, March, 2005). The total number of septic systems within the project watershed of Little Pee Dee River was estimated to be 9,800 based on the average number of people served per septic (approximately 2.55 people/septic) and the assumed number of people served by septic systems (approximately 25,000). By assuming an even distribution of population within the project watershed, the number of people served by septic systems in each County (Robeson, Scotland, Dillon and Marlboro) was determined by multiplying the ratio of the County area within the project watershed to the total area of the County by the number of people estimated to be served by septic systems within that County - 60% of the population in Robeson County, 50% in Scotland and Dillon Counties, and 40% Marlboro County (Table 3-3). The estimated number of people served by septic systems in all four Counties within the project watershed was then summed to determine the overall estimated population within the Little Pee Dee River project watershed served by septic systems. The total number of septic systems existing in the Little Pee Dee project watershed was then estimated by dividing the total estimated number of people using septics by the average rate of people served per septic (2.55).

The failure rate of septic systems were assumed to be approximately 20% in Robeson County, 2%-5% in Scotland County, 1% in Dillon County and 10% in Marlboro County (personal conversations, William Smith, Brian Lawry, Drake Rogers and Rodney Herring, County Health Department representatives, March, 2005). Table 3-3 lists the approximate number of people served by septic systems, and estimated failure rates in the different counties within the project watershed. The overall failure rate of septic systems within the project watershed was estimated to be 8.6%. 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).

TABLE 3-3
Population Served by Septic Systems and Failure Rates of Septic Systems that are Estimated to Occur in the Different Counties Located within the Little Pee Dee River Project Watershed.

County	Approximate Population Using Septic Systems	Failure rate of Septic Systems (%)	Information Contact from County Health Department
Robeson	5,887	20	William Smith
Scotland	15,954	2-5	Brian Lawry
Dillon	1,494	1	Rodney Herring
Marlboro	1,466	10	Drake Rogers

The city of Laurinburg, located in Scotland County, North Carolina, is a major urban source within the project watershed of the upper Little Pee Dee River. It was estimated that, in a typical year with frequented high storm conditions, such as the storm conditions that occurred in 2004 (including tropical storm Gaston and tropical storm Frances), approximately 15% of the sanitary sewer lines existing in Laurinburg can over flow (personal communication, Robert Ellis, City of Laurinburg Treatment Plant Director, February 23rd, 2005) and contribute fecal coliform bacteria load to the stream. The total sanitary sewer overflow volume encountered in 2004 (a typical high storm year) was determined from the sanitary sewer overflows/spills summary report provided by Robert Ellis (City of Laurinburg Treatment Plant Director) for the city of Laurinburg during 2004 (provided in Appendix C). This total overflow volume was then used to estimate the fecal coliform bacteria load deposited on land surface as a result of sanitary sewer overflows/spills that occur in a typical year under high storm conditions within the project watershed. An average fecal coliform concentration of 1.0×10^4 counts/100mL was used for untreated waste based on the work of Horsley and Witten (1996).

3.2.5 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 Little Pee Dee River project area, an average value of 1.13×10^7 counts/acre/day was used based on the work of Horner (1992).

4.0 LOAD-DURATION CURVE

The load duration curve method was used to calculate the existing and the TMDL load for Little Pee Dee River at DHEC water quality monitoring station PD-029E (located on Route 23). The load-duration method develops TMDLs based on a frequency analysis of the historic hydrologic record, resulting in a cumulative frequency of daily flows, and pollutant concentration data. A water quality standard load or “allowable load” is calculated by multiplying the numeric water quality criteria by the flows from the frequency analysis. Multiplying the water quality data by the daily flow calculates actual pollutant loads. The critical flow and allocation are determined by a comparison of the pollutant loads with the allowable loads.

The load-duration method was selected for this project because it is a relatively simple method that provides adequate estimate of fecal coliform bacteria loading over a range of stream flow conditions. In addition, the load-duration method has a successful track record of DHEC and USEPA approval for similar fecal coliform bacteria TMDL applications across the state of South Carolina. Primary disadvantages of the load-duration method are its limited predictive capability and its limited capability to link load reduction estimates, hydrologic conditions and contributing areas. In this project, the load duration curve analysis was supplemented by mass balance calculations to estimate the loads contributed by various non-point sources (as discussed on section 4.2). Estimates of the necessary load reduction were determined using a combination of results obtained from the mass balance approach and the calculated loads from the load-duration curve method. The load-duration curve method includes all flow conditions ensuring that critical conditions are protected.

4.1 Development of the Load-Duration Curve

Because the load-duration curve methodology is based on frequency analysis of stream flow, the first step in the analysis involved collecting or estimating historical record of flow in Little Pee Dee River at DHEC water quality monitoring station PD-029E. Little Pee Dee River at water quality monitoring station PD-029E is not gauged; as a result, it was desired to estimate flow for Little Pee Dee River at the DHEC water quality monitoring station for a preferably long period of time. To do this, a paired watershed approach, where the flow data obtained from a gauged stream (USGS station 02135000) with a long period of flow record having a similar land use and topography, was used to estimate flow for Little Pee Dee River at water quality monitoring station PD-029E from January 1, 1942 to September 30, 2003. A longer period of flow data was desired as this increases the confidence of the results obtained from the load-duration method.

The watershed area of Little Pee Dee River above the USGS station 02135000 (2,790 mile^2) is larger than above the Little Pee Dee River above the water quality monitoring station PD-029E (466 mi^2). The flow for Little Pee Dee River at PD-029E was estimated by multiplying the daily flow rates (for flow period ranging from January 1, 1942 to September 30, 2003) from Little Pee Dee River at the USGS station, down stream from

PD-029, by the ratio of Little Pee Dee River drainage area above PD-029E to that of Little Pee Dee River above the USGS station (0.167). These flow estimates were then used to generate the flow-duration curve at water quality monitoring station at PD-029E.

Flow data at water quality monitoring station for the time period of January 1, 1942 to September 30, 2003 were ranked from low to high and the values that exceeded certain selected percentiles were determined. The fecal coliform bacteria loads at the water quality monitoring station were calculated by multiplying the fecal coliform bacteria concentration data by the flow rate that corresponded to the date of coliform sampling. To generate the load-duration curves, the loads were plotted against the appropriate flow recurrence interval (Figure 4-1). The water quality standard load or "allowable load" (target line on Figure 4-1) was calculated by multiplying the appropriate fecal coliform bacteria standard concentration by the flows from the frequency analysis. At a given streamflow, fecal coliform bacteria loads above the target line are in violation of the standard, while loads below the line are in compliance.

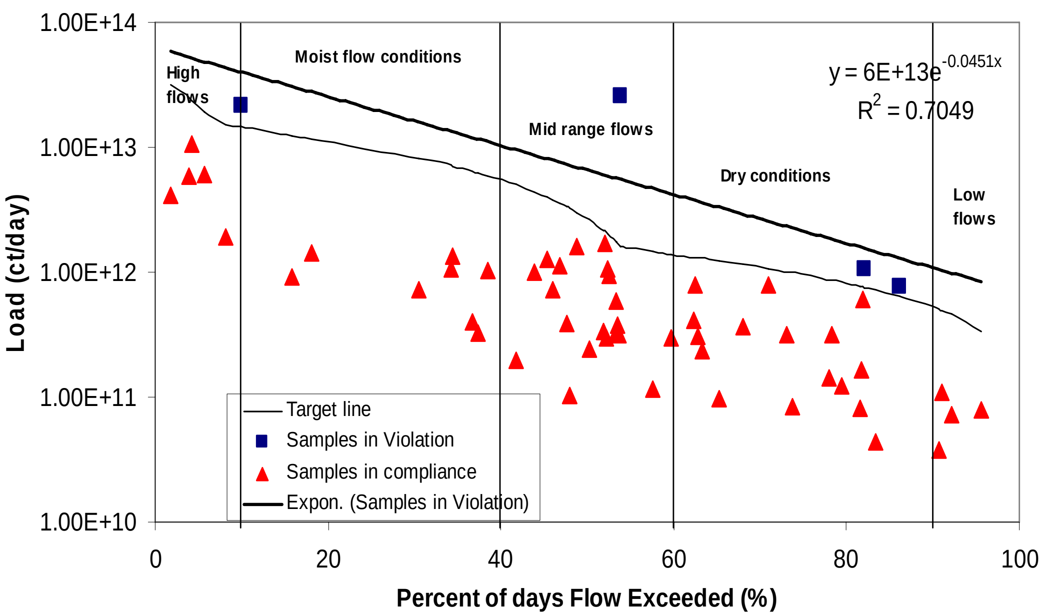


Figure 4-1: Load Duration curve for Little Pee Dee River at Monitoring Station PD-029E

The total existing load of fecal coliform bacteria at the water quality monitoring station in the upper Little Pee Dee River project area was determined from the samples that violated the water quality standard. That is, a best fit trend line was determined for fecal load data in violation of the standard and the equation of the trend line used to estimate loads for the range of the flow recurrence intervals that had a majority of the loads in violation of the standard. The existing loads were then calculated by taking the average of the loads estimated within those flow duration intervals. The best fit trend line at water quality monitoring station PD-029E was an exponential curve with a regression coefficient value of R^2 = 0.71. The majority of the violating loads were between 10%

and 90% streamflow duration intervals. Therefore, the average loads were determined within these flow duration intervals at 5% intervals. A table showing equation of the trend line developed for the loads in violation at the water quality monitoring station PD-029E and evaluated value of the exiting load is provided in Appendix B. Similarly, the allowable load at the monitoring station PD-029E on Little Pee Dee River was calculated by determining trend line for the target load at the water quality monitoring station and calculating the average load estimated within the appropriate flow duration intervals (i.e, 10% - 90%). Calculations for both existing and allowable loads are provided in Appendix B.

4.2 Mass Balance Calculations

A mass balance approach was used to estimate amounts of loads contributed by various non-point sources including grazing livestock, wildlife, litter application, spray irrigation, urban runoff, sanitary sewer overflows, and failing septic systems. In quantifying the fecal coliform bacteria load contributed by the various sources, the BIT described in section 3.0 was used to estimate coliform loads to the land surface and stream (USEPA, 2000a). In doing so, the Little Pee Dee River watershed above PD-029E was divided into four segments, to represent the four main Counties located within the watershed. These included Scotland County, North Carolina, Robeson County, North Carolina, Marlboro County, South Carolina and Dillon County, South Carolina. Fecal coliform bacteria load from the various non-point sources within the four Counties were then estimated. A small portion of Richmond County, North Carolina lies within the Little Pee Dee River Project watershed; however, because of the watershed extent in the County and distance from the impaired site, sources of fecal coliform bacteria in Richmond County were not considered, and were not included in the mass balance calculation.

The BIT spreadsheet was used to estimate loads to the land surface from wildlife, urban sources, livestock, poultry and treated swine waste applications, and failing septic systems. To determine the loads actually reaching the stream from these sources, land surface accumulated loads resulting from these sources were multiplied by an attenuation factor that was evaluated by a trial and error method as explained below. An attenuation factor is a fraction amount by which the total land surface accumulated load is reduced before it is directly deposited into the stream.

In determining the attenuation factor used, individual in-stream fecal coliform bacteria loads resulting from urban run-off, sanitary sewer overflow, failing septic systems, wildlife, livestock and poultry and treated swine waste applications were summed, and the resulting total load equated to the total existing load estimated from the load-duration curve method. The attenuation factor that allowed the summed total of the individual loads to equal the existing load estimated from the load-duration curve method was used in the mass balance calculation. Attenuation factor evaluated at the water quality monitoring station PD-029E was 0.529%. Percentages of the fecal coliform bacteria load contributed by each source were then evaluated, allowing for the determination of the dominant fecal coliform sources to the stream. It is important to note that the evaluated run-off fecal coliform bacteria load resulting from livestock is used to account for loads from all livestock sources, including grazing and in-stream livestock.

5.0 LOAD ASSESSMENT RESULTS

This section summarizes results of the total existing and recommended loads estimated by the load-duration curve analysis, and the breakdown by source as determined from the mass balance calculations.

5.1 Existing Conditions

Based on the load duration curve analysis, the total existing load at PD-029E is 1.09×10^{13} counts/day for flow recurrence interval ranging from 10% - 90%, which corresponds to a flow range of 56.7 ft^3/sec – 1632 ft^3/sec. According to the fecal coliform bacteria mass balance, livestock is the largest contributing source on an annual animal basis, followed by poultry litter application, then by spray irrigation of treated swine waste and wildlife. Urban runoff, sanitary sewer overflow and failing septic systems were estimated to be the least contributing sources; all showing very small components of the total load; which is not surprising given the small proportion of developed land and fairly low density of the population in the watershed. (Table 5-1). It is important to note that percentages of the total load contributed by each source are estimates, but these estimated percentages indicate the relative importance of each source.

Table 5-2 lists the estimated percentages of fecal coliform loads contributed by the various non-point sources within North Carolina and South Carolina. It was estimated that a larger portion of the fecal coliform load from livestock sources originate from South Carolina while larger portions of fecal loads resulting from animal waste applications (poultry and lagoon-treated swine waste) originate from North Carolina (Table 5-2). Overall, it was estimated that approximately equal proportion of the total fecal coliform load was contributed from sources in North Carolina and South Carolina (Table 5-2).

TABLE 5-1
Fecal Coliform Bacteria Load to Little Pee Dee River at Water quality Monitoring Station PD-029E

Source	Land Accumulated Load (count/day)	Fecal Load (count/day)	Percent of Total Load (%)
Wildlife	6.14E+13	8.95E+11	8.2
Livestock	1.26E+15	6.96E+12	63.8
Litter application (poultry)	3.65E+14	2.02E+12	18.5
Spray irrigation (lagoon-treated swine waste)	1.75E+14	9.69E+11	8.9
Urban Runoff	6.65E+10	3.69E+08	<0.1
Sanitary sewer overflow	1.14E+09	6.32E+06	<0.1
Failing septic systems	0	5.70E+10	0.5
ALL		**1.09E+13**	100.0

TABLE 5-2
Percentages of Fecal Coliform Bacteria Load Contributed from non-point sources in North and South Carolina to Little Pee Dee River at Water quality Monitoring Station PD-029E

Source	Percent of Total load from NC (%)	Percent of Total load from SC (%)
Wildlife	5.2	3.0
Livestock	16.3	47.6
Litter application (poultry)	15.9	2.6
Litter application (swine)	8.8	<0.1
Urban runoff	<0.1	<0.1
Sanitary sewer overflow	<0.1	0
Failing septic systems	0.4	0.1
ALL	46.6	53.4

5.2 Total Maximum Daily Load

The Total Maximum Daily Load (TMDL) is the maximum amount of a pollutant loading a water body can receive and still maintain water quality standards. In this case, the pollutant of concern is fecal coliform bacteria, and the load is expresses as counts/day (number of coliform bacteria counts/day). Conceptually, the TMDL load is calculated using the following equation:

TMDL = Sum of WLA + Sum of LA + MOS

Where:

WLA (Waste load allocation) is the pollutant load allocated to existing and future point sources.

LA (Load allocation) is the pollutant load allocated to non-point sources and natural occurrences.

MOS (margin of safety) is used to account for uncertainty in determining pollutant loads allowing for the unknown.

Table 5-3 shows the TMDL components for Little Pee Dee River at water quality monitoring stations PD-029E.

The South Carolina DHEC has previously used a margin of safety at 5% of the fecal coliform bacteria standard, or a fecal concentration of 20 counts/ 100 ml. For the Little Pee Dee River at water quality monitoring station PD-029E, this equates to MOS fecal load of 2.72×10^{11} counts/day.

The sum of the waste load allocations for the permitted discharge facilities located in North and South Carolina was calculated by using the water quality standard of 400 counts/ 100 ml for fecal coliform bacteria for a discharge flow of 5.8 MGD (2.20×10^{7} L/day), as has previously been done by South Carolina DHEC. The sum of the WLA for the permitted discharge facilities within the project watershed is 8.78×10^{10} counts/day. This WLA is applied to the TMDL calculation for Little Pee Dee River at monitoring station PD-029E.

The LA was determined from the target line of the load-duration curve within the range of flow recurrence intervals for which the water quality standard was violated (10% to 90% or stream flow ranging from 56.7 cfs to 1632 cfs), which was developed by setting the fecal coliform bacteria concentration of 380 counts/day that is equivalent to the standard concentration less the MOS. The LA for the Little Pee Dee River at PD-029E is 5.45×10^{12} counts/day.

TABLE 5-3
TMDL Components for Little Pee Dee River at Monitoring Stations PD-029E

Impaired Station	Sum of WLA (counts/day)	Sum of LA (counts/day)	MOS (counts/day)	TMDL (counts/day)
PD-029E	8.78×10^{10}	5.45×10^{12}	2.72×10^{11}	5.81×10^{12}

5.3 Critical Conditions

Both monitoring and load-duration curve results demonstrate that the fecal coliform bacteria standard at monitoring station PD-029E on Little Pee Dee River can be exceeded under low flow and high flow conditions. Load-duration curves show that at the monitoring station, PD-029E, most of the standard violations occurred during dry weather conditions; however, standard violations did occur for flow conditions ranging from high flows to dry weather conditions (Figure 4-1). Monitoring results also indicate that the critical seasonal condition for Little Pee Dee River at PD-029E is the warm weather period (July - October) when in-stream livestock depositions are active. Because the load duration method makes use of data from the full range of flow and seasonal conditions, the resulting TMDL inherently addresses the critical conditions.

6.0 POTENTIAL ALLOCATIONS

The required total load reduction is the difference between the existing load and the target load expressed as a percentage. The target load to the stream is the TMDL minus the MOS. The target loading for Little Pee Dee River at PD-029E requires a total reduction of 49.2% from the current load of 1.09×10^{13} counts/day (Table 6-1).

The sum of the WLA of the permitted discharge facilities, which discharges on Little Pee Dee River Tributaries upstream of PD-029E is equal to 8.78×10^{10} counts/day. This WLA value is almost an insignificant component of the TMDL at water quality monitoring station PD-029E. In practice, this requires continued compliance of all point source discharges with effluent limits for bacteria.

Because livestock sources are the major contributing sources of fecal coliform bacteria to Little Pee Dee River at monitoring station PD-029E (accounting for 64% of the total coliform load at the water quality monitoring station), it is recommended that allocations include one of the higher percentage of reductions from livestock sources at the impaired water quality monitoring station. Recommended allocations at monitoring station PD-029E include a 64% reduction in loads from livestock sources, a 41% reduction in loads from poultry litter and 100% reduction in loads from sanitary sewer overflows (SSOs) and failing septic systems. The net result is a 49.2% reduction in the total existing load of fecal coliform bacteria to Little Pee Dee River at the impaired station, which is the required reduction needed to achieve the target load.

The recommended load allocations are based on good engineering and agricultural practices. For example, although sanitary sewer overflows and failing septic systems are not major causes of water quality violations, their elimination is important for public health reasons. Similarly, the reduction in loads from poultry litter application will help reduce exceedances of the criteria magnitude during spring storm events and/or at times when poultry production increases, prevent over fertilization of certain crops and help improve maintenance of soil nutrient levels.

TABLE 6-1
Recommended Load Reduction for Little Pee Dee River at Monitoring Station PD-029E

Source	Existing Load (counts/day)	Target Load (counts/day)	Reduction (%)
Livestock	6.96×10^{12}	2.49×10^{12}	64
Litter application (poultry)	2.02×10^{12}	1.19×10^{12}	41
Sanitary Sewer Overflow	6.32×10^{6}	0	100
Failing Septic Systems	5.3×10^{10}	0	100
Total	*1.09×10^{13}*	*5.45×10^{12}*	***49.2***

7.0 AGRICULTURAL LAND USE CHARACTERIZATION

7.1 GIS Datalayer Development of Agricultural Land Uses

Numerous agricultural agencies in South Carolina and North Carolina are charged with the responsibility of satisfying the provisions described in this fecal coliform bacteria Load Reduction Management Plan, and any future requirements resulting from state TMDL development endeavors. GIS datalayers have been developed for the South Carolina and North Carolina portions of the upper Little Pee Dee River project watershed area to help accomplish the following future implementation planning tasks:

- Assess potential sources of fecal coliform bacteria loading from specific pasture and cropland land use areas;

- Effectively and efficiently consolidate and monitor corrective actions (i.e., Best Management Practices (BMPs) and conservation practices) associated with meeting the goals of the Load Reduction Management Plan;

- Facilitate consensus building among the various agencies and landowners during implementation decision making.

The datalayer development effort included the following steps:

1. The Farm Service Agency (FSA) Common Land Use (CLU) Geographic Information (GIS) Databases for Dillon and Marlboro Counties were accessed to acquire approximately 2,500 farm field polygons located in the South Carolina portion of the project watershed area. The FSA tract and CLU (individual farm field) administrative numbers were used as farm field unique identifiers.

2. Scanned, digitized, and georeferenced United States Geological Survey (USGS) topographic maps called Digital Raster Graphics (DRGs) were used to digitize the upper Little Pee Dee River project watershed area, and to divide the project watershed area into seven smaller watershed components. This information was combined with the farm field datalayer and other information (i.e., roads, hydrology, etc.) to form a GIS project database

3. 1999 and 1998 Color infrared Digital Orthophoto Quarter Quadrangles (DOQQs) were obtained for South and North Carolina aerial coverage, respectively. These aerial photographs were used during interviews with local agency personnel (i.e., Natural Resource Conservation Service (NRCS) District Conservationists) to identify locations of land use activities pertinent to fecal coliform bacteria loading from agricultural sources. In the South Carolina portion of the watershed, this information was added to the existing farm field polygons. In North Carolina, point data themes were placed directly over the aerial photographs as suggested by the Agency personnel; or were carried over from agency hand-marked maps.

4. A Geographic Positioning System (GPS) was linked to the GIS database. The GPS was connected to a laptop computer operating the GIS database with an interface to the GIS software from the GPS providing a real time display of the GPS location. The exact location, movements, and direction of movement was displayed on the laptop screen in conjunction with the GIS program displaying the DOQQ base map and spatial data, roads, streams, farm field boundaries, and other features. The GIS/GPS system was taken into the field where drive-byes were conducted to acquire information on fecal coliform bacteria-related loading information from agricultural sources in the South Carolina portion of the project watershed area. The GPS unit shows the movement of the survey vehicle on the roads datalayer. In addition, a record of those roads that have been traveled during the drive-bye survey was maintained. To note farm fields with pertinent bacteria information, the GIS database of farm fields was referenced to determine and record the administrative number of respective farm fields in question, and any bacteria loading information specific to the individual farm fields. The drive-bye information was later compiled in the GIS database by incorporating the following farm field GIS attributes or tabular data: agricultural land uses (i.e., pasture, hayfield, or cropland farm field types), farm fields that have gone idle, the location of poultry houses, and animal sitings.

7.2 Agricultural Land Use Characterization Results

The results of the agricultural land use characterization are detailed below for each of the seven upper Little Pee Dee River project watershed area subbasins depicted in Figure 1-2. Based on a review of the water quality information at the respective ambient water quality monitoring stations, it is recommended that those farm fields draining into streams that flow directly to the PD-029E station on the Route 29 Bridge (without flowing past the other South and North Carolina stations showing no fecal coliform bacteria impairments) be prioritized for project implementation. The prioritization areas include the following: All of the Wilkerson Creek subwatershed of the Lower Shoe Heel Creek Watershed in Robeson County, North Carolina (Figure 7-3D); all of the Sweat Swamp Watershed in Dillon and Marlboro Counties, South Carolina (Figure 7-7); and the portion of the Little Pee Dee River Mainstem in Dillon County downstream of the PD-069 ambient water quality monitoring station (Figure 7-6B).

The following subbasin descriptions and figures provide a detailed accounting of agricultural practices in the project watershed area.

Upper Gum Swamp Creek Watershed

The Upper Gum Swamp Creek Watershed is located entirely in Scotland County, North Carolina, and covers the northwest corner of the project watershed area. It is approximately 63 square miles in size. As noted in Figures 7-1, a number of agricultural land use activities in the Upper Gum Swamp Creek Watershed are potential sources of fecal coliform bacteria. Three distinct groupings of farm fields are delineated and presented in Figures 7-1A, 7-1B, and 7-1C. Table 7-1 shows those activities pertinent to fecal coliform bacteria within the three Farm Group areas. This watershed is not prioritized for project implementation activities.

Table 7-1 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading
Upper Gum Swamp Creek Watershed

Farm Group	Pastures	Poultry Houses	Hog Operations
A	4	5	1 sited north of Group A
B	11	4	0
C	0	0	1

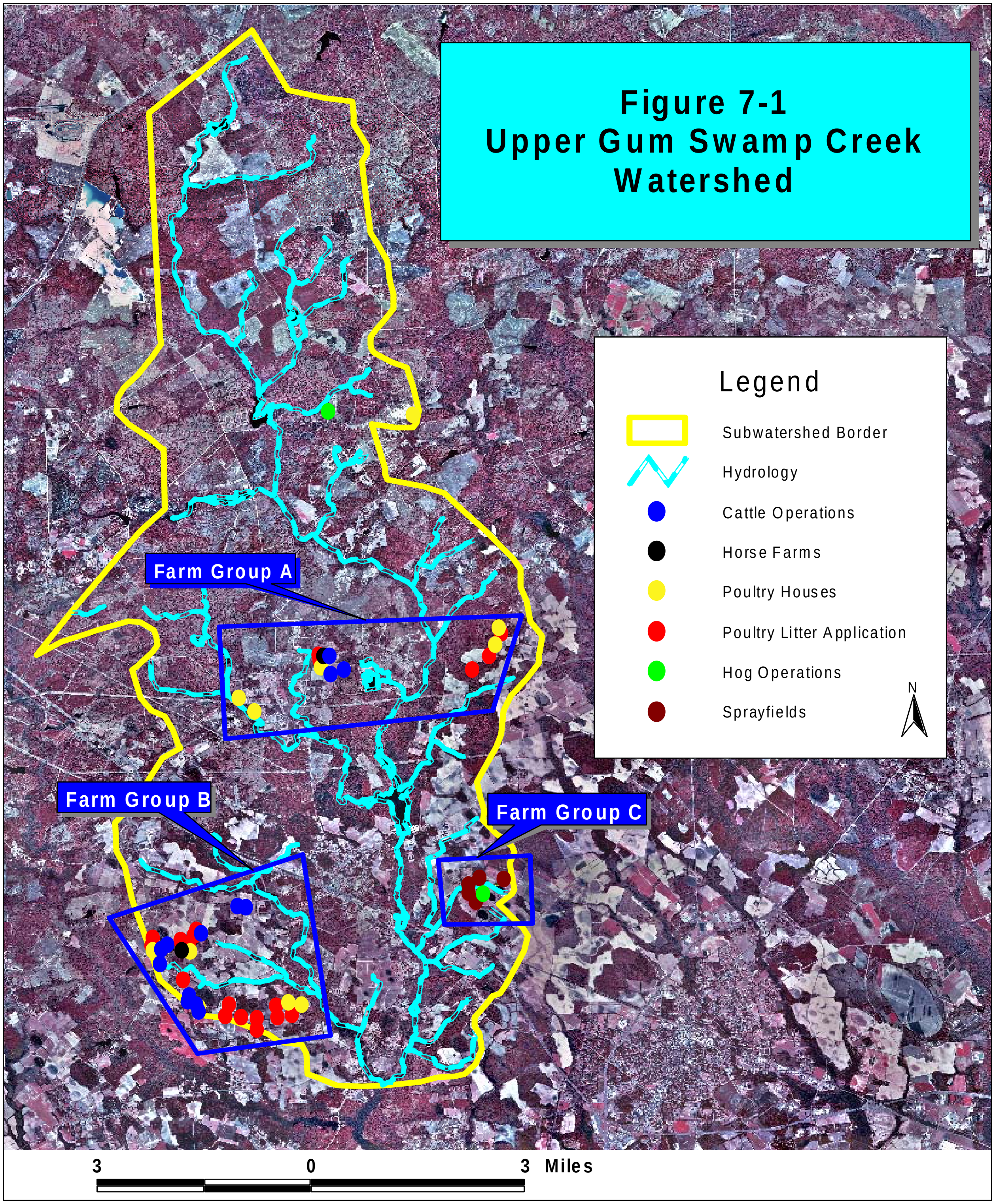


Figure 7-1
Upper Gum Swamp Creek
Watershed
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
Farm Group A
Farm Group B
Farm Group C
3
0
3 Miles

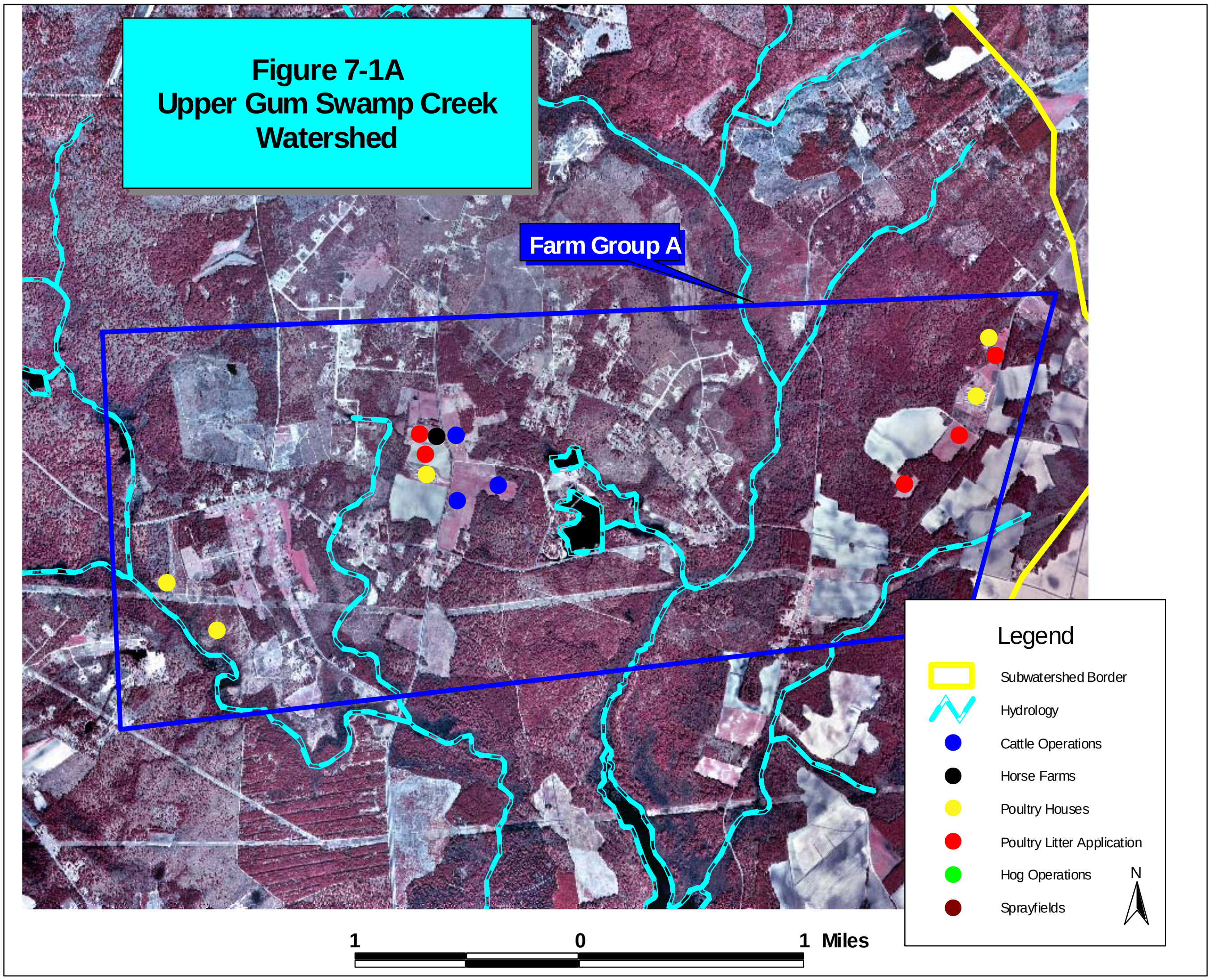


Figure 7-1A
Upper Gum Swamp Creek
Watershed
Farm Group A
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
1
0
1 Miles

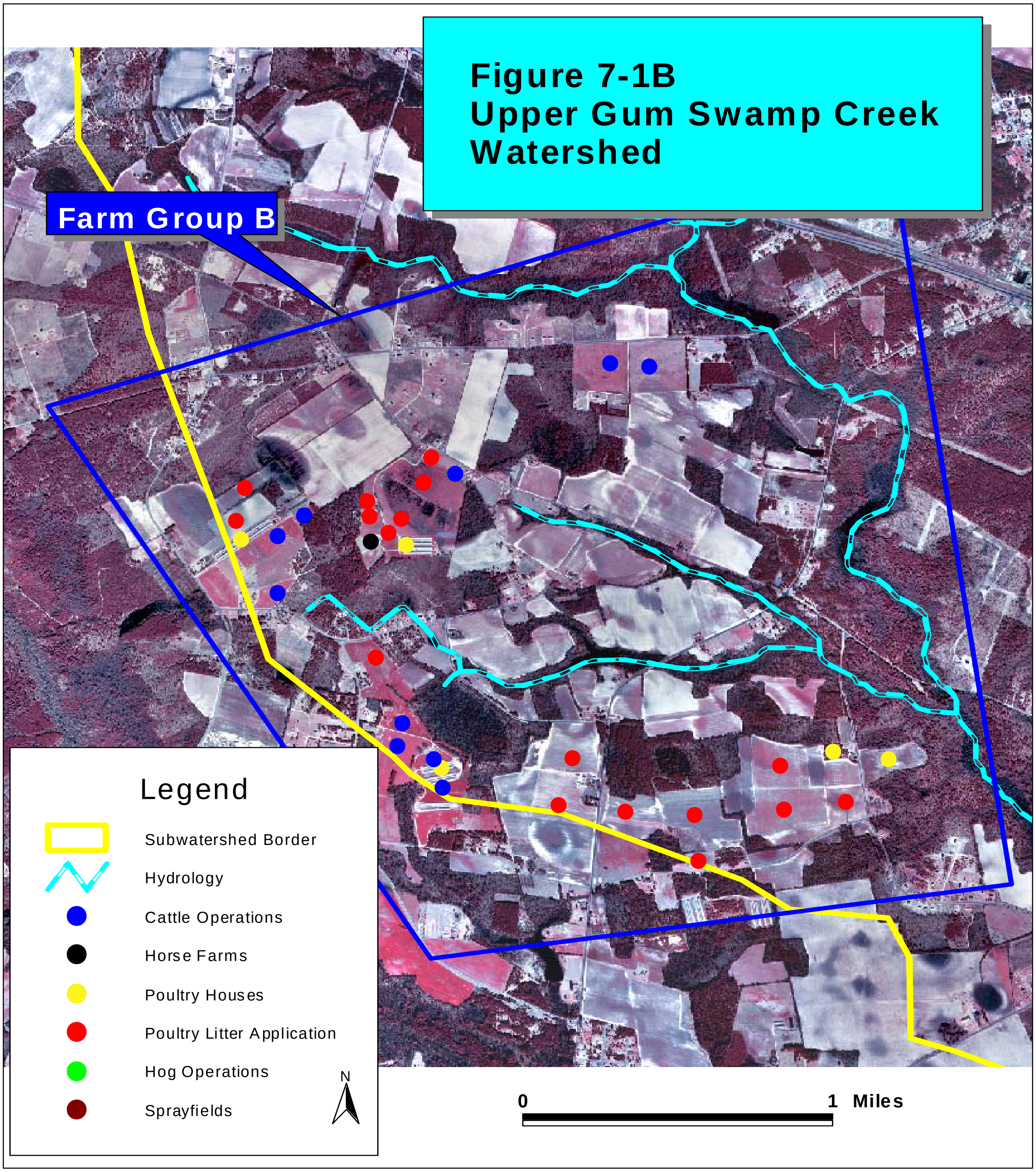


Figure 7-1B
Upper Gum Swamp Creek
Watershed
Farm Group B
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
1 Miles

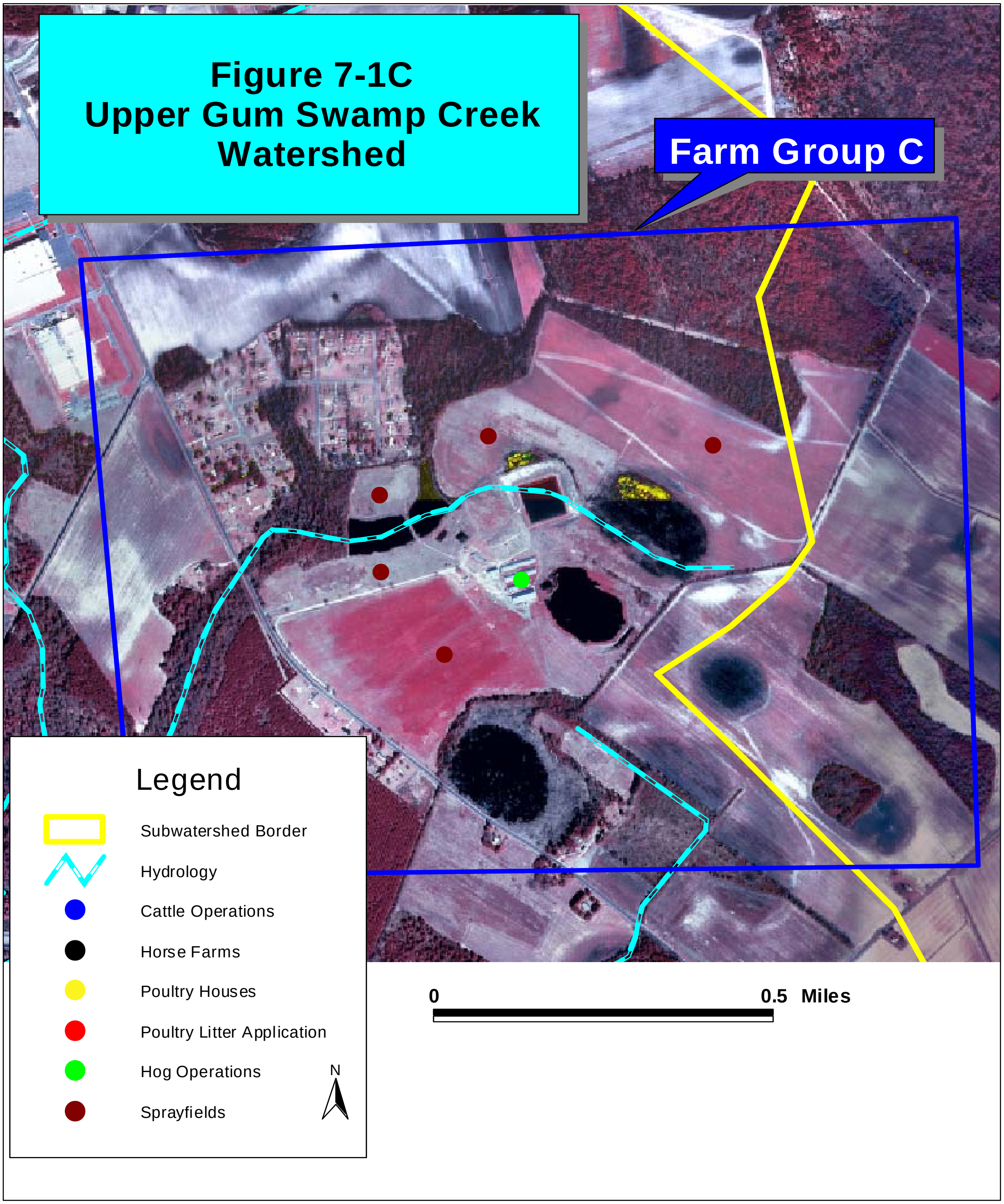


Figure 7-1C
Upper Gum Swamp Creek
Watershed
Farm Group C
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
0.5 Miles

Upper Shoe Heel Creek Watershed

The Upper Shoe Heel Creek watershed is approximately 76 square miles and is located entirely in Scotland County. It occupies the northeastern corner of the project watershed area. Figure 7-2 shows the location of potential sources of fecal coliform bacteria from agricultural land uses. Due to the size of the watershed and the quantity of agricultural land use activities, four distinct Farm Groups have been identified. Figures 7-2A through 7-2D provide a more detailed mapping of these Farm Groups. Table 7-2 shows those activities pertinent to fecal coliform bacteria within the four Farm Group areas. This watershed is not prioritized for project implementation activities.

Table 7-2 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading
Upper Shoe Heel Creek Watershed

Farm Group	Pastures	Poultry Houses	Hog Operations
A	0	5	0
B	10	2	5
C	10	2	3
D	4	1	3

Lower Shoe Heel Creek Watershed

The Lower Shoe Heel Creek Watershed is located predominately in North Carolina. Although the northern portion of the watershed above the Town of Maxton is in Scotland County, the majority of the Watershed occupies areas in Robeson County. A small section of the Watershed extends into Dillon County, South Carolina just prior to the Shoe Heel Creek flow entering the Little Pee Dee River not far from the fecal coliform bacteria impairment shown at the PD-029E ambient water quality monitoring station. The Watershed is approximately 81 square miles in size. An ambient water quality monitoring stations is located on the Gaddy Mill Road Bridge (I0530000) where Shoe Heel Creek samples are taken approximately 2.5 stream miles from the South Carolina border. Although fecal coliform bacteria impairments have not been noted at this monitoring station, the Wilkerson Creek tributary discharges into Shoe Heel Creek below this monitoring station. Its water quality is, therefore, first measured at the South Carolina fecal coliform bacteria impaired ambient water quality monitoring station at the Route 23 Bridge (PD-029E). As a consequence, the Wilkerson Creek drainage and the Shoe Heel Creek supporting watershed below the I0520000 monitoring station have been prioritized for project implementation activities. Although the hog operations in the Wilkerson Creek subwatershed do not show sprayfields because the Robeson Soil and Water Conservation District did not provide detailed mapping, it was stated by Tiffany Conrad of the North Carolina Cooperative Extension Service (March 2005) that many of the sprayfields associated with these hog operations also support the seasonal grazing of cattle. It is, therefore, recommended that potential cattle exclusion BMPs and conservation practices also be explored in the Wilkerson Creek subwatershed. Table 7-3 shows the location of those agricultural activities that are potential sources of fecal coliform bacteria loading. Two additional potential sources were also surveyed: a landfill and a hog truck washing operation. A more detailed accounting of specific Farm Groups are provided in Figures 7-3A through 7-3E. Table 7-3 lists quantities of agricultural land use activities in the Lower Shoe Heel Creek Watershed that potentially contribute to in-stream fecal coliform bacteria concentrations.

Table 7-3 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading
Lower Shoe Heel Creek Watershed

Farm Group	*Pastures	Poultry Houses	Hog Operations
A	0	1	3
B	0	0	3
C	0	1	8
D	0	4	3
South Carolina	9	0	0

*Does not include sprayfields supporting limited cattle grazing.

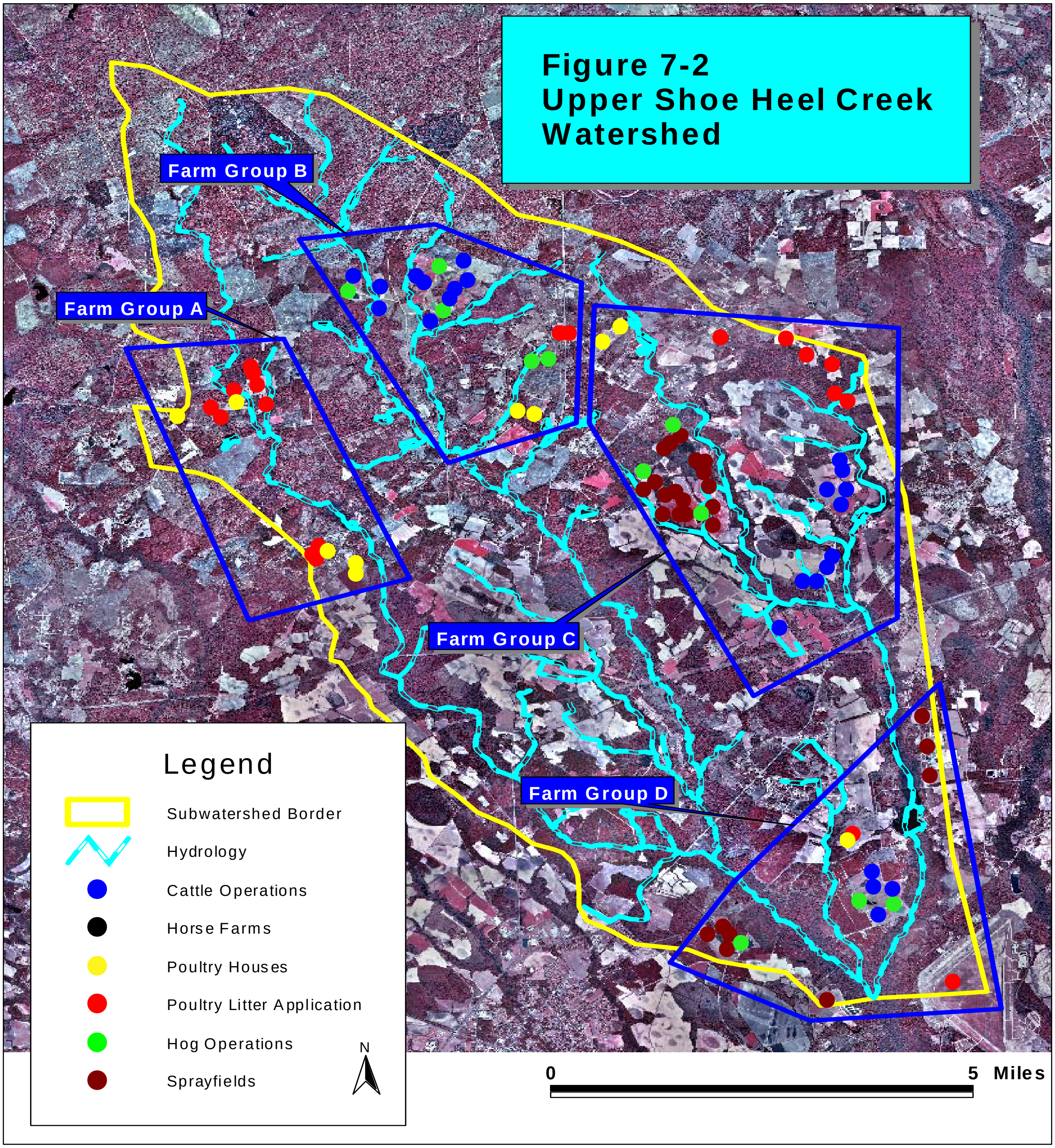


Figure 7-2
Upper Shoe Heel Creek
Watershed
Farm Group A
Farm Group B
Farm Group C
Farm Group D
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
5 Miles

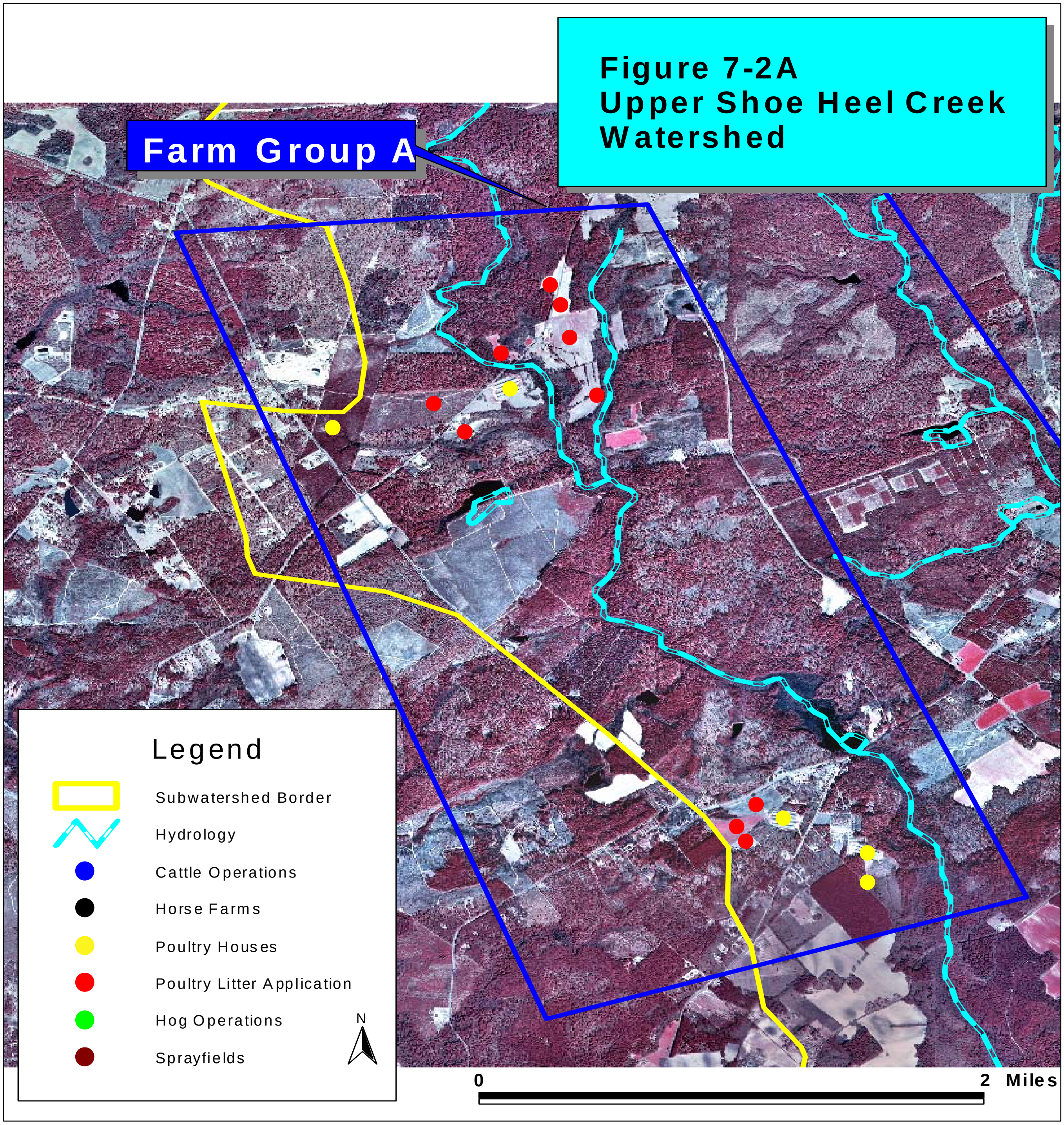


Figure 7-2A
Upper Shoe Heel Creek
Watershed
Farm Group A
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
2 Miles

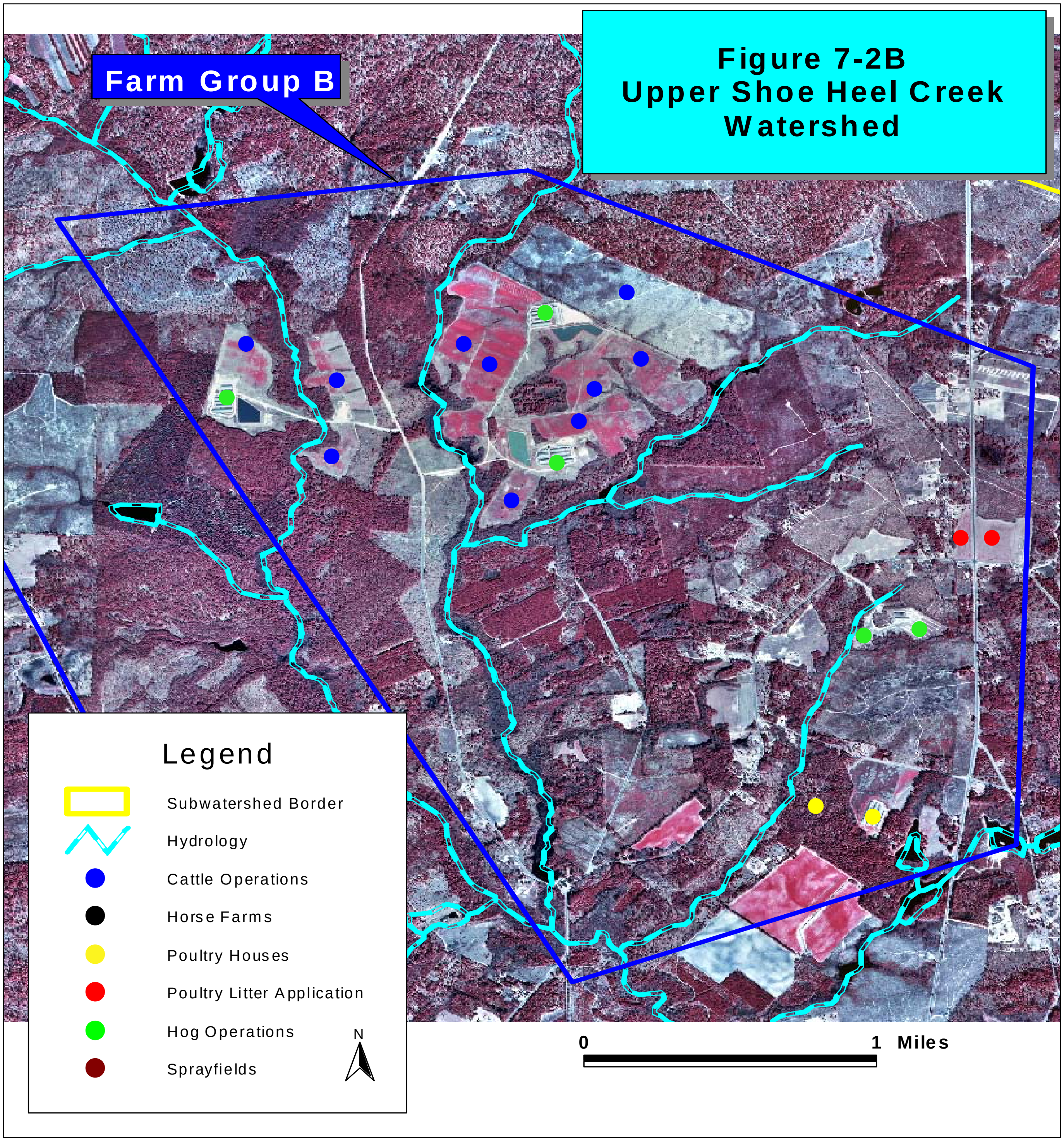
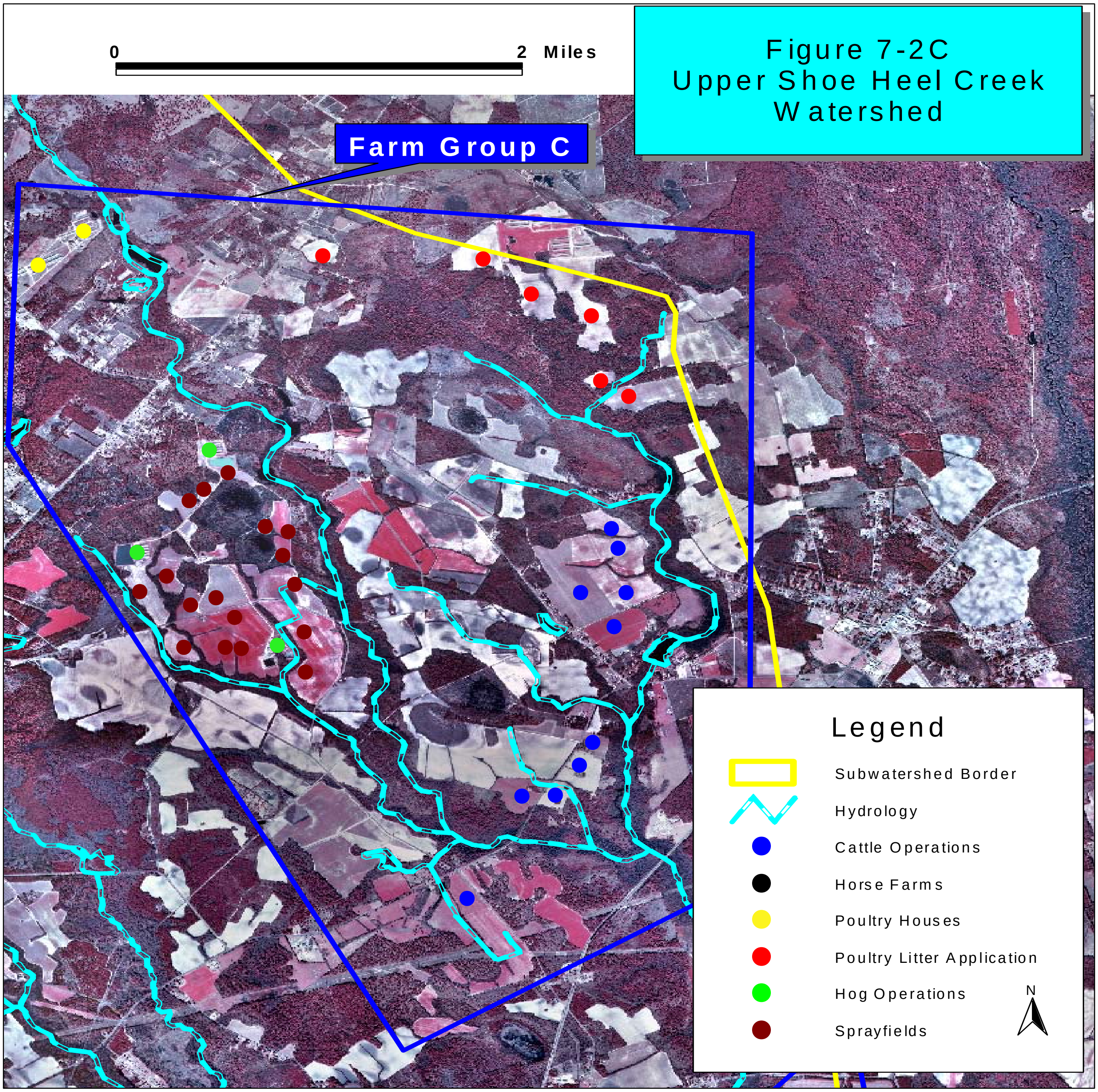
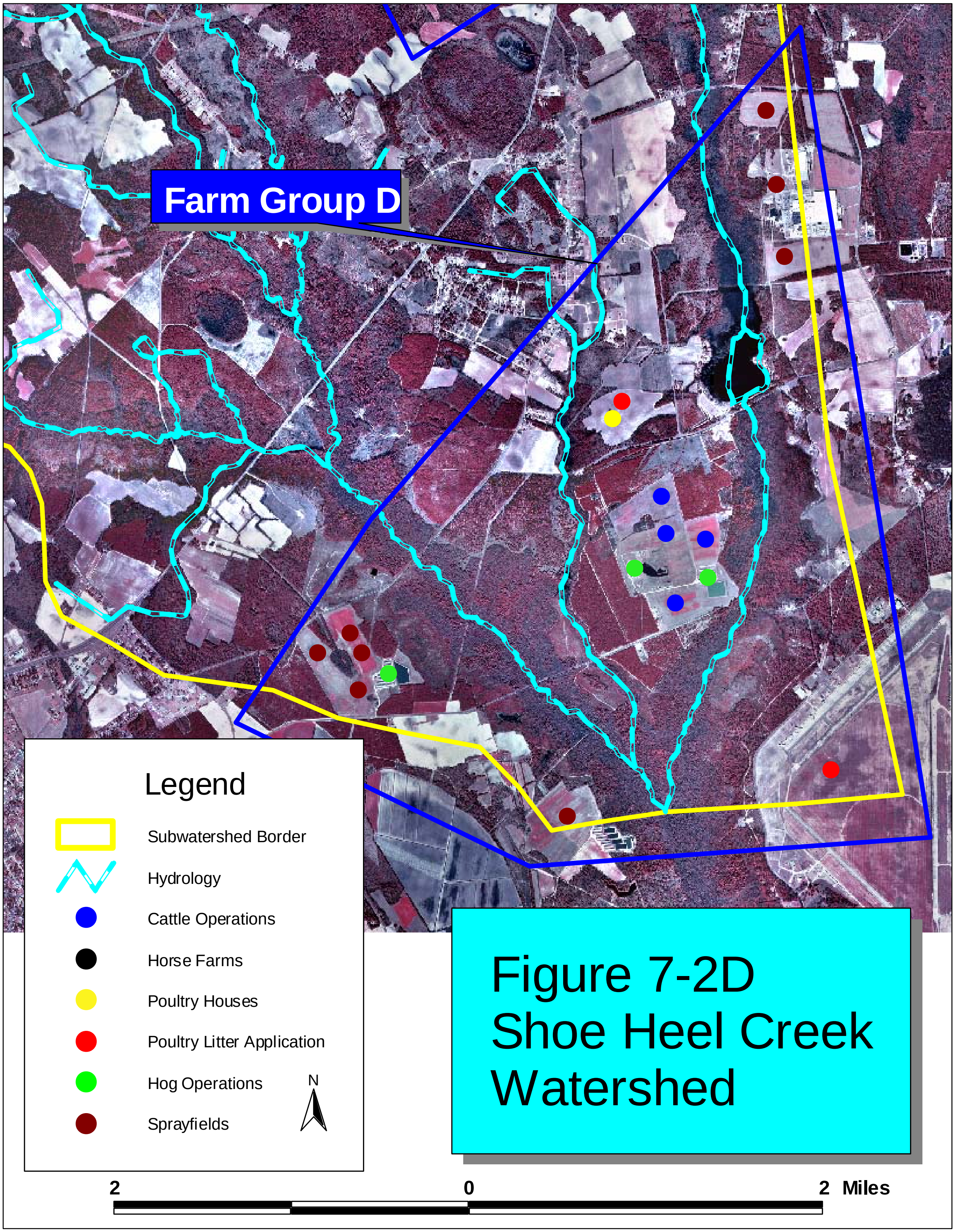


Figure 7-2B
Upper Shoe Heel Creek
Watershed
Farm Group B
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
1 Miles


0
2 Miles
Figure 7-2C
Upper Shoe Heel Creek
Watershed
Farm Group C
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N

*Many of the pastures surrounding the three hog operations are sprayfields supporting seasonal cattle grazing.



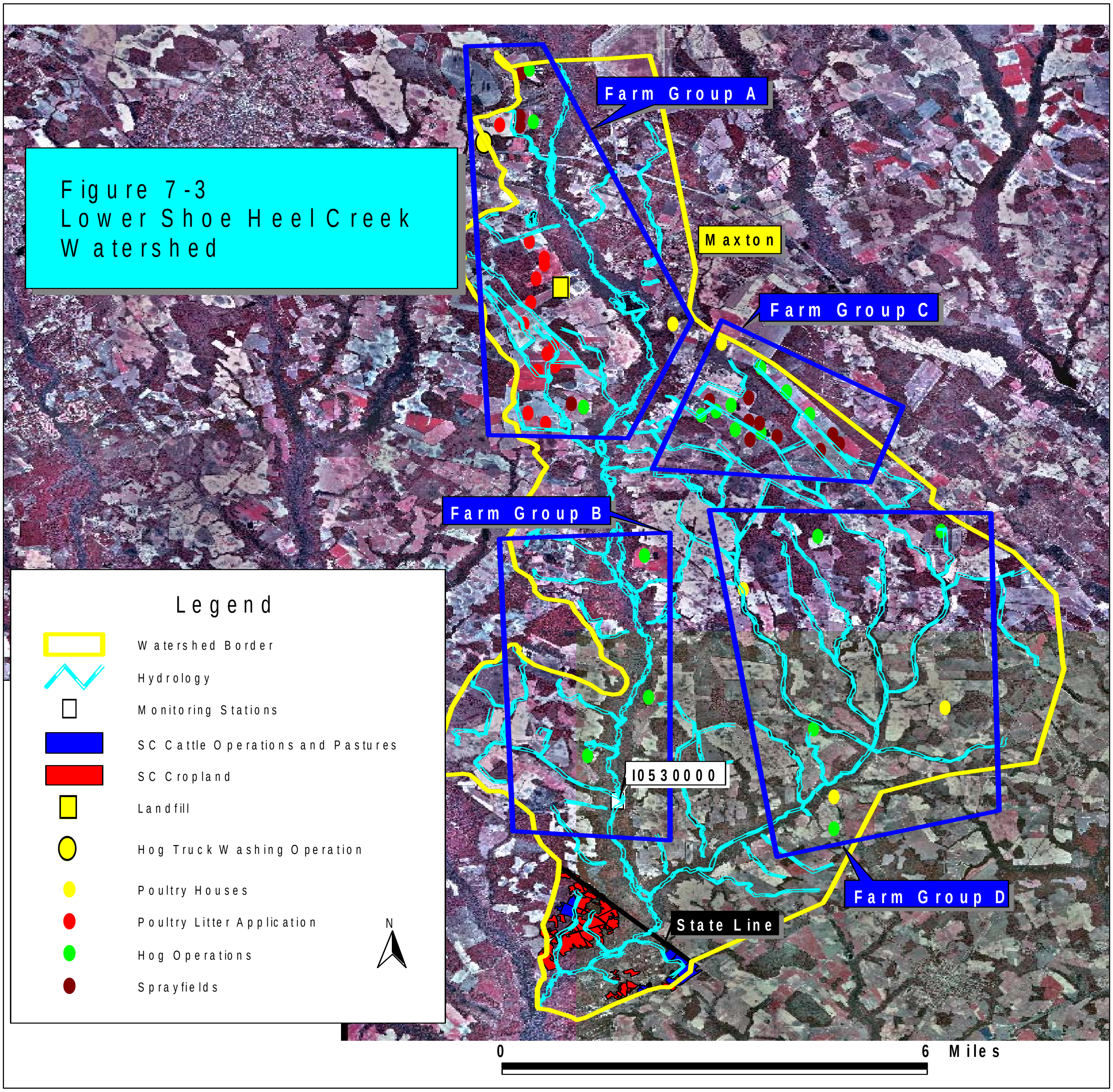


Figure 7-3
Lower Shoe Heel Creek
Watershed
Farm Group A
Maxton
Farm Group C
Farm Group B
Farm Group D
I0530000
State Line
Legend
Watershed Border
Hydrology
Monitoring Stations
SC Cattle Operations and Pastures
SC Cropland
Landfill
Hog Truck Washing Operation
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
6 Miles

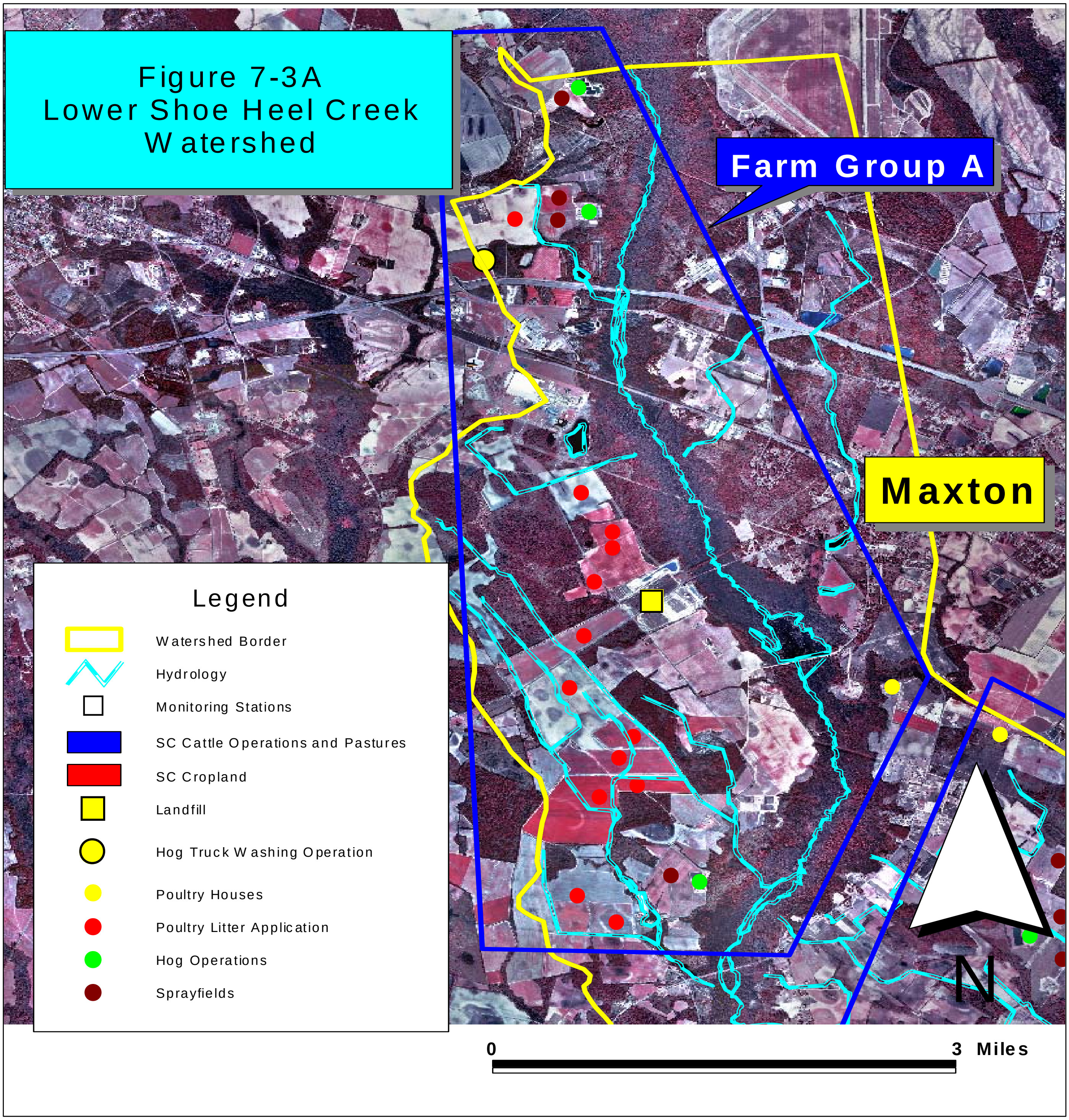


Figure 7-3A
Lower Shoe Heel Creek
Watershed
Farm Group A
Maxton
Legend
Watershed Border
Hydrology
Monitoring Stations
SC Cattle Operations and Pastures
SC Cropland
Landfill
Hog Truck Washing Operation
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
3 Miles

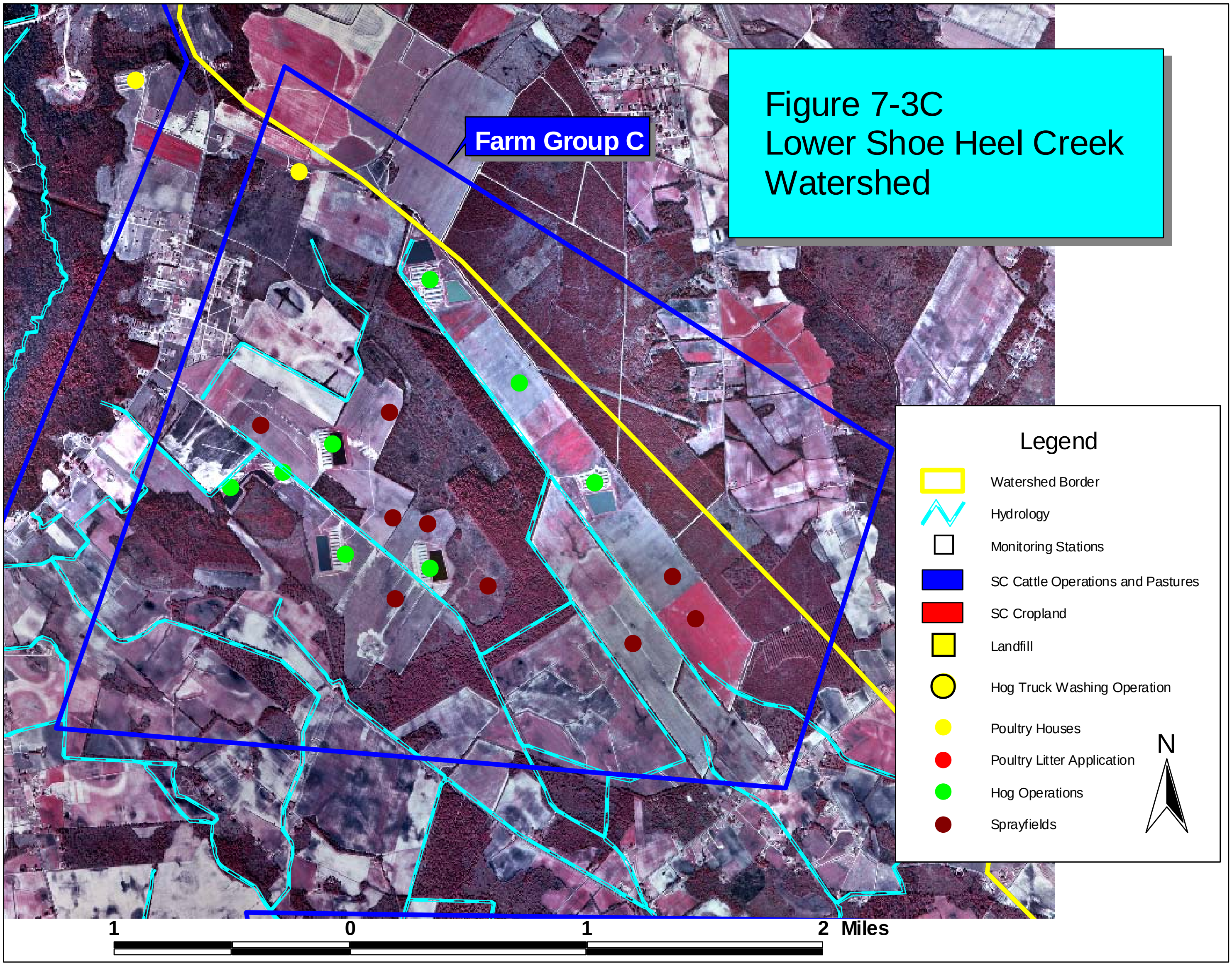
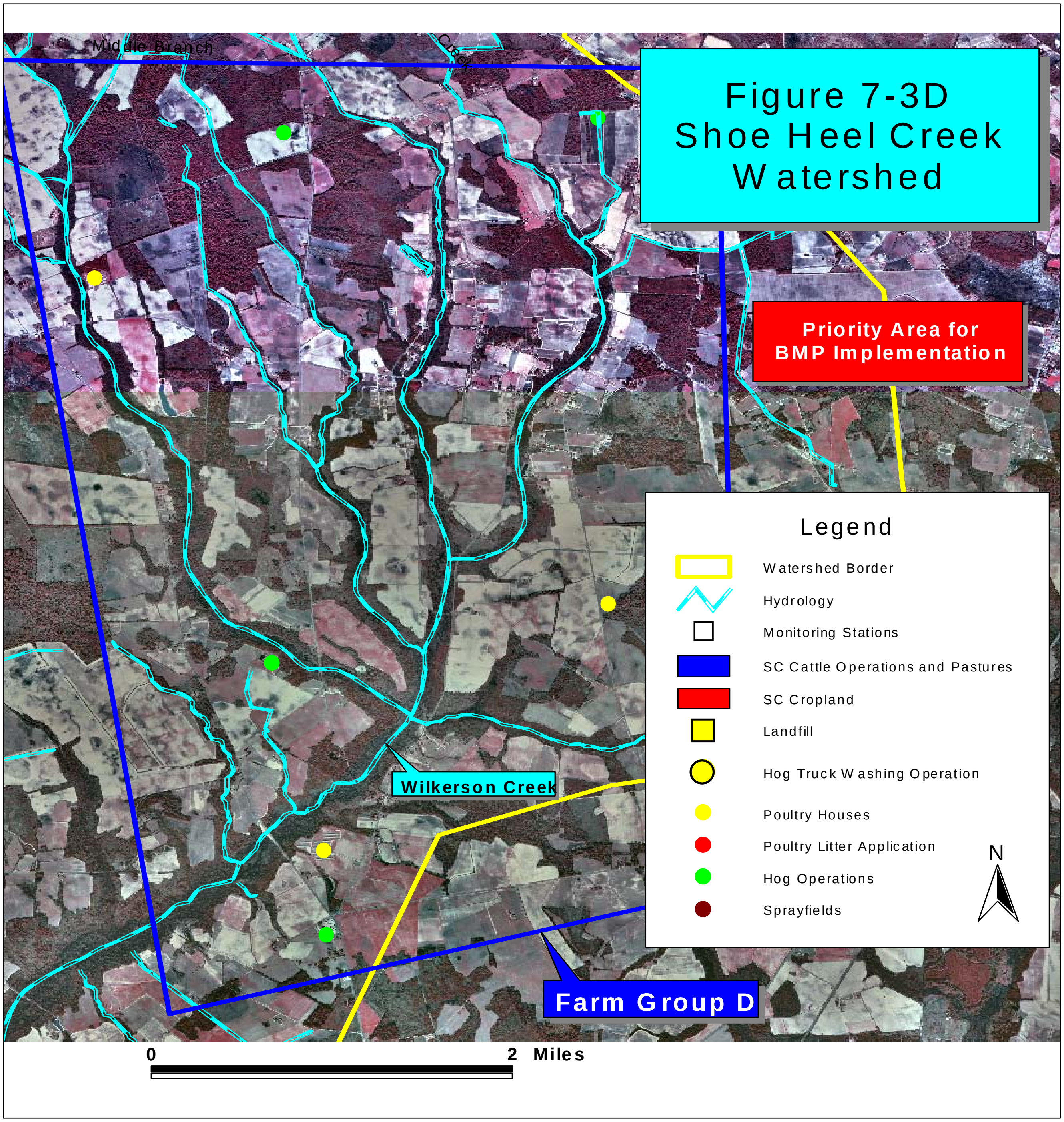


Figure 7-3C
Lower Shoe Heel Creek
Watershed
Farm Group C
Legend
Watershed Border
Hydrology
Monitoring Stations
SC Cattle Operations and Pastures
SC Cropland
Landfill
Hog Truck Washing Operation
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
1
0
1
2 Miles

*The hog operations shown in Figure 7-3D also possess sprayfields supporting seasonal cattle grazing.



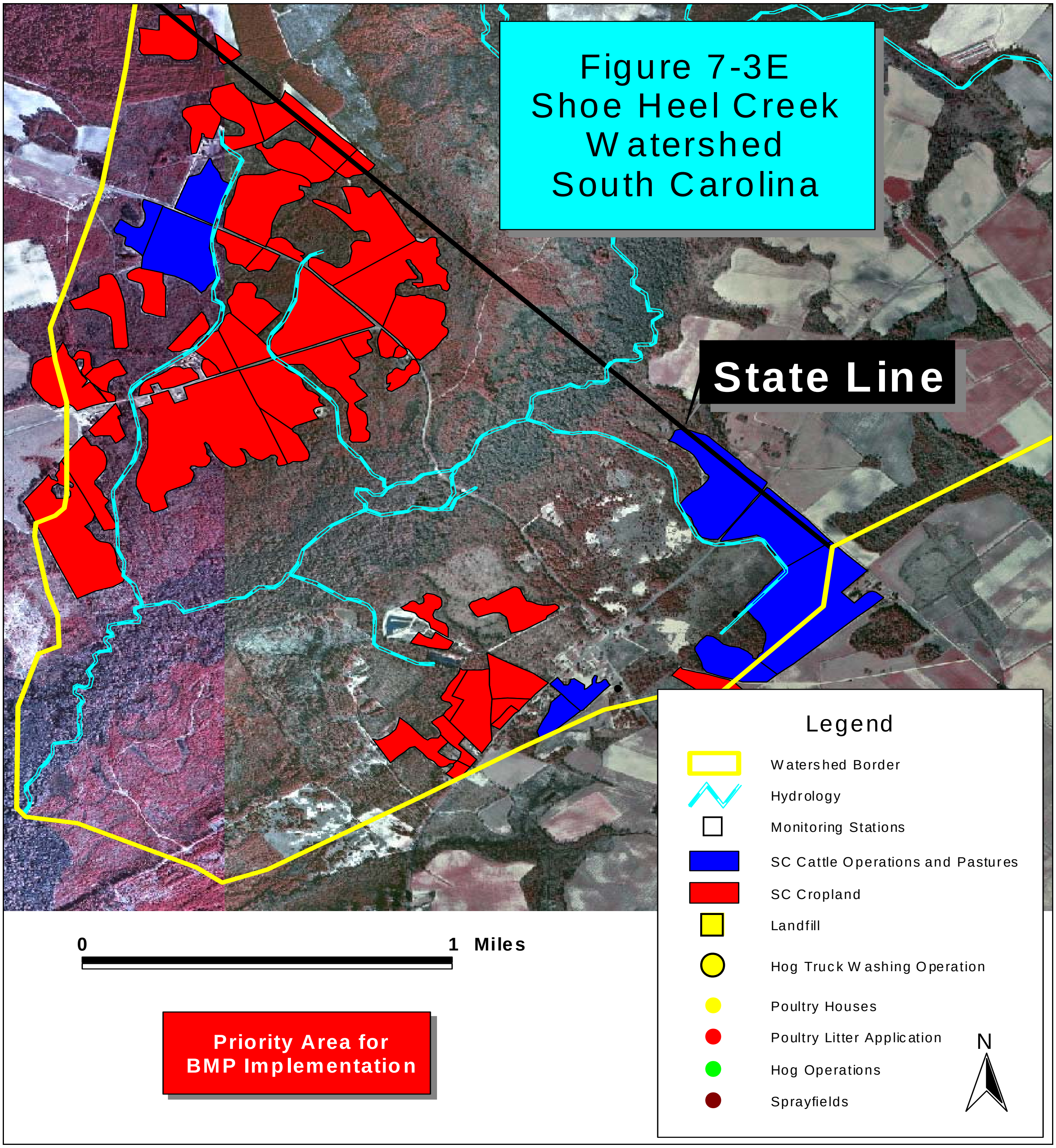


Figure 7-3E
Shoe Heel Creek
Watershed
South Carolina
State Line
Legend
Watershed Border
Hydrology
Monitoring Stations
SC Cattle Operations and Pastures
SC Cropland
Landfill
Hog Truck Washing Operation
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
1 Miles
Priority Area for
BMP Implementation

Leiths Creek Watershed

The Leiths Creek Watershed is approximately 76 square miles. The vast majority of the Watershed is located in North Carolina; approximately two-thirds of which is in Scotland County. A small portion of the Watershed extends into Marlboro County, South Carolina. Aside from the potential application of poultry litter on the South Carolina farm fields, no South Carolina agricultural land uses are related to fecal coliform bacteria loading. Residential and urban nonpoint source runoff from the City of Laurinberg is considered to be a potential source of fecal coliform bacteria loading. Concerns for loading from the eastern portion of the City are limited due to the lack of violations to the standard demonstrated at the I0490000 ambient water quality monitoring station. The affects of potential fecal coliform bacteria loading from the majority of the flows passing through the City are captured at the I0510000 ambient water quality monitoring station where impairments are noted. This station is also capturing drainage from substantial numbers of agricultural land use practices that are known to be potential sources of bacteria. Leiths Creek eventually drains into the Little Pee Dee River mainstem in South Carolina. These high concentrations of fecal coliform bacteria found at station I0510000 are apparently lowered by the Little Pee Dee River flows because the fecal coliform bacteria concentrations are not violating the South Carolina state standard at the PD-069 ambient water quality monitoring station; just 5.8 stream miles from I0510000. Although this portion of the Leiths Creek Watershed is not prioritized for implementation activities, concerns are warranted because the high fecal coliform bacteria concentrations may be affecting the assimilative capacity of the downstream Little Pee Dee River. Figure 7-4 shows the location of numerous agricultural land uses that may be sources of fecal coliform bacteria loading. More detail is provided in Figures 7-4A through 7-4D. Quantities of various agricultural land use types that are historically associated with fecal coliform bacteria loading are provided in Table 7-4.

Table 7-4 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading
Leiths Creek Watershed

Farm Group	Pastures	Poultry Houses	Hog Operations
A	0	1	1
B	16	2	3
C	0	0	0
D	0	0	4

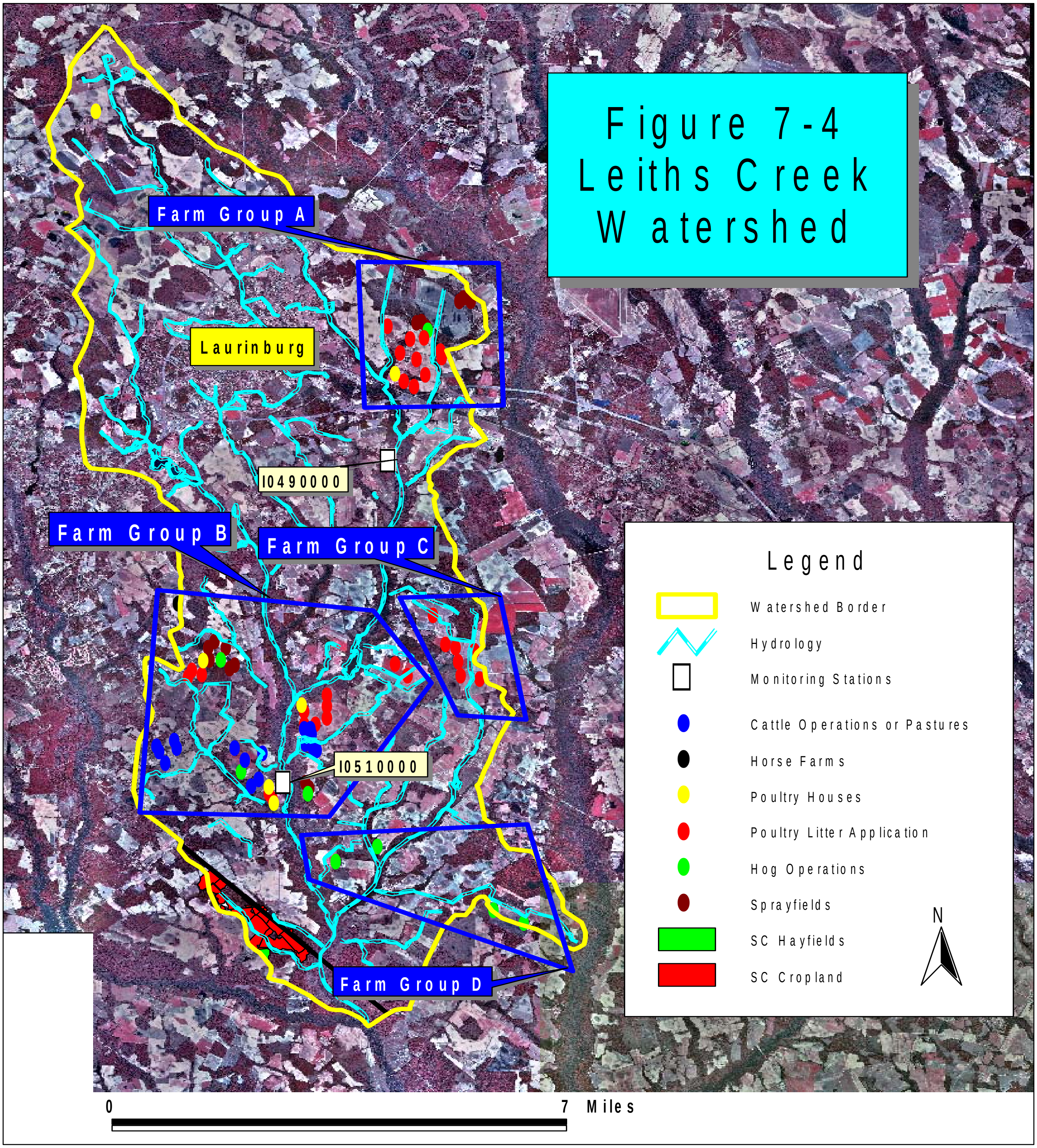


Figure 7-4
Leiths Creek
Watershed
Farm Group A
Laurinburg
I0490000
Farm Group B
Farm Group C
I0510000
Farm Group D
Legend
Watershed Border
Hydrology
Monitoring Stations
Cattle Operations or Pastures
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
SC Hayfields
SC Cropland
N
0
7 Miles

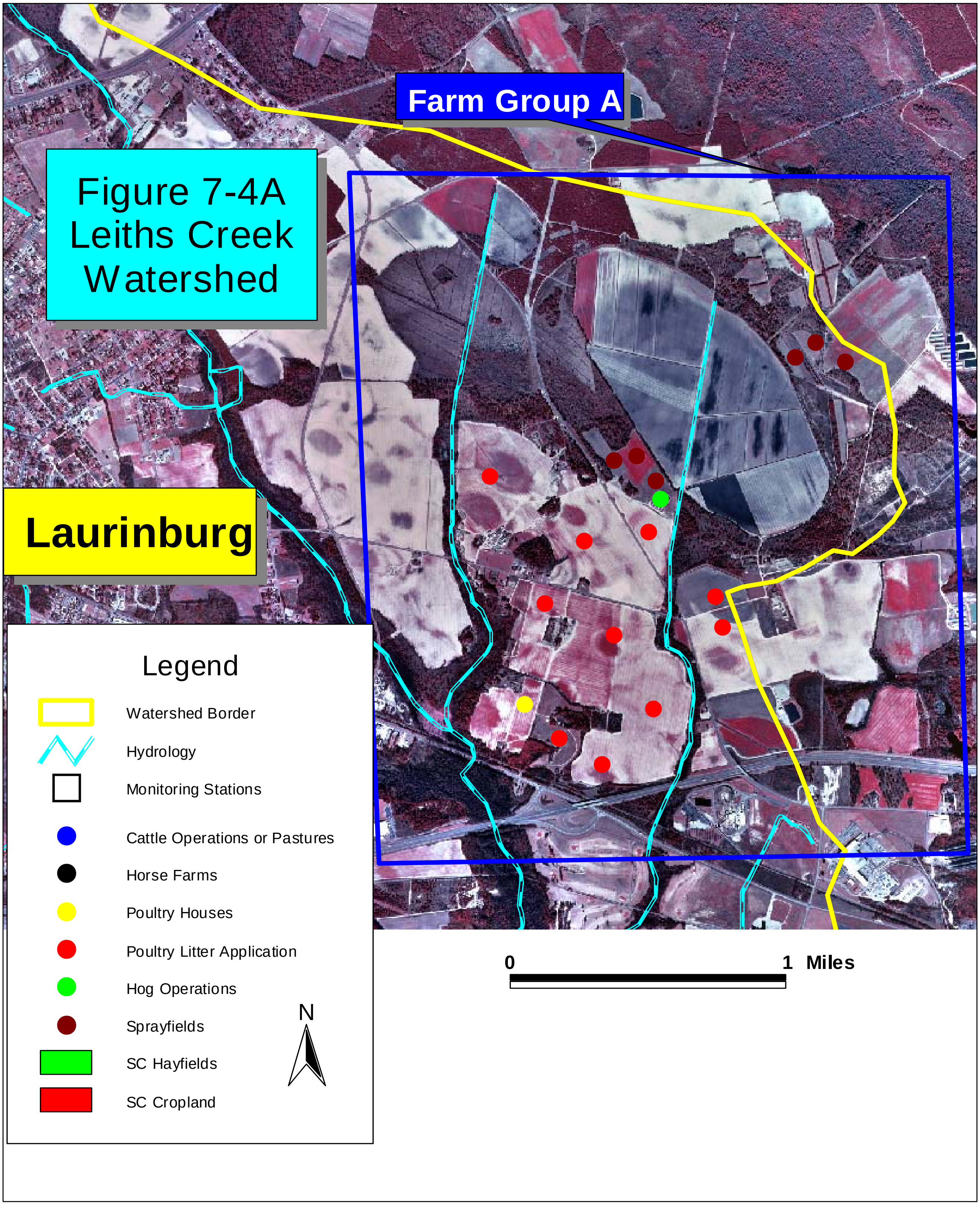


Figure 7-4A
Leiths Creek
Watershed
Farm Group A
Laurinburg
Legend
Watershed Border
Hydrology
Monitoring Stations
Cattle Operations or Pastures
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
SC Hayfields
SC Cropland
N
0
1 Miles

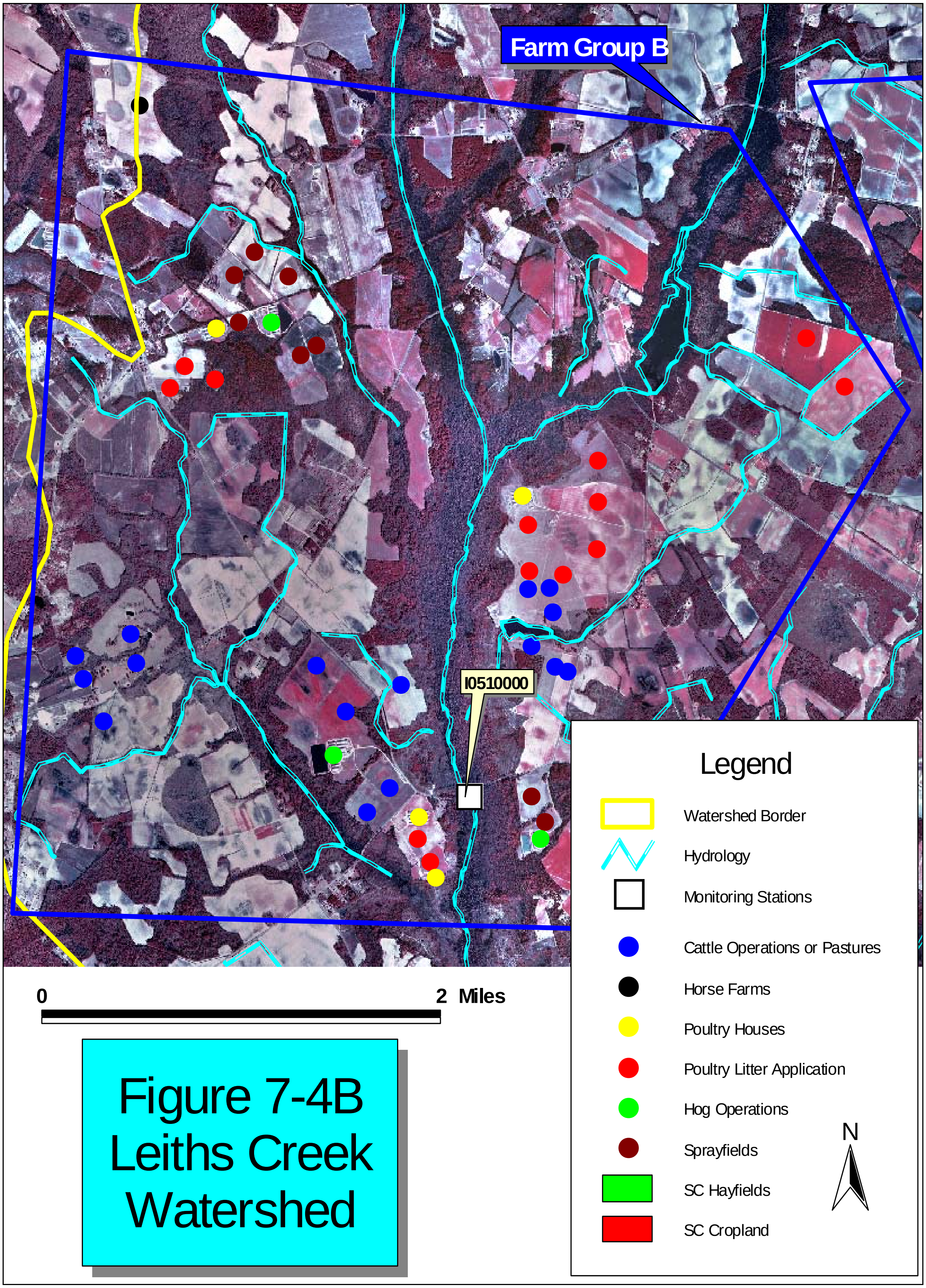


Figure 7-4B
Leiths Creek
Watershed

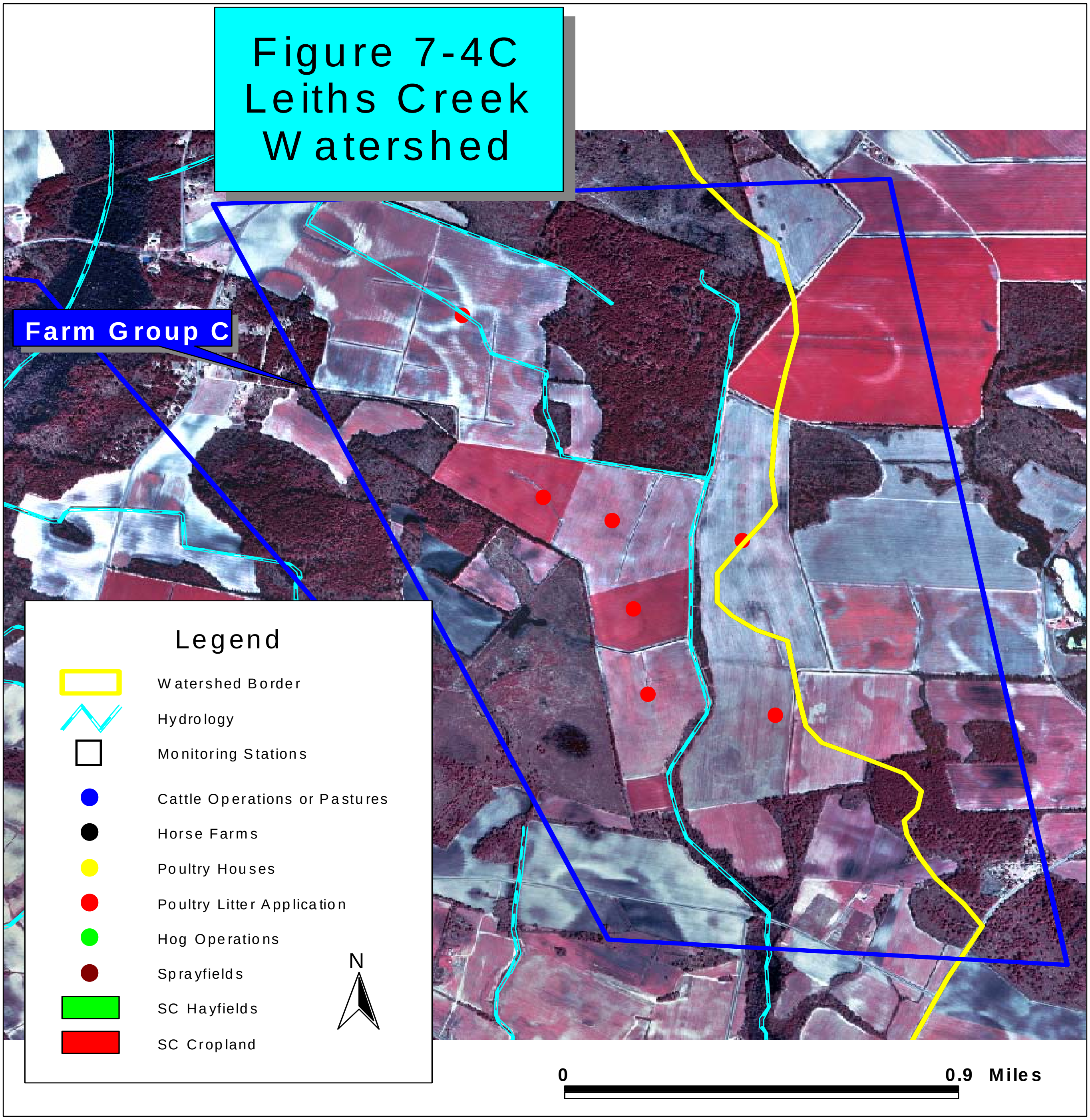


Figure 7-4C
Leiths Creek
Watershed
Farm Group C
Legend
Watershed Border
Hydrology
Monitoring Stations
Cattle Operations or Pastures
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
SC Hayfields
SC Cropland
N
0
0.9 Miles

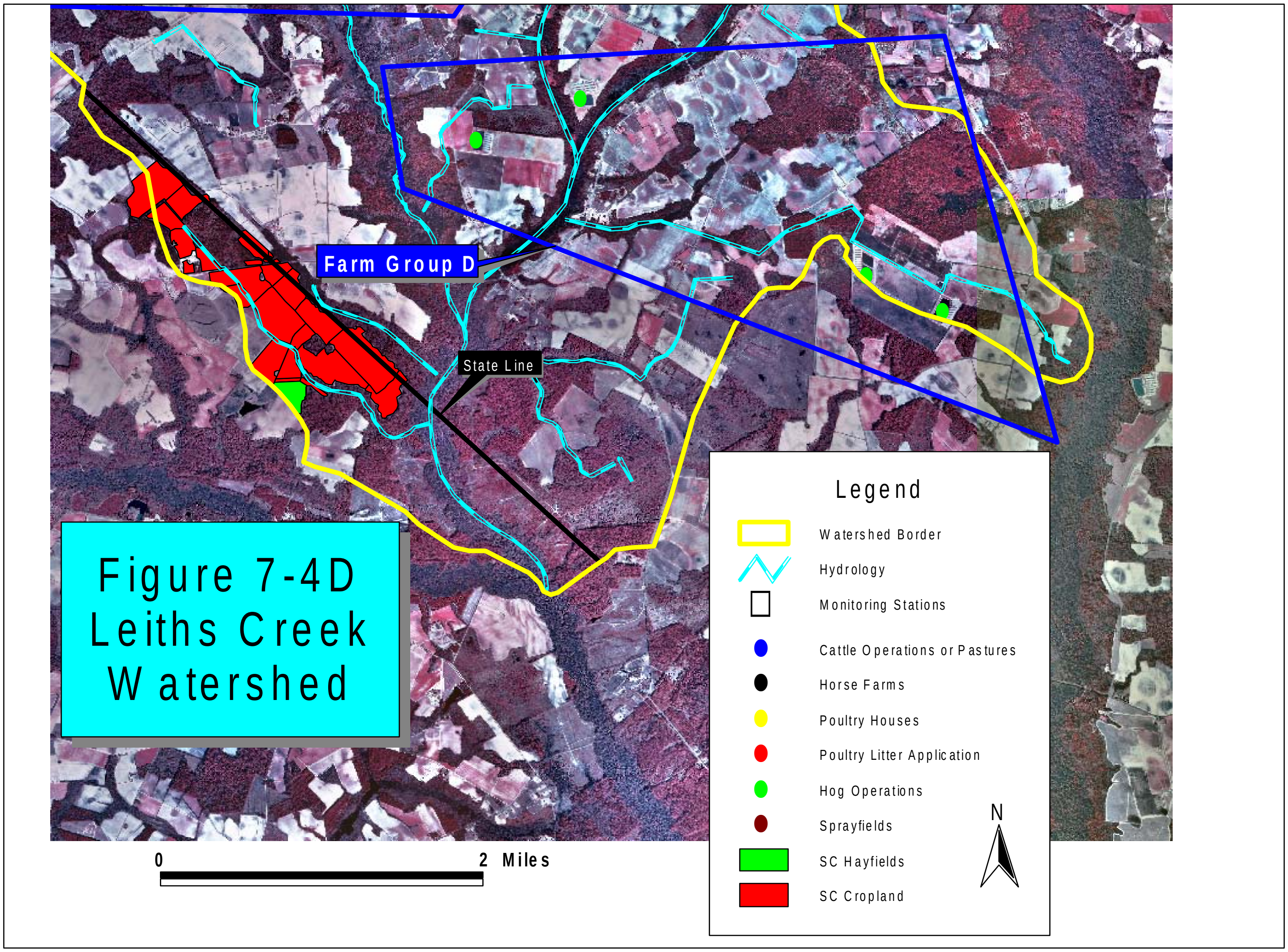


Figure 7-4D
Leiths Creek
Watershed
Farm Group D
State Line
Legend
Watershed Border
Hydrology
Monitoring Stations
Cattle Operations or Pastures
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
SC Hayfields
SC Cropland
N
0
2 Miles

Little Pee Dee River Mainstem Watershed – North Carolina

The Little Pee Dee River Mainstem Watershed is formed in Scotland County, North Carolina. The River flows in a southeastern direction until crossing the state border in the vicinity of McColl, South Carolina. The North Carolina portion of the Watershed is approximately 40 square miles. Three Farm Groups were delineated on Figure 7-5. A more detailed review of potential agriculture fecal coliform bacteria loading sources is shown in Figures 7-5A through 7-5C. Although no ambient water quality monitoring stations are located along the mainstem in North Carolina, three stations south of the state border (PD-062, PD-365, and PD-069) are not showing bacteria concentrations that are exceeding the state water quality standard. As a consequence, the North Carolina section of this Watershed has not been prioritized for project implementation. Specific quantities of agricultural land use types that are potential sources of fecal coliform bacteria are listed in Table 7-5.

Table 7-5 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading
Little Pee Dee River Mainstem – North Carolina

Farm Group	Pastures	Poultry Houses	Hog Operations
A	2	3(1 sited north of Group A)	1
B	2	4	0
C	5	0	1

Little Pee Dee River Mainstem Watershed – South Carolina

Once crossing the state border, the Little Pee Dee River Mainstem flows from Marlboro County to Dillon County, South Carolina. The Watershed size approximates 36 square miles. Although three ambient water quality monitoring stations (PD-062, PD-365, and PD-069) do not show a violation to the South Carolina water quality standard for fecal coliform bacteria, an impairment is occurring at the PD-029E station; the project endpoint at the Route 23 Bridge. As a result, the watershed supporting runoff between the PD-069 and the PD-029E is prioritized for agricultural BMP and conservation practice implementation. Aside from potential poultry litter transport into the Watershed, the only source of fecal coliform bacteria loading is associated with pasture management. Figure 7-6 shows the Little Pee Dee River Mainstem Watershed in South Carolina. The Watershed was divided into two portions: Those farm fields located above and below the PD-069 ambient water quality monitoring station. The prioritized farm fields are found in the Farm Group B delineation. More detailed mapping of the two subwatershed areas are found in Figures 7-6A and 7-6B. Quantities of agricultural land uses pertinent to fecal coliform bacteria loading are listed in Table 7-6.

Table 7-6 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading Little Pee Dee River Mainstem – South Carolina			
Farm Group	**Pastures**	**Poultry Houses**	**Hog Operations**
A	12	0	0
B	12	0	0

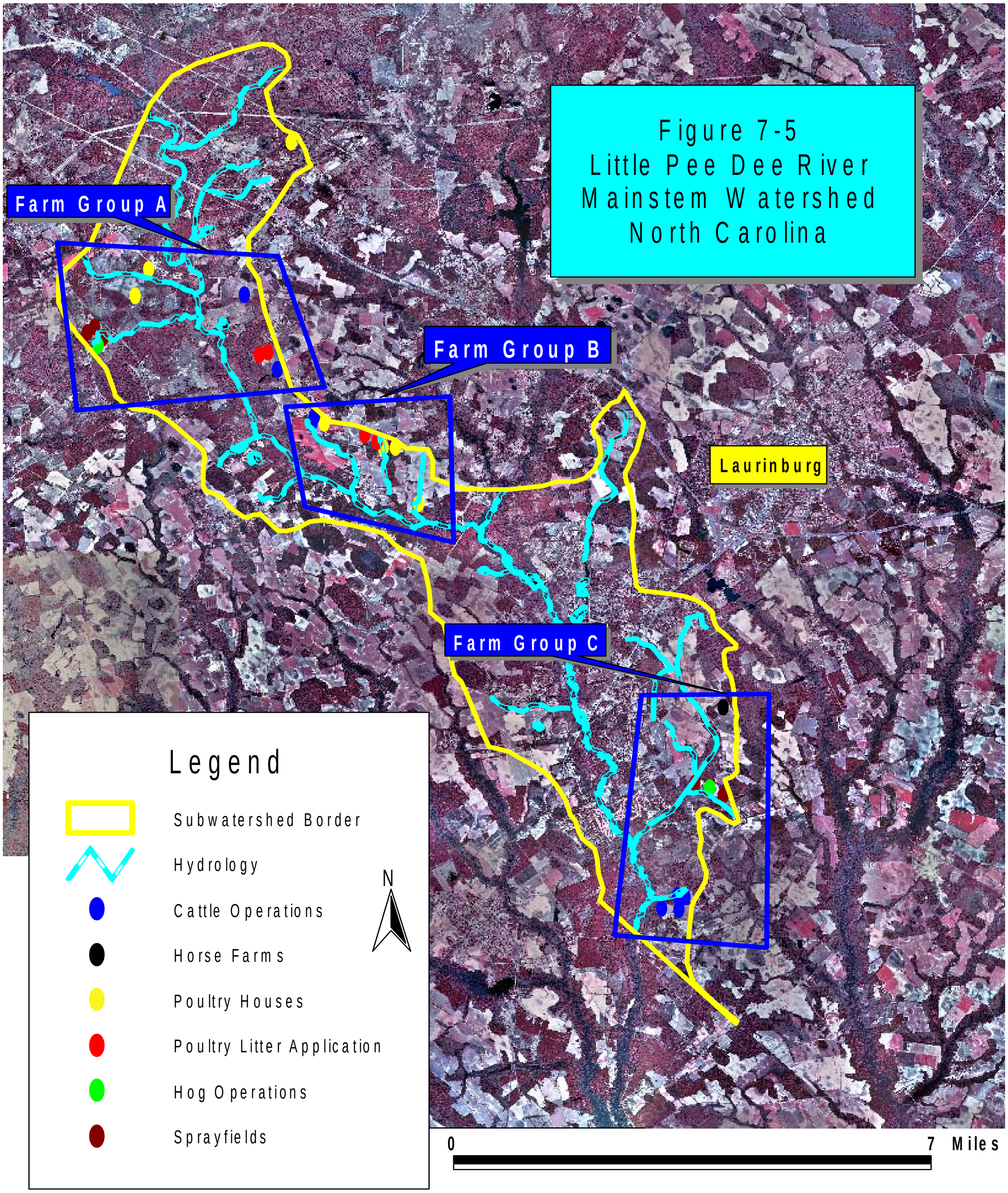


Figure 7-5
Little Pee Dee River
Mainstem Watershed
North Carolina
Farm Group A
Farm Group B
Farm Group C
Laurinburg
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
7 Miles

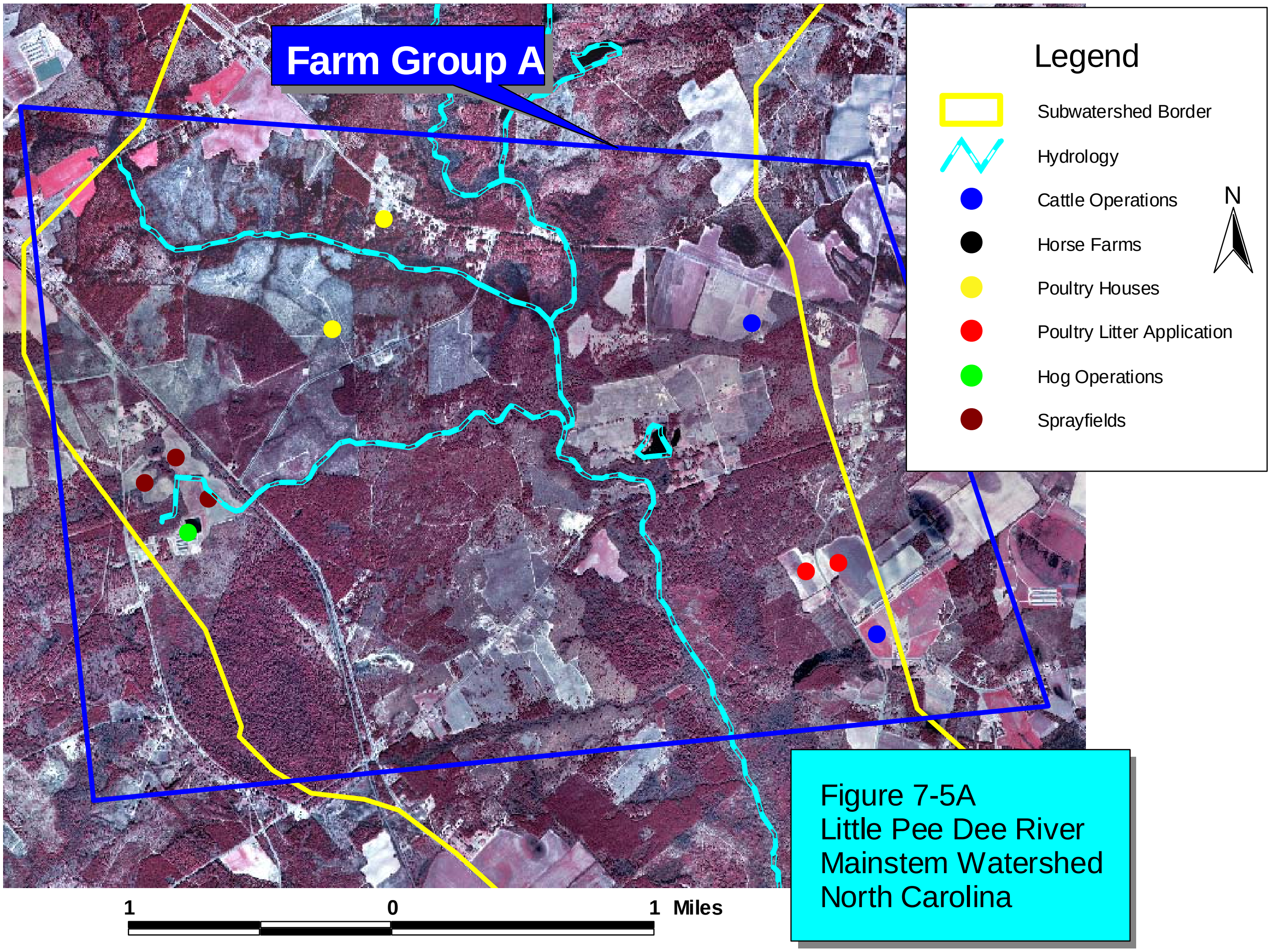
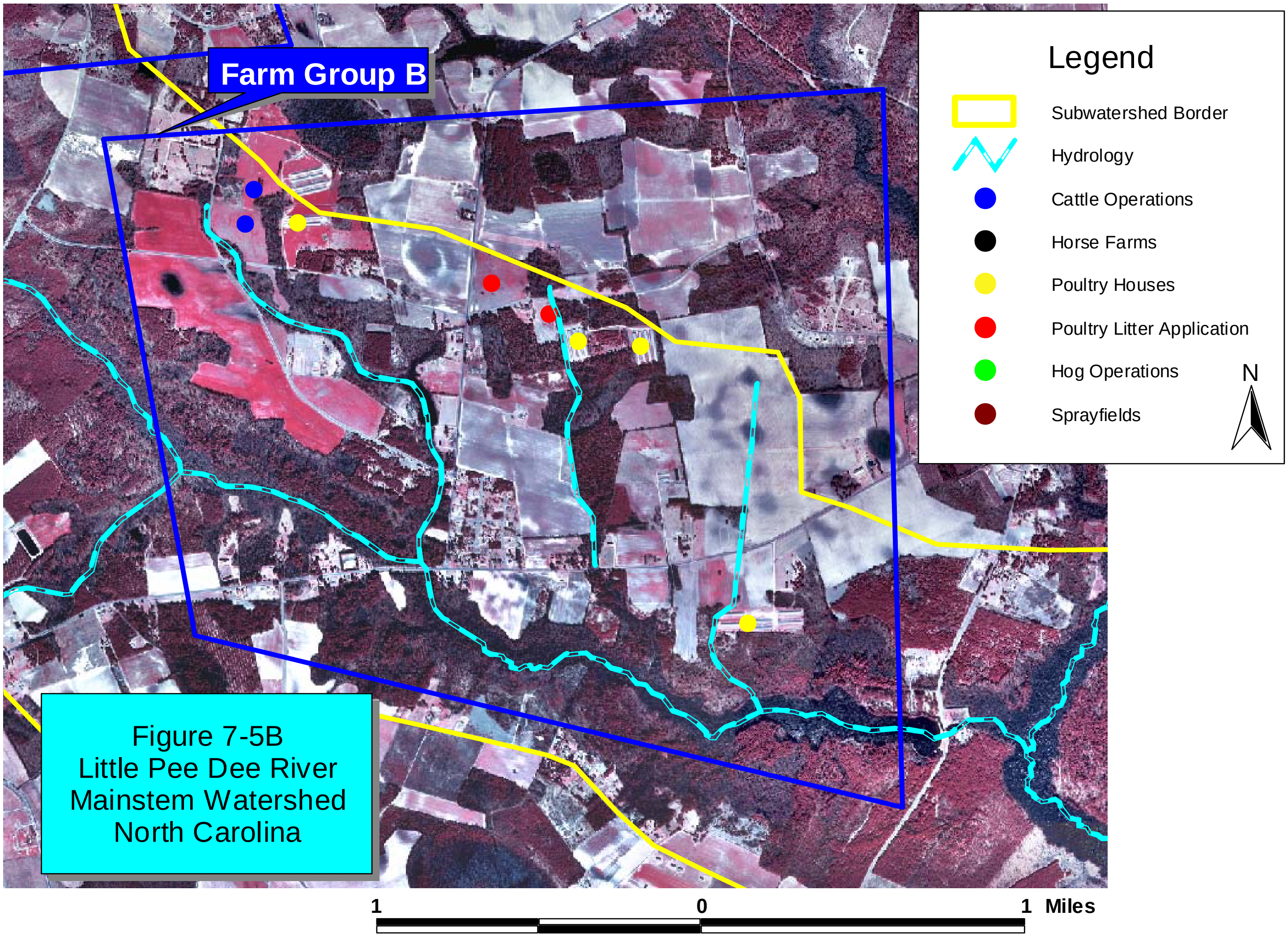


Figure 7-5A
Little Pee Dee River
Mainstem Watershed
North Carolina


Farm Group B
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
Figure 7-5B
Little Pee Dee River
Mainstem Watershed
North Carolina
1
0
1 Miles

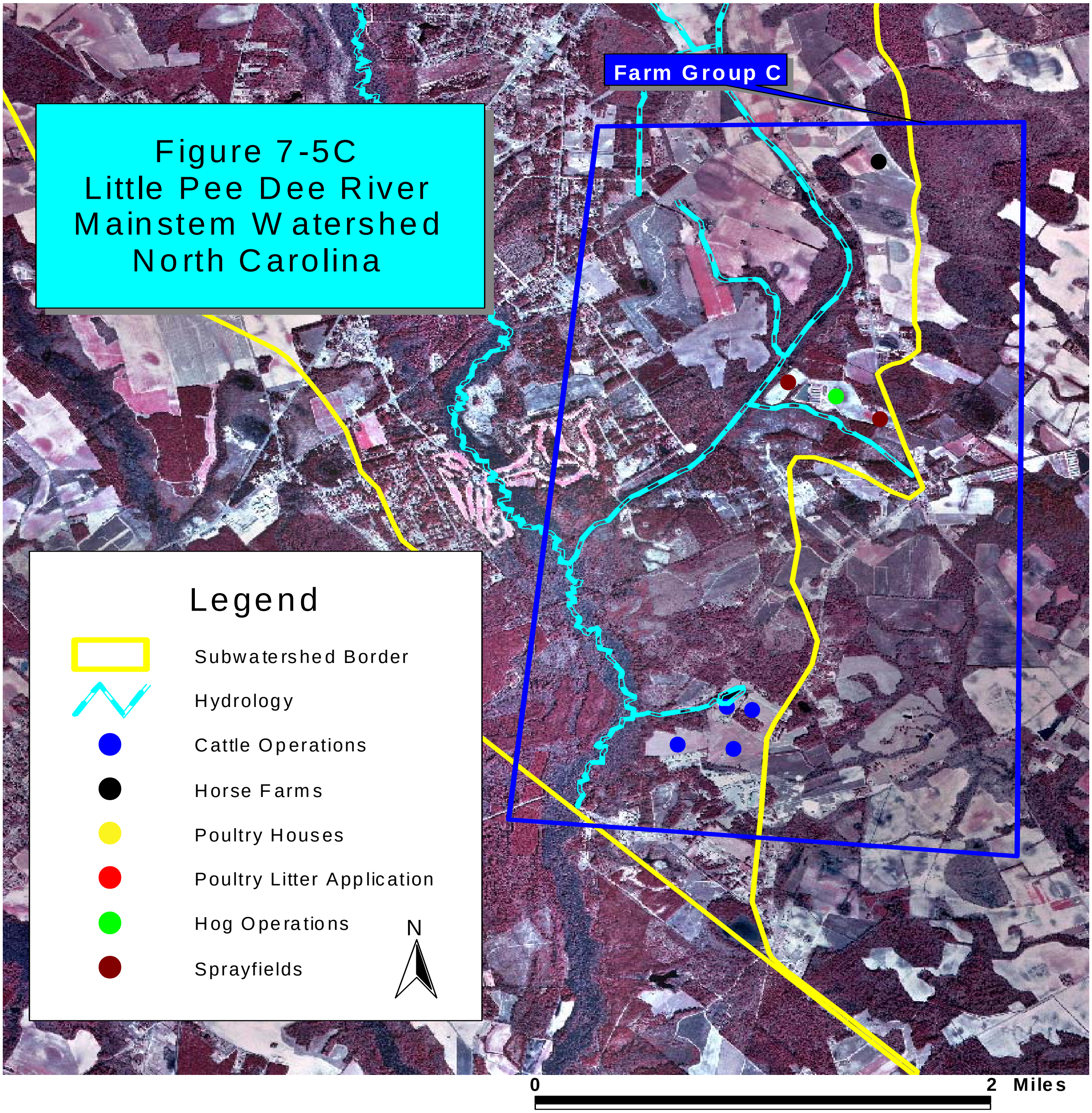


Figure 7-5C
Little Pee Dee River
Mainstem Watershed
North Carolina
Farm Group C
Legend
Subwatershed Border
Hydrology
Cattle Operations
Horse Farms
Poultry Houses
Poultry Litter Application
Hog Operations
Sprayfields
N
0
2 Miles

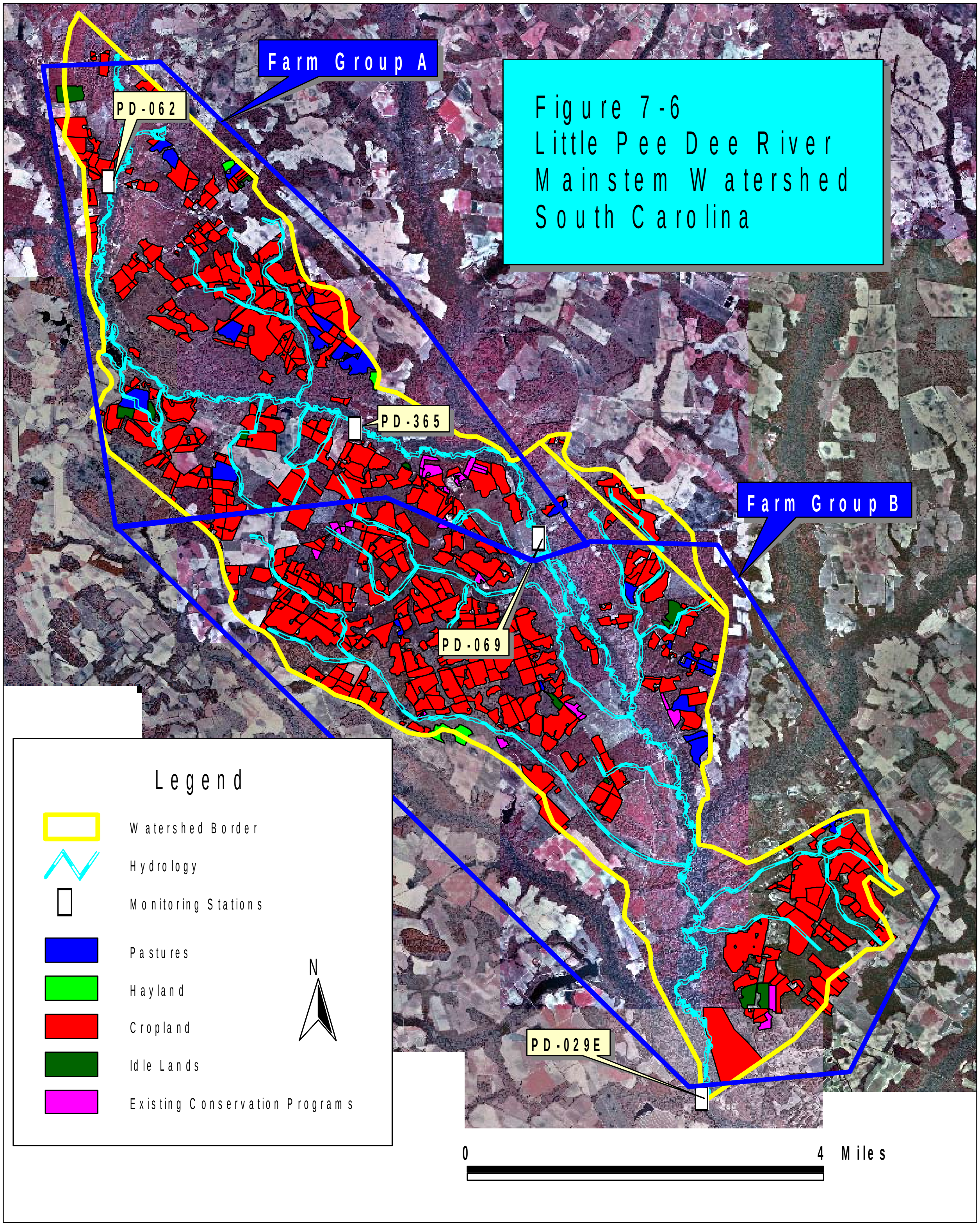
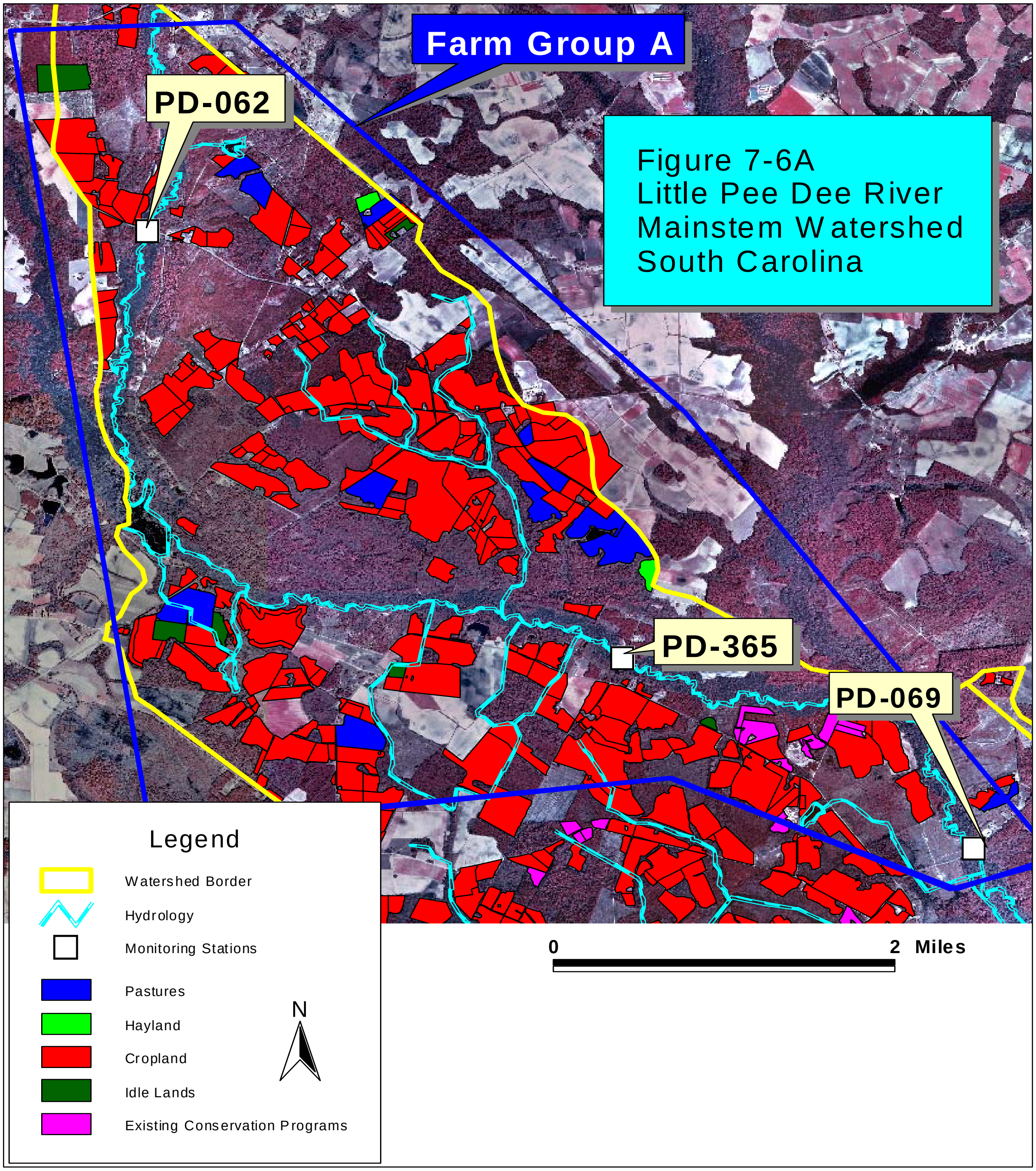
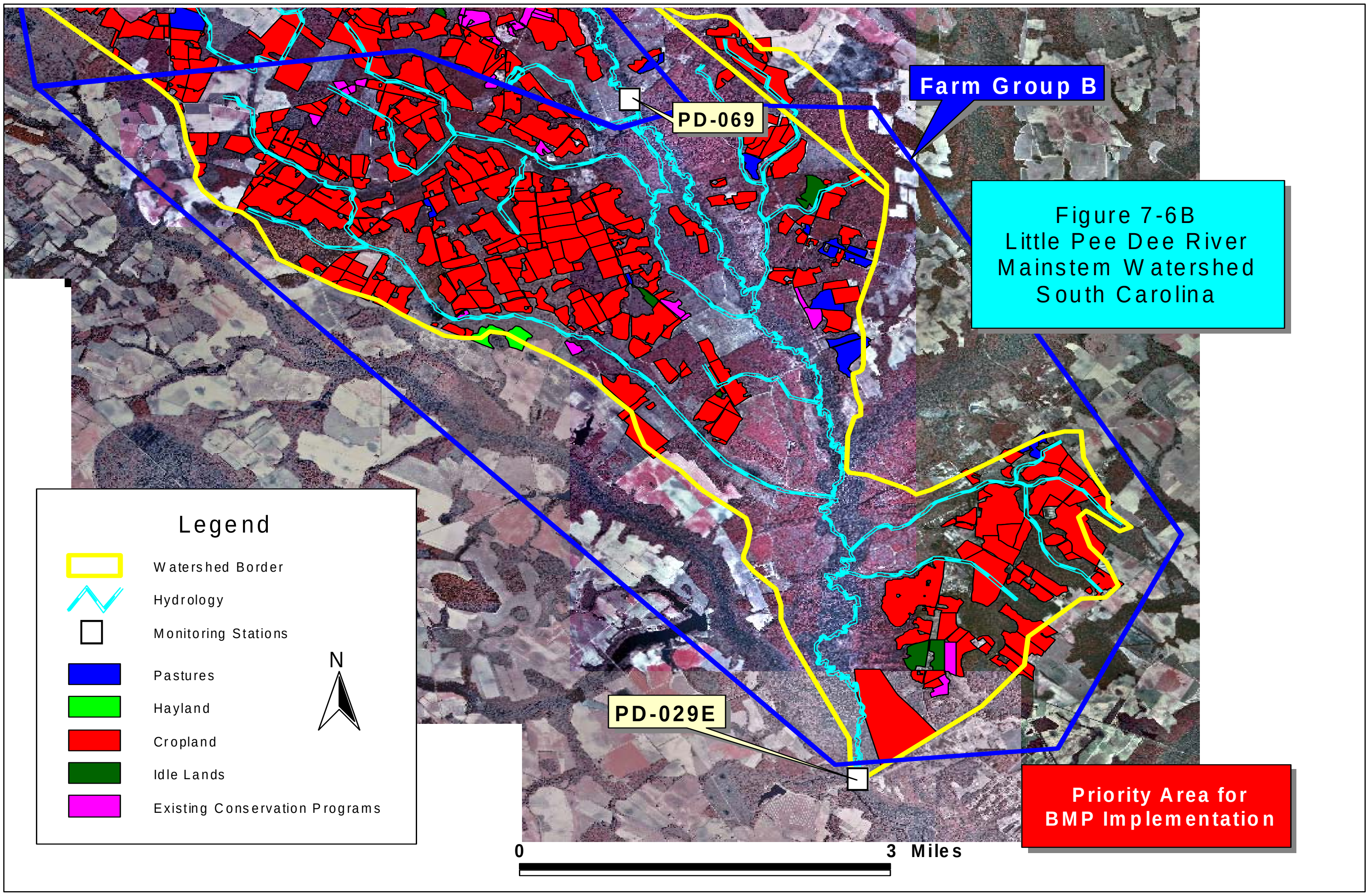


Figure 7-6
Little Pee Dee River
Mainstem Watershed
South Carolina
Farm Group A
Farm Group B
PD-062
PD-365
PD-069
PD-029E
Legend
Watershed Border
Hydrology
Monitoring Stations
Pastures
Hayland
Cropland
Idle Lands
Existing Conservation Programs
N
0
4 Miles


Farm Group A
Figure 7-6A
Little Pee Dee River
Mainstem Watershed
South Carolina
PD-062
PD-365
PD-069
Legend
Watershed Border
Hydrology
Monitoring Stations
Pastures
Hayland
Cropland
Idle Lands
Existing Conservation Programs
N
0
2 Miles


Farm Group B
PD-069
Figure 7-6B
Little Pee Dee River
Mainstem Watershed
South Carolina
Legend
Watershed Border
Hydrology
Monitoring Stations
Pastures
Hayland
Cropland
Idle Lands
Existing Conservation Programs
N
PD-029E
Priority Area for
BMP Implementation
0
3 Miles

Sweat Swamp Watershed

Sweat Swamp is located entirely in South Carolina and occupies parts of Marlboro and Dillon Counties. It supports a watershed area approximating 33 square miles in size. No ambient water quality monitoring stations are located in this Watershed, and its drainage enters the Little Pee Dee River mainstem just above the PD-029E fecal coliform bacteria impaired station. It is, therefore, prioritized for agricultural BMP and conservation practice implementation. As depicted in Figure 7-7, several pastures were noted containing a variety of farm animals, including cattle, horses, and goats. In addition, one poultry house was identified. The South Carolina portion of the project watershed area, including Sweat Swamp, is very productive and nearly all of the farm fields are cropland. Very few farm fields have gone idle. As a consequence, it is probable that considerable amounts of poultry litter have been shipped into the Sweat Swamp watershed from North Carolina. Farm field quantities that are pertinent sources of fecal coliform bacteria are included in Table 7-7.

Table 7-7 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading Sweat Swamp		
Pastures	**Poultry Houses**	**Hog Operations**
11	1	0

Beaverdam Swamp Watershed

Although a portion of the Beaverdam Swamp Watershed is located in North Carolina, the majority of the Watershed area resides in South Carolina. Beaverdam Swamp eventually discharges directly into the Little Pee Dee River. Figure 7-8 depicts the extent of the Watershed area; which encompasses approximately 45 square miles. Several ambient water quality monitoring stations are located in the South Carolina portion of the Watershed (PD-306, PD-016, and PD-017A). None are showing violations to the state fecal coliform bacteria standard. Moreover, ambient water quality monitoring stations in the Little Pee Dee River Watershed downstream of the Beaverdam Swamp discharge point (PD-365 and PD-069) are also meeting the water quality standard. As a result, the Beaverdam Swamp Watershed has not been prioritized for the immediate implementation of BMPs and conservation practices addressing fecal coliform bacteria loading. The Watershed is also very productive and it is highly probable that a number of cropland fields are receiving poultry litter. Table 7-8 shows the quantity of identified sites causing excessive potential fecal coliform bacteria loading in South Carolina. It was determined through interviews that two pastures and a poultry litter application site should be reviewed as potential sources of fecal coliform bacteria loading in North Carolina.

Table 7-8 Agricultural Land Use Activities Pertinent to Fecal Coliform Bacteria Loading Beaverdam Swamp		
Pastures	**Poultry Houses**	**Hog Operations**
35	0	0

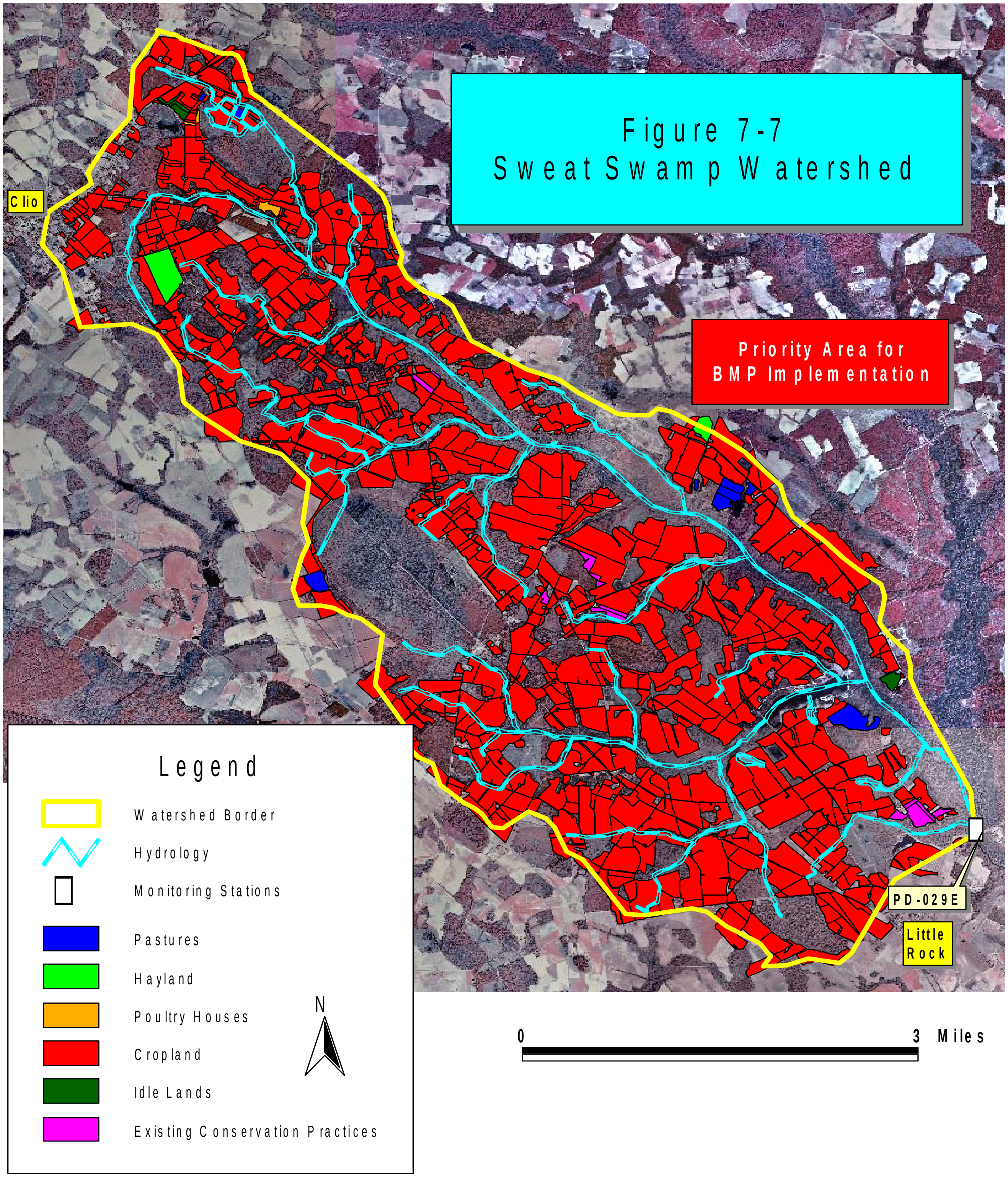


Figure 7-7
Sweat Swamp Watershed
Priority Area for
BMP Implementation
Clio
PD-029E
Little
Rock
Legend
Watershed Border
Hydrology
Monitoring Stations
Pastures
Hayland
Poultry Houses
Cropland
Idle Lands
Existing Conservation Practices
N
0
3 Miles

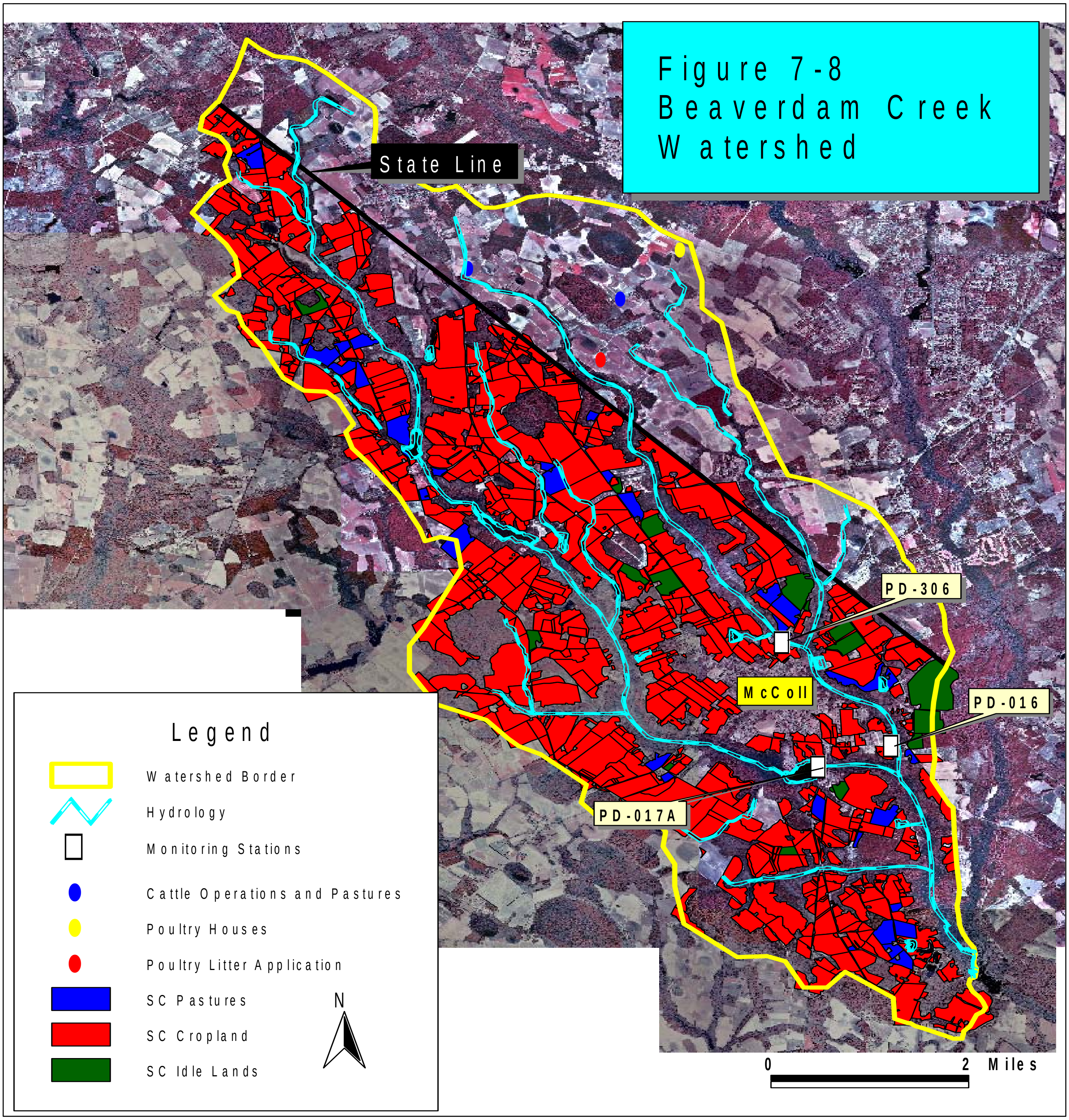


Figure 7-8
Beaverdam Creek
Watershed
State Line
PD-306
McColl
PD-016
PD-017A
Legend
Watershed Border
Hydrology
Monitoring Stations
Cattle Operations and Pastures
Poultry Houses
Poultry Litter Application
SC Pastures
SC Cropland
SC Idle Lands
N
0
2 Miles

8.0 IMPLEMENTATION PLANNING RECOMMENDATIONS

The Load Reduction Plan was developed using the best data available to identify a **load reduction allocation scenario** that, when implemented, will meet the state water quality goals for fecal coliform bacteria in the upper Little Pee Dee River project watershed area. Additional watershed planning efforts included in this Load Reduction Plan consist of a **detailed characterization and accounting of agricultural land uses** and the formation of an **interstate stakeholder group and an informed citizenry**. These three Load Reduction Plan components will facilitate and provide a structure for the development and application of an effective TMDL implementation plan. Four implementation planning strategies are recommended:

- Watershed Management and Planning Administration;
- Selection and Implementation of Corrective Actions;
- Citizen Awareness and Education; and
- Continued Water Quality Sampling.

Watershed Management and Planning

To reduce the quantities of fecal coliform bacteria from the potential loading sources within the project watershed area, a decision-making framework and management process is required. This framework will be developed to:

- Foster intra- and interstate cooperation between federal, state and local agencies and partners; and
- Advance a coordinated approach to acquiring landowner support for the implementation of corrective actions that meet the goals of the load reduction allocation scenario.

The recommended framework will contain provisions that address the monitoring of implementation tasks (and their measured success) in South Carolina and North Carolina, the application of a citizen awareness and education program, and the administration of multiple and concurrent grant projects.

Selection and Implementation of Corrective Actions

The administration of the load reduction allocation scenario suggests the need for a multi-phased approach to TMDL implementation to meet the applicable water quality standards and support the recreation use classification. The load reduction allocation scenario identifies a primary need for corrective actions that address fecal coliform bacteria loading reductions from direct livestock deposition into the stream; and secondary corrective actions that address loading from three agricultural land use sources of runoff:

pastures harboring grazing livestock, farm fields receiving poultry litter, and permitted hog farm sprayfields. The agricultural land use characterization has identified several hundred farm field cover type practices that are potential sources of fecal coliform bacteria. The spatial distribution of these problematic livestock, pasture management, and litter application practices are occurring throughout the upper Little Pee Dee River project watershed area.

Prioritization of Farm Fields

As a result of these quantities and widespread locations of potential fecal coliform bacteria loading sources, the targeting and ranking of farm fields for implementation measures is a necessary component to implementation planning. It not only ensures the optimum utilization of implementation revenues, but also facilitates a multi-phased implementation approach where stakeholders can identify and prioritize sets of farm fields for corrective action based on their probability of success and the availability of implementation funds. As illustrated in Figure 1-1, numerous ambient water quality monitoring stations are located throughout the upper Little Pee Dee River project watershed area. Only two of these stations are violating a state water quality standard for fecal coliform bacteria (I0510000 in North Carolina, and PD-029E in South Carolina). Several monitoring stations below the I0510000 station on Leiths Creek are showing no violation to the South Carolina state standard for fecal coliform bacteria. As a result, those areas between the project endpoint on the Little Pee Dee River (PD-029E at the Route 23 Bridge) and those upstream monitoring stations showing no violation to the bacteria standard have been prioritized for BMP and conservation practice implementation. Those areas immediately upstream of I0510000 in North Carolina should be reviewed for potential BMP and conservation practice implementation at the outset of the project implementation phase because the loading of fecal coliform bacteria from the identified land uses may be affecting the downstream assimilative capacity of the Little Pee River.

Corrective Action Implementation

Once farm fields have been prioritized based on their potential for causing unacceptable loads of fecal coliform bacteria, fundable and site-specific corrective actions will be selected. The South Carolina Department of Natural Resources and the NRCS have jointly developed a handbook of conservation practices applicable to South Carolina farming concerns entitled ***Farming for Clean Water in South Carolina*** (July, 1997). The Handbook provides descriptions of several corrective actions that address various sources of fecal coliform bacteria loading, and the relative costs for the implementation of these respective corrective actions. Corrective actions that are applicable to the direct deposition of farm animal waste into streams include:

- ‘Stream protection’ that promotes the fencing off buffer zones and managing livestock access to streams;

- ‘Stream crossings’ which allows livestock to drink and cross streams a designated points; and

- ‘Water tanks’ and ‘Farm Ponds’ that provide livestock with alternative sites for drinking water.

To limit fecal coliform bacteria loading from pasture runoff, ‘pasture management’ and ‘runoff management’ are recommended by the Handbook where rotational grazing, proper pasture stocking rates, paddock planning based on cutting intervals for forage, methods of keeping feedlots and loafing areas dry, and other grazing techniques that improve water quality are promoted.

To address the over-application and non-uniform application of poultry litter on farm fields in the project watershed area, it is suggested that an education program be adopted. This program could be designed to promote the following activities specified in the ‘Nutrient Management’ and ‘Manure Testing’ sections of the Manual:

- Testing litter at the poultry houses for fertilizer value;

- Testing farm field soils to determine if and how much litter should be applied to meet crop yield goals;

- Calibrating litter spreading by trucks to apply proper rates; and

- Applying litter at proper times and frequencies.

The stockpiling of litter has been field verified at numerous locations within the project watershed area. The leaching and runoff of litter from the open stockpiles could result in marked fecal coliform bacteria loading. Corrective actions could include the short-term application of plastic sheeting or long-term use of covered facilities with impervious ground liners.

Spray irrigation of treated swine waste was not determined to be a significant source of fecal coliform bacteria to the stream; however, the improper application of swine waste such as the application of excessive amounts of waste and application of the waste too close to streams can cause a potential problem. As a result, it is recommended to limit the amount of waste applied, especially during high storm conditions when the waste can easily be washed off by stormwater or to upgrade treatment systems used for swine waste, and to enforce a buffer zone from streams, wetlands and Ditches within which swine waste cannot be sprayed.

Site-specific corrective actions for the sources of fecal coliform bacteria outlined in the load reduction allocation scenario will be made by technical experts following on-site farm field investigations.

Citizen Awareness and Education

The success of this multi-phased approach to implementation also requires support and acceptance from the landowners, growers, and operators farming in the project watershed area. A citizen awareness and education program is, therefore, suggested to make the local citizenry aware of:

- The human health risks of fecal coliform bacteria impaired water bodies;
- The different sources of fecal coliform bacteria;
- How these sources are contributing to the specific water quality impairment in the project watershed area; and
- The available, voluntary, and often cost-shared corrective actions utilized to minimize fecal coliform bacteria loading into the upper Little Pee Dee River and its tributaries.

Outreach plan components may include field days where successful and demonstration corrective actions are endorsed; workshops presenting water quality issues and the benefits of corrective actions; use of agricultural operators willing to share management solutions; partner building with commodity groups to promote conservation; the use of local school districts to take part in water quality sampling or corrective action implementation and construction; and the development of brochures specific to fecal coliform bacteria impairment in the upper Little Pee Dee River project watershed area. The brochures could be used to facilitate the advancement of project goals at large forums or at one-on-one meetings with landowners, growers, and operators.

A foundation of support for implementation endeavors has been established during the development of this Load Reduction Plan. Local, state, and federal agricultural and environmental agencies have dedicated an interest in the project from both South Carolina and North Carolina; and landowners, growers, operators and farming organizations located in the watershed project area were introduced to the project at a project kick-off meeting. Moreover, project results will be presented to this group of agencies and local farming concerns in July/August 2005.

Continued Water Quality Sampling

It is recommended that sampling at the numerous ambient water quality monitoring stations in the upper Little Pee Dee River project watershed area continue to:

- Measure progress towards meeting the goals of the load reduction allocation scenario;
- Determine the effectiveness of the load reduction allocation scenario;

- Identify subbasin areas requiring a more intensive implementation focus; and

- Allow for implementation flexibility by providing justification for making mid-course changes to the load reduction allocation scenario.

Potential action item tasks associated with the four recommended implementation planning strategies are depicted in Table 8-1. Suggested lead organizations and funding sources for each action item task are also listed.

TABLE 8-1 RECOMMENDED IMPLEMENTATION ACTION ITEMS

Action Item	Lead Organization	Funding Source
WATERSHED MANAGEMENT PLANNING AND ADMINISTRATION		
Development of Decision Making Stakeholder Group for Implementation Planning.	Pee Dee RC&D Council	EPA Section 319 Program.
Project Management and Coordination of Tasks and Agencies/Organizations in South Carolina and North Carolina.	Pee Dee RC&D Council.	EPA Section 319 Program.
Identification of Funding Sources, Proposal Development, and Grant Administration.	Pee Dee RC&D Council. / North Carolina Division of Soil and Water Conservation.	EPA Section 319 Program.
Continuous Measurement of Project Success and Administration of Mid-Course Changes to Meet Project Goals.	Pee Dee RC&D Council.	EPA Section 319 Program.
SELECTION AND IMPLEMENTATION OF CORRECTIVE ACTIONS		
Targeting and Prioritizing Farm Fields for Implementation Using GIS Database of Farm Field Information (Criteria for Selection may Include Vicinity to Stream, Soil Types, Slopes, Land Use Practices, etc.).	Dillon, Marlboro, Scotland, and Robeson SWCD with Support from NRCS District Conservationists. South Carolina Department of Natural Resources.	EPA Section 319 Program.
Selection and Implementation of Farm Field Specific Corrective Actions.	Dillon, Marlboro, Scotland, and Robeson SWCD with Support from NRCS District Conservationists.	EPA Section 319 Program, USDA Conservation Reserve Program (CRP), USDA Environmental Quality Incentives Program

	South Carolina Department of Natural Resources.	(EQIP), USDA Wildlife Habitat Incentives Program (WHIP), USDA Wetland Reserve Program (WRP), North Carolina Clean Water Management Trust Fund, North Carolina Agricultural Cost-Share Program.
CITIZEN AWARENESS AND EDUCATION		
Development and Implementation of an Outreach Plan (and Outreach Materials; including Home*A*Syst and Farm*A*Syst Information) that Builds Support for Implementing Corrective Actions.	Pee Dee RC&D Council / SC Department of Natural Resources / NC Division of Soil and Water Conservation / SC DHEC.	EPA Environmental Education and/or Environmental Justice Grant Programs.
Promotion of Various Voluntary BMP / Conservation Practices to Landowners of Prioritized Farm Fields at One-on-One Meetings.	Dillon, Marlboro, Scotland, and Robeson SWCD with Support from NRCS District Conservationists. South Carolina Department of Natural Resources.	EPA Section 319 Program, USDA Conservation Reserve Program (CRP), USDA Environmental Quality Incentives Program (EQIP), USDA Wildlife Habitat Incentives Program (WHIP), USDA Wetland Reserve Program (WRP), North Carolina Clean Water Management Trust Fund, North Carolina Agricultural Cost-Share Program.
Poultry Litter and Sprayfield Application Training.	Dillon, Marlboro, Scotland, and Robeson SWCD with Support from NRCS District Conservationists. South Carolina Department of Natural Resources.	EPA Section 319 Program, USDA Conservation Reserve Program (CRP), USDA Environmental Quality Incentives Program (EQIP), USDA Wildlife Habitat Incentives Program (WHIP), USDA Wetland Reserve Program (WRP), North

		Carolina Clean Water Management Trust Fund, North Carolina Agricultural Cost-Share Program.
CONTINUED WATER QUALITY SAMPLING		
Collect and Analyze Water Quality Samples for Fecal Coliform Bacteria Concentrations Under all Flow Conditions.	South Carolina Department of Health and Environmental Control, North Carolina Division of Water Quality.	State funded.
Document Water Quality Improvements from Farm Field Specific Corrective Actions at the Respective Water Quality Sampling Sites.	Pee Dee RC&D.	EPA Section 319 Program.

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APPENDIX A

FECAL COLIFORM CONCENTRATION DATA FROM DHEC MONITORING STATION PD-029E

Date	Fecal coliform concentration (counts/100 mL)
5/1/1990	70.00
6/19/1990	83.00
8/9/1990	60.00
9/5/1990	63.00
10/2/1990	90.00
5/2/1991	20.00
6/7/1991	30.00
7/1/1991	35.00
8/9/1991	56.00
9/20/1991	120.00
10/18/1991	180.00
5/22/1992	90.00
6/4/1992	200.00
7/9/1992	130.00
8/21/1992	120.00
9/8/1992	120.00
10/6/1992	300.00
5/26/1993	85.00
6/29/1993	82.00
7/27/1993	300.00
8/25/1993	40.00
9/22/1993	73.00
10/26/1993	57.00
5/2/1995	70.00
6/13/1995	73.00
7/12/1995	33.00
8/22/1995	23.00
9/7/1995	73.00
10/16/1995	120.00
7/9/1996	28.00
8/29/1996	200.00
9/12/1996	170.00
5/21/1997	54.00
6/11/1997	60.00

Date	Fecal coliform concentration (counts/100 mL)
7/30/1997	30.00
8/21/1997	32.00
9/25/1997	280.00
10/21/1997	450.00
7/29/1999	230.00
8/26/1999	540.00
9/29/1999	90.00
10/25/1999	50.00
5/23/2000	140.00
6/29/2000	120.00
7/27/2000	6000.00
8/31/2000	120.00
9/21/2000	85.00
10/25/2000	81.00
1/21/2003	12.00
2/20/2003	15.00
3/27/2003	48.00
4/15/2003	28.00
5/12/2003	66.00
6/11/2003	24.00
07/24/03	560.00
08/12/03	46.00
09/25/03	44.00
10/07/03	36.00
11/13/03	66.00
12/03/03	30.00

APPENDIX B

CALCULATIONS OF EXISTING AND ALLOWABLE LOADS AT PD-029E

Calculation of Existing Load from Trend Line

Equation of Trend line: $y = 6E+13\ e^{-0.0451x}$

Percent Exceeded (%)	Existing Load (ct/day)
10.00	3.82E+13
15.00	3.05E+13
20.00	2.43E+13
25.00	1.94E+13
30.00	1.55E+13
35.00	1.24E+13
40.00	9.88E+12
45.00	7.88E+12
50.00	6.29E+12
55.00	5.02E+12
60.00	4.01E+12
65.00	3.20E+12
70.00	2.55E+12
75.00	2.04E+12
80.00	1.63E+12
85.00	1.30E+12
90.00	1.04E+12
Mean	**1.09E+13**

Existing Load = 1.09×10^{13} counts/day

Calculation of Allowable Load from Trend Line

Equation of Trend Line: $y = 3E+13\ e^{-0.0451x}$

Percent Exceeded (%)	Target Load (ct/day)
10.00	1.91E+13
15.00	1.53E+13
20.00	1.22E+13
25.00	9.72E+12
30.00	7.75E+12
35.00	6.19E+12
40.00	4.94E+12
45.00	3.94E+12
50.00	3.15E+12
55.00	2.51E+12
60.00	2.00E+12
65.00	1.60E+12
70.00	1.28E+12
75.00	1.02E+12
80.00	8.13E+11
85.00	6.49E+11
90.00	5.18E+11
Mean	**5.45E+12**

Allowable Load = 5.54×10^{12} counts/day

APPENDIX C

CITY OF LAURINBURG SANITARY SEWER OVERFLOWS/SPILLS REPORT OF 2004

Months	Location	Volume	Unit	Storm conditions
11-Jun-04	Pump Station #19, 2212 Elm Ave. (South)	2,500	Gallons	
8-Sep-04	Bridge Creek Pump Station (Southeast)	18,000	Gallons	Tropical storm Gaston
8-Sep-04	Manhole, 1811 S. Main Street (South)	12,720	Gallons	
8-Sep-04	Manhole, 1006 Port Street (North)	2,880	Gallons	
8-Sep-04	Manhole, 300 Caledonia Road (Central)	56,400	Gallons	
8-Sep-04	Manhole, 1004 Lila Drive (North)	2,880	Gallons	
8-Sep-04	Manhole on Cypress Street (North)	2,000	Gallons	
9-Sep-04	Leith Creek Pump Station (East)	1,000,000	Gallons	Tropical storm Frances
29-Oct-04	Pump Station #5B, 12171 Purcell Road (Southwest)	600	Gallons	
22-Dec-04	Manhole, McKay Street (Central)	900	Gallons	
	Total over flow/spills	**1,098,880**	Gallons	
	Total volume treated	719,984,000.00	Gallons	