FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHWEST DISTRICT • CHOCTAWHATCHEE–ST. ANDREW BAY BASINS

FINAL TMDL Report

Fecal Coliform TMDL for Camp Branch (WBID 251)

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Acknowledgments

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TMDL Program
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2008 305(b) Report
http://www.dep.state.fl.us/water/docs/2008_Integrated_Report.pdf
Criteria for Surface Water Quality Classifications
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Basin Status Report: Choctawhatchee–St. Andrew Bay
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Water Quality Assessment Report: Choctawhatchee–St. Andrew Bay
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U.S. Environmental Protection Agency

Region 4: TMDLs in Florida
http://www.epa.gov/region4/water/tmdl/florida/
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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for fecal coliform bacteria for Camp Branch, located in the Choctawhatchee–St. Andrew Bay Basins. The creek was verified as impaired for fecal coliform, and therefore was included on the Verified List of impaired waters for the Choctawhatchee–St. Andrew Bay Basins that was adopted by Secretarial Order on January 15, 2010. The TMDL establishes the allowable fecal coliform loading to Camp Branch that would restore the waterbody so that it meets its applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Choctawhatchee–St. Andrew Bay Basins into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Camp Branch is WBID 251.

Camp Branch is 1 of the 172 waterbody segments in the Choctawhatchee Basin and 1 of 8 waterbody segments in the basin included on the 1998 303(d) list for Florida. The watershed is located in the southeastern portion of Holmes County (**Figure 1.1**).

The headwaters of Camp Branch are in southeastern Holmes County. The creek flows southeast for approximately 5.4 miles to Open Creek, eventually draining into Holmes Creek, a principal tributary of the Choctawhatchee River. The creek receives flow from a number of smaller branches (**Figure 1.2**).

The drainage area within the Camp Branch WBID boundary is approximately 7.7 square miles (mi^2) (4,927 acres) and is predominantly made up of agricultural and forested land. Additional information about the hydrology and geology of this area is available in the Basin Status Report for Choctawhatchee–St. Andrew Bay (Department, 2003).

WBID 251 is located in the Dougherty Karst Plain ecoregion, which occupies a portion of the central Florida panhandle. This ecoregion is comprised of a flat-to-gently-rolling, southwestward sloping plains generally characterized by karst terrain.

The Floridan aquifer is at or near the surface in much of the region. In this area the aquifer is unconfined, allowing water to enter, move through, and discharge from the Floridan aquifer system more readily and rapidly (Miller, 1990). In these unconfined areas, the aquifer is either exposed or is covered by a thin layer of sand or by clayey, residual soil (Miller, 1990).

The karst features in the region allow for the rapid infiltration of surface water into the aquifer systems and offer direct access to the aquifers by natural and anthropogenic pollutants (Scott, 1992). Transport of pollutants in karst terrains is quick and attenuation is limited (Youno et al., 2001). The main sources and causes of groundwater pollution in karst areas fall under four groups municipal, industrial, agricultural and miscellaneous (Youno et al., 2001). Potential sources in predominantly agricultural areas located within karst terrain include organic compounds from the excessive and improper use of fertilizer and pesticides, and nitrate and bacteria from excessive livestock waste (Crawford and Whallon, 1985). In karst terrains with more urbanized areas contaminants associated with urban stormwater runoff (lead, chromium, oil and grease), bacteria from pet wastes, leaky underground storage tanks and septic tanks are potential problems (Crawford and Whallon, 1985). Other sources of potential ground water contamination include unauthorized hazardous waste disposal sites, old landfills, unauthorized dumps, and abandoned wells (ADEM, 2001).

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

Figure 1.1. Location of the Camp Branch Watershed (WBID 251) in the Choctawhatchee–St. Andrew Bay Basins and Major Geopolitical and Hydrologic Features in the Area

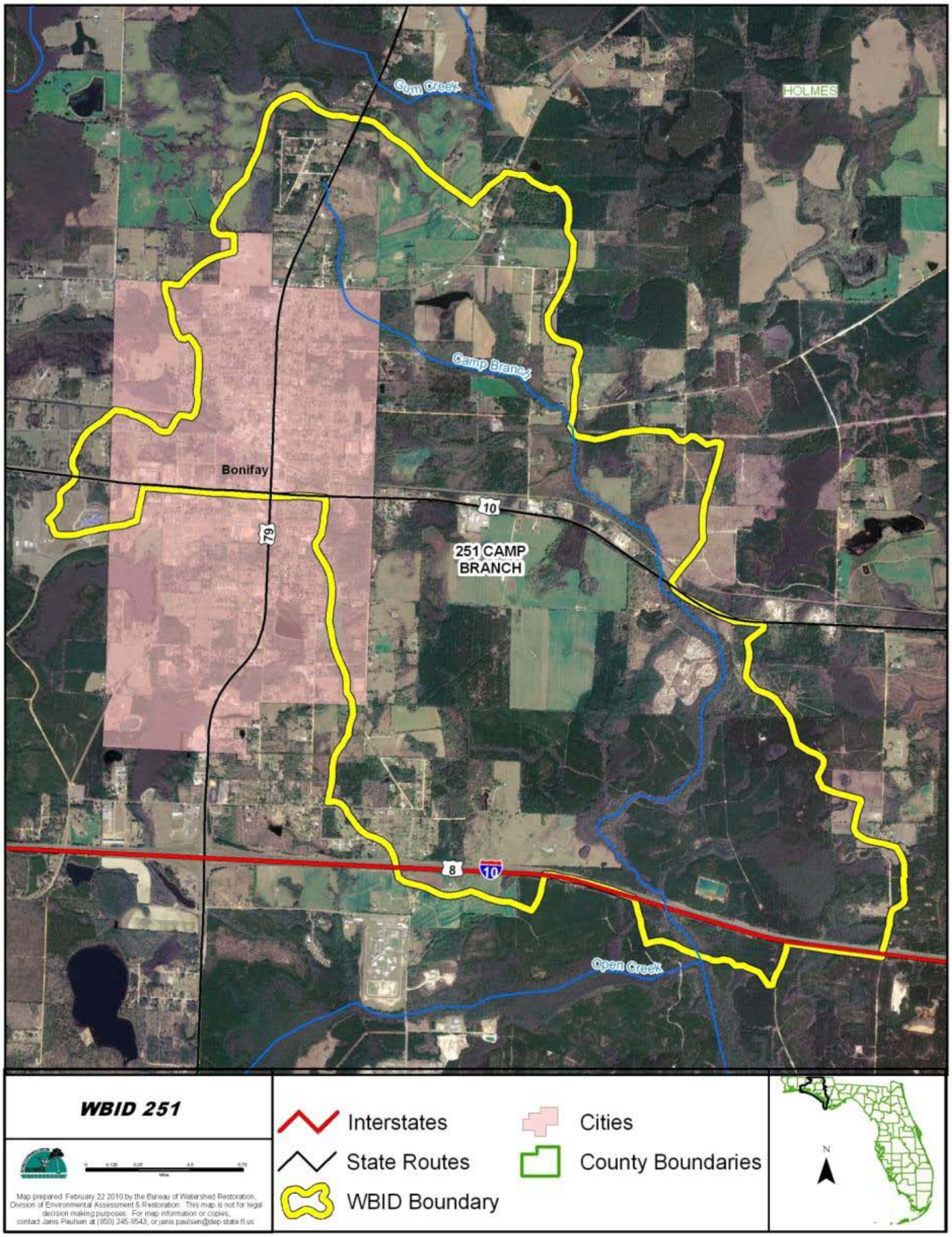

Figure 1.2. Location of the Camp Branch Watershed (WBID 251) in Holmes County

This TMDL report will be followed by the development and implementation of a restoration plan designed to reduce the amount of fecal coliform that caused the verified impairment of Camp Branch. These activities will depend heavily on the active participation of the Northwest Florida Water Management District (NWFWMD), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]); the state's 303(d) list is amended annually to include basin updates.

Florida identified eight impaired waterbodies in the Choctawhatchee Basin on its 1998 303(d) list. However, the FWRA (Section 403.067, F.S.) stated that all Florida 303(d) lists created before the adoption of the FWRA were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Camp Branch and has verified that this waterbody segment is impaired for fecal coliform bacteria. The verified impairment was based on the observation that for 15 out of 26 fecal coliform samples collected during the Cycle 2 verified period (January 1, 2002, through June 30, 2009), more than 10 percent of the values exceeded the assessment threshold of 400 counts per 100 milliliters (counts/mL) (see **Section 3.2** for details).

Table 2.1 summarizes the fecal coliform monitoring results for the Cycle 2 verified period for Camp Branch used in developing the TMDL.

Table 2.1. Summary of Fecal Coliform Monitoring Data for Camp Branch (WBID 251) During the Cycle 2 Verified Period (January 1, 2002, through June 30, 2009)

This is a three-column table. Column 1 lists the waterbody and WBID number, Column 2 lists the parameter, and Column 3 lists the Cycle 1 results.

Waterbody (WBID)	Parameter	Fecal Coliform
Camp Branch (WBID 251)	Total number of samples	26
Camp Branch (WBID 251)	IWR-required number of exceedances for the Verified List	6
Camp Branch (WBID 251)	Number of observed exceedances	15
Camp Branch (WBID 251)	Number of observed nonexceedances	11
Camp Branch (WBID 251)	Number of seasons during which samples were collected	4
Camp Branch (WBID 251)	Highest observation (counts/100mL)	7,400
Camp Branch (WBID 251)	Lowest observation (counts/100mL)	72
Camp Branch (WBID 251)	Median observation (counts/100mL)	445
Camp Branch (WBID 251)	Mean observation (counts/100mL)	1,192

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criterion Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

Camp Branch is a Class III (fresh) waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The criterion applicable to this TMDL is the Class III freshwater criterion for fecal coliform.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

Numeric criteria for bacterial quality are expressed in terms of fecal coliform bacteria concentration. The water quality criterion for the protection of Class III (fresh) waters, as established by Rule 62-302, F.A.C., states the following:

> ***Fecal Coliform Bacteria:***
>
> *The most probable number (MPN) or membrane filter (MF) counts per 100 mL of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day.*

The criterion states that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. There were insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for fecal coliform bacteria. Therefore, the criterion selected for the TMDL was not to exceed 400 counts/100mL in any sampling event for fecal coliform.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of pollutants in the impaired waterbody and the amount of pollutant loadings contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, such as those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term "point source" will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) ***and*** stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Potential Sources of Fecal Coliform within the Camp Branch WBID Boundary

4.2.1 Point Sources

Wastewater Point Sources

There are two NPDES-permitted facilities located within the Camp Branch WBID boundary: Jerkins, Inc.–Bonifay (Permit Number FLG110448) and City of Bonifay Wastewater Treatment Facility (WWTF) (Permit Number FL0027731). Although the Jerkins Bonifay facility is classified as a surface water discharge in the Department's Wastewater Facility Regulation (WAFR) database, it is a Concrete Batch General Permit (GP) facility and should therefore not contribute coliform discharges to Camp Branch.

The City of Bonifay WWTF is also classified as a surface water discharge in WAFR. The facility is permitted to discharge treated effluent to an unnamed tributary leading to Camp Branch, eventually flowing into Holmes Creek. The facility is permitted to discharge a 1.4 million-gallon-per-day (MGD) monthly average daily flow (MADF) to the unnamed tributary. No fecal coliform exceedances were reported for this facility during the Cycle 2 verified period (2002–09) in the Permit Compliance System (PCS) Data Monitoring Reports.

Municipal Separate Storm Sewer System Permittees

There are no NPDES Phase I or Phase II Municipal Separate Storm Sewer System (MS4) permits in the Camp Branch watershed.

4.2.2 Land Uses and Nonpoint Sources

Accurately quantifying the fecal coliform loadings from nonpoint sources requires identifying nonpoint source categories, locating the sources, determining the intensity and frequency at which these sources create high fecal coliform loadings, and specifying the relative contributions from these sources. Depending on the land use distribution in a given watershed, frequently cited nonpoint sources in urban areas include failed septic tanks, leaking sewer lines, and pet feces. For a watershed dominated by agricultural land uses, fecal coliform loadings can come from the runoff from areas with animal feeding operations or direct animal access to receiving waters.

In addition to the sources associated with anthropogenic activities, birds and other wildlife can also contribute fecal coliform to receiving waters. While detailed source information is not always available to accurately quantify the fecal coliform loadings from different sources, land use information can provide some hints on the potential sources of observed fecal coliform impairment.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the NWFWMD's year 2004 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the Camp Branch WBID boundary were aggregated using the simplified Level 1 codes and tabulated in **Table 4.1**. **Figure 4.1** shows the spatial distribution of the principal land uses within the WBID boundary.

As shown in **Table 4.1**, the total area within the Camp Branch WBID boundary is approximately 4,927 acres. The dominant land use categories are upland forest land (coniferous and hardwood forests; and pine flatwoods), which accounts for approximately 33 percent of the total WBID area, and agriculture (pastures, crops, hay fields, and tree nurseries), which accounts for about 25 percent of the total WBID area. Urban lands (urban and built-up; low-, medium-, and high-density residential; and transportation, communication, and utilities) occupy about 1,024 acres, or about 21 percent of the total WBID area. Natural land use areas, which include upland forests, water, wetlands and rangelands, occupy about 2,682 acres, accounting for about 54 percent of the total WBID area.

Livestock

Based on the land use distribution listed in **Table 4.1**, livestock and other agricultural animals are a potentially important nonpoint source of coliform in the WBID. Agricultural animal waste is associated with various pathogens in streams; these can include *E. coli, Salmonella, Giardia, Campylobacter, Shigella, and Cryptosporidiumparvum* (Landry and Wolfe, 1999). Agricultural activities, including runoff from pastureland and cattle in streams, can affect water quality. **Appendix B** provides detailed load estimates and describes the methods used for the quantification.

Table 4.1. Classification of Land Use Categories within the Camp Branch Watershed (WBID 251) Boundary

This is a four-column table. Column 1 lists the Level 1 land use code, Column 2 lists the land use, Column 3 lists the acreage, and Column 4 lists the percent acreage.

- = Empty cell/no data

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and built-up	233	5%
-	Low-density residential	142	3%
-	Medium-density residential	178	4%
-	High-density residential	369	8%
2000	Agriculture	1,221	25%
3000	Rangeland	164	3%
4000	Upland forest	1,634	33%
5000	Water	27	1%
6000	Wetland	857	17%
7000	Barren land	-	-
8000	Transportation, communication, and utilities	102	2%
-	**TOTAL**	**4,927**	**100.0%**

Urban Development

Although urban land use is not dominant within the Camp Branch WBID boundary, contributions from residential areas may still be possible sources for fecal coliform loadings due to failed septic tanks and pet feces that are inappropriately disposed of. A preliminary quantification of the fecal coliform loadings from these sources was conducted to demonstrate the relative contributions. **Appendix B** provides detailed load estimates and describes the methods used for the quantification. It should be noted that the information included in **Appendix B** is only used to demonstrate the possible relative contributions from different sources. The loading estimates were not used in establishing the final TMDL.

Wildlife and Sediments

In addition to livestock, wildlife and sediments could also contribute to the fecal coliform exceedances in the watershed. Wildlife such as birds, raccoons, bobcats, rabbits, deer, and feral hogs have direct access to the stream, especially under low-flow conditions, and deposit their feces directly into the water. Wildlife also deposit coliform bacteria with their feces onto land surfaces, where they can be transported during storm events to nearby streams. Studies have shown that fecal coliform bacteria can survive and reproduce in streambed sediments and can be resuspended in surface water when conditions are right (Jamieson et al., 2005).

Current source identification methodologies cannot quantify the exact amount of fecal coliform loading from wildlife and/or sediment sources.

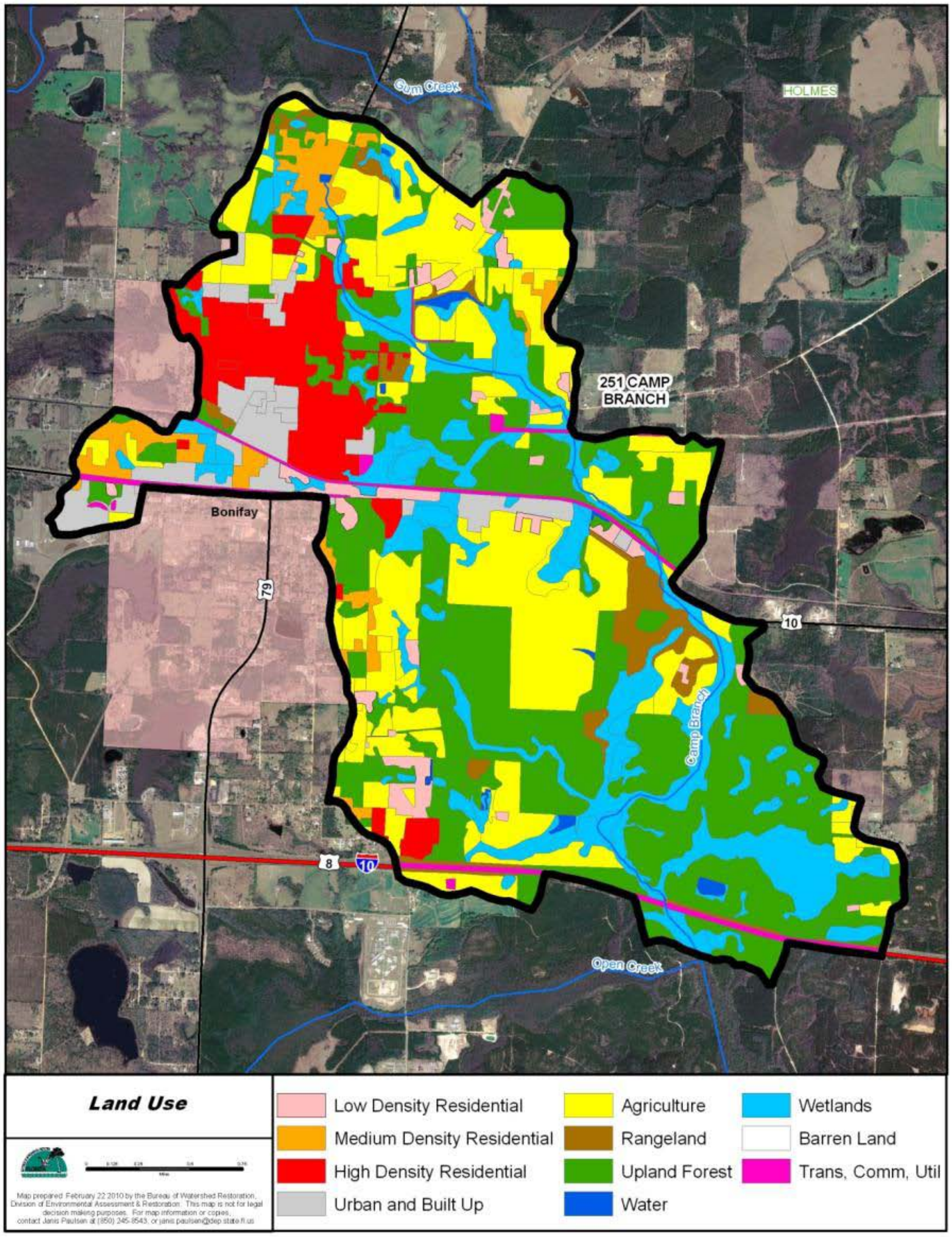

Figure 4.1. Principal Land Uses within the Camp Branch Watershed (WBID 251) Boundary in 2004

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

When continuous flow measurements in a watershed are available, a bacteria TMDL can be developed using the load duration curve method, which was developed by the Kansas Department of Health and Environment and provides the allowable daily bacteria load. However, flow data were not available for Camp Branch; therefore, the fecal coliform TMDL was developed using the “percent reduction” approach. Using this method, the percent reduction needed to meet the applicable criterion is calculated based on the 90th percentile of all measured concentrations collected during the Cycle 2 verified period (January 1, 2002, to June 30, 2009). Because bacteriological counts in water are not normally distributed, a nonparametric method is more appropriate for the analysis of fecal coliform data (Hunter, 2002). The Hazen method, which uses a nonparametric formula, was used to determine the 90th percentile. The EPA Region 4 uses this method in developing fecal coliform TMDLs. The percent reduction of fecal coliform needed to meet the applicable criterion was calculated as described in **Section 5.1.3**.

5.1.1 Data Used in the Determination of the TMDL

Data used to develop this TMDL were provided by the Department (Stations: 21FLGW 13695, 21FLPNS 304656508538530, 21FLPNS 304733508539324, 21FLPNS 304738408539220, and 21FLPNS 304808908540276). The majority of data were collected at Stations 21FLPNS 304656508538530 (n=8) and 21FLPNS 304808908540276 (n=11). See **Figure 5.1** for the locations of the water quality stations where fecal coliform data were collected in Camp Branch.

The Cycle 2 verified period includes data collected from January 1, 2002, through June 30, 2009. During this period, 26 fecal coliform samples were collected from the 5 sampling stations in WBID 251. The majority of fecal coliform data were collected in 2008, except for 1 sample collected in 2002. As a result, this analysis focuses on fecal coliform data collected in the latter part of the Cycle 2 verified period.

Concentrations ranged from 72 to 7,400 counts/100mL and averaged 1,192 counts/100mL during the period of observation. **Table 5.1** summarizes the descriptive statistics for the 2002 and 2008 fecal coliform results. **Figure 5.2** shows the fecal coliform concentration trends observed in Camp Branch for the 2002 and 2008 results.

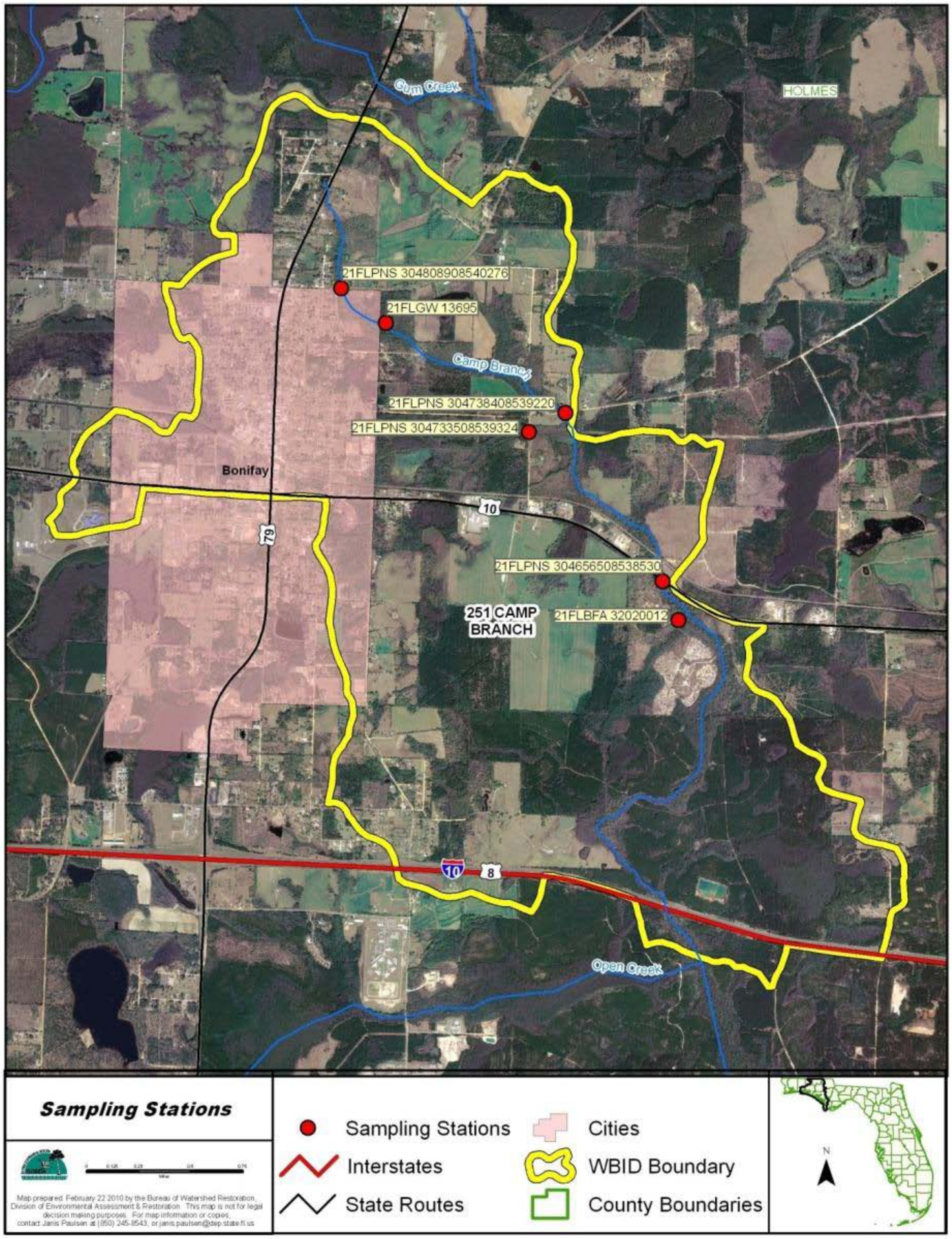

Figure 5.1. Location of Water Quality Stations with Fecal Coliform Data in Camp Branch (WBID 251)

Table 5.1. Descriptive Statistics of Fecal Coliform Data for Camp Branch (WBID 251) for Years 2002 and 2008 of the Cycle 2 Verified Period

This is a two-column table. Column 1 lists the descriptive statistic, and Column 2 lists the result.

Descriptive Statistic	Result
Mean observation (counts/100mL)	1,192
Standard deviation	1,741
Median observation (counts/100mL)	445
Highest observation (counts/100mL)	7,400
Lowest observation (counts/100mL)	72
25% quartile	153
75% quartile	1,250
Number of samples	26

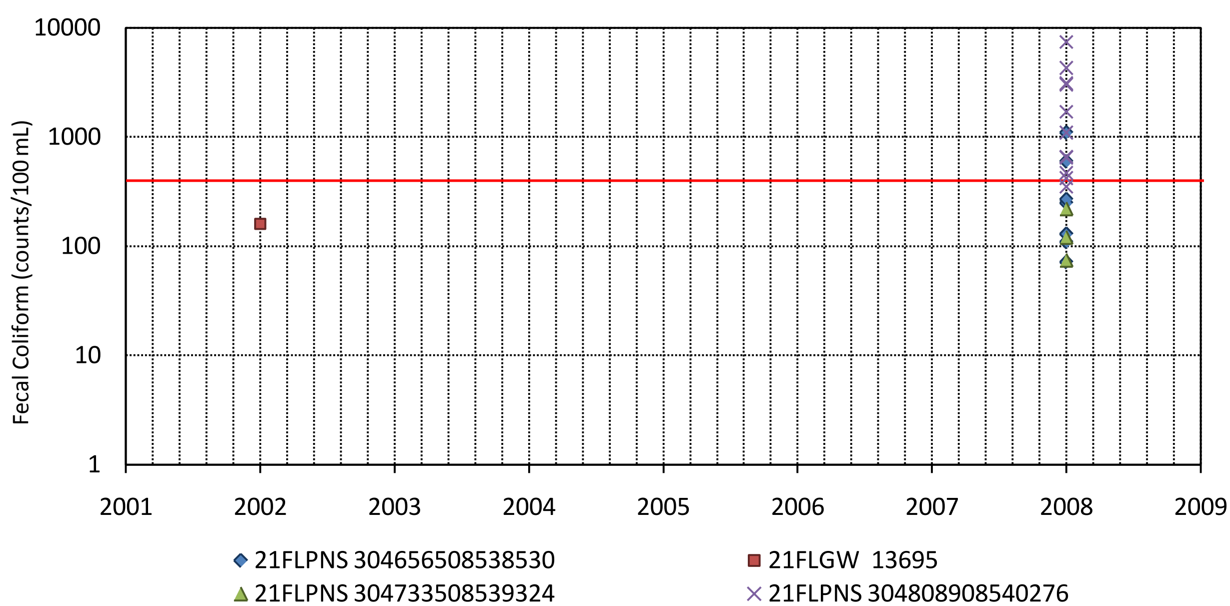

Figure 5.2. Fecal Coliform Concentration Trends in Camp Branch (WBID 251) for Years 2002 and 2008 of the Cycle 2 Verified Period

Note: The red line indicates the target concentration (400 counts/100mL).

Temporal Patterns

As all fecal coliform concentration data were collected in 2008 (n=25), except for one sample collected in April 2002, a typical seasonal trend could not be established with certainty. However, episodic peak fecal coliform concentrations were observed throughout the 2008 sampling season.

Seasonally, a peak in fecal coliform concentrations and exceedance rates is commonly observed during the third quarter (summer, July–September), when conditions are rainy and warm, and lower concentrations and exceedance rates in the first and fourth quarters (winter, January–March; and fall, October–December), when conditions are drier and colder. A similar relationship was observed in Camp Branch, where fecal coliform exceedances were recorded in the summer months (July and August).

However, contrary to common seasonal observations, the highest fecal coliform concentration, and one of the highest exceedance rates, was observed during the 4th quarter (December). In addition, fecal coliform exceedances and high percent exceedances were also observed during the 1st quarter (January). **Tables 5.2a** and **5.2b** summarize the monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data collected in 2008 for the Cycle 2 verified period for this WBID.

Table 5.2a. Summary Statistics of Fecal Coliform Data for All Stations in Camp Branch (WBID 251) by Month in 2008

This is an eight-column table. Column 1 lists the year, Column 2 lists the number of samples, Column 3 lists the minimum coliform count/100mL, Column 4 lists the maximum count, Column 5 lists the median count, Column 6 lists the mean count, Column 7 lists the number of exceedances, and Column 8 lists the percent exceedances.

- = Empty cell/no data
[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	4	120	3,600	1,800	1,830	3	75%
February	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-
April	-	-	-	-	-	-	-
May	2	250	660	455	455	1	50%
June	1	130	130	130	130	0	0%
July	3	270	4,300	1,700	2,090	2	66.7%
August	2	1,100	3,100	2,100	2,100	2	100%
September	7	74	580	350	318	3	42.9%
October	-	-	-	-	-	-	-
November	3	72	650	420	381	2	66.7%
December	3	130	7,400	1,100	2,877	2	66.7%

Table 5.2b. Summary Statistics of Fecal Coliform Data for All Stations in Camp Branch (WBID 251) by Season in 2008

This is an eight-column table. Column 1 lists the year, Column 2 lists the number of samples, Column 3 lists the minimum coliform count/100mL, Column 4 lists the maximum count, Column 5 lists the median count, Column 6 lists the mean count, Column 7 lists the number of exceedances, and Column 8 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	4	120	3,600	1,800	1,830	3	75%
Quarter 2	3	130	660	250	347	1	33.3%
Quarter 3	12	74	4,300	445	1,058	7	58.3%
Quarter 4	6	72	7,400	535	1,629	4	67%

Using rainfall data collected at the Chipley Climate Information for Management and Operational Decisions (CLIMOD) station (available: http://climod.meas.ncsu.edu/), it was possible to compare monthly rainfall in 2008 with monthly fecal coliform exceedance rates for the same period, as well as average quarterly rainfall with average quarterly fecal coliform exceedance rates at all stations (**Figures 5.3** and **5.4**). Peak fecal coliform concentrations commonly coincide with, or follow, periods of increased rainfall; this trend was observed in Camp Branch in only 1 of the samples with exceedances in 2008. In 2008, fecal coliform exceedances were associated with high 3-day precipitation (extreme and medium events) at 2 of the 4 sampling stations (e.g., when 3-day precipitation was 3.39 inches, the fecal coliform concentration was 4,300 counts/100mL at Station 21FLPNS 304808908540276 on July 1, 2008). The majority of fecal coliform exceedances in 2008 were associated with periods of medium or nonmeasurable precipitation events (**Section 5.1.2**).

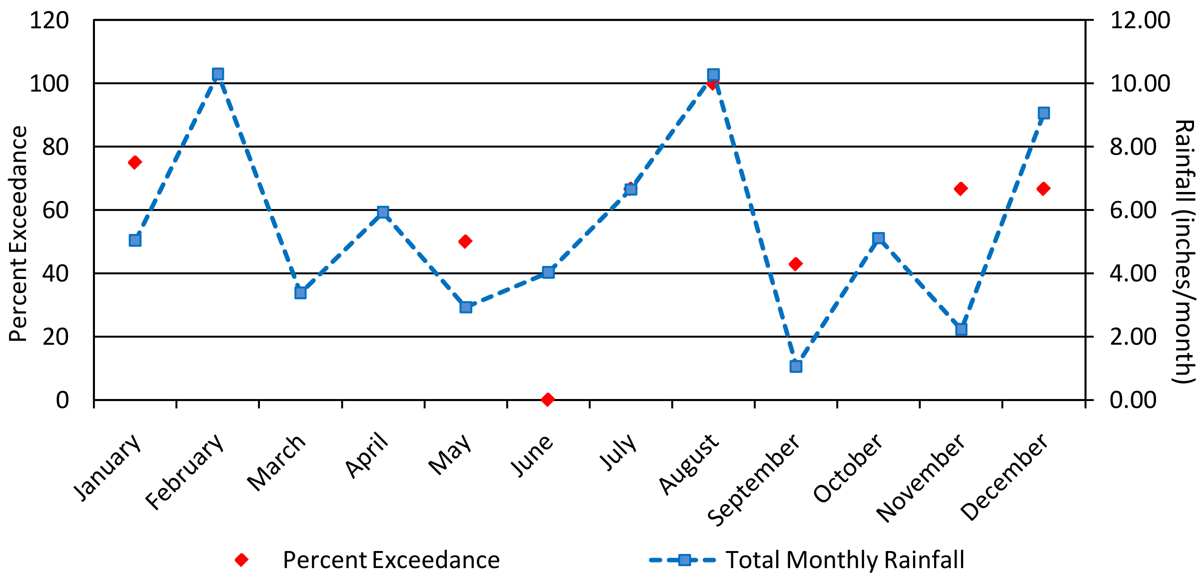

Figure 5.3. Fecal Coliform Exceedances and Rainfall in Camp Branch (WBID 251) by Month during Year 2008 of the Cycle 2 Verified Period

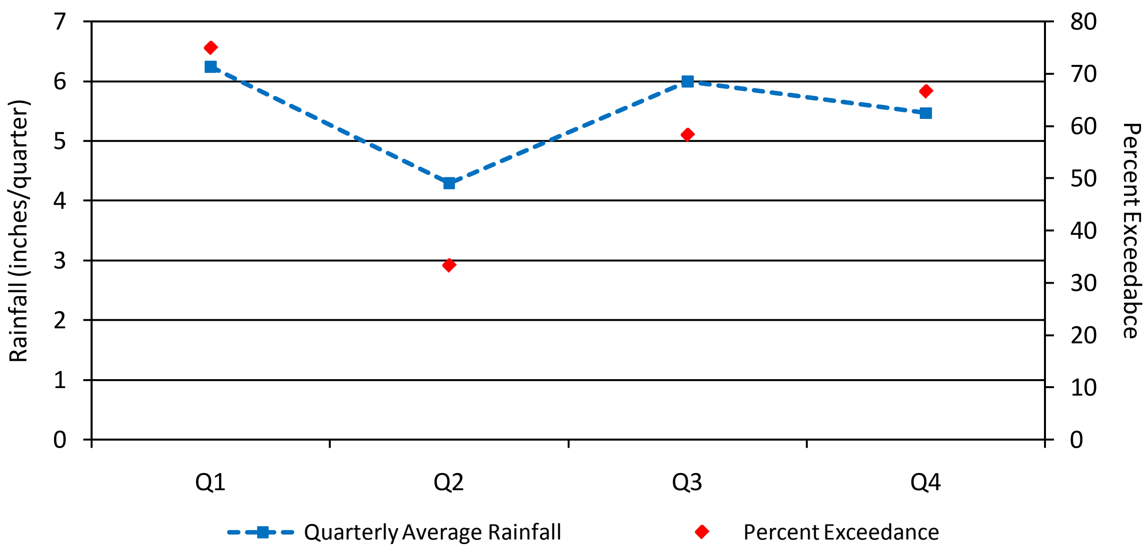

Figure 5.4. Fecal Coliform Exceedances and Rainfall in Camp Branch (WBID 251) by Season during Year 2008 of the Cycle 2 Verified Period

Spatial Patterns

Fecal coliform data from 2008 for Stations 21FLPNS 304808908540276 (upstream), 21FLPNS 304738408539220 (midstream), 21FLPNS 304733508539324 (midstream, at an unnamed tributary, draining east into Camp Branch), and 21FLPNS 304656508538530 (downstream) were analyzed to detect spatial trends in the data (**Figure 5.5**). In 2008, fecal coliform exceedances were observed in 3 of the 4 stations (21FLPNS 304656508538530, 21FLPNS 304738408539220, and 21FLPNS 304808908540276). The highest concentrations were recorded at Station 21FLPNS 304808908540276, located in the northern portion of the WBID (**Table 5.3**); 67 percent of the high fecal coliform concentrations in 2008 were recorded at this station. Land use surrounding this station is primarily high-density residential.

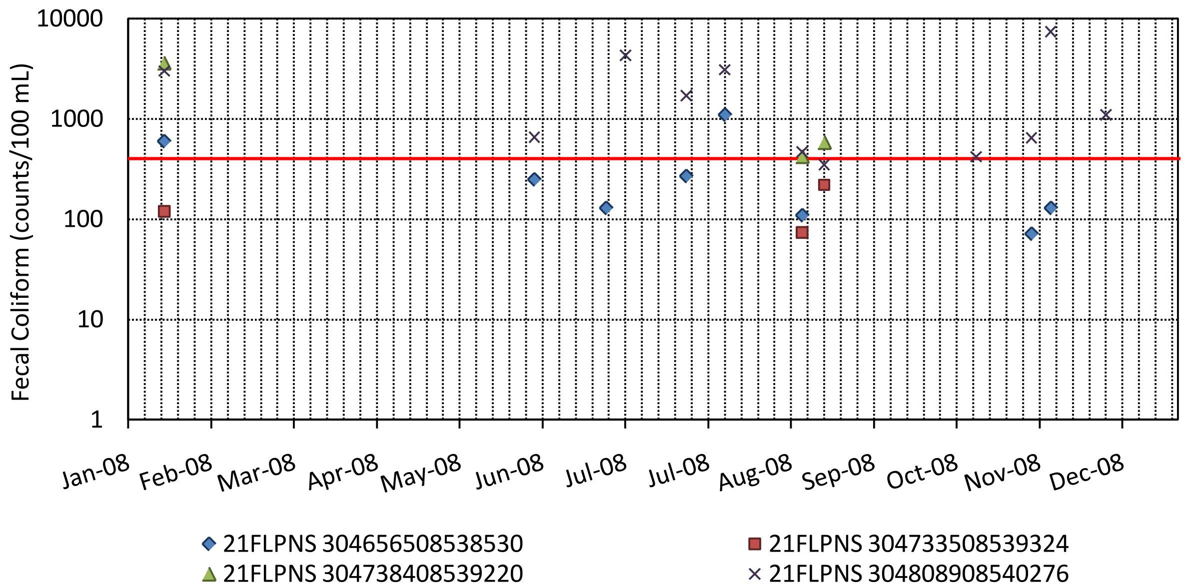

Figure 5.5. Spatial Fecal Coliform Concentration Trends in Camp Branch (WBID 251) in 2008

Note: The red line indicates the target concentration (400 counts/100mL).

Table 5.3. Station Summary Statistics of Fecal Coliform Data for Camp Branch (WBID 251) in 2008

This is an eight-column table. Column 1 lists the station, Column 2 lists the period of observation, Column 3 lists the number of samples, Column 4 lists the maximum count/100mL, Column 5 lists the mean count, Column 6 lists the median count, Column 7 lists the number of exceedances, and Column 8 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Mean[1]	Median[1]	Number of Exceedances[2]	% Exceedances
21FLPNS 304656508538530	2008	8	72	1,100	190	333	2	25%
21FLPNS 304733508539324	2008	3	74	220	120	138	0	0.0%
21FLPNS 304738408539220	2008	3	420	3,600	580	1,533	3	100%
21FLPNS 304808908540276	2008	11	350	7,400	1,100	2,105	10	91%

5.1.2 Critical Condition

The critical condition for coliform loadings in a given watershed depends on many factors, including the presence of point sources and the land use pattern in the watershed. Typically, the critical condition for nonpoint sources is an extended dry period followed by a rainfall runoff event. During the wet weather period, rainfall washes off coliform bacteria that have built up on the land surface under dry conditions, resulting in the wet weather exceedances. However, significant nonpoint source contributions can also appear under dry conditions without any major surface runoff event. This usually happens when nonpoint sources contaminate the surficial aquifer, and fecal coliform bacteria are brought into the receiving waters through baseflow. In addition, the fecal coliform contribution of wildlife with direct access to the receiving water can be more noticeable, by contributing to exceedances during dry weather. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

As no current flow data were available, hydrologic conditions were analyzed using rainfall. A loading curve–type chart that would normally be applied to flow events was created using precipitation data from the Chipley climate station instead. The chart was divided in the same manner as if flow were being analyzed, where extreme precipitation events represent the upper percentiles (0–5th percentile), followed by large precipitation events (5th–10th percentile), medium precipitation events (10th–40th percentile), small precipitation events (40th–60th percentile), and no recordable precipitation events (60th–100th percentile). Event precipitation ranges were derived based on these percentiles. Extreme events were those with rainfall greater than 2.11 inches; large events, 1.52 to 2.11 inches; medium events, 0.19 to 1.52 inches; small events, 0.01 to 0.19 inches; and nonmeasurable events, less than 0.01 inch. Three-day (the day of and 3 days prior to sampling) precipitation accumulations were used in the analysis (**Table 5.4** and **Figure 5.6**).

Historical data show that fecal coliform exceedances occurred over all hydrologic conditions, except for large precipitation events (1.52 to 2.11 inches), during which no samples were collected. A high percentage of exceedances (80 percent) occurred after small precipitation events, as well as during periods of extreme and nonmeasurable precipitation events (50 and 60 percent, respectively). Given that high exceedance rates and high concentrations followed all sampled precipitation events, and that there are no point source dischargers within the Camp Branch WBID boundary other than permitted point sources (i.e., a WWTF), it can be assumed that various nonpoint sources are a major contributing factor to high fecal coliform concentrations in the WBID. In particular, exceedance rates could indicate direct animal access to the creek. These exceedances may also result from fecal coliform pollution entering the creek in runoff after precipitation events and in baseflow during dry periods with little rainfall. Baseflow contributes to creek flow during dry conditions and can be impacted by failed septic tanks. **Table 5.4** and **Figure 5.6** show fecal coliform data by hydrologic condition.

As fecal coliform exceedances occurred following all sampled categories of precipitation events— extreme, medium, small, and not measurable—the target fecal coliform reduction calculated in the following section and shown in **Table 5.5** is applicable under all rainfall conditions in Camp Branch.

Table 5.4. Summary of Historical Fecal Coliform Data by Hydrologic Condition for Camp Branch (WBID 251)

This is a seven-column table. Column 1 lists the type of precipitation event, Column 2 lists the event range (in inches), Column 3 lists the total number of samples, Column 4 lists the number of exceedances, Column 5 lists the percent exceedances, Column 6 lists the number of nonexceedances, and Column 7 lists the percent nonexceedances.

Precipitation Event	Event Range (inches)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	>2.11"	2	1	50%	1	50%
Large	1.52" - 2.11"	0	0	0	0	0
Medium	0.19" - 1.52"	9	4	44.4%	5	56%
Small	0.01" - 0.19"	5	4	80%	1	20%
None/ Not Measurable	<0.01"	10	6	60%	4	40%

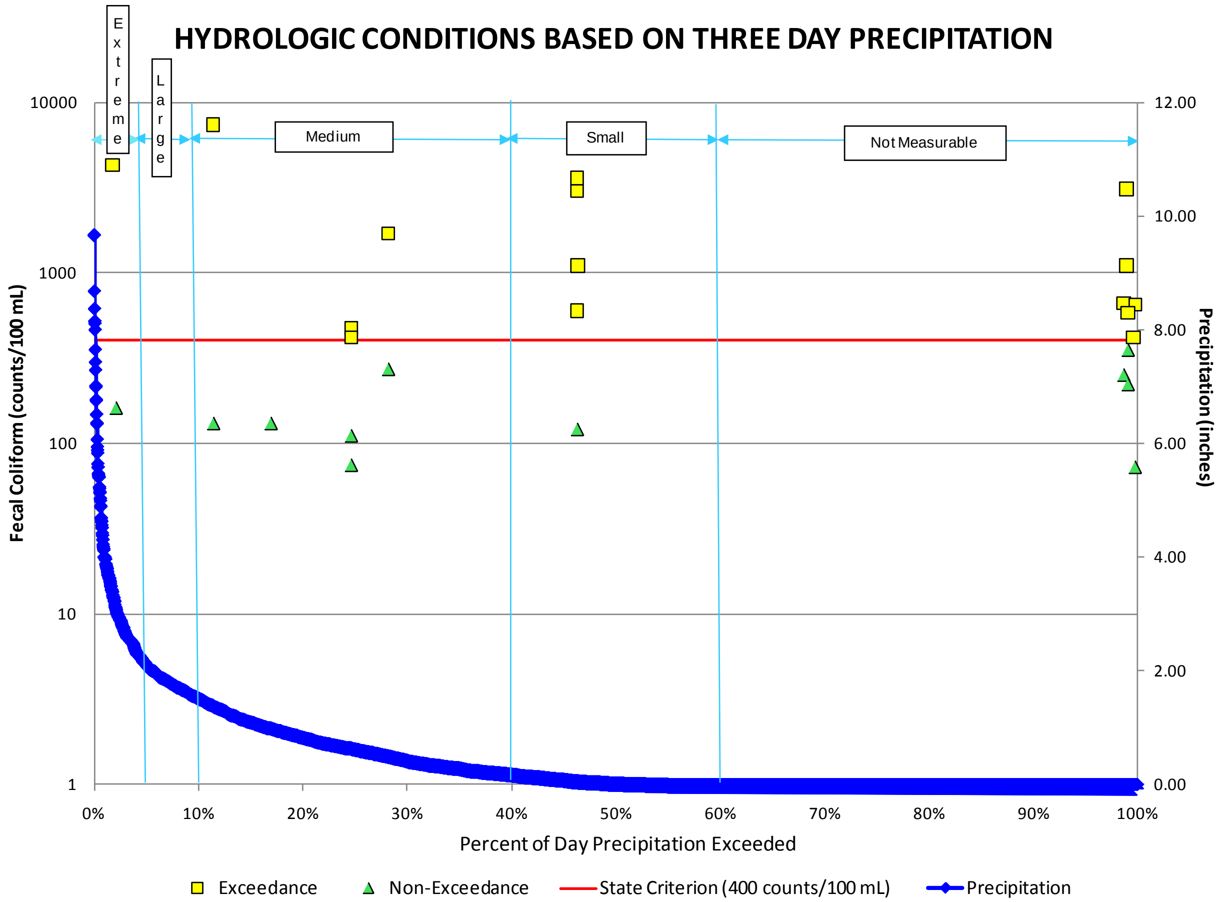

Figure 5.6. Historical Fecal Coliform Data by Hydrologic Condition for Camp Branch (WBID 251)

5.1.3 TMDL Development Process

Due to the lack of supporting information, mainly flow data, a simple reduction calculation was performed to determine the reduction in fecal coliform concentration necessary to achieve the concentration target (400 counts/100mL). The percent reduction needed to reduce the pollutant load was calculated by comparing the existing concentrations and target concentration using **Formula 1**:

$$\text{Needed \% Reduction} = \frac{\text{Existing } 90^{\text{th}} \text{ Percentile Concentration-Allowable Concentration}}{\text{Existing } 90^{\text{th}} \text{ Percentile Concentration}} \times 100$$ **Formula 1**

Using the Hazen method for estimating percentiles, as described in Hunter (2002), the existing condition concentration was defined as the 90th percentile of all the fecal coliform data collected during the Cycle 2 verified period (January 1, 2002, to June 30, 2009). The 90th percentile is also called the 10 percent exceedance event. This will result in a target condition that is consistent with the state bacteriological water quality assessment threshold for Class III waters.

In applying this method, all of the available data are ranked (ordered) from the lowest to the highest (**Table 5.5**), and **Formula 2** is used to determine the percentile value of each data point.

$$\text{Percentile} = \frac{\text{Rank} - 0.5}{\text{Total Number of Samples Collected}}$$ **Formula 2**

If none of the ranked values is shown to be the 90th percentile value, then the 90th percentile number (used to represent the existing condition concentration) is calculated by interpolating between the two data points adjacent (above and below) to the desired 90th percentile rank using **Formula 3,** as described below.

$$90^{\text{th}} \text{ Percentile Concentration} = C_{\text{lower}} + (P_{90\text{th}} * R)$$ **Formula 3**

Where:

C_{lower} is the fecal coliform concentration corresponding to the percentile lower than the 90th percentile (in this case, 3,100 counts/100mL).

P_{90th} is the percentile difference between the 90th percentile and the percentile number immediately lower than the 90th percentile (in this case, 88%), or 90% – 88% = 2%.

R is a ratio defined as R = (fecal coliform concentration $_{upper}$ – fecal coliform concentration $_{lower)}$ / (percentile $_{upper}$ – percentile $_{lower)}$.

To calculate *R*, the percentile values below and above the 90th percentile were identified, in this case, 88 and 92 percent, respectively (**Table 5.5**). Next, the fecal coliform concentrations corresponding to the lower and upper percentile values were identified (3,100 and 3,600 counts/100mL, respectively) (**Table 5.5**). The fecal coliform concentration difference between the lower and higher percentiles was then calculated and divided by the unit percentile. The unit percentile difference is the difference between the lower and upper percentiles (e.g., 92% – 88% = 4 percentile unit difference). R was then calculated as R = (3,600 – 3,100)/(92% – 88%) = 125.

The C_{lower}, P_{90th}, and R, were substituted into **Formula 3** to calculate the 90th percentile fecal coliform concentration (i.e., 90th Percentile Concentration = 3,100 + (2*125) = 3,350 counts/100mL).

Using **Formula 1**, the percent reduction for the period of observation (January 1, 2002, to June 30, 2009) was calculated as 88 percent for Camp Branch (i.e., % reduction needed = [(3,350 – 400)/3,350]*100 = 88%).

Table 5.5 shows the individual fecal coliform data, the ranks, the percentiles for each individual data, the existing 90th percentile concentration, the allowable concentration (400 counts/100mL), and the percent reduction needed to meet the applicable water quality criterion for fecal coliform.

A data distribution analysis identified 5 outliers (3,000, 3,100, 3,600, 4,300, and 7,400 counts/100mL) (**Figure 5.7**). Communication with the data providers provided no evidence that sampling or data quality concerns were associated with these results; therefore, there is no reasonable justification for removing these extreme values for the final percent reduction calculation. The final percent reduction number is not extremely biased or distorted by the outliers present in the dataset.

Table 5.5. Calculation of Fecal Coliform Reductions for the Camp Branch (WBID 251) TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the station, Column 2 lists the sampling date, Column 3 lists the fecal coliform exceedance concentration (MPN/100mL), Column 4 lists the rank, and Column 5 lists the percentile by the Hazen method.

- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLPNS 304656508538530	11/25/2008	72	1	4%
21FLPNS 304733508539324	9/3/2008	74	2	8%
21FLPNS 304656508538530	9/3/2008	110	3	12%
21FLPNS 304733508539324	1/16/2008	120	4	15%
21FLPNS 304656508538530	6/24/2008	130	5	19%
21FLPNS 304656508538530	12/2/2008	130	6	23%
21FLGW 13695	4/16/2002	160	7	27%
21FLPNS 304733508539324	9/11/2008	220	8	31%
21FLPNS 304656508538530	5/29/2008	250	9	35%
21FLPNS 304656508538530	7/23/2008	270	10	38%
21FLPNS 304808908540276	9/11/2008	350	11	42%
21FLPNS 304738408539220	9/3/2008	420	12	46%
21FLPNS 304808908540276	11/5/2008	420	13	50%
21FLPNS 304808908540276	9/3/2008	470	14	54%
21FLPNS 304738408539220	9/11/2008	580	15	58%
21FLPNS 304656508538530	1/16/2008	600	16	62%
21FLPNS 304808908540276	11/25/2008	650	17	65%
21FLPNS 304808908540276	5/29/2008	660	18	69%
21FLPNS 304656508538530	8/6/2008	1,100	19	73%
21FLPNS 304808908540276	12/22/2008	1,100	20	77%
21FLPNS 304808908540276	7/23/2008	1,700	21	81%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLPNS 304808908540276	1/16/2008	3,000	22	85%
21FLPNS 304808908540276	8/6/2008	3,100	23	88%
21FLPNS 304738408539220	1/16/2008	3,600	24	92%
21FLPNS 304808908540276	7/1/2008	4,300	25	96%
21FLPNS 304808908540276	12/2/2008	7,400	26	100%
-	-	-	**Existing condition concentration– 90th percentile (counts/100mL)**	**3,350**
-	-	-	**Allowable concentration (counts/100mL)**	**400**
-	-	-	**Final % reduction**	**88%**

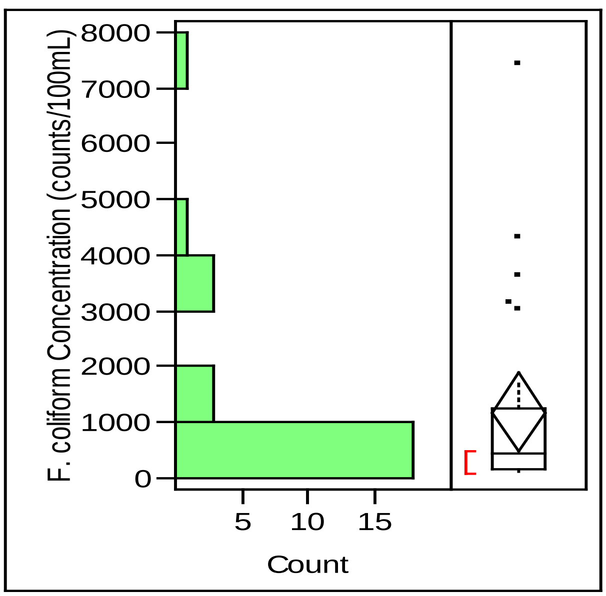

Figure 5.7. Histogram and Box Plot of Fecal Coliform Results for Camp Branch (WBID 251) for Years 2002 and 2008 Cycle 2 Verified Period Data

Note: Outliers are identified as points on the right.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of best management practices (BMPs).

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. The TMDL for Camp Branch is expressed in terms of counts/day and percent reduction, and represents the maximum daily fecal coliform load the stream can assimilate without exceeding the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Fecal Coliform in Camp Branch (WBID 251)

This is a six-column table. Column 1 lists the parameter, Column 2 lists the TMDL (counts/100mL), Column 3 lists the WLA for wastewater (counts/100mL), Column 4 lists the WLA for NPDES stormwater (percent reduction), Column 5 lists the LA (percent reduction), and Column 6 lists the MOS.

N/A = Not applicable

Parameter	TMDL (counts/100mL)	WLA for Wastewater (counts/100mL)	WLA for NPDES Stormwater (% reduction)	LA (% reduction)	MOS
Fecal coliform	400	Must Meet Permit Conditions	N/A	88%	Implicit

6.2 Load Allocation

Based on a percent reduction approach, the LA is an 88 percent reduction in fecal coliform from nonpoint sources. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

Only one of the two NPDES-permitted facilities within the WBID boundary could potentially contribute coliform discharges to Camp Branch: the City of Bonifay WWTF (Permit Number FL0027731). The state already requires all NPDES point source dischargers to meet bacteria criteria at the end of the pipe. It is the Department's current practice not to allow mixing zones for bacteria. Any point sources that may discharge in the watershed in the future will also be required to meet end-of-pipe standards for coliform bacteria.

6.3.2 NPDES Stormwater Discharges

There are no NPDES Phase I or Phase II MS4 permits within the Camp Branch WBID boundary.. It should be noted that any future MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was used in the development of this TMDL by not subtracting contributions from natural sources and sediments when the percent reduction was calculated. This makes the estimation of human contribution more stringent and therefore adds to the MOS

Chapter 7: TMDL IMPLEMENTATION

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines that a BMAP is needed to support the implementation of this TMDL, a BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- *Water quality goals (based directly on the TMDL);*
- *Refined source identification;*
- *Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);*
- *A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;*
- *A description of further research, data collection, or source identification needed in order to achieve the TMDL;*
- *Timetables for implementation;*
- *Implementation funding mechanisms;*
- *An evaluation of future increases in pollutant loading due to population growth;*
- *Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and*
- *Stakeholder statements of commitment (typically a local government resolution).*

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information in managing water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

7.2 Other TMDL Implementation Tools

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its designated uses. This is because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old-fashioned detective work that is best done by those in the area.

Many assessment tools are available to assist local governments and interested stakeholders in this detective work. The tools range from the simple (such as Walk the WBIDs and GIS mapping) to the complex (such as bacteria source tracking). Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize fecal coliform sources of pollution. Based on work in the Lower St Johns River Tributaries and Hillsborough Basins, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work.

In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

References

Alabama Department of Environmental Management (ADEM). 2001. *Water Down Under: Alabama's Ground Water Resources*. Montgomery, AL. Available: http://www.adem.state.al.us/newsEvents/pubs/GWpart2.pdf

Alderiso, K., D. Wait and M. Sobsey. 1996. Detection and characterization of make-specific RNA coliphages in a New York City reservoir to distinguish between human and nonhuman sources of contamination. In*: Proceedings of a Symposium on New York City Water Supply Studies*, J.J. McDonnell et al. (eds.). TPS-96-2. Herndon, VA: American Water Resources Association.

American Society of Agricultural Engineers (ASAE). 1998. 1998 *ASAE standards: Standards, engineering practices, data.* 45th edition.

Climate Information for Management and Operational Decisions (CLIMOD) website. 2008. *Southeast Regional Climate Center.* Available: http://climod.meas.ncsu.edu/.

Crawford, N.C. and A.J. Whallon. 1985. *Hydrologic Hazards in Karst Terrain*. U.S. Geological Survey Water Fact Sheet, 2.

Culver, T.B., Y. Jia, R. TiKoo, J. Simsic, and R. Garwood. 2002. *Development of the Total Maximum Daily Load (TMDL) for fecal coliform bacteria in Moore's Creek, Albemarle County, Virginia.* Virginia Department of Environmental Quality.

Florida Administrative Code. *Rule 62-302, Surface water quality standards.*

———. *Rule 62-303, Identification of impaired surface waters.*

Florida Department of Environmental Protection. February 2001. *A report to the Governor and the Legislature on the allocation of Total Maximum Daily Loads in Florida.* Tallahassee, FL: Bureau of Watershed Management.

———. 2003. *Basin status report* : *Choctawhatchee–St. Andrew Bay.* Tallahassee, FL: Division of Water Resource Management. Available: http://www.dep.state.fl.us/water/basin411/csa/status.htm.

———. 2006. *Water quality assessment report: Choctawhatchee–St. Andrew Bay.* Tallahassee, FL: Division of Water Resource Management. Available: http://www.dep.state.fl.us/water/basin411/csa/assessment.htm.

Florida Department of Health website. 2008. *Onsite sewage programs statistical data.* Available: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm.

Florida Watershed Restoration Act. *Chapter 99-223, Laws of Florida.*

Holmes County Property Appraiser Website. 2010. Available: http://www.qpublic.net/fl_search.php?county=fl_holmes&searchType=parcel.

Hubbard, R.K., G.L. Newton, and G.M. Hill. 2004. *Water quality and the grazing animal*. *Journal of Animal Science (82): E255-263.*

Hunter, P.R. 2002. Does calculation of the 95th percentile of microbiological results offer any advantage over percentage exceedance in determining compliance with bathing water quality standards? *Applied Microbiology (34): 283-286.*

Jamieson, R.C., D.M. Joy, H. Lee, R. Kostaschuk, and R.J. Gordon. 2005*. Resuspension of sediment-associated Escherichia coli in a natural stream. Journal of Environmental Quality (34): 581-589.*

Landry, M.S., and M.L. Wolfe. 1999. *Fecal bacteria contamination of surface waters associated with land application of animal waste.* Paper No. 99-4024. Toronto, Ont.: American Society of Agricultural Engineers.

Lim, S., and V. Olivieri. 1982. *Sources of microorganisms in urban runoff.* Johns Hopkins School of Public Health and Hygiene. Baltimore, MD: Jones Falls Urban Runoff Project.

Miller, James A. 1990. *Ground Water Atlas of the United States Alabama, Florida, Georgia, and South Carolina* (HA 730-G). U.S. Geological Survey. Available: http://pubs.usgs.gov/ha/ha730/ch_g/G-text6.html

Minnesota Pollution Control Agency. 1999. *Effect of septic systems on ground water quality.* Ground Water and Assessment Program. Baxter, MN.

Scott, Thomas M. 1992. *A Geological Overview of Florida*. Florida Geological Survey. Tallahassee.

Trial, W. et al. 1993. Bacterial source tracking: studies in an urban Seattle watershed. *Puget Sound Notes 30: 1-3.*

U.S. Census Bureau. 2000. Available: http://www.census.gov/.

U.S. Department of Agriculture. 2007. *National Agricultural Statistics Service: 2007 census of agriculture.* Available: http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp.

U.S. Environmental Protection Agency. January 2001. *Protocol for developing pathogen TMDLs*. Washington, DC: Office of Water. EPA 841-R-00-002.

US Geological Survey. 2010. *Karst and the USGS: What is karst?* Available: http://water.usgs.gov/ogw/karst/index

van der Wel, B. 1995. Dog pollution. *The Magazine of the Hydrological Society of South Australia 2(1) 1.*

Watson, T. June 6, 2002. Dog waste poses threat to water. *USA Today.*

Weiskel, P.K., B.L Howes, and G.R. Heufflder. 1996. Coliform contamination of a coastal embayment: Sources and transport pathway. *Environmental Science and Technology 1872-1881.*

Younos, Tamim , Fred W. Kaurish, Tern Brown, and Raymond de Leon. 2001. *Determining the Source of Stream Contamtnation in A Karst-Water System, Southwest Virginia, USA.* Journal of the American Water Resources Association. 37(2): 327-334.

Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations.

Rule 62-40, F.A.C., also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, they have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and the master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's stormwater/environmental resource permitting programs is that the NPDES Program covers both new and existing discharges, while the state's program focus on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Estimates of Fecal Coliform Loadings from Potential Sources

The Department provides these estimates for informational purposes only and did not use them to calculate the TMDL. These estimates are intended to give the public a general idea of the relative importance of each source in the waterbody. They were based on the best information available to the Department when the calculation was made. The numbers provided do not represent the actual loadings from the sources.

Pets

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff within the Camp Branch WBID boundary. Studies report that up to 95 percent of the fecal coliform found in urban stormwater can have nonhuman origins (Alderiso et al., 1996; Trial et al., 1993).

The most important nonhuman fecal coliform contributors appear to be dogs and cats. In a highly urbanized Baltimore catchment, Lim and Olivieri (1982) found that dog feces was the single greatest source of fecal coliform and fecal strep bacteria. Trial et al. (1993) also reported that cats and dogs were the primary source of fecal coliform in urban subwatersheds. Using bacteria source tracking techniques, it was found in Stevenson Creek in Clearwater, Florida, that the amount of fecal coliform bacteria contributed by dogs was as important as that from septic tanks (Watson, 2002).

According to the American Pet Products Manufacturers Association (APPMA), about 4 out of 10 U.S. households include at least 1 dog. A single gram of dog feces contains about 2.2 million fecal coliform bacteria (van der Wel, 1995). Unfortunately, statistics show that about 40 percent of American dog owners do not pick up their dogs' feces. The number of dogs within the Camp Branch WBID boundary is not known. Therefore, the statistics produced by APPMA were used in this analysis to estimate the possible fecal coliform loads contributed by dogs.

Information obtained from the Holmes County Property Appraiser's Office website (available: http://www.qpublic.net/fl_search.php?county=fl_holmes&searchType=parcel), residential land use areas identified using the NWFWMD's 2004 GIS land use coverage, and data obtained from the Florida Department of Health (FDOH), indicates that there are about 760 households within the Camp Branch WBID boundary. The next section describes the data provided by FDOH. Assuming that 40 percent of the households in this area have 1 dog, there are about 304 dogs within the WBID.

Assuming that 40 percent of dog owners do not pick up their dogs' feces, the total waste produced by dogs and left on the land surface in residential areas in the WBID is approximately 54,720 grams/day. The total load produced by dogs is about 1.20×10^{11} counts/day of fecal coliform. It should be noted that this load only represents the fecal coliform load created in the WBID and is not intended to be used to represent a part of the existing load that reaches the receiving waterbody. The fecal coliform load that eventually reaches the receiving waterbody could be significantly less than this value due to attenuation in overland transport. **Table B.1** shows the waste production rate for a dog (450 grams/animal/day) and the fecal coliform counts per gram of dog waste (2,200,000 counts/gram) based on the literature.

Table B.1. Dog Population Density, Wasteload, and Fecal Coliform Density based on the Literature

This is a five-column table. Column 1 lists the animal type (dog), Column 2 lists the population density, Column 3 lists the total number of dogs, Column 4 lists the wasteload, and Column 5 lists the fecal coliform density.

- = Empty cell/no data
* Number from APPMA

Animal Type	Population Density (animals/household)	Total Number of Dogs	Wasteload (grams/ animal-day)	Fecal Coliform Density (counts/gram)
Dog	0.4*	-	450	2,200,000

Livestock

The presence of livestock and other agricultural animals can result in high loading rates of pathogens to soils and waters. Livestock with direct access to the receiving water can contribute to exceedances during wet and dry weather conditions. Problems with grazing animals and pathogen loading rates derive primarily from animal density (Hubbard et al., 2004). At low animal densities, concerns relate primarily to livestock having free access to waterbodies, where they can directly deposit urine and manure (Hubbard et al., 2004). At high animal densities, concerns relate to the large amounts of urine and feces that are deposited in relatively small areas, increasing the probability of nutrients and pathogens being transported to surface waterbodies via surface runoff, or entering ground water (Hubbard et al., 2004). A major potential source of bacteria loading within the Camp Branch WBID is grazing livestock, primarily cattle (approximately 25 percent of the WBID is specifically categorized as Level 1 agricultural land use).

The estimation of fecal coliform loads from livestock for the Camp Branch WBID is derived from the EPA document, *Protocol for developing pathogen TMDLs: Source assessment* (2001). Data from the U.S. Department of Agriculture (USDA) (2007) were used to obtain the numbers of livestock for Holmes County, and data from the 2004 NWFWMD's land use coverage were used to obtain total pastureland areas for the county. Livestock counts and pasture areas were used to determine livestock densities (e.g., number of cows per acre of pastureland) for Holmes County, with the assumption that livestock are evenly distributed over pasture areas within the county.

Pasture areas of the WBID were used with the livestock density for the county to obtain livestock counts within the WBID. **Table B.2** summarizes pastureland acreage estimated for Holmes County and WBID 251, as well as the livestock densities per acre of pastureland estimated for the county. **Table B.3** summarizes cattle populations in Holmes County and estimates livestock populations for WBID 251.

Table B.3 also includes an estimate of fecal coliform loads produced by cattle in the WBID. These loads were obtained based on the cattle densities estimated for the WBID and the fecal coliform counts that the American Society of Agricultural Engineers (ASAE) (1998) estimates for fecal indicator concentrations for cattle (1×10^{11} counts/day). The total fecal coliform load produced by cattle in the Camp Branch WBID is about 5.72×10^{13} counts/day.

Table B.2. Summary of Pastureland Acreage in Holmes County and WBID 251, and Livestock Densities per Acre of Pastureland for Holmes County

This is a three-column table. Column 1 lists the geographic area, Column 2 lists the acres of pastureland, and Column 3 lists the cattle per acre of pastureland.

*Assumed to be the same as that of Holmes County

Geographic Area	Acres of Pastureland	Livestock (Cattle) per Acre of Pastureland
Holmes County	33,207	1
Camp Branch (WBID 251)	572	1*

Table B.3. Summary of Livestock Populations in Holmes County and WBID 251, Livestock Waste Estimates for WBID 251, and Fecal Coliform Loads for WBID 251

This is a four-column table. Column 1 lists the type of livestock, Column 2 lists the livestock population in Holmes County in 2007, and Column 3 lists the estimated livestock population in WBID 251 in 2007.

[1] USDA, 2007

Livestock Type	Livestock in Holmes County in 2007[1]	Estimated Livestock in WBID 251 in 2007	Fecal Coliform Density (counts/day)
Cattle	33,202	572	5.72×10^{13}

Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) can also be a potential source of fecal bacteria pollution. Human sewage can be introduced into surface waters even when storm and sanitary sewers are separated. Leaks and overflows are common in many older sanitary sewers where capacity is exceeded, high rates of infiltration and inflow occur (i.e., outside water gets into pipes, reducing capacity), frequent blockages occur, or sewers are simply falling apart due to poor joints or pipe materials. Power failures at pumping stations are also a common cause of SSOs. The highest risk of an SSO occurs during storm events; however, few comprehensive data are available to quantify SSO frequency and bacteria loads in most watersheds. Therefore, in this report, the possible fecal coliform load contributed by sewer line leakage was estimated based on an empirical leakage rate of 0.5 percent of the total raw sewage (Culver et al., 2002) created within the WBID by the households connected to the sewer system.

Based on the domestic wastewater permitting information obtained from the Department's Northwest District Office (T. Mian, personal communication, May 3, 2010), this TMDL analysis assumed that within the Camp Branch WBID, only those households located within the city limit of Bonifay are connected to the sewer service provided by the City of Bonifay WWTP. The wastewater permitting also showed that within Bonifay, 1,144 households are connected to the sewer system, accounting for about 94 percent of the 1,216 households in the city (U.S Census, 2000). This ratio was used to estimate the number of households located within both the WBID and the city boundaries that are connected to the sewer system. Using the FDOH parcel data, the number of parcels (commercial and residential) within the city of Bonifay was estimated; residential parcels were extrapolated from these results using the residential land use GIS coverage. The final number of households within the city and within the WBID boundary was calculated by executing a parcel ID query between the total number of households within the WBID (760) and the number of residential parcels within the city boundary within the WBID. As a result, it was estimated that 540 housing units within the city of Bonifay within the Camp Branch WBID boundary are connected to the sewer system (**Figure B.1**).

Fecal coliform loading from sewer line leakage can be calculated based on the number of people in the watershed, typical per household generation rates, and typical fecal coliform concentrations in domestic sewage, assuming a leakage rate of 0.5 percent (Culver et al., 2002). Based on this assumption, a rough estimate of fecal coliform loads from leaks and SSOs within the Camp Branch WBID boundary can be made using **Equation B.1.**

$$L = 37.85 * N * Q * C * F \qquad \textbf{Equation B.1}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the number of households using sanitary sewer in the WBID;
Q is the discharge rate for each household (gallons/day);
C is the fecal coliform concentration for domestic wastewater (counts/100mL);
F is the sewer line leakage rate; and
37.85 is a conversion factor (100mL/gallon).

The number of households *(N)* within the Camp Branch WBID boundary served by sewer systems is estimated to be 540. The discharge rate through sewers from each household (*Q*) was calculated by multiplying the average household size for the city of Bonifay (2.21) by the per capita wastewater production rate per day (70 gallons/day/person). The commonly cited concentration (*C*) for domestic wastewater is 1×10^6 counts/100mL for fecal coliform (EPA, 2001). The contribution of fecal coliform through sewer line leakage was assumed to be 0.5 percent of the total sewage loading created from the population not on septic tanks (Culver et al., 2002). Based on **Equation B.1**, the fecal coliform loading from sewer line leakage in the WBID is approximately 1.58×10^{10} counts/day.

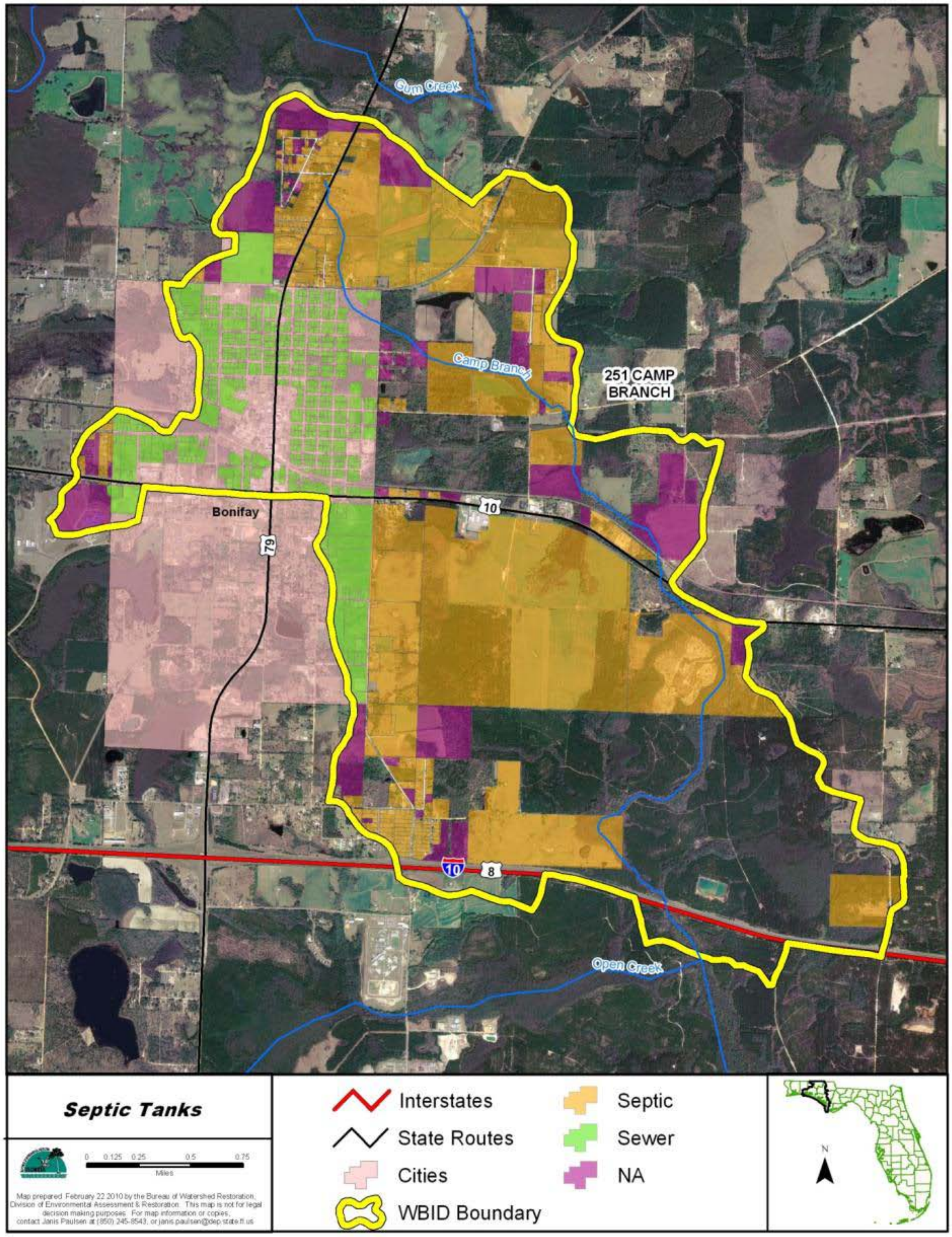

Figure B.1. Distribution of Onsite Sewage Disposal Systems (Septic Tanks) in the Residential Land Use Areas within the Camp Branch WBID Boundary

Septic Tanks

Septic tanks are another potentially important source of coliform pollution in urban watersheds. When properly installed, most of the coliform from septic tanks should be removed within 50 meters of the drainage field (Minnesota Pollution Control Agency, 1999). However, the physical properties of an aquifer, such as thickness, sediment type (sand, silt, and clay), and location play a large part in determining whether contaminants from the land surface will reach the groundwater (USGS, 2010). The risk of contamination is greater for unconfined (water-table) aquifers than for confined aquifers because they usually are nearer to land surface and lack an overlying confining layer to impede the movement of contaminants (USGS, 2010).

Sediment type (sand, silt, and clay) also determines the risk of contamination in a particular watershed. "Porosity, which is the proportion of a volume of rock or soil that consists of open spaces, tells us how much water rock or soil can retain. Permeability is a measure of how easily water can travel through porous soil or bedrock. Soil and loose sediments, such as sand and gravel, are porous and permeable. They can hold a lot of water, and it flows easily through them. Although clay and shale are porous and can hold a lot of water, the pores in these fine-grained materials are so small that water flows very slowly through them. Clay has a low permeability (USGS, 2010)."

Also, the risk of contamination is increased for areas with a relatively high ground water table. The drain field can be flooded during the rainy season, resulting in ponding and coliform bacteria can pollute the surface water through stormwater runoff. Additionally, in these circumstances, a high water table can result in coliform bacteria pollution reaching the receiving waters through baseflow.

In addition, watersheds located in karst regions are extremely vulnerable to contamination. Karst terrain is characterized by springs, caves, sinkholes, and a unique hydrogeology that results in aquifers that are highly productive (USGS, 2010). In comparsion to non-karst areas, the springs, caves, sinkholes, etc act as direct pathways for pollutants to enter waterbodies.

Septic tanks may also cause coliform pollution when they are built too close to irrigation wells. Any well that is installed in the surficial aquifer system will cause a drawdown. If the septic tank system is built too close to the well (e.g., less than 75 feet), the septic tank discharge will be within the cone of influence of the well. As a result, septic tank effluent may enter the well, and once the polluted water is used to irrigate lawns, coliform bacteria may reach the land surface and wash into surface waters through stormwater runoff.

A rough estimate of fecal coliform loads from failed septic tanks within the Camp Branch WBID boundary can be made using **Equation B.2**:

$$\mathbf{L = 37.85 * N * Q * C * F} \qquad \textbf{Equation B.2}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the number of households using septic tanks in the WBID;
Q is the discharge rate for each septic tank (gallons/day);
C is the fecal coliform concentration for the septic tank discharge (counts/100mL);
F is the septic tank failure rate; and
37.85 is a conversion factor (100mL/gallon).

Based on the estimated total number of households within the WBID (760) and the estimated number of households connected to the sewer system (540), 220 housing units *(N)* are thought to be using septic tanks to treat their domestic wastewater (**Figure B.1**).

The discharge rate from each septic tank (*Q*) was calculated by multiplying the average household size by the per capita wastewater production rate per day. Based on the information published by the Census Bureau, the average household size for Holmes County is about 2.43 people/household. The same population densities were assumed within the Camp Branch WBID boundary. A commonly cited value for per capita wastewater production rate is 70 gallons/day/person (EPA, 2001). The commonly cited concentration (*C*) for septic tank discharge is 1×10^6 counts/100mL for fecal coliform (EPA, 2001).

No measured septic tank failure rate data were available for the WBID when this TMDL was developed. Therefore, the failure rate was derived from the number of septic tanks in Holmes County based on FDOH's septic tank inventory and the number of septic tank repair permits issued in both counties as published by FDOH (available: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm). The cumulative number of septic tanks in Holmes County on an annual basis was calculated by subtracting the number of issued septic tank installation permits for each year from the current number of septic tanks in the county based on FDOH's 2008–09 inventory, assuming that none of the installed septic tanks will be removed after being installed (**Table B.4**). The reported number of septic tank repair permits was also obtained from the FDOH Website.

Based on this information, the annual discovery rates of failed septic tanks were calculated (**Table B.4**). The average annual septic tank failure discovery rate for Holmes County is approximately 0.31 percent. Assuming that failed septic tanks are not discovered for about 5 years, the estimated annual septic tank failure rate is about 5 times the discovery rate, or 1.54 percent for Holmes County. Based on **Equation B.2**, the estimated fecal coliform loading from failed septic tanks within the Camp Branch WBID boundary is approximately 2.19×10^{10} counts/day.

Table B.4. Estimated Number of Septic Tanks and Septic Tank Failure Rates for Holmes County (2002–08)

This is an eight-column table. Column 1 lists the type of statistic, Columns 2 through 7 list the estimate for each year from 2002 to 2007, respectively, and Column 8 lists the average.

* The failure rate is 5 times the failure discovery rate. **Descriptive Statistic**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Average**
New installations (septic tanks)	126	128	142	148	146	154	141
Accumulated installations (septic tanks)	8,054	8,180	8,308	8,450	8,598	8,744	8,389
Repair permits (septic tanks)	33	32	17	22	20	31	26
Failure discovery rate (%)	0.41%	0.39%	0.20%	0.26%	0.23%	0.35%	0.31%
Failure rate (%)*	2.05%	1.96%	1.02%	1.30%	1.16%	1.77%	1.54%

Wildlife

Wildlife is another possible source of fecal coliform bacteria within the Camp Branch WBID boundary. As shown in **Figure 4.1**, wetland areas border Camp Branch and several of its contributing branches within the WBID boundary. Additionally, rangeland (dry prairie, shrub, and brushland) and upland forested areas are close to the creek. These areas likely serve as habitat for wildlife that has the potential to contribute fecal coliform to the creek. However, as these represent natural inputs, this TMDL analysis does not assign any reductions to these sources.

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