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 Sikes Creek (WBID 142)

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Websites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

http://www.dep.state.fl.us/water/tmdl/index.htm

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf

Florida STORET Program

http://www.dep.state.fl.us/water/storet/index.htm

2008 305(b) Report

http://www.dep.state.fl.us/water/docs/2008_Integrated_Report.pdf

Criteria for Surface Water Quality Classifications

http://www.dep.state.fl.us/water/wqssp/classes.htm

Basin Status Report: Choctawhatchee–St. Andrew Bay

http://www.dep.state.fl.us/water/basin411/csa/status.htm

Water Quality Assessment Report: Choctawhatchee–St. Andrew Bay

http://www.dep.state.fl.us/water/basin411/csa/assessment.htm

U.S. Environmental Protection Agency

Region 4: TMDLs in Florida

http://www.epa.gov/region4/water/tmdl/florida/

National STORET Program

http://www.epa.gov/storet/

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for fecal coliform bacteria for Sikes Creek, 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 Sikes Creek 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. Sikes Creek is WBID 142.

Sikes Creek 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 central part of Holmes County (**Figure 1.1**).

The headwaters of Sikes Creek are in the mid-central portion of Holmes County. The creek flows southwest for approximately 12.5 miles to the Choctawhatchee River. It is joined by Tiger Ford Branch and receives flow from a number of smaller branches (**Figure 1.2**).

The drainage area within the Sikes Creek WBID boundary is approximately 16.9 square miles (mi^2) (10,830 acres) and is predominantly made up of forested land and wetlands. 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 142 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.

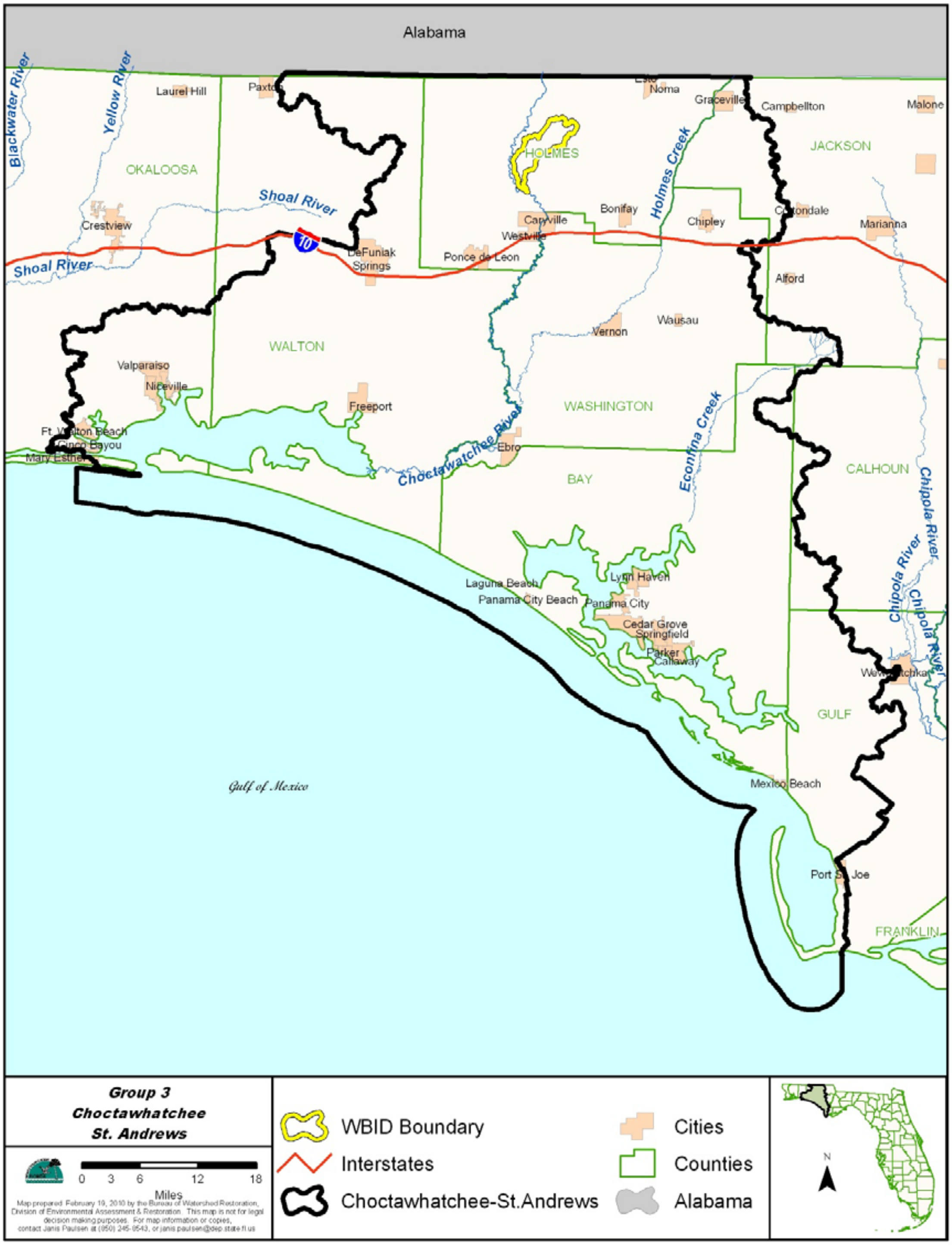

Figure 1.1. Location of the Sikes Creek Watershed (WBID 142) in the Choctawhatchee–St. Andrew Bay Basins and Major Geopolitical and Hydrologic Features in the Area

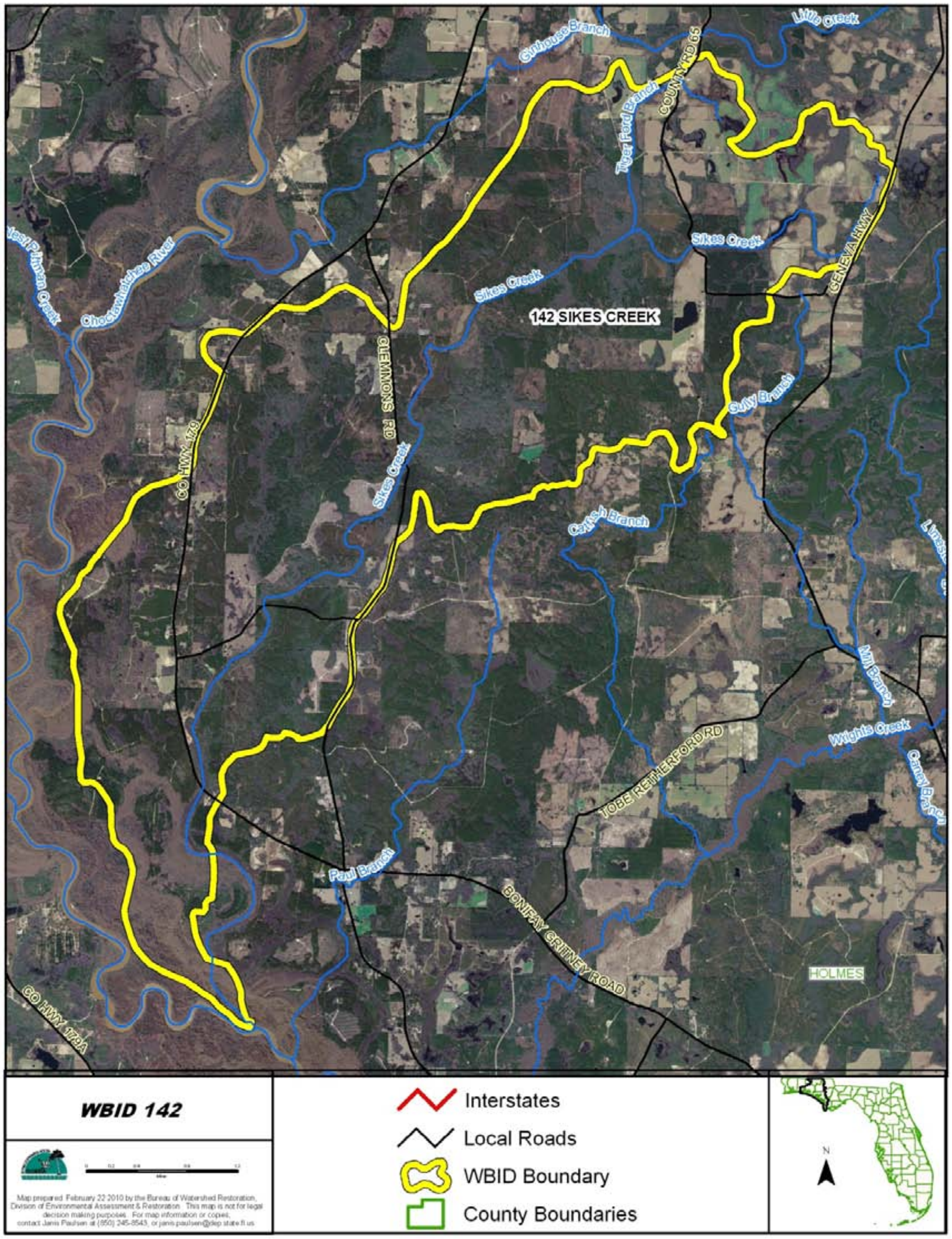

Figure 1.2. Location of the Sikes Creek Watershed (WBID 142) in Holmes County and Major Hydrologic Features in the Area

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 Sikes Creek. 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 Sikes Creek and has verified that this waterbody segment is impaired for fecal coliform bacteria. The verified impairment was based on the observation that for 5 out of 22 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/100mL) (see **Section 3.2** for details).

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

Table 2.1. Summary of Fecal Coliform Monitoring Data for Sikes Creek (WBID 142) 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
Sikes Creek (WBID 142)	Total number of samples	22
Sikes Creek (WBID 142)	IWR-required number of exceedances for the Verified List	5
Sikes Creek (WBID 142)	Number of observed exceedances	5
Sikes Creek (WBID 142)	Number of observed nonexceedances	17
Sikes Creek (WBID 142)	Number of seasons during which samples were collected	4
Sikes Creek (WBID 142)	Highest observation (counts/100mL)	1,470
Sikes Creek (WBID 142)	Lowest observation (counts/100mL)	6
Sikes Creek (WBID 142)	Median observation (counts/100mL)	136
Sikes Creek (WBID 142)	Mean observation (counts/100mL)	265

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)**

Sikes Creek 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 Sikes Creek WBID Boundary

4.2.1 Point Sources

Wastewater Point Sources

There are no NPDES-permitted wastewater facilities in the Sikes Creek watershed.

Municipal Separate Storm Sewer System Permittees

There are no NPDES Phase I or Phase II municipal separate storm sewer system (MS4) permits in the Sikes Creek 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 with 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 the 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 2004 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the Sikes Creek 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 Sikes Creek WBID boundary is approximately 10,830 acres. The dominant land use categories are upland forest land (coniferous and hardwood forests; pine flatwoods), which accounts for approximately 45 percent of the total WBID area, and wetlands, which account for approximately 36 percent of the total WBID area. Agricultural land occupies approximately 1,396 acres, or about 13 percent of the total WBID area. Urban lands (urban and built-up; low- and medium-density residential) occupy about 216 acres, or about 2 percent of the total WBID area. Natural land use areas, which include upland forests, water, wetlands, rangeland, and barren land, occupy about 9,215 acres, accounting for about 85 percent of the total WBID area.

Table 4.1. Classification of Land Use Categories within the Sikes Creek WBID 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	4	0.04%
-	Low-density residential	199	1.83%
-	Medium-density residential	13	0.12%
-	High-density residential	-	-
2000	Agriculture	1,396	12.9%
3000	Rangeland	434	4.0%
4000	Upland forest	4,868	44.95%
5000	Water	66	0.61%
6000	Wetland	3,847	35.52%
7000	Barren land	3	0.03%
8000	Transportation, communication, and utilities	-	-
-	**TOTAL**	**10,830**	**100.0%**

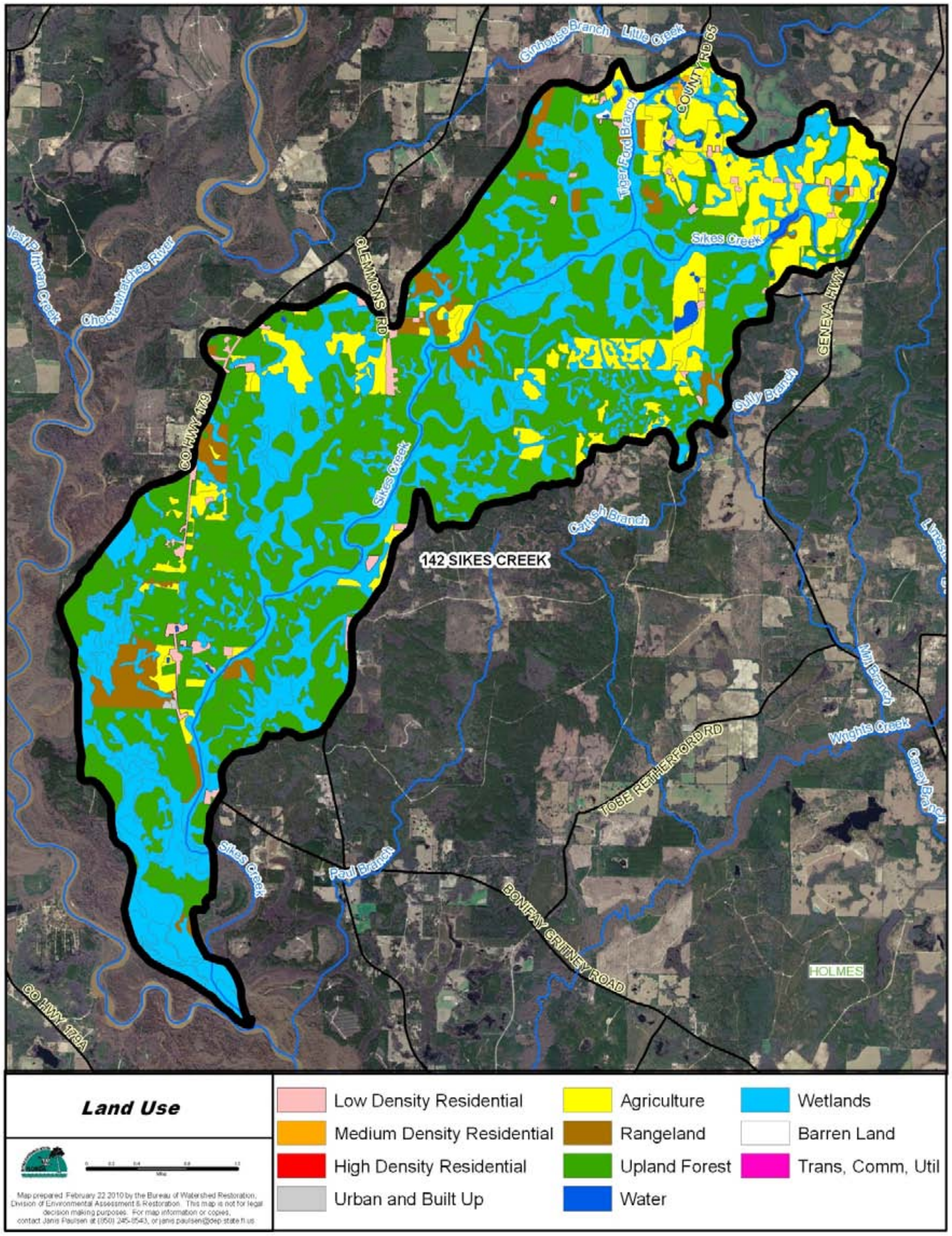

Figure 4.1. Principal Land Uses within the Sikes Creek (WBID 142) Boundary

Livestock

Although agriculture is not one of the primary land uses in the WBID, a potentially important nonpoint source of coliform includes livestock and other agricultural animals. 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 fecal coliform loading estimates from livestock in Sikes Creek and describes the methods used for the quantification.

Urban Development

Although urban land use is not dominant within the Sikes Creek WBID boundary, fecal coliform contributions from residential areas could not be excluded based on the current available data, especially for the residential areas located immediately adjacent to Sikes Creek or its tributaries. 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 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.

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 Sikes Creek; 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–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's Northwest District Office (Stations: 21FLPNS 32020114, 21FLPNS 32020154, 21FLPNS 32020155, 21FLPNS 32020156). The majority of data were collected at Stations 21FLPNS 32020114 (n=10) and 21FLPNS 32020155 (n=7). See **Figure 5.1** for the locations of the water quality stations where fecal coliform data were collected for Sikes Creek.

At the time of the assessment, the Department verified the water quality impairment in Sikes Creek based on the observation that 5 out of 22 fecal coliform samples collected during the Cycle 2 verified period (January 1, 2002, through June 30, 2009) exceeded the assessment threshold of 400 counts/100mL. This analysis also includes 3 data points (collected in 2008) incorporated into the IWR subsequent to the assessment. These new data results show exceedances of fecal coliform concentrations and thus do not change the verified impairment for the WBID.

The Cycle 2 verified period includes data collected from January 1, 2002, through June 30, 2009. During this period, a total of 25 fecal coliform samples were collected from the 4 sampling stations in WBID 142.

All fecal coliform data for Sikes Creek were collected in 2008; as a result, this analysis focuses on fecal coliform data collected in the latter part of the Cycle 2 verified period.

Concentrations for all samples collected during 2008 ranged from 6 to 1,470 counts/100mL and averaged 337 counts/100mL during the period of observation. **Table 5.1** summarizes the descriptive statistics for the 2008 fecal coliform results. **Figure 5.2** shows the fecal coliform concentration trends observed in Sikes Creek.

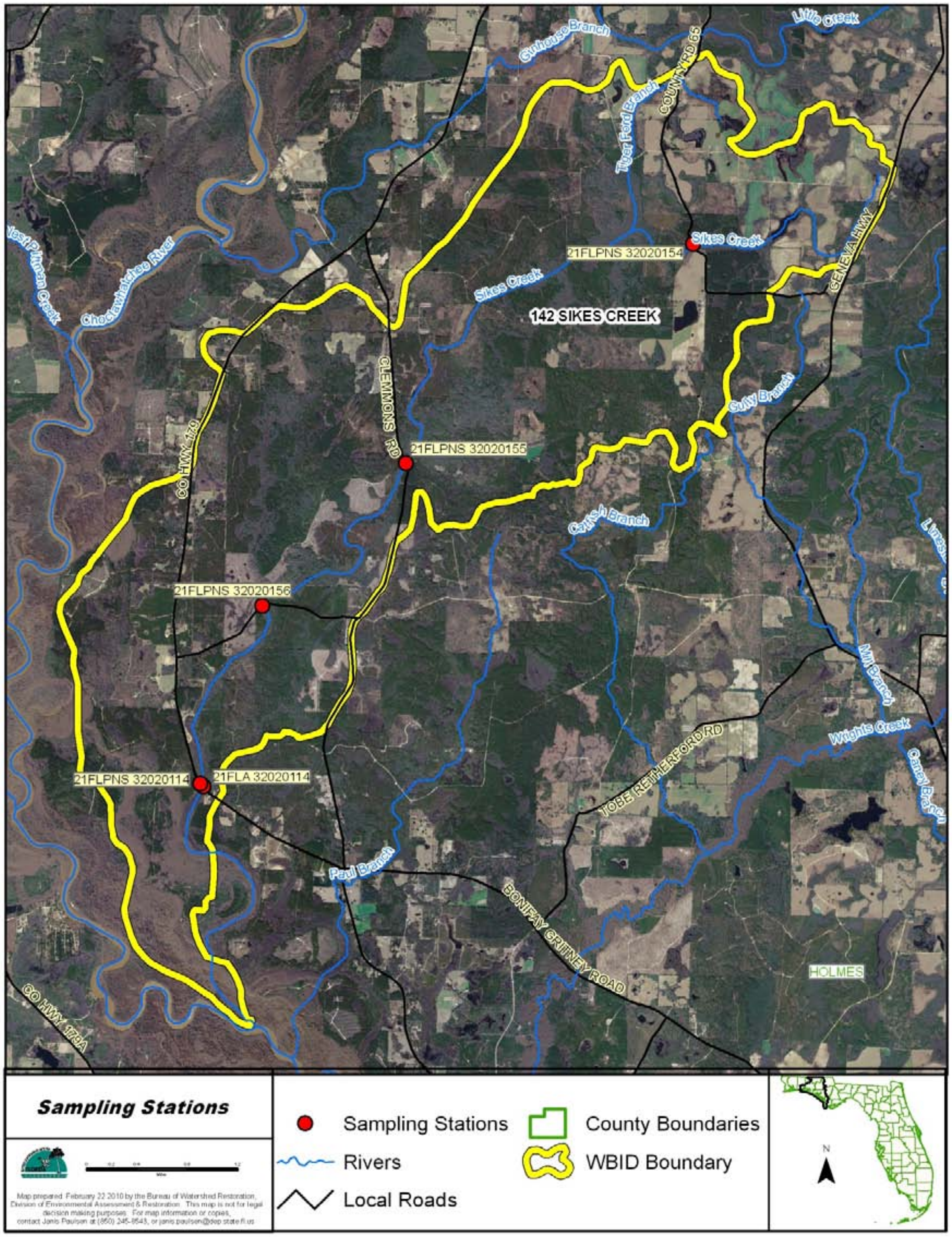

Figure 5.1. Location of Water Quality Stations with Fecal Coliform Data in Sikes Creek (WBID 142)

Table 5.1. Descriptive Statistics of Fecal Coliform Data for Sikes Creek (WBID 142) for 2008

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)	337
Standard deviation	384
Median observation (counts/100mL)	168
Highest observation (counts/100mL)	1,470
Lowest observation (counts/100mL)	6
25% quartile	54
75% quartile	535
Number of samples	25

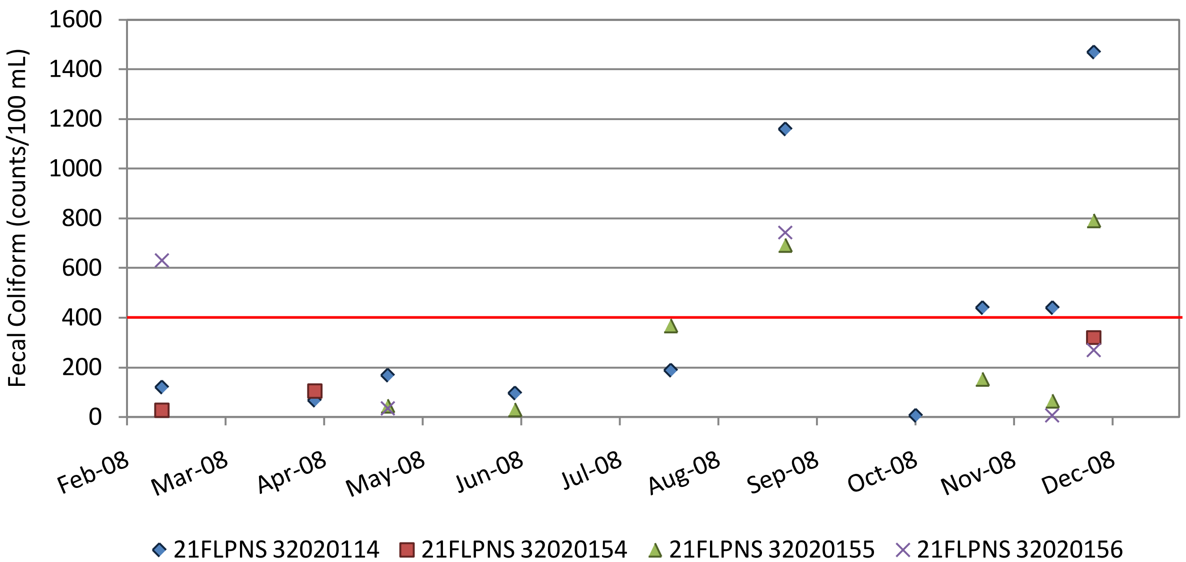

Figure 5.2. Fecal Coliform Concentration Trends in Sikes Creek (WBID 142) for 2008 during the Cycle 2 Verified Period

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

Temporal Patterns

As all fecal coliform concentration data were collected in 2008, a typical seasonal trend could not be established with certainty. However, episodic peak fecal coliform concentrations occurred throughout the period of observation.

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 are observed 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 Sikes Creek, where exceedances and the highest percent exceedances were recorded in the summer months (August). However, contrary to common seasonal observations, the highest fecal coliform concentration and one of the highest exceedance rates were observed during the fourth quarter (December). **Tables 5.2a** and **5.2b** summarizes 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 Sikes Creek (WBID 142) by Month for 2008 during the Cycle 2 Verified Period

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	-	-	-	-	-	-	-
February	3	28	630	120	259	1	33.3%
March	2	67	104	85.5	86	0	0%
April	3	36	168	44	83	0	0%
May	-	-	-	-	-	-	-
June	2	29	96	62.5	63	0	0%
July	2	188	367	278	278	0	0%
August	3	691	1,160	743	865	3	100%
September	-	-	-	-	-	-	-
October	3	6	440	152	199	1	33.3%
November	3	6	440	64	170	1	33.3%
December	4	270	1,470	555	713	2	50%

Table 5.2b. Summary Statistics of Fecal Coliform Data for All Stations in Sikes Creek (WBID 142) by Season for 2008 during the Cycle 2 Verified Period

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

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	5	28	630	104	190	1	20%
Quarter 2	5	29	168	44	75	0	0%
Quarter 3	5	188	1,160	691	630	3	60%
Quarter 4	10	6	1,470	295	396	4	40%

Using rainfall data collected at the New Hope CLIMOD station in Holmes County (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 Sikes Creek in 5 of the 8 exceedances in 2008. These fecal coliform concentrations correlated with 3-day precipitation (extreme and medium precipitation events) (e.g., when 3-day precipitation was 4.21 inches, the fecal coliform concentration was 1,160 counts/100mL at Station 21FLPNS 32020114 on August 26, 2008) (**Section 5.1.2**).

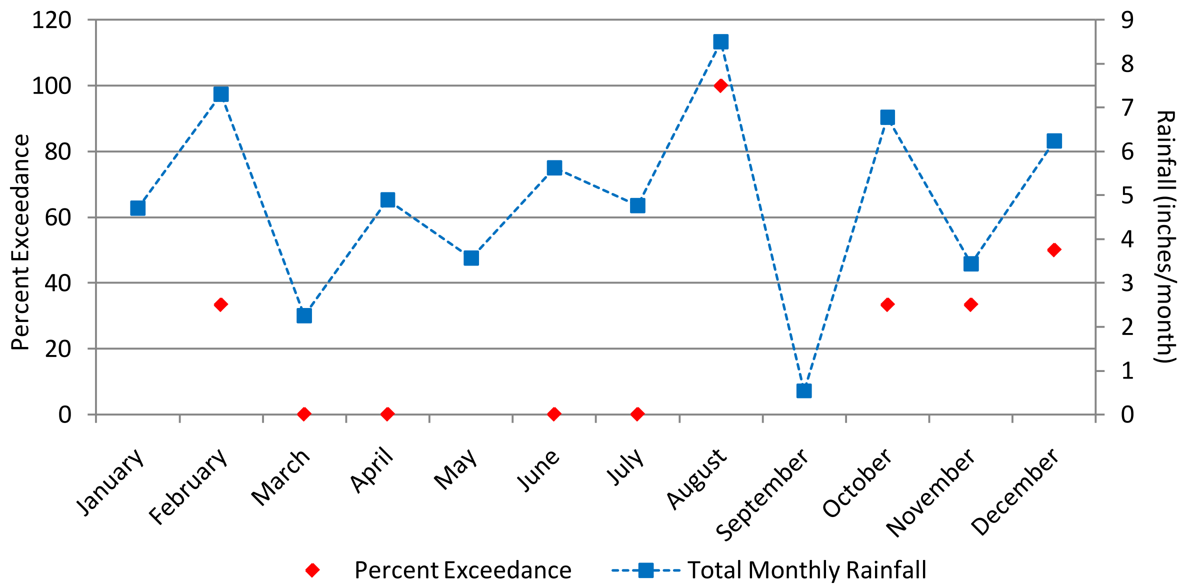

Figure 5.3. Fecal Coliform Exceedances and Rainfall at All Stations in Sikes Creek (WBID 142) by Month for 2008 during the Cycle 2 Verified Period

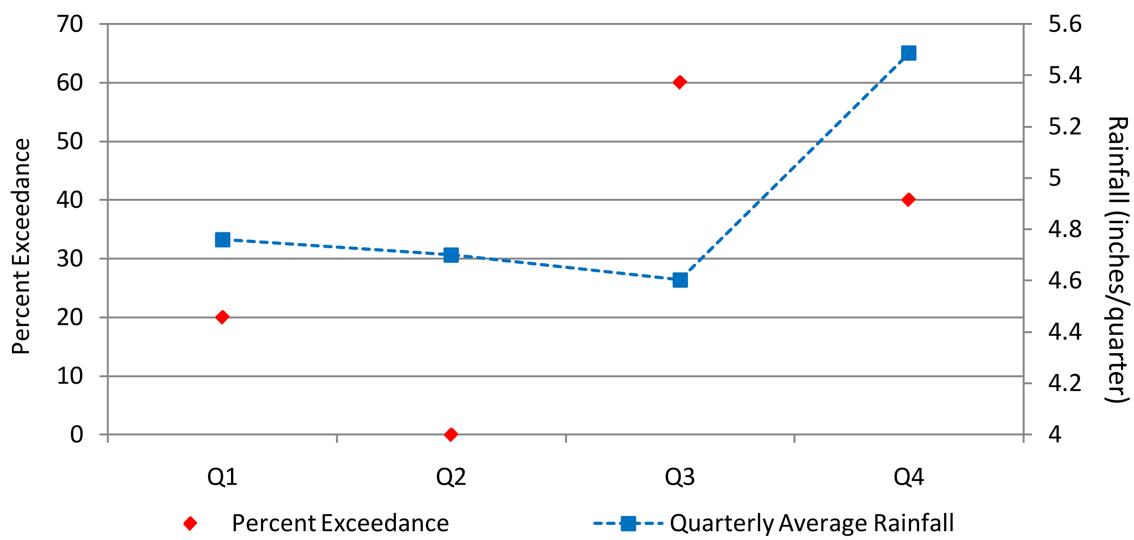

Figure 5.4. Fecal Coliform Exceedances and Rainfall at All Stations in Sikes Creek (WBID 142) by Season for 2008 during the Cycle 2 Verified Period

Spatial Patterns

Fecal coliform data from 2008 for Stations 21FLPNS 32020154 (upstream), 21FLPNS 32020155 and 21FLPNS 32020156 (midstream), and 21FLPNS 32020114 (downstream) were analyzed to detect spatial trends in the data (see **Figure 5.2**). Fecal coliform concentrations exceeding the state criterion (400 counts/100mL) were observed in three of the four stations. The highest concentrations were recorded at Station 21FLPNS 32020114 (**Table 5.3**), the most downstream site. Although land use surrounding this station is primarily wetlands and coniferous plantations, low-density residential areas are located upstream of the site.

Table 5.3. Station Summary Statistics of Fecal Coliform Data for Sikes Creek (WBID 142) 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 minimum count/100mL, Column 5 lists the maximum count, Column 6 lists the mean count, Column 7 lists the median count, Column 8 lists the number of exceedances, and Column 9 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 32020114	2008	10	6	1,470	178	415.5	4	40.0%
21FLPNS 32020154	2008	3	28	320	104	150.7	0	0.0%
21FLPNS 32020155	2008	7	29	790	152	305.3	2	28.6%
21FLPNS 32020156	2008	5	6	743	270	337.0	2	40.0%

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 during dry weather, by contributing to exceedances. 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 New Hope 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 determined as those with rainfall greater than 2.28 inches; large events, 1.53 to 2.28 inches; medium events, 0.17 to 1.53 inches; small events, 0.01 to 0.17 inches; and nonmeasurable events, less than 0.01 inch. Three-day (the day of and 2 days prior to sampling) precipitation accumulations were used in the analysis (**Table 5.4** and **Figure 5.5**).

Historical data show that fecal coliform exceedances occurred over extreme, medium, and not measurable precipitation events. Given that no samples were collected during large and small precipitation events, it can only be assumed, and not generalized, that fecal coliform exceedances occur over all hydrologic conditions.

The highest percentage of exceedances (100 percent) occurred after extreme precipitation events, but this period also had the fewest samples (n=3). Exceedances were also observed in samples collected after medium precipitation events (50 percent exceedances). The lowest percentage of exceedances occurred after periods of no measurable precipitation (17 percent). The fact that the highest exceedance rates occurred after extreme and medium precipitation events, rather than after periods of little or no rainfall, indicates that nonpoint sources are probably a major contributing factor. **Table 5.4** and **Figure 5.5** show fecal coliform data by hydrologic condition.

As fecal coliform exceedances occurred following all sampled categories of precipitation events—extreme, medium, 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 Sikes Creek.

Table 5.4. Summary of Historical Fecal Coliform Data by Hydrologic Condition for Sikes Creek (WBID 142)

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.

N/A = Not Available

Precipitation Event	Event Range (inches	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	>2.28"	3	3	100%	0	0%
Large	1.53" - 2.28"	0	N/A	N/A	N/A	N/A
Medium	0.17" - 1.53"	4	2	50%	2	50%
Small	0.01" - 0.17"	0	N/A	N/A	N/A	N/A
None/ Not Measurable	<0.01"	18	3	17%	15	83.3%

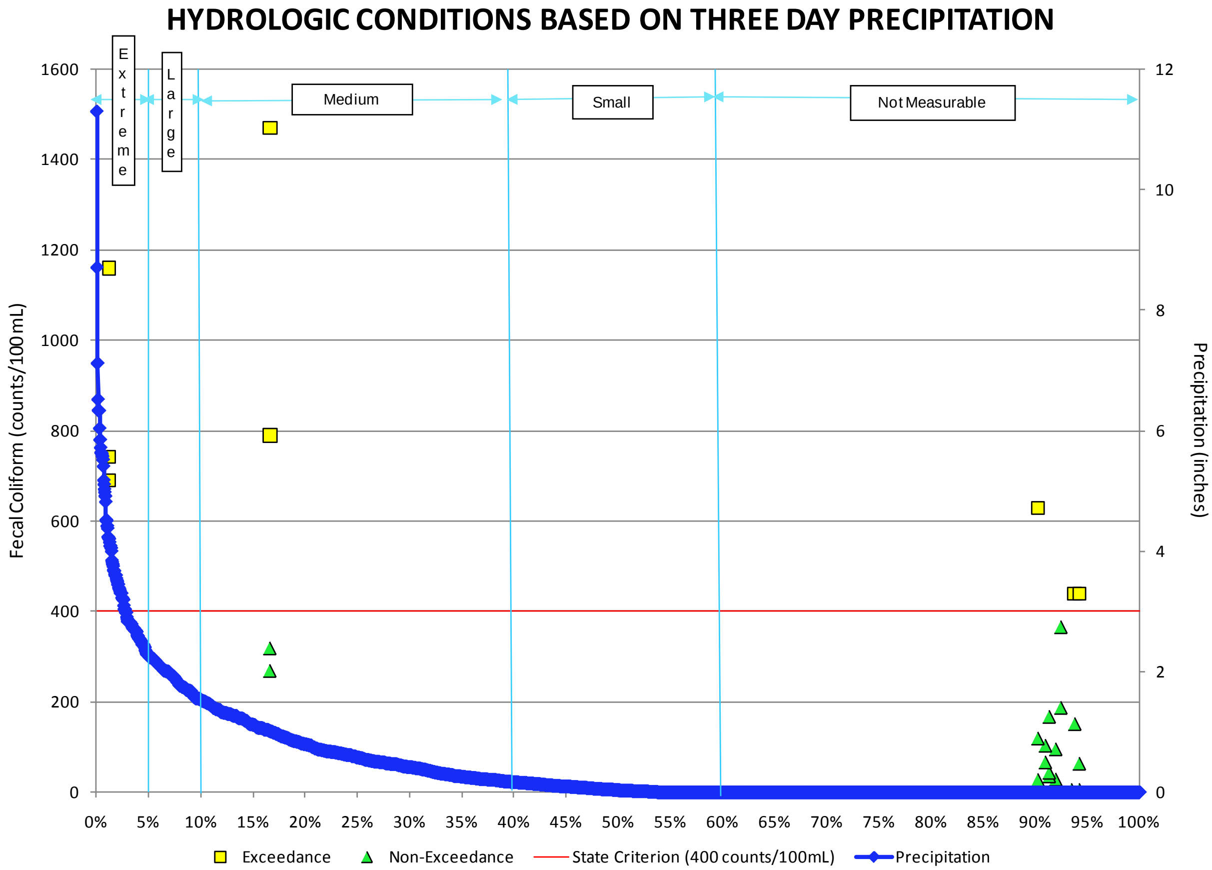

Figure 5.5. Historical Fecal Coliform Data by Hydrologic Condition for Sikes Creek (WBID 142)

Table 5.5. Calculation of Fecal Coliform Reductions for the Sikes Creek (WBID 142) 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/100 mL)	Rank	Percentile by Hazen Method
21FLPNS 32020114	10/6/2008	6	1	4%
21FLPNS 32020156	11/18/2008	6	2	8%
21FLPNS 32020154	2/12/2008	28	3	12%
21FLPNS 32020155	6/2/2008	29	4	16%
21FLPNS 32020156	4/23/2008	36	5	20%
21FLPNS 32020155	4/23/2008	44	6	24%
21FLPNS 32020155	11/18/2008	64	7	28%
21FLPNS 32020114	3/31/2008	67	8	32%
21FLPNS 32020114	6/2/2008	96	9	36%
21FLPNS 32020154	3/31/2008	104	10	40%
21FLPNS 32020114	2/12/2008	120	11	44%
21FLPNS 32020155	10/27/2008	152	12	48%
21FLPNS 32020114	4/23/2008	168	13	52%
21FLPNS 32020114	7/21/2008	188	14	56%
21FLPNS 32020156	12/1/2008	270	15	60%
21FLPNS 32020154	12/1/2008	320	16	64%
21FLPNS 32020155	7/21/2008	367	17	68%
21FLPNS 32020114	10/27/2008	440	18	72%
21FLPNS 32020114	11/18/2008	440	19	76%
21FLPNS 32020156	2/12/2008	630	20	80%
21FLPNS 32020155	8/26/2008	691	21	84%
21FLPNS 32020156	8/26/2008	743	22	88%
21FLPNS 32020155	12/1/2008	790	23	92%
21FLPNS 32020114	8/26/2008	1,160	24	96%
21FLPNS 32020114	12/1/2008	1,470	25	100%
-	**-**	**-**	**Existing condition concentration–90th percentile (counts/100mL)**	**767**
-	**-**	**-**	**Allowable concentration (counts/100mL)**	**400**
-	**-**	**-**	**Final % reduction**	**48%**

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 pollutant load was calculated by comparing the existing concentrations and target concentration using **Formula 1**:

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

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–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.

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

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.

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

Where:

> *C_{lower} is the fecal coliform concentration corresponding to the percentile lower than the 90th percentile, in this case, 743 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%), which is 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 (743 and 790 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 = (790 – 743)/(92% – 88%) = 11.75.

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 = 743 + (2*11.75) = 767 counts/100mL).

Using **Formula 1**, the percent reduction for the period of observation (January 1, 2002–June 30, 2009) was calculated as 48 percent for Sikes Creek (i.e., % reduction needed = [(767–400)/767]*100 = 48%).

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 1 outlier (1,470 counts/100mL) (**Figure 5.6**). Communication with the data providers provided no evidence that sampling or data quality concerns were associated with this result; therefore, there is no reasonable justification for removing this extreme value for the final percent reduction calculation. The final percent reduction number is not extremely biased or distorted by the outlier present in the data set.

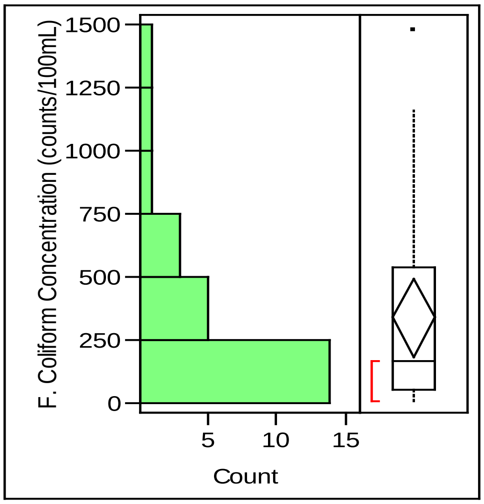

Figure 5.6. Histogram and Box Plot of Fecal Coliform Results for Cycle 2 Verified Period Data

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:

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

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

$$\mathbf{TMDL \cong \sum WLAs_{wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS}$$

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 Sikes Creek 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 Sikes Creek (WBID 142)

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	N/A	N/A	48%	Implicit

6.2 Load Allocation

Based on a percent reduction approach, the LA is a 48 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

No NPDES-permitted wastewater facilities were identified within the Sikes Creek WBID boundary.

It should be noted that the state requires all NPDES-permitted wastewater 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 WBID 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 in the Sikes Creek watershed. 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.

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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. They are intended to give the public a general idea of the relative importance of each source in the waterbody. The estimates were based on the best information available to the Department when the calculation was made. The numbers provided do not represent actual loadings from the sources.

Livestock

The presence of livestock and other agricultural animals can results 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 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 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).

Although agriculture is not one of the primary land uses in the WBID (approximately 13 percent of the WBID is specifically categorized as Level 1 agricultural land use), a potentially important nonpoint source of source of bacteria loading within the watershed can be grazing livestock, primarily cattle.

The estimate of fecal coliform loads from livestock for the Sikes Creek WBID was 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 NWFWMD's 2004 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.1** summarizes the pastureland acreage estimated for Holmes County and WBID 142, as well as the livestock densities per acre of pastureland estimated for the county. **Table B.2** summarizes cattle populations in Holmes County and provides an estimate of livestock populations for WBID 142 in 2007.

Table B.2 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 Sikes Creek WBID is about 7.95×10^{13} counts/day.

Table B.1. Summary of Pastureland Acreage in Holmes County and WBID 142, 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
Sikes Creek (WBID 142)	795	1*

Table B.2. Summary of Livestock Populations in Holmes County and WBID 142, and Fecal Coliform Loads for WBID 142

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 142 in 2007.

[1] USDA, 2007

Livestock Type	Livestock in Holmes County in 2007[1]	Estimated Livestock in WBID 142 in 2007	Fecal Coliform Density (counts/day)
Cattle	33,202	795	7.95×10^{13}

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 Sikes Creek 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 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 (100 mL/gallon).

Based on data obtained from FDOH, which is currently undertaking a project to inventory the use of onsite treatment and disposal systems (i.e., septic tanks) by determining the methods of wastewater disposal for developed property sites statewide, 102 housing units *(N)* within the Sikes Creek WBID boundary are known or thought to be using septic tanks to treat their domestic wastewater (**Figure B.1**). FDOH's parcel data were obtained from the Florida Department of Revenue 2008 tax roll. FDOH's wastewater disposal data were obtained from county Environmental Health Departments, wastewater treatment facilities, Department domestic wastewater treatment permits, existing county and city inventories, and other available information. If there was not enough information to determine with certainty whether a property used a septic system, FDOH employed a probability model to analyze the characteristics of the property and estimate the probability that the property was served by a septic tank.

Within the Sikes Creek WBID boundary, 4 properties are known to use septic tanks, and 98 are estimated to use septic systems. Because the probability that these 92 estimated septic tank properties are in fact served by septic tanks was 97 percent and higher, all 102 properties were assumed to be served by septic tanks for the purposes of this report. 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 Sikes Creek 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 $1x10^6$ 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 septic tank repair permits issued in both counties as published by FDOH (available: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm). Based on FDOH's 2008–09 inventory, 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, assuming that none of the installed septic tanks will be removed after being installed (**Table B.3**). 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 and are presented in **Table B.3**. 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.1**, the estimated fecal coliform loading from failed septic tanks within the Sikes Creek WBID boundary is approximately 1.01×10^{10} counts/day.

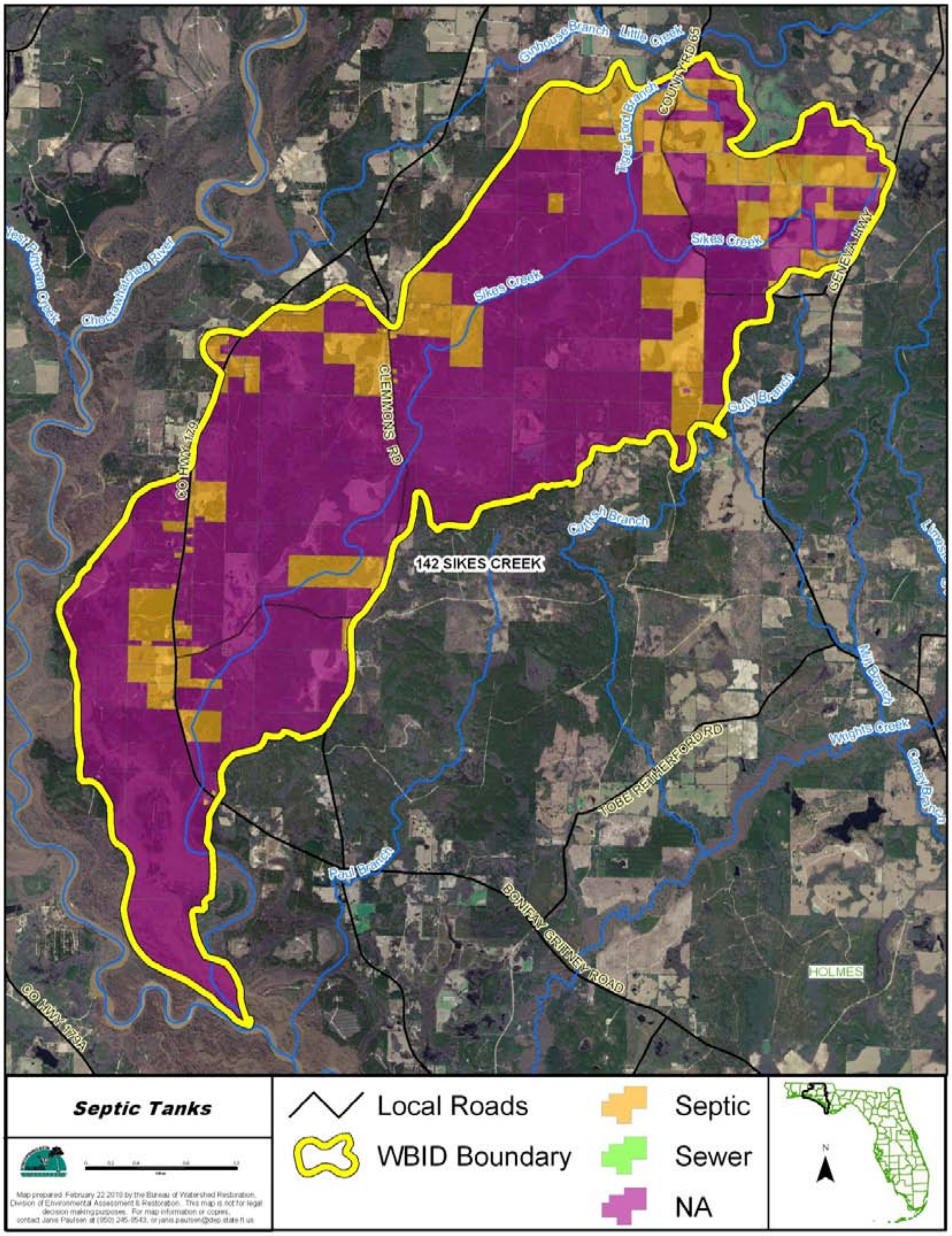

Figure B.1. Distribution of Onsite Sewage Disposal Systems (Septic Tanks) in the Residential Land Use Areas within the Sikes Creek WBID Boundary

Table B.3. Estimated Number of Septic Tanks and Septic Tank Failure Rates for Holmes County (2002–07)

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.

[1] 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 (%)[1]	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 Sikes Creek WBID boundary. As shown in **Figure 4.1**, wetland areas border Sikes Creek 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 does not assign any reductions to these sources.

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