FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

SOUTHWEST DISTRICT • TAMPA BAY BASIN

Final TMDL Report

Fecal Coliform TMDL for Bullfrog Creek (WBID 1666A) Bullfrog Creek (WBID 1666), and Little Bullfrog Creek (WBID 1688)

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Acknowledgments

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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

STORET Program

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

2008 Integrated 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 for the Tampa Bay Basin

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

Basin Water Quality Assessment Report for the Tampa Bay Basin

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

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

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

National STORET Program

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads (TMDL) for fecal coliform bacteria for Bullfrog Creek and Little Bullfrog Creek, within the Tampa Bay Basin. It distinguishes between the freshwater and marine portions of Bullfrog Creek (when needed) by labeling the waterbody either Bullfrog Creek (Fresh) or Bullfrog Creek (Marine). These waterbodies were verified as impaired for fecal coliform and therefore were included on the Verified List of impaired waters for the Tampa Bay Basin that was adopted by Secretarial Order on June 3, 2008. The TMDL establishes the allowable fecal coliform loadings to Bullfrog Creek (fresh and marine portions) and Little Bullfrog Creek that would restore these waterbodies so that they meet their applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

Bullfrog Creek and Little Bullfrog Creek are located in the southern portion of Hillsborough County, adjacent to the Interstate 75 corridor (**Figure 1.1**). Bullfrog Creek (Marine: about 3.05 miles in length; Fresh: about 16.32 miles long) flows northeast, entering Tampa Bay at its western edge just below the Alafia River. Little Bullfrog Creek (about 5.83 miles in length) flows southeast, feeding into Bullfrog Creek (Fresh) near its midpoint. Bullfrog Creek (Fresh), Bullfrog Creek (Marine), and Little Bullfrog Creek encompass drainage areas covering 27.02, 2.18, and 7.41 square miles, respectively. None of these waterbodies lies within the limits of a major city; the city of Tampa (336,823 people) is located about 10 miles northeast of Bullfrog Creek. There are three incorporated areas (Census Designated Places [CDPs]) located in these watersheds: Gibsonton (8,752 people), encompassing all of Bullfrog Creek (Marine) and portions of the northeastern edges of Bullfrog Creek (Fresh); and Wimauma (4,246 people) and Greater Sun Center (16,321 people), covering portions of the southern outskirts of Bullfrog Creek (Fresh). Additional information about the creeks' hydrology and geology is available in the Basin Status Report for the Tampa Bay Basin (Florida Department of Environmental Protection [Department], November 2001).

For assessment purposes, the Department has divided the Tampa Bay Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek are WBIDs 1666A, 1666, and 1688, respectively (**Figure 1.2**).

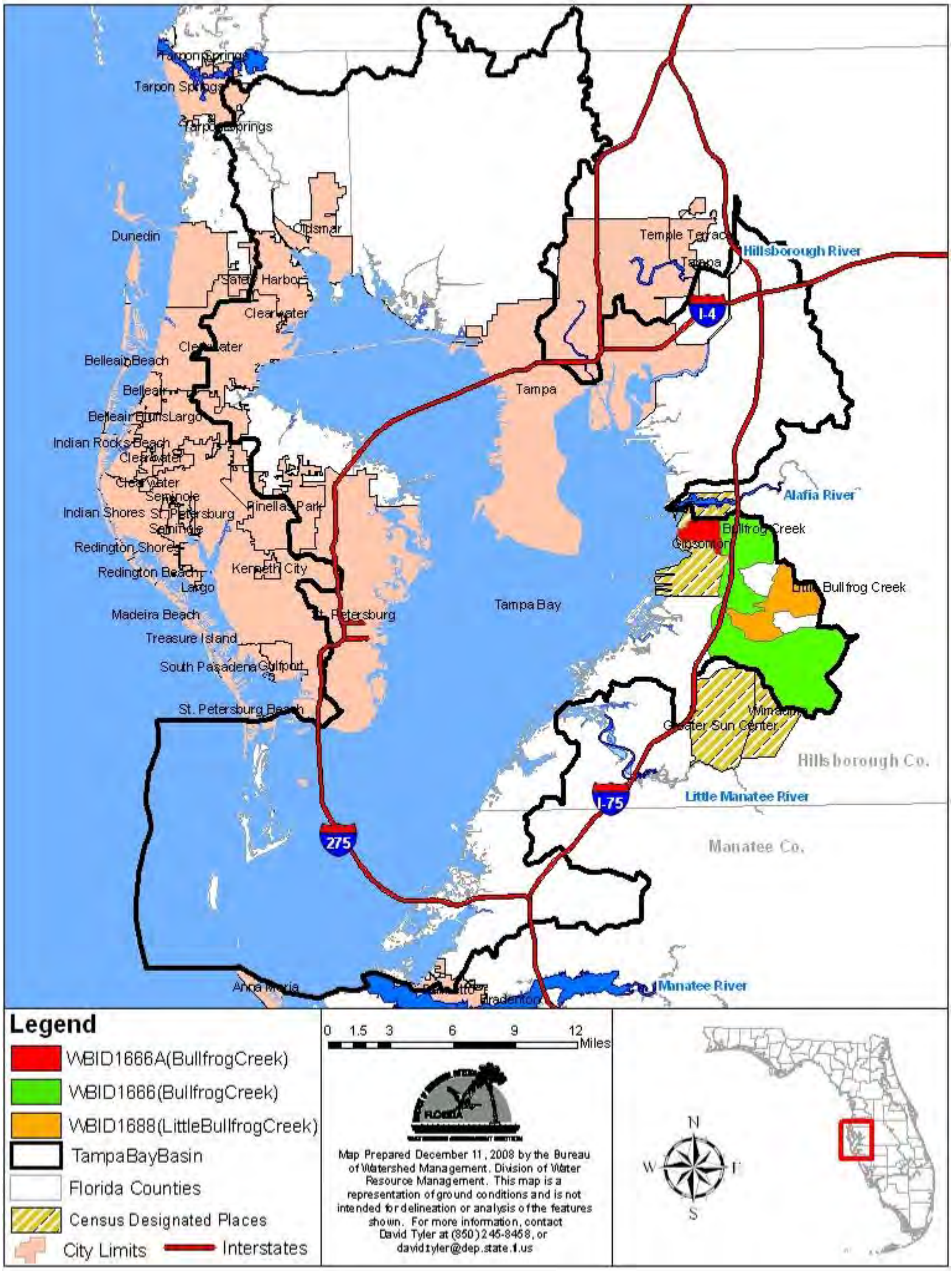

Figure 1.1. Location of the Bullfrog Creek and Little Bullfrog Creek Watersheds in the Tampa Bay Basin and Major Geopolitical Features in the Area

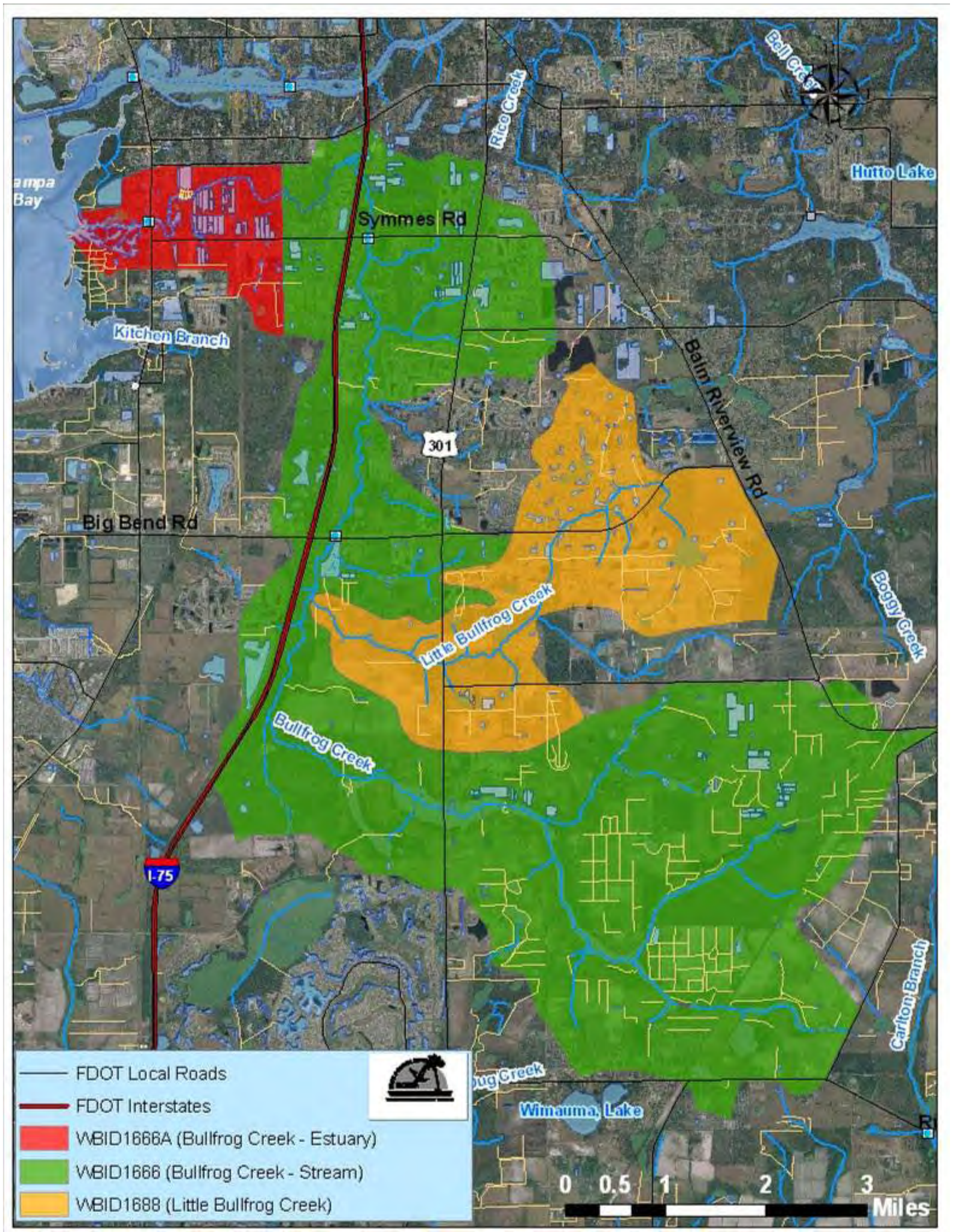

Figure 1.2. Location of the Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688) Watersheds in Hillsborough County

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.

This TMDL Report may be followed by the development and implementation of a Basin Management Action Plan, or BMAP, designed to reduce the amount of fecal coliform that caused the verified impairment of Bullfrog Creek (WBIDs 1666A and 1666) and Little Bullfrog Creek (WBID 1688). These activities will depend heavily on the active participation of the Southwest Florida Water Management District (SWFWMD), Hillsborough County's Environmental Protection Commission (HEPC), 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.

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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's 1998 303(d) list included 47 waterbodies in the Tampa Bay Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists 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 2004 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Bullfrog Creek (WBID 1666A), Bullfrog Creek (WBID 1666), and Little Bullfrog Creek (WBID 1688) and verified the impairments during the second cycle of the TMDL Program (**Table 2.1**). These waterbodies are spatially and hydrologically connected; thus the Department is including all three WBIDs in this report to address the fecal coliform impairments. **Table 2.2** summarizes the fecal coliform data collected during the verified period (January 1, 2000, through June 30, 2007). The projected year for the 1998 303(d) listed fecal coliform bacteria TMDL for Bullfrog Creek (WBID 1666A) was 2008, but the Settlement Agreement between EPA and Earthjustice, which drives the TMDL development schedule for waters on the 1998 303(d) list, allows an additional nine months to complete the TMDLs. As such, the TMDLs must be adopted and submitted to the EPA by September 30, 2009.

These waterbodies were verified as impaired based on fecal coliform because, using the IWR methodology, more than 10 percent of the values exceeded the Class III freshwater for (Bullfrog Creek, WBID 1666; and Little Bullfrog Creek, WBID 1688) and Class III marine (for Bullfrog Creek, WBID 1666A) criterion of 400 counts per 100 milliliters (counts/100mL) for fecal coliform: Bullfrog Creek (Marine – 33 out of 92 samples; Fresh – 124 out of 198 samples) and Little Bullfrog Creek (WBID 1688 – 30 out of 37 samples) in the verified period exceeded the criterion. The fecal coliform data used in this report are based on the IWRRun34 database.

The verified impairments were based on data collected by Hillsborough County and the Department's Southwest District. **Figure 5.1** shows the WBID locations and STORET stations. **Figures 2.1a, 2.1b**, and **2.1c** display the fecal coliform data collected from 2000 through 2007 for each watershed.

Table 2.1. Verified Impairments for Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688)

[1] WBID 1666A (Bullfrog Creek) was included on the 1998 303(d) list for fecal coliform, with a TMDL priority of low and due date of 2008.
[2] Class III Marine
[3] Class III Freshwater
[4] N/A – Not applicable

WBID	Waterbody Segment	Waterbody Type	Waterbody Class	1998 303(d) Parameters of Concern	Parameter Causing Impairment
1666A[1]	Bullfrog Creek	Estuary	IIIM[2]	Coliform	Fecal Coliform
1666A[1]	Bullfrog Creek	Estuary	IIIM[2]	Dissolved Oxygen	Dissolved Oxygen
1666A[1]	Bullfrog Creek	Estuary	IIIM[2]	N/A[4]	Mercury (in Fish Tissue)
1666A[1]	Bullfrog Creek	Estuary	IIIM[2]	Nutrients	Nutrients (Chlorophyll *a* and Historic Chlorophyll *a*)
1666	Bullfrog Creek	Stream	IIIF[3]	N/A[4]	Fecal Coliform
1688	Little Bullfrog Creek	Stream	IIIF[3]	N/A[4]	Fecal Coliform
					Dissolved Oxygen

Table 2.2. Summary of Fecal Coliform Data for Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID1666), and Little Bullfrog Creek (WBID 1688) During the Verified Period (January 1, 2000–June 30, 2007)

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

WBID	Total Number of Samples	IWR-Required Number of Exceedances for the Verified List[1]	Number of Observed Exceedances[1]	Number of Observed Nonexceedances[1]	Number of Seasons Data Were Collected	Mean[2]	Median[2]	Min[2]	Max[2]
1666A	92	14	33	59	4	747	260	10	20,000
1666	198	26	124	74	4	1,174	600	15	19,800
1688	37	7	30	7	4	1,314	1,100	100	4,400

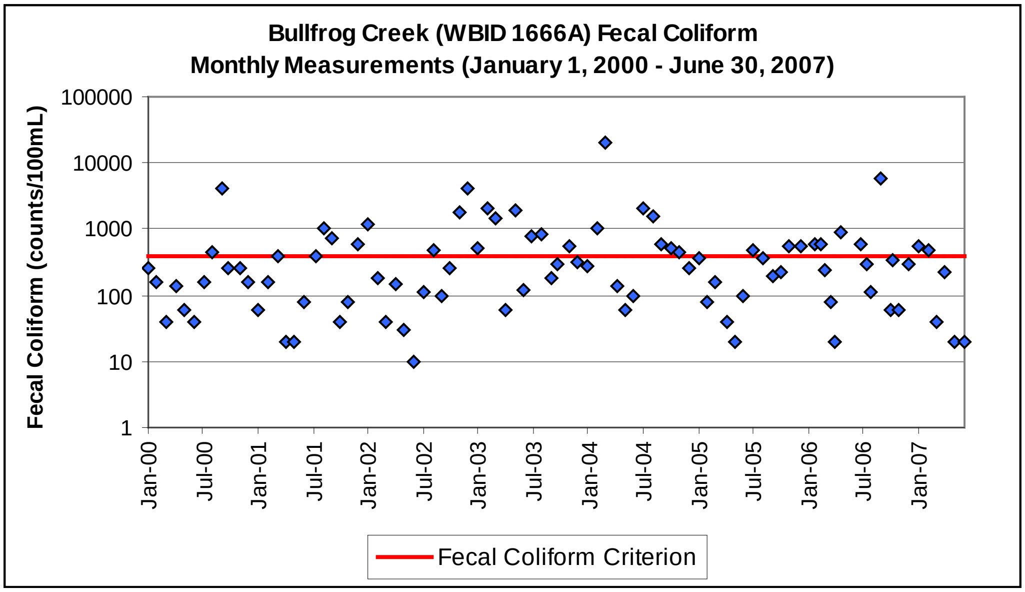

Figure 2.1a. Fecal Coliform Measurements for Bullfrog Creek (Marine) (WBID 1666A) During the Verified Period (January 1, 2000–June 30, 2007)

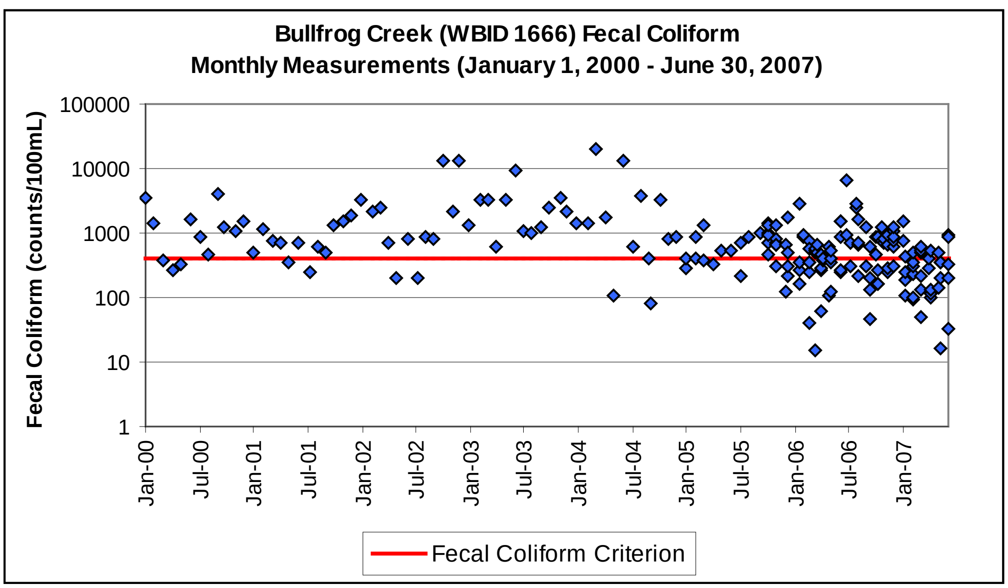

Figure 2.1b. Fecal Coliform Measurements for Bullfrog Creek (Fresh) (WBID 1666) During the Verified Period (January 1, 2000–June 30, 2007)

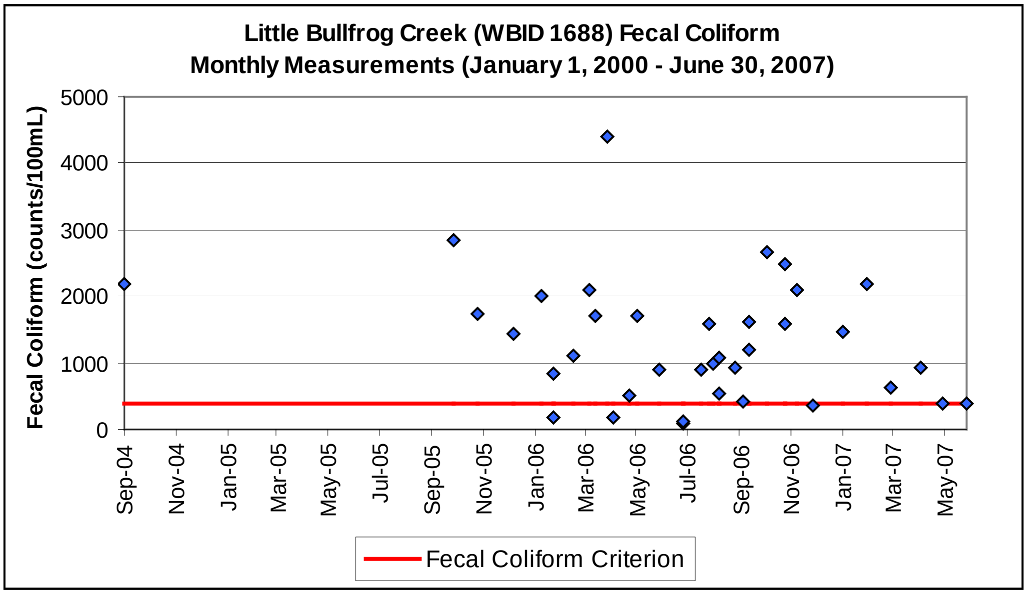

Figure 2.1c. Fecal Coliform Measurements for Little Bullfrog Creek (WBID 1688) During the Verified Period (January 1, 2000–June 30, 2007)

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria 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)**

Bullfrog Creek (WBIDs 1666A and 1666) and Little Bullfrog Creek (WBID 1688) are Class III waterbodies, with a designated use of recreation, propagation, and the maintenance of a healthy, well-balanced population of fish and wildlife. The criterion applicable to this TMDL is the Class III 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 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 state that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. During the development of the TMDLs (as described in subsequent chapters), 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 TMDLs was not to exceed 400 MPN/100mL in any sampling event for fecal coliform. The 10 percent exceedance allowed by the water quality criterion for fecal coliform bacteria was not used directly in estimating the target load, but was included in the TMDLs' margin of safety (as described in subsequent chapters).

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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 in the Bullfrog Creek and Little Bullfrog Creek Watersheds

4.2.1 Point Sources

There are no NPDES-permitted facilities discharging fecal coliform bacteria directly or indirectly into Bullfrog Creek or Little Bullfrog Creek.

Municipal Separate Storm Sewer System Permittees

The stormwater collection systems owned and operated by Hillsborough County and co-permittees (Florida Department of Transportation [FDOT] District 7, Florida's Turnpike Enterprise, and city of Plant City) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000006). There are no Phase II MS4 permits identified for Bullfrog Creek or Little Bullfrog Creek.

4.2.2 Land Uses and Nonpoint Sources

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. Nonpoint pollution is caused by rainfall moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even underground sources of drinking water (EPA, 1994). Potential nonpoint sources of coliform include loadings from surface runoff, wildlife, livestock, pets, leaking sewer lines, and leaking septic tanks. **Table 4.6** provides estimated fecal coliform loadings from dogs, septic tanks, and sanitary sewer overflows (SSOs) for the Bullfrog Creek and Little Bullfrog Creek watersheds. The information provided for septic tanks and sewers in this report is for information purposes only, and is designed to give a rough estimate of the fecal coliform counts/day from septic tank leakage and SSOs.

Wildlife

Wildlife deposit coliform bacteria with their feces onto land surfaces, where they can be transported during storm events to nearby streams. Some wildlife (such as otters, beavers, raccoons, and birds) deposit their feces directly into the water. The bacterial load from naturally occurring wildlife is assumed to be background. In addition, any strategy employed to control this source would probably have a negligible impact on attaining water quality standards.

Agricultural Animals

Agricultural animals are the source of several types of coliform loading to streams. Agricultural activities, including runoff from pastureland and cattle in streams, can affect water quality. Agricultural land occupies 21, 43, and 33 percent of the total land area in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds, respectively. **Table 4.1** lists 2002 livestock data for Hillsborough County.

Table 4.1. Livestock Distribution for Hillsborough County in 2002

[1] (D) = Data withheld to avoid disclosing data for individual farms.
Source: U.S. Department of Agriculture, 2002.

Livestock Distribution	Hillsborough County (number of livestock)
Cattle/Calves	65,501
Milk Cows	4,408
Beef Cows	33,144
Hogs/Pigs	1,724
Poultry Layers > 20 weeks	(D)[1]
Poultry Broilers	428
Sheep/Lambs	793
Horses and Ponies	4,975

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SWFWMD's 2006 land use coverage (scale 1:40,000) contained in the Department's geographic information system (GIS) library. Land use categories in the watershed were aggregated using the simplified Level 1 codes and tabulated in **Tables 4.2a, 4,2b,** and **4,2c**. **Figure 4.1** shows the acreage of the principal land uses in each of the watersheds.

As shown in **Tables 4.2a, 4,2b,** and **4,2c,** the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds drain about 1,396, 17,302, and 4,745 acres of land, respectively. The dominant land use category is urban land (urban and built-up; low-, medium-, and high-density residential; and transportation, communication, and utilities), which accounts for 44, 25, and 42 percent, of the watersheds' total area, respectively. Agriculture (including croplands and pasturelands, tropical fish farms [for WBID 1666A], rangeland, and feeding operations) accounts for 21, 43, and 33 percent, respectively. Natural land uses for the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds, including water/wetlands, forest/rural open, and barren land, occupy about 34, 26, and 22 percent of the watersheds' total area, respectively.

Table 4.2a. Classification of Land Use Categories for the Bullfrog Creek Watershed (Marine) (WBID 1666A)

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and Built-Up	147	10.53%
1100	Low-Density Residential	98	7.02%
1200	Medium-Density Residential	229	16.40%
1300	High-Density Residential	92	6.59%
2000	Agriculture	292	20.92%
3000	Rangeland	12	0.86%
4000	Forest/Rural Open	130	9.31%
5000	Water	124	8.88%
6000	Wetlands	183	13.11%
7000	Barren Land	45	3.22%
8000	Transportation, Communication, and Utilities	44	3.15%
	Total:	**1,396**	**100**%

Table 4.2b. Classification of Land Use Categories for the Bullfrog Creek Watershed (Fresh) (WBID 1666)

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and Built-Up	1,171	6.77%
1100	Low-Density Residential	1,438	8.31%
1200	Medium-Density Residential	520	3.01%
1300	High-Density Residential	800	4.62%
2000	Agriculture	7,442	43.01%
3000	Rangeland	1,029	5.95%
4000	Forest/Rural Open	2,420	13.99%
5000	Water	358	2.07%
6000	Wetlands	1,620	9.36%
7000	Barren Land	104	0.60%
8000	Transportation, Communication, and Utilities	400	2.31%
	Total:	**17,302**	**100**%

Table 4.2c. Classification of Land Use Categories for the Little Bullfrog Creek Watershed (WBID 1688)

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and Built-Up	1,030	21.71%
1100	Low-Density Residential	133	2.80%
1200	Medium-Density Residential	76	1.60%
1300	High-Density Residential	683	14.39%
2000	Agriculture	1,573	33.15%
3000	Rangeland	138	2.91%
4000	Forest/Rural Open	407	8.58%
5000	Water	198	4.17%
6000	Wetlands	438	9.23%
7000	Barren Land	8	0.17%
8000	Transportation, Communication, and Utilities	61	1.29%
	Total:	**4,745**	**100**%

Urban Development

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff in the Bullfrog Creek and Little Bullfrog Creek watersheds. In addition to pets, other animal fecal coliform contributors commonly seen in urban areas include rats, pigeons, and sometimes raccoons.

Studies report that up to 95 percent of the fecal coliform found in urban stormwater can come from 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 were the single greatest source for fecal coliform and fecal streptococcus bacteria. Trial et al. (1993) also reported that cats and dogs were the primary source of fecal coliform in urban watersheds. Using bacteria source tracking techniques, Watson (2002) found that the amount of fecal coliform bacteria contributed by dogs in Stevenson Creek in Clearwater, Florida, was as important as that from septic tanks.

According to the American Pet Products Manufacturers Association (APPMA), about 4 out of 10 U.S. households include at least one dog. A single gram of dog feces contains about 23 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.

Table 4.3 shows the fecal coliform concentrations of surface runoff measured in two urban areas (Bannerman et al., 1993; Steuer et al., 1997). While bacteria levels were widely different in the two studies, both indicated that residential lawns, driveways, and streets were the major source areas for bacteria.

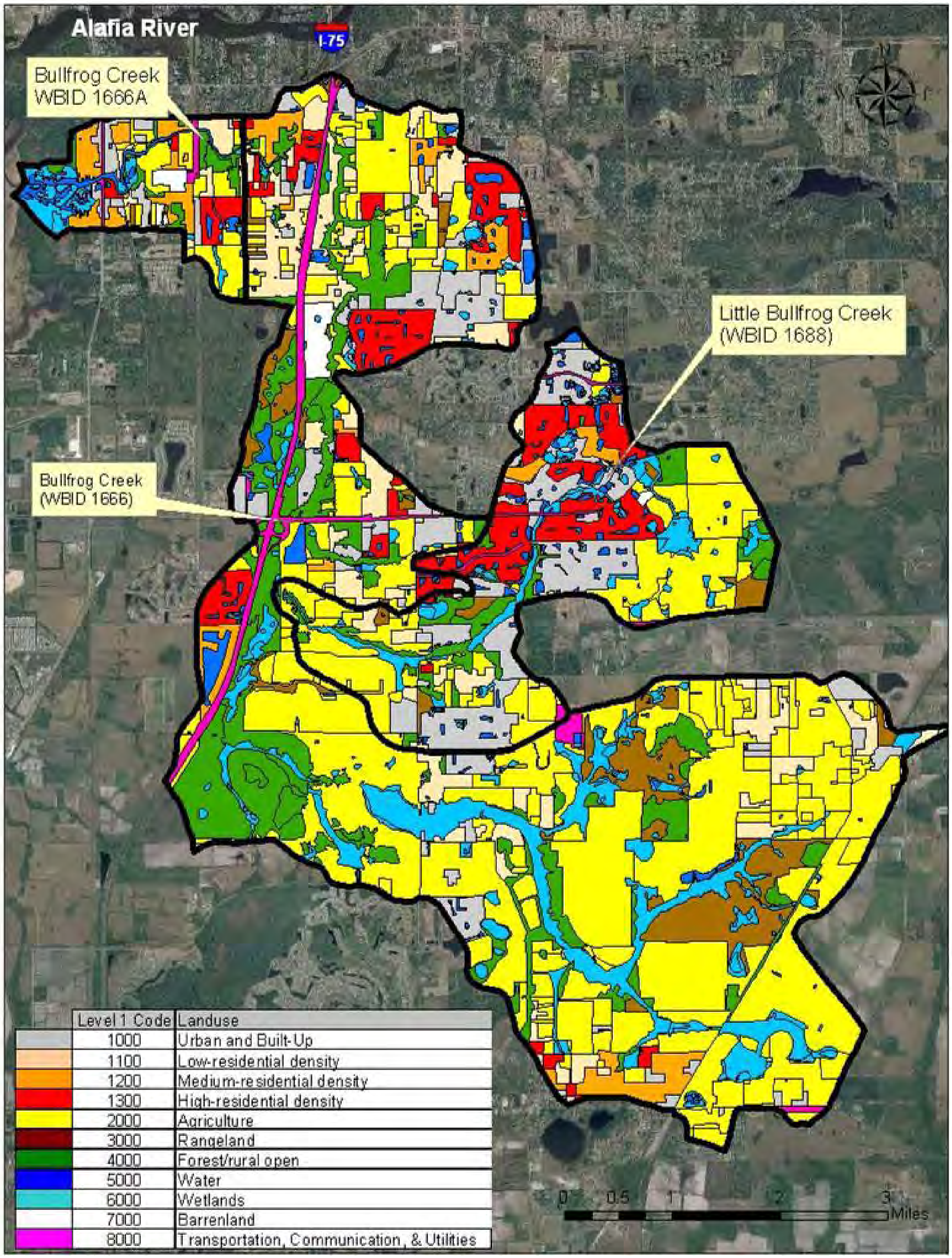


Figure 4.1. Principal Land Uses in the Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688) Watersheds in 2006

Table 4.3. Concentrations (Geometric Mean Colonies/100mL) of Fecal Coliform from Urban Source Areas (Steuer et al., 1997; Bannerman et al., 1993)

Geographic Location	Marquette, Michigan	Madison, Wisconsin
Number of storms sampled	12	9
Commercial parking lot	4,200	1,758
High-traffic street	1,900	9,627
Medium-traffic street	2,400	56,554
Low-traffic street	280	92,061
Commercial rooftop	30	1,117
Residential rooftop	2,200	294
Residential driveway	1,900	34,294
Residential lawns	4,700	42,093
Basin outlet	10,200	175,106

The number of dogs in the Bullfrog Creek and Little Bullfrog Creek watersheds is not known. Therefore, this analysis used the statistics produced by APPMA to estimate the possible fecal coliform loads contributed by dogs. The human populations in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds calculated from the census track using Tiger Track 2000 data (the Department's GIS library) were approximately 805, 8,674, and 2,867, respectively. According to the U.S. Census Bureau, there were 2.50 people per household in Hillsborough County in 2007. This results in an estimated 322, 3,470, and 1,147 households in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds, respectively. Assuming that 40 percent of the households in this area have 1 dog, the total number of dogs in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds is about 129, 1,388, and 459, respectively.

According to the waste production rate for dogs and the fecal coliform counts per gram of dog wastes listed in **Table 4.4**, and assuming that 40 percent of dog owners do not pick up dog feces, the total waste produced by dogs and left on the land surface of residential areas is 577,080 grams/day. The total fecal coliform produced by dogs for the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds is 5.11×10^{10}, 5.5×10^{11}, and 1.821×10^{11} counts/day of fecal coliform, respectively.

It should be noted that this load only represents the estimated fecal coliform load created in the watershed 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 4.4. Dog Population Density, Wasteload, and Fecal Coliform Density

* Number from APPMA.
Source: Weiskel et al., 1996.

Type	Population density (an/household)	Wasteload (grams/an-day)	Fecal coliform density (fecal coliform/gram)
Dog	0.4*	450	2,200,000

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, in areas with a relatively high ground water table, the drainage field can be flooded during the rainy season, and coliform bacteria can pollute surface water through storm runoff. 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 go into the well and once the polluted water is used to irrigate lawns, coliform bacteria may reach the land surface and wash into surface waters during rainy periods.

A rough estimate of fecal coliform loads from failed septic tanks in each watershed can be made using **Equation 4.1**:

$$L = 37.85 * N * Q * C * F \qquad \textbf{(Equation 4.1)}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the total number of septic tanks in the watershed (septic tanks);
Q is the discharge rate for each septic tank;
C is the fecal coliform concentration for the septic tank discharge; and
F is the septic tank failure rate.

Based on 2007 Florida Department of Health (FDOH) onsite sewage GIS coverage (available: http://www.doh.state.fl.us/environment/programs/EhGis/EhGisDownload.htm), about 90, 246, and 9 housing units (*N*) were identified as being on septic tanks in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds, respectively (**Figure 4.2**). 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 U.S. Census Bureau, the average household size for Hillsborough County is about 2.50 people/household. The same population density was assumed for the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds. 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 watersheds at the time this TMDL analysis was conducted. Therefore, the failure rate was derived from the number of septic tank and septic tank repair permits for the county published by FDOH (available: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm). The number of septic tanks in Hillsborough County was calculated assuming that none of the installed septic tanks will be removed after being installed. The reported number of septic tank repair permits was also obtained from the FDOH Website.

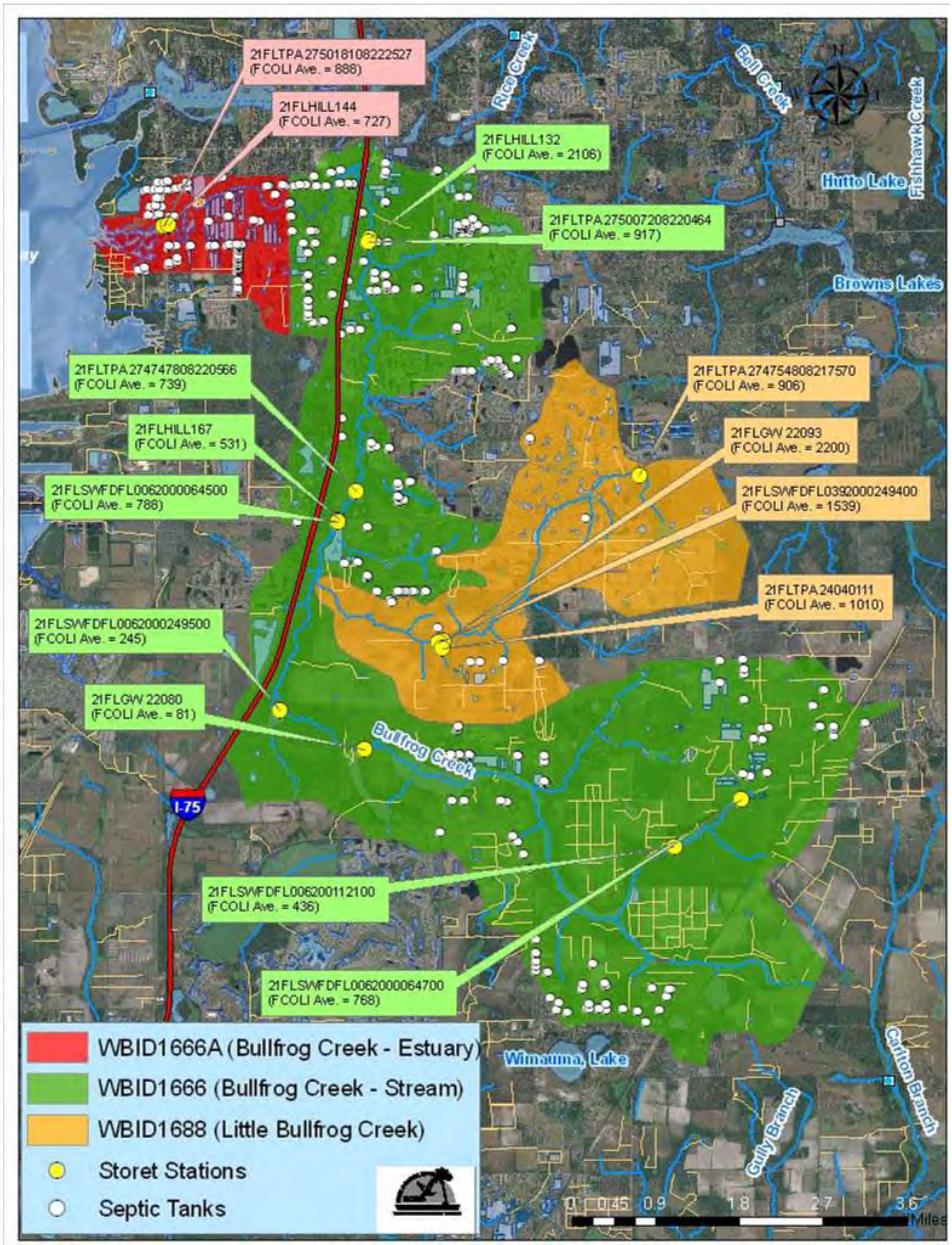


Figure 4.2. Distribution of Onsite Sewage Systems (Septic Tanks) in the the Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688) Watersheds

Based on this information, a discovery rate of failed septic tanks for each year between 2002 and 2007 was calculated and listed in **Table 4.5**. Using the table, the average annual septic tank failure discovery rate for Hilllsborough County is about 0.81 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 4.0 percent. Based on **Equation 4.1**, the estimated fecal coliform loadings from failed septic tanks in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds are approximately 2.39×10^{10}, 6.52×10^{10}, and 2.38×10^{9} counts/day, respectively.

Table 4.5. Estimated Septic Numbers and Septic Failure Rates for Hillsborough County, 2002–07

- = Empty cell
[1] The failure rate is 5 times the failure discovery rate.

-	2002	2003	2004	2005	2006	2007	Average
New installation (septic tanks)	986	1,031	1,005	1,314	1,236	487	1,010
Accumulated installation (septic tanks)	100,483	101,469	102,500	103,505	104,819	106,055	103,139
Repair permit (septic tanks)	998	929	735	815	751	754	830
Failure discovery rate (%)	0.99	0.92	0.72	0.79	0.72	0.71	0.81
Failure rate (%)[1]	5.0	4.6	3.6	3.9	3.6	3.6	4.0

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 greatest risk of an SSO occurs during storm events; however, few comprehensive data are available to quantify SSO frequency and bacteria loads in most watersheds.

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 the typical fecal coliform concentration 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 overflows of sanitary sewer in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds can be made using **Equation 4.2**:

$$L = 37.85 * N * Q * C * F \qquad \text{(Equation 4.2)}$$

Where:

- L is the fecal coliform daily load (counts/day);
- N is the number of households using sanitary sewer in the watershed;
- Q is the discharge rate for each household;
- C is the fecal coliform concentration for the domestic wastewater discharge; and
- F is the sewer line leakage rate.

The number of households (*N*) in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds that use sewer lines are 232, 3,224, and 1,138 (total households minus septic tank households), respectively. The discharge rate through the sewer line from each household (*Q*) was calculated by multiplying the average household size (2.50 people) by the per capita wastewater production rate per day (70 gallons). The commonly cited concentration (*C*) for domestic wastewater is $1x10^6$ counts/100mL for fecal coliform (EPA, 2001). Of the total number of households using the sewer line, 0.5 percent (*F*) was assumed as the sewer line leakage rate (Culver et al., 2002). Based on **Equation 4.2**, the estimated fecal coliform loading from sewer line leakage in the Bullfrog Creek (Marine), Bullfrog Creek (Fresh), and Little Bullfrog Creek watersheds is about 7.68×10^9, 1.07×10^{11}, and 3.77×10^{10} counts/day, respectively.

Nonpoint Source Summary

Table 4.6 summarizes the loading estimates from various nonpoint sources. It is important to note that this is not a complete list and represents estimates of potential loadings. Proximity to each waterbody, rainfall frequency and magnitude, soil types, drainage features, and temperature are just a few of the factors that could influence and determine the actual loadings from these sources that reach Bullfrog Creek and Little Bullfrog Creek.

Table 4.6. Estimated Fecal Coliform Loadings from Dogs, Septic Tanks, and SSOs in the Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688) Watersheds

Waterbody	Dogs (counts/day)	Septic Tanks (counts/day)	SSOs (counts/day)
Bullfrog Creek (Marine)	5.11 x 1010	2.39 x 1010	7.68 x 109
Bullfrog Creek (Fresh)	5.50 x 1011	6.52 x 1010	1.07 x 1011
Little Bullfrog Creek	1.82 x 1011	2.38 x 109	3.77 x 1010

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The TMDL methodology used for Bullfrog Creek (WBID 1666 – Fresh) is the load duration curve. Also known as the "Kansas approach" because it was developed by the state of Kansas, this method has been well documented in the literature, with improved modifications used by the EPA, Region 4. Basically, the method relates the pollutant concentration to the flow of the stream, in order to establish the existing loading capacity and the allowable pollutant load (TMDL) under a spectrum of flow conditions. It then determines the maximum allowable pollutant load and load reduction requirement based on the analysis of the critical flow conditions. This method requires four steps to develop the TMDL and establish the required load reduction:

1. *Develop the flow duration curve;*
2. *Develop the load duration curve for both the allowable load and existing loading;*
3. *Define the critical conditions; and*
4. *Establish the needed load reduction by comparing the existing loading with the allowable load under critical conditions.*

There are no flow gages located in Bullfrog Creek (Marine) (WBID 1666A) or Little Bullfrog Creek (WBID 1688); therefore, the fecal coliform TMDL calculation was developed using the "percent reduction" approach. For this method, the percent reduction needed to meet the applicable criterion is calculated for each value above the criterion, and then a median percent reduction is calculated.

5.1.1 Data Used in the Determination of the TMDL

Fecal coliform concentration and flow measurements were used to estimate both the allowable coliform loads and existing coliform loads. **Figure 5.1** shows the locations of the water quality sites where fecal coliform data were collected and the U.S. Geological Survey (USGS) gaging stations where the flow measurements were taken. **Figures 2.1a, 2.1b,** and **2.1c** display the data for fecal coliform used in this analysis. Data were mainly provided by Hillsborough County and the Department's Southwest District, as follows:

- *Bullfrog Creek (Marine) – Stations: 21FLHILL144 and 21FLTPA 275018108222527;*
- *Bullfrog Creek (Fresh) – Stations: 21FLSWFDFL0062000 – (064500, 064700, 112100, and 249500), 21FLHILL – (132 and 167), 21FLGW 22080, and 21FLTPA – (274747808220566 and 725007208220464); and*
- *Little Bullfrog Creek – Stations: 21FGW 22093, 21FLTPA – (24040111 and 274754808217570), and 21FLSWFDFL0392000249400.*

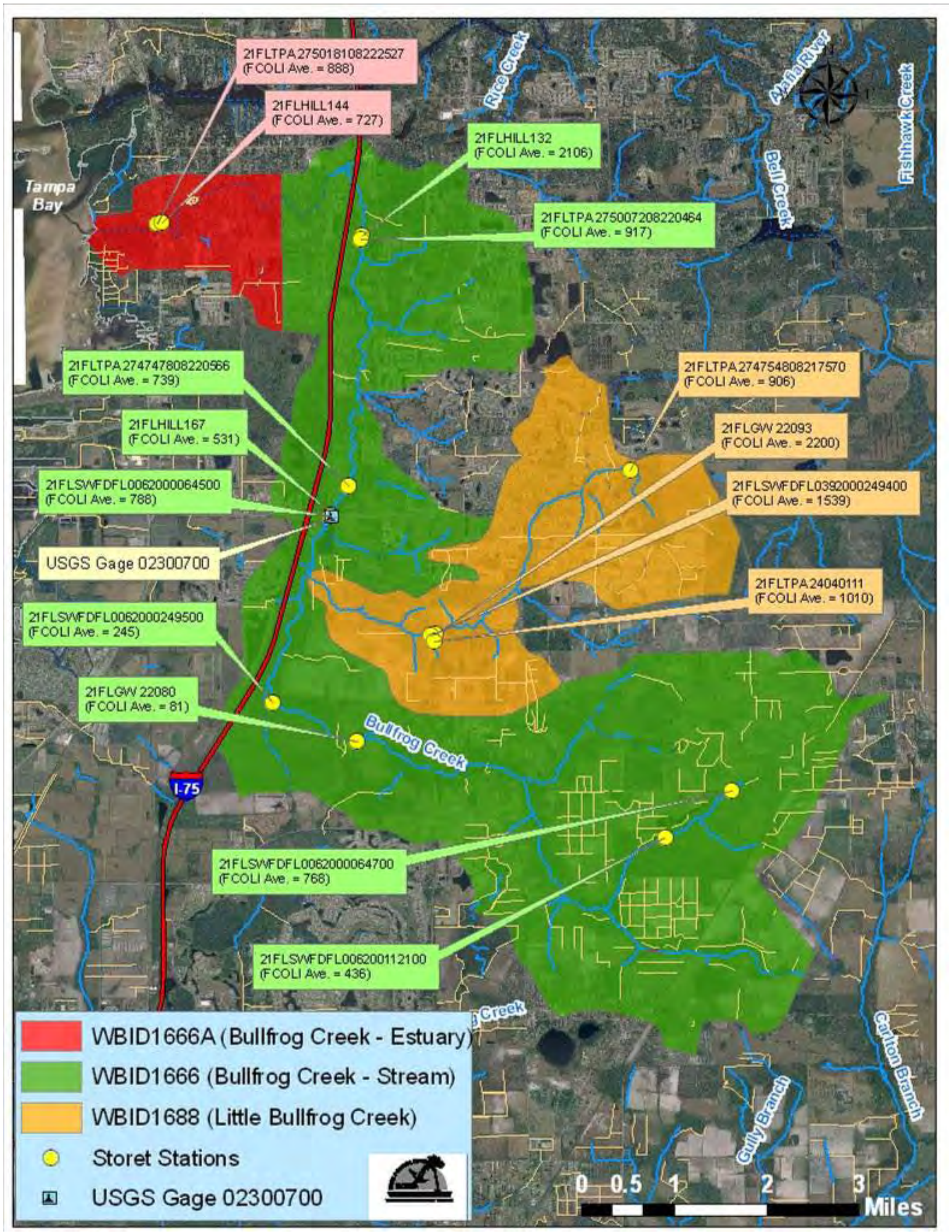


Figure 5.1. Locations of Water Quality Stations and USGS Gaging Station Where Water Quality Data and Flow Measurements Were Collected for This Report

5.1.2 TMDL Development Process for Bullfrog Creek (Fresh)

Develop the Flow Duration Curve

The first step in the development of load duration curves is to create *flow duration curves*. A flow duration curve displays the cumulative frequency distribution of daily flow data over the period of record. The duration curve relates flow values measured at a monitoring station to the percent of time the flow values were equaled or exceeded. Flows are ranked from low, which are exceeded nearly 100 percent of the time, to high, which are exceeded less than 1 percent of the time.

The range of flows from the USGS flow gage was divided into "flow zones." The concept of zones is adopted from Dr. Bruce Cleland (Cleland, 2002). The purpose of the zones is to demarcate hydrologic conditions between drought and peak flood into flow ranges such as low, dry, average, moist, and high. Expressing the flows in terms of frequency of recurrence (duration) allows a linkage of exceedances of the criterion to specific flow intervals and durations. Following Cleland's approach (Cleland, 2003), the Department selected the following flow zones: "High" (0–10), "Moist"(11–40), "Mid-Range" (41–60), "Dry" (61–90), and "Low" (91–100). **Figure 5.2** shows the flow duration curve for USGS Gage 02300700 (located in Wimuama, FL near water quality station 21FLHILL167 [Bullfrog Creek at Big Bend Rd]) (**Figure 5.1**). The period of record used for the flow duration analysis for Gage 02300700 is April 29, 1977, to October 8, 2007.

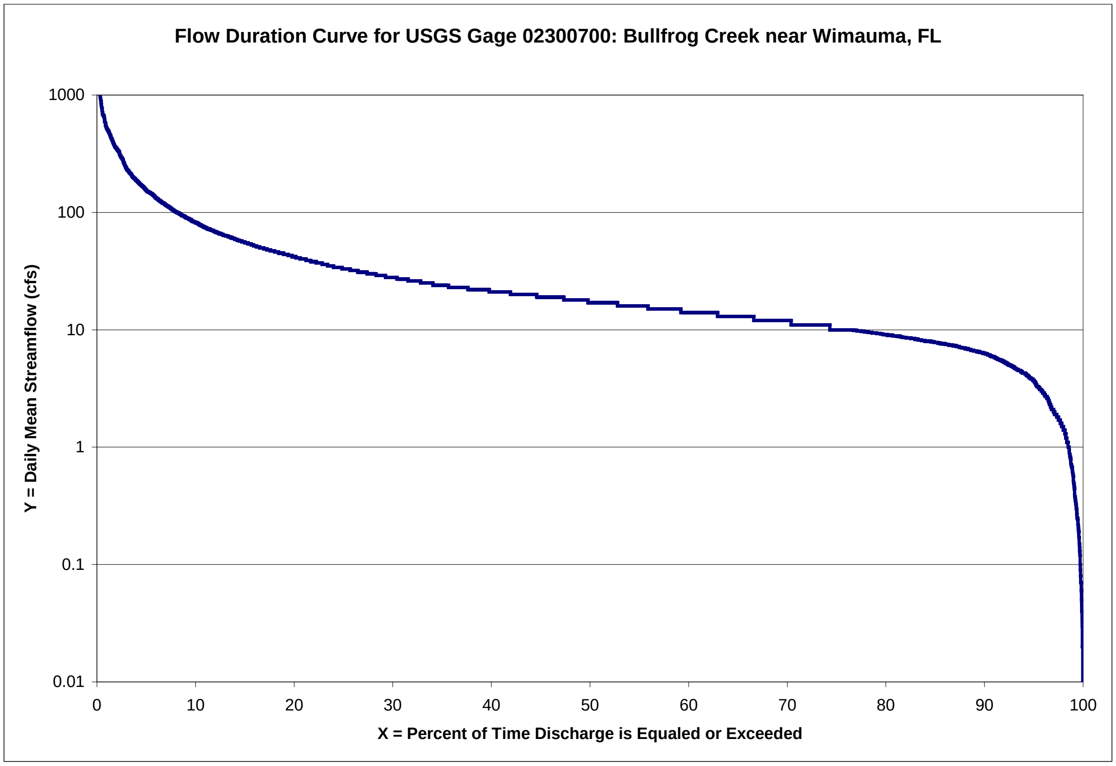


Figure 5.2. Flow Duration Curve for USGS Gage 02300700 (1977–2008)

Develop the Load Duration Curves for Both the Allowable Load and Existing Loading Capacity

Flow duration curves are transformed into load duration curves by multiplying the flow values along the flow duration curve by the fecal coliform concentration and the appropriate conversion factors. The final results of the load are typically expressed as MPN per day. The following equations were used to calculate the allowable loads and the existing loading:

Allowable load = (observed flow) x (conversion factor) x (state criterion) (Equation 5.1)

Existing loading = (observed flow) x (conversion factor) x (coliform measurement) (Equation 5.2)

On the load duration curve, allowable and existing loads are plotted against the flow duration ranking. The allowable load was calculated based on the water quality criterion and flow values from the flow duration curve, and the line drawn through the data points representing the allowable load is called the target line. The existing loads are based on the in-stream fecal coliform concentrations measured during ambient monitoring and an estimate of flow in the stream at the time of sampling. As noted previously, because insufficient data were collected to evaluate the fecal coliform geometric mean, 400 MPN/100mL was used as the target criterion for fecal coliform. **Figure 5.3** shows both the allowable loads and the existing loads over the flow duration ranking for Bullfrog Creek (Fresh). The points of the existing load that were higher than the allowable load at a given flow duration ranking were considered an exceedance of the criterion.

As shown in **Figure 5.3,** exceedances of the fecal coliform criterion in Bullfrog Creek (Fresh) occur across the entire span of the flow record. In general, exceedances on the right side of the curve typically occur during low-flow events, implying a contribution from either point sources or baseflow, which could come from the load from failed septic tanks and sewer line leakage that interact with surface water. The exceedances that appear on the left side of the curve usually represent loading from stormwater-related sources. In this case, the potential sources may include contributions from pets, such as dogs and cats, wild animals, failed septic tanks, and sewer line leakage.

Define the 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, wildlife having direct access to the receiving water can contribute to the exceedance during dry weather. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

For Bullfrog Creek (Fresh), because exceedances occur throughout the flow record, no critical flow condition was defined for this TMDL. The Department used the flow records and water quality data available for the 10^{th} to 90^{th} percentile flow duration interval for the TMDL analysis. Flow conditions that were exceeded less than 10 percent of the time were not used because they represent abnormally high-flow events, and flow conditions occurring greater than 90 percent of the time were not used because they are extreme low-flow events.

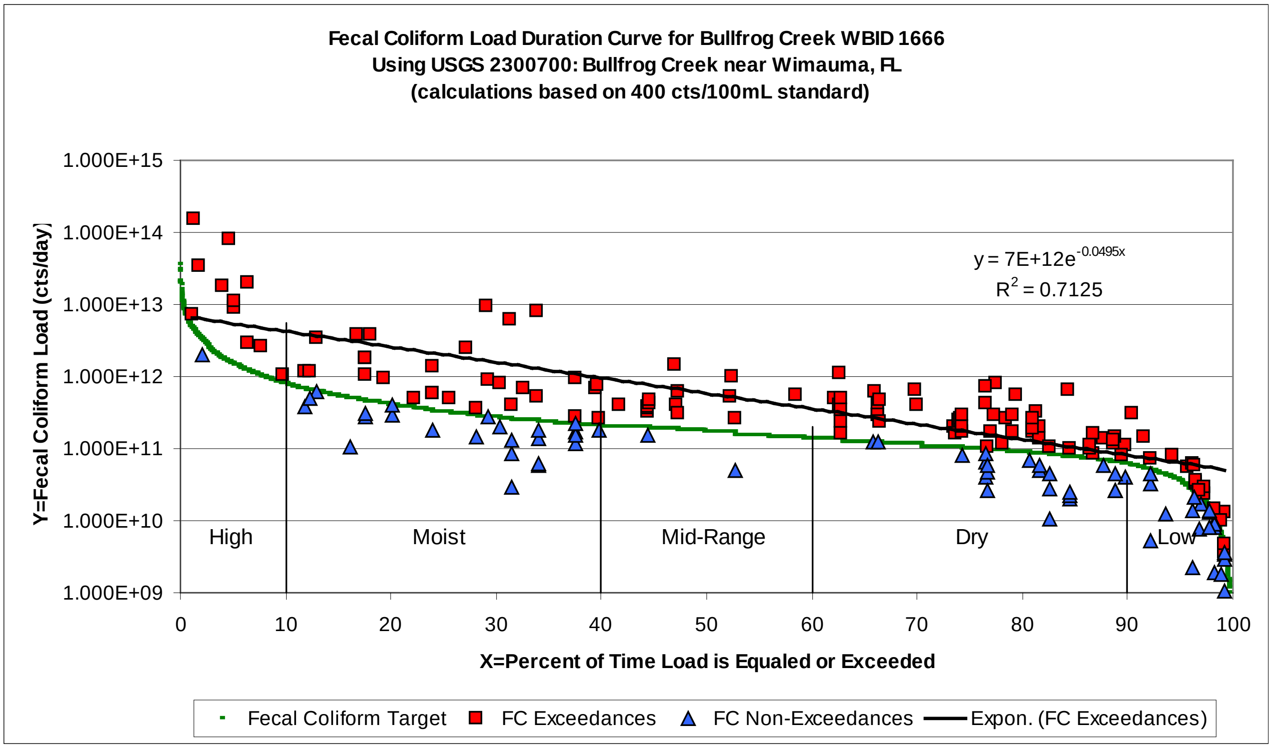


Figure 5.3. Load Duration Curve for Fecal Coliform in Bullfrog Creek (Fresh) (WBID 1666)

Establish the Needed Load Reduction by Comparing the Existing Load with the Allowable Load under the Critical Condition

The fecal coliform load reductions required to achieve the water quality criterion were established by comparing the existing loading with the allowable load at each flow recurrence interval between the 10^{th} and 90^{th} percentile (in increments of 5 percent). The actual needed load reduction was calculated using the following equation:

$$\textbf{Load Reduction} = \frac{\textbf{Existing loading} - \textbf{Allowable loading}}{\textbf{Existing loading}} \times \textbf{100\%} \qquad \textbf{(Equation 5.3)}$$

Allowable loading at each recurrence interval was calculated as the product of the water quality criterion and the flow corresponding to the given recurrence interval. To calculate *Existing loading,* a trend line was fitted to the loads that exceeded *Allowable loading*. Several types of trend lines were examined, and the exponential function was found to have the highest correlation coefficient for fecal coliform loading (R^2 = 0.7125). Therefore, the exponential function was used to predict the existing loads corresponding to the flow recurrence intervals used by *Allowable loading.* The following is the exponential equation developed for fecal coliform:

For fecal coliform: $Y = 7E +12e^{-0.0495x}$ **(Equation 5.4)**

Where:

X is the flow recurrence interval between the 10th and 90th percentile; and
Y is the predicted *Existing loading* for fecal coliform (**Equation 5.4**).

Figure 5.3 shows the trend lines and an exponential equation between fecal coliform bacteria load and flow ranking. After the trend lines were developed, they were used to determine the median percent reduction required to achieve the numeric criterion. At each recurrence interval between the 10th and 90th percentile (in increments of 5 percent), the equation of the trend line was used to estimate *Existing loading*.

The percent reduction required to achieve the target load was then calculated at each interval, and the final percent reduction needed was the median of these values. The TMDL and percent reductions were calculated as the median of all the loads and percent reductions calculated at the various recurrence intervals between the 10th and 90th percentile. **Table 5.1** shows the calculation of the TMDL and percent reductions for fecal coliform in Bullfrog Creek (Fresh).

Table 5.1. Calculation of TMDL and Percent Reduction for Fecal Coliform in Bullfrog Creek (Fresh) (WBID 1666)

* The median interval (50) is the TMDL calculation.

Interval	Allowable Load (counts/day)	Existing Load (counts/day)	% Reduction
10	8.02E+11	4.27E+12	81.19%
15	5.38E+11	3.33E+12	83.84%
20	4.11E+11	2.6E+12	84.20%
25	3.23E+11	2.03E+12	84.10%
30	2.74E+11	1.59E+12	82.72%
35	2.35E+11	1.24E+12	81.03%
40	2.06E+11	9.66E+11	78.74%
45	1.86E+11	7.55E+11	75.36%
50*	**1.66E+11**	**5.89E+11**	**71.76%**
55	1.57E+11	4.6E+11	65.96%
60	1.37E+11	3.59E+11	61.85%
65	1.27E+11	2.8E+11	54.63%
70	1.17E+11	2.19E+11	46.35%
75	9.79E+10	1.71E+11	42.74%
80	8.91E+10	1.33E+11	33.26%
85	7.63E+10	1.04E+11	26.73%
90	6.17E+10	8.13E+10	24.20%
Median:	**1.66E+11**	**5.89E+11**	**71.76%**

5.1.3 TMDL Development Process for Bullfrog Creek (Marine) and Little Bullfrog Creek

As described in **Section 5.1**, the percent reduction needed to meet the fecal coliform criterion was determined for each individual exceedance using the following equation:

$$\frac{\text{[measured exceedance – criterion]*100}}{\text{measured exceedance}} \qquad \textbf{(Equation 5.5)}$$

The fecal coliform TMDLs for Bullfrog Creek (Marine) and Little Bullfrog Creek were calculated as the median of the percent reductions needed over the data range where exceedances occurred (see **Tables 5.2a** and **5.2b** for data). As noted in the next section, exceedances occurred throughout the data period for Bullfrog Creek (Marine) and Little Bullfrog Creek, and the median percent reductions for this period were 46 and 74 percent, respectively.

5.1.4 Critical Conditions/Seasonality

The critical conditions for coliform loadings in a given watershed depend on the existence of point sources and land use patterns in the watershed. Typically, the critical condition for nonpoint sources is an extended dry period, followed by a rainfall runoff event. During wet weather periods, coliform bacteria that have built up on the land surface under dry weather conditions are washed off by rainfall, resulting in wet weather exceedances. However, significant nonpoint source contributions could also occur under dry weather conditions without any major surface runoff event. This usually happens when nonpoint sources contaminate the surficial aquifer, and coliform bacteria are brought into the receiving waters through baseflow. Livestock with direct access to the receiving water could also contribute to the exceedances during dry weather conditions. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

Exceedances occurred over the entire range of flow conditions in the Bullfrog Creek (Fresh) watershed, as shown in **Figure 5.3**. Based on the dominant type of land use (urban land and agriculture) in the watershed, it is likely that many of the exceedances in each of the flow intervals are from nonpoint sources and MS4s entering the waters through surface runoff. **Table 5.1** indicates that moist conditions are congruent with higher fecal coliform loads and percent reductions in the Bullfrog Creek (Fresh) watershed. This could indicate that fecal coliform builds up on the land during dry periods and washes off into local waters during rain events. Critical conditions are accounted for in the load curve analysis by using the flow records and water quality data available in the 10^{th} to 90^{th} percentile flow duration interval.

Table 5.2a. Calculation of Percent Reduction in Fecal Coliform Necessary To Meet the Water Quality Standard of 400 Colonies/100mL in Bullfrog Creek (Marine) (WBID 1666A)

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

Date	Station	Fecal Coliform Exceedances[1, 2]	Fecal Coliform Target[1]	% Reduction
8/16/2000	21FLHILL144	460	400	13.04%
11/17/2004	21FLHILL144	460	400	13.04%
7/20/2005	21FLHILL144	480	400	16.67%
2/21/2007	21FLHILL144	480	400	16.67%
8/21/2002	21FLHILL144	490	400	18.37%
10/20/2004	21FLHILL144	500	400	20.00%
1/15/2003	21FLHILL144	530	400	24.53%
11/16/2005	21FLHILL144	540	400	25.93%
12/21/2005	21FLHILL144	540	400	25.93%
11/19/2003	21FLHILL144	560	400	28.57%
1/17/2007	21FLHILL144	560	400	28.57%
12/12/2001	21FLHILL144	580	400	31.03%
2/6/2006	21FLTPA 275018108222527	590	400	32.20%
9/15/2004	21FLHILL144	600	400	33.33%
2/28/2006	21FLTPA 275018108222527	600	400	33.33%
7/10/2006	21FLTPA 275018108222527	600	400	33.33%
9/19/2001	21FLHILL144	740	400	45.95%
7/16/2003	21FLHILL144	780	400	48.72%
8/13/2003	21FLHILL144	820	400	51.22%
5/9/2006	21FLTPA 275018108222527	900	400	55.56%
8/22/2001	21FLHILL144	1,000	400	60.00%
2/18/2004	21FLHILL144	1,000	400	60.00%
1/16/2002	21FLHILL144	1,200	400	66.67%
3/19/2003	21FLHILL144	1,460	400	72.60%
8/18/2004	21FLHILL144	1,600	400	75.00%
11/20/2002	21FLHILL144	1,810	400	77.90%
5/21/2003	21FLHILL144	1,920	400	79.17%
2/19/2003	21FLHILL144	2,000	400	80.00%
7/21/2004	21FLHILL144	2,100	400	80.95%
9/20/2000	21FLHILL144	4,000	400	90.00%
12/11/2002	21FLHILL144	4,000	400	90.00%
9/12/2006	21FLTPA 275018108222527	6,000	400	93.33%
3/17/2004	21FLHILL144	20,000	400	98.00%
-	-	-	**Median:**	**45.95%**

Table 5.2b. Calculation of Percent Reduction in Fecal Coliform Necessary To Meet the Water Quality Standard of 400 Colonies/100mL in Little Bullfrog Creek (WBID 1688)

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

Date	Station	Fecal Coliform Exceedances[1, 2]	Fecal Coliform Target[1]	% Reduction
9/26/2006	21FLSWFDFL0392000249400	420	400	4.76%
5/15/2006	21FLTPA 24040111	510	400	21.57%
8/29/2006	21FLTPA 274754808217570	540	400	25.93%
3/20/2007	21FLSWFDFL0392000249400	620	400	35.48%
2/14/2006	21FLTPA 24040111	840	400	52.38%
6/20/2006	21FLSWFDFL0392000249400	900	400	55.56%
8/8/2006	21FLTPA 24040111	900	400	55.56%
4/24/2007	21FLSWFDFL0392000249400	920	400	56.52%
9/18/2006	21FLTPA 24040111	920	400	56.52%
8/22/2006	21FLSWFDFL0392000249400	1,000	400	60.00%
8/29/2006	21FLTPA 24040111	1,080	400	62.96%
3/8/2006	21FLSWFDFL0392000249400	1,100	400	63.64%
10/4/2006	21FLTPA 274754808217570	1,200	400	66.67%
12/28/2005	21FLSWFDFL0392000249400	1,450	400	72.41%
1/23/2007	21FLSWFDFL0392000249400	1,460	400	72.60%
8/16/2006	21FLTPA 24040111	1,600	400	75.00%
11/15/2006	21FLTPA 24040111	1,600	400	75.00%
10/4/2006	21FLTPA 24040111	1,631	400	75.48%
5/23/2006	21FLSWFDFL0392000249400	1,700	400	76.47%
4/4/2006	21FLTPA 24040111	1,720	400	76.74%
11/15/2005	21FLSWFDFL0392000249400	1,750	400	77.14%
1/31/2006	21FLSWFDFL0392000249400	2,000	400	80.00%
3/27/2006	21FLSWFDFL0392000249400	2,100	400	80.95%
11/29/2006	21FLSWFDFL0392000249400	2,,100	400	80.95%
9/23/2004	21FLGW 22093	2,200	400	81.82%
2/20/2007	21FLSWFDFL0392000249400	2,200	400	81.82%
11/15/2006	21FLTPA 274754808217570	2,500	400	84.00%
10/24/2006	21FLSWFDFL0392000249400	2,650	400	84.91%
10/18/2005	21FLSWFDFL0392000249400	2,850	400	85.96%
4/18/2006	21FLSWFDFL0392000249400	4,400	400	90.91%
-	**-**	**-**	**Median:**	**73.80%**

For Bullfrog Creek (Marine) and Little Bullfrog Creek, there were no flow gages to derive a flow duration curve; therefore, the Department used rainfall data to compare with the measured fecal coliform data for each waterbody. Measurements were sorted by month and season (the calendar year was divided into quarters) to determine whether there was a temporal pattern of exceedances. Monthly rainfall data from Plant City (087205) were also obtained and included in the analysis. **Tables 5.3a** and **5.3b,** and **Tables 5.4a** and **5.4b**, present summary statistics by month and season, respectively, for fecal coliform measurements (*Winter:* January–March; *Spring*: April–June; *Summer*: July–September; *Fall*: October–December) in Bullfrog Creek (Marine) and Little Bullfrog Creek, respectively. Fecal coliform exceedances occur throughout all seasons in both waterbodies, implying potential fecal coliform bacteria sources during both baseflow and surface runoff events. However, during the early summer months, with higher rainfall levels, there seems to be an initial dilution of fecal coliform in these waterbodies, followed by a steady increase in fecal coliform as the amount of rainfall levels off. **Figures 5.4a** and **5.4b** show this information graphically.

Table 5.3a. Summary Statistics of Fecal Coliform Data for Bullfrog Creek (Marine) (WBID 1666A) by Month

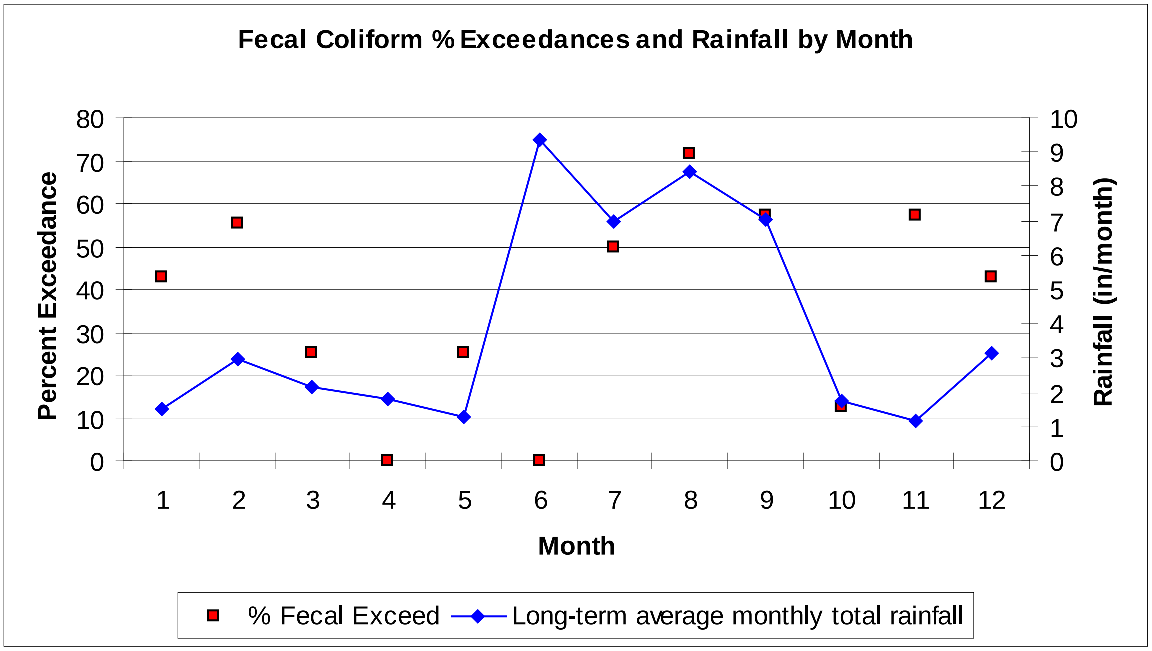
[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.

Month	Number of Cases	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances of Cases	Rainfall Mean (inches)
1	7	60	1,200	360	464	3	42.86%	1.5
2	9	80	2,000	480	583	5	55.56%	2.99
3	8	40	20,000	200	2,795	2	25.00%	2.13
4	9	20	220	80	97	0	0.00%	1.78
5	8	20	1,920	45	379	2	25.00%	1.3
6	7	10	120	80	67	0	0.00%	9.38
7	8	110	2,100	430	614	4	50.00%	6.99
8	7	110	1,600	490	691	5	71.43%	8.45
9	7	100	6,000	600	1,689	4	57.14%	7.03
10	8	40	500	255	245	1	12.50%	1.74
11	7	60	1,810	460	539	4	57.14%	1.16
12	7	160	4,000	320	880	3	42.86%	3.12

Table 5.3b. Summary Statistics of Fecal Coliform Data for Bullfrog Creek (Marine) (WBID 1666A) by Season

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

Season	Number of Cases	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances of Cases	Total Rainfall Mean (inches)
1	24	40	20,000	360	1,281	10	41.14%	7.20
2	24	10	1,920	80	181	2	8.33%	16.04
3	22	100	6,000	490	998	13	59.52%	25.34
4	22	40	4,000	320	555	8	37.50%	6.41



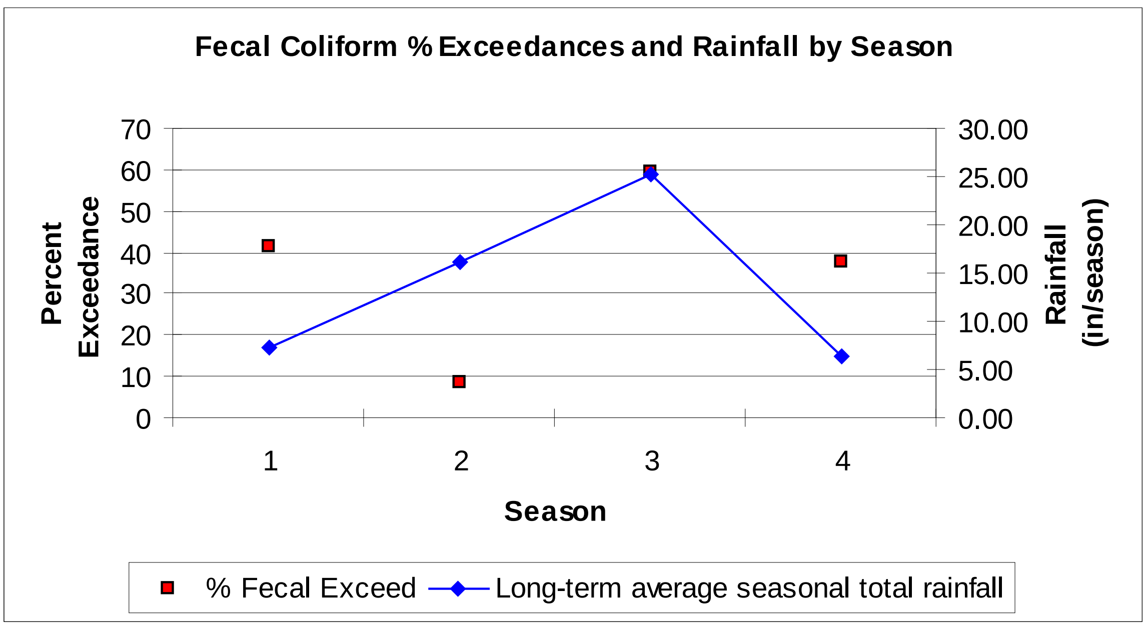


Figure 5.4a. Fecal Coliform Exceedances and Rainfall for Bullfrog Creek (Marine) (WBID 1666A) by Month and Season, 2000–07

Table 5.4a. Summary Statistics of Fecal Coliform Data for Little Bullfrog Creek (WBID 1688) by Month

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

Month	Number of Cases	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances of Cases	Rainfall Mean (inches)
1	2	1,460	2,000	1,730	1,730	2	100.00%	1.50
2	3	190	2,200	840	1,077	2	66.67%	2.99
3	3	620	2,100	1,100	1,273	3	100.00%	2.13
4	4	190	4,400	1,320	1,808	3	75.00%	1.78
5	3	400	1,700	510	870	2	66.67%	1.30
6	2	400	900	650	650	1	50.00%	9.38
7	2	100	120	110	110	0	0.00%	6.99
8	5	540	1,600	1,000	1,024	5	100.00%	8.45
9	3	420	2,200	920	1,180	2	66.67%	7.03
10	4	1,200	2,850	2,141	2,083	4	100.00%	1.74
11	4	1,600	2,500	1,925	1,988	4	100.00%	1.16
12	2	350	1,450	900	900	1	50.00%	3.12

Table 5.4b. Summary Statistics of Fecal Coliform Data for Little Bullfrog Creek (WBID 1688) by Season

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

Season	Number of Cases	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances of Cases	Rainfall Mean (inches)
1	8	190	2,200	1,100	1,360	7	88.89%	7.20
2	9	190	4,400	650	1,109	6	63.89%	16.04
3	10	100	2,200	920	771	7	55.56%	25.34
4	10	350	2,850	1,925	1,657	9	83.33%	6.41

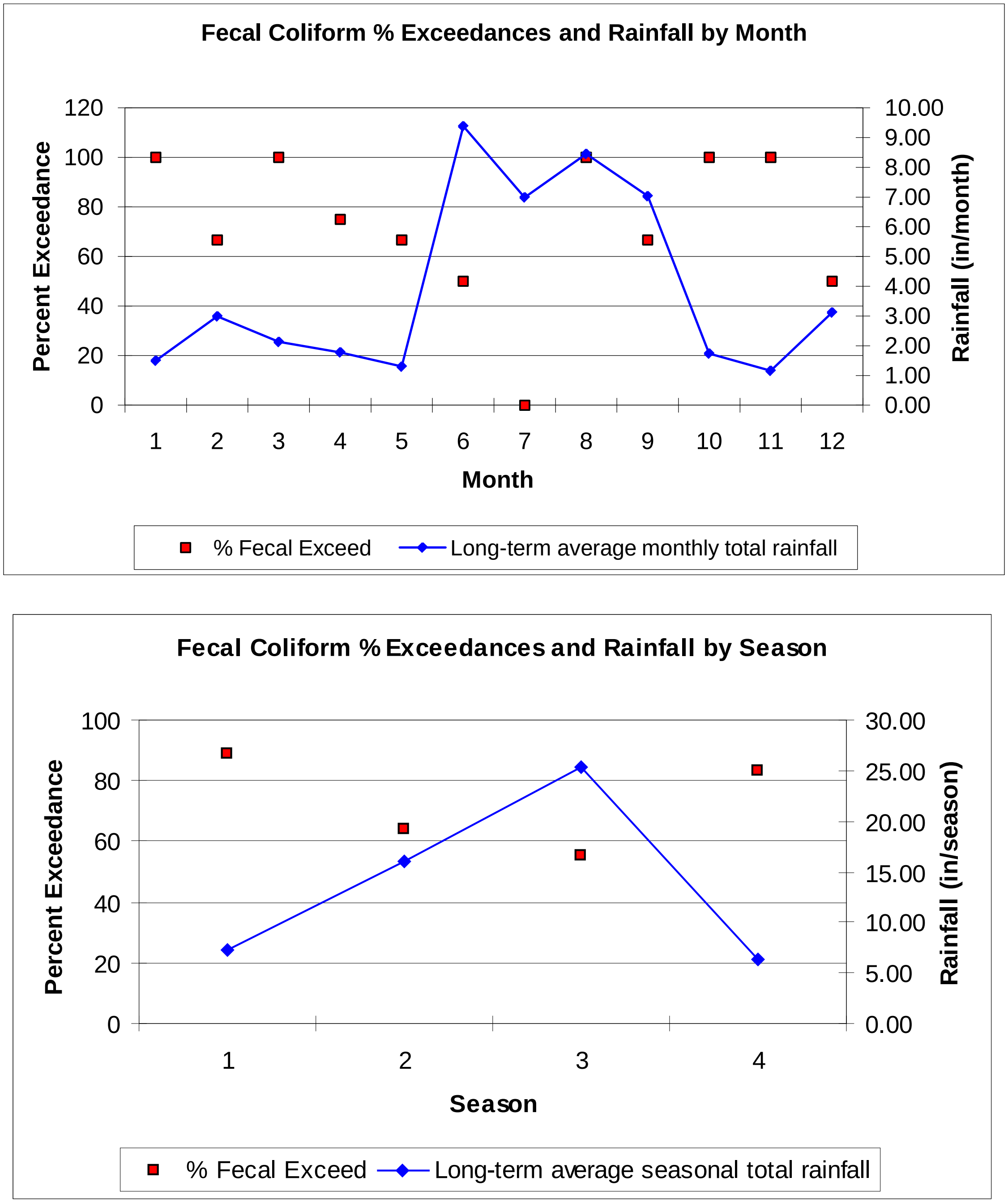


Figure 5.4b. Fecal Coliform Exceedances and Rainfall for Little Bullfrog Creek (WBID 1688) by Month and Season, 2000–07

5.1.5 Spatial Patterns

Bullfrog Creek (Marine–WBID 1666A)

For Bullfrog Creek (Marine), Station 21FLHILL144 recorded a very high fecal coliform maximum value of 20,000 counts/100mL on March 17, 2004 (**Table 5.5**); however, the Department has no information regarding any special event (septic tank or sewer leakage) that may have triggered the high fecal coliform value. Even with this high value, the overall fecal coliform average between both stations in this waterbody is similar, implying that no major spatial pattern exists for the fecal coliform data collected in Bullfrog Creek (Marine).

Bullfrog Creek (Fresh–WBID 1666)

Similarly, on March 17, 2004, Station 21FLHILL132 (located about 2.5 miles upstream of Station 21FLHILL144) in Bullfrog Creek (Marine) recorded a very high fecal coliform maximum value of 19,800 counts/100mL, followed by another high fecal coliform value of 13,600 counts/100mL on June 16, 2004. These results imply that the fecal coliform measurements are accurate and that both the freshwater and marine segments of Bullfrog Creek were affected by an unknown source of fecal bacteria.

Little Bullfrog Creek (WBID 1688)

No major spatial pattern was found in the fecal coliform data collected in Little Bullfrog Creek. Station 21FLGW 22093 did have the highest overall fecal coliform average among the four stations in this waterbody (**Table 5.3**); however, only one sample was collected for this station, making it difficult to derive any statistical conclusions.

Table 5.5. Station Summary Statistics of Fecal Coliform Data for Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688)

[1] Coliform counts are #/100mL.

WBID	Station	# of Samples	Average[1]	Minimum[1]	Maximum[1]
1666A	21FLHILL144	81	727	10	20,000
1666A	21FLTPA 275018108222527	11	888	20	6,000
1666	21FLSWFDFL0062000064700	21	768	100	6,500
1666	21FLSWFDFL0062000112100	19	436	95	1,450
1666	21FLGW 22080	1	81	81	81
1666	21FLSWFDFL0062000249500	21	245	15	1,100
1666	21FLSWFDFL0062000064500	19	788	200	2,900
1666	21FLHILL167	21	531	140	1,000
1666	21FLTPA 274747808220566	10	739	110	2,900
1666	21FLTPA 275007208220464	10	917	340	2,400
1666	21FLHILL132	76	2,106	110	19,800
1688	21FLTPA 274754808217570	5	906	100	2,500
1688	21FLGW 22093	1	2,200	2,200	2,200
1688	21FLSWFDFL0392000249400	20	1,539	350	4,400
1688	21FLTPA 24040111	11	1,010	120	1,720

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 Bullfrog Creek (WBID 1666) is expressed in terms of counts/day and percent reduction, while those for Bullfrog Creek (WBID 1666A) and Little Bullfrog Creek are expressed in terms of a percent reduction; these TMDLs represent the maximum daily fecal coliform loads the creeks can assimilate and maintain the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Fecal Coliform in Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688)

*Fecal coliform criterion (Subsection 62-302.530[6], F.A.C.; Class III)
** N/A – Not applicable

WBID	Parameter	TMDL (counts/day)	Wasteload Allocation for Wastewater (counts/day)	Wasteload Allocation for NPDES Stormwater (% reduction)	LA (% reduction)	MOS
1666A	Fecal Coliform	400 #/100mL*	N/A**	46%	46%	Implicit
1666	Fecal Coliform	1.66E +11	N/A**	72%	72%	Implicit
1688	Fecal Coliform	400 #/100mL*	N/A**	74%	74%	Implicit

6.2 Load Allocation

Fecal coliform reductions of 46, 72, and 74 percent for Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688) are needed 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 with fecal coliform limits were identified in Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688). 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

The WLA for stormwater discharges with an MS4 permit is a 46, 72, and 74 percent reduction in current fecal coliform for Bullfrog Creek (Marine) (WBID 1666A), Bullfrog Creek (Fresh) (WBID 1666), and Little Bullfrog Creek (WBID 1688), respectively. It should be noted that any 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, February 2001), an implicit MOS was used in the development of this TMDL by meeting the water quality criterion of 400 colonies/100mL, while the actual criterion allows for a 10 percent exceedance over that level.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, referred to as the BMAP. This document will be developed over the next year in cooperation with local stakeholders, who will attempt to reach consensus on detailed allocations and on how load reductions will be accomplished. The BMAP will include, among other things:

- *Appropriate load reduction allocations among the affected parties;*
- *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;*
- *Confirmed and potential funding mechanisms;*
- *Any applicable signed agreement(s);*
- *Local ordinances defining actions to be taken or prohibited;*
- *Any applicable local water quality standards, permits, or load limitation agreements;*
- *Milestones for implementation and water quality improvement; and*
- *Implementation tracking, water quality monitoring, and follow-up measures.*

An assessment of progress toward the BMAP milestones will be conducted every five years, and revisions to the plan will be made as appropriate, in cooperation with basin stakeholders.

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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, stormwater PLRGs 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 FDOT 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.

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