FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Environmental Assessment and Restoration,
Water Quality Evaluation and TMDL Program
NORTHEAST DISTRICT • SANTA FE RIVER BASIN

TMDL Report

Fecal Coliform TMDL for Santa Fe River Basin

Jonathan Turner

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Contents

List of Tables

List of Figures

Websites

Florida Department of Environmental Protection, Water Quality Evaluation and TMDL Program

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

2012 305(b) Report

http://www.dep.state.fl.us/water/docs/2012_integrated_report.pdf

Criteria for Surface Water Quality Classifications

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

Basin Status Report: Suwannee River Basin

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

Water Quality Assessment Report: Suwannee River Basin

http://www.dep.state.fl.us/water/basin411/suwannee/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 the impaired waterbodies in the Santa Fe River Basin (**Figure 1.1**). This TMDL establishes the allowable fecal coliform loading to the Santa Fe River Basin that would restore impaired waterbodies so that they meet the applicable water quality criteria for fecal coliform. **Appendix C** lists the verified impaired waterbodies assessed in this report, and **Appendices D and E** describe in more detail the individual verified impaired waterbodies. Spatial locations of these impaired waterbodies in the Santa Fe River Basin are shown in **Figures E.1 and E.2** in **Appendix E**.

Currently, the Department evaluates each waterbody that has been verified as impaired for fecal coliforms, identifies the reductions needed and assigns reductions to source categories as part of waterbody-specific, standalone reports. The strength of this approach is that it focuses on site-specific data and (by examining temporal and spatial trends) can be an effective tool for identifying the pollution sources causing or contributing to that particular waterbody impairment that need to be further evaluated as part of the subsequent pollutant load reduction implementation strategy. The weakness of this approach is that it is labor and time intensive, and fails to focus limited resources on the standard restoration strategies already well-accepted in addressing fecal coliform impairments and typically required independently by laws other than the Florida Watershed Restoration Act (section 403.067, Florida Statutes). Additionally, the Department often lacks widespread data throughout the entire basin (i.e., in surrounding watersheds), so the waterbody-specific approach can fail to take into account other nearby waterbodies which may also be impaired or are at risk of becoming impaired. This creates the potential for an inefficient and inequitable approach to solving the pollution problems in the state. Based on feedback received by the Department, some stakeholders have suggested that the Department implement a more universally applicable approach to setting Total Maximum Daily Loads (TMDLs) for waterbodies impaired by fecal coliform indicators. One way to accomplish this goal is through a regional TMDL, as described in this report.

Briefly, the approach laid out in the pages that follow extends the evaluation of data and impairments to the 8-digit Hydrologic Unit Code (HUC) scale. In this case, all of the available data for the entire period of record for the Santa Fe River HUC watershed (HUC ID: 03110206) are examined. In keeping with the requirements of section 403.067, Florida Statutes, the fecal coliform TMDL proposed in this report is only relevant for those waters in the Santa Fe River Basin that are verified for fecal coliform impairment. However, instead of setting waterbody-by-waterbody TMDL reduction targets, the Department is proposing to establish a single basin-wide concentration-based TMDL target. The concentration target for the fecal coliform TMDL is 400 counts/100 mL, which is consistent with the applicable bacteriological criteria for Class III waterbodies and is defined in the State's Surface Water Quality Standard (62-302.530(6), F.A.C).

This basin-wide TMDL will similarly apply to other waterbodies in this same 8-digit HUC when and if those waterbodies are verified as impaired for fecal coliforms in the future. However, the implementation strategies (primarily source identification and use of applicable Best Management Practices) for those waterbodies verified as impaired in the future will be no different from those applied now to the currently verified impaired waterbodies in the HUC basin. This HUC-based TMDL does not independently result in obligations to implement source identification and fecal indicator minimization strategies for any particular waterbody until such time as that waterbody is verified impaired. But because a source monitoring and pollutant reduction strategy that is applied across-the-board is more equitable and protective, the Department encourages all interested stakeholders to participate in a basin-wide cooperative effort to restore and protect Florida's waters and the health of our citizens.

Based on input from the U.S. Environmental Protection Agency, individual reduction targets must still be presented for the waterbodies verified as impaired for fecal coliform. Although information related to the estimated percent reduction needed to meet the TMDL is included in this report, it is for informational purposes only. This TMDL is expressed as a concentration-based target because, in the case of fecal indicators in particular, focusing on standard restoration strategies (source identification and fecal indicator minimization) is more effective and protective than trying to achieve a specific percent reduction number. First and foremost, and as the name implies, "fecal indicators" are only indicators of the pathogens that are the true health risk. Elevated fecal indicator counts signal that the presence of pathogens and a potential human health risk is more likely, but universal source reduction efforts will provide a greater level of assurance that the risk is being minimized. Second, attempting to achieve a specific percent reduction is challenging, as the tools available (particularly for nonpoint sources) to reduce fecal coliform counts are not based on an exact engineering solution, but rather usually represent a good-faith effort to minimize anthropogenic inputs. Third, fecal coliforms (and other fecal indicators) can also be present as a result of natural sources (e.g., birds and deer), such that even when all man-created sources have been removed from a watershed, there may still be natural sources that can cause samples with elevated fecal coliform levels to be collected, measured, and reported. Note: animals such as horses, cattle, poultry and dogs are not considered to be wildlife.

The basin-wide TMDL will apply to waterbodies in the basin that become verified impaired for fecal coliform in the future, assuming all of the circumstances and assumptions underlying this basin-wide TMDL still hold true. When these new waterbodies become verified for fecal coliform impairment, the Department will amend the TMDL report and submit the new waters to EPA for approval and incorporation into the basin-wide TMDL. The intent of the basin-wide approach is to provide a more efficient process, since the rule language in Chapter 62-304, F. A. C., will not need to be updated. The Department will update the TMDL report, however, to include the characteristics of the new WBIDs as well as analyses that the facts and circumstances assumed during the development of the basin-wide TMDL continue to apply to the new WBIDs under consideration. For example, this TMDL applies to all the Class III freshwater segments in the Santa Fe River Basin. If a given waterbody segment verified for fecal coliform impairment is not a Class III freshwater segment, a separate fecal coliform TMDL will be developed and proposed for the waterbody segment.

The Department intends to revise the TMDL report in the future by adding brief but sufficiently detailed information about the new WBIDs to allow the EPA to approve incorporating the new waterbodies into the basin-wide TMDL. The Department will add new impaired waterbodies to the appendix of the TMDL report, in a “fact sheet” format that allows the general public to quickly and easily understand the basis for the impairment listing, lists the general land use types and possible sources in the watershed of the impaired water segment, includes the critical condition analysis, and calculates the needed percent reduction to achieve the TMDL target.

An opportunity for public review and a point of entry for a challenge to the TMDL will both be provided to the general public for TMDLs of newly verified waterbodies. The public notice about these TMDLs will occur at the time of listing, when the verified impaired list is adopted by

Secretary Order. The waterbodies newly verified for fecal coliform impairment in the Santa Fe River Basin will be put into an assessment category of 4A, indicating that those waterbodies are verified for impairment but TMDLs have been developed. Although the adoption of the Verified List and Delist List is not a rule making process, it is a public process, with opportunities for stakeholder engagement in the vicinity of the impacted waters and a chance for affected parties to challenge the Department's action.

1.2 Identification of Waterbodies

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Santa Fe River Basin into water assessment areas with a unique **W**ater**B**ody **ID**entification (WBID) number. **Appendix E** contains summaries of all the WBIDs verified as impaired for fecal coliform in the Santa Fe River Basin.

The Santa Fe River Basin has 150 waterbody segments identified within the basin. The basin is covers a span of nine counties in northern central Florida. (**Figure 1.2**).

The Upper Santa Fe watershed, in the Northern Highlands (USEPA, 2004), is dominated by surface water runoff. At the Cody Scarp, the river goes underground and reemerges supplemented by ground water flow. As the Santa Fe flows across the Gulf Coastal Lowlands, it gains significant flow from numerous springs, including the Ichetucknee River. Because ground water dominates its flow, the Lower Santa Fe River is, for the most part, a spring-fed river.

The eastern two-thirds of the Santa Fe watershed has surface drainage features, including lakes, streams, and wetlands. The western third lacks surface drainage, except for the Santa Fe and Ichetucknee Rivers and Cow Creek. The upper watershed is characterized by nearly level pine flatwoods with gently rolling hills. Tributary streams are fairly well incised into the landscape, which occasionally opens into broad, forested floodplains. In the middle portion of the watershed, moderate to gently rolling hills with areas of prominent karstic features, such as sink depressions and captured streams, create surface relief. The lower watershed is primarily a broad, slightly undulating karst plain with interspersed wetlands (FDEP, 2003).

1.3 Background

This report is part of the Department's watershed management approach for restoring and protecting state waters under TMDL Program requirements. The watershed approach looks at waterbodies in a larger geographic context of 52 river basins. This is implemented by organizing the basins into five groups, with an individual basin group evaluated during a given single year; all basins are assessed during a 5-year cycle. The TMDL Program implements the 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, specifically its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards, as set by the State of Florida. They provide important water quality restoration goals that will guide restoration activities.

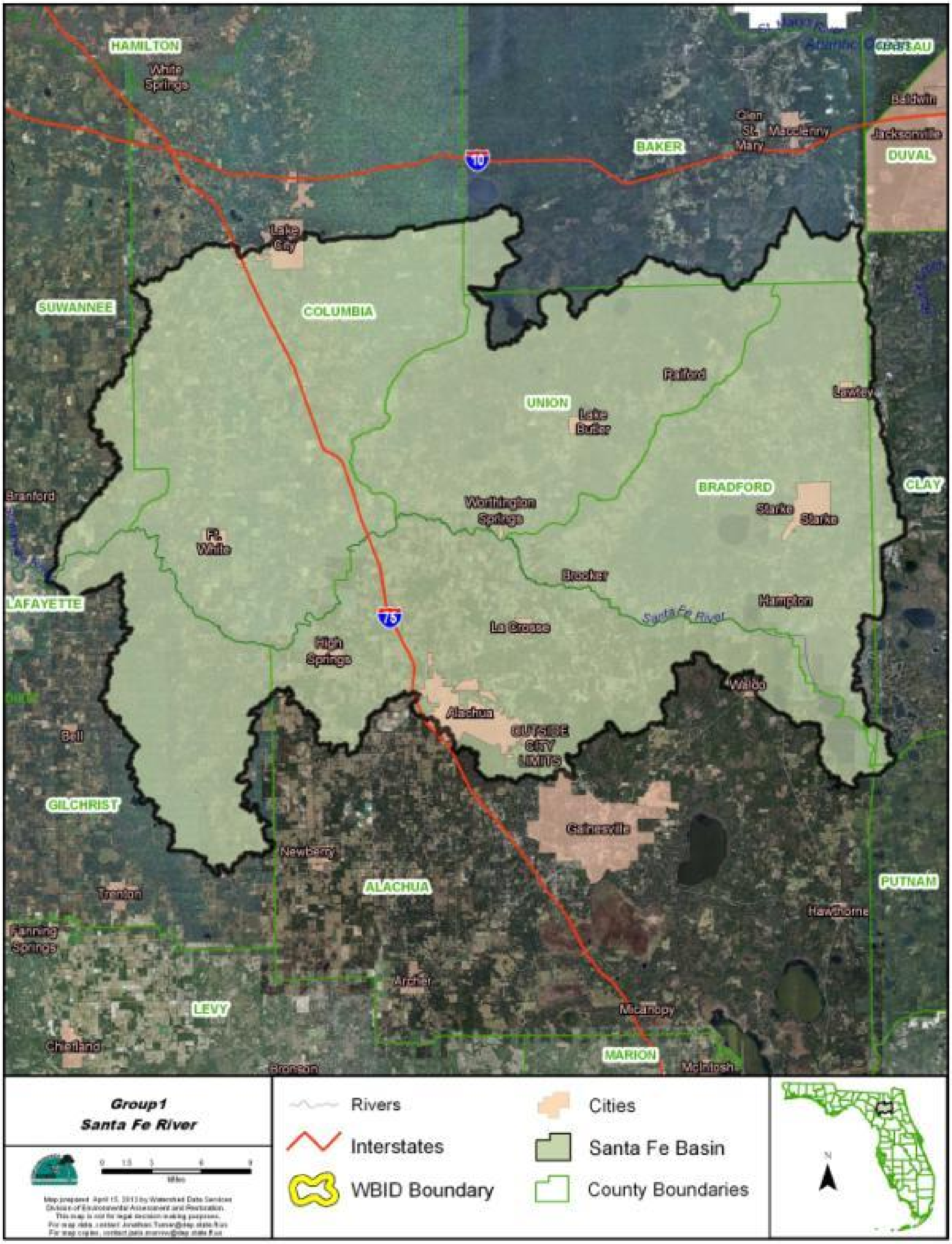

Figure 1.1. Locations of the Santa Fe River Basin and Major Geopolitical Features in the Area

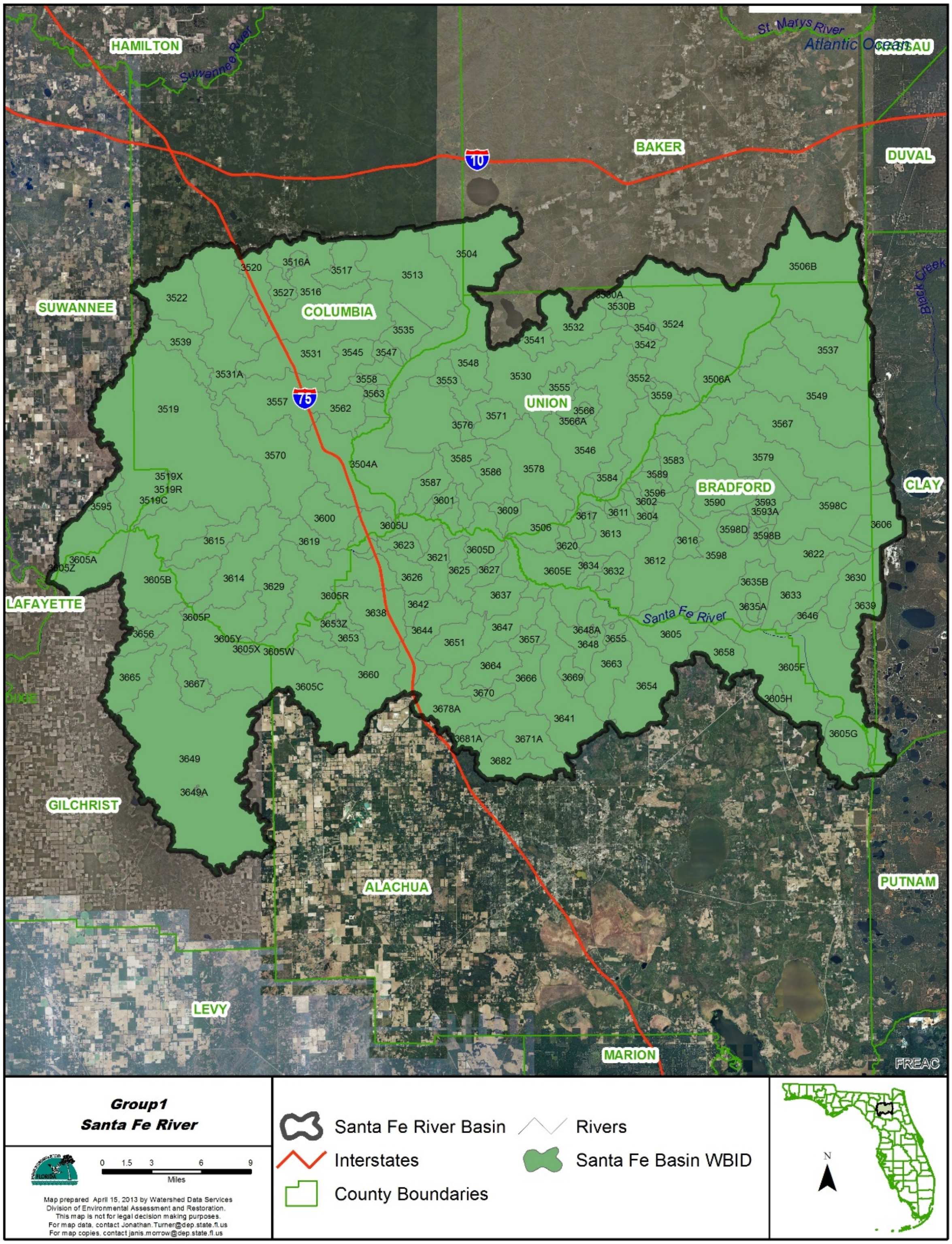

Figure 1.2. Santa Fe River Basin and All WBIDs Located within the Basin

This TMDL report will be followed by the development and implementation of a restoration plan designed to reduce the amount of fecal coliform below levels of impairment for the Santa Fe River Basin. These activities will solicit and include the active participation of the local citizen groups, as well as local and regional political entities such Suwannee River Water Management District (SRWMD), municipal 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 state 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 Florida Watershed Restoration Act (FWRA, Subsection 403.067[4], Florida Statutes [F.S.]); the state's 303(d) list is amended annually to include basin updates.

Florida identified four coliform-impaired waterbodies in the Santa Fe River 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 an extended 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, 2007, 2012 and 2013.

2.2 Information on Verified Impairment

Appendix C lists the impairment information for all WBIDs identified as being verified impaired for fecal coliforms. Any waterbodies verified impaired for fecal coliforms in the future will be included in this section.

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)**

All waterbodies in the Santa Fe River Basin, including the waterbodies impaired for fecal coliform, are Class III (Freshwater) waterbodies, 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 impaired WBIDs are identified as Class III waterbodies:

The water quality criteria 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% of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30 day period.*

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 regional TMDL was not to exceed 400 counts/100mL 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 sources within 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 discernible, 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 the 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 Santa Fe River Basin Boundary

4.2.1 Point Sources

Wastewater Point Sources

Examples can include discharges from wastewater treatment facilities (WWTFs), combined sewer overflows (CSOs) and concentrated animal feeding operations (CAFOs).

WWTFs

Potentially harmful bacteria may enter surface waters via wastewater discharges which contains a variety of organic and inorganic pollutant. This wastewater is treated by WWTFs in order to remove harmful waste products and to render it environmentally acceptable.

CAFOs

CAFOs are generally defined as farms with 700 or more head of livestock confined for more than 45 days. These facilities generally congregate and feed animals, manage their manure, and have production operations on a small land area.

There are 7 active NPDES-permitted facilities located in the Santa Fe River Basin. However, of these facilities, typically only Domestic Wastewater facilities that are listed in the Wastewater Facility Regulation (WAFR) database as direct surface water discharge facilities could potentially contribute to observed levels of fecal coliform bacteria within the area they are located.

Table 4.1 lists all NPDES-permitted facilities with permitted surface-water discharge capacity located in the Santa Fe River Basin. **Appendix D** lists all the potential point sources for each of the verified impaired WBIDs.

Table 4.1. Wastewater Point Sources: NPDES Permitted Facilities in the Santa Fe River Basin

This is a four-column table. Column 1 lists the permit number, Column 2 lists the facility name, Column 3 lists the type of facility and Column 4 lists the permitted capacity of wastewater discharge.

Permit ID	Facility Name	Type of Facility	Permitted Capacity (MGD)
FL0028126	Starke, City of WWTF	Domestic Wastewater	1.6500
FL0000051	EI DuPont De Nemours Trailridge Mine	Industrial Wastewater	30.0000
FLA011323	IFAS - Dairy Research Unit	Cattle Feeding Operation	0.1510
FL0000035	EI DuPont De Nemours - Highland Mine	Industrial Wastewater	40.0000
FLA116173	Branford Farm - American Dairyco FL LLC	Cattle Feeding Operation	0.1750

Municipal Separate Storm Sewer System Permittees

Stormwater runoff is water that doesn't soak into the ground during a rain storm, but instead flows over the surface of the ground until it reaches a waterbody. As the runoff moves, it picks up and carries away natural and human-made pollutants, such as soil and manure, eventually depositing them into surface and ground waters. Stormwater runoff is one of the leading sources of impairment of our nation's waters and often contains high concentrations of bacteria.

There is one municipal separate storm sewer system (MS4) permit in the Santa Fe River Basin. Alachua County (Permit # FLR04E005) has a Phase II MS4 permit that covers the City of Gainesville and unincorporated urban areas in the county. **Figure 4.1** shows the locations of the MS4 permit in the Santa Fe River basin.

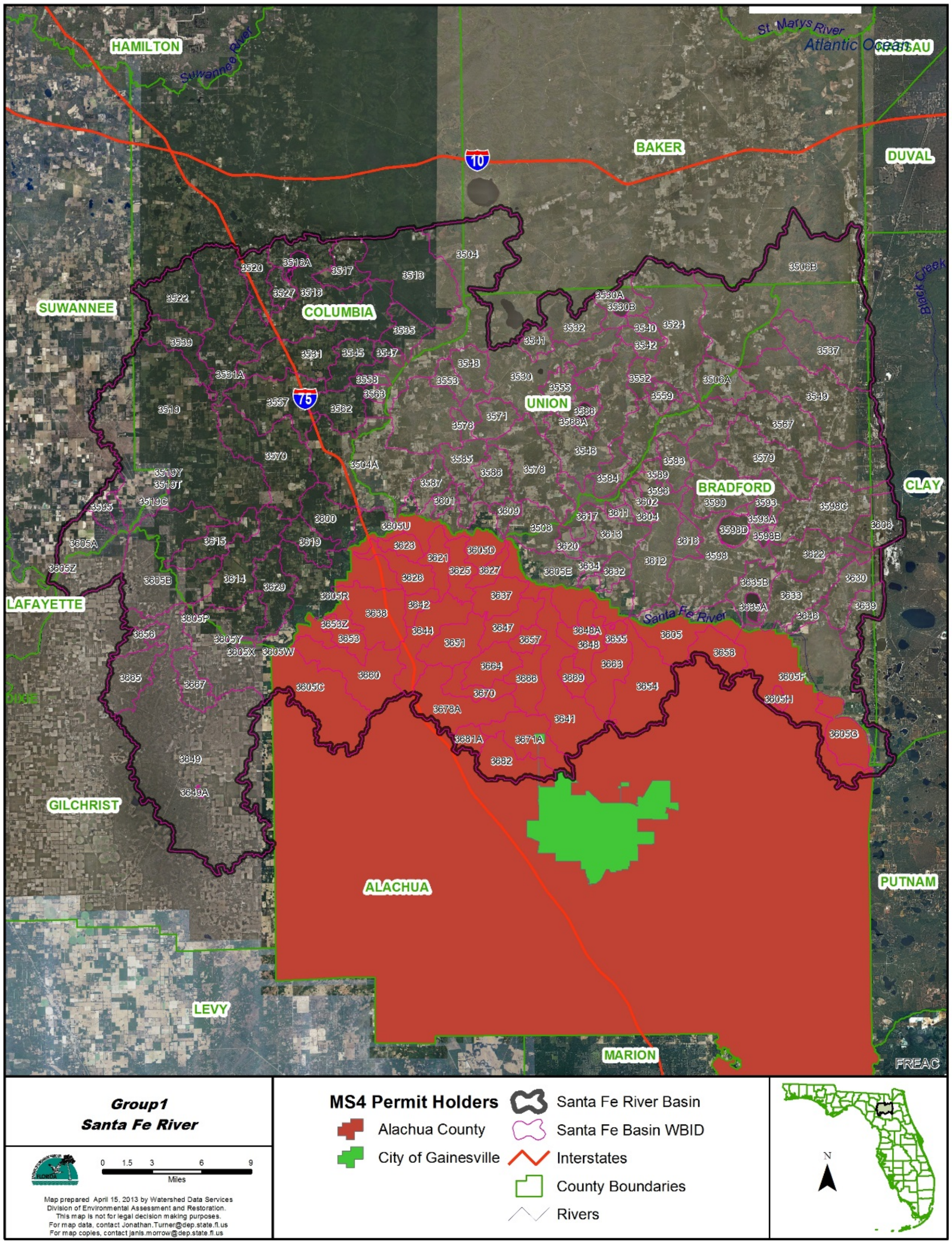

Figure 4.1. Locations of MS4 Permits in the Santa Fe River Basin

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. In watersheds with livestock agriculture, the livestock can be a source of fecal coliform bacteria; there is no livestock at scales to contribute to bacteria loads in this waterbody.

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 quantify accurately the fecal coliform loadings from different sources, land development information can provide some indications on the potential sources of observed fecal coliform impairment. However, the Alachua County Environmental Protection Department (ACEPD) conducted a microbial source tracking study in 2008 at two locations in Parener's Branch (WBID 3626). Human-specific markers were not detected at either location, while bovine-specific markers were found at the sampling location just downstream of a pasture where cows have free access to the creek [ACEPD, 2008].

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SRWMD's 2010-2011 and the SJRWMD 2009 land use coverages contained in the Department's geographic information system (GIS) library. Land use categories within the Santa Fe River Basin boundary were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low, medium and high density residential). These summary categories are presented in **Table 4.2**. **Figure 4.2** shows the mapped distribution of the principal land uses within the WBID boundary.

As shown in **Table 4.2**, the total area within the Santa Fe River basin is approximately 885,600 acres (~1,383 sq. mi.). The dominant land use categories are upland forest which accounts for approximately 408,909 acres, or about 46 percent of the total basin area, wetlands, which account for approximately 17 percent of the total basin area and agriculture which accounts for over 15 percent of the total basin area. Urban built-up and residential areas (low-, medium- and high-density residential) account for about 11 percent of the basin. Rangeland areas account for about seven percent of the total basin area. **Appendix D** lists land use information about each individual WBID.

Table 4.2. Classification of Land Use Categories within the Santa Fe River Basin Boundary

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

Level 1 Code	Santa Fe Basin Land Use	Acres	% Acreage
1000	Urban and Built up	15,866	1.79 %
-	Low Density Residential	78,587	8.87 %
-	Medium Density Residential	3,255	0.37 %
-	High Density Residential	659	0.07 %
2000	Agricultural	138,294	15.62 %
3000	Rangeland	60,839	6.87 %
4000	Upland Forest	408,909	46.17 %
5000	Water	14,065	1.59 %
6000	Wetlands	153,452	17.33 %
7000	Barren Land	1,226	0.14 %
8000	Transportation, Communication, and Utilities	10,453	1.18 %
	TOTAL	**885,605**	**100.0 %**

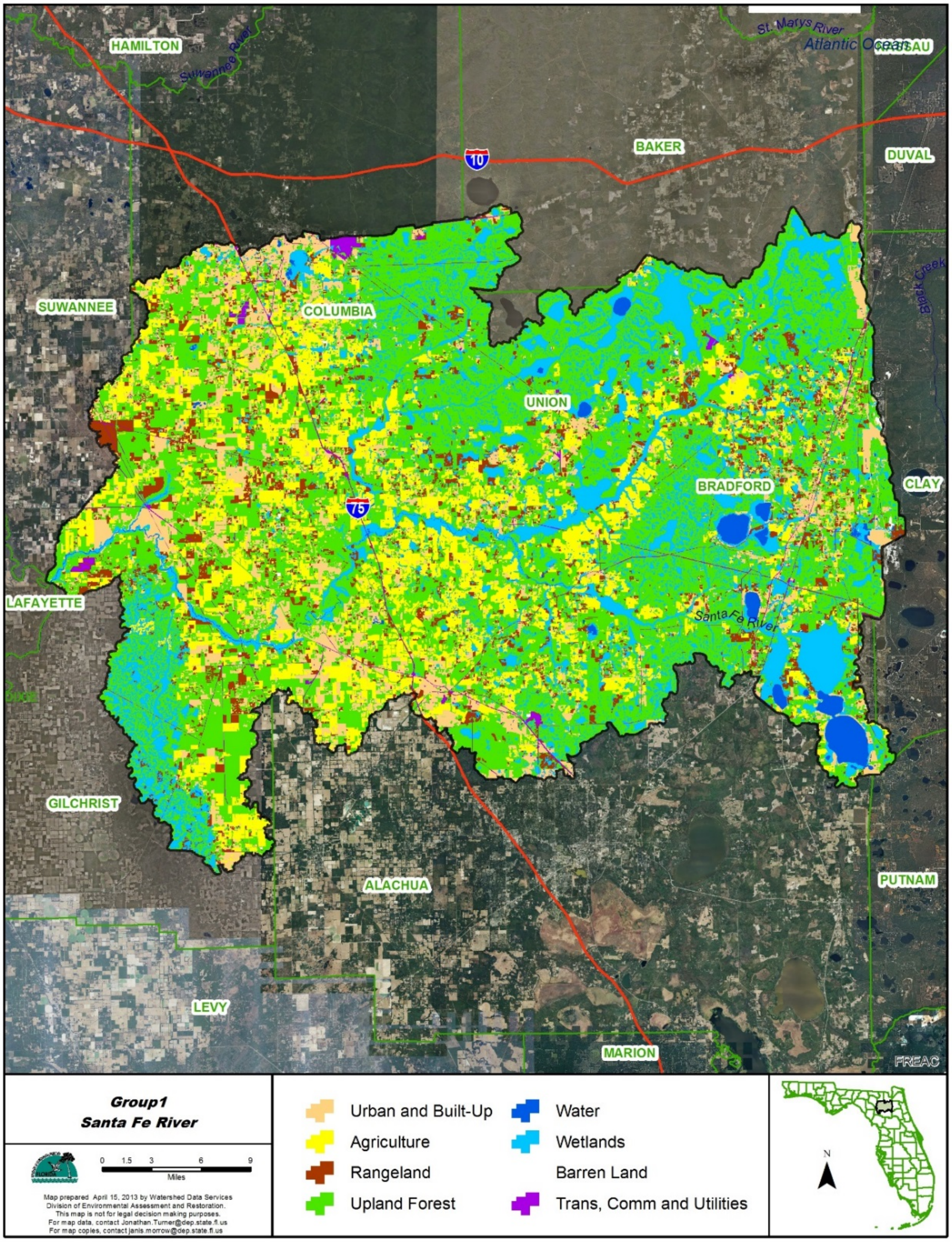

Figure 4.2. Principal Land Uses within the Santa Fe River Basin

Pets

Pets whose waste is deposited outdoors can be a significant source of coliform pollution through surface runoff in the Santa Fe River Basin. Studies report that up to 95 percent of the fecal coliform found in urban stormwater can have non-human origins (Alderiso et al., 1996; Trial et al., 1993). Appendix B provides calculations for potential loading from pets.

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).

As agriculture is one of the primary land uses in the WBID (Agriculture and rangeland make up 75% of the waterbody), a potentially important nonpoint source of source of bacteria loading within the watershed can be grazing livestock, primarily cattle. Appendix B also provides calculations for potential loading from livestock.

Wildlife and Sediments

In addition to livestock and wildlife populations, residual bacteria populations in sediments could contribute to fecal coliform exceedances in the watershed. Wildlife such as birds, raccoons, bobcats, rabbits, deer, and feral hogs have access to streams and may deposit their feces near or directly into the water. This wildlife deposition can be especially significant during low-flow conditions. Wildlife feces deposited on land surfaces can be transported during storm events to nearby streams. Studies have shown that fecal coliform bacteria can survive and reproduce in streambed sediments and then be re-suspended into surface water when conditions are right (Jamieson et al., 2005).

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

Urban Development

Although urban land use is not dominant within the Santa Fe River Basin boundary, contributions from residential areas may still be possible sources for fecal coliform loadings due to failed septic tanks, sewer line leakages and pet feces that are disposed of inappropriately. A preliminary quantification of the fecal coliform loadings from these sources for each of the 8 verified impaired WBIDs 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** was only used to demonstrate the possible relative contributions from different sources and were not used in the development of the TMDL.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The Santa Fe River Basin fecal coliform TMDL is a concentration-based TMDL. The concentration target for the TMDL is 400 counts/100 mL, which is consistent with the bacteriological criteria defined in the State's Surface Water Quality Standard (62-302.530(6), F. A. C.) for Class III waters. This concentration target is applicable to all the Class III waterbodies in the Santa Fe River Basin that are verified for fecal coliform impairment. To show the difference between the existing fecal coliform concentration and the target fecal coliform concentration in waters verified for the fecal coliform impairment, a needed percent reduction to achieve the target concentration is calculated for each impaired waterbody and is included in this TMDL report. (Described in **Section 5.1.3)**. It should be noted that the needed percent reduction only represents the relative difference between the existing and target fecal coliform concentrations. It should not be interpreted as the needed percent reduction of fecal coliform loads entering the impaired waters, it is provided in this report for informational purpose only.

The percent reduction needed to meet the applicable target is calculated based on the 90th percentile of all measured concentrations collected during the period of record (1966-2013). WBID-specific percent reductions needed to achieve the target concentration are provided in **Appendix D**.

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 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 Needed Percent Reduction to Achieve the Target Concentration

Data used for determining the needed percent reduction to achieve the target concentration in each impaired WBID, were collected by staff from the Department's Northeast District Office, the Department's Tallahassee office, the Biological Research Associates, the Suwannee River Water Management District, and the Alachua County Environmental Protection Department. **Appendix D** has figures for each verified impaired waterbody in the Santa Fe River Basin which show locations of the water quality stations where fecal coliform data were collected. **Appendix D** shows the descriptive statistics of the fecal coliform concentration data collected from each of these impaired waterbodies. **Appendix D** also shows the data being used to characterize the hydrology and the spatial and temporal distributions of fecal coliform in all impaired waters included in this TMDL.

Temporal Patterns

Fecal coliform data from the impaired waterbodies were analyzed for annual and seasonal trends. Episodic peak fecal coliform concentrations occurred throughout the period of observation.

Seasonally, a peak in fecal coliform concentrations and exceedance rates is expected during a year's third quarter (summer, July–September), when conditions are rainy and warm (Florida's rainy season). Conversely, lower concentrations and fewer exceedances are often observed in the first and fourth quarters (winter, January–March; and fall, October–December), when conditions are drier and cooler. Contrary to the expected seasonal pattern, the percent exceedances experienced in the verified impaired WBIDs were fairly even over all seasons with Q3 having the greatest percent exceedance. **Appendix D** shows the descriptive statistics of fecal coliform temporal distribution in impaired waterbodies on the monthly and quarterly bases, respectively.

Using rainfall data collected at the Lake City CLIMOD station in Columbia County (available: http://climod.meas.ncsu.edu/), it was possible to compare monthly rainfall with monthly fecal coliform exceedance rates, as well as average quarterly rainfall with average quarterly fecal coliform exceedance rates at all stations in impaired waters.

Peak fecal coliform concentrations commonly coincide with, or follow, periods of increased rainfall, especially rainfalls that individually or cumulatively provide volumes that move through surface soils and flush through stormwater ponds to surface waters. This trend was not observed in the Santa Fe River Basin. These fecal coliform concentrations don't seem to show a correlation to the cumulative 3-day precipitation (extreme and medium precipitation events). The exceedances occur during all types of rain events and fairly evenly over all seasons.

Spatial Patterns

Fecal coliform data for the period of record data from all stations in impaired waters were analyzed to detect spatial trends in the data. **Appendix D** lists information about the stations used for each individual impaired WBID, as well as displays all the data available for each WBID thru 2013. More information on the spatial patterns for each WBID can be found in **Appendix D**.

5.1.2 Critical Condition

The conditions that influence coliform loadings in a given watershed depend on many factors, including the presence of point sources and the land use pattern in the watershed. Typically, a critical condition for nonpoint sources is an extended dry period followed by a rainfall runoff event of size and duration that flushes feces waste materials, mixes contaminated sediments, and flushes through soils contaminated by leaking septic tanks. During wet weather periods, 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 occur under dry conditions without any major surface runoff event. This can happen 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 due to lessened dilution.

As not all necessary flow data were available, hydrologic conditions were analyzed using rainfall. A loading curve – a type of chart that would normally be applied to flow events - was created using precipitation data from the Lake City climate station as an analog for flow data. The chart was divided in the same manner as if flow were being analyzed, where precipitation ranges were derived based on percentiles, upper percentiles are large events and low percentiles correspond to little or no rain:

- extreme precipitation events represent the upper percentiles (0–5th percentile),

- large precipitation events (5^{th}–10^{th} percentile),
- medium precipitation events (10^{th}–40^{th} percentile),
- small precipitation events (40^{th}–60^{th} percentile), and,
- No recordable precipitation events (60^{th}–100^{th} percentile).

For the analysis, rain events were calculated as the three-day cumulative precipitation (the day of and 2 days prior to sampling). Detailed three-day accumulative rainfall under extreme, large, medium, small, and not recordable precipitation events and fecal coliform concentration exceedances under each of these rain events are listed in Table D6 and Figure D4 in Appendix D. The table and figure show that fecal coliform exceedances occurred over extreme, large, medium, small and not measurable precipitation events. Exceedances occurred over all hydrologic conditions.

As fecal coliform exceedances occurred in the majority of the precipitation intervals —large, medium, small, and not measurable—the 400 counts/100 mL target fecal coliform concentration is applicable under all rainfall conditions in the Santa Fe River Basin.

5.1.3 Determination of Percent Reduction

To show the difference between the existing fecal coliform concentration and the target fecal coliform concentration in waters verified for the fecal coliform impairment, a needed percent reduction to achieve the target concentration is calculated for each impaired waterbody and is included in this TMDL report. It should be noted that the needed percent reduction only represents the relative difference between the existing and target fecal coliform concentrations. It should not be interpreted as the needed percent reduction of fecal coliform loads entering the impaired waters, it is provided in this report for informational purpose only.

The percent reduction necessary to reduce pollutant load was calculated by comparing the existing concentrations and target concentration using **Formula 1**:

Formula 1:

$$\text{Needed \% Reduction} = \frac{\text{Existing } 90^{th} \text{ Percentile Concentration} - \text{Allowable Concentration}}{\text{Existing } 90^{th} \text{ Percentile Concentration}}$$

Using the Hazen method for estimating percentiles, as described in Hunter (2002), the existing condition concentration was defined as the 90^{th} percentile of all the fecal coliform data collected during period of record. The 90^{th} percentile is also called the 10 percent exceedance event, i.e., that threshold above which only 10% of exceedances occur. 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, and the Hazen Method (**Formula 2)** is used to determine the percentile value of each data point.

Formula 2:

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

If none of the ranked values calculates to be exactly 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 that bound (above and below) the 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.

P_{90th} is the percentile difference between the 90th percentile and the percentile number immediately lower than the 90th percentile

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

To calculate *R*, the percentile values below and above the 90th percentile are identified. Next, the fecal coliform concentrations corresponding to the lower and upper percentile values are identified. The fecal coliform concentration difference between the lower and higher percentiles is then calculated and divided by the unit percentile. The unit percentile difference is the difference between the lower and upper percentiles.

The percent reduction needed to achieve the concentration-based TMDL in each WBID was listed in the summary for each WBID in **Appendix E.**

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

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

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

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

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

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

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

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 the Santa Fe River Basin is expressed in as the concentration-based target, and will be applied to the nine WBIDs listed in this report that have been verified as impaired for fecal coliform (**Table 6.1**).

The basin-wide fecal coliform TMDL for the Santa Fe River Basin is a concentration based TMDL with the target fecal coliform concentration being 400 counts/100 mL, following the State bacteriological criteria. Because there were no local data available at the time when this TMDL was developed that allowed the Department to explicitly quantify the fecal coliform “loads” from all the sources within the watershed of each impaired waterbody segment and link the “loads” with the in-stream fecal coliform concentration, the WLA for stormwater discharge under the NPDES MS4 permits and the load allocation (LA) were implicitly considered as the appropriate restoration activities to bring the fecal coliform concentration in the impaired water below the 400 counts/100 mL target level. Because the restoration activities needed to restore different waterbodies impaired for fecal coliform are essentially the same, The Department created an implementation guidance document for fecal coliform TMDLs (http://www.dep.state.fl.us/water/watersheds/docs/fcg_toolkit.pdf) that outlines the typical activities for different types of sources (e.g., sewer infrastructure, onsite sewage treatment and disposal systems and stormwater).

Table 6.1. TMDL Components for Fecal Coliform in the Santa Fe River Basin

This is a seven-column table. Column 1 lists the waterbody, Column 2 lists the parameter, Column 3 lists the TMDL (counts/100mL), Column 4 lists the WLA for wastewater (counts/100mL), Column 5 lists the WLA for NPDES stormwater (counts/100mL), Column 6 lists the LA (counts/100mL), and Column 7 lists the MOS.

N/A = Not applicable

HUC Basin	Parameter	TMDL (counts/100mL)	WLA for Wastewater (counts/100mL)	WLA for NPDES Stormwater (counts/100mL)	LA (counts/100m)	MOS
Santa Fe River Basin	Fecal coliform	400	400 for areas covered with MS4 Permit	Must meet permit limits when applicable	400	Implicit

6.2 Load Allocation

Based on a concentration-based approach, the LA is 400 counts/100 mL 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

There are five NPDES permitted sites with surface discharges located within fecal coliform impaired WBIDs in the Santa Fe River Basin. **Table 4.1** lists all the NPDES-permitted wastewater facilities with permitted surface-water discharge.

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, i.e., to meet all permit requirements.

6.3.2 NPDES Stormwater Discharges

There is one municipal separate storm sewer system (MS4) permit in the Santa Fe River Basin. Alachua County (Permit # FLR04E005) has a Phase II MS4 permit that covers the southern portion of the Santa Fe River Basin and covers six of the verified impaired WBIDs. 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

As recommended by the Allocation Technical Advisory Committee (Department, 2001), a Margin of Safety (MOS) needs to be considered in the TMDL development to ensure that the TMDL target is protective of the designated use even under the influence of the uncertainty associated with the TMDL approach and the natural variation. The MOS could be explicit or implicit. The explicit MOS usually takes the form of setting a TMDL target at a certain percentage below the protective target. An implicit MOS can be achieved by making conservative assumptions or using conservative approaches when developing a TMDL. For Santa Fe River Basin fecal coliform TMDLs, the MOS is implicit. The implicit MOS was included because these TMDLs assume that the 400 counts/100 ml of fecal coliform are all from anthropogenic sources while, in reality, certain percentage of the 400 counts/100 ml can be from natural sources or regrowth of fecal coliform in the natural environment. This makes the allowable anthropogenic contribution lower than the 400 counts/100 ml, 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.

The Department has released a guidance document developed from the Department's experiences in collaborating with local stakeholders during BMAP efforts around the state (http://www.dep.state.fl.us/water/watersheds/docs/fcg_toolkit.pdf). The document provides local stakeholders useful information for identifying sources of fecal coliform bacteria in their watersheds and examples of management actions to address these sources. Tools such as the guidance document will assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

References

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

Alachua County Environmental Protection Department (ACEPD). 2008. Parener's Branch Microbial Source Tracking and Ambient Fecal Coliform Sampling Results.

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

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

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

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

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

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

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

Florida Department of Environmental Protection. February 2003. Suwannee River Basin Status Report. http://www.dep.state.fl.us/water/basin411/suwannee/status.htm

Florida Department of Health website. 2012. *Onsite sewage programs statistical data.* Available: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm.

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

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

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

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

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

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

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

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

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

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

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

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

U.S. Environmental Protection Agency. 2004. Level III and IV Ecoregions of EPA Region 4 Available: http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm

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

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

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

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

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

Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

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

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

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

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

Appendix B: Estimates of Fecal Coliform Loadings from Potential Sources for the Verified Impaired WBIDs

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).

Since agriculture is one of the primary land uses in the Basin (pasturelands make up 8% of the basin, with some impaired WBIDs as high as 27%), a potentially important nonpoint source of source of bacteria loading within the watershed can be grazing livestock, primarily cattle. Table B.1

Table B.1. Classification of Pastureland by Verified Impaired WBID within the Santa Fe River Basin

This is a ten-column table. Column 1 lists the WBID or basin, Column 2 lists the area of the WBID, Column 3 lists the acreage of the agricultural landuse (Level 1 Landuse = 2000) in the WBID, Column 4 is the percent of total agriculture to the total WBID area, Column 5 is the acreage of the landuse that is pastureland (Level 3 landuse = 2110, 2120, & 2130), and Column 6 is the percent of the pastureland to the total WBID area

- = Empty cell/no data

WBID	Total Area (Acres)	Total Agriculture Area (Acres)	Total Agriculture (% Total Landuse)	Pastureland (Acres)	Pastureland (% Total Landuse)
Basin-wide	885,605	138,294	15.6%	71,558	8.1%
3504A	18,907	7,772	41.1%	4,780	25.3%
3520	3,926	478	12.2%	408	10.4%
3598C	10,619	1,643	15.5%	874	8.2%
3626	3,650	1,499	41.1%	978	26.8%
3644	6,725	3,191	47.4%	1,801	26.8%
3654	10,182	1,246	12.2%	1,170	11.5%
3671A	6,205	648	10.4%	602	9.7%
3678A	8,329	2,387	28.7%	1,760	21.1%
3682	5,042	342	6.8%	287	5.7%

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 comparison 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 Santa Fe River Basin can be made using **Equation B.1**:

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

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, 1,442 housing units *(N)* within the impaired WBIDs of the Santa Fe River Basin 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.

Based on the information published by the Census Bureau, the average household size for Alachua County is about 2.35 people/household, Bradford County is about 2.65 people/household and Columbia County is about 2.64 people/household. The same population densities were assumed within the WBIDs based on their assigned County. A commonly cited value for per capita wastewater production rate is 70 gallons/day/person (EPA, 2001). The commonly cited concentration (*C*) for septic tank discharge is 1×10^6 counts/100mL for fecal coliform (EPA, 2001).

No measured septic tank failure rate data were available for the WBID when this TMDL was developed. Therefore, the failure rate was derived from the number of septic tanks in Alachua WBID 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 2011–12 inventory, the cumulative number of septic tanks in Alachua 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.1**. The average annual septic tank failure discovery rate for Alachua County is approximately 0.61 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 3.07 percent for Alachua County. Based on **Equation B.1**, the estimated fecal coliform loading from failed septic tanks within the Santa Fe River Basin is approximately 2.96×10^9 counts/day. **Appendix D** lists the breakdown of septic tanks for each impaired WBID.

Table B.2. Estimated Number of Septic Tanks in the Impaired WBIDs of the Santa Fe River Basin

This is a ten-column table. Column 1 lists the type of data, Columns 2 through 10 list the value.

	WBID 3504A	WBID 3520	WBID 3598C	WBID 3626	WBID 3644	WBID 3654	WBID 3671A	WBID 3678A	WBID 3682
# of households	1,856	3,400	7,386	327	515	578	4,293	5,280	3,732
People/household	2.64	2.64	2.65	2.35	2.35	2.35	2.35	2.35	2.35
Population in WBID	703	1,288	2,787	139	219	246	1,827	2,247	1,588
# of dogs	281	515	1,115	56	88	98	731	899	635
# of Septic tanks	165	232	471	29	60	90	65	187	143
# of Sewer	538	1,056	2,316	110	159	156	1,762	2,060	1,445

Sanitary Sewer Overflows

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

The number of properties connected to the sewer system was based on data obtained from the Florida Department of Health's (FDOH) ongoing inventory of wastewater treatment and disposal method for developed properties. Using information from the DOR's 2012 Cadastral tax parcel and ownership coverage, residential parcels were identified using DOR's land use codes. The final number of households within the WBID boundary was calculated by adding the number residential units on the parcels for all improved residential land use codes. As a result, it was estimated that 9,602 housing units within the Santa Fe River Basin are served by sewer systems.

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

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

Where:
L is the fecal coliform daily load (counts/day);
N is the number of households using sanitary sewer in the WBID;
Q is the discharge rate for each household (gallons/day);
C is the fecal coliform concentration for domestic wastewater (counts/100mL);

F is the sewer line leakage rate; and
37.85 is a conversion factor (100mL/gallon).

The total number of households *(N)* within the Santa Fe River Basin served by sewer systems is estimated to be 9,602. The discharge rate through sewers from each household (*Q*) was calculated by multiplying the average household size for the Alachua County (2.34 persons/ household) (US Census Bureau, 2000) by the per capita wastewater production rate per day (70 gallons/day/person). The commonly cited concentration (*C*) for domestic wastewater is $1x10^6$ counts/100 mL for fecal coliform (EPA, 2001). The contribution of fecal coliform through sewer line leakage was assumed to be 0.5 percent of the total sewage loading created from the population not on septic tanks (Culver et al., 2002). Based on **Equation B.1**, the total fecal coliform loading from sewer line leakage in the impaired WBIDs is approximately 3.14×10^{11} counts/day.

Table B.3. Estimated Number of Septic Tanks and Septic Tank Failure Rates for Alachua County (2005–11)

This is an eight-column table. Column 1 lists the type of statistic, and Columns 2 through 8 list the estimate for each year from 2005 to 2011, respectively.

[1] The failure rate is 5 times the failure discovery rate.

Descriptive Statistic	2005	2006	2007	2008	2009	2010	2011
New installations (septic tanks)	517	349	340	179	137	113	114
Accumulated installations (septic tanks)	39,453	39,970	40,319	40,659	40,838	40,862	40,975
Repair permits (septic tanks)	156	180	153	217	184	220	198
Failure discovery rate (%)	0.40%	0.45%	0.38%	0.53%	0.45%	0.54%	0.48%
Failure rate (%)[1]	1.98%	2.25%	1.90%	2.67%	2.25%	2.69%	2.42%

Wildlife

Wildlife is another possible source of fecal coliform bacteria within the Santa Fe River Basin boundary. As shown in **Figure 4.1**, wetland areas border the Santa Fe River and several of its contributing streams within the WBID boundary. Additionally, grassland and upland forested areas are close to the creek. These areas 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. Further the scale and composition of open space would not suggest significant loading from wildlife.

Pets

Pets whose waste is deposited outdoors can be a significant source of coliform pollution through surface runoff in the Santa Fe River Basin. Studies report that up to 95 percent of the fecal coliform found in urban stormwater can have nonhuman origins (Alderiso et al., 1996; Trial et al., 1993).

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

According to the American Pet Products Manufacturers Association (APPMA) about 4 out of 10 U.S. households include at least one dog. A single gram of dog feces contains about 23 million fecal coliform bacteria (van der Waal, 1995). Further implicating this potential source is that statistics show that about 40 percent of American dog owners do not pick up their dog's feces.

Using information from the Florida Department of Revenue's (DOR) 2009 Cadastral tax parcel and ownership coverage contained in the Department's geographic information system (GIS) library, residential parcels were identified using DOR's land use codes. The number of households within the Santa Fe River Basin boundary was estimated to be approximately 11,044. Assuming that 40 percent of the households in this area have one dog, there are about 4,418 dogs within the verified impaired WBIDs.

Assuming that 40 percent of dog owners do not pick up their dogs' feces, the total waste produced by dogs and left on the land surface in residential areas in the verified impaired WBIDs is approximately 795 kilograms/day. The total load produced by dogs is about 1.75 x 10^{12} counts/day of fecal coliform.

Table B.4. Estimated Number of Fecal coliform resulting from Dog Feces

This is a seven-column table. Column 1 lists impaired WBID, Columns 2 lists the fecal coliform load by dogs, Column 3 lists the number of dogs in the WBID, Column 4 listed the average amount of waste produced per dog, Column 5 lists the percent of waste not picked up, Column 6 lists the mass of waste not picked up, and Column 7 lists the fecal coliform density in dog waste.

WBID	FC Load by dogs (counts/day)	# dogs WBID	waste produced by dog (grams/day)	% not pick up	waste not picked up (grams/day)	FC density (counts/gram)
3504A	**1.11E+11**	281	450	0.4	50,616	2,200,000
3520	**2.04E+11**	515	450	0.4	92,736	2,200,000
3598C	**4.41E+11**	1,115	450	0.4	200,664	2,200,000
3626	**2.20E+10**	56	450	0.4	10,008	2,200,000
3644	**3.47E+10**	88	450	0.4	15,768	2,200,000
3654	**3.90E+10**	98	450	0.4	17,712	2,200,000
3671A	**2.89E+11**	731	450	0.4	131,544	2,200,000
3678A	**3.56E+11**	899	450	0.4	161,784	2,200,000
3682	**2.52E+11**	635	450	0.4	114,336	2,200,000

It should be noted that this load only represents the fecal coliform load created in the WBID and is not intended to be used to represent a part of the existing load that reaches the receiving waterbody. The fecal coliform load that eventually reaches the receiving waterbody could be significantly less than this value due to attenuation in overland transport. **Table B.1** shows the waste production rate for a dog (450 grams/animal/day) and the fecal coliform counts per gram of dog waste (2,200,000 counts/gram).

Appendix C: Information on Verified Impairment for Individual WBIDs in the Santa Fe River Basin

The Department used the IWR to assess water quality impairments in the Santa Fe River Basin and verified that nine waterbody segments are impaired for fecal coliform bacteria. These verified impairments were based on data available in the Verified Period of each assessment cycle. **Appendices D and E** lists the waterbodies impaired for fecal coliform in the Santa Fe River Basin. **Table C.2 in Appendix C** summarizes the Verified period data for Cycle 2 (Jan. 1, 1999 – June 30, 2006) and Cycle 3 (Jan 1, 2005 – June 30, 2012) for the Santa Fe River Basin used to verify the fecal coliform impairments. WBIDs 3506A and 3649 were incorrectly included on the Cycle 2 verified impairment list, however. Some data collected and used for the impairment of WBID 3649 in Cycle 2 were revised to be *E. coli* after the assessment (collected from 21FLBRA 3649-C and 21FLBRA 3649-D between April thru June 2007). WBID 3506A was verified due to a station being improperly assigned to it (21FLSUE NEW007C1 moved to WBID 3506B). These WBIDs were delisted by Secretarial Order on Jan 26, 2014 due to "analysis flaw." [See **Section 3.2** for details].

The Department shall limit the analysis to data collected during the five years preceding the planning list assessment and the additional data collected pursuant to this paragraph. (FAC 62-303.420) **Table C.1** summarizes the Verified period data for Cycle 2 and Cycle 3 for the Santa Fe River Basin used to verify the fecal coliform impairments.

Table C.1. Summary of Fecal Coliform Monitoring Data for the Santa Fe Basin during the Cycle 2 Listing, Verified Period (January 1, 1999 to June 30, 2006) and Cycle 3 Listing Verified Period (January 1, 2005 to June 30, 2012)

This is a six-column table. Column 1 lists the WBID number, Column 2 lists the Cycle in which the WBID was verified impaired, Column 3 lists the total number of samples used to verify the impairment, Column 4 lists the number of exceedances needed to verify the impairment, Column 5 lists the number of exceedances (>400 counts/100 mL) in each WBID, and Column 6 lists the number of samples that did not exceed 400 counts/100mL

* Exceedances represent values above 400 counts/100mL

WBID	Cycle Impaired	Total number of samples	IWR-required number of exceedances for Impairment Verification	Number of observed exceedances*	Number of observed nonexceedances
3504A	Cycle 2	24	5	5	19
3520	Cycle 2	16	5	9	7
3598C	Cycle 2	21	5	5	16
3626	Cycle 2	38	7	38	0
3644	Cycle 2	41	8	21	20
3654	Cycle 3	17	5	8	9
3671A	Cycle 3	30	6	9	21
3678A	Cycle 3	28	6	11	17
3682	Cycle 2	68	11	25	43

Note: Numbers are based upon applying the Water Quality Class III freshwater criteria of 400 counts / 100 mL and only using data available at the time of the Cycle 2 Verification or Cycle 3 Verification phase.

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