FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

SOUTHWEST DISTRICT • SPRINGS COAST BASIN –
ANCLOTE RIVER/COASTAL PINELLAS COUNTY PLANNING UNIT

FINAL TMDL Report

Fecal Coliform TMDLs for 34th Street Basin (WBID 1716A), Clam Bayou Drain (WBID 1716B), Clam Bayou (East Drainage) (WBID 1716C), and Clam Bayou Drain (Tidal) (WBID 1716D)

Moira Rojas

September 2012

Acknowledgments

This Total Maximum Daily Load (TMDL) analysis could not have been accomplished without contributions from the Florida Department of Environmental Protection's (Department) Watershed Assessment Section and Watershed Evaluation and TMDL Section. Map production assistance was provided by the Watershed Data Services Section with the Department's Division of Environmental Assessment and Restoration.

Editorial assistance was provided by Jan Mandrup-Poulsen and Linda Lord.

For additional information on the watershed management approach and impaired waters in the Springs Coast Basin, contact:

Terry Hansen
Florida Department of Environmental Protection
Bureau of Watershed Restoration
Watershed Planning and Coordination Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
Email: Terry.Hansen@dep.state.fl.us
Phone: (850) 245-8561
Fax: (850) 245–8434

Access to all data used in the development of this report can be obtained by contacting:

Moira Rojas
Florida Department of Environmental Protection
Bureau of Watershed Restoration
Watershed Evaluation and TMDL Section
2600 Blair Stone Road, Mail Station 3555
Tallahassee, FL 32399-2400
Email: moira.rojas@dep.state.fl.us
Phone: (850) 245–8460
Fax: (850) 245–8444

Contents

List of Tables

List of Figures

Websites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

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

Identification of Impaired Surface Waters Rule

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

Florida STORET Program

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

2012 Integrated 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

Water Quality Status Report: Springs Coast

http://waterwebprod.dep.state.fl.us/basin411/springscoast/status/SpringCst.pdf

Water Quality Assessment Report: Springs Coast

http://waterwebprod.dep.state.fl.us/basin411/springscoast/assessment/G5AS-Springs_Coast-LORES_Merged.pdf

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 Loads (TMDLs) for fecal coliform bacteria for the 34th Street Basin, Clam Bayou Drain, Clam Bayou (East Drainage), and Clam Bayou Drain (Tidal), located in the Springs Coast Basin. These systems were verified as impaired for fecal coliform by the Florida Department of Environmental Protection (Department) based on Cycle 2 assessment period data (January 1, 2004, through June 30, 2011), and therefore were included on the Verified List of impaired waters for the Springs Coast Basin that were adopted by Secretarial Order on February 7, 2012. These TMDLs establish the allowable fecal coliform loading to these water segments that would restore the waterbodies so that they meet the applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

For assessment purposes, the Department has divided the Springs Coast Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. **Table 1.1** lists the WBID numbers for the waterbodies addressed in this report.

Table 1.1. WBID Numbers and Waterbodies Included in This TMDL Report

This is a two-column table. Column 1 lists the WBID number, and Column 2 lists the corresponding waterbody segment name.

WBID	Waterbody Segment
1716A	34th Street Basin
1716B	Clam Bayou Drain
1716C	Clam Bayou (East Drainage)
1716D	Clam Bayou Drain (Tidal)

These waterbodies comprise 4 of the 93 waterbody segments in the Springs Coast Basin, Anclote River/Coastal Pinellas County Planning Unit. The parent WBID (WBID 1716, now retired) was 1 of 22 waterbody segments in the Springs Coast Basin included on the initial 1998 303(d) list submitted by the Department to the U.S. Environmental Protection Agency (EPA). The 1998 303(d) list was incorporated into a 1999 Consent Decree between the EPA and EarthJustice.

The initial list used data from stations listed in the Department's 1996 305(b) report. The report used the best available information at the time to generally characterize the quality of Florida's waters. Some of the delineations of waterbody areas and locations of sampling stations for the 1998 303(d) list were inaccurate due to technical limitations at that time. With the primary goal of providing more accurate assessments, the Department has revised these delineations over time.

The EPA has labeled the redrawing of WBID boundaries "resegmentation," as the original stations corresponded to specific WBID areas or segments. Resegmented WBIDs are those WBIDs that have been altered from the initial 1998 303(d) Consent Decree or previous cycle boundaries. As a result of the resegmentation process for the Group 5 basins, there are currently 40 Consent Decree waterbody segments in the Springs Coast Basin, including WBIDs 1716A, 1716B, 1716C, and 1716D, formed from the retired WBID 1716. This number is based on Impaired Surface Waters Rule (IWR) database Run 44x.

The four WBIDs addressed in this report are located within the southern portion of Pinellas County and drain west into the Gulf of Mexico (**Figures 1.1** and **1.2**). They are part of the Clam Bayou estuary, a 170-acre estuary in Pinellas County, surrounded by the cities of Gulfport to the west, St. Petersburg to the north and east, and Boca Ciega Bay to the south. Many of the natural areas within these urban centers have been lost due to development, and large coastal areas have been transformed into urban canals because of extensive dredge-and-fill practices (Southwest Florida Water Management District [SWFWMD] 2002). As a result, these WBIDs are located in highly developed urban areas with generally high pollution loading components (SWFWMD 2002). Additional information about the hydrology of this area is available in the U.S. Geological Survey (USGS) publication *General Hydrology of the Middle Gulf Area, Florida* (Cherry *et al.* 1970). **Table 1.2** lists the area, in square miles and acres, within each WBID boundary.

Table 1.2. Area within Each WBID Boundary in Square Miles and Acres

This is a four-column table. Column 1 lists the WBID number, Column 2 lists the waterbody name, Column 3 lists the WBID area in square miles, and Column 4 lists the WBID area in acres.

WBID	Waterbody	WBID Area (square miles)	WBID Area (acres)
1716A	34th Street Basin	2.1	1,326
1716B	Clam Bayou Drain	1.0	621
1716C	Clam Bayou (East Drainage)	2.3	1,477
1716D	Clam Bayou Drain (Tidal)	0.3	205

WBID 1716A (34th Street Basin) is situated completely within Pinellas County's 34th Street watershed (Drainage Basin #45) and lies entirely within the city of St. Petersburg. The main channel and its tributaries, which flow south into Clam Bayou, are approximately 3.1 miles in length. This outfall system is enclosed in box culverts for the majority of its reach. The area within the WBID is almost completely developed (Pinellas County Planning Department [PCPD] 2008).

WBIDs 1716B (Clam Bayou Drain) and 1716D (Clam Bayou Drain Tidal) are located within the cities of St. Petersburg and Gulfport. These segments comprise the freshwater (WBID 1716B) and marine water (WBID 1716D) portions of the Clam Bayou Drain system. The 2 WBIDs are located within the county's Clam Bayou watershed (Drainage Basin #46) and Gulfport watershed (Drainage Basin #47); however, the impaired segments are located completely within Basin #46. The primary drainage is approximately 1.6 miles in length and flows from north to south into Clam Bayou, with its outlet located in the easternmost portion of the city of Gulfport. The area within these WBIDs is almost completely developed (PCPD 2008).

Figure 1.1. Location of WBIDs 1716A, 1716B, 1716C, and 1716D in the Springs Coast Basin and Major Hydrologic and Geopolitical Features in the Area

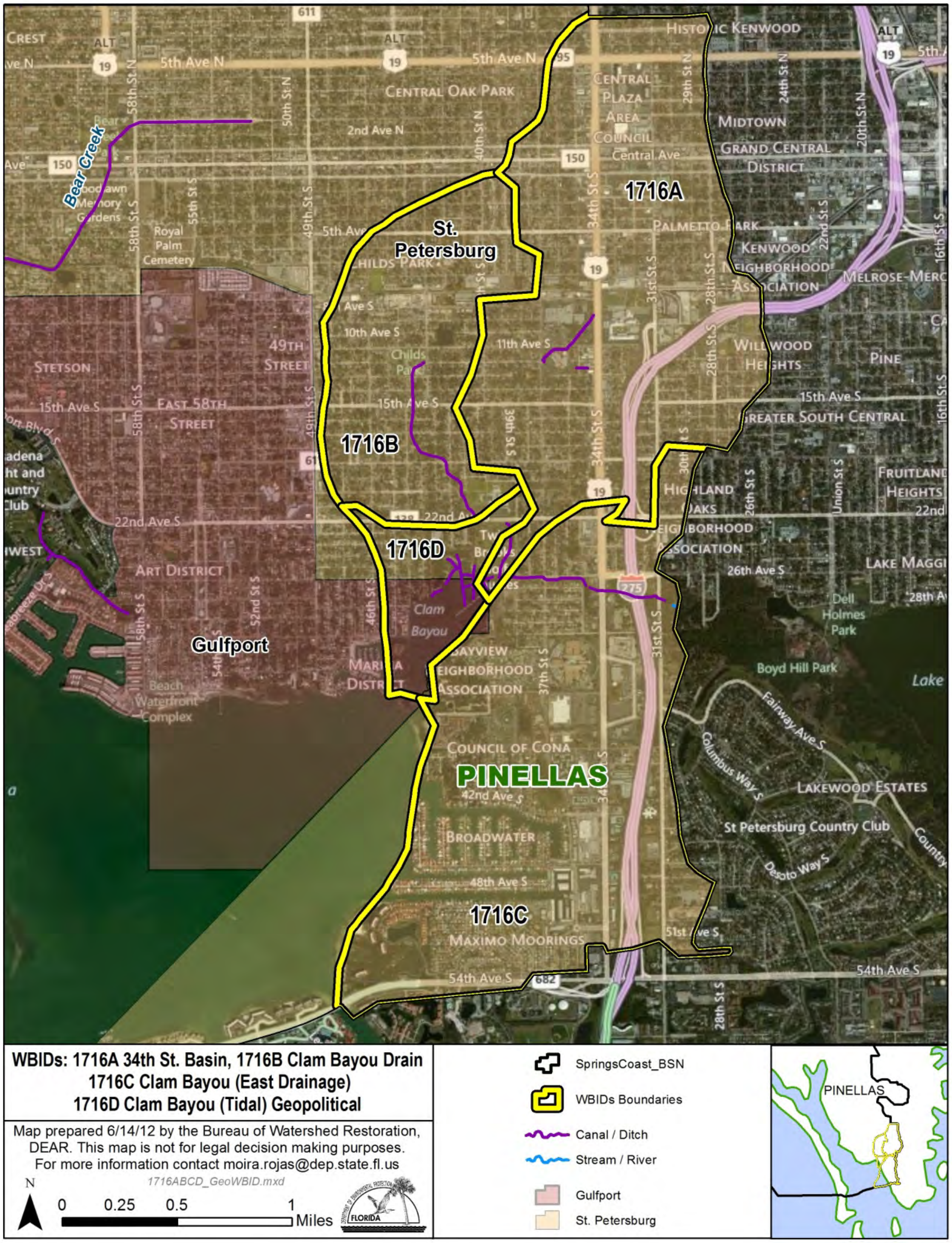

Figure 1.2. Location of WBIDs 1716A, 1716B, 1716C, and 1716D in Pinellas County

WBID 1716C (Clam Bayou East Drainage) is located within the city of St. Petersburg and the county's Frenchman's Creek watershed (Drainage Basin #48). The main channel and minor tributaries total approximately 1 mile in length and flow west into Boca Ciega Bay on the west basin shore. The area within this WBID is almost completely developed (PCPD 2008).

WBIDs 1716A, 1716B, 1716C, and 1716D are located in the west-central coastal region of peninsular Florida, in the area identified as the Gulf Coastal Lowlands physiographic region, where soils are poorly drained and the water table is near the land surface. Soils in this region vary, ranging from excessively drained sands to moderate or poorly drained soils with a sandy subsoil (U.S. Department of Agriculture [USDA] 2006). As a result of extensive changes in the land surface for development, large portions of this area have soil types characterized as urban land (SWFWMD 2002).

Two main aquifers are found in Pinellas County: the surficial aquifer and the Floridan aquifer. The surficial aquifer system consists of undifferentiated sands, shell material, silts, and clayey sands of varying thickness (Causseaux 1985). The principal uses for the surficial aquifer in Pinellas County are irrigation, limited domestic use, and dewatering projects for mining and infrastructure installation (SWFWMD 2006). The Floridan aquifer system consists primarily of highly permeably carbonate rocks and is separated into two principal zones consisting of the fresh potable water of the upper Floridan aquifer and the highly mineralized water of the lower Floridan aquifer (Causseaux 1985). In Pinellas County, the upper Floridan aquifer is the principal source of water and is used for industrial, mining, public supply, domestic use, and irrigation purposes, as well as brackish water desalination in coastal communities (SWFWMD 2006).

An important feature of the area is karst topography. Watersheds located in karst regions are extremely vulnerable to contamination. Many of these karst features infiltrate the water table, forming a direct connection between the land surface and the underlying aquifer systems, allowing interactions between surface and ground water (SWFWMD 2002) and increasing the threat of ground water contamination from surface water pollutants (Trommer 1987). Potential sources of contamination include saltwater encroachment and the infiltration of contaminants carried in surface water, the direct infiltration of contaminants (such as chemicals or pesticides applied to or spilled on the land, or fertilizer carried in surface runoff), landfills, septic tanks, sewage plant treatment ponds, and wells used to dispose of stormwater runoff or industrial waste (Miller 1990).

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, Section 403.067, 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 will be followed by the development and implementation of a restoration plan designed to reduce the amount of fecal coliform that caused the verified impairment of the four watersheds in the Clam Bayou system. These activities will depend heavily on the active participation of the SWFWMD, local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

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

Florida identified 22 impaired waterbodies in the Springs Coast Basin on its initial 1998 303(d) list. As a result of the resegmentation process for the Group 5 basins, there are currently 40 Consent Decree waterbody segments in the Springs Coast Basin (see **Section 1.2**). However, the FWRA (Section 403.067, F.S.) stated that all Florida 303(d) lists created before the adoption of the FWRA were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in WBIDs 1716A, 1716B, 1716C, and 1716D, and has verified that these waterbody segments are impaired for fecal coliform bacteria. The verified impairment was based on the observation that, with a 90% confidence limit based on binomial distribution, more than 10% of values exceeded the assessment threshold of 400 counts per 100 milliliters (counts/100mL) in these WBIDs (see **Section 3.2** for details).

WBIDs 1716A, 1716B, 1716C, and 1716D were verified as impaired during the Cycle 2 verified period (January 1, 2004, through June 30, 2011). **Table 2.1** summarizes the fecal coliform monitoring results used to verify impairment for the Cycle 2 assessment (based on IWR Run44x) for all four WBIDs.

Table 2.1. Summary of Fecal Coliform Monitoring Data for WBIDs 1716A, 1716B, 1716C, and 1716D During the Cycle 2 Verified Period (January 1, 2004, through June 30, 2011)

This is a five-column table. Column 1 lists the parameter, and Columns 2 through 5 list the WBID number and corresponding Cycle 2 results for each WBID.

Parameter	WBID 1716A	WBID 1716B	WBID 1716C	WBID 1716D
Total number of samples	20	38	17	21
IWR-required number of exceedances for the Verified List	5	7	5	5
Number of observed exceedances	19	15	8	5
Number of observed nonexceedances	1	23	9	16
Number of seasons during which samples were collected	4	4	4	4
Highest observation (counts/100mL)	20,000	6,000	13,000	14,000
Lowest observation (counts/100mL)	380	27	40	2
Median observation (counts/100mL)	1,750	252	350	62
Mean observation (counts/100mL)	5,205	999	1,781	1,254

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 WBIDs addressed in this report are Class III waterbodies, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. WBIDs 1716A and 1716B are Class III freshwater waterbodies, and WBIDs 1716C and 1716D are Class III marine waterbodies. The criterion applicable to these TMDLs is the Class III (freshwater and marine) 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 (freshwater and marine) waters, as established by Rule 62-302, F.A.C., states the following:

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

The criterion states that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. There were insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for fecal coliform bacteria. Therefore, the criterion selected for these TMDLs 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 source categories, source subcategories, or individual sources of pollutants in the impaired waterbody and the amount of pollutant loadings contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

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

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

4.2 Potential Sources of Fecal Coliform within the Boundaries of WBIDs 1716A, 1716B, 1716C, and 1716D

4.2.1 Point Sources

Wastewater Point Sources

Florida Rock Industries Inc. – St Petersburg Plant (Permit FLG110174), located in WBID 1716A, is the only NPDES-permitted wastewater facility situated within the WBIDs addressed in this report. However, the facility is a concrete batch plant and is therefore unlikely to be a source of fecal coliform bacteria.

Municipal Separate Storm Sewer System Permittees

Two NPDES municipal separate storm sewer system (MS4) permits (FLS000005 and FLS000007) cover WBIDs 1716A, 1716B, 1716C, and 1716D. **Table 4.1** lists the NPDES MS4 permits, permit holders, and co-permittees.

Table 4.1. MS4 Permits Covering WBIDs 1716A, 1716B, 1716C, and 1716D

This is a four-column table. Column 1 lists the WBID number, Column 2 lists the permit number, Column 3 lists the permit holder, and Column 4 lists the co-permittee.

WBID	Permit ID	Permit Holder	Co-Permittee
1716A	FLS000005	Pinellas County	City of Gulfport
1716A	FLS000005	Pinellas County	Pinellas County
1716A	FLS000005	Pinellas County	Florida Department of Transportation (FDOT) District 7
1716A	FLS000007	City of St. Petersburg	City of St. Petersburg
1716B	FLS000005	Pinellas County	Pinellas County
1716B	FLS000005	Pinellas County	FDOT District 7
1716B	FLS000007	City of St. Petersburg	City of St. Petersburg
1716C	FLS000005	Pinellas County	City of Gulfport
1716C	FLS000005	Pinellas County	Pinellas County
1716C	FLS000005	Pinellas County	FDOT District 7
1716C	FLS000007	City of St. Petersburg	City of St. Petersburg
1716D	FLS000005	Pinellas County	City of Gulfport
1716D	FLS000005	Pinellas County	Pinellas County
1716D	FLS000005	Pinellas County	FDOT District 7
1716D	FLS000007	City of St. Petersburg	City of St. Petersburg

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 each source. 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 addition to the sources associated with anthropogenic activities, birds and other wildlife can also act as fecal coliform contributors to receiving waters.

While detailed source information is not always available for accurately quantifying the fecal coliform loadings from different sources, land use information can provide some hints on the potential sources of observed fecal coliform impairment.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SWFWMD's 2009 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the boundaries of WBIDs 1716A, 1716B, 1716C, and 1716D were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low-, medium-, and high-density residential) and tabulated in **Table 4.2**. **Table 4.2** also shows the total area within each WBID. **Figure 4.1** shows the spatial distribution of the principal land uses within the WBID boundaries**.**

Within all WBID boundaries, the dominant land use categories are residential (low-, medium-, or high-density) and urban built-up (commercial and services, industrial, institutional, and recreational). These land uses account for approximately 59% to 98% of the total acreage for each WBID. Low-impact land uses, including rangeland, upland forest, water, wetlands, and barren lands, make up anywhere from about 1% to 41% of the total area in each WBID.

Urban Development

Because the dominant land use categories contributing to nonpoint source pollution are urban land areas, possible sources for fecal coliform loadings can include failed septic tanks, sewer line leakage, and pet feces that are disposed of inappropriately. A preliminary quantification of the fecal coliform loadings from these sources was conducted to demonstrate the relative contributions. **Appendix B** provides detailed load estimates and describes the methods used for the quantification. It should be noted that the information included in **Appendix B** was only used to demonstrate the possible relative contributions from different sources.

Based on information obtained from the Florida Department of Health (FDOH) onsite sewage data (FDOH 2011), all housing units within the WBID boundaries are served by sewer systems.

Table 4.2. Classification of Land Use Categories for WBIDs 1716A, 1716B, 1716C, and 1716D in 2009

This is a 10-column table. Column 1 lists the Level 1 land use code, Column 2 lists the land use description, and Columns 3 through 10 list the acreage and percent acreage, respectively, of each land use in each WBID.

\- = Empty cell/no data

Level 1 Code	Land Use	WBID 1716A Acreage	WBID 1716A % Acreage	WBID 1716B Acreage	WBID 1716B % Acreage	WBID 1716C Acreage	WBID 1716C % Acreage	WBID 1716D Acreage	WBID 1716D % Acreage
1000	Urban and built-up	534	40.3%	127	20.4%	412	27.9%	41	20.1%
-	Low-density residential	0	0%	0	0%	42	2.9%	0	0%
-	Medium-density residential	0	0%	0	0%	16	1.1%	0	0%
-	High-density residential	688	51.9%	486	78.2%	671	45.4%	80	38.9%
2000	Agriculture	0	0%	0	0%	0	0%	0	0%
3000	Rangeland	0	0%	0	0%	0	0%	0	0%
4000	Upland forest	0	0%	0	0%	39	2.6%	0	0.2%
5000	Water	1	0.1%	9	1.4%	105	7.1%	39	19.0%
6000	Wetland	6	0.4%	0	0%	32	2.2%	45	21.8%
7000	Barren land	0	0%	0	0%	0	0%	0	0%
8000	Transportation, communication, and utilities	97	7.3%	0	0%	160	10.8%	0	0%
-	**TOTAL**	**1,326**	**100%**	**621**	**100%**	**1,477**	**100%**	**205**	**100%**

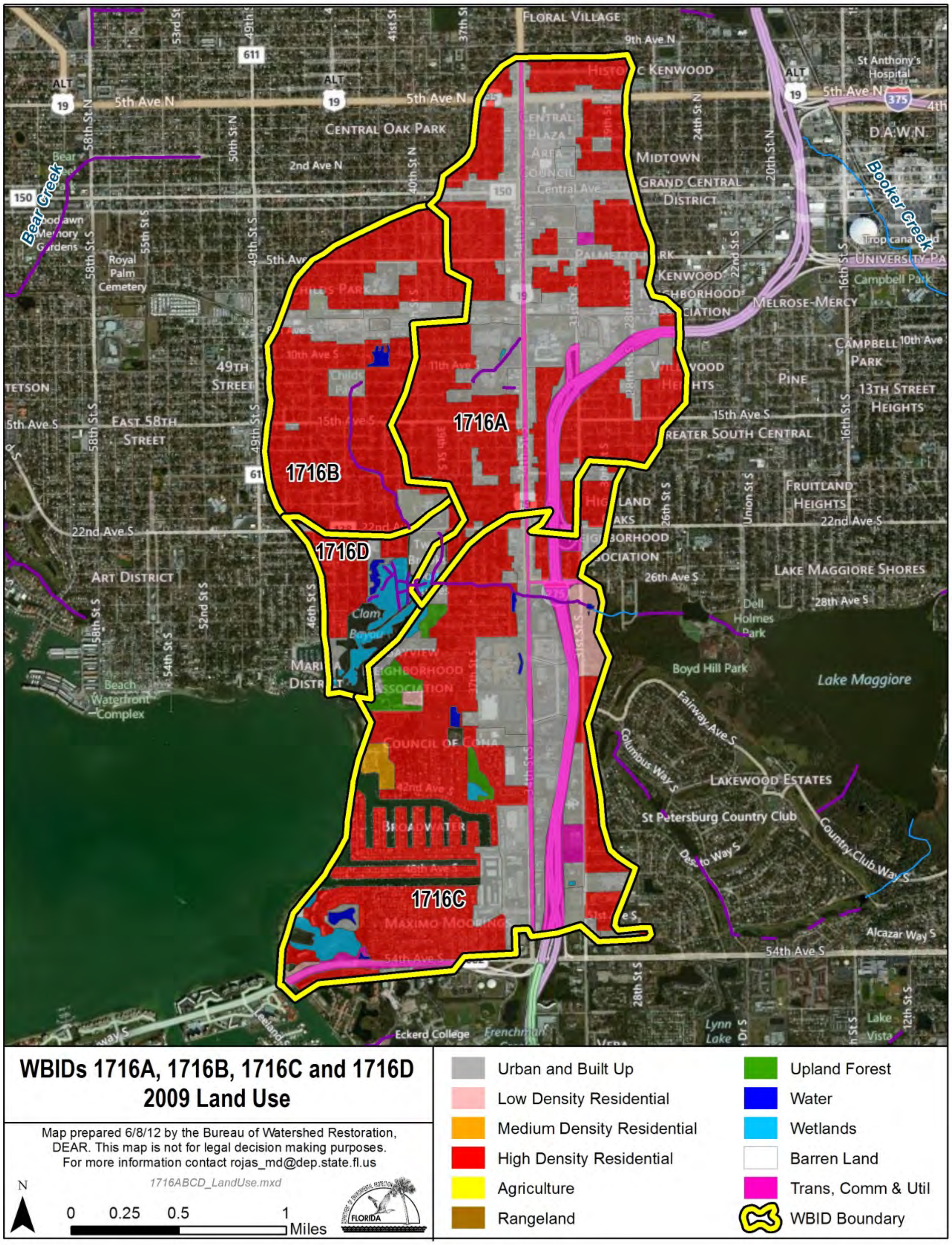

Figure 4.1. Principal Land Uses within the Boundaries of WBIDs 1716A, 1716B, 1716C, and 1716D in 2009

Wildlife and Sediments

Wildlife and sediments could also contribute to fecal coliform exceedances in the watersheds. Wildlife such as birds and raccoons have direct access to these waterbodies and can deposit their feces directly into the water. They also deposit coliform bacteria with their feces onto land surfaces, where they can be transported during storm events to nearby streams. Studies have shown that fecal coliform bacteria can survive and reproduce in streambed sediments and can be resuspended in surface water when conditions are right (Jamieson *et al.* 2005; Desmarais *et al.* 2002).

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

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The fecal coliform TMDLs for WBIDs 1716A, 1716B, 1716C, and 1716D were developed using the “percent reduction” approach. Using this method, the percent reduction needed to meet the applicable criterion is calculated based on the 90th percentile of all measured concentrations collected during the Cycle 2 verified period (January 1, 2004, through June 30, 2011).

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 5.1.2**.

5.1.1 Data Used in the Determination of the TMDLs

Data used to develop the TMDLs were primarily collected by the Department, the Department’s Southwest District, and the Pinellas County Department of Environment and Infrastructure (DEMI). All data used in the development of these TMDLs and corresponding analyses were collected during the Cycle 2 verified period (January 1, 2004, through June 30, 2011). **Table 5.1** lists the stations in each WBID where fecal coliform data were collected during this period. **Figure 5.1** shows the locations of the water quality stations where the data were collected. **Table 5.2** summarizes the descriptive statistics for WBIDs 1716A, 1716B, 1716C, and 1716D for the Cycle 2 verified period fecal coliform results based on IWR Run44x.

Plots of fecal coliform data against time determined that no significant increasing or decreasing trends (Prob>0.05) were observed in any of the WBIDs addressed in this report during the period of observation (January 1, 2004, through June 30, 2011). **Figures 5.2a** through **5.2d** show the fecal coliform concentration trends observed in WBIDs 1716A, 1716B, 1716C, and 1716D during the Cycle 2 verified period.

Table 5.1. Stations Where Water Quality Samples Were Collected for Fecal Coliform Data During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a three-column table. Column 1 lists the WBID number, Column 2 lists the station ID, and Column 3 lists the agency collecting the data

WBID	Station ID	Agency
1716A	21FLPDEM45-03	Pinellas County DEMI
1716B	21FLGW 35438	Department
1716B	21FLPDEM46-03	Pinellas County DEMI
1716B	21FLTPA 27450158241217	Department Southwest District
1716B	21FLTPA 27450868241289	Department Southwest District
1716B	21FLTPA 27451788241338	Department Southwest District
1716C	21FLTPA 27444078240537	Department Southwest District
1716C	21FLTPA 27444078241071	Department Southwest District
1716D	21FLTPA 274414908241375	Department Southwest District
1716D	21FLTPA 274425108241352	Department Southwest District
1716D	21FLTPA 27443468241194	Department Southwest District

Table 5.2. Descriptive Statistics of Fecal Coliform Data for WBIDs 1716A, 1716B, 1716C, and 1716D for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a six-column table. Column 1 lists the WBID number; Columns 2 through 5 list the mean, median, highest, and lowest observations, respectively; and Column 6 lists the number of samples.

[1]Coliform counts are #/100mL.

WBID	Mean Observation[1]	Median Observation[1]	Highest Observation[1]	Lowest Observation[1]	Number of Samples
1716A	5,205	1,750	20,000	380	20
1716B	999	252	6,000	27	38
1716C	1,781	350	13,000	40	17
1716D	1,254	62	14,000	2	21

Figure 5.1. Location of Water Quality Stations with Fecal Coliform Data in WBIDs 1716A, 1716B, 1716C, and 1716D

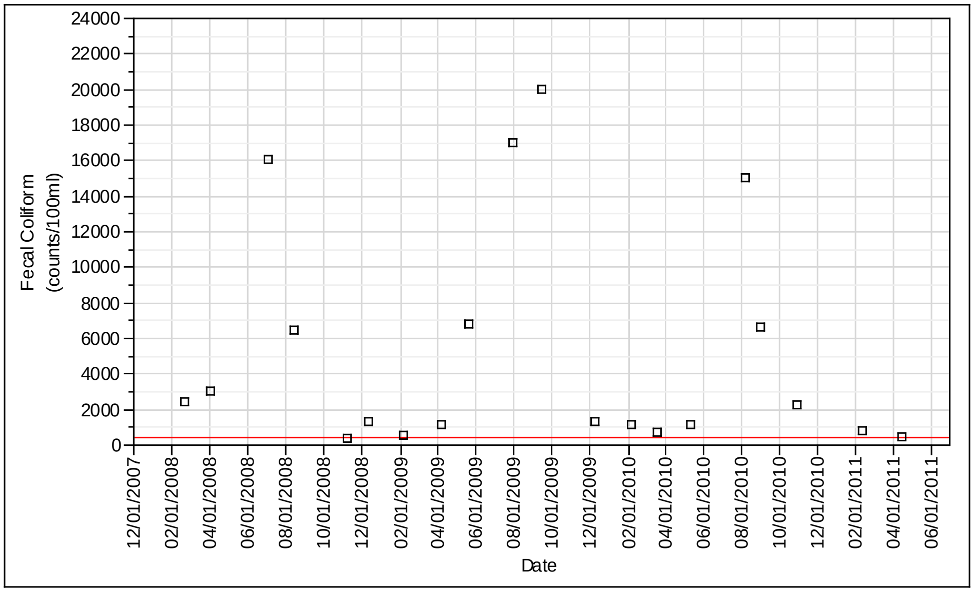

Figure 5.2a. Fecal Coliform Concentration Trends in the 34th Street Basin (WBID 1716A) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

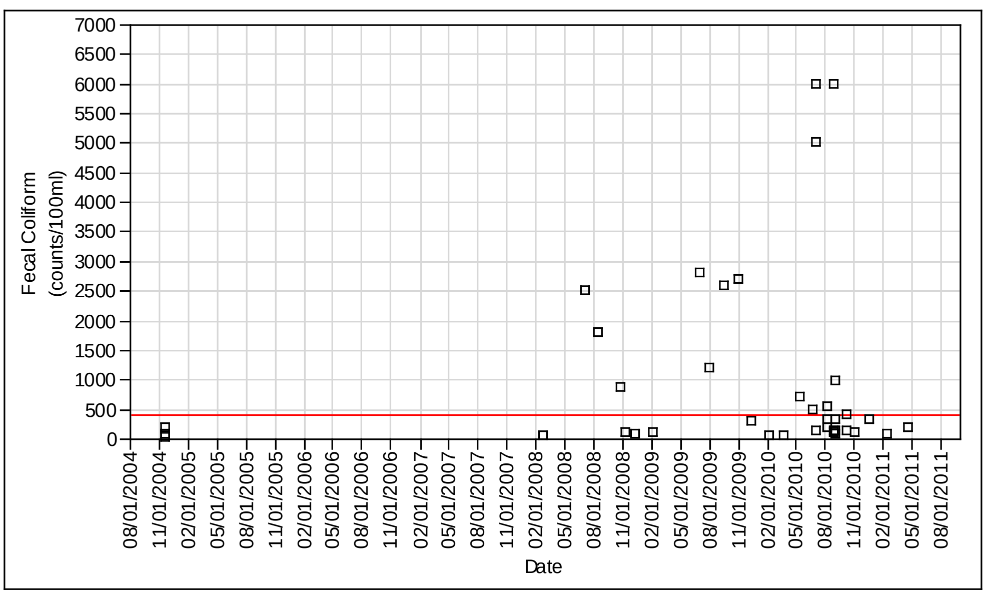

Figure 5.2b. Fecal Coliform Concentration Trends in Clam Bayou Drain (WBID 1716B) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

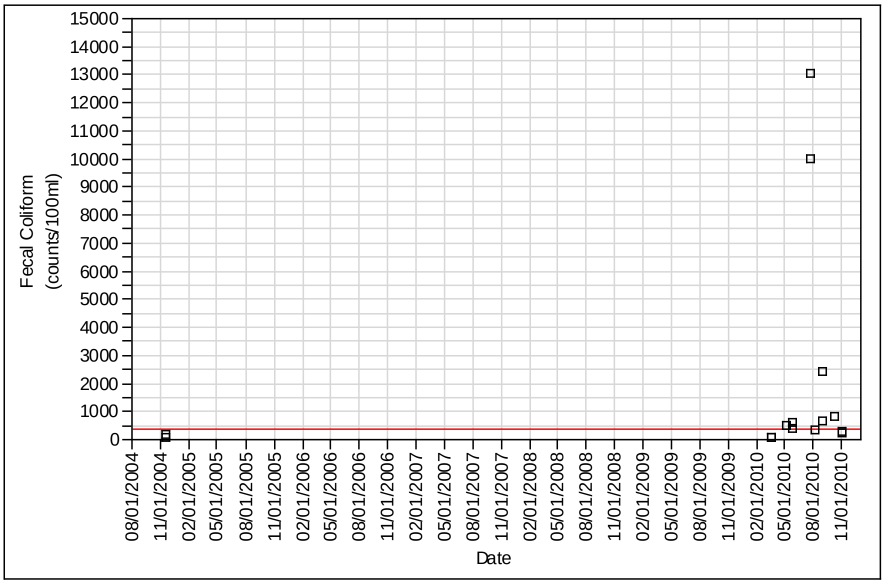

Figure 5.2c. Fecal Coliform Concentration Trends in Clam Bayou (East Drainage) (WBID 1716C) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

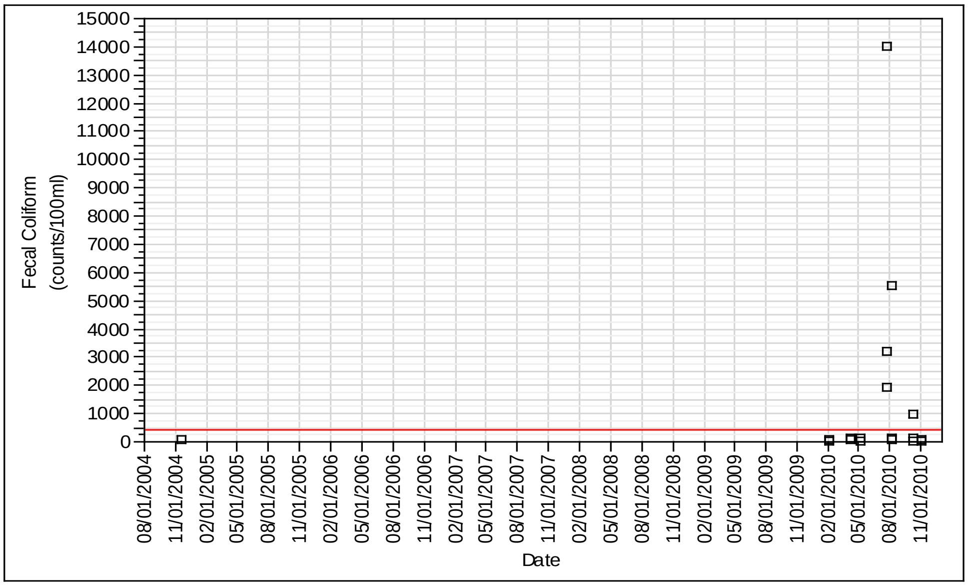

Figure 5.2d. Fecal Coliform Concentration Trends in Clam Bayou Drain (Tidal) (WBID 1716D) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

Temporal Patterns

Monthly and Seasonal Trends

Seasonally, in an impaired water influenced mainly by nonpoint sources, higher fecal coliform concentrations and exceedance rates are expected during the third quarter (summer, July–September), when conditions are rainy and warm, and lower concentrations and exceedance rates are expected in the first and fourth quarters (winter, January–March; and fall, October–December), when conditions are drier and colder (**Tables 5.3a** through **5.3h**). However, in three of the four WBIDs in this report, exceedances occurred during both the wet and dry seasons, as described in greater detail below.

The WBIDs addressed in this report are located in an environment of humid southern temperate to subtropical climatic zones, with frosts/freezing temperatures occurring at least once a year. The average mean daily temperature is 70^{o}F, with mean summer temperatures in the low 80s and mean winter temperatures in the upper 50s. Average annual rainfall is approximately 53 inches, with two-thirds of rainfall occurring between June and September. Rainfall variability is high, both seasonally and from year to year. The Gulf of Mexico is the prevailing factor affecting climate in this area; Gulf waters influence winter cold fronts and high summer temperatures (SWFWMD 2002).

34th Street Basin (WBID 1716A)

Elevated fecal coliform concentrations and exceedance rates greater than 50% were observed during every quarter, with quarterly exceedance rates of 100% observed during the first, second, and third quarters, and the highest quarterly average fecal coliform concentration (13,500 counts/100mL) observed during the third quarter. Episodic exceedances in fecal coliform concentrations occurred throughout the period of observation (2004–11). With the exception of November, fecal coliform exceedances, and monthly exceedance rates of 100%, were observed in the 34th Street Basin in all the other months in which measured fecal coliform concentrations were available (no samples were collected in January and June). The highest monthly average fecal coliform concentration in a month with a sample size greater than 1 (n=2), was observed in July (16,500 counts/100mL). **Tables 5.3a** and **5.3b** summarize the monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data collected for the Cycle 2 verified period for this WBID.

Table 5.3a. Summary Statistics of Fecal Coliform Data for All Stations in the 34th Street Basin (WBID 1716A) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	0	-	-	-	-	-	-
February	4	540	2,400	930	1,200	4	100%
March	1	680	680	680	680	1	100%
April	3	440	3,000	1,100	1,513	3	100%
May	2	1,100	6,800	3,950	3,950	2	100%
June	0	-	-	-	-	-	-
July	2	16,000	17,000	16,500	16,500	2	100%
August	3	6,400	15,000	6,600	9,333	3	100%
September	1	20,000	20,000	20,000	20,000	1	100%
October	1	2,200	2,200	2,200	2,200	1	100%
November	1	380	380	380	380	0	0%
December	2	1,300	1,300	1,300	1,300	2	100%

Table 5.3b. Summary Statistics of Fecal Coliform Data for All Stations in the 34th Street Basin (WBID 1716A) by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	5	540	2,400	760	1,096	5	100%
Quarter 2	5	440	6,800	1,100	2,488	5	100%
Quarter 3	6	6,400	20,000	15,500	13,500	6	100%
Quarter 4	4	380	2,200	1,300	1,295	3	67%

Clam Bayou Drain (WBID 1716B)

Elevated quarterly average fecal coliform concentrations and high exceedance rates were observed during the second quarter (2,191 counts/100mL and 71%, respectively) and third quarter (1,207 counts/100mL and 50%, respectively). In Clam Bayou Drain, episodic exceedances in fecal coliform concentrations occurred throughout the period of observation (2004–11), with the highest monthly average fecal coliform concentration observed in June (2,888 counts/100mL). **Tables 5.3c** and **5.3d** summarize the monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data collected for the Cycle 2 verified period for this WBID.

Table 5.3c. Summary Statistics of Fecal Coliform Data for All Stations in Clam Bayou Drain (WBID 1716B) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	0	-	-	-	-	-	-
February	4	50	110	71.5	76	0	0%
March	1	46	46	46	46	0	0%
April	1	180	180	180	180	0	0%
May	1	720	720	720	720	1	100%
June	5	140	6,000	2,800	2,888	4	80%
July	2	1,200	2,500	1,850	1,850	2	100%
August	11	70	6,000	320	964	4	36%
September	1	2,600	2,600	2,600	2,600	1	100%
October	4	130	2,700	650	1,033	3	75%
November	5	27	204	110	108	0	0%
December	3	92	320	300	237	0	0%

Table 5.3d. Summary Statistics of Fecal Coliform Data for All Stations in Clam Bayou Drain (WBID 1716B) by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	5	46	110	53	70	0	0%
Quarter 2	7	140	6,000	720	2,191	5	71%
Quarter 3	14	70	6,000	440	1,207	7	50%
Quarter 4	12	27	2,700	167	448	3	25%

Clam Bayou (East Drainage) (WBID 1716C)

Elevated fecal coliform concentrations and exceedance rates greater than 50% were observed during the second, third, and fourth quarters (50%, 75%, and 75%, respectively), with the highest quarterly average fecal coliform concentration (4,450 counts/100mL) observed during the third quarter. Episodic exceedances in fecal coliform concentrations occurred throughout the period of observation (2004–11), with the highest monthly average fecal coliform concentration observed in July (11,500 counts/100mL). **Tables 5.3e** and **5.3f** summarize the monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data collected for the Cycle 2 verified period for this WBID.

Table 5.3e. Summary Statistics of Fecal Coliform Data for All Stations in Clam Bayou (East Drainage) (WBID 1716C) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	0	-	-	-	-	-	-
February	0	-	-	-	-	-	-
March	2	40	68	54	54	0	0%
April	0	-	-	-	-	-	-
May	4	350	580	495	480	3	75%
June	0	-	-	-	-	-	-
July	2	10,000	13,000	11,500	11,500	2	100%
August	4	320	2,400	490	925	2	50%
September	0	-	-	-	-	-	-
October	1	820	820	820	820	1	100%
November	4	72	290	187.5	184	0	0%
December	0	-	-	-	-	-	-

Table 5.3f. Summary Statistics of Fecal Coliform Data for All Stations in Clam Bayou (East Drainage) (WBID 1716C) by Season during the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	2	40	68	54	54	0	0%
Quarter 2	4	350	580	495	480	3	75%
Quarter 3	6	320	13,000	1,520	4,450	4	75%
Quarter 4	5	72	820	210	311	1	50%

Clam Bayou Drain (Tidal) (WBID 1716D)

The highest quarterly average fecal coliform concentration and exceedance rate were observed during the third quarter (4,132 counts/100mL and 67%, respectively). No exceedances were observed during the cooler and drier seasons (first and second quarters). Episodic exceedances in fecal coliform concentrations occurred throughout the period of observation (2004–11). Monthly exceedance rates of 33% and greater were observed in 3 of the 7 months sampled (no samples were collected in January, March, June, September, or December). The highest monthly average fecal coliform concentration and highest monthly exceedance rate were observed in July (6,367 counts/100mL and 100%, respectively). **Tables 5.3g** and **5.3h** summarize the monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data collected for the Cycle 2 verified period for this WBID.

Using rainfall data collected at the SWFWMD rainfall gauge station (ID 22894) (SWFWMD 2011), 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 all WBIDs (**Figures 5.3a** through **5.3h**).

Table 5.3g. Summary Statistics of Fecal Coliform Data for All Stations in Clam Bayou Drain (Tidal) (WBID 1716D) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	0	-	-	-	-	-	-
February	3	10	43	30	28	0	0%
March	0	-	-	-	-	-	-
April	3	4	100	30	45	0	0%
May	3	2	100	7	36	0	0%
June	0	-	-	-	-	-	-
July	3	1,900	14,000	3,200	6,367	3	100%
August	3	62	5,500	130	1,897	1	33%
September	0	-	-	-	-	-	-
October	3	11	980	100	364	1	33
November	3	15	64	54	44	0	0%
December	0	-	-	-	-	-	-

Table 5.3h. Summary Statistics of Fecal Coliform Data for All Stations in Clam Bayou Drain (Tidal) (WBID 1716D) by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

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

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	3	10	43	30	28	0	0%
Quarter 2	6	2	100	18.5	41	0	0%
Quarter 3	6	62	14,000	2,550	4,132	4	67%
Quarter 4	6	11	980	59	204	1	17%

Rainfall Patterns

34th Street Basin (WBID 1716A)

The impact of rainfall on monthly and quarterly exceedances in WBID 1716A is inconclusive for the Cycle 2 verified period. Monthly exceedance rates do not appear to be correlated with monthly rainfall (**Figure 5.3a**). Monthly exceedances were recorded both during drier and wetter months. High quarterly exceedance rates (67% and above) were also recorded in all 4 quarters, during drier and wetter seasons (**Figure 5.3b**). The fact that high exceedance rates occur during wet and dry seasons indicates that water quality in the watershed is negatively affected both by high rainfall, as well as local sources contributing to elevated fecal coliform concentrations.

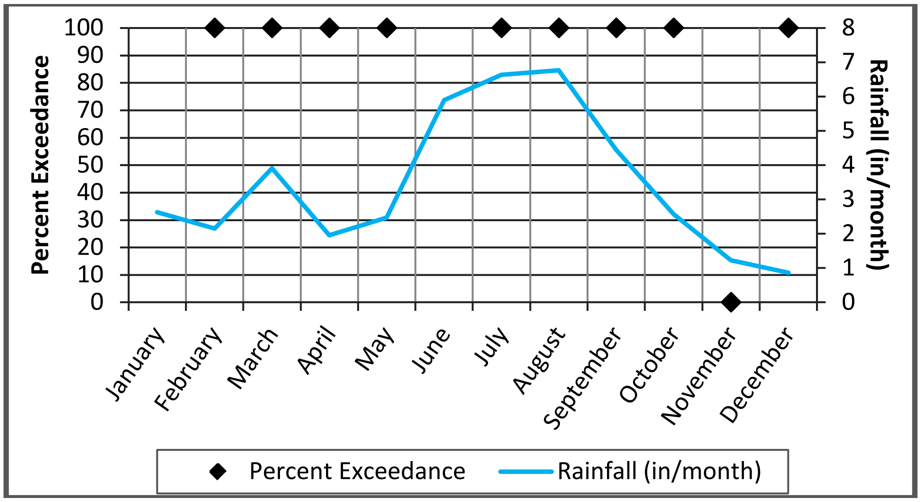

Figure 5.3a. Fecal Coliform Exceedances and Rainfall at All Stations in the 34th Street Basin (WBID 1716A) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

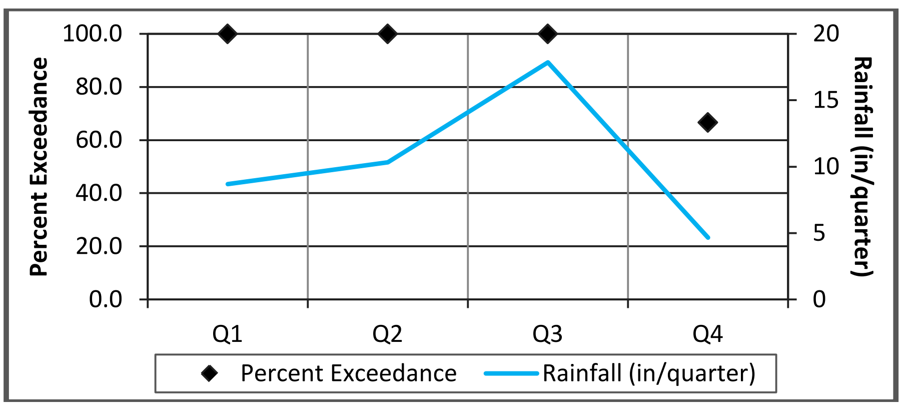

Figure 5.3b. Fecal Coliform Exceedances and Rainfall at All Stations in the 34th Street Basin (WBID 1716A) by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Clam Bayou Drain (WBID 1716B)

The impact of rainfall on monthly and quarterly exceedances in WBID 1716B is inconclusive for the Cycle 2 verified period; monthly exceedance rates do not appear to be correlated with monthly rainfall (**Figure 5.3c**). However, higher exceedance rates were mostly observed during the wetter months. Quarterly exceedances were recorded only during the last three quarters of the year; all three exceedances coincide with wetter months (**Figure 5.3d**). The fact that higher exceedance rates occur during wet seasons indicates that high rainfall negatively affects water quality in the watershed.

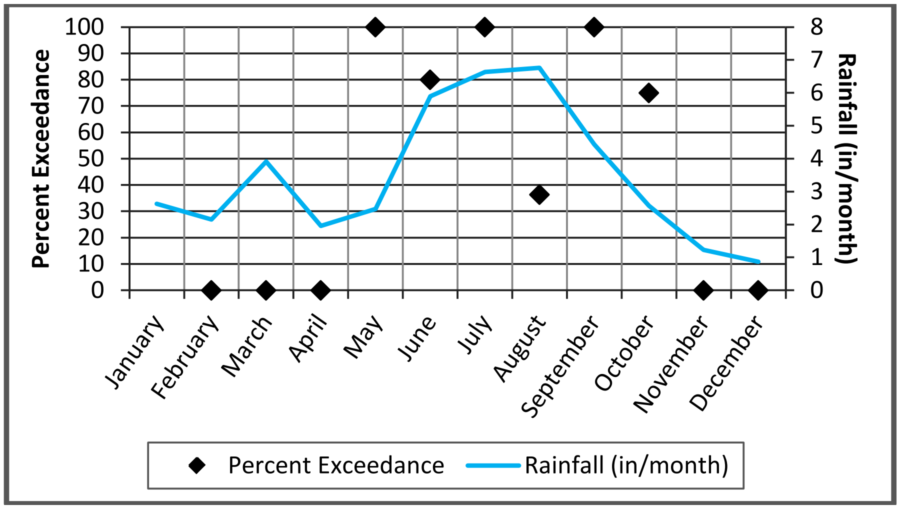

Figure 5.3c. Fecal Coliform Exceedances and Rainfall at All Stations in Clam Bayou Drain (WBID 1716B) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

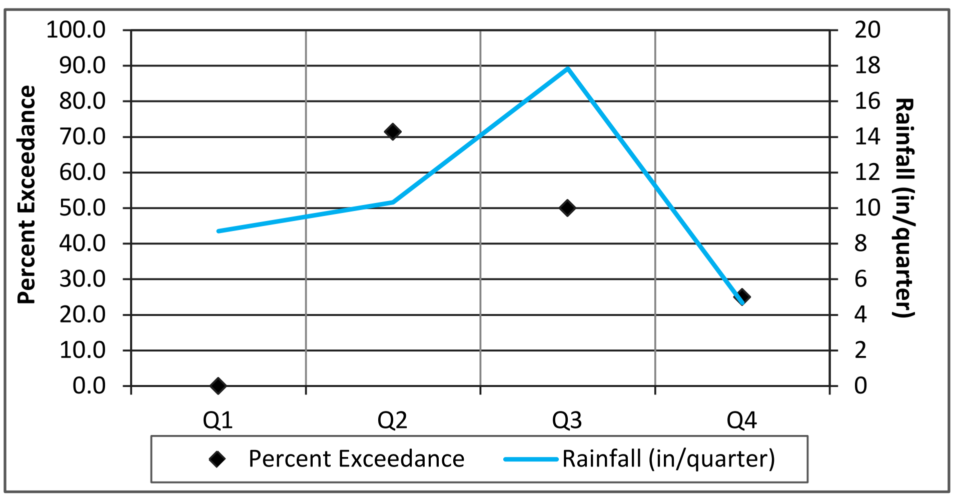

Figure 5.3d. Fecal Coliform Exceedances and Rainfall at All Stations in Clam Bayou Drain (WBID 1716B) by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Clam Bayou (East Drainage) (WBID 1716C)

In WBID 1716C, both monthly exceedance and nonexceedances were recorded during wetter months (**Figure 5.3e**). Quarterly exceedances were recorded only during the last three quarters of the year; all three exceedances coincide with wetter months (**Figure 5.3f**). The fact that higher exceedance rates occur during wet seasons indicates that high rainfall negatively affects water quality in the watershed.

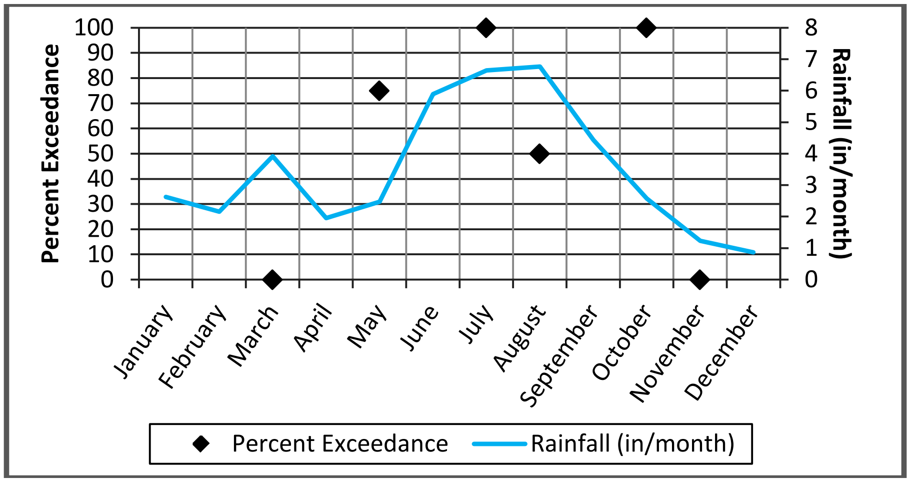

Figure 5.3e. Fecal Coliform Exceedances and Rainfall at All Stations in Clam Bayou (East Drainage) (WBID 1716C) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

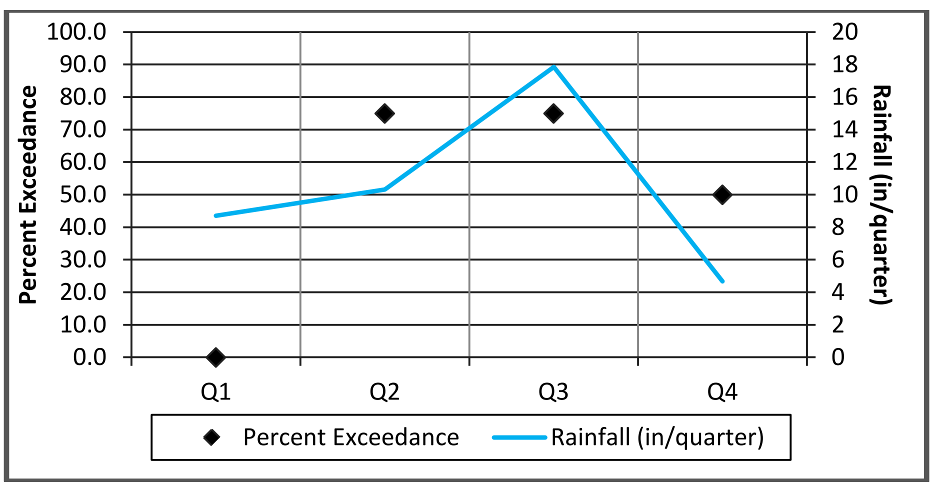

Figure 5.3f. Fecal Coliform Exceedances and Rainfall at All Stations in Clam Bayou (East Drainage) (WBID 1716C) by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Clam Bayou Drain (Tidal) (WBID 1716D)

The impact of rainfall on monthly and quarterly exceedances in WBID 1716D is inconclusive for the Cycle 2 verified period; monthly exceedance rates do not appear to be correlated with monthly rainfall (**Figure 5.3g**). However, the highest exceedance rate was observed during the wettest month. Quarterly exceedance rates occurred only in during the last two quarters of the year, with the highest quarterly exceedance rate coinciding with the highest rainfall period (**Figure 5.3h**). The fact that higher exceedance rates occur during wet seasons indicates that high rainfall negatively affects water quality in the watershed.

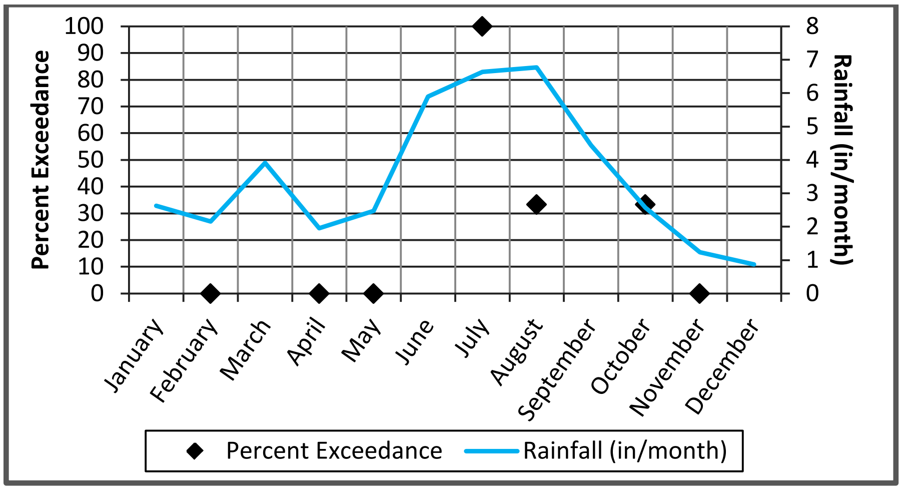

Figure 5.3g. Fecal Coliform Exceedances and Rainfall at All Stations in Clam Bayou Drain (Tidal) (WBID 1716D) by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

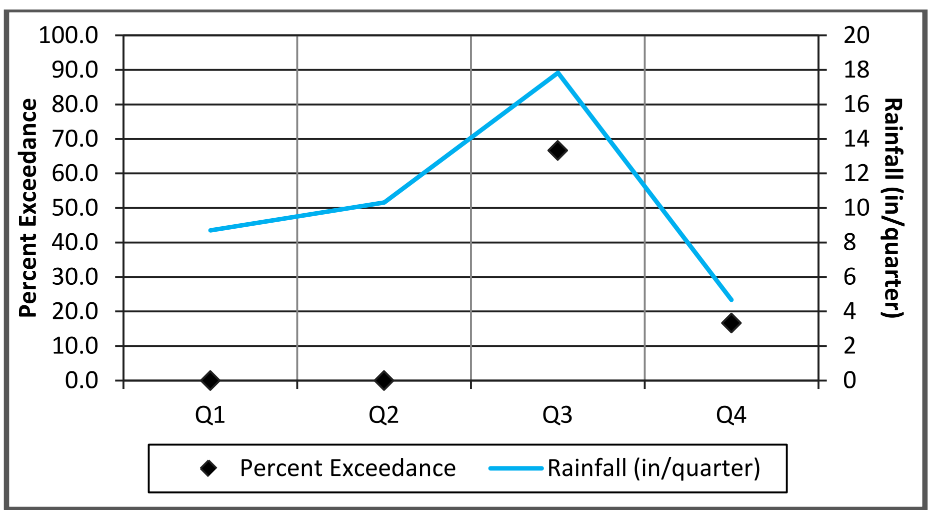

Figure 5.3h. Fecal Coliform Exceedances and Rainfall at All Stations in Clam Bayou Drain (Tidal) (WBID 1716D) by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Period Of Record Trend

Although a historical plot of fecal coliform data against time revealed no significant (Prob>0.05) increasing or decreasing trends for the entire period of record in WBIDs 1716A, 1716B, 1716C, or 1716D (**Figures 5.4a** through **5.4d**), it is expected that continued restoration and infrastructure improvement efforts will result in future water quality improvements in the Clam Bayou watershed.

The city of St. Petersburg, SWFWMD, and various other organizations have been steadily working to improve water quality through projects that should result in runoff water quality improvement and potentially reduce fecal coliform concentrations in the Clam Bayou watershed.

The Clam Bayou Habitat Restoration and Stormwater Treatment project, a partnership among the SWFWMD, city of St. Petersburg, city of Gulfport, Tampa Bay Estuary Program, and Department, was established with the goal of restoring Clam Bayou's ecosystems and treating stormwater runoff with acres of ponds designed to filter pollutants and improve water quality before the runoff reaches Clam Bayou. Between 2006 and 2012, the city of St. Petersburg and SWFWMD invested over $10 million for restoration activities in the Clam Bayou channel. Construction on the project began in April 2010 and was completed in April 2012. Although several sampling events occurred in the summer of 2012, data are not yet available to compare pre- vs post-restoration water quality.

In addition, the city of St. Petersburg has been proactive in improving its sanitary sewer infrastructure, with over $96 million spent on upgrading the city's sanitary sewer system to reduce or eliminate sanitary sewer overflows citywide. The city is also constantly monitoring the system for any failures (leaks, seepages, overflows, etc.).

However, fecal coliform concentrations that exceed the state criterion are frequently recorded in these WBIDs. Many of these samples are collected during periods of low or no rainfall, indicating that exceedances in concentrations may not be a consequence of stormwater discharges but rather local sources.

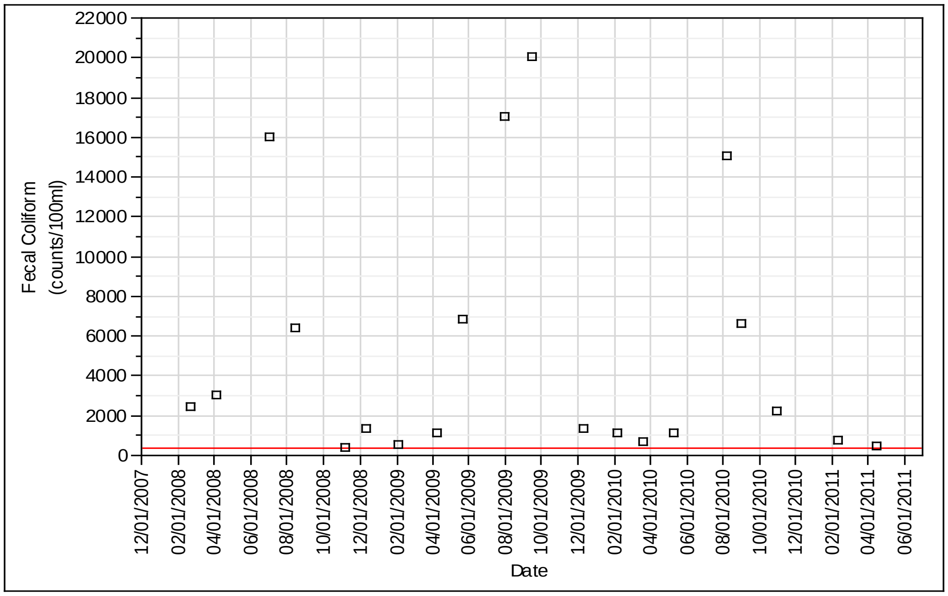

Figure 5.4a. Fecal Coliform Concentration Trends in the 34th Street Basin (WBID 1716A) for the Entire Period of Record (2008–11)

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

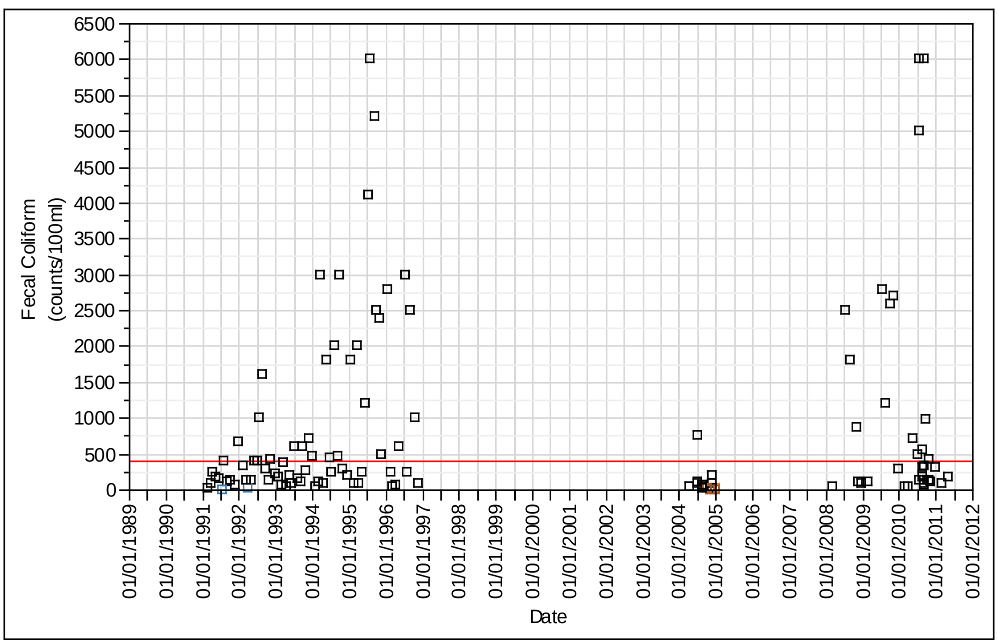

Figure 5.4b. Fecal Coliform Concentration Trends in Clam Bayou Drain (WBID 1716B) for the Entire Period of Record (1991–2011)

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

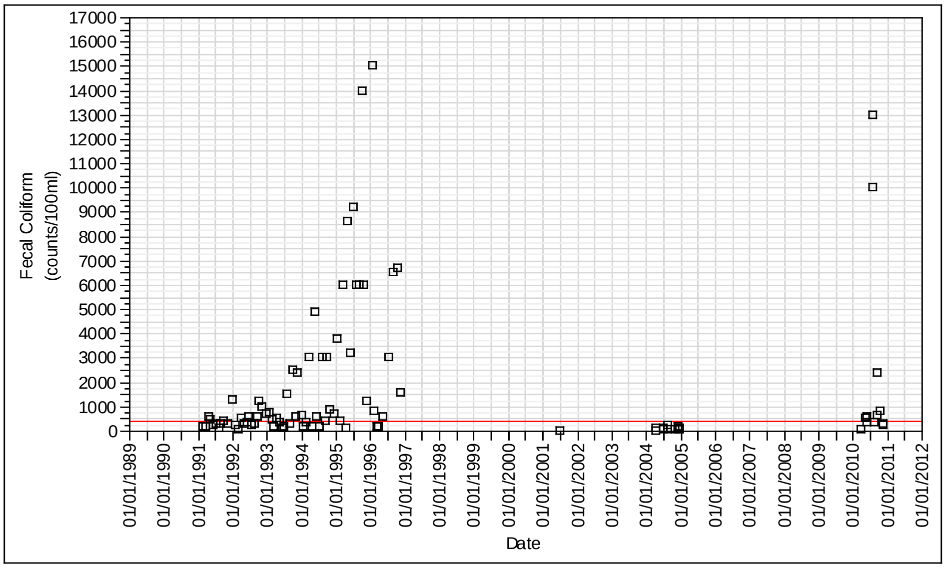

Figure 5.4c. Fecal Coliform Concentration Trends in Clam Bayou (East Drainage) (WBID 1716C) for the Entire Period of Record (1991–2010)

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

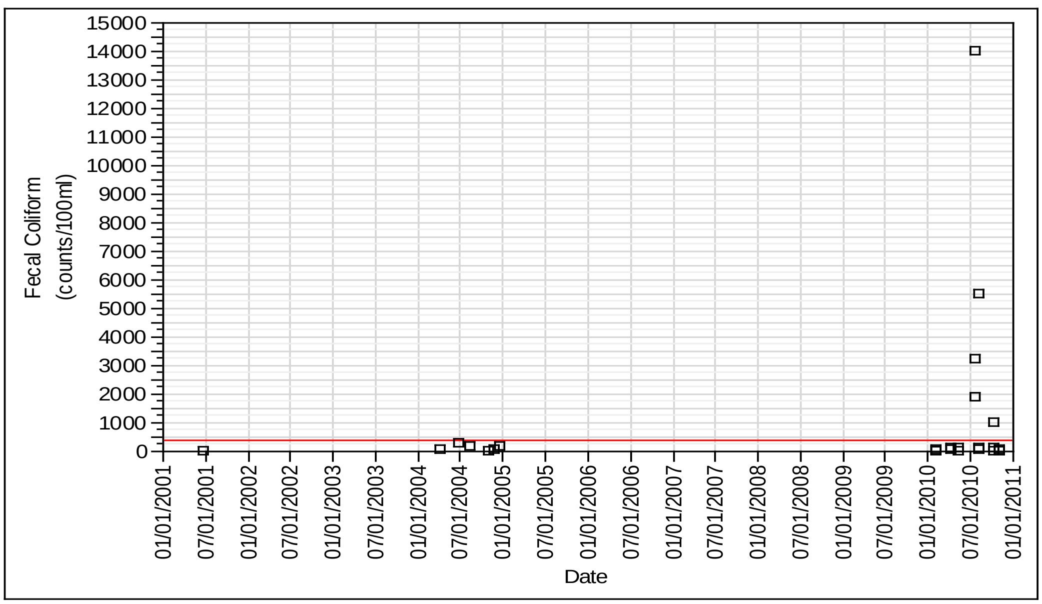

Figure 5.4d. Fecal Coliform Concentration Trends in Clam Bayou Drain (Tidal) (WBID 1716D) for the Entire Period of Record (2001–10)

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

Spatial Patterns

Fecal coliform data from the Cycle 2 verified period (January 1, 2004, through June 30, 2011) were analyzed to detect spatial trends (**Figures 5.5a** through **5.5c**; **Tables 5.4a** through **5.4d**). Stations are displayed from upstream to downstream. **Figure 5.6** shows the spatial distribution of the principal land uses and the locations of the water quality stations within each of the four watersheds.

34th Street Basin (WBID 1716A)

As samples in WBID 1716A were collected from only one station, a spatial trend could not be established.

A 95% exceedance rate was observed in the single sampling station within the WBID. The mean concentration recorded at this station was 5,205 counts/100mL. Samples exceeded the single-sample maximum criterion of 800 counts/100mL (**Table 5.4a**). The station (21FLPDEM45-03) is located on the main channel and is surrounded primarily by highly developed urban areas (classified as educational institutional).

Table 5.4a. Station Summary Statistics of Fecal Coliform Data for the 34th Street Basin (WBID 1716A) During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a nine-column table. Column 1 lists the station, Column 2 lists the period of observation, Column 3 lists the number of samples, Column 4 lists the minimum count/100mL, Column 5 lists the maximum count, Column 6 lists the mean count, Column 7 lists the median count, Column 8 lists the number of exceedances, and Column 9 lists the percent exceedances.

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

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLPDEM45-03	2008–11	20	380	20,000	1,750	5,205	19	95%

Clam Bayou Drain (WBID 1716B)

Fecal coliform concentrations that exceeded the state criterion were observed at all 5 sampling stations within the WBID (**Figure 5.5a**). The highest exceedance rate was recorded at Station 21FLGW 35438 (100%); however, only 1 sample was collected at this station. Station 21FLPDEM46-03, where the most samples were collected (n=19), had an exceedance rate of 47%. Station 21FLTPA 27450868241289 had the highest fecal coliform concentration recorded in the WBID (1,154 counts/100mL). Samples at all 5 stations exceeded the single-sample maximum criterion of 800 counts/100mL (**Table 5.4b**).

Land use surrounding all stations in this WBID is predominantly classified as high-density residential and urban built-up (educational institutional and recreational).

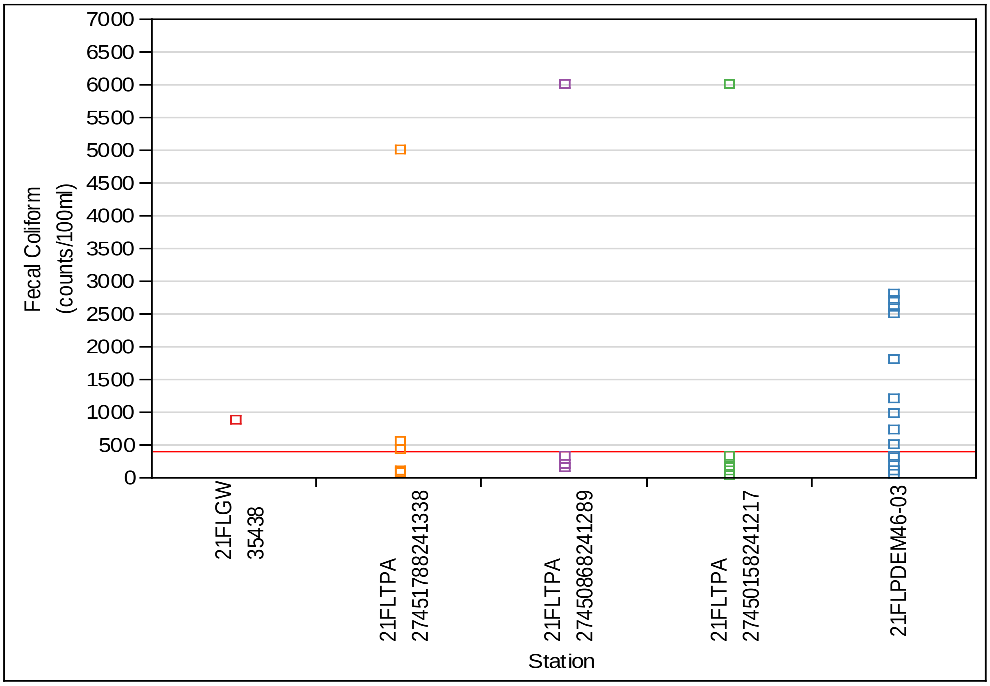

Figure 5.5a. Spatial Fecal Coliform Concentration Trends in Clam Bayou Drain (WBID 1716B) by Station During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

Table 5.4b. Station Summary Statistics of Fecal Coliform Data for Clam Bayou Drain (WBID 1716B) During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a nine-column table. Column 1 lists the station, Column 2 lists the period of observation, Column 3 lists the number of samples, Column 4 lists the minimum count/100mL, Column 5 lists the maximum count, Column 6 lists the median count, Column 7 lists the mean count, Column 8 lists the number of exceedances, and Column 9 lists the percent exceedances.

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

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLGW 35438	2008	1	880	880	880	880	1	100%
21FLPDEM46-03	2008–11	19	46	2,800	320	903	9	47%
21FLTPA 27450158241217	2004 and 2010	6	27	6,000	160	1,131	1	17%
21FLTPA 27450868241289	2004 and 2010	6	130	6,000	172	1,154	1	17%
21FLTPA 27451788241338	2004 and 2010	6	70	5,000	260	1,038	3	50%

Clam Bayou (East Drainage) (WBID 1716C)

Fecal coliform concentrations that exceeded the state criterion were observed in the 2 sampling stations within the WBID (**Figure 5.5b**). The highest exceedance rate was recorded at Station 21FLTPA 27444078241071 (n=9) (56%), and the highest fecal coliform concentration was recorded at Station 21FLTPA 27444078240537 (13,000 counts/100mL). Samples at both stations exceeded the single-sample maximum criterion of 800 counts/100mL (**Table 5.4c**).

Land use surrounding both stations in this WBID is predominantly classified as high-density residential. Station 21FLTPA 27444078241071 is also located close to a golf course.

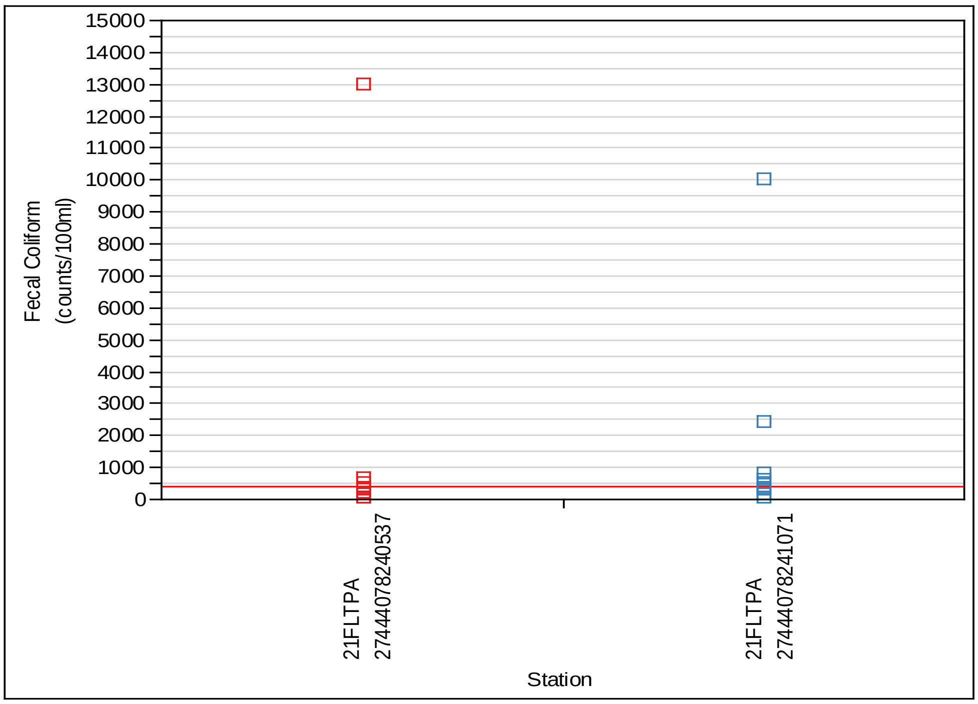

Figure 5.5b. Spatial Fecal Coliform Concentration Trends in Clam Bayou (East Drainage) (WBID 1716C) by Station during the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

Table 5.4c. Station Summary Statistics of Fecal Coliform Data for Clam Bayou (East Drainage) (WBID 1716C) During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a nine-column table. Column 1 lists the station, Column 2 lists the period of observation, Column 3 lists the number of samples, Column 4 lists the minimum count/100mL, Column 5 lists the maximum count, Column 6 lists the median count, Column 7 lists the mean count, Column 8 lists the number of exceedances, and Column 9 lists the percent exceedances.

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

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLTPA 27444078240537	2004 and 2010	8	40	13,000	335	1,890	3	38%
21FLTPA 27444078241071	2004 and 2010	9	68	10,000	500	1,685	5	56%

Clam Bayou Drain (Tidal) (WBID 1716D)

Fecal coliform concentrations that exceeded the state criterion were observed in the 3 sampling stations within the WBID (**Figure 5.5c**). The highest exceedance rate and highest concentration were recorded at Station 21FLTPA 27443468241194 (38% and 14,000 counts/100mL, respectively). Samples at all stations exceeded the single-sample maximum criterion of 800 counts/100mL (**Table 5.4d**).

All stations in the WBID are surrounded primarily by natural areas, wetlands (mangrove swamps), and water (classified as bayous and estuaries).

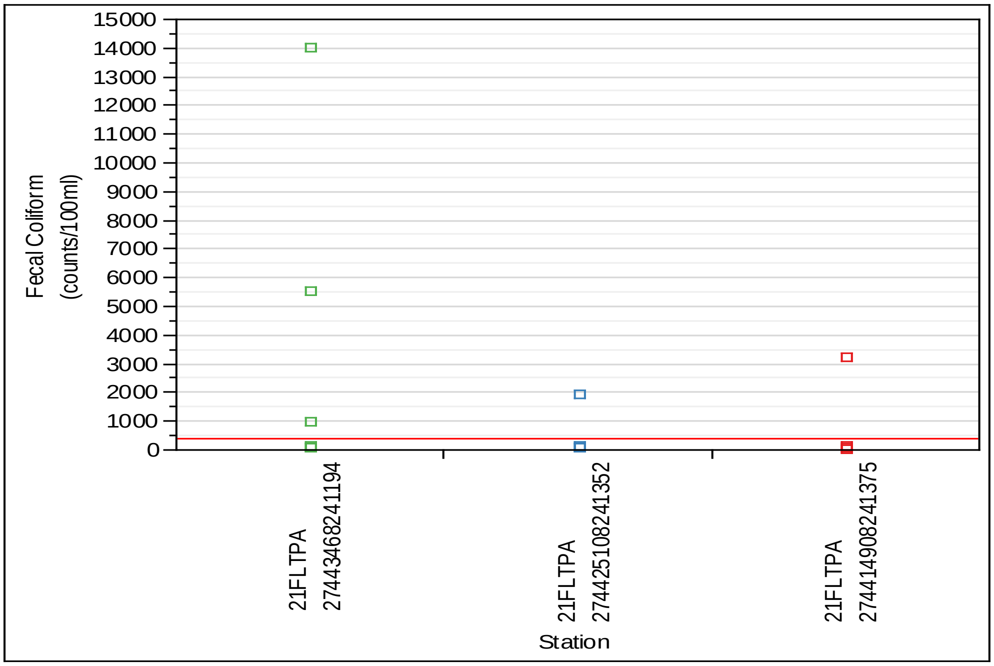

Figure 5.5c. Spatial Fecal Coliform Concentration Trends in Clam Bayou Drain (Tidal) (WBID 1716D) by Station During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

Table 5.4d. Station Summary Statistics of Fecal Coliform Data for Clam Bayou Drain (Tidal) (WBID 1716D) During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a nine-column table. Column 1 lists the station, Column 2 lists the period of observation, Column 3 lists the number of samples, Column 4 lists the minimum count/100mL, Column 5 lists the maximum count, Column 6 lists the median count, Column 7 lists the mean count, Column 8 lists the number of exceedances, and Column 9 lists the percent exceedances.

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

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLTPA 274414908241375	2010	6	2	3,200	27	565	1	17%
21FLTPA 274425108241352	2010	7	7	1,900	30	303	1	14%
21FLTPA 27443468241194	2004 and 2010	8	30	14,000	100	2,604	3	38%

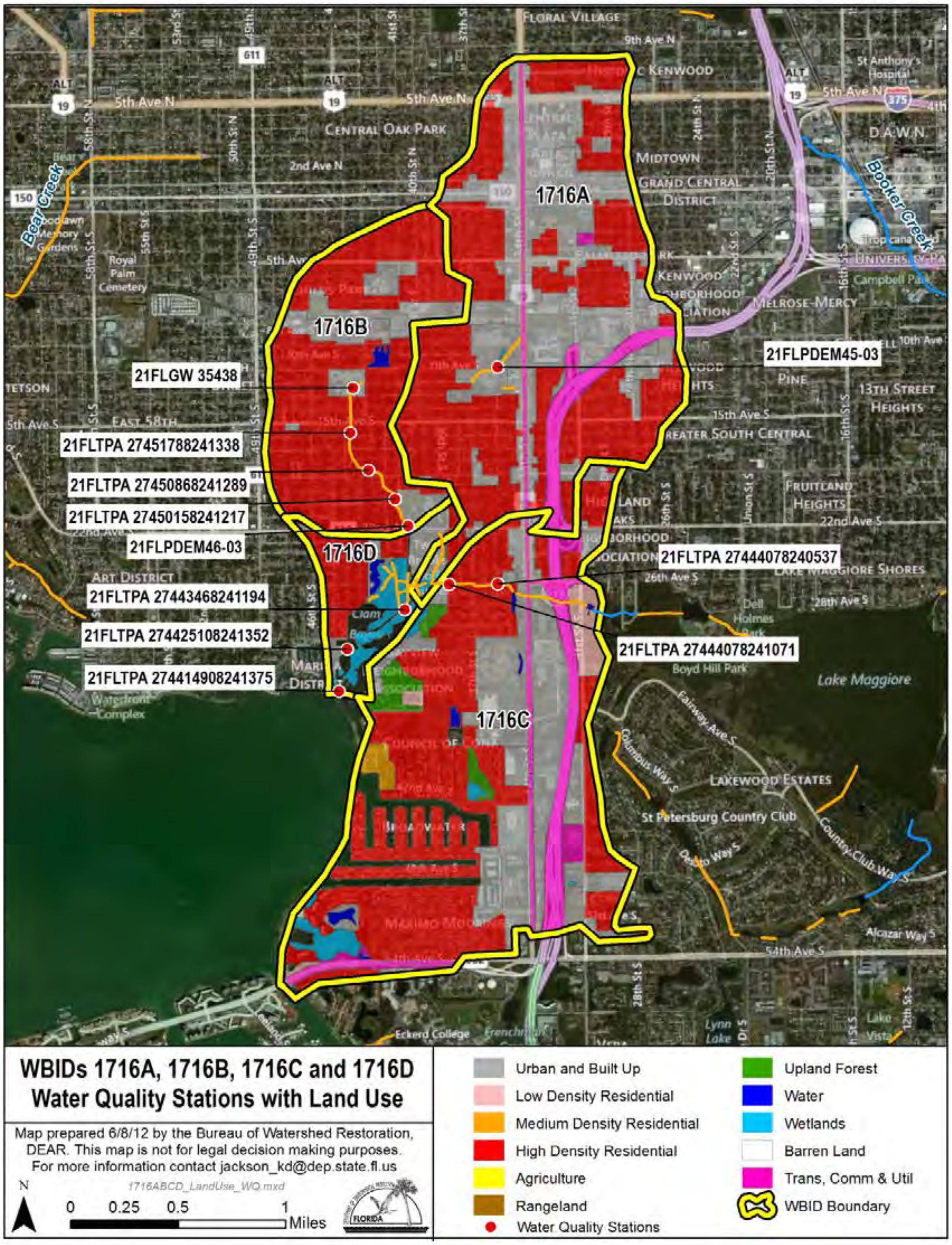

Figure 5.6. Principal Land Uses and Location of Water Quality Stations with Fecal Coliform Data in WBIDs 1716A, 1716B, 1716C, and 1716D

5.1.2 Critical Condition

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

Hydrologic conditions were analyzed using rainfall. A flow duration curve–type chart that would normally be applied to flow events was created using precipitation data from the SWFWMD rainfall gauge station (ID 22894). The chart was divided in the same manner as if flow were being analyzed, where extreme precipitation events represent the upper percentiles (0–5th percentile), followed by large precipitation events (5th–10th percentile), medium precipitation events (10th–40th percentile), small precipitation events (40th–60th percentile), and no recordable precipitation events (60th–100th percentile). Event precipitation ranges for all WBIDs were derived based on these percentile ranges (**Table 5.5**). Three-day (the day of and 2 days prior to sampling) precipitation accumulations were used in the analysis (**Tables 5.6a** through **5.6d; Figures 5.7a** through **5.7d**).

Table 5.5. Precipitation Event Ranges for Rainfall Data for WBIDs 1716A, 1716B, 1716C, and 1716D

This is a seven-column table. Column 1 lists the WBID, Column 2 lists the rainfall period of record for each WBID, and Columns 3 through 7 list the range (in inches) for each precipitation event.

WBID	Rainfall Period of Record	Extreme (inches/ 3 days)	Large (inches/ 3 days)	Medium (inches/ 3 days)	Small (inches/ 3 days)	None/ Not Measurable (inches/3 days)
1716A	1983–2012	>1.9"	1.18" - 1.9"	0.07" - 1.18"	0.01" - 0.07"	<0.01"
1716B	1983–2012	>1.9"	1.18" - 1.9"	0.07" - 1.18"	0.01" - 0.07"	<0.01"
1716C	1983–2012	>1.9"	1.18" - 1.9"	0.07" - 1.18"	0.01" - 0.07"	<0.01"
1716D	1983–2012	>1.9"	1.18" - 1.9"	0.07" - 1.18"	0.01" - 0.07"	<0.01"

34th Street Basin (WBID 1716A)

Historical data show that fecal coliform exceedances occurred over all sampled hydrologic conditions, with percentages of exceedances greater than 86% occurring after all sampled events. A 100% exceedance occurred after periods of extreme, medium, and small precipitation. The lowest percentage of exceedances (86%) occurred after periods of none/not measurable precipitation.

Given that exceedance rates and exceedances in concentrations followed all of the sampled precipitation events and that, other than MS4s, there are no traditional point source dischargers which would contribute to observed levels of fecal coliform bacteria within the 34th Street Basin WBID boundary, it can be assumed that various nonpoint sources are a major contributing factor to high fecal coliform concentrations in the WBID. While the lowest percentage of exceedances occurred after periods of no or little rainfall, the exceedance rate should not be considered insignificant and might indicate that local sources are contributing to elevated fecal coliform concentrations. **Table 5.6a** and **Figure 5.7a** show fecal coliform data by hydrologic condition.

As fecal coliform exceedances occurred in all the of the precipitation intervals, the target fecal coliform reduction calculated in the following section and shown in **Table 5.6a** is applicable under all rainfall conditions in the 34th Street Basin watershed.

Table 5.6a. Summary of Fecal Coliform Data by Hydrologic Condition in the 34th Street Basin (WBID 1716A) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

- = Empty cell/no data

Precipitation Event	Event Range (inches/ 3 days)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	> 1.9"	4	4	100%	0	0%
Large	1.18" - 1.9"	0	-	-	-	-
Medium	0.07" - 1.18"	5	5	100%	0	0%
Small	0.01" - 0.07"	4	4	100%	0	0%
None/ Not Measurable	< 0.01"	7	6	86%	1	14%

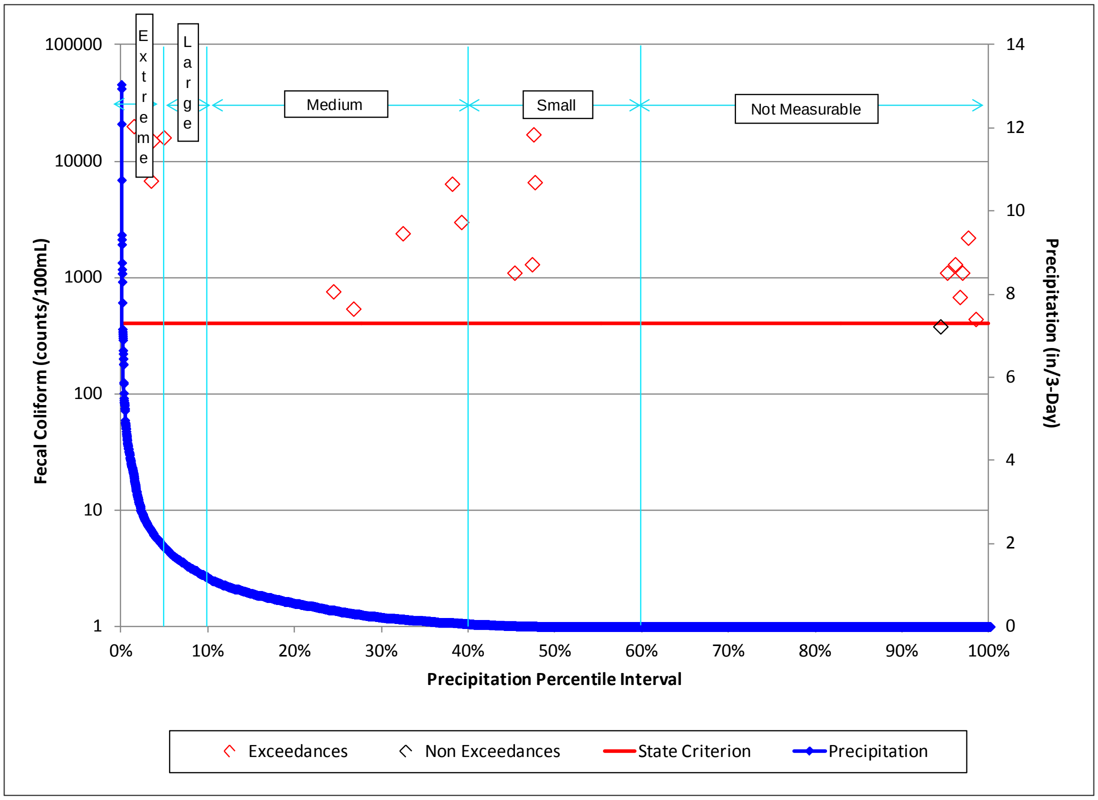

Figure 5.7a. Fecal Coliform Data by Hydrologic Condition for the 34th Street Basin (WBID 1716A) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Clam Bayou Drain (WBID 1716B)

Historical data show that fecal coliform exceedances occurred over all hydrologic conditions, with percentages of exceedances greater than 30% occurring after all sampled events. The highest percentage of exceedances (100%) occurred after periods of extreme precipitation, and the lowest percentage (33%) occurred after periods of large and small precipitation.

Given that exceedance rates and exceedances in concentrations followed all of the sampled precipitation events and that, other than MS4s, there are no traditional point source dischargers which would contribute to the observed levels of fecal coliform bacteria within the Clam Bayou Drain WBID boundary, it can be assumed that various nonpoint sources are a major contributing factor to high fecal coliform concentrations in the WBID. The fact that exceedance rates of 30% and greater occurred after all sampled precipitation events indicates that both nonpoint sources and local sources are major contributing factors to elevated fecal coliform concentrations. **Table 5.6b** and **Figure 5.7b** show fecal coliform data by hydrologic condition

As fecal coliform exceedances occurred in all the of the sampled precipitation intervals, the target fecal coliform reduction calculated in the following section and shown in **Table 5.6b** is applicable under all rainfall conditions in the Clam Bayou Drain watershed.

Table 5.6b. Summary of Fecal Coliform Data by Hydrologic Condition for Clam Bayou Drain (WBID 1716B) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

Precipitation Event	Event Range (inches/ 3 days)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	> 1.9"	2	2	100%	0	0%
Large	1.18" - 1.9"	3	1	33%	2	67%
Medium	0.07" - 1.18"	14	5	36%	9	64%
Small	0.01" - 0.07"	4	2	50%	2	50%
None/ Not Measurable	< 0.01"	15	5	33%	10	67%

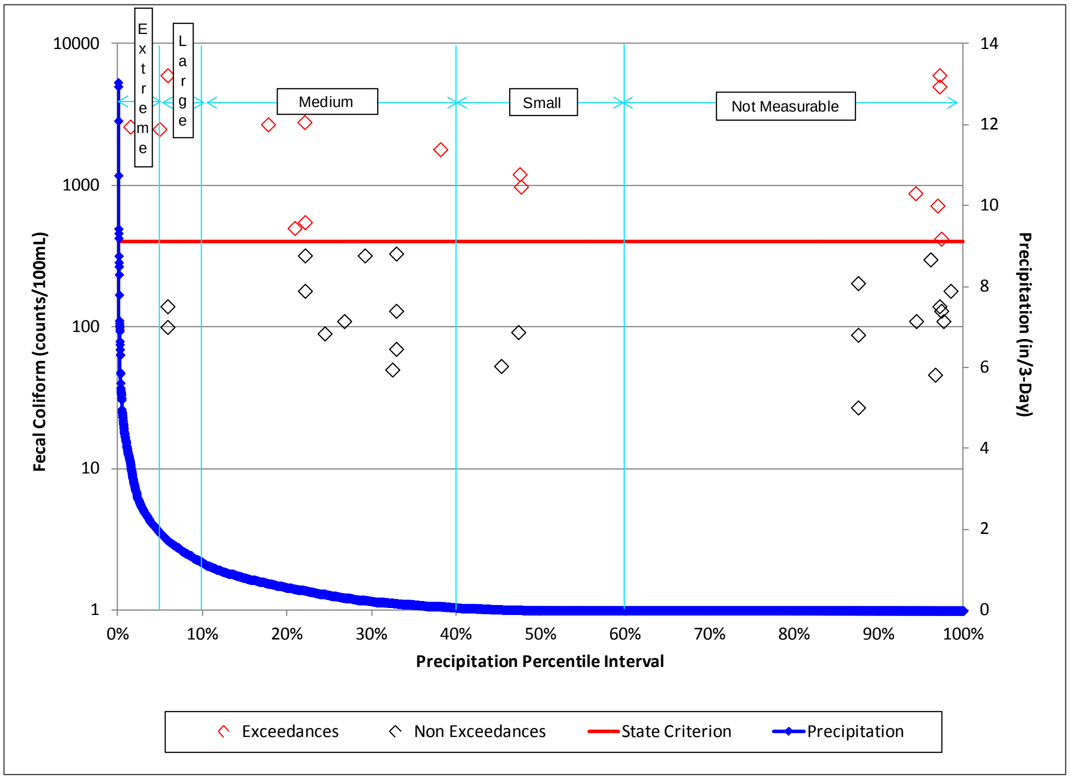

Figure 5.7b. Fecal Coliform Data by Hydrologic Condition for Clam Bayou Drain (WBID 1716B) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Clam Bayou (East Drainage) (WBID 1716C)

Historical data show that fecal coliform exceedances occurred over all hydrologic conditions during which samples were collected (medium and none or not measurable events). The highest percentage of exceedances (67%) occurred after periods of medium precipitation, and the lowest percentage (36%) occurred after periods of none or not measurable precipitation.

Given that exceedance rates and exceedances in concentrations followed all of the sampled precipitation events and that, other than MS4s, there are no traditional point source dischargers which would contribute to observed levels of fecal coliform bacteria within the Clam Bayou (East Drainage) WBID boundary, it can be assumed that various nonpoint sources are a major contributing factor to high fecal coliform concentrations in the WBID. While the lowest percentage of exceedances occurred after periods of no or little rainfall, the exceedance rate should not be considered insignificant and might indicate that local sources are contributing to elevated fecal coliform concentrations. **Table 5.6c** and **Figure 5.7c** show fecal coliform data by hydrologic condition

As fecal coliform exceedances occurred in all the of the sampled precipitation intervals, the target fecal coliform reduction calculated in the following section and shown in **Table 5.6c** is applicable under all rainfall conditions in the Clam Bayou (East Drainage) watershed.

Table 5.6c. Summary of Fecal Coliform Data by Hydrologic Condition for Clam Bayou (East Drainage) (WBID 1716C) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

- = Empty cell/no data

Precipitation Event	Event Range (inches/ 3 days)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	> 1.9"	0	-	-	-	-
Large	1.18" - 1.9"	0	-	-	-	-
Medium	0.07" - 1.18"	6	4	67%	2	33%
Small	0.01" - 0.07"	0	-	-	-	-
None/ Not Measurable	< 0.01"	11	4	36%	7	64%

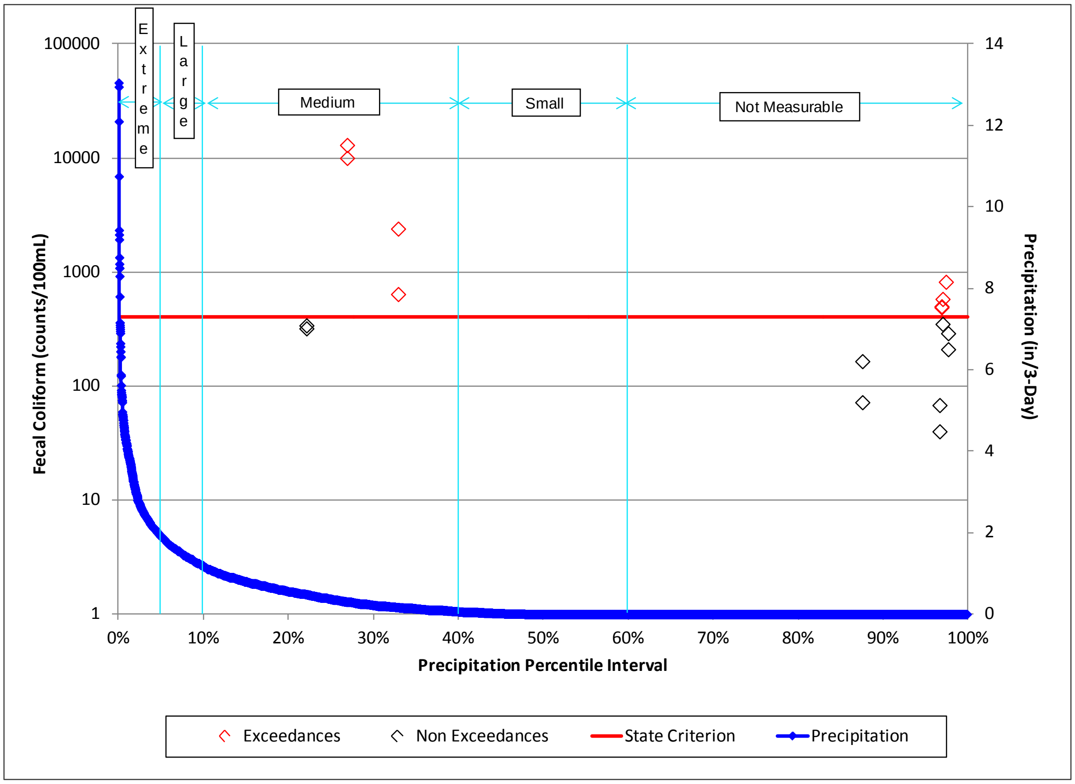

Figure 5.7c. Fecal Coliform Data by Hydrologic Condition for Clam Bayou (East Drainage) (WBID 1716C) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Clam Bayou Drain (Tidal) (WBID 1716D)

Historical data show that fecal coliform exceedances occurred over most of the hydrologic conditions during which samples were collected (medium and none or not measurable events); no exceedances occurred during periods of small precipitation. The highest percentage of exceedances (67%) occurred after periods of medium precipitation, and the lowest percentage (8%) occurred after periods of none or not measurable precipitation.

Given that exceedance rates and exceedances in concentrations followed all of the sampled precipitation events and that, other than MS4s, there are no traditional point source dischargers which would contribute to observed levels of fecal coliform bacteria within the Clam Bayou Drain (Tidal) WBID boundary, it can be assumed that various nonpoint sources are a major contributing factor to high fecal coliform concentrations in the WBID. While the lowest percentage of exceedances occurred after periods of no or little rainfall, the exceedance rate should not be considered insignificant and might indicate that local sources are contributing to elevated fecal coliform concentrations. **Table 5.6d** and **Figure 5.7d** show fecal coliform data by hydrologic condition

As fecal coliform exceedances occurred in all the of the sampled precipitation intervals, the target fecal coliform reduction calculated in the following section and shown in **Table 5.6d** is applicable under all rainfall conditions in the Clam Bayou Drain (Tidal) watershed.

Table 5.6d. Summary of Fecal Coliform Data by Hydrologic Condition for Clam Bayou Drain (Tidal) (WBID 1716D) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

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

- = Empty cell/no data

Precipitation Event	Event Range (inches/ 3 days)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	> 1.9"	0	-	-	-	-
Large	1.18" - 1.9"	0	-	-	-	-
Medium	0.07" - 1.18"	6	4	67%	2	33%
Small	0.01" - 0.07"	3	0	0%	3	100%
None/ Not Measurable	< 0.01"	12	1	8%	11	92%

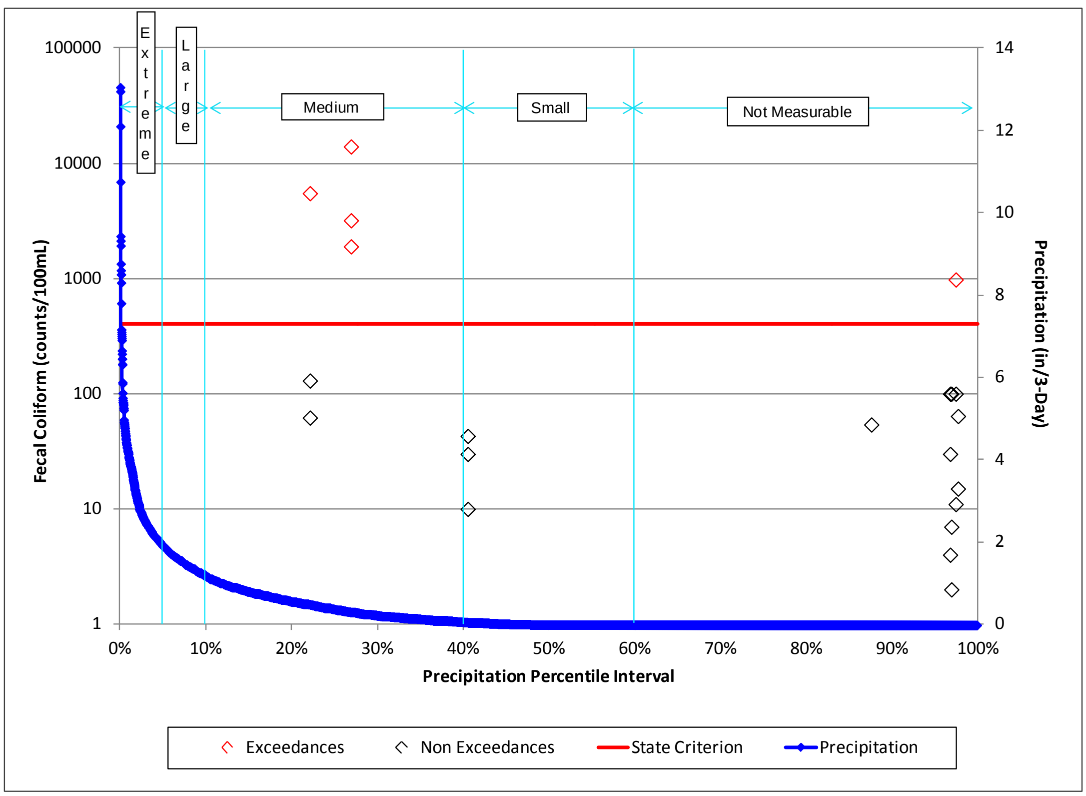

Figure 5.7d. Fecal Coliform Data by Hydrologic Condition for Clam Bayou Drain (Tidal) (WBID 1716D) for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

5.1.3 TMDL Development Process

A simple reduction calculation was performed to determine the reduction in fecal coliform concentration necessary to achieve the concentration target (400 counts/100mL). The percent reduction needed to reduce the pollutant load was calculated by comparing the existing concentrations and target concentration using **Formula 1**:

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

Using the Hazen method for estimating percentiles, as described in Hunter (2002), the existing condition concentration was defined as the 90^{th} percentile of all the fecal coliform data collected during the Cycle 2 verified period (January 1, 2004, to June 30, 2011). The 90^{th} percentile is also called the 10% exceedance event. This will result in a target condition that is consistent with the state bacteriological water quality assessment threshold for Class III waters.

In applying this method, all of the available data are ranked (ordered) from the lowest to the highest (**Tables 5.7a** through **5.7d**), and **Formula 2** is used to determine the percentile value of each data point:

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

If none of the ranked values is shown to be the 90^{th} percentile value, then the 90^{th} percentile number (used to represent the existing condition concentration) is calculated by interpolating between the 2 data points adjacent (above and below) to the desired 90^{th} percentile rank using **Formula 3,** as described below; data for WBID 1716A are used as an example:

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

Where:

- *C_{lower} is the fecal coliform concentration corresponding to the percentile lower than the 90^{th} percentile (in this case, 16,000 counts/100mL).*
- *P_{90th} is the percentile difference between the 90^{th} percentile and the percentile number immediately lower than the 90^{th} percentile (in this case, 88%), or 90% – 88% = 2%.*
- *R is a ratio defined as R = (fecal coliform concentration $_{upper}$ – fecal coliform concentration $_{lower}$) / (percentile $_{upper}$ – percentile $_{lower}$).*

To calculate *R*, the percentile values below and above the 90^{th} percentile were identified, in this case, 88% and 93%, respectively (**Table 5.7a**). Next, the fecal coliform concentrations corresponding to the lower and upper percentile values were identified (16,000 and 17,000 counts/100mL, respectively) (**Table 5.7a**). The fecal coliform concentration difference between the lower and higher percentiles was then calculated and divided by the unit percentile. The unit percentile difference is the difference between the lower and upper percentiles (e.g., 93% –

88% = 5 percentile unit difference). R was then calculated as R = (17,000 – 16,000) / (93% – 88%) = 200.

The C_{lower}, P_{90th}, and *R,* were substituted into **Formula 3** to calculate the 90th percentile fecal coliform concentration (i.e., 90th percentile concentration = 16,000 + (2*200) = 16,400 counts/100mL).

Using **Formula 1**, the percent reduction for the period of observation (January 1, 2004, to June 30, 2011) was calculated as 98% for the 34th Street Basin (i.e., % reduction needed = [(16,400 – 400) / 16,400]*100 = 98%).

Tables 5.7a through **5.7d** show the individual fecal coliform data, the ranks, the percentiles for each individual data point, the existing 90th percentile concentration, the allowable concentration (400 counts/100mL), and the percent reduction needed to meet the applicable water quality criterion for fecal coliform.

Table 5.7a. Calculation of Fecal Coliform Reductions for the 34th Street Basin (WBID 1716A) TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the sampling station, Column 2 lists the sampling date, Column 3 lists the fecal coliform concentration (counts/100mL), Column 4 lists the concentration ranking, and Column 5 lists the percentile concentration distribution.

Note: Boldface type and yellow highlighting indicate the concentration used in percent reduction calculations.
- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLPDEM45-03	11/6/2008	380	1	3%
21FLPDEM45-03	4/14/2011	440	2	8%
21FLPDEM45-03	2/3/2009	540	3	13%
21FLPDEM45-03	3/18/2010	680	4	18%
21FLPDEM45-03	2/9/2011	760	5	23%
21FLPDEM45-03	4/7/2009	1,100	6	28%
21FLPDEM45-03	2/4/2010	1,100	7	33%
21FLPDEM45-03	5/10/2010	1,100	8	38%
21FLPDEM45-03	12/9/2008	1,300	9	43%
21FLPDEM45-03	12/9/2009	1,300	10	48%
21FLPDEM45-03	10/28/2010	2,200	11	53%
21FLPDEM45-03	2/19/2008	2,400	12	58%
21FLPDEM45-03	4/2/2008	3,000	13	63%
21FLPDEM45-03	8/13/2008	6,400	14	68%
21FLPDEM45-03	8/31/2010	6,600	15	73%
21FLPDEM45-03	5/21/2009	6,800	16	78%
21FLPDEM45-03	8/5/2010	15,000	17	83%
21FLPDEM45-03	**7/2/2008**	**16,000**	**18**	**88%**
21FLPDEM45-03	**7/29/2009**	**17,000**	**19**	**93%**
21FLPDEM45-03	9/14/2009	20,000	20	98%
-	**-**	**-**	**Existing condition concentration–90th percentile (counts/100mL)**	**16,400**
-	**-**	**-**	**Allowable concentration (counts/100mL)**	**400**
-	**-**	**-**	**Final % reduction**	**98%**

Table 5.7b. Calculation of Fecal Coliform Reductions for the Clam Bayou Drain (WBID 1716B) TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the station, Column 2 lists the sampling date, Column 3 lists the fecal coliform concentration (counts/100mL), Column 4 lists the concentration ranking, and Column 5 lists the percentile concentration distribution.

Note: Boldface type and yellow highlighting indicate the concentration used in percent reduction calculations.
- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLTPA 27450158241217	11/17/2004	27	1	1%
21FLPDEM46-03	3/18/2010	46	2	4%
21FLPDEM46-03	2/19/2008	50	3	7%
21FLPDEM46-03	2/4/2010	53	4	9%
21FLTPA 27451788241338	8/30/2010	70	5	12%
21FLTPA 27451788241338	11/17/2004	88	6	14%
21FLPDEM46-03	2/9/2011	90	7	17%
21FLPDEM46-03	12/9/2008	92	8	20%
21FLTPA 27451788241338	8/23/2010	100	9	22%
21FLPDEM46-03	11/6/2008	110	10	25%
21FLPDEM46-03	2/3/2009	110	11	28%
21FLTPA 27450158241217	11/1/2010	110	12	30%
21FLTPA 27450868241289	8/30/2010	130	13	33%
21FLTPA 27450868241289	10/4/2010	130	14	36%
21FLTPA 27450158241217	8/23/2010	140	15	38%
21FLTPA 27450868241289	6/28/2010	140	16	41%
21FLPDEM46-03	4/14/2011	180	17	43%
21FLTPA 27450158241217	8/2/2010	180	18	46%
21FLTPA 27450868241289	11/17/2004	204	19	49%
21FLPDEM46-03	12/9/2009	300	20	51%
21FLPDEM46-03	12/13/2010	320	21	54%
21FLTPA 27450868241289	8/2/2010	320	22	57%
21FLTPA 27450158241217	8/30/2010	330	23	59%
21FLTPA 27451788241338	10/4/2010	420	24	62%
21FLPDEM46-03	6/21/2010	500	25	64%
21FLTPA 27451788241338	8/2/2010	550	26	67%
21FLPDEM46-03	5/10/2010	720	27	70%
21FLGW 35438	10/20/2008	880	28	72%
21FLPDEM46-03	8/31/2010	980	29	75%
21FLPDEM46-03	7/29/2009	1,200	30	78%
21FLPDEM46-03	8/13/2008	1,800	31	80%
21FLPDEM46-03	7/2/2008	2,500	32	83%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLPDEM46-03	9/14/2009	2,600	33	86%
21FLPDEM46-03	**10/27/2009**	**2,700**	**34**	**88%**
21FLPDEM46-03	**6/29/2009**	**2,800**	**35**	**91%**
21FLTPA 27451788241338	6/28/2010	5,000	36	93%
21FLTPA 27450158241217	6/28/2010	6,000	37	96%
21FLTPA 27450868241289	8/23/2010	6,000	38	99%
-	**-**	**-**	**Existing condition concentration–90th percentile (counts/100mL)**	**2,770**
-	**-**	**-**	**Allowable concentration (counts/100mL)**	**400**
-	**-**	**-**	**Final % reduction**	**86%**

Table 5.7c. Calculation of Fecal Coliform Reductions for the Clam Bayou (East Drainage) (WBID 1716C) TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the station, Column 2 lists the sampling date, Column 3 lists the fecal coliform concentration (counts/100mL), Column 4 lists the concentration ranking, and Column 5 lists the percentile concentration distribution.

Note: Boldface type and yellow highlighting indicate the concentration used in percent reduction calculations.
- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLTPA 27444078240537	3/16/2010	40	1	3%
21FLTPA 27444078241071	3/16/2010	68	2	9%
21FLTPA 27444078240537	11/17/2004	72	3	15%
21FLTPA 27444078241071	11/17/2004	165	4	21%
21FLTPA 27444078240537	11/1/2010	210	5	26%
21FLTPA 27444078241071	11/1/2010	290	6	32%
21FLTPA 27444078240537	8/2/2010	320	7	38%
21FLTPA 27444078241071	8/2/2010	340	8	44%
21FLTPA 27444078240537	5/24/2010	350	9	50%
21FLTPA 27444078240537	5/3/2010	490	10	56%
21FLTPA 27444078241071	5/3/2010	500	11	62%
21FLTPA 27444078241071	5/24/2010	580	12	68%
21FLTPA 27444078240537	8/30/2010	640	13	74%
21FLTPA 27444078241071	10/4/2010	820	14	79%
21FLTPA 27444078241071	**8/30/2010**	**2,400**	**15**	**85%**
21FLTPA 27444078241071	**7/19/2010**	**10,000**	**16**	**91%**
21FLTPA 27444078240537	7/19/2010	13,000	17	97%
-	-	-	**Existing condition concentration– 90th percentile (counts/100mL)**	**8,733**
-	-	-	**Allowable concentration (counts/100mL)**	**400**
-	-	-	**Final % reduction**	**95%**

Table 5.7d. Calculation of Fecal Coliform Reductions for the Clam Bayou Drain (Tidal) (WBID 1716D) TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the station, Column 2 lists the sampling date, Column 3 lists the fecal coliform concentration (counts/100mL), Column 4 lists the concentration ranking, and Column 5 lists the percentile concentration distribution.

Note: Boldface type and yellow highlighting indicate the concentration used in percent reduction calculations.
- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLTPA 274414908241375	5/3/2010	2	1	2%
21FLTPA 274414908241375	4/5/2010	4	2	7%
21FLTPA 274425108241352	5/3/2010	7	3	12%
21FLTPA 274425108241352	2/1/2010	10	4	17%
21FLTPA 274414908241375	10/4/2010	11	5	21%
21FLTPA 274425108241352	11/1/2010	15	6	26%
21FLTPA 27443468241194	2/1/2010	30	7	31%
21FLTPA 274425108241352	4/5/2010	30	8	36%
21FLTPA 274414908241375	2/1/2010	43	9	40%
21FLTPA 27443468241194	11/17/2004	54	10	45%
21FLTPA 274425108241352	8/2/2010	62	11	50%
21FLTPA 27443468241194	11/1/2010	64	12	55%
21FLTPA 27443468241194	4/5/2010	100	13	60%
21FLTPA 27443468241194	5/3/2010	100	14	64%
21FLTPA 274425108241352	10/4/2010	100	15	69%
21FLTPA 274414908241375	8/2/2010	130	16	74%
21FLTPA 27443468241194	10/4/2010	980	17	79%
21FLTPA 274425108241352	7/19/2010	1,900	18	83%
21FLTPA 274414908241375	**7/19/2010**	**3,200**	**19**	**88%**
21FLTPA 27443468241194	**8/2/2010**	**5,500**	**20**	**93%**
21FLTPA 27443468241194	7/19/2010	14,000	21	98%
-	-	-	**Existing condition concentration– 90th percentile (counts/100mL)**	**4,120**
-	-	-	**Allowable concentration (counts/100mL)**	**400**
-	-	-	**Final % reduction**	**90%**

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:

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) 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 (2) 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 TMDLs for the 34th Street Basin, Clam Bayou Drain, Clam Bayou (East Drainage), and Clam Bayou Drain (Tidal) are expressed as a percent reduction, and represent the maximum daily fecal coliform load these waterbodies can assimilate without exceeding the fecal coliform criterion (**Table 6.1**).

6.2 Load Allocation

Table 6.1 presents the LA for percent reduction in fecal coliform from nonpoint sources for each WBID, based on a percent reduction approach. 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**).

Table 6.1. TMDL Components for Fecal Coliform in WBIDs 1716A, 1716B, 1716C and 1716D

This is an eight-column table. Column 1 lists the WBID, Column 2 lists the waterbody name, Column 3 lists the parameter, Column 4 lists the TMDL (counts/100mL), Column 5 lists the WLA for wastewater (counts/100mL), Column 6 lists the WLA for NPDES stormwater (percent reduction), Column 7 lists the LA (percent reduction), and Column 8 lists the MOS.

[1] N/A = Not applicable

WBID	Waterbody Name	Parameter	TMDL (counts/100mL)	WLA for Wastewater (counts/100mL)	WLA for NPDES Stormwater (% reduction)	LA (% reduction)	MOS
1716A	34th Street Basin	Fecal coliform	400	N/A[1]	98%	98%	Implicit
1716B	Clam Bayou Drain	Fecal coliform	400	N/A[1]	86%	86%	Implicit
1716C	Clam Bayou (East Drainage)	Fecal coliform	400	N/A[1]	95%	95%	Implicit
1716D	Clam Bayou Drain (Tidal)	Fecal coliform	400	N/A[1]	90%	90%	Implicit

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

Wastewater Point Sources

Florida Rock Industries Inc. – St Petersburg Plant (Permit FLG110174), located in WBID 1716A, is the only NPDES-permitted wastewater facility situated within the WBIDs addressed in this report. The facility is a concrete batch plant and is therefore not considered a source that is likely to contribute to the levels of fecal coliform bacteria.

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 future point sources that may discharge in the WBID in the future will also be required to meet end-of-pipe standards for coliform bacteria.

6.3.2 NPDES Stormwater Discharges

Table 6.1 presents the WLA for stormwater discharges with an MS4 permit percent reduction in current fecal coliform loading for each WBID.

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

Chapter 7: TMDL IMPLEMENTATION

7.1 Basin Management Action Plan

Following the adoption of these TMDLs by rule, the Department will determine the best course of action regarding their implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of each waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbodies. 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 these TMDLs, a BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, is 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*:* J.J. McDonnell *et al.* (eds.), *Proceedings of a symposium on New York City water supply studies* (Herndon, VA: American Water Resources Association, TPS-96-2).

Causseaux, K.W. 1985. *The surficial aquifer in Pinellas County, Florida.* U.S. Geological Survey Water-Resources Investigations Report 84-4289. Tallahassee, FL.

Cherry, R.N, J.W. Stewart, and J.A. Mann. 1970. *General hydrology of the middle Gulf area, Florida.* Report of Investigation No. 56. Tallahassee, FL. Prepared by the U.S. Geological Survey in cooperation with the Florida Department of Natural Resources and the Southwest Florida Water Management District. Available: http://ufdc.ufl.edu/WL00004709/00001.

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.

Desmarais, T.R., H.M. Solo-Gabriele, and C.J. Palmer. 2002. Influence of soil on fecal indicator organisms in a tidally influenced subtropical environment. *Applied and Environmental Microbiology* 68: 1165–1172.

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 Health website. 2011. *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.*

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.

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, J.A. 1990. *Ground water atlas of the United States: Alabama, Florida, Georgia, and South Carolina. Floridan aquifer system.* 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.

Pinellas County Planning Department. 2008. *Surface water management element of the Pinellas County Comprehensive Plan.* Available: http://www.pinellascounty.org/Plan/comp_plan/11surface/1-intro.pdf.

Southwest Florida Water Management District. 2002. *Tampa Bay/Anclote River Comprehensive Watershed Management Plan.* Available: http://www.swfwmd.state.fl.us/documents/plans/cwm/cwm-tampabayanclote.pdf.

———. Revised February 2006. *Aquifer characteristics within the Southwest Florida Water Management District.* Fourth Edition. Report 99-1. Technical Services Department Resource Regulation. Available: http://www.swfwmd.state.fl.us/permits/wellconstruction/aquifer_characteristics.pdf.

———. 2011. *Water Management Information System Data Warehouse.* Available: http://www18.swfwmd.state.fl.us/ResData/Search/ExtDefault.aspx.

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

Trommer, J.T. 1987. *Potential for pollution of the upper Floridan aquifer from five sinkholes and an internally drained basin in west-central Florida.* U.S. Geological Survey Water-Resources Investigations Report 87-4013. Tallahassee, FL. Prepared in cooperation with the Southwest Florida Water Management District. Available: http://pubs.usgs.gov/wri/1987/4013/report.pdf.

U.S. Census Bureau. 2010. Available: http://www.census.gov/.

U.S. Department of Agriculture. September 2006. *Soil Conservation Service soil survey of Pinellas County, Florida*. Available: http://soildatamart.nrcs.usda.gov/manuscripts/fl103/0/pinellas.pdf.

U.S. Environmental Protection Agency. 1993. *Guidance specifying management measures for sources of nonpoint pollution in coastal water: Management measures for marinas and recreational boating.* Available: http://www.epa.gov/owow/NPS/MMGI/Chapter5/ch5-1.html#Pathogen.

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

U.S. 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.

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

Appendix B: Estimates of Fecal Coliform Loadings from Potential Sources

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

Pets

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

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

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

Using information from the Florida Department of Revenue's (DOR) 2010 Cadastral tax parcel and ownership coverage contained in the Department's GIS library, residential parcels were identified using DOR's land use codes. The final number of households within each WBID boundary was calculated by adding the number of residential units on the parcels for all improved residential land use codes. **Table B.1** shows the estimated number of households within each of the WBID boundaries.

Table B.1 also shows the estimated number of dogs within each WBID boundary, assuming that 40% of the households in these areas have 1 dog; the total waste produced (grams/day) by dogs and left on the land surface in residential areas in the WBIDs, assuming that 40 % of dog owners do not pick up their dogs' feces; and the total load of fecal coliform produced by dogs (counts/day) within each WBID boundary.

It should be noted that this load only represents the fecal coliform load created in the WBIDs and is not intended to be used to represent a part of the existing load that reaches the receiving waterbodies. The fecal coliform load that eventually reaches the receiving waterbodies could be significantly less than this value due to attenuation in overland transport.

Table B.2 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).

Table B.1. Estimated Number of Households and Dogs, Waste Produced (grams/day) by Dogs Left on the Land Surface, and Total Load of Fecal Coliform (counts/day) Produced by Dogs within each WBID Boundary

This is a five-column table. Column 1 lists the WBID number, Column 2 lists the number of households, Column 3 lists the number of dogs, Column 4 lists the waste produced left on land, and Column 5 lists the fecal coliform loading.

WBID	Number of Households	Number of Dogs	Waste Not Picked Up (grams/day)	Loading (counts/day)
1716A	3,659	1,464	263,448	5.80E+11
1716B	2,182	873	157,104	3.46E+11
1716C	3,420	1,368	246,240	5.42E+11
1716D	452	181	32,544	7.16E+10

Table B.2. Dog Population Density, Wasteload, and Fecal Coliform Density Based on the Literature (Weiskel *et al*. 1996)

This is a four-column table. Column 1 lists the animal type (dog), Column 2 lists the population density, Column 3 lists the wasteload per dog, and Column 4 lists the fecal coliform density.

* Number from APPMA

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

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% of the total raw sewage (Culver *et al.* 2002) created within the WBIDs by the households connected to the sewer system.

The estimated number of properties connected to the sewer system was based on data obtained from FDOH's ongoing inventory of wastewater treatment and disposal methods for developed properties. Using information from DOR's 2010 Cadastral tax parcel and ownership coverage, residential parcels were identified using DOR's land use codes. The final number of households within each WBID boundary was calculated by adding the number of residential units on the parcels for all improved residential land use codes (see **Table B.1**). **Table B.3** shows the estimated number of households *(N)* within the WBID boundaries served by sewer systems (**Figure B.1**).

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

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

Where:

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

The discharge rate through sewers from each household (*Q*) was calculated by multiplying the average household size for Pinellas County (2.21) (U.S. Census Bureau 2010) 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/100mL for fecal coliform (EPA 2001). The contribution of fecal coliform through sewer line leakage was assumed to be 0.5% of the total sewage loading created from the population not on septic tanks (Culver *et al.* 2002). Based on **Equation B.1**, the approximate fecal coliform loading from sewer line leakage in each WBID is summarized in **Table B.3.**

Table B.3. Estimated Number of Households Served by Sanitary Sewers and Estimated Fecal Coliform Loading from Sewer Line Leakage within each WBID Boundary

This is a three-column table. Column 1 lists the WBID number, Column 2 lists the number of households served by sanitary sewers, and Column 3 lists the sanitary sewer loading

WBID	Number of Households Served by Sanitary Sewers	Sanitary Sewer (counts/day)
1716A	3,659	1.1E+11
1716B	2,182	6.4E+10
1716C	3,420	1.0E+11
1716D	452	1.3E+10

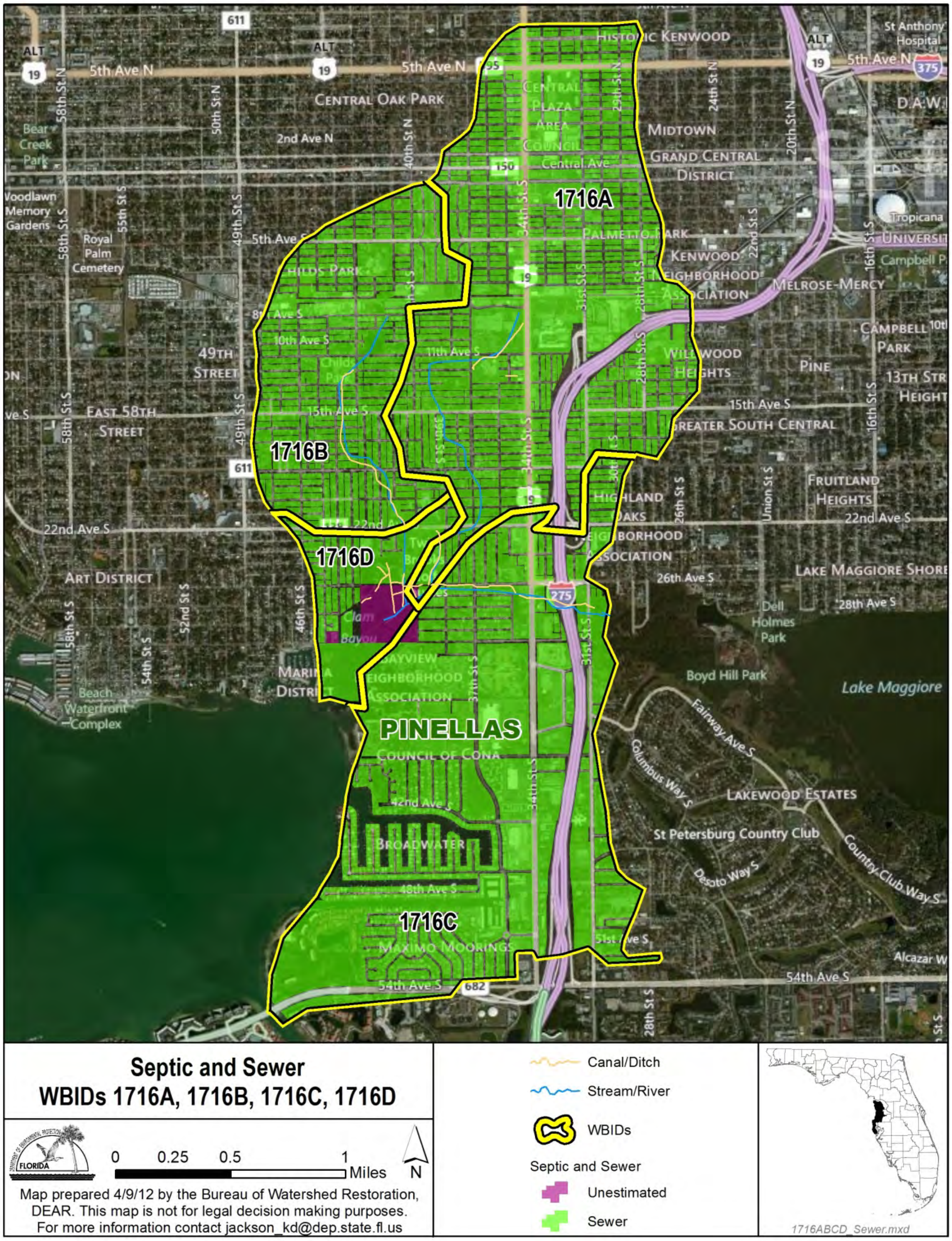

Figure B.1. Distribution of Sanitary Sewers in the Residential Land Use Areas within the WBID Boundaries

Septic Tanks

Based on information obtained from FDOH's onsite sewage data, all housing units within the WBID boundaries are served by sewer systems.

Wildlife

Wildlife (birds, raccoons, etc.) are another possible source of fecal coliform bacteria within the WBID boundaries. However, as these represent natural inputs, no reductions are assigned to these sources by these TMDLs.

Appendix C: TMDL Public Comments for Fecal Coliform TMDLs

September 24, 2012

Thomas B. Gibson, P.E. Director
Engineering and Capital Improvements
City of St. Petersburg
Post Office Box 2842
St. Petersburg, Florida 32731-2842

Re: Draft TMDL Report – Fecal Coliform TMDLs for the 34th Street Basin (WBID 1716A), Clam Bayou Drain (WBID 1716B), Clam Bayou (East Drainage) (WBID 1716C) and Clam Bayou Drain (Tidal) (WBID 1716D)

Dear Mr. Gibson:

Thank you for your comments regarding our recently proposed Total Maximum Daily Load (TMDL) reports for fecal coliform in the Springs Coast basin. The Department appreciates the time and effort you put into reviewing these draft TMDLs. This letter is in response to your comment letter dated July 23, 2012. Below are the comments from the City of St. Petersburg and our responses to these comments:

<u>City of St. Petersburg comment:</u>

Regarding WBID 1716, on page 32 of the proposed TMDL document, the Department does acknowledge the efforts in developing and constructing the extensive stormwater treatment system and for the restoration of Clam Bayou channel.

However, it is not apparent in the proposed TMDL the extent of the restoration activities. In Fact, between 2006 and 2012, the City of St. Petersburg and SWFWMD invested over $10 million for such restoration. Construction began in April 2010, and the project isonly recently near completion. SWFWMD has advised that they are now preparing to begin the post construction sampling program. The restoration has not yet been provided enough time to evaluate the positive effect it should have on the entire WBID. Attacched as Exhibit “A: is a FDEP document that details the Clam Bayou stormwater program designed for each upstream WBID.

Further, between 1997 and 2008, the City invested over $96,000,000 in corrective actions to reduce or eliminate sanitary sewer overflows citywide pursuant to a Consent Order (OGC file no. 97-0134) with the Department. (The Department incorrectly stated on page 32 of the draft TMDL report that the amount invested was $10 million rather than $96 million.) Significant, major maintenance projects and capital improvement projects were implemented within WBID 1716 since the area was identified a problematic area in the City’s Sewer System Evaluation and Management Report dated March 1998.

Thomas B. Gibson, P.E. Director
Engineering and Capital Improvements
City of St. Petersburg
September 24, 2012
Page Two

FDEP Response:

Additional language has been added to the report regarding restoration activities and corrections have been made to incorrect amounts cited in the report.

With the adoption of TMDLs for these WBIDs, local stakeholders will need to take actions to put together a restoration plan that would take into consideration all the completed or ongoing restoration activities that are related to the fecal impairment. If local stakeholders find that the completed or ongoing projects are sufficient to address the fecal issue, a decision can be made that no further actions are needed. This decision would need to be followed by additional water quality monitoring, which in the next listing cycle could show that the impaired segment is no longer exceeding the state water quality criteria for fecal coliform bacteria. In addition, the Department suggests that if possible, the City of St. Petersburg conduct source tracking investigations. This would allow the City to demonstrate that any exceedances observed in the WBIDs after all potential sources in the area have been addressed with restoration activities are not due to anthropogenic sources in the basin.

Given that the sampling stations in WBIDs 1716A and 1716C are upstream of the location of the restoration activities, future sample results in WBIDs 1716A and 1716C may not be influenced by the Clam Bayou Habitat Restoration and Stormwater Treatment project. Therefore, additional restoration activities might be necessary for areas covered by these two WBIDs.

FDEP recognizes the huge expenditure of funds for restoration activities in Clam Bayou and for major maintenance and capital improvement projects within WBID 1716. However, FDEP reviewed the fecal coliform data for WBIDs 1716A-D, and there were no indications that the data were inappropriate for use in TMDL development.

Due to the fact that the TMDLs are based primarily on data collected between 2008 and 2011, the exceedances reflect the conditions of these WBIDs after the rehabilitation and restoration projects were implemented. The fecal coliform sampling results in these WBIDs show exceedances in fecal coliform concentrations after April 2008 (see Figure 1.); indicating additional load reductions may be necessary. For example, in WBID 1716A seventeen of the eighteen samples collected after April 2008 exceed the state criterion of 400 counts/100mL (see Figure 2).

Thomas B. Gibson, P.E. Director
Engineering and Capital Improvements
City of St. Petersburg
September 24, 2012
Page Three

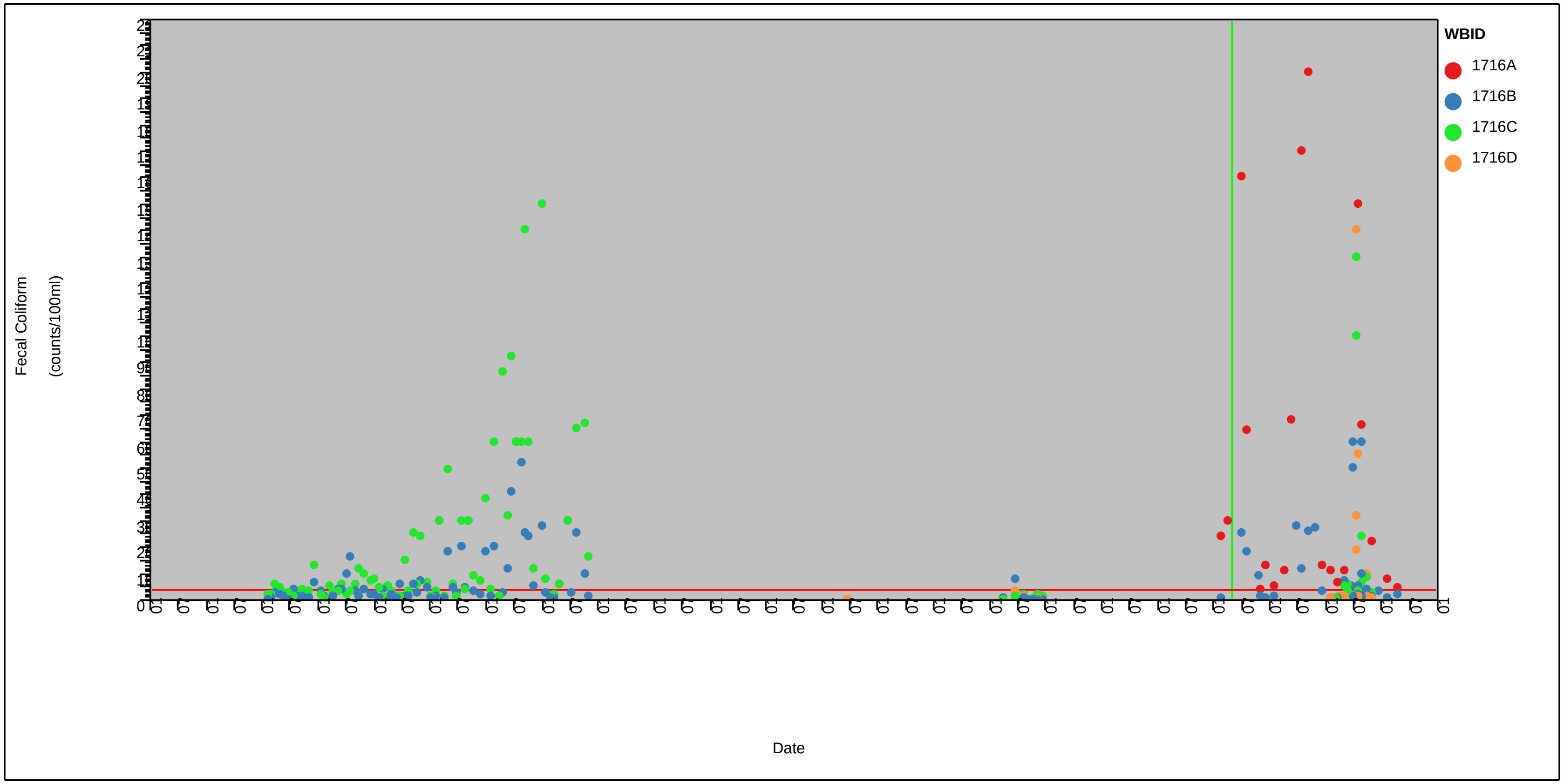

Figure 1. Period of record data (1991-2011) for WBIDs 1716A, 1716B, 1716C and 1716D, combined. The red horizontal line indicates the target concentration (400 counts/100mL). The green vertical line indicates the time of completion of the City of St. Petersburg's Sanitary Sewer Project (April 2008) based on Exhibit E provided by the City.

Thomas B. Gibson, P.E. Director
Engineering and Capital Improvements
City of St. Petersburg
September 24, 2012
Page Four

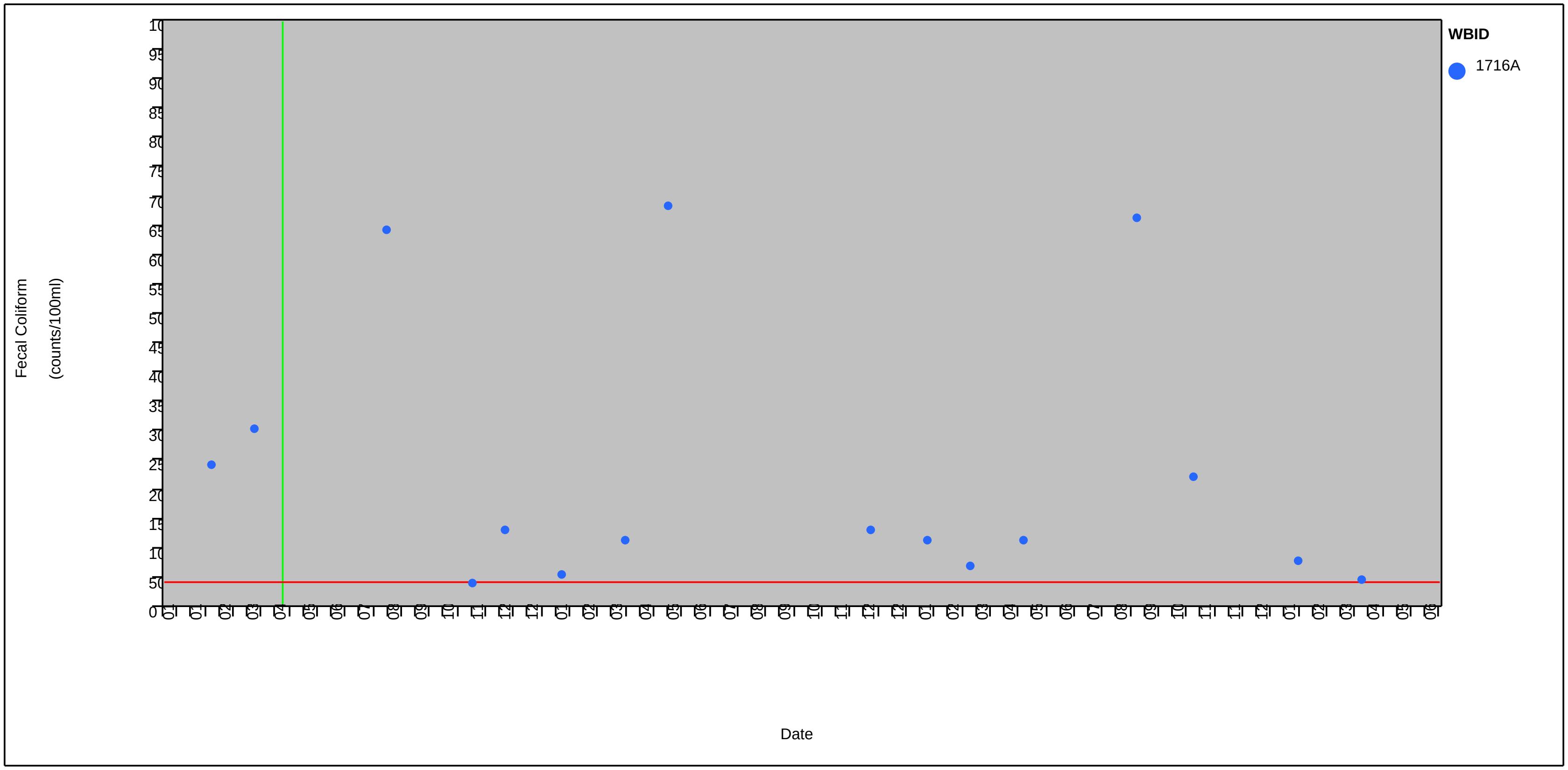

Figure 2. Cycle 2 Verified Period (January 1, 2004 through June 30, 2011) for WBID 1716A. The red horizontal line indicates the target concentration (400 counts/100mL). The green vertical line indicates the time of completion of the City of St. Petersburg's Sanitary Sewer Project (April 2008) based on Exhibit E provided by the City

Thomas B. Gibson, P.E. Director
Engineering and Capital Improvements
City of St. Petersburg
September 24, 2012
Page Five

City of St. Petersburg comment:

Specifically as to WBID 1716D, further analyses of the fecal coliform data collected for the basin show that the deciding basis for establishing the TMDL was heavily weighted on a one day occurrence where three samples collected concurrently on July 19, 2010 had elevated results. The remaining data, including the planning data dating back to 2001, had only two other elevated reults. This one day event occurred during the construction phase and prior to the operational phase of the treament system that is in place.

In additin, the data was likely influenced by the active construction within the WBID 1716D that had been ongoing upstream of and adjacent to the locatins of the samples producing results that are not indicative of the waterbody. Included as Exhibit "B" are photographs taken from SWFWMD's website (http://www.swfwmd.state.fl.us/projects/clambayou/aerials.php) that document construction progression for the months of May, 2010, June, 2010 and July, 2010. The approximate location of the ongoing construction is shown on the sample location map from the proposed TMDL document. SWFWMD has advised that they are preparing to begin the sampling program now that construction is complete.

FDEP Response:

The Department realizes that WBID 1716D was verified with 21 samples and five exceedances. While three of the exceeding samples were collected on the same day, they were collected from different sites, and they were not collected under the 25-year 24-hour rainfall condition, which would allow for the exclusion of these data. Although there were construction activities upstream of these sampling sites when exceedances were observed, we do not have sufficient data and evidence to link the construction to these observed exceedances. Therefore, the Department does not have a sufficiently strong justification to exclude these data points from the TMDL analyses. As was mentioned in a previous response, if the City decided that these exceedances were indeed caused by the short-term effect of the construction project, a decision could be made that no restoration activities will be needed. However, this decision would need to be supported by additional monitoring to determine the exceedances of the fecal coliform citeria in 1716D are not a chronic problem.

City of St. Petersburg comment:

The City respectfully requests that the Department conclude that no TMDL is needed, or that the Department determine that a Category 4e is more appropriate for the WBID so that development of a TMDL, if necessary, is postponed until data collection has been completed to analyze the positive results from the storm system and sanitary sewer system improvements.

Thomas B. Gibson, P.E. Director
Engineering and Capital Improvements
City of St. Petersburg
September 24, 2012
Page Six

FDEP Response:

As explained in a previous response, some WBIDs (e.g. WBIDs 1716A and 1716C) are upstream of the restoration activities; the Department does not have enough evidence to show that TMDLs are not needed for these WBIDs. For the WBIDs covered by the restoration activities, even with the proposed TMDLs, the City can still make a decision that no further restoration actions will be needed beyond those already completed, and support the decision using monitoring data collected later on. If that is the case, a TMDL with a decision document showing that the fecal impairment covered by the TMDL will be addressed by the existing restoration activities will have the same result as putting these WBIDs into the 4e category.

Again, thank you very much for your time and effort in reviewing our TMDLs. We hope to continuously working with you to improve the quality of our TMDLs and restore Florida waters. Please contact me at Jan.Mandrup-Poulsen@dep.state.fl.us if you have any further comments.

Sincerely,

Jan Mandrup-Poulsen, Environmental Administrator
Watershed Evaluation and TMDL Section
Florida Department of Environmental Protection

Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
2600 Blair Stone Road
Tallahassee, FL 32399-2400